PN-ABC-152

Small Ruminant

Collaborative Research Support Program

Annual Report for

Kenya

Program Year Seven

1985-1986

Small Ruminant CRSP
University of California
Davis, CA 95688

THE SMALL RUMINANT

COLLABORATIVE RESEARCH SUPPORT PROGRAM

(SR-CRSP)

ANNUAL REPORT FOR KENYA

PROGRAM YEAR SEVEN

1985-1986

Edited and Compiled by the Management Entity

SMALL RUMINANT

COLLABORATIVE RESEARCH SUPPORT PROGRAM

ANNUAL REPORT

KENYA 1985-1986*

TABLE OF CONTENTS

*Similar reports for Brazil, Indonesia, Morocco and Peru as well as a summary report of the full program are available from the Small Ruminant CRSP Management Entity, University of California, Davis, CA 95616.

SMALL RUMINANT CRSP

IN KENYA 1985/86

ANNUAL REPORT

INTRODUCTION

Much of Western Kenya is blessed with fertile soils and a bimodal rainfall pattern allowing two cropping seasons per year. This area largely escaped the drought which recently brought hunger to many parts of sub-Saharan Africa. However, this good fortune has had unfortunate consequences. Human population numbers have grown rapidly, severely taxing the food and income generating capacity of the land. As family sizes have increased, average farm sizes have declined to less than one ha in many districts. These small farms often provide neither adequate nutrition or income to meet family needs.

The situation in Western Kenya is all too typical of problems elsewhere in tropical Africa. Wherever agricultural potential is high, numbers of people are likely to be increasing rapidly. Traditional agricultural systems become inappropriate -- producing less food than is needed even for subsistence while often severely eroding the natural resource base. Changes in traditional systems are needed, if they are to yield the necessary balance of protein and energy food and generate additional income to improve the family living standard.

The Small Ruminant CRSP is addressing this problem in Kenya. The goal of the SR-CRSP is to develop dual-purpose goat (DPG) productions systems suited to the needs and resources of smallholders. Goats have many potential advantages in such systems. Their diet can consist of feeds which are by-products of food crops and browse from marginal lands. Keeping 3 to 5 does instead of a cow adds a small, but consistent, milk protein supplement to family diet year-round. Litters of two or three kids at 7 to 8 month intervals can also substantially increase offtake of slaughter stock for family consumption or marketing. Because goat meat is a highly desired product, goats are potentially a significant new "cash crop."

To meet the needs of smallholders, DPG production systems must be based on low-cost, low-risk technology and be minimally competitive -- preferably complementary -- with cropping activities. Research to develop appropriate DPG production systems involves the close collaboration among a multidisciplinary team of Kenyan and expatriate scientists. The Ministry of Agriculture and Livestock Development is the principal host country institution. In addition, the SR-CRSP collaborates with scientists from the University of Nairobi, Egerton College, and other Kenyan institutions.

U.S. institutions participating in the SR-CRSP/Kenya include:

Texas A&M University -- breeding, systems analysis
Washington State University -- health
University of Missouri -- sociology
Winrock International -- economics, production systems (goat nutrition-management, feed resources)

Each of the six senior resident scientists employed by U.S. institutions works with a least two MALD scientists, most of whom have completed graduate level training under SR-CRSP sponsorship.

The implementation strategy followed by the SR-CRSP in Kenya is diagrammed in figure 1. This strategy has involved a three-stage process:

Stage 1 (1980-82). Characterization of social-economic-biological activities of traditional farming systems; on-station component research in breeding, health, goat nutrition, and agronomy.

Stage 2 (1983-85). Monitoring limited numbers of DPG on farms; scientist-managed, on-farm component research (agronomy, goat nutrition, health management); on-station component research in breeding, health, nutrition, and agronomy; preliminary cost/benefit and social feasibility analyses.

Stage 3 (1986-1990). Large scale technical, economic, and social evaluation of DPG production systems under farmer management; component research -- both on station and farm -- will continue.

Emphasis has been placed on a farming systems approach to ensure that research will be relevant to needs and resources of farmers in Western Kenya. In addition, the general principles and many of the specific technologies developed by SR-CRSP should prove adaptable to farming systems in other parts of the tropics.

Even as comprehensive evaluation of DPG production systems continues, SR-CRSP research in Kenya has already yielded significant results. Examples include:

Development of an effective vaccine for contagious, caprine pleuropneumonia (CCP).

Identification of an indigenous tree legume (Sesbania sesban) which provides a protein supplement for livestock, improves soil fertility, serves as both a living fence and a source of firewood.

Development of computer models of goat production systems to support *ex ante* analysis of DPG systems in Kenya and elsewhere.

Importation of superior dairy bucks to provide the foundation for developing a new breed "synthetic" as well as up-grade the dairy merit of Kenya goats.

Establishment of the technical feasibility of DPG production on small farms in Western Kenya, leading to a substantial demand for DPG from farmers.

Training of 16 Kenyans to M.Sc. level and 4 Kenyans to Ph.D. level under SR-CRSP sponsorships.

The success of the SR-CRSP in Kenya demonstrates the advantages of a multidisciplinary farming systems approach. Significant benefits can be expected from the milk and meat produced by dual-purpose goats. However, perhaps even greater benefits will be realized from the SR-CRSP demonstration of effective collaboration between U.S. and Kenyan institutions successfully working together to the benefit of smallholder agriculturists.

TRAINING-SR-CRSP SPONSORED STUDENTS IN DEGREE PROGRAMS IN US.

NAME	DEGREE	PROGRAM	TRAINING DATES	NATIVE COUNTRY
CAL POLY				
Kimotho, Judith W.[8]	MS Animal Science	Cal Poly	8/81 - 6/84	Kenya
Muhuyi, William[8]	MS Animal Science	Cal Poly	6/80 - 6/82	Kenya
Rotich, Daniel[2]	MS Animal Science	Cal Poly	6/82 - 6/85	Kenya
COLORADO STATE UNIVERSITY				
Ali Musa, Osheik[2]	PhD Pathology	Colorado	9/83 - 12/84	Sudan
UNIVERSITY OF MISSOURI				
Aboud, Abdillahi[3]	MS Rural Sociology	Missouri	9/79 - 3/82	Kenya
Mbabu, Adiel Nkonge	PhD Rural Sociology	Missouri	8/84 - 12/87	Kenya
Noble, Amanda[15]	MS Rural Sociology	Missouri	9/79 - 8/82	US
Suda, Collette[2]	PhD Rural Sociology	Missouri	6/82 - 5/86	Kenya
TEXAS A&M UNIVERSITY/BREEDING				
Ahuya, C.O.	BS Animal Science	Texas A&M/Breeding	1/84 - 5/85	Kenya
Ahuya, C.O.	MS Animal Science	Texas A&M/Breeding	6/85 - 6/87	Kenya
Bougi, Natalie[2]	MS Animal Breeding	Texas A&M/Breeding	1/84 - 5/86	Ivory Coast
Gathuka, Zachariah[4]	MS Animal Breeding	Texas A&M/Breeding	9/80 - 5/82	Kenya
Kiriro, Philip	BS Animal Breeding	Texas A&M/Breeding	1/81 - 6/83	Kenya
Mathenge, James	MS Animal Breeding	Texas A&M/Breeding	6/80 - 12/81	Kenya
Okeyo-Mwai, Alfeyo[14]	MS Animal Science	Texas A&M/Breeding	9/81 - 6/84	Kenya
TEXAS A&M UNIVERSITY/MANAGEMENT				
Norris, Therese[2]	MS Physiology/Reproduction	Texas A&M/Manage.	9/84 - 9/86	US
TEXAS A&M UNIVERSITY/SYSTEMS				
Baker, Jerry[2]	PhD Animal Breeding	Texas A&M/Systems	9/79 - 12/81	US
Blackburn, Harvey[15]	PhD Animal Breeding	Texas A&M/Systems	10/79 - 12/84	US
Brenni, Geanlucca[2]	PhD Animal Breeding	Texas A&M/Systems	1/79 - 6/83	Switzerland
Hawariatt, Girma[2]	PhD Animal Breeding	Texas A&M/Systems	9/78 - 12/82	Ethiopia
Howard, Pamela Jo	PhD Animal Breeding	Texas A&M/Systems	9/82 - 9/85	US
Mwandotto, Bonfance[2]	PhD Animal Breeding	Texas A&M/Systems	9/81 - 6/84	Kenya

NAME	DEGREE	PROGRAM	TRAINING DATES	NATIVE COUNTRY
TEXAS A&M UNIVERSITY/SYSTEMS (CONT.)				
Nelson, T.C.	PhD Animal Breeding	Texas A&M/Systems	8/79 - 7/80	US
Tallum, Steven	MS Animal Science	Texas A&M/Systems	1/83 - 12/85	Kenya
Woldehawariat, G.	PhD Animal Breeding	Texas A&M/Systems	9/79 - 9/81	Ethiopia
TEXAS TECH UNIVERSITY				
Khainga, Mohammed Salim[12]	MS Range Science	Texas Tech	8/84 - 9/85	Kenya
UNIVERSITY OF CALIFORNIA/BREEDING				
Odenya, William[4]	MS Animal Science	UCD Breeding	9/80 - 9/82	Kenya
Rege, Edward[16]	PhD Genetics	UCD Breeding	9/80 - 12/84	Kenya
WASHINGTON STATE UNIVERSTIY				
Bari, Johnson	MS Veterinary Microbiology	Washington	9/80 - 6/84	Kenya
Mbwiria, Stanley	MS Veterinary Physiology	Washington	4/81 - 4/84	Kenya
Mwamachi, Derrick	MS Veterinary Immunology	Washington	1/83 - 4/86	Kenya
Njanja, J.	MS Veterinary Parasitology	Washington	4/82 - 4/85	Kenya
Oluoch, Elizabeth[2]	MS Veterinary Immunology	Washington	9/84 - 9/85	Kenya
Shavulimo, R.[13]	MS Parasitology	Washington	10/83 - 10/85	Kenya
Shompole, Patrick	MS Veterinary Microbiology	Washington	3/85 - 3/88	Kenya
Waghela, Suryakant	PhD Veterinary Immunology	Washington	9/84 - 3/88	Kenya
WINROCK INTERNATIONAL/MANAGEMENT				
Boor, Kathryn[2,53]	MS Food Science	Winrock/Systems	9/81 - 9/83	US
Kibuchi, James N.[7]	MS Animal Management	Winrock/Management	9/80 - 7/82	Kenya
Mathuva, Moses[13]	MS Animal Production	Winrock/Management	9/82 - 12/83	Kenya
Mukisira, Ephraim[10]	MS Ruminant Nutrition	Winrock/Management	8/82 - 8/84	Kenya
Otieno, Kenneth[13]	MS Science & Plant Ag	Winrock/Systems	9/84 - 10/85	Kenya
Sands, Michael[11,15]	PhD Animal Science	Winrock/Management	1/80 - 8/82	US
WINROCK INTERNATIONAL/ECONOMICS				
Howard, Pamela Jo[5]	MS Marketing	Winrock/Economics	1/81 - 12/81	US
Job, Morgan[6,15]	PhD Agricultural Economics	Winrock/Economics	6/80 - 12/82	Trinidad/Tobago
Mortimer, Dana Lee[9,15]	MS Animal Health	Winrock/Economics Washington	6/79 - 5/82	US
Nyaribo, Fanny9	PhD Agricultural Econ.	Winrock/Economics	8/84 - 8/87	Kenya

TRAINING OF OVERSEAS DEGREE CANDIDATES OVERSEAS WITH CRSP SUPPORT

STUDENT	PROGRAM/INSTITUTION	SUPPORT	DATES	NATIVE COUNTRY
CRSP EXCHANGE FUNDS				
Kitivo, Daniel	MS Grassland Science Reading University	CRSP Exchange Funds	8/82 - 12/83	Kenya
UNIVERSITY OF MISSOURI				
Amuhinda, P.[2]	Diploma Course, Social Dev. Kenya Institute of Admin.	Missouri	2/86 - 9/86	Kenya
Kiguhi, H.[2]	Certificate Course -Social Dev. Maseno Gov. Training Institute	Missouri	2/86 - 9/86	Kenya
Ochieng, E.[2]	Certificate Course Social Dev. Maseno Gov. Training Institute	Missouri	2/86/ 9/86	Kenya
Otieno, E[2]	Certificate Course Social Dev. Maseno Gov.Training Institute	Missouri	2/ 86 - 9/86	Kenya
WINROCK INTERNATIONAL/ECONOMICS				
Ogada, Henry[1]	MS Agricultural Economics Nairobi University	Winrock/Economics	11/84 - 9/85	Kenya
WINROCK INTERNATIONAL/MANAGEMENT				
Mathuva, Moses	MS Grassland Science Reading University	Winrock/Management	8/82 - 12/83	Kenya

------

1 Support for thesis research only
2 Partial support
3 Attending Ohio State University; thesis research supported by Missouri
4 Partially supported by FAO
5 Attended University of Florida
6 Attended Purdue University
7 Attended Tuskegee Institute
8 Partially supported by USDA
9 Attending Washington State University
10 Attended Louisiana State University
11 Attended Cornell University
12 Studies discontinued student will not complete the program.
13 Attending University of Reading, UK
14 Attended University of California
15 Research conducted in Kenya
16 Partially supported by World Bank Fellowship

SR-CRSP SPONSORED SHORTCOURSES

COURSE	NUMBER OF PARTICIPANTS	SPONSORED BY	WHERE HELD	DATES
Veterinary Lab Techniques		Washington	Kabete, Kenya (6 weeks)	6-7/81
Fourth Annual Kenya Workshop	60	Kenya Site	Kenya	March 85
Fifth Annual Kenya Workshop	60	Kenya Site	Kenya	Oct. 86
Systems Analysis for Small Ruminants	6	TAMU Systems	TAMU	7/85-8/85
Systems Analysis Short Course	4	TAMU Systems	TAMU	July 85 (6 weeks)

SR-CRSP SPONSORED INFORMAL TRAINING

SUBJECT MATTER	NUMBER OF PARTICIPANTS	TRAINER	PROJECT	LOCATION	DATES
Field Survey Techniques for Kenyan Enumerators	4 plus replacements and others	Mike Sands	Kenya Projects	Maseno,	1980- Kenya1985
Goat Milk Processing and Cheesemaking	Peace Corps volunteers & Vet. farm staff	Kathy Boor	Winrock Production Systems	Maseno, Kenya	Oct. 1982
Goat Management and Feed Production	10 farmers - (goat recipients)	Dan Brown & Sandra Russo	Winrock Prod. Systems	Maseno, Kenya	March 1983
Livestock Feed Production and Preservation	Small farmers	Moses Onim & co-workers	Winrock Prod. Systems	Maseno, Kenya	4/85
Semen Processing and Artificial Insemination	Several Kenyans	E.A. Nelson	Cal Poly Repro.	Kabete, Kenya	
Animal Health Lab. Equipping and Teaching Techniques	Kenyan Staff	S. Schmidt & K. Farnsworth	WSU Animal Health	Kabete, Kenya	June-July 81
Use of SR-CRSP Sheep and Goat Models on IBM Personal Computers	3 professionals	H. Blackburn	TAMU-Systems	Kabete, Kenya	Nov. 1985
Hay Making, Feed Production and Foat Nutrition Mangement	District extension officers & staff of Western and Nyanja Provinces	Kenya Project personnel	Winrock Production System	Kenya	
Lecture on Goat Management	Action-AID organizational staff	Kenya Project personnel	Winrock Production Systems	Kenya Farmers Training Center	

INDIVIDUAL TRAINING INCLUDING PARTIAL SUPPORT TO ATTEND PROFESSIONAL MEETINGS *a

NAME	TRAINING	PROJECT	DATES
K. Otieno	Regional Training Workshop in Farming Systems Research CIMMYT, Zimbabwe	Winrock Production Systems	February 1984
M. Mathuva	Forage Analysis and Animal Nutrition, ILCA, Addis Ababa	Winrock Production Systems	3 week short course
Luke Oyugi	Farming Systems Research Workshop, University of Zimbabwe	Winrock Economics	9/1/86 - 9/12/86
Adrian Mukhebi	ILCA Workshop on Liverstock Farming Systems Addis Ababa, Ethiopia	Winrock Economics	6/24/85 - 6/28/85
Adrian Mukhebi	Attend FSSP Worshop	Winrock Economics Attend AHEA Meeting	7/1/85 - 8/2/85

*aSee also publication section for papers presented by SR-CRSP participants at meetings.

SR-CRSP

ANNUAL REPORT

1985-86

I.	**Project Title:**	Genetic Inprovements of Dual-Purpose Goats Under Smallholder Farming Systems
II.	**Host Country:**	Kenya
III.	**Principal Investigator:**	Thomas C. Cartwright
IV.	**Personnel:**	Host Country Co-Workers: M. Okeyo, Research Officer, MALD C. Ahuya, Technical Officer, MALD S. Gichora, Technical Officer, MALD U.S. Co-Workers: R. Ruvuna, Resident Scientist H. Blackburn, Research Scientist J. Sanders, Associate Professor J. Baker, Assistant Professor J. Bassett, Professor

V. Introductory

The broad objective of this breeding project is to develop a synthetic composite breed of dual purpose goat (DPG) for Kenya, especially the western Kenyan smallholder. No breed, indigenous or exotic, approached being suitable for dual purpose production in Kenya so that a new breed or cross was necessary. The approach has been to evaluate the dairy potential within the indigenous breeds and then select strains and individuals from within this indigenous stock. The selected indigenous stock was combined with exotic dairy goat breeds. The F_1 indigenous-exotic has proven well suited and adapted. These F_1's are being used in collaboration with other projects for on farm testing and a basis for the composite synthetic. The new DPG breed was designed by Systems Analysis to retain adaptability, meet production needs, retain maximal heterosis and be manageable in Kenya. In addition to breed development and supplying goats to other projects, a number of experiments have been conducted which were needed to determine suitable health and management practices and evaluate milk, meat and other characters. Information from these experiments is needed for developing total production system DPG packages for smallholders.

VI. Research Accomplishments

The re-development of the base research flock at Ol'Magogo initiated by the current PI has been completed. The original unselected indigenous East African and Galla have been cycled out and replaced as quickly as practicable with strains and individuals within these breeds that were screened for dairy potential and purchased from the native populations. These does have now all gone through quarantine procedures and are in the breeding flock. Research project results have shown that the adaptability of the East African to higher rainfall areas is more critical than originally assumed. Neonatal and preweaning deaths are higher in the Galla and Galla crosses. However, milk yield of the average East African is very low; therefore introduction of a strain of East African which have been developed for milking was especially critical. The exotic breeds used are the Toggenburg and Nubian. Semen of these breeds has been imported into Kenya purchased from the University of California at Davis. Also semen has been collected in Kenya. Forty Toggenburg, Nubian and Alpine bucks were imported from England jointly with the Production Systems project.

The basic breeding plan has been described in earlier reports and is given below. Basically, it was designed to meet optimal phenotypes determined from system analysis studies. It is based on producing indigenous x exotic F_1s, and from these F_1s producing a 4-way cross. This provides an exceptional base for selection and maximal heterosis retention. Since systems analyses studies for the Production Systems project have shown that a higher milk yield is required to meet smallholder milk yield goals within the flock size arbitrarily chosen by Production Systems, the Alpine breed was introduced for testing as an addition to the 4-way synthetic composite. The introduction will in no way delay the breeding program; it is a means of possible future improvement.

The doe flock has been built to over 1000 does. The building and water facilities, housing for personnel and supplementary casual labor force to milk, weigh and otherwise care for the research flock requiring extensive data collection have also been developed in collaboration with MALD. Also, a feed reserve policy is in place. The approximate current inventory of the breeding flock is given below.

Inventory of Goats at Ol'Magogo SR-CRSP Breeding Project[a]

Breed	Female	Males	Total
East African (EA)	282	11	293
Galla (G)	403	10	413
Toggenburg (T)	23	19	42
Nubian (N)	0	34	34
Alpine	0	3	3
EA x G	15	17	32
EA x T	95	29	124
EA x N	41	8	49
G x T	55	39	94
G x N	34	19	53
DPG (4 breed)	14	22	36
Other Crosses[b]	122	68	190
Total	1084	279	1363

[a] includes only postweaning and mature does and bucks.

[b] Unknown sire breed and uncertain dairy-exotic percentage (purchased).

The current seman bank has 1400 straws from imported bucks stored at CAIS, Kabete.

Because of early failure at AI, the present PI has used AI only as necessary. After 1981 AI conception rates have been acceptable. However, it is obvious that AI techniques have not been developed for indigenous goats to the extent as for some other species (our success rates are comparable to AI with Zebu vs AI with dairy cattle breeds). Out of 200 does first inseminated, 42 kidded. Later, out of 180 does, 90 kidded.

Successful development of a DPG for small scale farms in Kenya depends upon the understanding that realized productivity is a consequence of two groups of factors, one related to production potential and the other related to resistance to environmental stresses. Several methods are available to approach this phenomenon. One option is to adopt a system of mating that will rapidly displace indigenous stock with stock originating from imported dairy goat breeds. An alternative is to evaluate and utilize the dairy potential within indigenous breeds. The first method is rapid but the incompatibility of upgraded stock and limited smallholder resources has historically led to poor results. The latter alternative, though considerably slower, offers higher expectations through utilizing the variability of goats indigenous and adapted to the Kenya environment. Variability is important in order that individuals with large potential for milk production along with the ability to survive and grow may be identified. The breeding strategy utilized for the DPG breeding project has combined elements of both approaches to assure improved production potential with a reasonable period of time while incorporating adaptability and creating a genetic pool that offers wide scope of a follow up selection program.

The following genetic strategies were designed:

A. To exploit immediate gains needed in milk potential by importing germ plasm of dairy breeds of the U.S. and Europe. The breeds chosen were Toggenburg, Anglo Nubian and Alpine. The importations were via semen and bucks.

B. To exploit the adaptability of the indigenous East African and Galla breeds while sacrificing as little milk potential as feasible by screening the populations of these breeds in Kenya for high milking strains and further selecting the highest producting individuals available within these strains.

C. To crossbreed the exotic bucks in (A) with the indigenous does and utilize the F_1's and other crosses as the basis for breed development.

D. To evaluate the various crosses developed in (C) for milk production, growth and survivability (adaptability).

E. To develop and refine selection criteria, correction factors and data recording and breeding value evaluation procedures.

F. To develop a synthetic breed based on a composite developed from the F_1 crossbreds.

G. To establish elite flocks of synthetics from (F) and continue selection under practical (prevailing) production conditions. In order to effectively utilize data for continued improvement through selection, a record keeping program, possibly involving selected farmers, will be developed. Artificial insemination and embryo transfer were to be employed as feasible and as needed to test and propagate elite sires and dams.

H. To establish a breeding scheme to distribute selected bucks and does to farmers, assist farmers with record keeping and recover sires identified with proven, outstanding performance. This phase of the program is only at the conceptual level and no definite mechanism or detail have been developed.

Figure 1 shows the breeding program being followed for evolving a Kenya improved dual purpose goat breed. A new synthetic composite breed established from multibreed combinations is indicated as the most logical and practical approach for obtaining a DPG for Kenya. The present research direction is mainly focused on DPG development. The strategies being adopted are based on, first, retaining indigenous breeding for adaptability while, second, increasing milk potential by use of an appropriate mating plan to incorporate exotic dairy stock. Four breeds composed of 2 indigenous breeds, East African and Galla, and 2 imported dairy breeds, Toggenburg and Anglo-Nubian are being intermated to gain advantage of hybrid vigor retention and to combine complementary traits of milk yield breeds and adapted native stock. Such synthetics have proved especially valuable as a means of incorporating improved productivity with fitness (e.g. Dorper sheep).

Crossbreeding the EA and G with Toggenburg (T) and Anglo Nubian (N) was started in 1982. Semen of T and N breeds was imported from the University of California at Davis and used on the EA and G does to produce T x EA crosses, T x G crosses, N x EA crosses and N x G crosses. Limited number of T and N bucks that were available in the country originating from Britain and Switzerland were used as clean-up bucks in all matings. In some years when semen was in short supply T and N bucks were used in natural matings. The bucks were randomly assigned to does to mate overnight in different pens. Does that were mated at night were recorded the next morning by identifying the ink marks left by the bucks on the does at the time of mating.

Data on economic characters which define total dual-purpose merit; milk yield, milk composition, growth parameters, mature size, reproduction and viability (adaptability) on the indigenous straightbreds and their crosses are being collected. A summary of results to-date on the economic characters are in table 1.

MILK PRODUCTION

Galla does exhibited higher average daily milk yield than East African does. Average daily milk yields for East African and Galla were 385 and 409 gm/day, respectively. The large variability in milk production of the indigenous breed has implications for the selection of indigenous stock. Of the small numbers of Toggenburg and Toggenburg crosses available, the average daily milk yields were much higher than the indigenous breeds. Average daily

Figure 1. Diagram of breeding programme for evolving a Kenya improved dual purpose sysnthetic goat breed.

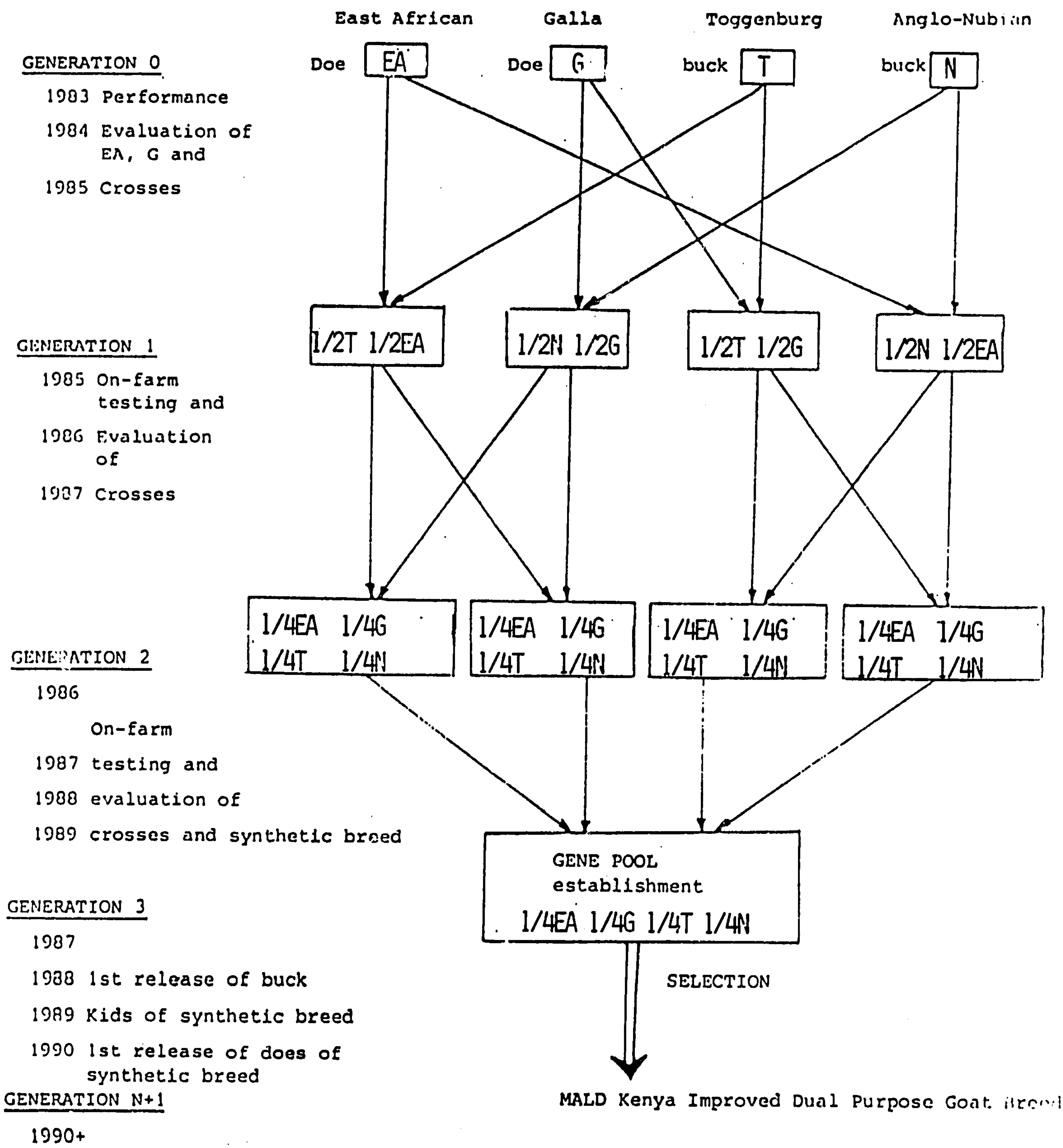

TABLE 1. Estimates of Economic Traits Required For Evaluation Of Breeds Or Types For Dual-Purpose Production Potential[a]

Category Trait	EA	G	T	T-Crosses
1. Fitness				
a. Kid survival (% of total kids born)	90%	83%	71%	81%
b. Adult survival (% of total does)	93%	88%	79%	76%
2. Reproduction				
a. Fertility (% does kidded of total does mated)	90%	75%	---	---
b. Litter size (No. of kids/ doe kidded)	1.3	1.1	---	---
c. Postpartum interval to 1st estrus (da)	68	77	---	---
d. Gestation length	148	149	---	---
3. Weight				
a. Birth weight (kg)	2.2	2.7	---	2.8
b. Growth rate to weaning (daily gain in gm/day to 120 days of age)	56	55	---	63
c. Doe mature weight (kg)	28.0	36.0	41.9	33.3
4. Lactation				
a. Milk yield (gm/day)	385	409	800	510
b. Milk composition:				
i) Crude protein %	5.41	4.63	2.97	---
ii) Fat %	3.34	4.57	3.31	---

EA = East African, G = Galla, T = Toggenburg

[a] Source: Ol'Magogo data 1982-84; Ruvuna et al. (1983, 1984, 1985), Okeyo et al. (1984)

yield for Toggenburg and Toggenburg crosses were estimated to be 800 and 500 gm/day, respectively. The composition of milk seems to be different for different breeds. Estimated crude protein for EA and Galla and Toggenburg respectively, was 5.4%, 4.63%, and 2.97%; estimated fat was 3.34%, 4.57%, and 3.3%, respectively (Ruvuna et al., 1984).

WEIGHT

Indigenous breeds, Galla and East African, had lower birth weights and daily gain to weaning than their crosses with Toggenburg temperate dairy breed. Average mature body weight for Galla does was estimated to be 36 kg and EA 28 kg. A limited number of Toggenburg and Toggenburg crosses had average mature body weights of 33 and 42 kg, respectively.

REPRODUCTION

Does were randomly exposed to East African, Toggenburg and Anglo-Nubian bucks for a mating period lasting 6 wk each time. Two weeks post-partum, vasectomized bucks were left to run with the does and time of estrus manifested in the form of acceptable mounting was recorded for each doe. The proportion of does joined that kidded (fertility) was higher among the East African does than the Galla, within and across the two years of study; 90% and 75% for East African and Galla, respectively. Average litter size, a measure of twinning rate, was 1.2 kids per doe kidding. Twinning rate of East African does was higher (29%) than of Galla (10%).

G stati
d) than singles (149 d). This difference could be attributed to the fact that twins were heavier (total birth weight) and presented a heavier physiological demand on the dam thus initiating earlier parturition. Comparison of East African and Galla does indicated similar gestation length for both breeds (148 d for EA versus 149 d for G).

FITNESS (Adaptability)

Survivability of kids is one of the most important production traits being measured. Kid mortality has been high on average (23%) and would be expected to be higher for smallholder production. The East African consistently has had lowest kid mortality (10%), followed in order by Galla (17%), Toggenburg (21%) and Toggenburg crosses (24%). Death from multiple births was higher than death from single births. The commonest disease has been pneumonia accounting for 60% of total kid deaths followed by scours (Ruvuna et at., 1983).

Exposure of different prospective dual-purpose goat breeds in a tsetse infested environment in Kenya for one year showed that all the goat breeds, East African, Galla, Galla x East African, Toggenburg x East Africa, Toggenburg x Galla, and Toggenburg x (East African x Toggenburg), were susceptible to natural infection of *T. vivax* and *T. congolense*. During the one-year study, the East African breed had the lowest percentage infection (34%) with the Toggenburg x Galla having the highest percentage infection

(73%) (table 2). Though quite a number of goats were infected (48%), only a small proportion (6%) died of trypanosomiasis. The small percentage of infected animals that died may partially explain why some goats are apparently able to survive in these areas without use of trypanocidal drugs. The infected animals tended to drop in PCV and weight the first 30 days postinfection. By 120 d postinfection the goats had values similar to the uninfected group.

Evaluation of genetic resistance against Haemoncus contortus in three goat breed groups (East African, Galla, East African x Toggenburg) artificially infected at the rate of 500 larvae/kg body weight, demonstrated lower susceptibility to H. contortus in the East African than the other breed groups (table 3) based on:

1. Mortality: East African (25%), Galla (67%); and Toggenburg x East African (40%).

2. Loss in weight as percent of average weight of controls 13 wk postinfection: East African (7.3%), Galla (17.6%), and East African x Toggenburg (13.8%).

DISTRIBUTION OF BREEDING STOCK

The DPG concept has become popular among farmers and herders in Kenya. In order to informally test the value of increasing the genetic potential for milk production and to directly assist some Kenyan farmers, the Breeding Project in collaboration with MALD released F_1 bucks to 14 recipients. All recipients have agreed to cooperate by feeding back information on progeny.

The bucks, all F_1 dairy exotic-native, were distributed in lots of 1 to 5 to one international organization, 3 farmer or herder groups and 11 individual farmers or herders. These were mostly in Rift Valley province but there were one or two recipients each in North East, Central and Coastal provinces.

A major shipment of F_1 does has been committed to distribution to farmers collaborative with the Production System Project. One hundred F_1 does have been transferred to Maseno in preparation for release and 50 more F_1 does are reserved and ready for transfer. These does will be used to evaluate the productivity of the 1/2 exotic dairy-1/2 native under smallholder farmer conditions. Feedback information will be valuable to the Breeding Project.

VII. Significance of Findings

It is widely recognized that where feed supplies are limited such as occurs on small farms in developing countries, meat and milk production with large animals is inefficient because nearly all feed energy available is required to satisfy maintenance requirements (McDowell and Bove, 1977). Kenya like many developing countries is faced with population pressure especially in agriculturally high potential areas (Kayongo and Kategile, 1984). Considering 60% of the farms in the high intensive agricultural areas are less than 2 ha, it is realistic to assume that a Dual Purpose Goat (DPG) will have a major

TABLE 2. Number of Infected goats Expressed as Proportion (%) of Total Goats[a] For Each Breed[a]

Breed Group	Total Goats Exposed	Percent Infected (%)	Number Dead
EA	32	34	1
G	16	50	0
G x EA	7	43	1
T x EA	8	50	1
T x G	11	73	2
T x (EA x T)	9	67	0
TOTAL	83	48	5(6%)

EA = East African

G = Galla

T = Toggenburg

[a] Source: Ruvuna et al. (1985).

TABLE 3. Comparison Of Breed Groups Artificially Infected With Haemoncus Contortus

Trait/Category		Breed Groups East African	Galla	Toggenburg
Number of animals	a. No. uninfected (C)	5	4	5
	b. No. infected (T)	12	9	13
Larvae Establishment	a. Average No. larvae infected per animal	6333	5417	5714
	b. Larvae establishment (% of total larvae)	37%	39%	43%
Mortality after 13-weeks	a. Control dead (% of total)	0%	0%	0%
	b. Infected dead (% total)	25%	67%	46%
Beginning Weight (kg) (week-0)	a. Control (C)	11.7	10.7	11.5
	b. Infected (T)	12.7	10.8	11.9
	c. Difference (% of C)	-8.5%	-0.9%	-30.5%
End Weight (kg) (week-13)	a. Control (C)	12.3	13.6	13.0
	b. Infected (T)	11.4	11.2	11.2
	c. Difference (% of C)	7.3%	17.6%	13.8%
PCV Week-13	a. Control (C)	27.3	25.2	27.0
	b. Infected	17.7	17.1	15.1

[a] Source: Shavulimo et al. (1985).

role to play in the livelihood of smallholders. Among the advantages of the goat is its small size and lower per head nutrient requirements that may fit limited resources of the smallholder or marginal grazing lands that cannot sustain larger animals throughout the production cycle. Earliness of sexual maturity leads to shorter periods of nonproductivity and shorter generation intervals that increase the potential response to selection. Advantages that favor goats over cows include: loss of an individual animal has less impact on family welfare; initial investment per animal is low; mating does to kid in different seasons allows a small, but consistent daily supply of milk throughout the year; and litters of one to two kids at 7 to 8 mo intervals markedly increase offtake of slaughter stock for family consumption or sale to provide needed income.

A summary of some facts on population growth and land utilization in Kenya is presented in table 4. Further points that favor a DPG under a smallholder production system include:

1. The small proportion of land given to livestock (25%) in relation to that given to crops (75%) in high potential areas.

2. The small increase in agricultural production (1%) in relation to population growth (4%).

3. The rapid decrease in land per capita with time; e.g. land per capita in 1975 of .64 hectares compared to land per capita in 1984 of .51 hectares.

The above facts coupled with the fact that livestock is considered the highest asset for the smallholder, contribute about 36% of total farm assets.

The development and use of the DPG for the smallholder in Western Kenya is a major project and of primary interest. However, the potential for similar utilization of the DPG in other areas of Kenya and in other tropical countries is very real. The current DPG, the DPG crosses with local strains, or the DPG modified by varying fractions of input breeds can be utilized. One specific potential is development of a DPG strain for intensive, relatively high milk yield dairies; this option may provide smallholders an option to overcome subsistence level production.

It is clear that biologically and economically viable dual purpose goat production in all areas of Kenya and similar countries can not be developed without a suitable breed or type which has not been available.

VIII. Future Direction

A synthesis of the breed and type comparisons for "Total Economic Merit" indicate:

1. No breed or type excells in all the economic performance traits.

TABLE 4. Population And Land Use In Kenya[a]

1. Population Figures	
Area	580,400 sq km
Population	17 million
Density/sq km	29.3
2. Land Use Figures	
Arable land	1,790,000 ha
High Potential area (15% Arable land)	268,500 ha
Agriculture as % of GNP	36.6%
3. Land Use vs. Population	
Land to livestock in high potential (25%)	67,125 ha
Land to crops in high potential (75%)	201,75 ha
Population Growth	4.0%
Increase in Agricultural Production	1.0%
Land per capita (1979)	.64 ha
Land per capita (1984 to present)	.51 ha

[a] Source: Kayongo-Male, 1983.
Kayongo-Male and Kategile, 1984.

TABLE 5. Value of Small Scale Farmer's Assets[a]

Item	Value Kshs.	Value %
Livestock	2,462	35.76
Land	1,800	26.14
Building	1,796	26.09
Crop (store and planted)	433	6.29
Equipment	380	5.52
Input in store	14	0.20
TOTAL	6,885	100

[a] Source: Kayongo-Male, 1983
Kayongo-Male and Kategile, 1984

2. Existing heterogeneity of performance among different breed types provides a useful pool of genetic resources for continued tapping to meet production requirements under widely varying environmental and managerial conditions of smallholders.

3. The results show definite opportunities for mixing and matching these genotypic resources to fit production conditions and production demand for the smallholder.

4. Heterogeneity among the breed types resulting from generations of genetic isolation of these breeds suggests that substantial hybrid vigor may result from crossbreeding.

The present and future research direction is on development followed by on-farm testing of the new improved synthetic dual purpose goat. The first 4-breed composite kids were dropped in early 1985. During 1986-87, composite or intermediate cross does will be used to initiate on-farm tests to identify and quantify interactions between the synthetic and location (station vs on-farm) for performance measures. The F_1 crosses produced in the mating plan are and will continue to be used not only as a step in creating the composite but also they will be used continously for on-farm testing. The research to follow will be smallholder on-farm "Total Merit" evaluation of the new synthetic Kenya DPG in comparison with F_1 crosses.

The breeding and selection of a Kenya DPG is the primary breeding goal. Several general research and development objectives remain:

A. To document heterosis for the various crosses for various characters; emphasis to be placed on net productivity of meat and milk.

B. To determine the amount of residual heterosis in the DPG and its importance to net productivity.

C. To establish specific selection criteria and methods to develop, improve and preserve the DPG as a breed; to include a computer record keeping plan.

D. To determine any variation of the fraction of the 4 original DPG breeds and the newly available Alpine that would increase net productivity for other areas of Kenya (e.g. drier areas), for intensive dairies, or for export to other countries.

E. To establish breed criteria, registration/recordation requirements, release procedures and performance testing programs.

F. To initiate drafting of an illustrated brochure on the Kenya DPG for use in breed establishment and for possible use in semen distribution.

G. To initiate a semen bank for the Kenya DPG.

SR-CRSP

ANNUAL REPORT

1985-86

I. Project Title: Systems Analysis and Synthesis of Small Ruminant Production

II. Host Countries: Kenya
Peru
Brazil
Indonesia

III. Principal Investigator: Thomas C. Cartwright

IV. Personnel: Host Country Co-Workers:
S. Tallam, MALD, Kenya
A. Siregar, BPT, Indonesia
E. Figueiredo, EMBRAPA, Brazil

U.S. Co-Workers:
H. D. Blackburn, Research Scientist
F. Ruvuna, Resident Sci. in Kenya, Texas A&M
P. Howard, Graduate Assistant, Texas A&M Univ.
E. Lentz, Graduate Assistant, Texas A&M Univ.

V. Introductory

The Systems Analysis Project has placed major emphasis in Kenya and will continue research there, but will redirect efforts to other host countries and to regionalization. It is timely for this annual report for Kenya to relate the systems analyses results which follow the SR-CRSP in Western Kenya to its present status. Therefore, this and the next three sections are presented in a form to document the logical sequence of collaborative systems research in Kenya without taking components out of context. Of necessity, results from previous years are included. This portion will be identified as Kenya sequence. Then, these sections will be repeated to report results for Kenya (other than Western Kenya), Brazil, Peru, and Indonesia for 1985-86. This second portion will be identified as Update.

KENYA SEQUENCE

The western Kenya work site provides a production environment where there is a high population density and growth rate but limited physical and financial resources so that diets often do not meet minimal nutrient requirements. The major goal of the SR-CRSP is to collaborate with MALD to conduct research that will result in information needed to develop programs that will improve both the nutritional status and the financial resources of small land holders by introducing a dual purpose goat (DPG). For the DPG to be a viable alternative for smallholders, it must produce a usable quantity of milk on a consistent basis (a target of 200gm/person/day). Excess kids produced by the DPG flock contribute to the financial resources by providing a product for cash income.

For researchers and extension personnel to make knowledgable recommendations for effective use of the DPG, inputs and outputs of the total production system must be understood. Understanding the net effects of inputs and outputs on DPG production results in the ability to manipulate management, nutrition and breeding into various production packages that optimally meet the needs of smallholders in different ecozones or with varying resources.

To evaluate DPG production in various physical environments and superimpose a layer of different management and nutritional tactics would extend live animal experiments past financial, physical and time constraints of the SR-CRSP. Alternatively, optimal management, nutrition and breeding practices can be evaluated by systems analysis as a basis for formulating sets of practices (packages) that are optimal for a given production resource; i.e. practices most likely to succeed under practical conditions based on scientific knowledge.

The goat model used, has been described in detail by Blackburn et al (1986). Input information provided to the model, by the user, includes three sets of parameters.

FORAGE: availability kg/head/day, digestibility and crude protein of the diet for each 15-day time step.

GENOTYPE: in terms of potentials for mature size, milk production and ovulation rate

MANAGEMENT: breeding policies, dairy milk extraction, weaning, supplementation and parasite control.

By altering these input parameters, it is possible to simulate the effects of different environmental conditions or management practices. These paramenters are obtained mostly from results of other SR-CRSP projects.

The systems analyses reported document the steps involved in (1) the choice of a genotype for the DPG, (2) the examination of potential productivity of DPG flocks on smallholder farms, (3) the limitations of nutritional interventions required to meet production goals, and (4) considerations of management practices. These results provide the framework for designing DPG technology packages. General goals of the Systems Analysis project, in collaboration with other SR-CRSP projects may be stated as research objectives or questions to be answered in quantitative terms:

1. Is it feasible for smallholder family flocks of DPGs to produce a minimal supply of 200 gm of milk per day for each family member throughout the year in Western Kenya? What are the limiting factors?

2. What practices of intercropping, introduction of new forages, storing forages, etc. will be required for vaiable DPG production?

3. What management practices are optimal for smallholder objective functions?

4. Is DPG production sociologically as well as economically feasible?

VI. Research Accomplishments/Significance of Findings - Kenya

(These two sections are combined for the purpose of sequential continuity)

These results of systems analyses to examine the questions posed above are presented below in four categories: Genetics, Nutrition, Management, and Economics.

GENETICS (Target DPG Genotype)

The limitations of using East African (EA) and Galla (G) breeds were documented by the early work of the SR-CRSP breeding project (Ruvuna et al., 1983). Indigenous breeds were shown to be lower in milk production (200 g/day) than Toggenburg crosses (670 g/day) at peak lactation. However, indigenous breeds had higher levels of kid survival. If the Systems Analysis stated goal for the SR-CRSP of 200 g/day for each family member is to be met, goats with the higher levels of milk yield must be used. Cartwright (1984) stated that there are 3 basic functions which must be incorporated into breeding and selecting a DPG for smallholders. These are: growth, reproduction and lactation, and survival. The breeding project decided that the most effective way to combine these 3 functions was to develop a synthetic breed comprised of 2 exotic dairy breeds and 2 indigenous breeds. This procedure would take advantage of the milk and growth potential of the dairy breeds, and the disease resistance and survival characteristics of the indigenous population while retaining a high level of heterosis. However, the genetic potential to select as an optimal combination in the new breed for Western Kenya was unknown and no research information was available on which to base an opinion. Therefore simulations were performed to determine optimal genetic potentials for size/age (or growth rate) maturing rate and milk production. These simulations were performed to provide the breeding project with information upon which to base breed choice and combinations as well as intensity of selection.

Initial simulations were performed for a western Kenya production situation, using different genetic potentials for mature size (GSIZE) and peak daily milk production (GMILK) of a mature doe. Genetic potentials, expressed as GSIZE/GMILK, for the breeds are: East African 30/2.5, Galla 35/3.0 and Toggenburg 55/6.0. The crossbreds are somewhat above the average of these potentials. Genotypes chosen for testing were: 35/3.0, 35/4.5, 45/3.0 and 45/4.5. Simulations indicated that the environment is capable of sustaining genotypes other than the indigenous type of goat (35/3.0). These simulations showed that the 35/4.5, 45/3.0 and 45/4.5 could produce more milk and wean heavier kids than the 35/3.0.

These initial simulations led to a more extensive evaluation of genotypes for doe lifetime productivity (table 1). Genotypes tested were 50/6.0, 45/4.5, 40/4.0, 35/3.0, 30/2.0. These genotypes represent expectations of the size and milk production of indigenous goats selected out of the Kenya

TABLE 1. SIMULATED AVERAGE LIFETIME PRODUCTION OF 5-YEAR-OLD DOES OF 5 GENOTYPES RAISED ON MASENO AREA FORAGE

Item	Mature Size/Milk Potential				
	50/6.0	45/4.5	40/4.0	35/3.0	30/2.0
No. Kids	6	6	7	6.5	0
Av. Wean Wt., kg	17.2	17.1	13.8	12.0	0
Av. Milk Per Lactation, kg	157	149	115	98	0
Doe Condition, Minimum %[a]	67	68	77	63	0

[a] Percentage of normal unstressed body condition; e.g., weight of body fat of doe as a percentage of weight of body fat of a dry doe on good quality forage.

population for dairy potential mated to the indigenous breeds. Simulated does were placed into test conditions at weaning and remained there. Four criteria examined were: number of kids born, average weaning weight, average dairy milk production per lactation and minimum doe body condition. The 30/2.0 genotype was not suitable for use as a DPG since the 30/2.0 doe was not able to produce dairy milk, grow and reproduce in the Western Kenya environment; therefore, it registered zero for all characters examined. The 50/6.0, 45/4.5 and 35/3.0 proved not to be a suitable potential DPG due to the low level of body condition of does which dipped to critical levels at times of the year. Low body condition was an indicator that these does were producing at a level which stressed their biological system. These stressed does were more susceptible to debilitating effects of disease and parasite infestation, could not reproduce regularly and were more prone to die. Does of genotype 40/4.0 maintained a higher minimum body condition and had more kids over 5 years than the other genotypes tested. The higher number of kiddings implies that there would be a more continuous supply of milk per doe during her lifetime. However, in terms of quantity of milk yield and weight of kids weaned, the 40/4.0 was not maximum. The 50/6.0 and 45/4.5 were more productive in these respects. Nevertheless, the combination of performance characters make the 40/4.0 the most appealing choice since it has an acceptable production level and retains robustness. The extra body reserves indicate that, if the production conditions of the smallholder periodically deteriorates, the 40/4.0 DPG will have some resiliency with which it can continue producing, while the 45/4.5 and 50/6.0 would not have as much buffering capacity. As farmers become more familiar with management of a DPG production system the possibility of increasing the genetic potential past 40/4.0 will be re-examined.

These data suggest that the DPG should have a genotype of 40/4.0. Ruvuna et al. (1984) showed that a doe with a mature size of 40 kg is feasible and not difficult to breed. The length of time to select for a GMILK of 4.0 kg was unknown. Due to the time required to develop a 4-breed synthetic DPG, with the 40/4.0 genotype, the question was whether an up-graded intermediate goat be used as a stop-gap measure until the DPG could be produced. Therefore the systems analysis project evaluated the performance of a goat with a 40/3.0 genotype. This would represent a goat with 1/4 to 3/8 dairy breeding vs the 1/2 dairy breeding of the synthetic breed being developed by the Breeding project.

Simulations were performed with a 4-doe flock of the 40/3.0 genotype to compare with a 4-doe flock of 40/4.0 (table 2). For most characters studied, the 40/4.0 produced more milk and salable kids. However, the 40/3.0 was similar to the 40/4.0 in many respects. The most undesirable characteristic of the 40/3.0 genotype was that the total number of goats in the flock had to be increased to remain stable in number (i.e. more kids had to be kept to assure replacement of does). This may appear a minor difference, but the problem manifests itself by increasing the amount of forage consumed (9%) and the labor and space needed for the flock. If the increased dry matter consumption, labor and space requirements are acceptable, then it can be concluded that the 40/3.0 would be an effective intermediate genotype in Western Kenya; therefore, does of this combination, which are more readily produced, may be useful in initiating smallholder involvement with the DPG.

TABLE 2. SIMULATED PRODUCTIVITY OF 40/4.0 AND 40/3.0 GOATS IN A 4-DOE FLOCK USING MASENO AREA FORAGE PARAMETERS

Item	40/4.0	40/3.0
Total No. of Goats[a]	7.0	8.0
Av. No. Lactating Does/Period/Year	1.9	2.1
Flock Dairy Yield kg/yr	332	319
Dairy Yield kg/day	.92	.89
Dairy Yield kg/Lact Doe/yr	175	152
No. Yearlings Sold/Lact Doe/Yr	1.5	1.6
Av. Yearling Weight, kg	24	19
No. Culls Sold/ Lact Doe/Yr	.4	.4
Av. Cull Wt, kg	30	30
Total Weight Sold/ Lact Doe/Yr, kg	48	42
Total Feed Consumed, kg/yr	2175	2376

[a] Does, suckling kids, weaned kids for sale and for doe replacement up to 1 year of age.

NUTRITION

Dual purpose goat production in Kenya is dependent on forage which varies in quantity and quality throughout the year in a cycle which cycles parallel to, but a short time later than, the rainfall pattern. Flocks may be managed so that fluctuating nutrient demands that vary with the growth, pregnancy and lactation status of each individual, tend to best coincide with the seasonal forage variation. However, the degree to which this can be done and meet the needs of the smallholder families is limited. One objective of the SR-CRSP is to smooth out the production cycle so that there is a more continuous supply of milk. Simulation results showed that this stability requires short term storing of feedstuffs for use during critically deficit periods (e.g. see table 3). Also development of additional feed resources is necessary.

Understanding the varying nutritional requirements of DPG does is essential for successful adjustment of the feed resource. An example of the forage which DPG's have access to is presented in table 3 as Base II-85, these values were obtained from the forage project (Hart et al., 1984). A simulation was performed to determine how a DPG of 40/4.0 would respond to this nutritional environment (Blackburn et al., 1985). During the nonlactating phases, the protein and energy requirements of the doe were met. However, during lactation the Base II-85 diet did not yield sufficient protein and energy to meet lactation requirements plus maintenance requirements. As table 4 shows, energy was the most limiting nutrient. Simulations were designed and conducted to provide an objective, quantitative basis for examining management practices that would eliminate or minimize the nutritional deficit.

Two other diets, Base II-85 supplemented with modest amounts of sudangrass plus pigeon pea (SPP-85) and an improved diet (ID-85) (table 3), were used for simulation. These results indicated that when sudangrass and pigeon pea are incorporated into the diet, the energy deficit is reduced by approximately 20%; however, a nutritional impediment to production remains especially during early lactation (table 4). These results led to the formulation of a diet designed to alleviate some of the nutritional limitations to milk production. This improved diet (ID-85, table 3) was based on limited use of harvested Sesbania leaves which has produced promising results from initial forage research (Sidahmed et al., 1984) and appears to be a practical alternative.

The first series of simulations related to nutrition were reported by Cartwright et al. (1983). For the Maseno area (table 3, 1983 Maseno), the results showed that if the DPG is to be viable and continuously supply milk to smallholders, storage of forage is necessary in order to make sufficient quantities of feed available during critical periods. By shifting feed from one month where quantity was limiting to the next month in three cases, the problem of forage availability could be solved; however, as previously shown this simple shifting does not solve the diet quality problem.

The SR-CRSP identified two different eco-zones, Kakamega and Siaya, in which to work. In Kakamega, farms are higher in elevation and are approximately 1 ha in size. In Siaya average farm size is 1.5 ha and the elevation is lower. Therefore, it was of interest to evaluate DPG production in each of these environments. The two production environments were

TABLE 3. FORAGE QUALITY PARAMETERS USED FOR SIMULATING DPG PRODUCTION

Year, location Forage resource Diet Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983 Maseno												
BASE												
CP %	7/9	8	9	10	13	15	13	8	8/10[a]	10	8	8
DIG %	46	45	50	55	58	60	58	51	51/55[a]	55	50	51
1984 Siaya												
BASE												
CP %	4.8	9.9	9.9	14.9	9.7	10.5	7	9.7	9.7	9.7	7.6	9.9
DIG %	47	47	47	53	47	49	53	47	47	47	52	47
STORED												
CP %	4.8	9.9	9.9	14.9	9.7	10.5	7	6.7	6.2	9.7	7.6	9.9
DIG %	47	47	47	54	47	49	53	50	49	47	47	47
Supplement (Suppl) [b]												
Amount, kg	.25	0	0	0	0	0	25	.25	.25	0	0	0
1984 Kakamega												
BASE												
CP %	4	9.5	16.8	15	9	9.6	7	9	9	9	9	7.2
DIG %	47	47	55	53	45	47	53	50	49	48	48	53
STORED												
CP %	4	9.5	16.8	15	9	9.6	7	6.3	5.5	4.6	4	7.2
DIG %	47	47	55	53	45	47	53	50	49	48	48	53
Supplement (Suppl) [b]												
Amount, kg	.25	0	0	0	0	0	.25	.25	.25	.25	.25	0
1985 Kakamega												
BASE I												
CP %	10	10	10	10	10	10	7	10	10	10	10	8
DIG %	47	47	52	52	47	47	52	47	47	47	47	51
BASE II												
CP %	10	10	10	10	10	10	7	10	10	10	10	8
DIG %	47	47	47	47	47	47	52	47	47	47	47	51
Sudangrass & Pigeon Pea (SPP)												
CP %	10	14	14	13	15	16	9	13	10	10	10	10
DIG %	49	53	54	52	53	53	52	53	50	50	50	52
Improved Diet (ID)												
CP %	10	10	10	10	10/15[a]	15	15	15	15	15	10	10/8[a]
DIG %	47	47	47	47	47/68[a]	68	68	68	68	68	47	47/51[a]

[a] Denotes a split in parameters fed in the same month.
[b] CP = 16%; DIG = 70%; added to stored diet.
Taken from: Hart, 1982, personal communication; Hart et al., 1984; Sands, 1983.

TABLE 4. PERCENTAGES OF PROTEIN AND ENERGY REQUIREMENTS FOR LACTATION WHICH WERE MET FOR DPG DOES

Period of Lactation[a]	Base II-85		SPP-85		ID-85	
	Energy	Protein	Energy	Protein	Energy	Protein
1	55.5	63.2	61.6	61.6	85.6	91.2
2	41.6	42.3	55.5	54.8	93.1	100.0
3	47.6	52.6	61.6	66.4	100.0	100.0
4	53.3	61.6	62.4	70.6	100.0	100.0
5	58.5	74.8	69.7	85.6	100.0	100.0
6	64.8	100.0	77.4	100.0	100.0	100.0
7	64.0	100.0	80.1	100.0	100.0	100.0
8	65.6	100.0	83.7	100.0	100.0	100.0
9	65.6	100.0	87.4	100.0	86.5	91.2
10	100.0	100.0	100.0	100.0	92.2	100.0

[a] Period = 15 days.

characterized by differences in forage quality and quantity (Sands, 1983; Hart, personnel communication). The Kakamega values ranged from about 8 to 16% CP and 45 to 60% Digestible (O_{19}) while the range at Siaya was about 6 to 14% CP and 45 to 54% Digestible and peaked for briefer period (Siaya Base-84 and Kakamega Base 084, table 3).

The objectives of the simulations were to compare DPG productivity in the existing environment with the same resource plus the feeding of stored forage when a shortfall of the existing forage base occured. Stored forage was assumed to be composed of maize stover and other crop residues readily available, stored in a manner similar to stacking hay. This approach would require little input from farmers. The stored forage was fed in September and August in Siaya (Stored-84), and September, October and November in Kakamega (Stored-84, table 3). In addition to the stored forage concept, the forage project was interested in selectively feeding small amounts of sudangrass obtained from inter-cropping with maize. Simulations were performed to examine how goats would respond in growth, lactation and reproduction to sudangrass fed as a supplement (.25 kg/day) during months when crude protein of feed fell below 7%, Suppl-84, Siaya and Suppl-84, Kakamega (table 3).

The forage availability (kg/doe/day) was the determining factor in the number of does that a farm could support. In Kakamega, with no intervention (Base-84, table 3), only 3 does/farm could be supported. In terms of the SR-CRSP goals of providing a somewhat continuous year-round supply of milk of 100 g/day for each family member, three does were not satisfactory. However, with forage stored (Stored-84,Kakamega) six does can be supported. In Siaya both standing (Base-84) and stored (Stored-84) treatments could support 6 DPG does. The average lifetime productivity of a DPG doe in both locations and nutritional treatments is provided in table 5. For the Siaya environment utilizing stored feed increased the number of kids born. However, due to the does higher reproductive performance, weaning weight and average milk production were decreased. For the lifetime of the doe, stored feed did enable her to wean more kilograms of kid, but the total quantity of milk produced was not increased (Cartwright et al., 1984).

Flock model simulations were performed to evaluate standing forage (Base-84), stored forage (Stored-84), and stored forage plus sudangrass supplementation (Suppl-84) in both the Siaya and Kakamega (table 3). Table 6 gives flock performance data for the three practices. By improving the DPG's diet in Siaya, reproductive rate increased from 120% for Base-84 to 125% for Stored-84 and to 132% for Suppl-84, and to 20.2 kg for Suppl-84. Dairy milk yield increased by 14% and 39%. For Kakamega, sudangrass supplement in addition to stored forage (Suppl-84) increased reproductive performance (102 vs 118% weaned kids), weaning weights (15.1 vs 21.4 kg) and dairy milk yield by 27%. This information indicates that both the practice of storing feed and providing sudangrass supplementation in moderate amounts has a significant impact upon the output from the DPG flocks. In addition, the milk production is more consistent throughout the year. Provided with these simulated production data, questions to be answered by the economics component of SR-CRSP related to the economics of storing feed and interplanting sudangrass on maize or pigeon peas.

Work by Hart et al. (1984) indicated that forage quantity is not the most limiting factor for the Hamisi, Kakamega area but that it is forage quality.

TABLE 5. AVERAGE LIFETIME PRODUCTION OF A 5-YEAR OLD DOE WITH A MATURE SIZE POTENTIAL OF 40 KG AND A MATURE MILK POTENTIAL OF 4.0 KG PER DAY

Item	Kakmega-84	Siaya-84	
	Stored	Base	Stored
Number of Kids	6	5	6
Av. Weaning Weight, kg	13.9	15.4	13.6
Av. Milk Yield Per Lactation, kg	117	142	115
Doe Condition, Minimum Score, %	64	61	64

TABLE 6. SIMULATED TEN YEAR FARM FLOCK AVERAGES WITH A MATURE SIZE POTENTIAL OF 40 KG AND A MATURE MILK POTENTIAL OF 4.0 KG PER DAY

Item	SIAYA-84[a]			KAKAMEGA-84	
	Base	Stored	Suppl	Stored	Suppl
Dry Matter Consumed Per Year Per Flock, kg	2592	2819	2766	2420	3180
Average Number of Does	5.0	5.2	4.4	4.9	5.6
Live Births Per Year	6.3	6.5	5.8	5.0	6.6
Kids Weaned Per Total Kids Born Per Year, %	62.5	60.0	58.0	51.0	57.0
Kids Sold Per Year:					
Number	5.0	5.0	4.4	3.7	4.9
Total Weight, kg	71	80	89	56	105
Total Weight Sold Per Year, kg (Kids and Cull Does)	101	108	107	87	118
Milk Production Per Year:					
Total Production	1466	1665	1857	1983	2009
Dairy Production	544	620	756	610	777

[a] See table 3 for forage parameters.

The forage quality values given by Hart et al. (1984) are lower than those reported by Sands (1983). The forage consisted of dried corn stover, fence row forage, fallow growth, bean leaves and cassava leaves. Examined in addition to this forage base (Base I-85) were base forage plus sudangrass and pigeon peas (SPP-85), and sesbania (Se) as a selective feed supplement (CP = 22%, DIG = 74%) which was fed at a rate of .5 kg/day to a doe or yearling when body condition dropped to a critical level (72%). Effects of alterations of the nutrition were examined with a 4-doe flock simulation (table 7). Generally, providing DPG's with Base I-85 plus SE supplement increased productivity to a level similar to that of SPP-85 treatment (table 3). Providing DPG's with either SPP-85 or Se supplements improved dairy milk offtake but had little impact on total weight of kid sold when compared to the SPP diet.

These simulations indicate 3 viable practices for smallholders to raise DPGs. Economic and sociological evaluation of these options can provide the SR-CRSP with the additional information necessary for determining which practices are optimal for smallholder production systems and objectives.

MANAGEMENT

A major management consideration for DPG production is determining the amount of dairy milk to extract and the impact this extraction has on kid performance. Work by Cartwright et al. (1983) documented the effects of extracting 1/2 the milk on kid weaning weight for indigenous and dairy genotypes. This led to experiments reported by the SR-CRSP Breeding project (Ruvuna et al., 1984) where different types of milking strategies were tested. Further quantification of milk division strategies are summarized here (Blackburn et al., 1985).

Milking Strategies. Four milking procedures were tested using forage input parameters from Hamisi, Kakamega and the DPG genotype (40/4.0). The four milking procedures were 1) unlimited access by the kid to dam's milk and the remainder, if any, for dairy; 2) kid takes 1/2 of the milk and the remaining 1/2 for dairy throughout lactation; 3) kid consumes a maximum of .5 kg milk and the remainder, if any, for dairy; 4) kid consumes a maximum of .3 kg milk and the remainder, if any, for dairy. With each of these treatments the comparison of base forage (Base II-85) to base forage plus supplement (SPP-85) was made (the supplement consisted of sudangrass and pigeon pea), supplement was fed throughout the year (table 3). The term dairy is used to refer to milk taken for family use or sale. There were two concerns for treatments 3 and 4. One was that at some point in lactation the amount of dairy milk produced is not worth the labor required for milking, therefore the farmer leaves the total amount for the kid. Another was that there is a maximum amount of milk necessary for acceptable kid growth.

Simulated results indicate that treatment 1 weaned the heaviest kid while treatment 4 weaned the smallest (17.4 vs 10.0 kg). Intermediate weaning weights were obtained for treatment 2 and 3 (12.8 and 13.1 kg). Using base forage plus supplement increased weaning weights for treatments 1, 2 and 3 (10.3 to 11.7%) but had little effect on kid weaning weight in treatment 4 (10.0 vs 10.7 kg). This indicates that kids raised by the treatment 4 method are under stress and results in stunting of growth (table 8). The percentages

TABLE 7. SIMULATED MEAT AND MILK OFFTAKE BY FLOCK SIZE, GENOTYPE[a] AND FORAGE[b]

	2 Doe		4 Doe						6 Doe	
	40/4.0		40/4.0				40/3.0		40/4.0	
Item	B	SPP	B	SPP	B+Se	SPP+ Se	B	SPP	B	SPP
Av. No. Lactating Does/Period/Yr	1.0	1.2	1.9	2.2	2.1	2.3	2.1	2.3	2.8	3.4
Flock Dairy Yield KG/YR	162	288	332	507	508	622	319	584	424	716
Diary Yield KG/Day	.45	.8	.92	1.4	1.4	1.7	.89	1.6	1.2	2.0
Dairy Yield KG/Lact Doe/Yr	162	240	175	230	242	270	152	254	151	211
No. Yearlings Sold/Lact Doe/Yr	1.5	1.8	1.5	1.9	1.6	1.6	1.6	1.5	2.0	1.9
Av. Yearling Wt, KG	21	29	24	31	24	32	19	30	19	30
No. Culls Sold/Lact Doe/Yr	.2	.3	.4	.2	.3	.3	.4	.4	.3	.2
Av. Cull Wt, KG	29	35	30	42	37	40	30	43	40	38
Total Wt Sold/Lact Doe/Yr	43	55	48	73	48	61	42	55	50	66

[a] Genotype refers to the mature doe body weight of the DPG as 40 KG and peak potential daily milk yield of 4.0 or 3.0 KG

[b] 1985 forage data, see table 3; B = Base I.

TABLE 8. EFFECTS OF DAIRY MILK EXTRACTION PRACTICE AND SUPPLEMENTATION ON DUAL PURPOSE GOAT PRODUCTION[a]

	Treatment							
	Unrestricted(1)		1/2 Milk (2)		.5 kg Milk/d(3)		.3 kg Milk/d(4)	
Item	Base	Base +SPP	Base	Base +SPP	Base	Base +SPP	Base	Base +SPP
Weaning Weight, kg	17.4	19.2	12.8	14.3	13.1	14.6	10.0	10.7
Dairy Milk, kg	10.2	18.5	51.6	64.4	48.0	66.0	63.5	84.9
Length of Dairy Lactation, d	15.0	30.0	150.0	150.0	75.0	75.0	90.0	120.0
Av. Milk/d kg	.68	.62	.34	.43	.64	.88	.71	.71

a. 1985 forage data, table 3.

of milk used for dairy were 10, 50, 46 and 61% for treatments 1, 2, 3 and 4, respectively.

For length of lactation, treatments ranked 2, 4, 3 and 1, longest to shortest, with and without supplementation. However, when comparing average dairy milk/day the ranking is 4, 3, 2 and 1 without supplement and 3, 4, 2 and 1 with supplement. This situation provides critical trade-offs between length of lactation and dairy milk yield. Input from both economic and sociological components in the project can make a valuable contribution to determine which strategy is of most benefit to the smallholder.

Treatments 2 and 3 provide an intermediate combination of weight of kids for sale and dairy milk yield. The major difference is the length of time does produce dairy milk. The treatment a smallholder selects may be dependent upon the number of does he owns. Farmers with fewer does may opt for treatment 2 which would provide milk from a doe for a longer period of time. Conversely, if a farmer has more does, he may switch to a shorter lactation which yields more milk/day but for a shorter period of time, without going through a "dry" period.

Flock Size. Flock size and replacement policy are difficult areas to assess with real goats and the limited resources of the SR-CRSP. Use of Goat Model simulations makes it feasible to evaluate the potential productivity of flocks of any number of does. Initially a flock of 6 does was evaluated which had evenly spaced parturitions and lactations. These initial simulations demonstrated that the forage resource (1983 Maseno, table 3) was capable of sustaining 6 does and that a 6-doe flock could supply sufficient milk to meet the Kenya SR-CRSP goal 200 g/person. These initial simulations did not account for the replacements necessary to make the flock self-sustaining. It, also assumed that does would continue to have evenly spaced parturitions. Elimination of these restrictions was necessary to test the feasibility of the 6-doe flock. Further simulations utilizing forage parameters Base I-85 and SPP-85 (table 3) were designed to examine 2, 4 and 6-doe flocks, where does were not forced to rebreed at a particular time, and young kids (up to 1 yr of age) and replacement does were simulated as part of the flock.

Performance of 2, 4, and 6-doe flocks is given in table 9 (Cartwright et al., 1985). Average weaning, yearling and culling weights as well as per doe milk yield varied slightly as expected due to breeding at different times of the year, etc. The total number of goats in the flocks ranged up to 12.6 head.

A question which the sociology project may address is whether the smallholder is capable of, or willing to, maintain flocks of goats which range in size from 7 to 13 head.

The milk yield a farmer could expect to receive throughout the year from flocks of various sizes was simulated (table 10). Average milk per day per doe varies from year to year for the same time period due to age effects of does, postpartum interval and flock mortality. Similar but different fluctuations occur for liveweight production. A more critical point of flock size is consistency; the range of milk production by period for a 5-year span of time is given in table 11. The critical point is the frequency with which milk yield falls to zero. The respective milk yield of the 2, 4, and 6-doe

TABLE 9. ANNUAL AVERAGES FOR FLOCK SIZES OF 2, 4, OR 6, DPG[a] DOES ON BASE AND SPP FORAGE[b]

Forage & Flock Size	Total No. Goats	No. Live Births	Av. No. Lact	Dairy Milk, kg	Av. Wean Wt, kg	Av. Yearling Wt, kg	Av. Cull Wt, kg	Total Wt Sold, kg	Dry Matter Consumed, kg
Base I									
2 Does	4.8	3.2	1.01	162.9	13.4	20.7	29.0	43.0	1317.0
4 Does	7.0	5.4	1.88	332.4	13.7	23.6	30.0	90.4	2175.0
6 Does	10.4	7.8	2.84	424.4	13.0	19.3	40.0	140.2	3156.0
SPP									
2 Does	4.6	3.2	1.15	288.4	16.2	29.0	34.5	66.2	1503.0
4 Does	7.8	6.4	2.23	507.0	15.9	30.5	42.0	160.4	2973.0
6 Does	12.6	9.4	3.43	716.1	15.9	30.2	38.0	223.6	4512.0

[a] DPG = Dual purpose goat breed assumed to have genetic potential at maturity, when nutrition is not limiting, of 40 kg body weight and 4.0 kg milk at peak day of lactation.

[b] 1985 forage data, table 3.

TABLE 10. SIMULATED AVERAGE DAILY DAIRY MILK YIELD, KG PER DOE, AVERAGED OVER A 5-YEAR PERIOD, FOR DPG

Period average	Base I Forage[a]			SPP Forage		
	2 Does	4 Does	6 Does	2 Does	4 Does	6 Does
1	.22	.48	.58	.59	.49	.48
2	.21	.47	.48	.55	.61	.44
3	.19	.38	.38	.58	.74	.63
4	.21	.33	.26	.42	.69	.65
5	.26	.51	.33	.45	.68	.51
6	.32	.67	.35	.55	.69	.87
7	.29	.52	.30	.47	.63	.67
8	.37	.73	.46	.38	.52	.48
9	.34	.60	.31	.27	.49	.59
10	.37	.38	.32	.14	.66	.49
11	.29	.43	.31	.75	.54	.55
12	.23	.44	.16	.72	.51	.69
13	.35	.39	.38	.87	.58	.53
14	.23	.41	.41	1.00	.54	.68
15	.33	.72	.55	.89	.49	.49
16	.47	.78	.72	.73	.36	.69
17	.38	.53	.62	.49	.35	.50
18	.31	.52	.55	.44	.44	.49
19	.25	.46	.44	.40	.79	.55
20	.19	.36	.31	.36	.69	.53
21	.43	.32	.23	.87	.72	.41
22	.39	.49	.19	.67	.63	.52
23	.32	.54	.31	.61	.68	.55
24	.28	.58	.33	.46	.58	.51
Av. No. Does Lact/ Period	1.01	1.88	2.84	1.15	2.23	3.43
Av. Dairy Milk/ Day	.30	.94	1.11	.66	1.32	1.92

[a] 1985 forage data, see table 3.

TABLE 11. RANGE OF AVERAGE DAILY DAIRY MILK YIELD FOR EACH 15-DAY PERIOD OVER FIVE YEARS OF SIMULATION ON IMPROVED SPP-85, KAKAMEGA FORAGE PARAMETERS[a]

Period	No. Does		
	2	4	6
1	0 - 1.96	0 - 2.28	.84 - 5.40
2	0 - .82	1.17 - 2.91	.22 - 2.92
3	0 - .91	.92 - 2.92	.32 - 3.40
4	0 - .75	.74 - 3.48	.26 - 3.08
5	0 - 1.64	.40 - 4.44	0 - 1.86
6	0 - 1.00	.34 - 4.16	.99 - 2.54
7	0 - .93	.27 - 3.76	.71 - 2.12
8	0 - .76	0 - 3.04	.56 - 2.60
9	0 - .65	0 - 1.64	.94 - 3.48
10	0 - .43	.33 - 1.86	0 - 1.88
11	0 - 2.17	.26 - 1.90	.93 - 4.50
12	0 - 2.46	0 - 2.16	.66 - 2.82
13	0 - 3.86	.90 - 1.88	.54 - 3.75
14	0 - 3.54	0 - .89	.95 - 3.08
15	0 - 3.12	0 - .77	.96 - 4.44
16	0 - 2.58	0 - 1.59	1.02 - 3.84
17	0 - 1.70	0 - .96	.81 - 2.52
18	0 - 1.30	.36 - 2.04	.51 - 3.65
19	.58 - 1.04	.87 - 2.78	1.23 - 3.90
20	0 - 1.78	.52 - 3.78	.84 - 1.52
21	.22 - 2.10	.22 - 2.98	.58 - 3.42
22	0 - 1.90	0 - 2.42	.20 - 3.24
23	0 - 1.75	0 - 3.33	0 - 3.30
24	0 - 1.50	0 - 3.06	0 - 4.68

[a] The range includes the lowest and highest flock yield during each period over a five year span.

periods during 5 years. A 6-doe flock is required for a high level of dairy milk availability; during five years, a family would be without milk only during 4 periods (2 months) over 5 years.

The simulations reported in this section provide insight into the production response patterns of goats in different flock sizes. The model was not constructed to answer economic or sociological aspects of the three scenarios. However, the simulations do identify as area of needed research, thus fulfilling one of the objectives of systems analysis at the biological level.

Replacement Policy. Simulations were performed with 2 types of replacement policies: 1) keeping female replacements after weaning only if a doe had died or was sold, and 2) keeping all kids to 1 yr of age before selling them or adding them to the flock. The results from these simulations showed that by following the first option the flock milk yield was erratic and milk yield often fell to zero. Periods of low productivity were caused by not having a replacement doe kid which was old enough to breed and begin lactation, after a short interval, when an older doe died or was culled. Keeping doe kids to 1 yr of age allowed a smoother transition of does exiting and entering the flock. Therefore, it appears clear that smallholders should keep at least 1 weaned doe kid as a replacement at all times even though this practice results in a somewhat lower efficiency of conversion of the feed resource by the flock.

ECONOMICS

A partial economic analysis of the simulated results from DPG milking practices and forage improvement as reported by Mukhebi et al., (1985). Using marginal net benefit (MNB) and benefit cost ratio (BCR), the methods of milk extraction previously discussed were analyzed. Benefit cost ratios indicated that all treatments tested, in both locations, with Base II-85 and SPP-85 (table 3) forage, were superior to letting the kid have unrestricted access to its dam's milk (table 12). Generally, feeding the kid .5 kg of its dam's milk (treatment 3) had the highest benefit cost ratio indicating a larger return to the smallholder. There were instances where the 1/2 total milk practice (treatment 2) was equal to or only slightly below treatment 3. In all cases treatment 3 and 2 were superior to allowing .3 kg of milk for kid consumption (treatment 4).

Examination of marginal net benefits (table 13) showed the additional monetary value of incorporating one of the milking practices into the production system. As with BCR, all experimental treatments would provide smallholders with a greater return per kid weaned. However, the farmer would receive more money by practicing treatment 4, in both locations and with unimproved and improved forages. Treatments 2 and 3 yielded similar monetary advantage with unimproved forages. Using improved forages made a greater difference between treatment 2 and 3; treatment 3 ranked higher than treatment 2.

Evaluating BCR for unimproved vs improved forage showed that improving the forage base across the different treatments resulted in small and slightly negative economic differences for some treatments (table 14). The negative

TABLE 12. BENEFIT COST RATIOS FOR PRE-WEANING FEEDING PRACTICES FOR DPG ON IMPROVED AND UNIMPROVED FORAGES IN HAMISI AND MASUMBI CLUSTERS[a]

Location & Treatment[b]	Unimproved Forage	Improved Forage	Unimproved and Improved Forage
Hamisi 1	Control	Control	Control
Hamisi 2	2.3	2.4	2.4
Hamisi 3	2.3	2.9	2.6
Hamisi 4	1.7	2.0	1.9
Masumbi 1	Control	Control	Control
Masumbi 2	2.1	2.0	1.3
Masumbi 3	2.4	2.8	2.6
Masumbi 4	1.8	2.0	1.9

[a] From Mukhebi et al., 1985.

[b] Treatments 2, 3 and 4 as test treatments over treatment 1, as the control where treatment:
1 = Unrestricted feeding of mothers milk
2 = Feeding 1/2 of mother's milk
3 = Feeding .5 kg of mother's milk
4 = Feeding .3 kg of mother's milk

Locations: Hamisi, Kakamega and Masumbi, Siaya.

13. MARGINAL NET BENEFITS PER WEANED KID FOR VARIOUS PRE-WEANING FEEDING PRACTICES IN HAMISI AND MASUMBI CLUSTERS, KSHS/WEANED KID[a]

ion & ment[b]	Unimproved	Improved
i 1	Control	Control
i 2	77.42	86.51
i 3	71.30	95.00
i 4	91.79	119.85
bi 1	Control	Control
bi 2	71.33	85.22
bi 3	74.33	93.53
bi 4	94.25	118.05

n Mukhebi et al., 1985.

itments 2, 3 and 4 as test treatments over treatment 1, as the control iere treatment:
- = Unrestricted feeding of mothers milk
- = Feeding 1/2 of mother's milk
- = Feeding .5 kg of mother's milk
- = Feeding .3 kg of mother's milk

ions: Hamisi, Kakamega and Masumbi, Siaya.

TABLE 14. BENEFIT COST RATIOS FOR PRE-WEANING FEEDING PRACTICES OF GOATS ON IMPROVED VS UNIMPROVED FORAGE, HAMISI AND MASUMBI CLUSTERS[a]

Location & Treatment[b]	Benefit Cost Ratios of Improved over Unimproved Forage
Hamisi 1	-0.6
Hamisi 2	-0.5
Hamisi 3	-0.1
Hamisi 4	0.1
Masumbi 1	-0.3
Masumbi 2	0.1
Masumbi 3	0.2
Masumbi 4	-0.3

[a] From Mukhebi et al., 1985.

[b] Treatments are:
1 = Unrestricted feeding of mothers milk
2 = Feeding 1/2 of mother's milk
3 = Feeding .5 kg of mother's milk
4 = Feeding .3 kg of mother's milk

Locations: Hamisi, Kakamega and Masumbi, Siaya.

value would indicate that there is no benefit for the smallholder to incorporate improved forages. It is of interest to note that treatment 1 (the control) had the lowest ratio in both locations. Within the Hamisi location the only positive BCR was for treatment 4 with treatment 3 ranking second but, having a negative BCR. In Masumbi treatments 2 and 3 had positive BCR indicating that with use of improved forages these milking practices should be followed.

Although the simulations indicate that use of improved forages is not economically viable, further analyses must be conducted. These results indicate the need for continued forage research perhaps with some redirection. The initial economic analysis do provide insight as to which milking practices should be recommended. As should be expected, they vary with location and forage base. Further interaction among the SR-CRSP projects as more data are collected should provide more complete and definitive answers to these types of questions.

VII. UPDATE (Research Accomplishments)

Kenya

In addition to use of the DPG for the Western Kenya smallholder farmer, it is anticipated that the DPG or modifications may be utilized in other areas or in other systems. One potential that will be pursued by the Breeding Project is for more intensive goat dairies. In order to validate the goat model for intensive dairy production in Kenya, Mr. S. Tallam, of MALD conducted a systems analysis study using data from the Prairie View International Dairy Goat Research Center.

These data are from a 2x2x3 factorial experiment involving 89 primiparous does. Two breeds of does (Alpine and Anglo-Nubian) were fed 2 levels of total digestible nutrients (TDN of 58% or 72%) and 3 levels of crude protein (CP of 12%, 15% or 18%) during a 140-day lactation. The model closely simulated a tual lactation performance and doe live weights. Levels of simulated voluntary dry matter intake within breed was dependent on feed energy density. No differences in simulated intake were observed between crude protein levels. It was concluded that the goat model adequately simulated actual intensive dairy goat milk production and doe live weight. Results of voluntary intake indicated that complete feeds fed at fixed levels of digestibility and crude protein, where feed quality components are independently altered to a degree not normally found in forage or range situations, the model does not simulate voluntary intake satisfactorily. For such simulations it is suggested that model revision be done on intake functions to allow crude protein content and digestibility to have independent effects on intake. For dairy production based on forages or forages supplemented with grain, oilseed meals or similar products, the model simulations validated closely.

Brazil

In collaboration with Dr. Elsio Figueiredo, EMBRAPA, CNPC at Sobral (on study leave at TAMU through May 1986) and the SR-CRSP Breeding/Management and Range Projects, a systems analysis study was completed for Northeast Brazil sheep production. Input data for the sheep were obtained from analysis of data from Brazil on the Morada Nova breed (Figueiredo, 1986). Input data for the forage input were obtained from published results of the SR-CRSP Range Project (Pfister, 1983; Kirmse, 1984).

The flock model (FM) was used to simulate a 3x3 factorial experiment where 3 levels of genetic potential for size/age (characterized by 30, 40 and 50 kg of live weight at maturity of doe), three levels of genetic potential for milk production (1.0, 1.5 and 2.0 kg of milk per eve per day at peak of lactation), and three levels of genetic potential for prolificacy (1.65, 2.20 and 2.75 ova per ovulation) were studied. All 27 combinations were simulated for a period of 8 yr. The simulation results showed that efficiency of sheep production for meat in Northeast Brazil (total weight sold/total dry matter consumed by the flock/year) increased with increases in genetic potential for ovulation rate and with increases in genetic potential for milk production, but it decreased with increases in genetic potential for mature size/age, medium milk and high ovulation, followed closely by the genotypes with medium size/age, low milk and high ovulation rate and in turn by low size/age, medium milk and high ovulation rate. High size/age genotypes were not among the eleven genotypic combinations that ranked above the base genotype (current Morada Nova). These genotypes included medium and high ovulation rate in equal proportions and genotypes of low, medium and high milk also in equal proportions.

The results from these simulations were used to establ sh optimal levels for selection. These criteria indicated a 25% change in the genetic potential for prolificacy, 25% change in the genetic potential for milk production and no change in the genetic potential for mature size. A selection index was constructed for selecting sheep in the EMBRAPA flock and to be recommended for Northeast Brazil based on the systems analysis results. (The development of this index, along with the necessary theoretical statistical techniques, was a major accomplishment in theoretical animal breeding).

Peru

In collaboration with the Range and Breeding Projects in Peru, a systems analysis study was completed for Dr. Carlos Fierro (Texas Tech, Range Project resident in Peru for a Period) to examine optimal use of cultivated pasture (ryegrass) for improved sheep production in the Altiplano (Fierro, 1985; Blackburn et al. 1986).

This simulated experiment was performed for a sheep production system in Southern Peru using the single animal version of the sheep model. The production alternatives examined were breeding season (June vs April) and ryegrass pasture supplementation vs no supplementation. The response variables of most interest were weaning weight of lambs and fleece weight of ewes. Lambs conceived in June were heavier at weaning (17.8 kg for singles and 15.7 kg for twins) than those conceived in April (14.3 kg for singles and 9.3 for twins). When ryegrass supplementation was available these weaning weights were 24.7 kg (singles) and 21.7 kg (twins) for June and 18.8 kg (singles) and 12.8 kg (twins) for April. Differences in treatments for clean fleece weight were not large except for ewes with twins lambing in April: 2.1 kg for June singles, 2.0 for April singles, 2.1 kg for June twins, and 1.7 kg for April twins. It appears clear that June breeding is superior to April breeding. These results provide a basis for further enquiry using the flock model to facilitate examination of flock productivity in terms of reproduction, lamb mortality and net flock offtake.

The effect of drought and extreme drought were also simulated. The effects were significant in terms of body condition of the ewes, particularly at the end of the dry and wet season. Fleece weight was not affected, but milk production and weaning weights of lambs were significantly reduced over 3 kg. The effects of extreme drought conditions were devastating, affecting all animal performance parameters. The simulated extreme drought, through effects of low forage availability and quality, caused ewes to abort in early November. After abortion, the ewes recuperated more rapidly than under less extreme drought conditions, because they had lost their lambs.

These simulations provided the opportunity to examine the effect on ewe and lamb productivity of alternative uses of the ryegrass pastures in much shorter time than would have been possible with live animal experimentation (even if resources had been available).

Indonesia

Contacts have been established, systems analysis research agreed upon in terms of a initial study, and a scientist, Mr. A. R. Siregar, BPT, trained in the basic structure, functions and operation of the simulation model. Only demonstration simulations were conducted. Mr. Siregar will conduct a systems analysis as part of his Ph.D. research at Bogor Agricultural University.

Texas A&M University

Model structure, functions, operation procedures and sets of input parameters are continually reviewed and revised or refined. The PI and SR-CRSP systems group meet once a week for reviewing revision. One example of this continual study is that related to the parasite component of the model.

Helminthiasis of sheep is a world wide problem affecting sheep productivity. There is a great deal of variation between animals in their susceptability to this disease. Therefore, worm burden and resistance were built into the Single Animal Version (SAV) to simulate their effects on growth, milk production, reproduction and body condition. Since there are very few data in the literature in this area, a sensitivity analysis was conducted by varying the effective larvae intake from 500 to 5000 larvae with increments of 500 and for three resistance levels of 20%, 50% and 100%. The purpose of the sensitivity analysis is to determine the degree of responsiveness of the model through the likely range of parasite load.

The results show that weaning weight of the lamb is less affected by worm intake when the resistance is high than when it is low. The reduction is weaning weight due to lower resistance increased as the worm intake increased, unless the dam's body condition had decreased to a critically low level. A similar trend was observed for milk production.

Seasonal changes which lowered forage quality and quantity was compared with non-limiting forage conditions. Sheep with the same resistance appeared to reach minimal body condition at much lower worm burdens (500 to 2500, depending on the resistance level) in variable forage conditions. With non-limiting forage conditions, the sheep with the same resistance tolerated greater worm burdens (3000 to 5000 depending on resistance level) before reaching their minimal body condition (and therefore imminent death). The sensitivity analysis indicates that the model is responsive to different levels of worm infestation and genetic resistance. Also the parasitic effect reduces animal performance as expected. This increases the confidence we can place in using this component of the model. The next phase will be to study seasonal fluctuations in parasite load and how that will influence model response. Additionally we plan to perform validation studies of this component of the model.

A planned field experiment to infest sheep of different breeds with various levels of larvae has been initiated in collaboration with veterinary parasitologists. A number of measures of levels of worm population and of effects on tissues and performance will be obtained from live lambs and serially sacrified lambs. The findings and data will be used for model validation. If the parasite component is not accurately reflecting the response of actual animals, the data generated in this study could be used to restructure this component to more accurately reflect the biological mechanisms involved. Funding to support this study was secured by the PI outside of the SR-CRSP.

UPDATE (Significance of Findings)

The significance of research findings was mostly covered along with the research accomplishments.

In general, the systems research has translated individual project research findings into producer application in the practical context of the total production systems. Examples are:

a. Optimal breeding and selection goals for DPG, Kenya

b. Number of does required in smallholder flocks, Kenya

c. Identification and quantification of the limiting nutritional factors of DPG production, Kenya

d. Supplementation, timing and amount, required for viable DPG production, Kenya

e. Dairy milking practices most practical, Kenya

f. Replacement doe practices, Kenya

g. Optimal utilization of planted supplemental pasture by sheep, Peru

h. Optimal breeding season in the Altiplano, Peru

i. Optimal selection strategy for Morada Nova sheep, Brazil

j. Optimal practices for sheep production in arid lands*, Kenya

k. Optimal selection for sheep in arid lands, Kenya

*The results of this systems analysis, for example, illustrated that the recommendations for another organization to limit the breeding season would be counter productive. Based on these results, the developmental program to institute seasonal breeding by use of aproned rams is being re-examined.

VIII. Future Directions

Data collected from SR-CRSP projects are continuing to become available; many of these data have been analyzed and published. As recommendations related to production of sheep and goats, particularly packages, are formulated, systems analysis, either informal or formal, must be applied. The Systems Analysis Project has all the elements in place including an annual workshop to train scientists in the use of the TAMU Simulation models. For the current year (1985-86) outside funding for the workshop has been obtained.

Therefore, following the original, stated plan, almost all future activities will be collaborating with SR-CRSP projects in host countries. The Texas A&M team will continue to refine and extend the simulation model, modify it for special uses and make it more user friendly. A separately funded two-year project will interface the sheep model with a forage model. Also a separately funded project designed to explicate cause and effect relationships between helminths and physiological functions is in progress. The objective is to provide information so that the current empirical functions can be restructed on a biological basis.

The Systems Project has established contacts, working relationships, and background knowledge of sheep and/or goat production systems in all SR-CRSP host countries except Morocco. Dr. Eddebbarh, a Ph.D. from Morocco trained in quantitative methods, will participate in the Systems Workshop this (1986) summer; however, there are no specific plans for work in Morocco. Research activities for other host countries are given below.

Kenya

Mr. Steve Tallam, MALD, has received an M.S. degree at Texas A&M working in systems. He is now in place in Kenya initiating systems analyses. He has access to an IBM PC XT and the Systems Project along with the Breeding project will purchase an IBM PC AT to place at his immediate disposal.

The primary concern in Kenya is conducting the research and using the information to establish flocks of viable DPG with smallholders in Western Kenya. The Systems Project has identified some limiting factors and will continue to evaluate them and assist in evaluating and synthesizing packages of practices.

In addition, MALD is now capable of conducting systems analysis in areas other than Western Kenya and with organizations in Kenya other than the SR-CRSP (e.g. ILAC and KALRES). The Systems Project will collaborate in these activities to provide direction in design, conduct and interpretation as well as support to assure that operating necessities are provided to Mr. Tallam.

Peru

Initial system analyses have been completed. These analyses will be extended in collaboration with the Range and Breeding Projects in Peru. Dr. Blackburn of the Systems project also established links with Peruvians and gained on-site experience. Plans include work with the Community Project and the SAIS's.

Brazil

Dr. Elsio Figuerido, EMBRAPA, has completed his Ph.D. at Texas A&M in Animal Breeding, also working in systems (see above). He used forage and sheep data from CNPC - SR-CRSP projects to work out a selection program, based on systems analyses, and will continue that research. Mr. Hasan Rajab will use similar data, extended to include data on Santa Inez and Barbadoes as well as the Morada Nova data that Dr. E. Figueiredo used, for his Ph.D. dissertation at Texas A&M. While Dr. Figueiredo worked out a selection program, Mr. Rajab will examine breed x environmental interaction and management alternatives (simulating factorial experiments) in order to evaluate a more complete set of practices for sheep production in Northeast Brazil.

Linkages are established with both Brazilian and U.S. SR-CRSP project scientists and considerable knowledge and experience about Northeast Brazil sheep and goat production is present at Texas A&M.

Indonesia

Mr. A. R. Siregar, BPT, participated in the 1985 workshop and plans to do his Ph.D. research using systems analysis. His level of expertise will require direct assistance from the Systems Analysis project. Plans are for Systems Project scientists to travel to Indonesia to establish and formulate specific collaborative research. This can not be funded in 85-86, but will be planned for 86-87. The linkages will be with SR-CRSP projects through both U.S. and Indonesia scientists.

Regionalization

The results of the basic research (model development) of the Systems Project is directly transferable to other regions. The Systems Workshop (separately funded in 1986) will provide one avenue for extending our SR-CRSP research. Other countries are sending Ph.D. students and post docs to Texas A&M to work with the SR-CRSP Systems project. Post docs must be limited; to date two have been accepted, one from ICARDA based in Peru and one from INTA in Argentina. Invitations to consider collaboration on systems projects have been received from Egypt and two more developed countries.

KENYA

Breeding/Systems - Texas A & M University

Books and Chapters in Books

Smith, G. M. 1983. Simulation Models for Evaluating the Management of Ruminants in Developing Countries. In Feed Information and Animal Production. Ed. G. E. Robards and R. G. Packham. Commonwealth Ag. Bureaux. p. 463-473. **TAMU-Systems/Breeding**

Theses--(SR-CRSP)

PhD

Blackburn, H. 1984. Simulation of Genetic and Environmental Interaction of Sheep Performance in Northern Kenya. Texas A&M University, College Station. 199 pp. **TAMU-Systems/Breeding**

M. S.

Odenya, W. O. 1982. Relationship of Coat Cover and Production Traits in the Dorper Breed of Sheep. University of California, Davis. 74 pp. **UCD-Breeding**

Okeyo, M. A. 1984. Comparative Reproductive Performance of Dorset Finn Sheep and Rambouillet Ewes and Their F_1 Crosses. University of California, Davis. **UCD-Breeding/TAMU-Systems**

Tallam, S. K. 1985. Validation of the TAMU Goat Simulation Model and Application to Goat Production Systems in Kenya. Texas A & M University, College Station 100 pp. **TAMU-Systems/Breeding**

Theses-(Supporting)

PhD

Figueiredo, E. A. P. 1986. Potential Breeding Plans Developed from Observed Genetic Parameters and Simulated Genotypes for Morada Nova Sheep in Northeast Brazil. Texas A&M University, College Station, Texas. **TAMU-Breeding/Mgmt**

Mohamed, A. M. 1984. Characterization of Five Breeds of Dairy Goats. Texas A&M University, College Station. **Winrock/TAMU-Systems/Breeding**

Stobart, R. 1983. Genetic and Phenotypic Analysis of Liveweight Maturing Patterns and Their Relationship to Ewe Productivity in Columbia, Rambouillet and Targhee Sheep. Texas A&M University, College Station. 112 pp. **TAMU-Systems/Breeding and Montana-Breeding**

M. S.

Bogui, N. S. 1986. Reproductive Performance and Preweaning Growth of Spanish Goats. Texas A&M University, College Station. **TAMU-Breeding/Mgt.**

Coronado, L. F. 1983. Performance of Purebred and Crossbred Sheep on Accelerated Lambing and Cultivated Pastures in Peru. Texas A&M University, College Station. 99 pp. **TAMU-Systems/Breeding**

Mathenge, J. W. 1981. Growth Curve Analysis of Rambouillet Ewes. Texas A&M University, College Station. **TAMU-Systems/Breeding**

Journal Articles, Refereed (SR-CRSP)

Blackburn, H. D. and T. C. Cartwright. 1986. Impact of Environmental Stress on the Performance of Sheep with Different Mature Sizes and Milk Potentials. 3rd. Wld. Cong. Genetics Applied to Livestock Production. 11:510. **TAMU-Breeding/Systems**

Iniguez, L. C., G. E. Bradford and Okeyo A. Mwai. 1986. Lambing Date and Lamb Production of Spring-mated Rambouillet, Dorset and Finnsheep Ewes and Their F1 Crosses. J. Anim. Sci. 63:715-728. **UCD-Breeding**

Journal Articles, Refereed (Supporting)

Stobart, R. H., J. D. Bassett, T. C. Cartwright and R. L. Blackwell. 1986. An Analysis of Body Weights and Maturing Patterns in Western Range Ewes. J. Anim. Sci. 63:729-740. **TAMU-Systems/Breeding--Montana/Breeding**

Manuscripts Submitted or In Press (SR-CRSP)

Blackburn, H. D. and T. C. Cartwright. 1986. Description and Validation of the Texas A & M Sheep Simulation Model. J. Anim. Sci. Submitted. **TAMU-Breeding/Systems**

Blackburn, H. D. and T. C. Cartwright. 1986. Simulated Genotype, Environment and Interaction Effects on Performance of Sheep. J. Anim. Sci. Submitted. **TAMU-Breeding/Systems**

Blackburn, H. D. and T. C. Cartwright. 1986. The Simulated Effects of Genotype and Drought on Sheep Production in Northern Kenya. UNEP-MAB Integrated Project in Arid Lands. IPAL Technical Report. In Press. **TAMU-Systems/Breeding**

Blackburn, H. D. and T. C. Cartwright. 1986. Simulated Production and Biological Efficiency of Sheep in Shifting Environments. J. Anim. Sci. Submitted. **TAMU-Breeding/Systems**

Blackburn, H. D., T. C. Cartwright, F. Ruvuna and A. Mukhebi. 1985. Breed, Nutrition and Management Effects on Milk Production and Weaning Weight of Dual-Purpose Goats. Proc. 4th Small Ruminant-CRSP Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Blackburn, H. D., T. C. Cartwright, G. M. Smith, N. McC. Graham and F. Ruvuna. 1986. The Texas A&M Sheep and Goat Models. Texas Agric. Exp. Sta. Bul. pp. 155. In Press. **TAMU-Systems/Breeding**

Blackburn, H. and C. R. Fields. 1985. Performance of Somali Blackhead Sheep and Galla Goats in Northern Kenya. Int'l. Goat and Sheep Res. In Press. **TAMU-Systems/Breeding**

Blackburn, H. D., L. C. Fierro, T. C. Cartwright, F. C. Bryant and E. Figueiredo. 1986 Simulacion Computarizada de Epocas de Empadre y Programo de Supplementacion Nutricional en al Produccion de Ovinos Corriedale en el Sur de Peru. In: X Reunion ALPA, pp 31. Peru. **TAMU-Systems/Breeding and TT-Range**

Cartwright, T. C., P. Howard, F. Ruvuna and H. Blackburn. 1985. Feasibility of Dual-Purpose Goats for Small Farms of Western Kenya: A Systems Analysis of Meat and Milk Off-Take Potentials and Limiting Factors. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Mukhebi, A., H. Blackburn and F. Ruvuna. 1985. Economics of Pre-weaning Kid Rearing Practices. Proc. 4th Small Ruminant CRSP Workshop. Kakamega, Kenya. **TAMU-Systems/Breeding**

Okeyo, M. A., H. Kayongo-Male, F. Ruvuna, M. Wanyoike, T. C. Cartwright and S. Lumiti. 1985. Feeding and Behavior Patterns of Different Goat Breeds at Ol'Magogo. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Okeyo, M. A., F. Ruvuna, T. C. Cartwright and S. Lumiti. 1985. The Fertility Levels and Heat Detection in East African and Galla Does. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Okeyo, M. A., N. Wanyoike, Gichura, F. Ruvuna, T. C. Cartwright and D. J. Wachira. 1985. Comparison of Edible Meat Yields Among Different Goat Breeds. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Ruvuna, F., T. C. Cartwright and M. A. Okeyo. 1985. The Kenya Dual-Purpose Goat, its Development and Utility. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Ruvuna, F., T. C. Cartwright. 1986. Development of a Kenya Dual Purpose Goat for Smallholder Intensive Farming. J. Anim. Sci. Submitted **TAMU-Breeding/Systems**

Ruvuna, F., T. C. Cartwright, M. A. Okeyo and H. D. Blackburn. 1986. Lactation Performance of Tropical Goat Breeds and Growth Rate of Kids Under Different Milking and Rearing Methods. J. Anim. Sci. Submitted **TAMU-Systems/Breeding**

Ruvuna, F., T. C. Cartwright, M. A. Okeyo, H. D. Blackburn and S. Chema. 1986. Characterization of Goat Production Potential in a Tropical Environment. 1. Factors Influencing Gestation Length in Different Breeds and Breed Crosses of Goats. J. Anim. Sci. Submitted **TAMU-Systems/Breeding**

Ruvuna, F., T. C. Cartwright, M. A. Okeyo, H. D. Blackburn and S. Chema. 1986. Characterization of Goat Production Potential in a Tropical Environment. 2. Factors Affecting Body Weight of East African and Galla Goats and Estimates of their Mature Weight. J. Anim. Sci. Submitted
TAMU-Systems/Breeding

Ruvuna, F., M. A. Okeyo, T. C. Cartwright and S. Lumiti. 1985. Growth and Suckling Patterns of Kids Grazed With Their Dams. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Ruvuna, F., F. Rurangirwa, Kiio, T. McGuire, T. C. Cartwright, S. Chema and M. A. Okeyo. 1985. Dual-Purpose Goat Potential in Tsetse Areas of Kenya; Growth and Survival Evaluation at Ukunda Research Station. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU-Systems/Breeding**

Tallam, S., T. C. Cartwright, P. Howard, C. D. Lu and H. Blackburn. 1985. Validation of the Kenya Goat Simulation Model for Application to Dairy Production. Proc. 4th Small Ruminant-CRSP Workshop, Kakamega. In Press.
TAMU-Systems/Breeding

Manuscripts Submitted or In Press (Supporting)

Stobart, R. H., R. L. Blackwell, T. C. Cartwright and J. W. Bassett. 1986. Relationships Between Growth and Productivity of Range Ewes. J. Anim. Sci. Submitted. **TAMU-Systems/Breeding/Montana-Breeding**

Abstracts (SR-CRSP)

Blackburn, H. D., T. C. Cartwright and F. Ruvuna. 1986. Simulation of Breed, Nutrition and Management Effects on Milk Production and Weaning Weight of Dual Purpose Goats. Proc. IV International Conference on Goats. Brazil. Submitted.

Blackburn, H. D., P. J. Howard, T. C. Cartwright and F. Ruvuna. 1986. Simulation of the Effect of Flock Size and Nutrition on Goat Productivity in Kenya. Proc. IV International Conference on Goats, Brazil. Submitted.

Ruvuna, F., T. C. Cartwright, M. A. Okeyo and H. D. Blackburn. 1986. Milk Yield and Growth Rates of Kids Under Different Milking Methods of Tropical Goat Breeds. Proc. IV International Conference on Goats. Brazil. Submitted.

Ruvuna, F., T. C. Cartwright, M. A. Okeyo, H. D. Blackburn and S. Chema. 1986. Characterization of Indigenous Goats of Kenya for Dual Purpose Potential. 1. Pre and Postweaning Growth. Proc. IV International Conference on Goats. Brazil. Submitted.

Ruvuna, F., T. C. Cartwright, M. A. Okeyo, H. D. Blackburn and S. Chema. 1986. Characterization of Indigenous Goats of Kenya for Dual Purpose Potential. 2. Weights and Postpartum Interval. Proc. IV International Conference on Goats. Brazil. Submitted.

Tallam, S. K., T. C. Cartwright and C. D. Lu. 1986. Validation of TAMU Goat Simulation Model for Intensive Dairy Goat Production. Proc. IV International Conference on Goats, Brazil. Submitted.

Abstracts (Supporting)

Blackburn, H. D., T. C. Cartwright and G. M. Smith. 1984. The Simulated Effect of Environmental Shifts on the Flock Dynamics of Sheep with Different Genotypes. J. Anim. Sci. 59 (Suppl. 1):157. **TAMU-Systems/Breeding**

Blackburn, H. D. and T. C. Cartwright. 1985. Validation of the Texas A&M Sheep Production Model. J. Anim. Sci. 61 (Suppl. 1):440. **TAMU-Systems/Breeding**

Bogui, N. S., T. C. Cartwright and J. M. Shelton. 1986. Reproductive Performance and Preweaning Growth of Meat Goats in Texas. Proc. IV International Conference on Goats, Brazil. Submitted. **TAMU-Systems/Breeding**

Cartwright, T. C. and G. M. Smith. 1982. Systems Analysis of Goat Production. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. p. 503. **TAMU-Systems/Breeding**

Osorio, S., A. Pumayualla and J. Bassett. 1985. Parametros Techologicos de la Fibra de Alpaca Huacaya Proveniente de Rebanos Mejorados y de Comunicades Campesinas del Pepartamento de Puno. V Convencion Internacional Sobre Camelidos Sudamericanos. June 1985. Cuzco, Peru. **TAMU-Breeding and National Agrarian University, La Molina, Lima, Peru.**

Technical Communications (SR-CRSP)

Blackburn, H. D., T. C. Cartwright, A. B. Carles and F. Ruvuna. 1984. A Conceptual Overview of the SR-CRSP Goat Production Model. Proc. 3rd Small Ruminant-CRSP Kenya Workshop, Kabete. p. 219-230. **TAMU-Systems/Breeding**

Blackburn, H. D., T. C. Cartwright, C. R. Field and A. B. Carles. 1984. A Simulation of Genetic Environmental Interactions of Sheep Productivity in Northern Kenya. Proc. 3rd Small Ruminant-CRSP Kenya Workshop, Kabete. p. 261-274. **TAMU-Systems/Breeding**

Carles, A. B. 1984. Introduction of Systems Analysis Concepts in Agricultural Education. Proc. 3rd Small Ruminant-CRSP Workshop, Kabete. p. 275-277. **TAMU-Systems/Breeding**

Cartwright, T. C. 1984. A Strategy for Breeding Dual-Purpose Goats in Kenya. Proc. 3rd Small Ruminant-CRSP Kenya Workshop, Kabete. p. 199-202. **TAMU-Systems/Breeding**

Cartwright, T. C. 1984. The Concept of Systems Analysis and its Application to Examining Practical Problems in Kenya. Proc. 3rd Small Ruminant-CRSP Workshop, Kabete. p. 217-218. **TAMU-Systems/Breeding**

Cartwright, T. C., A. B. Carles, F. Ruvuna, G. M. Smith, H. D. Blackburn, P. J. Howard and S. K. Tallam. 1984. Special Report of the SR-CRSP Systems Analysis Project. Anim. Sci. Dept., Texas A&M University, Mimeograph. p. 413. **TAMU-Systems/Breeding**

Cartwright, T. C., R. Hart, H. Blackburn, F. Ruvuna, S. Tallam and P. Howard. 1984. Results of Systems Analysis Application to Dual-Purpose Goat Production in Western and Nyanza Provinces. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. pp. 231-260. **TAMU-Systems/Breeding**

Cartwright, T. C., F. Ruvuna, B. Hart, H. Blackburn, G. Smith and A. Carles. 1983. Simulated Dual Purpose Performance of Goats Utilizing Forage Production Potential of a Smallholder. Proc. 2nd SR-CRSP Kenya Workshop. pp 119. **TAMU-Systems/Breeding**

Cartwright, T. C. and G. M. Smith. 1983. Application of the Kenya Dual Purpose Goat Model. TAMU Mimeograph. (Update of Original Version Distributed in 1979.) **TAMU-Systems/Breeding**

Supporting Technical Communications

Bradford, G. E. 1981. The Potential of Dairy Goats as a Source of Milk for Smallholder Farms in Kenya. Proc. An. Prod. Soc. of Kenya (12 pp.) and SR-CRSP Tech. Rpt. #7. **UCD-Breeding**

Bradford, G. E., Y. M. Berger, V. Chemitei, and D. Kimenye. 1982. Progress and Future Work on the Small Ruminant CRSP Breeding Project. Proc. SR-CRSP Kenya Workshop. pp. 8-9. **UCD-Breeding**

Cartwright, T. C. 1982. Net Herd Productivity as a Selection Objective. Proc. Austr. Assoc. Anim. Breed. and Genetics. **TAMU-Systems/Breeding**

Cartwright, T. C. 1982. Developing Animal Breeding Strategies to Increase Herd Efficiency and to Cope with Change. 5th A. S. Nivison Memorial Address. Univ. of New England. Armidale, N. S. W., Australia. p. 16. **TAMU-Systems/Breeding**

Cartwright, T. C. 1982. Herd Level Modeling as a Tool in Breeding Systems in the Tropics. Proc. 2nd World Congr. on Genetics Applied to Livestock Prod. VI. pp. 269-278. **TAMU-Systems/Breeding**

Cartwright, T. C. 1986. Trends and Potentials in Developing Countries for Improving Dairy Goats. Proc. Third Dairy Goat Field Day, Prairie View International Dairy Goat Research Center. pp. 21-23. **TAMU-Systems/Breeding**

Coppock, D. L., J. E. Ellis, J. Wienpahl, J. T. McCabe, D. M. Swift and K. A. Galvin. 1983. A Review of Livestock Studies of the South Turkana Ecosystem Project. Proc. SR-CRSP Kenya Workshop. pp. 168-172.

Field, C. R. 1982. The Smallstock Program of the UNESCO-Integrated Project in Arid Lands. Proc. SR-CRSP Kenya Workshop. pp. 151-167.

Kimenye, D., C. Ngugi, Y. Berger, C. Ahuya and F. Ruvuna. 1983. Artificial Insemination and Its Potential Use on Goats in Kenya. Proc. 2nd SR-CRSP Kenya Workshop. pp. 102-104. **TAMU-Systems/Breeding**

Pumayalla, A. and J. W. Bassett. 1983. Efectos de la Esquila, Tiempo de Crecimiento y Mejoramiento Genetico en Fibra de Alpaca del Departamento de Puno. Informe Parcial. La Molina. **TAMU-Systems**

Ruvuna, F., T. C. Cartwright, A. M. Okeyo, W. Muhuyi, C. Ahuya and J. Kitilit. 1984. Effects of Partial Suckling on Lactation Performance of Galla and East African Goats and the Growth Rates of the Kids. Prod. 3rd Small Ruminant-CRSP Kenya Workshop, Kabete. p. 203-216. **TAMU-Systems/Breeding**

Ruvuna, F., T. C. Cartwright, G. M. Smith, G. E. Bradford, Y. Berger, C. Ahuya and J. Muia. 1983. Preliminary Results of Performance of Different Breeds of Goats at Ol Magogo. Proc. 2nd SR-CRSP Kenya Workshop. pp. 83-98. **UCD-Breeding/TAMU-Systems/Breeding**

Smith, G. M., A. B. Carles, H. J. Schwartz, H. Blackburn, F. Ruvuna and T. C. Cartwright. 1982. Analysis and Synthesis of Small Ruminant Production Systems. Proc. SR-CRSP Kenya Workshop. p. 41. **TAMU-Systems/Breeding**

Verbal Presentations (SR-CRSP)

Blackburn, H. D. 1985. Using Systems Analysis to Link Physiological and Nutritional Factors Together as a Method to Evaluate Ram Nutrition. Asoc. Peruna de Prod. Anim. VIII Reunion y II Curso Intnl. de Produccion Ovina. Huancayo, Peru. **TAMU-Breeding/Systems**

Blackburn, H. D. 1985. Simulation of Genetic and Environmental Interaction of Sheep Performance in Northern Kenya. Seminar. Texas A & M. **TAMU-Breeding/Systems**

Blackburn, H. D. 1981. The Use of Systems Analysis Techniques in Animal Production. University of Nairobi, Kenya. **TAMU-Breeding/Systems**

Blackburn, H. D., L. C. Fierro, T. C. Cartwright, F. C. Bryant and E. Figueiredo. 1986. Simulacion Computarizada de Epocas de Empadre y Programas de Suplementacion Nutricional en la Produccion de Ovinos Corriedale en Pastoreo en el Sur de Peru. X Mtg. Latin Am. Anim. Prod. Asoc. Acupulco, Mexico. **TAMU-Systems/Texas Tech-Range**

Tallam, S. K. 1985. Validation of the TAMU Goat Simulation Model and Application to Goat Production Systems in kenya. Seminar. Texas A&M. **TAMU-Breeding/Systems**

Supporting Verbal Presentations

Gathuka, Z. 1982. Milk Production of Spanish Does and Milk Intake and Growth of Their Kids. Prof. Paper, Anim. Brd. Sect., Texas A&M. **TAMU-Systems**

SR-CRSP

ANNUAL REPORT

1985-86

I.	**Project Title:**	Economic Analysis of Small Ruminant Production and Marketing Systems
II.	**Host Country:**	Kenya
III.	**Principal Investigator:**	Hendrik C. Knipscheer
IV.	**Personnel:**	Host Country Co-Workers: A. Mukhebi L. Oyugi H. Ogadi U.S. Co-Workers: A. J. De Boer F. Nyaribo

V. Project Goals

1. Develop useful whole-farm economic model of Western Kenya small farms to assist in <u>ex ante</u> evaluation of dual-purpose goat acceptance.

2. 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.

VI. Objectives

Analysis of component technologies. A variety of analytical techniques will be applied to the experimental data generated from trials on 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 linear programming (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.

Goat and goat product market, market practices, and prices policy analysis.

VII. Research Accomplishments

The Economics Project has formulated two accounting models for quantifying costs and benefits of various component DPG technologies and management practices, namely the gross margin model and the partial budget model.

The gross margin model has been used for determining gross margins (GM) of various farm enterprises as measures of their relative profitability. It involves quantifying products of each farm enterprise and their farm-gate prices, as well as variable inputs used by the enterprise and their farm gate costs. Enterprise GM is then calculated as the difference between the value of enterprise products and cost of enterprise variable inputs. Enterprise GMs are computed per unit of land, labor, and capital inputs as measures of short-run enterprise resource returns.

The GM model has been used by the Economics Project in developing input-output coefficients for the LP model, and for preliminary comparisons of the profitability of the DPG enterprise with other competing farm enterprises in clusters.

The partial budget model has been used for economic analyses of selected component DPG technologies and management practices. It involves quantifying incremental costs and benefits of a test technology or practice over a conventional one, and determining the marginal net benefit or benefit-cost ratio (absolute marginal rate of return) of the test technology or practice. The benefit cost ratio or marginal rate of return is then used as a choice indicator for ranking and identifying economically most promising DPG technologies or management practices. Examples of partial budget analyses undertaken are summarized below.

1. Economics of Intercropping Forage Crops with maize in Kaimosi cluster. This analysis quantified economic costs and benefits of intercropping selected forage crops with maize; assessed the impact of applying fertilizer to maize both ir pure stand and intercropped with forage crops, and identified economically most promising maize forage intercrops for the target area.

2. Although based upon biological data from one season only, several conclusions were drawn from the results. First, intercropping maize with forage crops with or without fertilizer application has no economic advantage over pure stand maize at Maseno station, and in Masumbi cluster without fertilizer application. Second, intercropping maize with forage crops yields greater economic returns than pure stand maize, with or without fertilizer application in Kaimosi cluster, and with fertilizer application in Masumbi cluster except for the maize-pigeon pea intercrop. Third, for Kaimosi cluster, maize intercropped with leguminous forages yields higher economic returns than maize intercropped with sudan grass when fertilizer is not applied. In this case, the maize-pigeon pea and maize-sesbania intercrops in that order are the economically most promising intercrops for Kaimosi cluster.

Fourth, for Kaimosi cluster, maize-sudan grass intercrop generates greater economic returns than maize-legume intercrop when fertilizer is applied. For this case, maize-sudan grass and maize-pigeon pea intercrops in that order are the economically most promising intercrops. Fifth, for Masumbi cluster, maize-sesbania followed by maize-sudan grass are the most promising intercrops only when fertilizer is applied. When fertilizer is not applied, pure stand maize is economically superior to the maize-forage intercrops. Sixth, fertilizer application was economically more profitable than nonfertilizer application at all sites for both pure stand maize and maize intercrops. Seventh and lastly, while intercropping maize with forage crops yields greater economic returns than pure stand maize in some areas, it may lead to economic loss in other areas depending upon soil fertility and climatic conditions of the areas in question.

3. Economics of Preweaning Kid Feeding Practices at Maseno Research Station. This analysis quantified economic costs and benefits of various preweaning kid feeding practices, assessed the impact of supplementing milk with forage in such practices, and identified economically most promising practices.

   Several conclusions were drawn from this study. First, the practice of feeding kids all mother's milk is less economical than feeding half, 0.5 kg and 0.3 kg of mother's milk. Second, given natural or improved forage conditions, the most economically promising kid rearing practice is feeding kids 0.5 kg of mother's milk, followed by feeding half of mother's milk. Third, it is uneconomical to feed East African Goats on improved forage.

   On the basis of the above calculations, it is recommended that the East African goats should be reared on natural pastures and the preweaning kids should be fed at least 0.5 kg of mother's milk.

4. Economics of Internal Parasite Control Among Goats. The analysis quantified economic costs and benefits of controlling worm infestation among goats and assessed the economic performance of different breeds of goats under both worm infested and uninfested conditions.

   It was concluded from the above study that 1) substantial economic benefits are generated from drenching East African, Galla, and East African x Toggenburg Cross goats against internal parasites; 2) East African goats are economically superior to the Galla and East African x Toggenburg Cross goats under uncontrolled internal parasite conditions, and superior to the Galla goats even under controlled internal parasite conditions; 3) East African x Toggenburg Cross is economically superior to the Galla both under controlled and uncontrolled internal parasite conditions, and superior to the East African only under controlled internal parasite conditions.

The following recommedations were made from these conclusions. First, goats should be drenched regularly against internal parasites. Second, when control of internal parasites is not practiced, East African rather than the Galla or East African x Toggenburg Cross goats should be reared. Third, when control of internal parasites is practiced, the East African x Toggenburg Cross should be reared.

5. Economics of Simulated Preweaning Kid Rearing Practices for the East African Goats in Hamisi, Western Kenya. This analysis quantified economic costs and benefits of various simulated kid rearing practices and identified the economically most promising practices.

   The conclusions flow from the results of this study were the following. The practice of feeding kids milk ad lib is economically inferior to the other feeding practices with or without forage supplementation. When forage supplement is not provided, the practice of feeding kids mother's milk only is the most promising economically, followed by feeding half mother's milk are the economically most promising preweaning feeding practices. On average, it is uneconomical to supplement milk with forage in preweaning kid feeding practices, except when the practice of feeding half mother's milk is adopted.

   Two recommendations were made from the above conclusions. First, feeding kids milk ad lib with or without forage supplementation should not be encouraged. Second, feeding kids half or about half mother's milk supplemented with forage should be encouraged as the preweaning kid feeding practices.

Several livestock markets in Western Kenya were monitored weekly by enumerators during a full calendar year. Analysis of data is presently underway. Preliminary data suggests distinct seasonal fluctuations in supply and prices.

VIII. Funding

Grant No. AID/DSAN-XII-G-0049 from 1985/86 subgrant: $289,529

KENYA

Economics - Winrock International

Theses--(SR-CRSP)

PhD

Job, M. O. 1982. A Study of Technology Adoption by Subsistence Farmers with a Case Study Involving Dairy Goats in Kenya. Purdue University, Lafayette. 215 pp. **Winrock-Economics**

M. S.

Mortimer, D. L. 1982. A Socioeconomic Assessment of Small Ruminant Disease in Kenya. Dept. of Agricultural Economics, Washington State University, Pullman. 188 pp. **Winrock-Economics**

Journal Articles, Refereed (Supporting)

DeBoer, A. J. 1981. Socioeconomic Aspects of Dairying in Developing Countries. J. Dairy Sci. 64(12):2453-2462. **Winrock-Economics**

Manuscripts Submitted or In Press (SR-CRSP)

DeBoer, A. J., M. Job and G. Maundu. 1984. The Relative Profitability of Meat Goats, Angora Goats, Sheep and Cattle in Four Agroeconomic Zones of Kenya. World An. Review. Submitted. **Winrock-Economics**

Job, M., B. McCarl and J. DeBoer. 1984. An Economic Analysis of Dual-Purpose Goat Adoption on Small Farms in Western Kenya. Am. J. of Ag. Econ. Submitted. **Winrock-Economics**

Moore, D. L., R. J. Folwell, A. J. DeBoer, J. Bari and S. Mbweri. 1985. Small Ruminants in Western Kenya: Producer Socioeconomic Status Relative to Fecal Helminth Egg Counts. Int'l. Goat and Sheep Res. In Press. **Winrock-Economics**

Mukhebi, A., H. Blackburn and F. Ruvuna. 1985. Economics of Pre-Weaning Kid Rearing Practices. Proc. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega. In Press. **TAMU/WI-Systems & Economics**

Manuscripts Submitted or In Press (Supporting)

Redfern, J. M., P. D. Rundle, M. D. Norman, J. A. Yazman and A. J. DeBoer. 1983. An Economic Analysis of Commercial Dairy Goat Producers in Northern Arkansas and Southern Missouri. Int'l. Goat and Sheep Res. Submitted. **Winrock-Economics**

Abstracts (SR-CRSP)

DeBoer, A. J., M. Job and G. Maundu. 1982. The Relative Profitability of Meat Goats, Angora Goats, Sheep, and Cattle in Four Agro-Economic Zones of Kenya. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. p. 355.

Technical Communications (SR-CRSP)

DeBoer, A. J., M. Job and R. W. Matthewman. 1982. Economic Modeling of Small Farms in Western Kenya. Proc. SR-CRSP Kenya Workshop. pp. 91-96.
Winrock-Economics

DeBoer, A. J., M. O. Job and B. A. McCarl. 1983. Economic Factors Influencing the Simulated Adoption of Dual-Purpose Goats on Representative Small Farms in Western Kenya. Proc. 2nd SR-CRSP Kenya Workshop. pp. 40-48.
Winrock-Economics

Matthewman, R. W. and J. DeBoer. 1982. Economic Constraints on Dual-Purpose Goat Production in Western Kenya. Proc. SR-CRSP Kenya Workshop. pp. 97-112.
Winrock-Economics

Mukhebi, A. W. and E. Reynolds. 1985. Ensuring Socioeconomic Relevance in Dual Purpose Goat Technology Generation for Small Scale Farmers in Western Kenya. Workshop on Methodologies, Practical Approaches and Potential Contribution of Farming Systems Research for Rural Development in Sub-Saharan African, Egerton College, Njoro, Kenya.
Winrock-Economics/Missouri-Sociology

Mukhebi, A. W., E. Reynolds, H. C. Knipscheer and A. J. De Boer. 1985. Socioeconomic Methodologies in the Dual-Purpose Goat Farming Systems Research in Western Kenya. Regional Workshop on Livestock in Mixed Farming Systems Research Methodologies and Priorities, FSSP/ILCA, Addis Ababa.
Winrock-Economics/Missouri-Sociology

Mukhebi A. W., F. Ruvuna and H. Blackburn. 1985. Economics of Simulated Preweaning Kid Rearing Practices for the East African Goats in Hamisi, Western Kenya. 4th SR-CRSP Kenya Workshop, Kakamega, Kenya. **Winrock-Economics**

Mukhebi, A. W. and J. F. M. Onim. 1985. Economics of Inter-Cropping Forage Crops With Maize in Kaimosi, Kakamega District. SR-CRSP Kenya Workshop, Kakamega, Kenya. **Winrock-Economics**

Mukhebi, A. and M. Onim. 1985. Economics of Intercropping Forage Crops With Maize in Kaimosi. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya.
Winrock-Production Systems

Mukhebi, A. W., J. E. Reynolds, F. B. Nyaribo, A. N. Mbabu and R. H. Bernsten. 1984. A Socioeconomic Evaluation of the Dual Purpose Goat Enterprise in Small Scale Farming Systems in Western Kenya. Proc. 3rd SR-CRSP Kenya Workshop. pp. 95-108. **Winrock-Economics/U. Mo.-Sociology**

Mukhebi, A. W. and A. E. Sidahmed. 1985. Economics of Preweaning Kid Feeding Practices at Maseno Research Station. 4th SR-CRSP Kenya Workshop, Kakamega, Kenya. **Winrock-Economics**

Mukhebi, A., R. S. Shavulimo, F. Ruvuna, and F. Rurangirwa. 1985. Economics of Internal Parasite Control Among Goats. 4th Small Ruminant-CRSP Kenya Workshop, Kakamega, Kenya. **Winrock-Economics**

Nyaribo, F. B. 1983. Analysis of Household Consumption in Western Kenya During the Short and Long Rains with a Comparison of On-Farm Produced Food and Off-Farm Food Purchases. Proc. 2nd SR-CRSP Kenya Workshop. pp. 152-162. **Winrock/MLD-Economics**

Technical Communications (Supporting)

DeBoer, A. J., H. A. Fitzhugh, R. H. Bernsten, W. Getz and D. W. Robinson. 1983. Sheep and Goats in Developing Countries. A World Bank Technical Paper. 116 pp. **Winrock-Economics**

deLeeuw, P. N. and C. P. Peacock. 1982. The Productivity of Small Ruminants in the Maasi Pastoral System, Kajiado District, Kenya. Proc. SR-CRSP Kenya Workshop. pp. 118-138.

Raun, N. S. 1982. The Emerging Role of Goats in World Food Production. Proc. 3rd Int'l. Conf. on Goat Prod.and Dis., Tucson, AZ. pp. 133-141. **Winrock**

SR-CRSP

ANNUAL REPORT

1985-86

I.	**Project Title:**	Animal Health Research Component
II.	**Host Country:**	Kenya
III.	**Principal Investigator:**	Travis McGuire
IV.	**Personnel:**	Host Country Co-Workers: S. Chema D. Mwamachi A. Kibor S. Waghela Mwakima Kio R. Shavulimo J. Njanja U.S. Co-Workers: F. Rurangirwa F. Ruvuna R. Wescott

V. Research Accomplishments (listed by experiment)

EXPERIMENT NUMBER: HL/Kab/S/85-86-1

TITLE: Production and testing of an inactivated and lyophilized vaccine for contagious caprine pleuropneumonia (CCPP)

OBJECTIVE: Determine the effect of vaccine concentration on longevity of immunity induced by both one and two doses of lyophilized F-38 vaccine.

Eight groups of 5 goats each were immunized with different doses of lyophilized F-38 strain of mycoplasma to determine the minimum dose that will induce protective immunity against virulent challenge of CCPP. Seven of the groups were immunized with the F-38 incorporated in saponin as an adjuvant while the remaining group was immunized with the highest dose (1.50 mg) of the F-38 in presence of saponin as an adjuvant was the minimum dose that could induce protective immunity against virulent challenge of CCPP. The highest dose without adjuvant had no protective effect. Even after 14 months of storage at 22°C or 4°C, the minimum dose for protection remained the same.

SIGNIFICANCE:

The research shows that lyophilization and storage of F-38 at 22°C or 4°C does not affect its immunogenicity provided that saponin is used as an adjuvant. Furthermore, large quantities of lyophilized F-38 can be produced and stored at either temperature for up to 14 months without affecting determinants necessary for inducing protective immunity for more than one year and that can be stored under field conditions in Kenya.

EXPERIMENT NUMBER:HL/Kab/S/85-86/2

TITLE: A field diagnostic test for contagious caprine pleuropneumonia using a purified carbohydrate antigen

OBJECTIVE: To coat latex or other inert particles with isolated carbohydrate antigen and determine its efficacy as a field diagnostic test.

A polysaccharide was extracted by warm aqueous phenol from the F-38 strain of Mycoplasm that causes CCPP. After acid hydrolysis, the polysaccaride was found to be composed of the neutral sugars glucose, galactose, mannose and fucose and the aminosugars galactosamine and glucosamine, all present in approximately equal quantities. Unmodified goat erythrocytes bound the polysaccharide readily and the sensitized cells reacted with antibodies in sera from goats with experimental or natural CCPP. The unique composition of the F-38 polysaccharide and the specific reactivity of polysaccharide-sensitized red cells with antibodies from CCPP infected animals suggests that the polysaccharide should be useful for identification of F-38 organisms and diagnosis of the disease.

Latex beads were sensitized with a polysaccharide isolated from F-38 culture supernatant and used in an agglutination test to detect serum antibodies in goats with CCPP. The latex agglutination test (LAT) detected antibodies in the sera of goats 22 days after CCPP contact exposure. In contrast, the complement-fixation test (CFT) detected antibodies 24 days after contact exposure. When the two tests were performed on 181 sera from a CCPP free farm, they were both negative. However, when the same tests were performed on 256 sera from a farm with an outbreak of CCPP, 59% were postive by LAT, while 27% were positive by CFT. Besides being more sensitive, the LAT can be performed in the field on undiluted serum and read within 5 minutes.

SIGNIFICANCE:

Our current studies demonstrate for the first time that the F-38 strain produces large quantities of an extracellular polysaccharide that reacts within antibodies in sera from experimentally or naturally infected goats, and the lack of activity in sera from goats with no history of CCPP indicate that the polysaccharide should be useful as a diagnostic antigen as well as for identification of the F-38 strain of Mycoplasm.

EXPERIMENT NUMBER: HL/Kab/S/85-86/3

Title: Preparation of antigens for the diagnosis and prevention of heartwater in goats

Objectives: Develop a serologic test. Isolate heartwater organisms from infected tick nymphs.

Heartwater is a rickettsial disease of goats, sheep and cattle. In goats, the disease causes a very high mortality and can be devastating in susceptible populations. Transmission is by ticks, which are widely distributed in Kenya. A Ph.D. student is currently working on this project with the hope of producing a more effective diagnostic method and working toward a vaccine for the disease.

SIGNIFICANCE:

This research is directed toward diagnosing and preventing one of the most serious diseases of goats in Kenya and other parts of Africa.

EXPERIMENT NUMBER: HL/Kab/S/85-86/4

TITLE: Development of strategies to introduce crossbred goats into areas with trypanosomiasis

OBJECTIVE: To determine the difference in disease parameters between kids receiving immune colostrum and those receiving non-immune colostrum when both groups are challenged with the *Trypanosoma congolense* clone and later by the immediate relapse populations

Newborn goats allowed to suckle from mothers immunized with variable surface glycoprotein of *T. congolense* clone ILNat 3.1 survived for an average of 89 days while those that suckled non-immunized mothers survived for an average of only 51 days. The fact that all animals died is attributed to antigenic variation that produces different trypanosome populations at different times. The longevity was not correlated with the level of antibody detectable by indirect fluorescent antibody test on acetone fixed smears, probably because of the poor sensitivity of this test. The degree of anemia in the kids that suckled immunized mothers was significantly lower than in the controls even though the parasitemia was significantly lower in the test kids starting from the second week after infection. The two groups, however, experienced no significant difference in weight gain or body temperature.

SIGNIFICANCE:

The kids receiving antibody to the infecting clone lived longer and had fewer parasites, indicating that if antibodies to multiple antigenic variants were transferred, marked protection would be obtained. Goats introduced to new areas would benefit from passive antibody to trypanosomes.

EXPERIMENT NUMBER: HL/Kab/S/85-86/5

TITLE: Evaluation of genetic resistance to trypanosomiasis

OBJECTIVE: To evaluate genetic resistance to trypanosomiasis in indigenous and crossbred goats.

The overall purpose of the Kenya project is to introduce dual purpose goats--those that produce both milk and meat. This goal requires the use of milk-producing goats from outside Africa bred with native goats. Since it appears that goats from tsetse-infested areas of Africa have a tolerance to trypanosomiasis while others do not, this research was undertaken to determine the susceptibility of different goat breeds under natural tsetse-transmitted trypanosoma challenge, to quantify the effect of trypanosome infection on performance and to assess the biological significance of use of trypanocidal drugs in treating the infected goats.

After a year of grazing in a tsetse-infested area of Kenya, 48 percent of the goats on experiment had contracted trypanosomiasis, although only 6 percent died of the disease. The highest infection rates occurred during June through October, which accounted for 80 percent of the total infections. The East African breed was least susceptible to trypanosomiasis and Toggenburg X Galla was most susceptible, but all breeds suffered from infection. Measurements of weight and packed cell volume showed that PCV and weight both dropped during the first 30 days of infection, compared with the same values for uninfected animals. By 120 days post-infection, however, infected and uninfected goats had similar values.

SIGNIFICANCE:

The finding that all breeds of goat are susceptible to trypanosomiasis infection, though some breeds are somewhat less susceptible than others, may have an important bearing on the choice of breeds to use in a breeding project involving goats to be introduced into trypanosomiasis areas of Kenya.

EXPERIMENT NUMBER: HL/Kab/S/85-86/6

TITLE: To determine the cause of any diseases and deaths of the exotic crossbred goats introduced to farms in Western Kenya.

OBJECTIVE: Determine health problems of goats introduced to SR-CRSP sites in Western Kenya

SR-CRSP animal health personnel and MALD scientists are monitoring the health of goats introduced onto small farms in Kenya. This work is continuing, although it is clear that strategies that involve minimal intervention are going to be the most useful.

EXPERIMENT NUMBER: HL/MA/S/85-86/7

TITLE: Evaluation of breed differences in resistance to *Haemonchus contortus*

OBJECTIVE: Challenge different breeds of goats with *Haemonchus contortus* and evaluate resistance

Twelve East African, 9 Galla and 13 East African X Toggenberg crosses were artificially infected with 500 *Haemonchus contortus* larvae per kilogram of live weight. Five East African, 4 Galla and % East African X Toggenberg crosses were uninfected controls. Measurements of live weights, packed cell volume, worm egg counts, clinical signs and mortality indicated that the Galla breed suffered the most damaging effects of acute infection and that the East African breed was best able to resist larval challenge. Statistical analysis of the mortality data showed that infection had a significant effect on mortality of the combined breeds, but there was no significant difference when the breeds were compared with each other. The same is true of live weight changes and packed cell volume. The Galla goats had the highest worm egg count in the feces, but the difference among breeds was not significant.

SIGNIFICANCE:

Like the trypanotolerance work, this research might influence the choice of which breeds of goats to use in producing a dual-purpose goat.

EXPERIMENT NUMBER: HL/Kab/S/85-86/8

TITLE: Control of Haemonchosis and other gastrointestinal parasites

OBJECTIVES: To initiate studies to compare the effectiveness of IVOMEC and PARATECT for control of gastrointestinal nematodes in goats

Since we were unable to obtain a slow-release bolus of Morantel suitable for use in goats, the experiment is postponed until a formulation can be obtained.

EXPERIMENT NUMBER: HL/Kab/S/85-86/9

TITLE: Monitoring of caprine arthritis encephalitis (CAE) virus in Kenya

OBJECTIVES: Continue CAE testing. Continue evaluation of new, more sensitive tests.

Samples from 300 goats and 300 sheep herded together were tested for CAE antibodies. All samples were negative. No new cases of CAE have been detected since the eradication program in Kenya.

SIGNIFICANCE:

CAE has been eradicated from Kenya. We recommend that all goats imported into Kenya and adjacent countries be tested for CAE.

EXPERIMENT NUMBER: HL/Kab/S/85-86/10

TITLE: Identification of antigenic determinants on the surface of trypanosomes

OBJECTIVES: Identify exposed peptides on VSG

The structural relationship between surface exposed regions of five different variable surface glycoproteins (VSGs) from WaTat 1 trypanosomes was examined. Four of these trypanosome clones were known, from immunofluorescence tests, to share exposed epitopes. Tryptic peptides of VSGs from surface labelled trypanosomes were mapped by Reverse Phase-High Pressure Liquid Chromatography (RP-HPLC). Four trypanosomes, WaTat 1.1, 1.12, 1.13, and 1.14 shared six labeled peptides eluting at 23, 43, 50, 68, 72, and 84 minutes. The peptide eluting at 68 minutes was the predominant radiolabeled component in all four maps. Overall, HPLC elution profiles of surface labelled peptides from these four trypanosomes were very similar, although peptides unique to individual clones were observed. The maps were clearly distinct from that of WaTat 1.2 organisms, which did not share exposed epitopes with the other four clones. The results that WaTat 1.1, 1.12, 1.13 and 1.14 trypanosomes have similar VSG amino acid sequences exposed on their surfaces.

SIGNIFICANCE:

This demonstrated similarity among trypanosome clones shows that it might be possible to group organisms in accordance with shared exposed epitopes. If this hypothesis is correct, it might be possible to break down the large VSG repertoire into groups sharing common VSG tertiary structures and also exposed epitopes, if a suitable immune response can be induced.

VI. Future Direction

The following major areas are targeted for future research:

1. The control of heartwater, which is a tick-transmitted disease of goats in all of Africa. Heartwater is a major problem when introducing goats into endemic areas and threatens entire strategies that depend on expanding goat populations.

2. Exploiting genetic resistance to diseases as a way of controlling major disease problems without costly interventions by farmers. We have preliminary evidence of differences in breed susceptibility to both haemonchosus (a major helminth parasite) and trypanosomiasis (a protozoa). These observations must be verified and the mechanisms of the resistance determined so that they can be exploited in goat breeding.

KENYA

Health - Washington State University

Books and Chapters in Books

Chema, S. 1984. Low Input Low Output Animal Health Programmes: Generating Data for Their Improvement in a Pastoral System. In Impact of Diseases on Livestock Production in the Tropics (H. P. Riemann and M. J. Burridge Eds.). Elsevier Sci. Publishers. **MALD-Health**

Theses--(SR-CRSP)

Garmendia, A. E. 1986. The Mechanism, Isotypes Involved and Effect of Passive Immunoglobulin Transfer to the Newborn Alpaca. Washington State University, Pullman. **WSU-Health**

M. S.

Bari, J. K. Development of an Enzyme-Linked Immunosorbant Assay for Detection of Contagious Caprine Pleuropneumonia in Goats. 1984. Washington State University, Pullman, Washington. **WSU-Health**

Kibor, A. 1983. Cultural, Biochemical and Antigenic Characteristics of Caprine Mycoplasmas Isolated in Kenya. University of Nairobi. **Washington-Health**

Mbwiria, S. K. Selenium Status in Goats and Sheep in Selected Areas of Kenya. 1984. Washington State University, Pullman. **WSU-Health**

Njanja, J. C. 1985. Control of Naturally-Occurring Nematode Infections of Goats in Kenya with Ivermectin. 1985. Washington State University, Pullman. **WSU-Health**

Oluoch, E. O. 1985. Peptide Mapping of Surface Exposed Regions of the Variable Surface Glycoproteins of African Trypanosomes. Washington State University, Pullman. **WSU-Health**

Shavulimo, R. S. 1985. Gastrointestinal Nematodes, with Special Reference to Haemonchus contortus, as a Constraint to the Introduction of Exotic Goat Breeds in Western Kenya. University of Reading, Reading, England. **MALD/WSU-Health**

Journal Articles, Refereed (SR-CRSP)

McGuire, T. C., J. C. Carlson and D. M. Mwamachi. 1985. Comparison of the Effects of African Trypanosomiasis in Four Breeds of Dairy Goats. Res. Vet. Sci. 39:252-253. **WSU-Health**

Mwangi, E., P. Sayer, J. C. Njanja and J. F. Bell. 1985. Tick Survey on Goats and Sheep in Siaya and Kakamega Districts, Kenya. Trop. Anim. Health Prod. 17:102-106. **WSU-Health**

Njanja, J. C., J. F. Bell and R. B. Wescott. 1985. Apparent Lack of Toxicity in Adult East African Goats on Parenterally Administered Ivermectin. Bull. Anim. Hlth Prod. Afr. 33:123-127. **WSU-Health**

Journal Articles, Refereed (Supporting)

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. 44:1670-1675. **WSU-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. **WSU-Health**

Adams, D. S., R. E. Oliver, E. Ameghino, J. C. DeMartini, D. W. Verwoerd, D. J. Houwers, S. Waghela, J. R. Gorham, B. Hyllseth, M. Dawson, F. J. Trigo, and T. C. McGuire. 1986 Serologic Evidence of Caprine Arthritis-Encephalitis Virus Infection in Eleven of Fourteen Countries Tested. Veterinary Record. 115:493-495. **WSU-Health/Colorado-Health**

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. **WSU-Health**

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/WSU-Health**

Leathers, C. W., W. J. Fetcher and K. M. Foreyt. 1982. Clinical Fascioliasis in Domestic Goats in Montana. J. Amer. Vet. Med. Assoc. 180:1451-1454. **WSU-Health**

McGuire, T. C., J. Regnier, T. Kellom, and N. L. Gates. 1983. Failure in Passive Transfer of Immunoglobulin G_1 to Lambs: Measurement of Immunoglobulin G_1 in Ewe Colostrums. Am. J. Vet. Res. 44:1064-1067. **WSU-Health**

Wescott, R. and B. LeaMaster. 1982. Efficacy of Ivermectin Against Naturally and Experimentally Induced Nematodiasis in Sheep. Am. J. Vet. Res. 43:531-533. **WSU-Health**

Wright, H. J., D. S. Adams and F. J. Trigo. 1983. Meningoencephalitis After Hot-Iron Disbudding of Goat Kids. Vet. Med./Small Animal Clinician. 4:599-601. **WSU-Health**

Zimmerman, G. L., L. W. Jen, J. E. Cerro, K. L. Farnsworth and R. B. Wescott. 1982. Diagnosis of Fasciola Hepatica Infections in Sheep by an Enzyme-Linked Immunosorbent Assay. Am. J. Vet. Res. 43:2097-2100. **WSU-Health**

Manuscripts Submitted or In Press (SR-CRSP)

Garmendia, A. E. and T. C. McGuire. 1986. The Mechanism and Isotypes Involved in Passive Immunoglobulin Transfer to the Newborn Alpaca. Am. J. Vet. Res. In Press **WSU-Health**

Garmenia, A. E., G. H. Palmer, J. C. DeMartini and T. C. Mcguire 1986. Failure of Passive Immunoglobulin Transfer: A Major Determinant of Mortality in Newborn Alpacas. Am. J. Vet. Res. In Press **WSU-Health**

Mbwiria, S. K., J. O. dickinson and J. F. Bell. Blood Selenium Concentrations of Sheep and Goats from Selected Areas of Kenya. Trop. Anim. Health Prod. In Press. **WSU-Health**

Mortimer, D. L., R. J. Folwell, A. J. DeBoer, J. Bari and S. Mbwiria. 1983. Socioeconomic Assessment of Small Ruminant Disease in Kenya. Trop. Ani. Health and Prod. Submitted. **Winrock-Economics/WSU-Health**

Mwangi, E., R. Heinonen and J. F. Bell. 1984. Uncontrolled Parasitism of Ticks on Native Goats on Savannah Pasture (and Night Boma). Submitted. **WSU-Health**

Njanja, J. C., R. B. Wescott and F. Ruvuna. Comparison of Ivermectin and Thiabendazole for Treatment of Naturally Occurring Nematode Infections of Goats in Kenya. Vet. Parasitol. In Press. **WSU-Health**

Rurangirwa, F. R., T. C. McGuire and N. S. Magnuson. 1986. Composition of a Polysaccharide from Mycoplasma (F-38) Recognized by Antibodies from Goats with Contagious Pleuropneumonia. Res. Vet. Sci. In Press **WSU-Health**

Abstracts (SR-CRSP)

Rurangwira, F. R., T. C. McGuire, A. Kibor, J. K. Bari, W. Waghela and A. Wambuga. 1984. Preliminary Studies on Induction of Protective Immunity in Goats Against CCPP by Freeze-Dried F-38 Antigens. Proc. SR-CRSP Sci. Mtg. Kabete, Kenya. **WSU/MALD-Health**

Rurangwira, F. R., T. C. McGuire, A. J. Musoke, A. Kibor, C. Nkonge and J. K. Bari. 1984. Attempts to Characterize F-38 Protein(s) Which Induce Growth Inhibiting Antibodies in Immunized and/or Infected Host. Proc. SR-CRSP Scientific Mtg., Kabete, Kenya. **WSU/MALD-Health**

Rurangirwa, F. R., T. C. McGuire, A. J. Musoke and A. Kibor. 1986. Monoclonal Antibody the Differentiates F-38 Group of Mucoplasmas from Other Mycoplasma Species. 6th Intn'l Congress of Intn'l. Org. for Mycoplasmology, Birmingham, Alabama. August **WSU-Health**

Rurangirwa, F. R., T. C. McGuire, S. Chema and A. Kibor. 1986. Vaccination Against Contagious Caprine Pleuropneumonia Caused by F-38. 6th Intn'l Congress of Intn'l. Org. for Mycoplasmology, Birmingham, Alabama. August. **WSU-Health**

Abstracts (Supporting)

Fetcher, A. 1982. Clinical Outbreak of Fasciola Hepatica in Domestic Goats in Montana. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. p. 499. **WSU-Health**

Jasmer, D. P., R. B. Westcott and J. W. Crane. 1986. Influence of Cold Temperatures upon Development and Survival of Eggs of Washington Isolates of Hemonchus contortus and Ostertagia circumcincta. Proc. Helminthological Soc. of Washington. In Press. **WSU-Health**

Shen, D. T., L. W. Jen and J. R. Gorman. 1982. The Detection of Corynebacterium Pseudotuberculosis Antibody in Goats by the Enzyme-Linked Immunosorbent Assay (ELISA). Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. **WSU-Health**

Technical Communications (SR-CRSP)

Abinanti, F. 1982. Accomplishments of the Animal Health Component in Kenya. Proc. SR-CRSP Kenya Workshop. pp. 64-83. **WSU-Health**

Abinanti, F., P. Sayer, J. Bari, S. Mbwiria, J. Njanja and M. Zegler. 1983. A Small Ruminant Herd Health Survey in Western Kenya: Research Data. SR-CRSP Tech. Rpt. #25. **WSU-Health**

Bari, J. K., R. Heinonen, and S. Waghela. 1983. Use of ELISA in Serodiagnosis of CCPP. Proc. 2nd SR-CRSP Kenya Workshop. p. 175. **WSU-Health**

Bari, J. K., Waghela, S., Heinonen, R. 1984. Comparison of the Enzyme-Linked Immunosorbent Assay (ELISA) with Complement Fixation and Indirect Fluorescent Antibody as Diagnostic Tests for Contagious Caprine Pleuropneumonia in Kenya. Proceedings of SR-CRSP Scientific Meeting, Kabete, Kenya, March 1984. **WSU-Health**

DeBoer, A. J. and D. L. Mortimer. 1983. Some Relationships Between Farm Characteristics and Herd/Flock Health Indicators on a Sample of Farms in Western Kenya. Proc. 2nd SR-CRSP Kenya Workshop. pp. 49-63. **Winrock-Economics/WSU-Health**

Kibor, A. C. and P. G. Waiyaki. 1984. Serological Characteristics of Mycoplasma F-38 Strains and Other Mycoplasma Species Isolated from Caprine Pleuropneumonia. Proc. SR-CRSP Kenya Workshop, Kabete, Kenya. **WSU-Health**

Mbwiria, S. and J.F. Bell. 1983. The Role of Selenium in Small Ruminant Nutrition. Proc. 2nd SR-CRSP Kenya Workshop. p. 170. **WSU-Health**

Mbwiria, S. K., J. O.Dickinson, J. F. Bell. 1984. Blood Selenium Concentration of Sheep and Goats from Selected Areas of Kenya. Proc. SR-CRSP Scientific Meeting, Kabete, Kenya, March 1984. **WSU-Health**

Mwangi, E., R. Heinonen and F. Bell. 1983. Uncontrolled Parasitism of Ticks on Native Goats. Proc. 2nd SR-CRSP Kenya Workshop. p. 77. **WSU-Health**

Mwangi, E. N., P. D. Sayer, J. C. Njanja, and J. F. Bell. 1984. Tick Survey on Goats and Sheep in Siaya and Kakamega Districts, Kenya. Proc. SR-CRSP Sci. Meeting, Kabete, Kenya. **WSU-Health**

Njanja, J. C., Ruvuna, F., Wescott, R. B. 1984. Evaluation of New Anthelmintic for Control of Naturally Occurring Nematode Infections of Goats in Kenya. Proc. SR-CRSP Sci. Mtg., Kabete, Kenya. **WSU-Health**

Rurangirwa, F. R., T. C. McGuire, A. Kibor, J. K. Bari, S. Waghela, and A. Wambugu. 1984. Preliminary Studies on Induction of Protective Immunity in Goats Against CCPP by Freeze-Dried F-38 Antigens. Proceedings of SR-CRSP Scientific Meeting, Kabete, Kenya, March 1984. **WSU-Health**

Rurangirwa, F. R., T. C. McGuire, A. J. Musoke, A. Kibor, C. Nkonge, and J. K. Bari. 1984. Attempts to Characterize F-38 Protein(s) Which Induce Growth Inhibiting Antibodies in Immunized and/or Infected Host. Proceedings of SR-CRSP Scientific Meeting, Kabete, Kenya, March 1984. **WSU-Health**

Shavulimo, F., A. E. Sidahmed, , F. Gisemba and O. Odero. 1984. Health Problems in Goats in Western Kenya. Proc. SR-CRSP Scientific Meeting, Kabete, Kenya. March.

Technical Communications (Supporting)

Shen, D. T., L. W. Jen and J. R. Gorham. 1982. The Detection of Corynebacterium Pseudotuberculosis Antibody in Goats by the Enzyme-Linked Immunosorbent Assay (ELISA). Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. pp. 445-448. **WSU-Health**

Whitelaw, D. D. and M. Murray. 1982. Experimental Evaluation of Genetic Resistance to African Trypanosomiasis in Sheep and Goats in Kenya. Proc. SR-CRSP Kenya Workshop. pp. 143-144.

Verbal Presentations (SR-CRSP)

Sidahmed, A. E., J. E. Reynolds, R. S. Shavulimo, et.al. 1985. On-Farm Dual Purpose Goat Production; Biological and Social Perspectives. 4th SR-CRSP Kenya Workshop, Kakemega, Kenya. **Winrock-Production Systems**
U. Mo.-Sociology
WSU-Health

Oral Presentations (Supporting)

Abinanti, F. R. 1981. The Goals of the SR-CRSP and Washington State University's Role in the Animal Health Aspects. Spokane, Washington Television Program. **WSU-Health**

Farnsworth, M. and R. Wescott. 1981. Diagnosis of Fasciola hepatica Infections of Sheep by Enzyme-Linked Immunosorbant Assay (ELISA). Presented at Rocky Mtn. Conf. on Parasitology. **WSU-Health**

LeaMaster, B. and R. Wescott. 1980. Efficacy of Ivermectin 8/a for Treatment of Experimentally Induced and Naturally Acquired Nematode Infections of Sheep. Presented at Conf. Res. Workers in Anim. Disease.

WSU-Health

SR-CRSP

ANNUAL REPORT

1985-86

I. Project Title: Dual-Purpose Goat Production Systems for Smallholder Agriculturalists

II. Host Country: Kenya

III. Principal Investigator: Henry A. Fitzhugh

IV. Personnel:

Host Country Co-Workers:
R. Shavulimo
W. Ochieng
M. Mathuva
K. Otieno
S. Karimi
L. Musalia
M. Khainga
J. Odour
S. Malanda
G. Ochieng
E. Budamba
A. Astiba
P. Mukwana
P. Ochola
P. Amuhinda
H. Kiguhi
E. Ochieng
E. Otieno

U.S. Co-Workers:
J. Onim
P. Semenye

V. Introductory

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 train technical and scientific personnel interested and qualified in multidisciplinary research relevant to the needs of developing countries.

Research to achieve these goals involves development of 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. Within this overall project objective, the general objective of the subproject "Feed Resources" is to design and test feed production and preservation techniques appropriate for dual-purpose goat production on small farms in the high potential tropics.

Research activities are based 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. The Production Systems project also 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 continue collaborative research to characterize small farm systems in Western Kenya with respect to potential for introducing dual-purpose goats to the system.

Experimental activities during 1985-86 included:

1. GOAT NUTRITION - MANAGEMENT

<u>On-station</u>

a. Performance of dual-purpose does and kids under different milking and nursing management systems.

b. Growth and nutrition of replacement female from weaning to end of first lactation.

c. Evaluation of low-cost feed resources produced on small farms in Western Kenya for dual-purpose goat nutrition and management.

<u>On-farm</u>

a. Monitoring performance of dual-purpose goats, local goats, sheep, and cattle on small farms of Western Kenya.

b. Evaluation of unimproved lands, roadside lands, and harvested fields as a source of year-round diet.

2. FEED RESOURCES

<u>On- station</u>

a. Effect of planting density and cutting frequency on Sesbania fencerow forage production.

b. Define recommendation domains for the dual-purpose goat production systems.

c. Yield evaluation of forage legumes and grasses.

On-station and farm

a. Evaluation of maize and finger millet and maize and sweet potato intercropping systems.

On-farm

a. Farmer acceptance of pigeon pea, sorghum, Sudan grass, and Sesbania forage production alternatives.

b. Evaluation of potential interventions to increase feed production from cassava based cropping systems.

VI. Research Accomplishments

DUAL-PURPOSE GOAT PRODUCTION

Performance traits for dual-purpose goats monitored on-farm and on-station are presented in table 1. Data on milk production and consumption under different milking management systems (table 2) have been collected from does fed menus based on feeds available on farms and on practical health-management packages.

On-farm monitoring of live body weight changes and kid growth rates in the three cluster continued for the third year (1983-85). Data on weight of kids on farm are presented in table 3. Other data included changes in body weight of does (dual-purpose and local goats), local ewes, and local cows at 14-day intervals.

The birth weights of kids born in Masumbi cluster were less than those of kids born in Hamisi and Kaimosi (2.34 ± 0.05, 2.83 ± 0.16, and 2.94 ± 0.25; mean ± SE, respectively). However, all kids had similar body weights up to 180 days (table 3). The mortality rate (from birth to 180 days) was higher among kids born in Masumbi (30%) and kids placed in the three cluster from Maseno research station (25%) than among kids born in Hamisi and Kaimosi (table 3). This high survival rate among kids born in Kakamega district should be considered when new DPG placements are considered. Pregnant or dry does should be placed rather than mothers with followers

Recommended weaning is at 10 kg of body weight. Therefore, if this recommendation is accepted by the farmers, kids will be nursed up to the age of 100 days. This will provide farmers with 100 days of shared doe milk and only 50 days when all milk produced will be used by the household members, assuming the doe is dried five months after kidding.

ON-FARM EVALUATION OF NATURAL FEED RESOURCES

The characterization phase of Kakamega and Siaya smallholder farming systems has emphasized the importance of improved lands as principal sources of ruminant feeds. Typically, animals spend most of the daytime tethered or herded on unimproved lands, along road sides, and in harvest fields. The contribution of these resources to the diets of dual-purpose and local goats was investigated. Both breeds of goats consumed submaintence levels between

June and October, the relatively dry season. Although both breeds had similar body weights, the amount consumed by the DPG was significantly ($P < 0.05$) larger (1.79 ± 0.13 SE versus 1.36 ± 0.15 SE, respectively). Both breeds selected diets higher in crude protein and neutral detergent residue (NDR) than vegetation on-offer ($P < 0.05$). However, in vitro dry matter digestibility values were similar and below levels required by ruminants to attain maximum genetic capacity of performance in weight gan or milk yield.

Using fistulated animals in remote farm trials necessitated collection of extrusa (diet) and fecal samples from goat other than those used during the initial sampling periods. Some fistulated animals died or culled due to poor body condition. The experience of the respondent farmers regarding foraging behaviour of goats were considered when diet sampling protocols were scheduled. It was observed that active morning grazing starts at 1100 hours and not a 800 hours -- the time when goats were released out of the night enclosures (bomas). Probably high, ground-level humidity during the early morning hours discourages foraging, particularly grazing, by goats.

Information on utilization and quality of target feed resources was obtained from on-station metabolic studies. Local feedstuffs consumed by DPGs during early to late pregnancy did not reflect what was offered in quality and quantity. By exhibiting a very selective behaviour, the goats consumed only small quantities of some feeds (i.e., Sesbania, pigeon pea, and napier grass), although the digestible energy of what was consumed was high.

FEED RESOURCE COMPONENT

Nutritive Value of Natural and Coltivated Forages

Farmers practice cut-and carry of forages to supplement tethering or a combination of tethering and grazing. Uncultivated plant species constitute approximately 60% of the total biomass fed to the livestock, while the rest comes from cultivated species. The dominant plant species that the goats consumed in roadside and fallow land pastures and presented in table 4. The grasses had a mean CP of 16.3% with star grass showing a high value of 21.7%. Common weeds had a CP level of 23.6%, however, several species had very high levels. These included *Amaranthus* spp. (32.5%), *Tagetes minuta* (26.8%), *Leonotis mollisima* (25.2%), *Lantana camara* (24.1%), and *Bidens pilosa* (21.0%). These protein values indicate that when livestock graze in these pastures and consume enough DM, they should get adequate CP and DE.

The cultivated forage legumes have been selected and evaluated for their nutritional qualities. Because these forage legumes have such high CP levels and grow readily in Western Kenya, their potential as sources of high protein feeds is very promising. Forage legumes also provide human food (e.g., *Cajanus cajan*), nitrogen fixation, fences, and shade (e.g., *Leucaena*, *Sesbania*, and *Gliridicia* species).

Intercropping Feed/Food Crops

Because of high population density, most of the land is planted under food crops, leaving little fallow land for communal or family grazing needs. It has, therefore, become necessary to develop experiments in which food and forage crops are intercropped. In such crop combinations, the forage crop should not significantly reduce the yields of the associated food crops. Maize is the main food crop in these areas, and, therefore, several potential forage crops have been tested with it. Tested forage crops were legumes (pigeon pea, Sesbania) and Sudan grass. These crop combinations were grown with or without NPK (20-20-0) fertilizer at the rate of 40 kg/ha of NP_2O_5. Although this trial was conducted at three sites, data from only one site (Kaimosi) are presented to show the interaction of combinations.

There were no significant differences ($P < 0.05$) in maize grain yields between the various treatments in nonfertilized plots, except between maize/Sudan grass, maize/Sesbania, and maize/pigeon pea. In the fertilized plots, maize/pigeon pea intercrop significantly ($P < 0.05$) out-yielded both pure maize and maize/Sesbania intercrop. There was no significant differences between other crop combinations.

In the nonfertilized plots, the maize/Sudan grass intercrop performed significantly ($P < 0.05$) poorer that both the maize/Sesbania and maize/pigeon pea combinations. The nonfertilized maize/pigeon pea plot gave the second highest grain yield (2.34 mt/ha cf. 2.47 mt/ha in maize/Sesbania). Although not significantly different, pure maize yields ranked third in both fertilized and nonfertilized cropped plots yielded more grain than pure maize plots by 0.35 mt/ha (18.9%). Data on the effect of fertilizer on forage dry matter yields in Kaimosi show that fertilizer increased forage dry matter yields by 6.9 mt/ha (57.3%). Intercropping increased forage dry matter yields by large margins, 11.95 mt/ha (174.4%) and 18.27 mt/ha (166%) in nonfertilized and fertilized plots, respectively.

Several food crops also have a potential for producing animal feeds. The following forage yields were observed over several locations and seasons: maize 18, pigeon pea 4, sweet potato 5, and finger millet 4 mt DM/ha per four months, respectively. It would, therefore, seem that in Western Kenya, fallow grazing lands can be efficiently replaced by forages derived from the cut-and-carry of weeds and planted forage crops, intercropping food crops with forage crops, intercropping food crops with forage crops, and utilizing forage parts of food crops.

On-Farm Feed Conservation

On way of overcoming feed shortages during the dry season is by introducing interventions like planting feed banks and alley cropping forage with food crops of intercropping forage with food crops or hedgerow cut-and-carry forages. In Western Kenya, these interventions can improve the feed supply from a monthly average of 2240 Mcal of DE to 3500 Mcal of DE (figure 1). However, where there is no feed conservation method developed, this improved feed situation cannont benefit the livestock throughout the year because of a poor distribution profile.

If surpluses are conserved by deferred grazing or by hay baling or making into silage, these could be fed during periods of feed shortage. Hay baling is perhaps the easiest method. Results in Western Kenya show that a simple hay baling box is not only accepted by small scale farmers, but is also very effective. The only materials required are a wooden box, a grass cutting sickle and sisal twine. One family can make 10 bales each of 20 kg in one month on a part time basis, and 4 bales a day on a full time basis.

Grasses and legumes are cut and left to dry in the field for two to three days. These can then be baled either in the field or at home. Forages that have been successfully baled include grasses and legumes. The quality of the hay remains good as long as the bales are stored in dry place. Pigeon pea (Cajanus cajan), Sesbania, and Leucaena leaves can be made into a fine leaf hay with a CP content of about 26%. Fresh twigs of these forage legumes are cut and placed on a mat, on a polthene sheet or on cleared ground. After about 12 hours in the sun, the leaves drop and are collected and bagged for future use as feed supplements.

CP values for fresh forages and 6-month-old hays are presented in table 5. These results show interesting differences between grasses and legumes. The CP of Sudan grass did not change between fresh and 6-month-old hays. That of bana grass showed a slight increase (11.1%) and that of mixed grasses showed a slight decrease (8.7%). The changes in the three legumes are, however, much larger. Leucaena showed a CP drop of 27.4% for hay as compared to the fresh forage. The poisonous protein, mimosine, is believed to disintegrate upon drying, rendering dry leucaena less poisonous and, perhaps, causing the observed reduction of CP in leucaena hay.

CP in both pigeon pea and sesbania increased by 32% from 28% in fresh forages to 36% in hays. This increase indicates that some changes occurred in the plant tissue as it dried or during storage that increased CP. Fungal growth could be a plausable explanation, however, both hays dried fast and maintained a low moisture content of 4% throughout storage.

Supplementation with Purchased Forages

Farmers in Western Kenya not only supplement their livestock with cut-and-carry forages from hedges and planted fodders, but also with purchased forages. The types of forages purchased from the markets near Maseno are presented in table 6. For small ruminants, the consumable portion of the purchased green maize "stover," napier grass, and sugarcane tops constitute approximately 50%. For cattle, the whole sample might be consumed if it is chopped. All mixed riverside and roadside grasses can be consumed by both small stock and cattle. DM of the leaves is about twice DM in the young stems of maize, napier grass, and sugarcane tops.

Prices that the farmers pay for DM/ton of the purchased forages are presented. Mean prices for consumable portions by small ruminants of sugarcane tops, napier grass, green maize "stover" and mixed grasses were Kshs 2394, 3443, 1599, and 2270/tons of DM, respectively. Although not many farmers purchase forages from the market, those who do so pay dearly.

VII. Significance of Findings

Results to-date have demonstrated that dual-purpose goats can make an important contribution to the nutrition and economic welfare of small farm families. Principal constraints to successful dual-purpose goat production are availability and quality of feed, especially during the dry season. This constraint can, however, be overcome. The elements of a feasible package of technology appear to be in place.

VIII. Future Directions

The major on-farm evaluation of the dual-purpose goat production system will begin in July, 1986. On-farm evaluation of the production package will involve collaboration of the full multidisciplinary SR-CRSP team in Kenya.

Numbers of does available for on-farm testing is currently 150 dairy x African crosses. In collaboration with the breeding project, 40 purebred dairy males (Toggenburg, Alpine, and Nubian) were imported to Kenya in January, 1986. These males are now being mated to approximately 1,000 East African and Galla females to produce additional crossbred does for use in on-farm testing.

Research in nutrition-management and feed resource components will continue as the on-farm evaluation identifies new problems.

IX. Funding

Grant No. AID/DSAN/XII-G-0049 from 1985/86 subgrant: $240,000

Winrock Matching Contribution from 1985/86 subgrant: 89,410

KENYA

Production Systems - Winrock International

Books and Chapters in Books

DeBoer, A. J., H. A. Fitzhugh, R. D. Hart, M. W. Sands, M. O. Job and S. Chema. 1984. Production of Meat and Milk from Goats in Mixed Farming Systems in the High Potential Tropics. In J. R. Simpson and P. Evangelou (Ed.) Livestock Development in Subsaharan Africa--Constraints, Prospects, Policy. Westview Press, Boulder, Colorado. pp. 335-359.
Winrock-Economics/Production Systems

Fitzhugh, H. A. 1985. Designing Production Systems to Optimize Net Merit and Profit. In: F. H. Baker and M. E. Miller (Eds.) Emerging Technology and Management of Ruminants. Westview Press, Boulder.
Winrock-Production Systems

Fitzhugh, H. A. 1984. Hair Sheep: Meat Production Without Wool. In: F. H. Baker and M. E. Miller (Eds.) Sheep and Goat Handbook 4. Westview Press, Boulder, Colorado. **Winrock-Production Systems**

Fitzhugh, H. A. 1984. Systems Approach to Small Ruminant Research and Development. In: Proceedings of FAO Workshop, Small Ruminant Research and Development in the Near East; Tunis, Tunisia. **Winrock-Production Systems**

Fitzhugh, H. A. 1981. Small Ruminants as Food Producers. In New Protein Foods. Volume IV. (A. M. Altschul and H. L. Wilke, Eds.) Academic Press. pp. 135-157. **Winrock-Production Systems**

Fitzhugh, H. A. and A. J. DeBoer. 1981. Physical and Economic Constraints to Intensive Animal Production in Developing Countries. In Intensive Animal Production in Developing Countries. (A. J. Smith and R. G. Gunn, Eds.) British Soc. Animal Prod. Occ. Publ. 4:23-50.
Winrock-Production Systems/Economics

Hart, R. D., H. A. Fitzhugh and M. W. Sands. 1982. Mixed Farming Systems in Western Kenya with Interaction among Maize, Sorghum, Beans, Cassava with Goats, Hair Sheep and Cattle. In Proc. Workshop--Research on Crop-Animal Systems. CATIE, CARDI and Winrock Int'l. pp. 278-298.
Winrock-Production Systems

Onim, J. F. M., P. P. Semenye and H. A. Fitzhugh. 1985. Nutritional Constraints to Small ruminants in Africa. In: R. T. Wilson and D. Bourzat (Eds.) Small Ruminants in African Agriculture. ILCA, Addis Ababa.

Sidahmed, A. E., J. F. M. Onim, A. W. Mukhebi, R. S. Shavulimo, A. J. DeBoer and H. A. Fitzhugh. 1985. On-Farm Trials with Dual Purpose Goats on Small Farms in Western Kenya. In: T. C. Nordbloom, A. E. K. Hamid Ahmed and G. R. Potts (Eds.) Research Methodology for Livestock on Farm Trials. ICARDA and IDRC, Aleppo.

Theses--(SR-CRSP)

PhD

Sands, M. W. 1983. Role of Livestock on Smallholder Farms in Western Kenya. Cornell University, Ithaca, New York. **Winrock-Production Systems**

M. S.

Boor, K. J. 1983. Goat Milk Products for Rural Western Kenya. University of Wisconsin, Madison. **Winrock-Production Systems**

Hansen, H. H. 1981. Goat Diets in an Upland Hardwood Ecosystem. University of Florida, Gainesville. **Winrock-Production Systems**

Theses-(Supporting)

M. S.

Ashley, A. 1980. Evaluation of Sweet Potato Vines and Leaves as an Energy Source for Small Ruminants. Tuskegee Institute. **Tuskegee-Management**

Kibuchi, J., 1982. A Study of the Feasibility of Substituting Sweet Potato Meal for Corn in a Diet of Growing Goats. Tuskegee Inst., Tuskegee, Alabama. **Winrock-Prod. Systems**

Mukisira, E. A. 1984. Nutritional Evaluation of Selected Warm Season Forages. Louisiana State University, Baton Rouge. **Winrock-Production Systems**

Journal Articles, Refereed (SR-CRSP)

Brown, D. L. and E. Chavalimu. 1985. Effects of Ensiling and of Drying on Five Forage Species in Western Kenya: Zea Mays (Maize Stover), Pennisetum Purpureum (Pakistan Napier Grass), Pennisetum Sp. (Bana Grass), Impomea Batata (Sweet Potato Vines) and Cajanus Cajan (Pigeon Pea Leaves). Animal Feed Science and Technology 13:106. **MALD/Winrock-Production Systems**

Journal Articles, Refereed (Supporting)

Boor, K. J., C. H. Amundson and D. L. Brown. 1986. Protein Conversion efficiencies of Four Test Diets Based on Milk, Two Milk and Tea Treatments, and Casein. J. Dairy Sci. 69:979-982. **Winrock-Production Systems**

Quick, T. C. and B. A. Dehority. 1986. A Comparative Study of Feeding Behavior and Digestive Function in Dairy Goats, Wool Sheep and Hair Sheep. J. Anim. Sci. 63:1516-1526. **Ohio State/Winrock-Production Systems**

Manuscripts Submitted or In Press (SR-CRSP)

Boor, K. J., D. L. Brown and H. A. Fitzhugh. 1986. Goat Milk Products for Western Kenya. Submitted to World Animal Review.
Winrock-Production Systems

Brown, D. L., M. Salim, E. Chavulimu and H. A. Fitzhugh. 1985. Intake, Selection, Apparent Digestibility, and Chemical Composition of Napier Grass and Pigeon Pea Foliage as Utilized by Lactating Goats in Kenya. Tropical Animal Production 10. In Press. **Winrock-Prod. Systems**

Otieno, K., J. F. M. Onim, S. Russo, M. N. Mathuva and R. Hart. 1986. The Potential of Pugeon Pea (Cajanus Cajan (L) Millsp.) As a Forage Legume in Western Kenya. Submitted to Animal Feed Science and Technology.
Winrock-Prod. Systems

Abstracts (SR-CRSP)

Boor,, K. J., H. A. Fitzhugh, D. L. Brown and E. Ochieng. 1983. Consumer Evaluation of Goat and Cow Milk Products in Western Kenya. J. Dairy Sci. 66:93. **Winrock-Prod. Systems**

Boor, K. J., H. A. Fitzhugh, D. L. Brown and S. Chema. 1982. Introduction and Consumer Acceptance of Goat Milk Products in Western Kenya. Proc. Trop. An. Prod. for the Benefit of Man, Antwerp, Belgium. p. 518.
Winrock-Production Systems

Hart, R. D., S. L. Russo and M. Mathuva. 1982. A Farming Systems Research Strategy to Increase Forage Production in Western Kenya. Proc. Am. Soc. of Agronomy. p. 45. **Winrock-Production Systems**

Mukisira, E. A., F. G. Hembry, C. P. Bagley and W. M. Craig. 1984. Digestibility and Voluntary Intake of Alyce Clover, Sudan-sorghum, Millet and Coastal Bermudagrass Hay. ASAS Abstract 390. **Winrock-Management**

Russo, S. L., M. Mathuva and R. D. Hart. 1982. Different Strategies to Increase Forage Production from Maize, Sorghum and Bean Cropping Systems in Western Kenya. Proc. Am. Soc. Agronomy. p 49.
Winrock-Production Systems

Sands, M. W. H. A. Fitzhugh and S. Chema. 1982. Livestock Production on Small Farms of Western Kenya. Abst. 199, Joint ASAS-CSAS Mtg., Guelph, Ontario. J. Animal Sci. 55(S1):200. **Winrock-Production Systems**

Sands, M. W., H. A. Fitzhugh and S. Chema. 1982. Seasonal Variation in Feed Resources on Small Farms of Western Kenya. Abst. 506, Joint ASAS-CSAS Mtg., Guelph, Ontario. J. Animal Sci. 55(S1):322 **Winrock-Production Systems**

Sands, M. W., H. A. Fitzhugh, M. Job, J. Kekovole, P. N. Gachuki and R. E. McDowell. 1982. Potential for Dual Purpose Goats on Small Farms in Kenya. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. p. 354.
Winrock-Production Systems

Sidahmed, A. E., J. F. M. Onim, A. W. Mukhebi, R. S. Shavulimo, A. J. DeBoer and H. A. Fitzhugh. 1985. On-Farm Trials with Dual-Purpaose Goats on Small Farms in Western Kenya. Research Methodology for Livestock On-Farm Trials Proc. Workshop Aleppo, Syria, March 25-28.**Winrock/MALD-Production Systems**

Abstracts (Supporting)

Brown, D. L. and D. E. Hogue. 1982. Effects of Monensin Sodium on Lactating French Alpine Does. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. p. 306. **Winrock-Production Systems**

Collins, J. A., J. M. Rakes, N. Kasireddy, C. H. Mannasmith and J. A. Yazman. 1980. Bacterial and Somatic Cell Evaluation of a Grade-A Goat Milk Herd in Arkansas. J. Dairy Sci. 63(S1):40. **Winrock-Production Systems**

Hansen, H. H. and R. D. Child. 1980. Goat Diets on an Upland Hardwood Ecosystem. ASAS, Abst. 325. **Winrock-Production Systems**

Rakes, J. A., J. A. Collins, F. B. Johnson, J. A. Yazman and C. H. Mannasmith. 1980. The Effect of Stage of Lactation on Breed, on Production, and Composition of Goat Milk Produced in Arkansas. J. Dairy Sci. 63(S1). **Winrock-Production Systems**

Yazman, J. A. and C. H. Mannasmith. 1982. Bioeconomics of Commercial Dairy Goat Milk Production in Central Arkansas. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. p. 290. **Winrock-Production Management**

Yazman, J. A. 1982. Bioeconomics of Commercial Diary Goat Milk Production in Central Arkansas. Proc. III International Conference on Goat Production and Disease. Scottsdale, Arizona. p. 290. **Winrock-Production Systems**

Technical Communications (SR-CRSP)

Boor, K. J., D. L. Brown and H. A. Fitzhugh. 1984. Consumer Acceptance of Goat Milk Products in Western Kenya. SR-CRSP Tech. Rpt. #41. NTIS #PB8-4-207471. **Winrock-Production Systems**

Boor, K., E. Ochieng and H. A. Fitzhugh. 1984. Comparison of Goat and Cow Milk for Human Consumption in Western Kenya. Proceedings of the Third Small Ruminant CRSP Kenya Workshop. Kabete, Kenya. **Winrock-Production Systems**

Boor, K., E. Ochieng and H. A. Fitzhugh. 1983. Consumer Acceptability of Goat Milk Products in Western Kenya. Proc. 2nd SR-CRSP Kenya Workshop. pp. 35-39. **Winrock-Production Systems**

Brown, D. L., E. Chavulimu and H. A. Fitzhugh. 1983. Responses of Lactating Goats to Free Water Restriction and Diet Based on Sweet Potato Vines. Proc. 2nd SR-CRSP Kenya Workshop. pp. 28-34. **Winrock-Production Systems**

Brown, D., E. Chavulimu, H. A. Fitzhugh and A. E. Sidahmed. 1984. Effects of Ensiling or Drying on Five Kenya Feedstuffs: Maize Stover (Zea Mays), Pakistan Napier Grass (Pennisetum Purpureum), Bana Grass, Sweet Potato Vines (Impomea Batata) and Pigeon Pea Leaves (Cajamus Cajan). Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. **Winrock-Production Systems**

Brown, D. L., H. A. Fitzhugh, E. Chavulimu, H. Kiguhi, E. Oltieno and P. Amuhinda. 1983. Evaluation of Lactating Toggenburg x East African Does on Small Farms in Western Kenya. Proc. 2nd SR-CRSP Scientific Meeting. Naivasha, Kenya. **Winrock-Production Systems**

Brown, D. and M. Nderito. 1982. Nutritional Strategies for Dual-Purpose Goats. Proc. SR-CRSP Kenya Workshop. pp. 84-90. **Winrock-Production Systems**

Brown, D. and M. Nderito. 1983. Performance and Milk Requirements of Toggenburg x (Toggenburg x East African) Kids Weaned at Two Months of Age or Ten Kilograms Body Weight. Proc. 2nd SR-CRSP Kenya Workshop. pp. 17-19. **Winrock-Production Systems**

Brown, D., S. Russo, E. Chavulimu, H. A. Fitzhugh and A. E. Sidahmed. 1984. Short Rains Maize Leaf Strippings from Maseno, Kenya Yields and Feed Value. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. pp. 37-46. **Winrock-Production Systems**

Chavulimu, E. 1983. Forage Chemical Analytical Laboratory at NHRS. Proc. 2nd SR-CRSP Kenya Workshop. pp. 142-143. **Winrock-Production Systems**

Fitzhugh, H. A. 1982. Dual Purpose Goat Production Systems for Smallholder Agricultural[illegible]s. Proc. SR-CRSP Kenya Workshop. pp. 10-11. **Winrock-Production Systems**

Fitzhugh, H. A. and M. Sands. 1983. Description of Mixed Small Farm Systems in Western Kenya. Proc. 2nd SR-CRSP Kenya Workshop. pp. 3-10. **Winrock-Production Systems**

Fitzhugh, H. A. 1984. Small Ruminant CRSP in Kenya. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. pp. 11-14. **Winrock-Production Systems**

Fitzhugh, H. A., D. Brown, M. Salim, M. Sands, A. E. Sidahmed, H. Kiguhi, P. Amuhinda and E. Toieno. 1984. Monitoring On-Farm Performance of Dual-Purpose Goats in Western Kenya. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. **Winrock-Production Systems**

Fitzhugh, H. A. 1985. SR-CRSP in Kenya. Prospects for the Testing of the Dual-Purpose Goat Technology in Western Kenya. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Hart, R. D. 1982. Synthesis and Evaluation of Dual-Purpose Goat Production for Small Mixed Farm in Western Kenya. Proc. SR-CRSP Kenya Workshop. pp. 35-40. **Winrock-Forages**

Hart, R., M. Onim, S. Russo, M. Mathuva, K. Otieno and H. Fitzhugh. 1984. Analytical Framework for Feed Resources Research on Mixed Farms in Western Kenya. SR-CRSP Technical Report #46. **Winrock-Production Systems**

Hart, R. D., S. L. Russo and M. Mathuva. 1981. Feed Production Systems Research in Western Kenya. I. A Preliminary Overview of Farm Systems and Cropping. II. General Strategy and Short Rains Work Plans. Winrock Int'l. 22 pp. **Winrock-Production Systems**

Karimi, S. K., P. P. Semenye, A. E. Sidahmed, H. A. Fitzhugh and J. F. M. Onim. 1985. Feed Consumption and Selection by Dual-purpose Goats and Local Goats from Masumbi CLuster in Siaya District, Western Kenya. Proc. 4th SR-CRSP Kenya Workshop.

Mathuva, M., M. Onim, H. A. Fitzhugh, and K. Otieno. 1985. Yield and Quality Evaluation of Selected Forage Grasses. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Mathuva, M, J. F. M. Onim, H. A. Fitzhugh and K. Otieno. 1985. Evaluation of Potential Interventions to Increase forage Production from Cassava Based Cropping Systems in Western Kenya. Proc. 4th SR-CRSP Kenya Workshop. pp__.

Mathuva, M., M. Onim, K. Otieno, H. A. Fitzhugh and K. Otieno. 1985. Forage Production From Cassava-Based Intercropping Systems. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Mohammed Salim, K. 1983. Suppression of Small Ruminant Ticks in Kakamega and Siaya by a Low-Cost Tick Control Method. Proc. 2nd SR-CRSP Kenya Workshop. pp. 144-151. **Winrock-Production Systems**

Mukebi, A. W. and J. F. M. Onim. 1985. Economics of Intercropping Forage Crops with Maize in Kaimosi, Western Kenya. Proc. 4th SR-CRSP Kenya Workshop.
Mukhebi, A. W. and J. F. M. Onim. 1985. Economics of Pre-weaning Kid Practices at Maseno Research Station, Western Kenya. Proc. 4th SR-CRSP Kenya Workshop. pp__.

Mukhebi, A. and A. E. Sidahmed. 1985. Economic Evaluation of Preweaning Kid Feeding Practices. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Mukisira, E. and F. Hembry. 1985. A Nutritional Assessment of Warm Season Forages by In Vivo and In Vitro Techniques. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Onim, M., R. Hart, K. Otieno and H. A. Fitzhugh. 1984. Potential of
I t ppi rd SR-CRSP
Kenya Workshop. Kabete, Kenya. **Winrock-Production Systems**

Onim, M., M. Mathuva, K. Otieno, R. Hart and H. A. Fitzhugh. 1985. Potential of Food-Feed Crops in Western Kenya. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Onim, J. F. M., M. Mathuva, K. Otieno, P. P. Semenye and H. A. Fitzhugh. 1985. Feed Resources for Small Ruminants in Small Holder Farms in Western Kenya. Proc. Workshop on Animal Feed R s urces for Small-scale Livestock Producers. Proceedings PANESA Workshop on Animal Feed Resources for Small-scale Livestock Producers. ILCA, Nairobi.

Onim, M., M. Mathuva, K. Otieno, A. E. Sidahmed and H. A. Fitzhugh. 1985. Simplified Hay Making for Small-Scale Farmers. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Production Systems**

Onim, M., A. E. Sidahmed, R. Hart, D. Brcwn, S. Russo and H. A. Fitzhugh. 1984. Matching Feed Resources to R quirements for Dual-Purpose Goats in Western Kenya. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. **Winrock-Production Systems**

Otieno, K., M. Onim, R. Hart and H. A. Fitzhugh. 1984. Botanical Composition and Crude Protein Content of Forages Grazed and Grazing Behaviour of Goats at Maseno Farm and SR-CRSP Clusters. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. **Winrock-Production Systems**

Russo, S. F., R. Hart, K. Otieno and J. Owino. 1983. Forage Producing Strategies for Small Farms in Western Kenya. Proc. 2nd SR-CRSP Kenya Workshop. pp. 20-24. **Winrock-Production Systems**

Russo, S., R. Hart, K. Otieno, J. Owino and J. Onim. 1983. Feed Production Research for Smallholder Agriculturalists in Western Kenya. CIMMYT Workshop Animal Feeding in Small Farm Systems. Mbabane, Swaziland. **Winrock-Production Systems**

Russo, S. F., M. Muthuva and R. Hart. 1982. Feed Production Systems for Dual Purpose Goats on Small Farms in Western Kenya. Proc. 1st SR-CRSP Kenya Workshop. Nairobi, Kenya. **Winrock-Production Systems**

Said, A. N., A. E. Sidahmed, K. Yilala, M. Onim, B. Amwayi and E. Mokaya. 1985. Evaluation of Local Feeds Produced on Small Farms in Western Kenya for the Nutrition of Dual-Purpose Goats: Digestibility, Intake, and Nitrogen Retention of Two Forms (Fresh Hay) of Sesbania, Pigeon Pea and Sudan Grass. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **Winrock-Prod. Systems**

Salim, M., W. Ochieng, H. A. Fitzhugh, M. Sands, D. Brown and A. E. Sidahmed. 1984. SR-CRSP Dual-Purpose Goat in Western Kenya: History and Record. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya. **Winrock-Prod. Systems**

Sands, M. W., H. A. Fitzhugh, J. Kekovole and P. Gachuki. 1982. Results of Small Farm Systems Survey with Implication to the Potential for Dual Purpose Goats on Small Farms in Kenya. Proc. SR-CRSP Kenya Workshop. pp. 12-34. **Winrock-Production Systems**

Sands, M. W., H. A. Fitzhugh, R. E. McDowell and S. Chema. 1982. Mixed Crop-Animal Systems on Small Farms in Western Kenya. SR-CRSP Tech. Rpt. #17. NTIS #PB8-4-190719. **Winrock-Production Systems**

Sidahmed, A. E., M. Salim, H. A. Fitzhugh and L. Musalia. 1984. Performance of Dual-Purpose Does and Kids Under Different Milking and Nursing Management Systems. Proc. 3rd SR-CRSP Kenya Workshop. Kabete, Kenya.
Winrock-Prod. Systems

Sidahmed, A. E., R. S. Shavulimo, J. E. Reynolds, H. A. Fitzhugh, J. Sagwa, J. Atichi, P. Pacha,, P. Amuhinda, E. Otieno, H. Kiguhi, E. Mokaya and K. Karimi. 1985. On-Farm Dual-Purpose Goat Production. Biological and Social Perspective. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya.
Winrock-Prod. Systems

Technical Communications (Supporting)

Bernsten, R. H., H. Fitzhugh and H. C. Knipsheer. 1983. Livestock in Farming Systems Research. Proc. Third Ann. Farming Systems Sym., Kansas State Univ., Manhattan. **Winrock-Economics/Production Systems**

Burzlaff, D. F. 1982. Range Management Research Expansion Project. Proc. SR-CRSP Kenya Workshop. pp. 139-142. **Winrock**

Fitzhugh, H. A. 1983. Systems for Efficient Livestock Production: Commercial Systems Producing Marketable Products. Proceedings V World Conference on Animal Production. Tokyo, Japan.
Winrock-Production Systems

Fitzhugh, H. A. and G. E. Bradford. 1979. Hair Sheep Production Systems--A Survey of Genetic R s urces. USAID/Winrock Int'l. Morrilton, AR.
Winrock-Production Systems/UCD-Breeding

Hart, R. D. 1985. Crop/Livestock Interactions as Crop Production Determinants. Cornell International Agriculture Mimeo 107.
Winrock-Production Systems

Hart, R. D., H. A. Fitzhugh and N. Gutierrez. 1982. Crop-Animal Production System Research at Winrock International. Proc. Workshop--Research on Crop-Animal Systems. CATIE, CARDI and Winrock Int'l. pp. 42-45.
Winrock-Production Systems

Henderson, E. A. and H. A. Fitzhugh. 1983. Bibliography of International Literature on Goats. Winrock International, Morrilton, Arkansas.
Winrock-Production Systems

Henderson, E. A., L. Turillo, M. W. Sands, J. A. Yazman and H. A. Fitzhugh. 1981. Annotated Bibliography: Goat Management, Reproduction, Lactation, and Growth. Winrock Int'l., Morrilton, AR. **Winrock-Production Systems**

Kayongo-Male, H. and A. N. Abate. 1982. Role of Systematic Maize (Corn) Defoliation in Small Ruminant Production. Proc. SR-CRSP Kenya Workshop. pp. 145-150.

Mannasmith, C. H. 1981. A Herd Health Program for a Goat Dairy. Int'l. Stockmen's School. Sheep and Goat Handbook, Vol. 2. Agriservices Fdtn. Clovis, CA. pp. 342-345. **Winrock-Production Systems**

Mannasmith, C. H. 1981. Mastitis in Dairy Goats. Int'l. Stockmen's School. Sheep and Goat Handbook, Vol. 2. Agriservices Fdtn. Clovis, CA.
Winrock-Production Systems

Winrock International. 1983. The role of Sheep and Goats in Developing Countries: Their Present and Potential Role. World Bank Technical Paper. The World Bank, Washington, D. C. **Winrock-Economics/Prod. Systems**

Yazman, J. A. 1979. Economics of Commercial Dairy Goat Milk Production in Central Arkansas. Proc. 1979 Calif. Dairy Goat Day, Univ. of California, Davis, CA. **Winrock-Production Systems**

Yazman, J. A. 1980. Rajas Caprinas, Alimentacion y Produccion de Leche en los Estados Unidos. Proc. Primer Encuentro Int'l. para Impulsar la Produccion de Leche de Cabra, Mexico. Diego Palacio, Diego, Mexico.
Winrock-Production Systems

Yazman, J. A., L. Turillo and H. A. Fitzhugh. 1980. Systems of Feeding Preweaning Dairy Goat Kids. Proc. Calif. Dairy Goat Day, Univ. of California, Davis. CA. pp. 42-52. **Winrock-Production Systems**

Verbal Presentations (SR-CRSP)

Onim, J. M. 1985. Small Ruminant CRSP Kenya Goat Project, It's Organization and Feeds Production. Conf. on Small Ruminant Prod. Sys. in the Humid Zone of West Africa, IITA, Ibadan, Nigeria. **Winrock/MALD-Feed Resources**

Onim, J. M. 1984. Nutritional Constraints to Goat Productivity. Conf. on Small Ruminants in Africa Agr. Systems, ILCA, Addis Ababa, Ethiopia.
Winrock/MALD-Feed Resources

Onim, J. F. M., H. A. Fitzhugh, R. D. Hart, K. Otieno and A. Sidahmed. 1984. SR-CRSP Kenya Goat Project: Its Organization and Feeds Production. Presented at Workshop on Small Ruminant Production Systems in the Humid Zone of West Africa, IITA, Ibadan, Nigeria. **Winrock-Production Systems**

Sidahmed, A. E., J. E. Reynolds, R. S. Shavulimo, et. al. 1985. On-Farm Dual Purpose Goat Production; Biological and Social Perspectives. 4th SR-CRSP Kenya Workshop. Kakemega, Kenya. **Winrock-Prod. Systems**

Sidahmed, A. E. et al. 1985. The Farming Systems Research Approach to Developing On-Farm Trials With Small Ruminants in Kenya and Indonesia. Conf. on Res. Meth. for Livestock On-Trials, ICARDA, Aleppo, Syria.
Winrock/MALD-Prod. Sys.

Verbal Presentations (Supporting)

Fitzhugh, H. A. 1983. New Horizons for Genetic Improvement of Livestock in Developing Countries. ASAS, Pullman, WA. Sci. Submitted.

Fitzhugh, H. A. 1978. Small Ruminants for Small Farms. Conf. on Integrated Crop and An. Prod. on Small Farms in Dev. Countries, Bellagio, Italy.
Winrock Production Systems

SR-CRSP

ANNUAL REPORT

1985-86

I.	**Project Title:**	Sociological Analysis of Small Ruminant Production Systems
II.	**Host Country:**	Kenya
III.	**Principal Investigator:**	Michael F. Nolan
IV.	**Personnel:**	Host Country Co-Workers: A.N. Mbabu, MALD Counterpart S. Chema, HCR-MALD SR-CRSP Enumerators Rural Sociology Field Assistants U.S. Co-Workers: T. Conelly, UMC/Winrock International Resident Scientist J. Reynolds, UMC Resident Scientist

V. Introductory

The broad goals of the Rural Sociology (RS) project in Kenya are as follows:

1. To develop a body of information for assessing technological interventions and management strategies related to dual purpose goats (DPG) and their likelihood of acceptance within the West Kenya small farm population.

2. To assess whether existing infrastructure can adequately support the DPG package proposed.

3. Through graduate training and technical support, to increase the capability of the Ministry of Agriculture and Livestock Development to conduct sociological research on agricultural/livestock production problems in Kenya.

More specifically, the Rural Sociology Project in Kenya seeks to assess the feasibility and acceptability for smallholder farmers of DPG technologies and management strategies being developed by SR-CRSP researchers through station and on-farm trials in western Kenya. The western study sites extend across a region of marked environmental, socio-economic, and cultural diversity, and thus present a range of domains under which components of DPG husbandry must be assembled and tested. The complexity of this research context is heightened by the nature of the interventions with which the Kenya Program deals. Small ruminants figure variously as minor to moderately important components of existing agricultural production systems across the study region. But DPG enterprises as envisioned represent substantially new and different approaches, and it cannot be automatically assumed that they will be easily integrated as innovations in smallholder livestock activities. DPGs represent perhaps more of a transformation than a transition in their significance vis-a-vis established patterns of animal husbandry, and this makes the task of assessing sociological problems and prospects for successful technology adoption all the more important.

VI. Research Accomplishments

SUBPROJECTS:

SR-CRSP Exhibits at Annual Agricultural Shows

This has been a continuing activity since 1982. Each year the RS Project has coordinated SR-CRSP exhibits at the two major agricultural shows in the western Kenya area of operations: Kisumu and Kakamega. Exhibits include instructional and pictorial posters for each project, examples of research findings and publications, forage displays, information leaflets for distribution to the public, and livestock (DPG) and milking demonstrations. In 1985, for the first time, an SR-CRSP exhibit was mounted at the national Agricultural Society in Kenya Show in Nairobi and included displays of SR-CRSP goats from the Ol'Magogo Breeding Station. As in the past, participation at agricultual shows has been possible through the cooperation of many members of the Kenya Programme team. This year, other SR-CRSP projects have taken an even more active role in the organization of show activities. Indeed, the 1985 Kakamega Show was directed entirely by Production Systems personnel (Nutrition and Management, Feed Resources).

Historical Profiles of West Kenya Ethnic Groups

This has been a longterm, intermittent activity which is described in detail in earlier reports. The objective is to compile historical and ethnographic profiles of Luo and Luhya study communities with particular emphasis on changing lifestyles and their implications for smallscale farming and livestock development. During 1985, further key-informant interviews were carried out by members of the RS team and the project enumerators. Additional data have been collected as part of the "Extension Services and the Smallholder" surveys. Archival and literature sources have also been reviewed. Preliminary results were presented during last year's workshop. Final analysis is in progress, and results will appear in a technical paper under preparation. These profiles examine significant developments which have led to the present circumstances of community life in western Kenya -- rapid expansion of population, patterns of out-migration for wage employment, growth of economic and social-amenity infrastructure, and transformation in crop and livestock production activities; implications for the future are also assessed.

Participant Observation by SR-CRSP Field Enumerators

This is another continuing activity, in progress since 1983. Justification, objectives, and early results have been detailed elsewhere.

Briefly, however, the aim is to develop enumerators' skills at social research while at the same time supplying additional, evaluative information relevant to SR-CRSP research thrusts in all parts of the programme. Enumerators were trained to keep regular journals of their field observations; these notes were weekly submitted to and discussed with the RS Resident Scientist, and then filed for reference in technical reports and for use in design of future research. During 1985 this work continued on a routine basis. Copies of all enumerator notes are being catalogued and bound for filing at Maseno.

Extension Services and the Smallholder Part I; Survey of Divisional Livestock Technical/Extension Personnel

The background and justification for this activity have already been covered in earlier reports. A three-part survey was constructed with the assistance of colleagues in other SR-CRSP projects. Areas of investigation included: the personal background of 62 technical/extension workers involved in livestock development, and their training and career outlooks (Part I); field staff duties and problems encountered in providing service to local communities, plus staff perceptions of farmers' circumstances and responsiveness (Part II); and livestock health and management issues (Part III). Interviews were conducted with all MALD field officers concerned with livestock extension activities in five administrative divisions of Kakamega, Siaya, and Kisumu Districts, encompassing a region in which SR-CRSP researchers at Maseno have been conducting on-farm trials, or plan to do so in future. Fieldwork was completed in early 1984, and initial data tabulations provided the basis for a working paper presented at the Third Small Ruminant CRSP Workshop held in March of that year. More comprehensive coding and compilation of the data was done during 1985 under the supervision of N. Mbabu. These data, along with a further set generated from Part II of this study, are now ready for full processing; and a technical paper is in progress.

Extension S
Survey of Local Farmers

This is the second part of the study described above. During 1984, multi-stage interviews were conducted with 104 farmers representing 13 villages in Maseno Division of Kisumu District, Siaya District, Boro Division, and three divisions of Kakamega District (Emuhaya, Hamisi, and Vihiga). Interview schedules were devised with the assistance of colleagues in the Health, Production Systems, and Economics projects. The first stage interview covered the personal background of respondents, household composition, land ownership, and other socio-economic indicators. The second stage concerned aspects of farming and livestock activity including crops and animals raised, yields and offtakes, inputs use, and farm improvement measures effected or planned. The last interview dealt with farmers' experiences with and views of the MALD extension services. Fieldwork was completed in the last quarter of 1984, and resulted in an extensive set of data which was sent to the University of Missouri for computer coding and processing, under the supervision of N. Mbabu. Coding progressed through 1985, and the data are now ready for comprehensive analysis. In the meantime, selected portions of the data were manually tabulated in Maseno in preparation for a working paper delivered at the Fourth Small Ruminant CRSP Workshop held at Kakamega in March, 1985. Another technical paper is now in progress.

Evaluation of On-Farm Feed Resources Trials

This has been an ongoing study in conjuction with the Feed Resources (FR) and Economics Projects to test different forage-producing alternatives in farmers' fields. The background and justification for earlier investigations in this area are given in past FR work plans. Apreliminary report on Rural Sociology (RS) participation in this study was given at the March 1985 SR-CRSP Workshop. In addition to monitoring farmers' reactions and preferences vis-a-vis the FR trials and interventions, the RS project has collected data on past and continuing methods of feed-forage production, and the reasons for changes in people's patterns and preferences. In 1985 the FR team concentrated on preservation through haay-baling as a means to cope with periods of feed deficit during dry seasons. The RS and Economics Projects started monitoring and follow-up work for this on-farm activity as well. During October, RS conducted formal interviews with farmers about their participation and interest in the preservation trials, problems encountered, and the prospects for future development. Additional informal interviews also gathered further impressions of the course of hay baling activities in the sites, and of possibilities for different methods and materials which might also be tried out with participating farmers. Reporting of this phase of the evaluation work is in progess.

On-Farm DPG Trial Monitoring

Monitoring respondents' experiences with the cross-bred goats placed on farms in the study areas is a regular RS activity carried out in cooperation with the Health and the Nutrition & Management Projects. As in the forage trial evaluations, this investigation combines informal and formal data collection techniques. Participant observation and regular journal recordings by field enumerators complement the use of formal questionnaires. Areas of monitoring and evaluation embrace famers' reactions to milk yields, health performance, feed practices, and overall care and maintenance of DPGs. Enumerators also gauge farmers' interest and attention in DPG production, and their cooperation with field research personnel. An RS update of on-farm DPG trial monitoring was given at the March 1985 SR-CRSP Workshop.

Preliminary Study to Define Recommendation Domains

The objective of this project (see previous Feed Resources Project workplans) is to specify continuities and variations within the western-Kenya study region in terms of environmental and socio-economic factors which may affect research recommendations for SR-CRSP stock distribution and on-farm monitoring. FR personnel have established three transect routes across the general region, and have been conducting surveys of principal physical features (altitude, soil, and vegetation variations). RS's role is to provide information on household and settlement patterns, farming and livestock activity, and other socio-economic features. This information will be assembled from the Extension and Smallholder surveys already completed. A working paper on overall results is in preparation.

Socio-economic Methodologies & SR-CRSP Research in Western Kenya

During 1985, SR participated in two regional workshops on methodologies and farming systems research. Reynolds co-authored presentations with the Economics Resident Scientist, A.W. Mukhebi, on the conduct of social science research in the SR-CRSP in Kenya. These presentations highlighted the variety of field studies and methodologies in the Programme's socio-economic work, including collaborative efforts with biological scientists. They also emphasized that SR-CRSP social science research outcomes have been both positive and negative.

VII. Significance of Findings

To carry out their projects, SR-CRSP researchers depend on the interest and cooperation of both local people and government personnel. It is therefore important to communicate the purposes and nature of Programme research in western Kenya. The Agricultural Society of Kenya (ASK) shows, which are held around the country on an annual basis, attract thousands of visitors, local residents and government personnel alike. In the west, the Kakamega and Kisumu shows provide excellent opportunities for informing people about the Programme and generating public awareness of the possibilities for DPG production on small-scale farms. Since 1982, RS has co-ordinated SR-CRSP exhibits at these two shows. The response of those visiting the exhibits has been very enthusiastic, with many people expressing a desire to begin raising "grade" goats right away. Indeed, Maseno scientists have received a deluge of requests to sell cross-bred animals.

The Rural Sociology project's work on historical and ethnographic profiles has provided both a rich body of data and a research model to aid developers in devising and fine-tuning technological packages for smallscale farm production in specific ethnic and regional contexts, as has the participant-observation information derived from enumerators' field journals, plus their auto-evaluations. These data have directed attention to a number of critical issues concerning 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."

In the latter regard, technical and extension field personnel have been a consistent focus of research in the Rural Sociology Project for several reasons: a) they should be readily available to provide information on livestock health and management problems in their areas of posting; b) they are likely to be quite familiar with local farmers and their circumstances; and c) the development of a DPG package in western Kenya must take into account existing livestock extension services and extension agents' ability to support smallholders' efforts by delivering appropriate technical assistance and advice. Preliminary results from Part I of the extension-services study discussed above indicate that extension personnel take a very positive view of the potential for smallholder DPG production in the western Kenya region. It seems clear, however, that any future effort at disseminating DPG technology cannot count upon substantial support from extension staff given present conditions of service and training. In terms of staff-to-client ratios alone, the extension services are hopelessly over-extended (Table 1). There is a critical need to devise group-extension or other alternative strategies to address the extreme disproportions between extensionists and the client population of smallholders they are supposed to serve.

TABLE 1: CURRENT LEVELS OF EXTENSION SERVICE

DIVISION	TOTAL # OF EXTENSION STAFF	TOTAL # OF HOUSEHOLDS*	TIME REQUIRED TO COVER HOUSEHOLDS**
Maseno	15	18,128	4.3
Vihiga-Emuhaya	23	47,739	7.4
Hamisi	13	17,032	4.7
Boro	11	20,784	6.8
Total	62	103,683	6.0

*Source for farming household figures: Farm Management Handbook of Kenya, Vol. II (MALD 1982).

**Assuming 23.2 households/month/extensionist.

Preliminary analysis of Part II of the extension-services survey suggests that, while farmers are open to obtaining more help from extension staff and can list ways in which they would like to see such help come, the situation of farmer-extension contact and farmer perception of service is not very encouraging. A majority of farmers are aware of the extension staff who operate in their areas, but most respondents reported that they were "not always satisfied" with assistance when received. Furthermore, rates of actual farm visits by extension staff during the period surveyed were rather low. A substantial majority of interviewees did not think that staff visit farmers often enough or work hard enough at their duties. Less than a quarter of the farmers said they went for help or advice during 1983-84, and about the same proportion said they always got assistance when needed.

Farmers recognize that extension personnel face difficulties which prevent more effective delivery of service. When asked to cite such difficulties, many respondents claimed not to know of any; but others cited "not enough staff" and "lack of transport." The farmer survey data show some notable similarities to the extension staff's responses concerning client-service contact. Extension workers themselves emphasized that farmers are not visited often enough. Also, like the respondent farmers, they cited lack of transport and staff as the principal bottlenecks to effective delivery of service. Table 2 summarizes some of the findings from this study.

TABLE 2: EXTENSION SERVICE CONTACT, EXPERIENCES, AND REACTIONS

QUESTION	% POSITIVE RESPONSES
Knows Any Extension Staff in Area?	65.4
Received Any Visit During 83/84?	29.8
Went for Help/Advice During 83/84?	22.1
Think Extension Staff Visit Often Enough?	30.8
Always Get Assistance when Needed?	21.2
Always Satisfied with Assistance?	47.1
Think Extension Staff Work Hard Enough?	30.8

A number of significant findings have emerged from the on-farm feed resources trials. First, farmer perception of the utility of particular forage crops seems closely linked with areal variation. For example, high ratings are given to pigeon pea by both Hamisi and Masumbi farmers, but for different reasons. In Hamisi, where land pressures are extreme, the crop is approved because it provides human food as well. In Masumbi, where conditions are much drier, farmers instead cite the "drought resistant" properties of pigeon peas.

These preliminary findings underline the primary importance of food crops in local communities. For example, whereas farmers frequently mention the dual food-feed potential of some of the forage crops introduced through the on-farm trials, traditional food crops like millet and sweet potato are stereotyped as human food only. This suggests that more efforts should be made to demonstrate the multi-purpose potential of established crops. Similarly, food priorities are emphasized by farmers' stated preference for fence-row production of forage, as a means of conserving food crop production areas. Another feed production method which find favor with farmers because it more efficiently utilizes existing (and scarce) land resources is hay-baling. A major constraint here, however, is adequate on-farm storage. This requires further investigation by both technical and social sciences.

RS monitoring of DPG on-farm trials has produced two significant findings: many farmers' interest and cooperation in DPG introduction is fairly high; but most express concern about health, milk yield, and management issues (Table 3). To the extent that farmers are undergoing a period of trial adjustment, perhaps such concerns will diminish as they learn to accommodate the higher performance DPGs. However, it is clear that technical researchers must further sensitize DPG technologies to smallholders' limited land, labor, and other resources.

TABLE 3: ON-FARM DPG TRIALS: FARMERS' MOST FREQUENTLY CITED PROBLEMS, COMPLAINTS

PROBLEM/COMPLAINT	TOTAL TIMES NOTED
Poor Health	13
Poor Milk Yields	12
Too Much Sampling	10
Animals Require Much Care and Feed	8
Goats are Old/"Useless"	4
Animals Difficult to Breed in Time	3
Farmer Thinks His/Her Luck Bad	3
Animals too Small	2

A number of significant lessons were learned from the examination of SR-CRSP socio-economic methodologies and collaborative research. E.G.: a) interaction of biological and social scientists facilitates collection of more realistic data for evaluation; b) staff turn-over necessitates careful documentation of research activities in order to avoid costly duplications of work; c) publicity about on-farm trials can create excessive farmer demand for inclusion in trials; d) prolonged use of the same farmers and enumerators may fray rapport, patience, and cooperation; and e) particular care must be taken to allay defensiveness and apprehension among colleagues from different disciplines since suggestions and criticisms can be easily misread.

VIII. Future Directions

RS Resident Scientist Dr. J. Eric Reynolds completed his contract in mid-1986. Dr. Thomas Conelly has replaced him, working under a Rockefeller Foundation International Development Internship. In the near future, RS will be consolidating research activities already undertaken into a series of comprehensive technical reports, while also conducting further investigations in selected areas -- particularly in the planned largescale distribution of new DPG stock for on-farm testing. Overall, field study plans include the following:

1. Criteria will be developed for selecting participating farmers for the second, 1986 DPG distribution. Such criteria as farm size, socio-economic status, gender of household head, household education levels, community integration, etc., will be used to ensure that participating farmers are representative of the larger population. Monitoring farmers' responses to specific components of on-farm experiments will enable evaluation of the socio-economic impact of crossbred goats on smallholders and will thereby inform preliminary adoption packages for appropriate DPG technologies.

2. The degree to which DPG care and management compete with other household labour needs will be a major factor affecting acceptance of DPG technologies. RS will analyze household time allocations -- not only farm labor but also activities like marketing, wage labor, and child care. The decision-making process determining farmers' time allocations will also be studied.

3. Land-use strategies among sample farmers will be assessed in order to identify their criteria for allocating scarce land to achieve various goals, e.g. food, cash crop, and livestock production. This will lead to identification of possible constraints on technology adoption and of areas of flexibility where interventions may be most easily introduced.

IX. Funding

Subgrant	$250,000	
Kenya		43,872
Matching	83,400	
Host Country Contribution (estimate) Kenya		10,000

KENYA

Sociology - University of Missouri

Theses--(SR-CRSP)

M. S.
Aboud, A. 1982. Range Management Extension Services on Pastoral Societies of Kenya. Departments of Agricultural Economics and Rural Sociology, Ohio State University, Columbus. **U. Mo.-Sociology**

Noble, A. 1981. Women and Livestock in Western Kenya: An Organizational Analysis. University of Missouri, Columbia. **U. Mo.-Sociology**

Journal Articles, Refereed (Supporting)

Campbell, R. R., M. F. Nolan and John F. Galliher. 1981. Reflections of Title XII Collaborative Research: The Case of Sociology in the Small Ruminant CRSP. (Presented at 5th World Congress for Rural Sociology, Mexico City.) The Rural Sociologist 1(1):2-10. **U.Mo.-Sociology**

Technical Communications (SR-CRSP)

Aboud, A. 1982. Range Management Extension in Kenya. Proc. SR-CRSP Kenya Workshop. p. 117. **Ministry of Livestock Development**

Campbell, R. R., H. Lionberger and C. Suda 1984. A Social Systems Description of Small Farmers in Two Western Kenya Districts. SR-CRSP Tech. Rpt. #43. NTIS #PB 8-5-113850 **U. Mo.-Sociology**

Noble, A. L. and M. F. Nolan. 1983. Sociological Constraints and Social Possibilities for Production of Goats in Western Kenya. SR-CRSP Tech. Rpt. #18. NTIS #PB8-4-238591. **U. Mo.-Sociology**

Noble, A. and M. Nolan. 1982. Women and Goats in Western Kenya: Dilemmas for Development. Proc. 3rd Int'l. Conf. on Goat Prod. and Dis., Tucson, AZ. pp. 197-200. **U.Mo.-Sociology**

Nolan, M. F. 1982. Dual Purpose Goats in Western Kenya: A Summary of Sociological Constraints. Proc. SR-CRSP Kenya Workshop. pp. 113-114. **U. Mo.-Sociology**

Reynolds, J. E. 1983. Data Collection and Dual Purpose Goat Trials in Siaya and Kakamega Districts, West Kenya. SR-CRSP Research Report. Maseno, Kenya. **U. Mo.-Sociology**

Reynolds, J. E. 1985. Response of Smallholder Farmers to Feed Resource Intervention Trials in Western Kenya. Proc. 4th/SR-CRSP Kenya Workshop, Kakamega, Kenya. **U. Mo.-Sociology**

Reynolds, J. E. 1986. Small Ruminants and Small Holders: SR-CRSP in Western Kenya. Symp. on Social Science and Agricultural Research: The Experience of the Small Ruminant CRSP, U. of Missouri, Columbia. **U. Mo.-Sociology**

Reynolds, J. E. 1984. Seeking the "Udder" Truth About Goats in Western Kenya: Conversations With Community Elders. Proc. 3rd SR-CRSP Kenya Workshop, pp. 113-118. **U. Mo.-Sociology**

Reynolds, J. E., P. Amuhinda, H. Kiguhi, E. Ochieng, E. Otieno and M. F. Nolan. 1984. Field Research and the Western Kenya Study Communities: Observations by the SR-CRSP Enumerators. Proc. 3rd SR-CRSP Kenya Workshop, pp. 119-124. **U. Mo.-Sociology**

Reynolds, J. E. and A. N. Mbabu. 1984. The Programme and the Public: SR-CRSP Exhibits at Agricultural Shows. Proc. 3rd SR-CRSP Kenya Workshop, pp. 109-112. **U. Mo.-Sociology**

Reynolds, J. E., A. N. Mbabu and M. F. Nolan. 1984. Extension Services and the Smallholder: A Report of Preliminary Findings. Proc. 3rd SR-CRSP Kenya Workshop, pp. 125-132. **U. Mo.-Sociology**

Reynolds, J. E., A. N. Mbabu and M. F. Nolan. 1985. Extension Services and the Small Holder: The Farmers' Views. Proc. 4th SR-CRSP Kenya Workshop. Kakamega, Kenya. **U. Mo.-Sociology**

Reynolds, J. E., M. K. Salim and F. B. Nyaribo. 1983. Problems and Prospects for a Small-Scale Tick Control Method. Some Observations on the SR-CRSP Dipping Trials in Kakamega and Siaya Districts. Proc. 2nd SR-CRSP Kenya Workshop. pp. 64-82 **U. Mo. Sociology**

Verbal Presentations (SR-CRSP)

Reynolds, J. E. 1983. Foraging for Extra Protein: Dual Purpose Goat Research and Development in West Kenya Smallholder Communities. African Studies Association, Boston. **U. Mo.-Sociology**

Sidahmed, A. E., J. E. Reynolds, R. S. Shavulimo, et. al. 1985. On-Farm Dual Purpose Goat Production: Biological and Social Perspectives. 4th SR-CRSP Kenya Workshop, Kakemega, Kenya. **U. Mo.-Sociology**