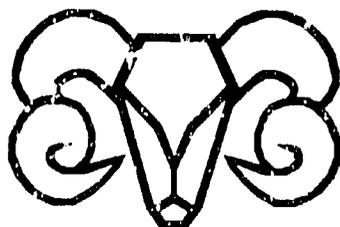


PW-ABC-401 6017 -

**Small Ruminant  
Collaborative Research  
Support Program  
Annual Report for  
Kenya  
Program Year Eight  
1986-87**



Small Ruminant CRSP  
University of California  
Davis, California 95616

<u>COUNTRY</u>	<u>SR-CkSP DISCIPLINE</u>	<u>PRINCIPAL INVESTIGATOR</u>	<u>PRINCIPAL COUNTERPART</u>
<b>Brazil:</b>	Animal Breeding & Management	M. Shelton	E. Figueiredo
	Animal Health	H. Olander	F.S. Alves
	Animal Nutrition	W.L. Johnson	N.N. Barros
	Economics	H. Knipscheer	J. Souza-Neto
	Range Management	J. Malechek	E. Oliveira
	Sociology	M. Nolan	M.C. Neumaier
<b>Indonesia:</b>	Animal Nutrition	W.L. Johnson	M. Rangkuti
	Economics	H. Knipscheer	A. Muljadi
	Genetic Improvement	E. Bradford	Subandriyo
	Sociology	M. Nolan	K. Suradisastra
<b>Kenya:</b>	Animal Breeding Systems Analysis	T. Cartwright	F. Ruvuna S. Tallum
	Animal Health	T. McGuire	F. Rurangirwa
	Economics	H. Knipscheer	F. Nyaribo
	Production Systems Feed Resources Nutrition/Management	H. Fitzhugh	M. Onim P. Semenyé
	Sociology	M. Nolan	A.N. Mbabu
<b>Morocco:</b>	Genetic Improvement	G.E. Bradford	A. Lahlou-Kassi
	Nutrition	W.L. Johnson	F. Guessous
	Range	J. Malechek	H. Narjisse
	Sociology	M. Nolan	A. Hammoudi
<b>Peru:</b>	Animal Health	J. DeMartini	E. Ameghino
	Breeding & Management	P. Burfening	M. Carpio
	Economics	H. Knipscheer	D. Martinez
	Range Management Sociology	F. Bryant M. Nolan	A. Florez M. Fernandez

# SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM

## ANNUAL REPORT FOR KENYA

1986 - 1987

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If more information is desired, the Principal Investigator of the specific project may be contacted at his U.S. institution or by enquiry from the Management Entity, Small Ruminant Collaborative Research Support Program, University of California, Davis 95616. In addition to this series of annual reports by host country, the Management Entity has compiled a complete roster of trainees and a full listing of over 2000 theses, book chapters, scientific journal articles, abstracts of papers presented at meetings, and written and verbal technical presentations which reflect the activity of the SR-CRSP prior to 1988.

## 1986/87 ANNUAL REPORT

### INTRODUCTION

Much of Western Kenya is blessed with fertile soils and a bimodal rainfall pattern allowing two cropping seasons per year. Unfortunately, wherever agricultural potential is high, human population is likely to be growing 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 provide 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) production 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 2 to 3 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 have potential as 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 Kenyan and expatriate scientists. The Kenya Agricultural Research Institute and the Ministries of agriculture and Livestock Development are the principal host country institutions. 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)

The implementation strategy followed by the SR-CRSP in Kenya has involved a 3-stage process:

Stage 1 (1980-1982). Characterization of social-economic-biological activities of traditional farming systems; on-station component research in breeding health, goat nutrition, and agronomy.

Stage 2 (1983-1985). Monitor 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--continues.

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 development by SR-CRSP should prove adaptable to farming systems in other parts of the tropics.

During 1986-1987, the potential of SR-CRSP research results for improving the welfare of small farm families became readily apparent. Research generated technologies such as vaccine for contagious caprine pleuropneumonia (CCP), which can be safely stored at room temperature, are ready for commercial utilization. Agronomic interventions such as fast-growing tree legumes (leucaena and sesbania) are being incorporated by private voluntary organizations (PVOs) in their local community development programs. Socioeconomic field surveys established the strong demand for milk by the people in the test region and the availability of sufficient family labor to support a dual-purpose goat component in the local farming systems.

Good progress was made in multiplication of dairy x local cross goats needed for the large scale on-farm evaluation of DPG technology packages slated to start in June 1988. Development of the four breed synthetic entered the breed stabilization and selection phase.

Additional highlights and details of research programs are presented in the separate project reports which follow.

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. Unfortunately, sharp reductions in available funding have and will continue to impact on the progress toward these research goals. Nevertheless, all involved in the SR-CRSP/Kenya team remain optimistic that research progress will continue and that the DPG technology packages will be successfully evaluated as planned.

## 1986/87 ANNUAL REPORT

Title: **Genetic Improvement of Dual Purpose Goats Under Smallholder Farming Systems**

Principal Investigator T. C. Cartwright

U.S. Institutions: Texas Agricultural Experiment Station (TAES), Texas A&M University System

Host country Institution: Kenya Agricultural Research Institute (KARI)

Personnel: Principal Investigators  
T. C. Cartwright, Professor, TAES

### Host Country Co-Workers

M. A. Okeyo, Research Officer, KARI  
C. O. Ahuya, Research Officer, KARI  
S. Gichora, Technical Officer, KARI  
J. Kariuki, Veterinary Officer, KARI

### U.S. Co-Workers

F. Ruvuna, Resident Scientists, TAES  
H. D. Blackburn, Research Scientist, TAES  
P. J. Howard, Graduate Assistant, TAES  
J. F. Baker, Assistant Professor, TAES  
J. W. Bassett, Professor, TAES

## RESEARCH RESULTS

The major thrusts of this project are 1) to genetically synthesize a new dual purpose goat breed that can thrive and produce milk and meat in Western Kenya and 2) to provide goats for other SR-CRSP projects. The "computer designed" four-breed composite synthetic breed (DPG) is now entering the multiplication, breed stabilization and selection phase. Presently there are approximately 150 head of DPG; this number will increase to over 600 in 1988. The current flock at Ol Magogo numbers approximately 1,300 head. The composition of this flock is being phased, as planned, to reduce the purebred indigenous and F1s and build to a DPG herd size of over 1,000 which is a viable number for breed development, by 1989. The intermediate F1s produced in the breed formation stage have been popular for release to farmers and herders. A major collaborative effort has been to provide other SR-CRSP projects with goats for research; distribution to projects include: Feed Resources (41, Maseno), Health (36, Maseno, haemonchus; 21 Kabete, heartwater; 110, Ukunda, trypanosomiasis) and Production Systems (150, Maseno).

A major program was instituted in collaboration with the Health Project to evaluate all male kids, as a progeny test, for mutual immunity to

haemonchus. This evaluation and other data related to fitness to the Kenya environment are to be used as primary selection data for the DPG to supplement the milk production and growth data. The current DPG does are projected to reach 40 kg mature weight and 3.0 kg milk per day at peak of lactation based on F1 data. Optimal selection goals have been determined to be 40 kg weight and 4.0 kg milk at peak lactation (vs. the current level of 3.0 kg). It has been estimated, based on the data collected at Ol Magogo, that approximately 4 generations (6 years) will be required to reach the selection goal of 4.0 kg milk per day at peak of lactation. These individuals will form the basis for an elite flock to provide improved genetic resources for eastern Africa. A plan is being developed to establish a breed organization with breeding and selection criteria (Cartwright et al., 1987).

Detailed growth, milk and other data kept on this flock have been, and are continuing to be, analyzed to provide useful information to develop "tech packs" for utilizing DPGs and improving goat production of meat and milk in general. These include characterizing breeds and crosses for growth and milk production (Ruvuna et al., 1985a,; Ruvuna et al., 1987 a, b, d, e), reproduction (Ruvuna et al., 1987a; Okeyo, 1985 a, d) mortality (Okeyo et al., 1986d) disease immunity/resilience (Ruvuna 1985B), heterosis (Ahuya, 1987) milking strategy (Ruvuna et al., 1987a, b; Ruvuna 1985c;) and use of teeth as an age indicator (Okeyo et al. 1987). For example, it has been found that the Gala (G) provides a better maternal environment than East African (EA); however, when these are crossed with Toggenburg and Nubian and used as F1 dams, the maternal heterosis of the EA F1s is superior. This information is very useful since the EA has superior fitness for Western Kenya and its combining ability (non-additive genetic effects) with the exotic overcomes its lower production (additive genetic) effects (Ahuya, 1987). Two milking strategies proved suitable for adoption in dual purpose production: either provide the kid with 0.5 kg milk per day or let it suckle 1/2 of the udder; for the DPG the 0.5 kg/day is preferred (Ruvuna et al., 1987a, c; Ruvuna 1985c). Excess bucks have been used for an experiment to characterize the carcass and meat of goats and effects of castration (Okeyo et al., 1985c); this area is an almost complete void in the scientific literature.

Determining the selection strategy for the DPG is a critical part of this project. The optimal "computer designed" values of 40 kg mature doe weight and 4.0 kg peak milk must be included in an index balanced with natural disease immunity/resilience (principally haemonchus) and other survival or fitness characteristics (Ruvuna et al., 1987). An overall long term strategy for breed development was designed (Cartwright et al., 1986).

Feedback data from direct placement of F1 bucks with farmers, has been highly favorable and requests far exceed current supply. The first kids from these bucks are currently producing farmer observational data. These data will be useful in designing "grading up" strategies for release of the DPG to smallholders.

The design of the new DPG has incorporated concepts of modern genetic use of a breed. The project includes genetic resources to adapt the DPG

on the one hand for more intensive, larger or specialized goat dairies on the other hand for utilization in more arid, more extensive areas (Cartwright et al., 1986). The proposed strategies are being tested by the Systems Project.

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### **TRAINING:**

C. O. Ahuya, A Kenya citizen, KARI completed his M. S. under PI in January, 1987 and has returned as a research officer on the Breeding Project. He is the second Breeding Project sponsored student to return to the Project. (Three other M. S. students of the PI work directly with sheep and goats in Kenya).

H. M. Rajab, a citizen of Syria, completed his Ph.D. in August, 1987 using breeding data from SR-CRSP in Brazil. Mr. Rajab was funded from other sources (U.S. AID). (Rajab is also listed under Systems Project).

E. L. Lentz, U. S. permanent resident, is working toward a Ph.D. She received minor Breeding Project Funding. Expected date of completion is December, 1988. (Also listed under Systems Project.)

P. J. Howard, U.S. citizen, is working toward a Ph.D. She received minor Breeding Project funding. Expected date of completion is September, 1988. Howard received an M. S. at the Univ. of Florida under SR-CRSP Economics Project graduate assistantship. (Also listed under Systems Project.)

## 1986/87 ANNUAL REPORT

Title: **Systems Analysis and Synthesis of Small Ruminant Production Systems**

Principal Investigator: T. C. Cartwright

U.S. Institution: Texas Agricultural Experiment Station  
(TAES)  
Texas A&M University System

Host Country Institutions: Kenya Agricultural Research Institute  
(KARI)

Personnel: Principal Investigator  
T. C. Cartwright, Professor, TAES

Host Country Co-Workers  
S. K. Tallam, Research Officer, KARI

U.S. Co-workers  
H. D. Blackburn, Co-investigator,  
Research Scientist, TAES  
F. C. Bryant, Professor, Texas Tech  
University  
F. Ruvuna, Resident Scientist, Kenya,  
TAES  
E. L. Lentz, Graduate Assistant, TAES  
P. J. Howard, Graduate Assistant, TAES

### RESEARCH RESULTS

The Systems Analysis project was involved at three work sites in FY 86-87: Peru, Brazil and Kenya. The major emphasis of the project has been to apply the developed and validated simulation models in different SR-CRSP countries. The simulations were performed to integrate information generated by other SR-CRSP and host country projects into a form which could lead to more complete analysis and formulation of recommendations concerning the application of technologies as balanced sets. In addition to computer simulations a shortcourse in August, 1986 was held at Texas A&M to instruct interested persons on the use of the sheep and goat simulation models. Participants attending were from West Germany, Mexico, Zimbabwe, Morocco, Tanzania and the U.S. This effort enhances regionalization and practical application of SR-CRSP results.

### KENYA SYSTEMS ANALYSES

Simulations for this SR-CRSP site are continuing to focus on problems that smallholders in Western Kenya face when engaged in goat production. Because the milk of each doe is to be divided between use by humans and kids, it is critical that kids receive adequate milk to assure an appropriate level of growth. Therefore, it was of interest to

determine how kids would respond if weaned at 30, 60, 90, 120 and 150 days of age under 3 different levels of nutrition. It was assumed that kids were allowed to take up to 0.5 kg of milk per day. With base forage (forage normally available to the farmer) weaning could not be practiced at less than 150 days of age. With improved levels of nutrition, weaning could feasibly be done as early as 90 days of age. Because milk intake for the kid is limited (0.5 kg/day), improving nutrition did little to increase weaning weight; however yearling weights were increased approximately 100% and milk production increased from 30 to 144% (Tallam et al., 1986).

A second area of work was to determine if dedicating specific land areas (0.1 ha) to forage production for dual purpose goats had any advantages for smallholders (Tallam et al., 1986). Three genotypes (designated by mature size/peak lactation potentials, weight/milk per day in kg, of 40/3.0, 40/4.0 and 50/5.0) were tested in this series of simulations. By developing a dedicated forage resource, milk production was more consistent throughout the year. The 40/3.0 genotype produced a higher level of kid offtake (15.5%) but lower dairy milk yield (16.4%). The 40/3.0 also had a 19% lower biological efficiency than the 40/4.0.

These results have several far reaching implications first, marked improvement in goat product offtake can be obtained by dedicating small land areas for growing forage for goats; and second, the 40/4.0 genotype which is the target genotype for the dual purpose goat has a high level of robustness enabling it to produce in marginal as well as improved production situations.

The results of all these simulations, in detailed quantitative terms, are provided to the Economic Projects for economic analysis.

KARI personnel, Mr. Steve Tallam, with computing equipment provided by the Breeding/Systems Project have been completely self sufficient for conducting systems analyses with the SAV models. Continued collaborative research support will be mutually beneficial.

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- Blackburn, H. D. and T. C. Cartwright. 1987. Simulation on an individual animal level as an aid in determining breeding objectives. J. Anim. Sci. (Submitted).
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- Lentz, E. L. and H. D. Blackburn. 1987. User Guide for specifying input parameters for the TAMU Sheep and Goat Simulation Models, SAV Version. Small Ruminant CRSP. Tech. Rep. 90. (14 pages)
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- Blackburn, H. D., P. J. Howard, T. C. Cartwright and F. Ruvuna. 1987. Simulation of the effect of flock size and nutrition on goat productivity in Kenya. Proc. IV Int'l. Conf. on Goats II:1540.
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Tallam, S. K., T. C. Cartwright, C. D. Lu, P. J. Howard and H. D. Blackburn. 1985\*. Validation of Kenya Goat Simulation Model for Application to Dairy Goat Production. Proc. 4th SR-CRSP Kenya Workshop, Kakamega (pp 114).

#### Dissertation

Rajab, M. H., 1987. Simulation of genetic and environmental interaction of three tropical hair sheep breeds for meat production (in Brazil). Ph.D. Dissertation. Texas A&M Univ., College Station (155 pages)\*\*.

\* These 1985 proceedings were not listed last year because they were not published.

\*\* Cross-listed with the Breeding Project.

## 1986/87 ANNUAL REPORT

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

Principal Investigator: Hendrik C. Knipscheer

Host Country: Kenya

Personnel: Host Country Co-workers  
A. Mukhebi  
L. Oyugi  
H. Ogadi

U.S. Co-workers  
F. Nyaribo (Ph.D. student)

### RESEARCH RESULTS

The general projects goals are 1) to develop useful whole-farm economic model of western Kenya small farms to assist in ex ante evaluation of dual-purpose goat acceptance, and 2) to conduct 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.

Whole farm analysis was the basis for two economic studies in the Kenya SR-CRSP. One was the analysis of cash flow patterns of small-scale farm households of western Kenya, and the other was the development of a Ph.D.'s proposal by Ms. Fanny Nyaribo.

Evidence from earlier SR-CRSP Economics Project studies indicates that over 50% of foods consumed by farm households in Kakamega and Siaya districts in western Kenya are purchased from the market. What was not ascertained from these studies are the sources of cash that enable these relatively large food purchases to be made. The cash flow study was therefore conducted to identify sources, levels, and patterns of cash in-flows and out-flows of the farm households in the SR-CRSP cluster areas in W. Kenya and explore their implication for the DPG technology adoption.

A daily record of cash in-flow and out-flow was kept by 11 farmers in Kaimosi, 13 farmers in Hamisi, and 13 farmers in Masumbi clusters for the period April 1, 1984 to April 30, 1985. The farmers were requested and instructed to keep a daily record that included the date, description of the cash flow (sale, purchase, receipt/gift), quantity of the item involved, unit price and total cash received or spent on the item. The records were checked twice weekly by an enumerator living in

the cluster and regularly reviewed by the SR-CRSP economists. Items of cash receipts and cash expenditures were classified into broad categories and monthly cash in-flows and out-flows were summarized by category. Data were collected for a complete year in order to identify seasonal patterns.

Cash in-flow represents all receipts of cash by the household. Quantities of purchased milk can be derived from cash expenditures on milk. Assuming a price of KShs. 5.50 per liter of milk, an average household purchases an annual amount of 56 lt in Kaimosi, 74 lt in Hamisi, and 10 lt in Masumbi. More recent data suggest even higher quantities (172 lt for Hamisi and 83 lt for Masumbi). These amounts of milk can be made from one DPG doe yielding an average of 1.2 lt per day for a 150-day lactation period. This amount of milk yield is within some observed on-farm production level in the clusters.

The cash-flow analysis showed that small-farm households in western Kenya have little or no savings for substantial on-farm investment. Such investment would require access to credit. Return on investment into the dual-purpose goat enterprise would be enhanced by cash savings from current expenditures on milk purchases. Quantities of milk purchased per household are within on-farm DPG production levels per doe observed in SR-CRSP research clusters.

Good progress was made in model conceptualization and research design for the development of a whole-farm linear programming (LP) model. The general objective of this study is to evaluate new goat husbandry technologies by simulating optimal farm plans with DPG as an enterprise on the smallholder farms in Siaya and Kakamega districts of western Kenya. The analysis is centered on the key questions as to how the DPG compares with other enterprises on the target farms. The initial baseline survey was principally to characterize basic features of the target area and to identify the major constraints to DPG adoption and production on small-scale farms: limited land size, labor constraints during peak demand periods, scarce capital, and inadequate livestock marketing infrastructure.

Biological constraints were identified as inadequate quality feeds on a year-round basis, susceptibility of goats to diseases and parasites, and lack of genotypes with the capacity to produce surplus milk beyond kid requirements for human consumption. In addition to the cost-benefit and gross margin analyses that have been carried out, whole-farm Linear Programming models will be formulated for a number of representative farms.

Another study focused on the demand for and the supply of milk and small ruminants in western Kenya. Small Ruminant Collaborative Research Programs (SR-CRSP) is conducting research to develop Dual Purpose Goats (DPG) for small-scale farmers to provide increased production of food protein through milk and meat. With population growth rate of about 4% per annum, Kenya is experiencing diminishing land resource base to provide sufficient feed for a lactating cow, but may support several lactating goats. From baseline survey in 1980-81, inadequate livestock marketing infrastructure was identified of which economics project

undertook a study to assess capacity of market to absorb milk and meat from potential DPG production.

The evaluation of demand for and supply milk and small ruminants (sheep and goats) in Kakamega District, one of SR-CRSP large areas, quantified supply, demand, and prices of these products in selected livestock markets and explained their seasonal variations. This study was carried out from January 1985 to January 1986 in Kakamega District, which is one of the operation sites of the SR-CRSP projects. A sample of several livestock markets, regional markets, and local markets were selected purposely for the study.

The implications of the study for dual-purpose goat production are the following.

1. The information available is not conclusive enough to assess the demand, supply, and prices for dual-purpose goats (DPG), since the goats under study were small East African goats which are mainly meat goats. Therefore, the demand for the small East African goat does not necessarily reflect the demand for DPGs. The DPG market would be correctly assessed once these goats are available commercially.
2. Since DPGs have the capacity to produce extra milk for human consumption in addition to meat, the introduction of the goats would go a long way in alleviating the existing excess demand for milk in western Kenya. Studies have revealed that consumer acceptability of goat-milk products would not be a constraint to the establishment of DPG production systems in western Kenya.

#### **PUBLICATIONS:**

Oyugi, L. A., A. W. Mukhebi, H. K. Ogada, and H. C. Knipscheer. 1986. The Demand for an Supply of Milk and Small Ruminants in Western Kenya. Paper SR-CRSP Workshop, ILRAD, Nairobi, Nov. 4-5.

Mukhebi, A. W., F. Nyaribo, L. Oyugi, and H. C. Knipscheer. 1986. Cash Flow Patterns of Small-scale Farm Households in Western Kenya. Paper SR-CRSP Workshop, ILRAD, Nairobi, Nov. 4-5.

Oyugi, L. A. and A. W. Mukhebi. 1986. Hay Baling Box. SR-CRSP paper. Maseno

Mukhebi, A. W., M. Gituhu, J. Kavo, and J. Troha. 1986. Agropastoral Systems of Southern Machakos District of Kenya. Kiboko Technical Report No. 7. MALD.

#### **TRAINING:**

Ms. Fanny Nyaribo has completed her course work for he Ph.D. degree in agricultural economics at Washington State University and is presently working on her Ph.D. dissertation.

## 1986/87 ANNUAL REPORT

TITLE: Kenya Animal Health Research Component

Principal Investigator: Travis C. McGuire

U.S. Institution: Washington State University  
Pullman, Washington 99164

Host Country Institution: Ministry of Livestock Development,  
Government of Kenya

Collaborating Personnel: F. R. Rurangirwa, S. Chema, S. Waghela,  
A. Kibor, R. Shavulimo, and P. Shompole

### RESEARCH RESULTS

#### Contagious Caprine Pleuropneumonia (CCPP) Vaccine Development

CCPP is the most serious disease of goats in Kenya and is present in at least 33 other countries in Africa and Asia. The disease is caused by F38 mycoplasma and occurs in epidemics that cause high mortality and great economic loss. A project to develop an inactivated and lyophilized vaccine for CCPP is nearing completion. This year's focus was to evaluate the number of doses required and to determine the duration of immunity. Goats given a single vaccination resisted contact challenge 2 years later. These results, taken together with data indicating the vaccine can be stored at room temperature for over 1 year, show that the vaccine development is complete and that field trials are needed.

#### A Field Diagnostic Test for Contagious Caprine Pleuropneumonia

A rapid diagnostic test for CCPP is needed for immediate treatment of sick goats having the disease, vaccination of goats at risk to CCPP, and screening of goats for purchase. A latex agglutination test detects antibodies to CCPP in 2 minutes and has been extended for use on undiluted serum or whole blood. The test is made by coating latex particles with a carbohydrate moiety isolated from F38. Tests on goats from farms free of CCPP are negative while 63% of 763 sera from farms with outbreaks of classical CCPP were positive. The test is ready for possible commercialization or government-supported distribution.

#### Diagnosis and Prevention of Heartwater in Goats

Heartwater is a rickettsial disease of goats, sheep and cattle. Transmission is by Amblyoma ticks, which are widely distributed in Kenya. In goats, the disease causes high mortality and is devastating to susceptible goats moved to an area with infected ticks. An objective of the health component is development of ways to diagnose and control heartwater in goats and sheep. A stabilite of Cowdria ruminantium that causes heartwater in goats has been evaluated and used to infect

ticks. Infected tick larvae were used as a source of C. ruminantium organisms. Since large amounts of antigens are needed, genomic DNA has been isolated from the heartwater organism and used to construct a DNA library in plasmids. Transformed bacteria are being evaluated for expression of C. ruminantium proteins. These expressed proteins will be used as antigens in diagnostic tests and for vaccines. Also, cloned C. ruminantium DNA can be used for hybridization probes to evaluate carrier goats and infected ticks.

#### Evaluation of natural Resistance of Goats to Haemonchus contortus

This project is an attempt to identify natural resistance to a parasite that can be exploited to reduce costly intervention by farmers. A preliminary observation that the East Africa breed was better able to resist Haemonchus larval challenge than the Galla breed needs further evaluation. To extend the study and to evaluate infection rates of individuals in various breeds, evaluation of goat kids from the breeding project at Ol Magogo are being done. This project has just been initiated and there are no results.

#### Collaborative Project with Colorado State Animal Health Component on Neonatal Alpaca Mortality

High neonatal alpaca mortality occurs in Peru and a study was done to determine the cause. Passive transfer of maternal immunoglobulins to the neonate was shown to be by ingestion and absorption of immunoglobulins, primarily IgG<sub>1</sub> from colostrum. No placental IgG or IgM transfer occurred. Neonatal alpacas that failed to obtain immunoglobulin had a very high mortality rate due to infections and these alpacas accounted for most of the deaths. These and other data demonstrated that failure of passive transfer of immunoglobulin from colostrum was a major determinant of mortality in newborn alpacas. Management strategies ensuring that neonatal alpacas obtain as much colostrum as soon after birth as possible should be initiated.

#### **PUBLICATIONS:**

##### Refereed Journals

- Rurangirwa, F. R., McGuire, T. C., Magnuson, N. S., Kibor, A. and Chema, S. 1987. Composition of a Polysaccharide from Mycoplasma (F-38) Recognized by Antibodies from Goats with Contagious Pleuropneumonia. *Research in Veterinary Science*. 42:175-178
- Garmendia, A. E. and McGuire, T. C.. Mechanism and Isotypes Involved in Passive Immunoglobulin Transfer to the Newborn Alpaca (Lama pacos). *American Journal of Veterinary Research*. In press.
- Garmendia, A. E., Palmer, G. H., DeMartini, J. G. and McGuire, T. C. Failure of Passive Immunoglobulin Transfer: A Major Determinant of Mortality in Newborn Alpacas (Lama pacos). *American Journal of Veterinary Research*. In press.

Rurangirwa, F. R., McGuire, T. C., Chema, S. and Kibor, A. Vaccination Against Contagious Caprine Pleuropneumonia Caused by F-38. Israel Journal of Medicine. In press.

Rurangirwa, F. R., McGuire, T. C., Kibor, A. and Chema, S. A Latex Agglutination Test for Field Diagnosis of Contagious Caprine Pleuropneumonia. Veterinary Record. In press.

Rurangirwa, F. R., McGuire, T. C., Kibor, A. and Chema, S. An Inactivated Vaccine for Contagious Caprine Pleuropneumonia. Veterinary Record. In press.

#### Abstracts

Rurangirwa, F. R., McGuire, T. C., Musoke, A. J. and Kibor, A. 1986. Monoclonal Antibody that Differentiates F-38 Group of Mycoplasma from Other Mycoplasma Species. Birmingham, Alabama: 6th International Congress of the International Organization for Mycoplasmaology.

#### Master's Thesis

Derrick M. Mwamachi. 1987. Immune Colostrum Induces Trypanotolerance in Goat Kids Challenged with Trypanosoma congolense. Washington State University, Pullman.

#### Doctoral Thesis

Antonio Garmendia. 1986. The Mechanism, Isotypes Involved, and Effect of Passive Immunoglobulin Transfer to the Newborn Alpaca. Sponsored in cooperation with Colorado State University (Peru animal health component). Washington State University, Pullman.

#### **TRAINING:**

##### a) Degree oriented:

All students are Kenyan; all are working toward degrees awarded by Washington State University.

Mwamachi, Derrick M. S. Veterinary Medicine, Washington 1/83-8/87

Waghela, Suryakant is working toward completion of a Ph.D. Veterinary Medicine, Washington 9/84-5/88

Shompole, Patrick is working toward completion of an M. S. with an expected completion date of May 1988.

##### b) Non-degree oriented:

Dr. Fred Rurangirwa, WSU's on site coordinator, attended a course in Mycoplasma Gene Technology at Bordeaux, France, from June 22 to July 8. Because of the practical nature of the course, it will be very valuable to Dr. Rurangirwa and to SR-CRSP as he guides graduate students and conducts research on this topic.

## 1986/87 ANNUAL REPORT

**Title:** Dual Purpose Goat Production Systems for Smallholder Agriculturists

**Principal Investigator:** H. A. Fitzhugh

**U.S. Institution:** Winrock International Institute for Agricultural Development

**Host Country Institution:** Kenya Agricultural Research Institute, Ministry of Livestock Development, Ministry of Agriculture

**Personnel:**

Host Country Co-workers  
L. Musalia, Nutrition-Health Mgmt.  
M. Mathuva, Agronomy  
K. Otieno, Agronomy  
R. Shavulimo, Health Mgmt.  
W. Ochieng, Farm Manager  
J. Odour, Laboratory Manager  
P. Pacha, Records  
H. Ingati, Secretary

Winrock Staff in Kenya  
J. F. M. Onim, Agronomist  
P. P. Semenyé, Animal Scientist  
W. T. Conelly, Sociologist (joint appointment with University of Missouri during 1986)

### RESEARCH RESULTS:

Background. The human population in western Kenya has expanded rapidly, placing greater pressure on the land to produce enough food and generate income to support smallholder farmers. Thus, production systems must be based on low-cost, low-risk technology which fits the land, labor, and capital resources of local farming systems.

Dual-purpose goats have many potential advantages under these conditions. They eat by-products of food crops and browse from marginal lands. Keeping three to five does can provide a small but consistent milk-protein supplement to the family diet year-round. Litters of two to three kids at intervals of less than a year can increase family meat supplies and cash income.

Goals of the dual-purpose goat (DPG) production systems research are to develop and adapt production systems to the needs of smallholder agriculturists in the humid and semihumid tropics utilizing dual-purpose goats to produce milk and meat. Specific objectives include 1) design and test appropriate feed-production and preservation techniques, 2) develop nutritional and management strategies to match the feed resources that are available through the year with the requirement of

the goats (year-round breeding, growing kids, replacement females, lactating does, and continuous milk supply for farm family use), and 3) determine through on-farm evaluation under farmer management that production technologies are technically and economically feasible for small-scale farmers in the high-potential tropics.

Research has been implemented in three stages. 1980-1982: Characterizing the social, economic, and biological activities of traditional farming systems and on-station research in management and nutrition of goats and in agronomy. 1983-1985: Monitoring performance of dual-purpose goats on farms; scientist-managed, on-farm research in agronomy and goat nutrition management; on-station research in goat nutrition and agronomy. 1986-1990: Evaluating technical, economic, and social feasibility of dual-purpose goat production systems under farmer management. The farming systems approach is emphasized to ensure relevance to the needs and resources of farmers in western Kenya.

Research activities during 1986-87 have included:

Forage productivity. A cutting frequency experiment on the Maseno station compared forage productivity of pigeon pea, sesbania, and leucaena to maize stover (Onim, 1987). The legumes were cut to a height of 60 cm from ground ever 2 months. Three cuttings were made prior to harvesting maize. Cumulative DM and CP yields (kg/ha) were: sesbania, 7,529 and 1,635; leucaena, 5,224 and 1,152; pigeon pea, 3,118 and 603; and maize, 2,769 and 266. Sesbania was clearly superior in yield of forage dry matter (DM) and crude protein (CP).

Feed preservation. Feed shortages during the dry season can be alleviated by feed banks and alley cropping forage with food crops or intercropping forage with food crops or hedgerow cut-and-carry forages. In western Kenya, these interventions improved the feed supply from a monthly average of 2,250 Mcal of digestible energy (DE) to 3,500 Mcal of DE. Seasonal surpluses conserved by deferred grazing, by hay baling, or by silage making can be fed during periods of feed shortage. Hay baling methods evaluated only required a wooden box, a grass cutting sickle, and sisal twine. Both grasses and legumes have been successfully baled. The quality of the hay remains good as long as the bales are stored in a dry place. Pigeon pea, sesbania, and leucaena leaves also provide a fine leaf hay with a CP content of about 26%. In preliminary trials, hand-chopped maize and sorghum stover wet with molasses, packed in gunny bags (woven plastic strip feed bags) and then buried have yielded silage readily accepted by goats (Unim et al., 1986b).

Community nurseries. Farmers do not have ready access to adapted grasses such as Napier and fast-growing tree legumes such as sesbania and leucaena. In collaboration with CARE, ACTION AID, and other PVUs, the project has established community nurseries for propagation and distribution of seedlings. Production of forage from these seedlings is part of recommended DPG technology package. Assessment of community nurseries is underway in collaboration with sociology project.

Maize grain/forage. Maize is the staple food crop in western Kenya. Experimental comparisons of local farmers' cultivars and commercial varieties have indicated important differences in grain yields and stover feeding value with the advantages frequently in favor of local cultivars. For example, stover DM yield (kg/ha) exceeded that for the locally recommended commercial hybrid by 2 to 4 times (i.e., 5,904 to 17,081 kg/ha vs 4,713 kg/ha) with no significant differences in CP or DE. Even more striking were the results for grain yield (kg/ha); yields for local cultivars were substantially higher than for the commercial variety (2,742 to 5,266 kg/ha vs 1,159 kg/ha). As might be expected, these results have generated considerable discussion among maize scientists in Kenya. Cooperative trials are now underway comparing grain and forage characteristics for other varieties and hybrids in collaboration with Kenyan maize breeders (Onim et al., 1986a).

Goat multiplication. More than 500 crossbred does are needed for the large-scale evaluation of DPG technology packages planned to begin in July 1988. Production of these crossbred does is a joint activity of Breeding and Production Systems projects. Purebred dairy bucks have been mated to Small East African (SEA) does. Multiplication efforts by Production Systems project involving 255 SEA does are underway at four sites in Western Kenya: Maseno Farm, Bukuru College, Homa Hills Centre, and Lela Community. In addition, 196 DPG have already been placed on small farms of cooperators. Multiplication efforts were sharply restricted by reduced AID funding during 1986, jeopardizing the production of sufficient goats for starting full-scale evaluation in mid-1988.

Nutrient values. Goats are known for their highly selective feeding behavior, which is not always well suited to small-farm, cut-and-carry feeding management. Feed sources on farms or produced through research are tested for palatability and percentage refusals in feeding trials as well as in vitro nutrient analysis. Palatability ranking from a cafeteria trial of six high-protein forages (%CP) were: 1) sweet potato vine (17), 2) leucaena (21), 3) tylossema (12), 4) sesbania (14), 5) pigeon pea (12), and 6) gliricidia (11). Among six grasses, an agricultural "weed", couch grass (Digitaria abyssinica), was preferred over several species of Pennisetum, Panicum, and Brachiaria (Musalia et al., 1987).

Kid rearing. Competition exists for DPG milk for family use versus for kid rearing. Research has been directed toward early weaning and low cost milk "replacers." Kids weaned at 1 month were fed 1.1 kg/day of sweet potato vines (308 g DM, 20% CP) freeing approximately one additional kg of milk for family use per day. Supplemented, early-weaned kids actually weighed about 25% more at 90 days (7.5 vs 6 kg) than did kids suckling to 90 days (Semenye et al., 1986). Thus, early weaning combined with low-cost, farm-produced supplementation can release more milk for family use without limiting kid growth.

## PUBLICATIONS:

### Refereed Journals

- Boor, K. J., D. L. Brown, and H. A. Fitzhugh. 1987. The Potential for Goat Milk Production. *World Animal Review* 62:31-40.
- Brown, D. L., M. Salim, E. Chavalimu, and H. A. Fitzhugh. 1987. Intake, Selection, Apparent Digestibility, and Chemical Composition of Pennisetum purpureum and Cajanus cajan Foliage Utilized by Lactating Goats. *Small Ruminant Research*. (In press)
- Johnson, W. C., J. E. Van Eys, and H. A. Fitzhugh. 1986. Sheep and Goats in Tropical and Subtropical Agricultural Systems. *J. Animal Sci.* 63:1587-1599.

### Monographs

- Fitzhugh, H. A. 1987. Systems Approach to Small Ruminant Research and Development. In: A. W. Qureshi and H. A. Fitzhugh (eds.) *Small Ruminants in the Near East*. FAO Anim. Prod. and Health Paper 54:1-12
- Onim, J. R. M. 1987. Alternative Uses of Pigeon Pea (Cajanus cajan (L) Millsp.). Eastern and Northern African Regional Research on Grain Legumes. ICRISAT/ILCA; Addis Ababa, Ethiopia. (In press)
- Onim, J. R. M. and B. H. Owella. 1987. Sesbania Species in the Pasture Network for Eastern and Southern Africa (PANESA). PANESA, ILCA/IDRC, Arusha, Tanzania. (In press)

### Proceedings

- Fitzhugh, H. A., J. R. M. Onim, P. P. Semanye, and A. E. Sidahmed. 1987. Integration of Goats with Crop Production and Other Livestock Production Systems: Mixed Farming Systems in Tropics. Invited paper. Proc. 4th Intl. Conf. on Goats, Brasilia. (In press)
- Hart, R. D. and H. C. Knipscheer. 1987. Characteristics and Socioeconomic Aspects of Small Ruminant Production Systems: An Analytical Framework. In: C. Devendra (ed.). *Small Ruminant Production Systems in South and Southeast Asia*. IDRC/SR-CRSP, Bogor. p 10-28.
- Mathuva, M., M. Onim., K. Otieno, A. Mukhebi, and H. Fitzhugh. 1986. Effect of Environment on Biomass Productivity and Economies of Intercropping Maize with Beans, Pigeon Pea, and Sesbama. Proc. 5th Annual SR-CRSP Workshop, Kabete, Kenya. (In press)
- Musalia, L., P. Semanye, and H. Fitzhugh. 1986. Preference Ranking of Forages by Goats in Western Kenya. Proc. 4th Intl. Conf. on Goats, Brasilia. (Abstract.)

Onim, J. R. M., M. Mathuva, R. Hart, H. Fitzhugh, and K. Otieno. 1986. Recommendation Domains for DP Goat Research in Western Kenya. Proc. 5th Animal SR-CRSP Workshop, Kabete, Kenya. (In press)

Semenye, P. P., L. Musalia, and H. Fitzhugh. 1986. Dual Purpose Goat Performance on Station and on Farms in Western Kenya. Proc. 5th Animal SR-CRSP Workshop, Kabete, Kenya. (In press)

Semenye, P. P., and L. Musalia. 1987. Improving Reproduction in Sheep and Goats. Proc. Anim. Prod. Society of Kenya. (In press)

### Bulletins

Semenye, P. P. 1987. Handbook for Farmers - Goat Production Strategies. SR-CRSP, Kenya.

Semenye, P. O., L. Musalia, and H. Fitzhugh. 1987. Small Ruminant Nutrition on Small Farms in Kenya. Bull. Anim. Health and Prod in Africa. (In press)

### **TRAINING:**

Degree oriented. Plans had been made for two Kenyan students (one in Agronomy, the other in Animal Science) to begin M. S. programs in 1986-87. AID funds for Production Systems project were reduced by a total of \$70,000 during 1986. In order to complete research already underway and to prepare for on-farm technology evaluation in 1988, degree-oriented training activities have been deferred until adequate funding is available.

### Nondegree-oriented/short-term.

#### Dates

#### Activity

July 1986,  
August 1986

Milk and Meat Production from Sheep and Goats in the Workshop was held at Egerton College, Kenya. Participants included 44 representatives from private voluntary and governmental organizations in Kenya, Tanzania, Uganda, Sudan, Mozambique, Ghana, Nigeria, Sierra Leone, and Togo. Sponsors included USAID/Office of Private and Voluntary Cooperation and Winrock International. Lectures and practicals were conducted by P. O. Semanye and J. R. M. Onim.

July 1986,  
November 1986,  
June 1987,  
July 1987

Lectures and demonstrations on feed production and preservation and on goat nutrition and management were held at Maseno Farmers Training Centre, Kenya. Participants included women farmers and Ministry of Livestock Development extension agents. Lectures and demonstrations by P. P. Semanye, J. R. M. Onim, M. Mathuva, K. Otieno and L. Musalia.

- March 1987 Consultation on Design of Dual-purpose Goat Project in the Gambia undertaken by the University of Wisconsin with USAID funding. Patterson Semenye spent two days with animal scientists in Madison, Wisconsin. The Gambian project counterpart will visit Maseno later in 1987.
- June 1987 Feed Production and Goat Management. Lectures and demonstrations by project staff were held at Maseno Farm for students from Saulagongo School and Siriba College.
- July-August, 1987 Training in plant germplasm collection (sesbania) for Kenneth Otieno in Tanzania. Sponsored by PANESA and Production Systems project.

## 1986/87 ANNUAL REPORT

Title: **Sociological Analysis of Small Ruminant Production Systems**

Principal Investigator: Michael F. Nolan

U.S. Institution: University of Missouri-Columbia

Host Country Institution: Ministry of Livestock Development

Personnel: Resident Scientist: W. Thomas Conelly  
Collaborating Scientist: Nkonge Mbabu  
Field Assistants: Joseph Atichi, George Ambogo

### RESEARCH RESULTS:

During 1986-87 an effort was made to combine qualitative sociological insights with quantitative data to further our understanding of the potential for introducing dual purpose goats (DPGs) among smallholder farmers in Kenya. Research included:

1. Co-ordination of a multi-disciplinary rapid survey designed to identify key characteristics of 75 farm households participating in a large-scale on-farm trial of DPGs. This work included setting up procedures for sampling the target communities, assisting in the design of survey questions, and coordinating the logistics of the actual survey which was carried out in May and June 1986 in three areas of Western Kenya.
2. Examination of aspects of the local farming system relevant to the adoption of the DPG enterprise by small-scale farmers. This research included a study of time allocation, labor use, and the organization of household labor in two research clusters. It also involved an analysis, in conjunction with the Production Systems projects, of existing livestock management strategies and ways in which the DPGs could be most effectively integrated into the indigenous management system.
3. Evaluation of the impact of the DPGs on household nutritional status and economic welfare conducted in collaboration with the Economics Project. This study involved both interviews with farmers concerning recent changes in diet and the utilization of milk products as well as a year-long multiple visit dietary survey. The survey was intended to assess the contribution of milk as a source of high quality protein in the diet, determine the relative importance of farm-produced and purchased milk for household consumption, identify inter-household variation in milk consumption and purchases, and monitor the impact of the introduction of the DPGs on household nutritional and economic welfare.

4. In collaboration with the Nutrition/Management and Feed Resources Projects, evaluation of farmer response to on-farm trials of management practices developed to improve the performance of DPGs and other livestock. Research included a preliminary assessment of sweet potato cultivars that have been selected for their leaf and stem growth as an improved livestock feed. On-farm trials were started during the 1986 long rains and continue today. Preliminary interviews have been conducted with farmers concerning their sweet potato cultivation practices, the characteristics they look for in good sweet potato cultivars, and their initial response to the SR-CRSP cultivars.

### Significant Findings

#### 1. Time Allocation and Labor Costs of the DPG Enterprise

The one year time allocation study employed interviews with farmers as well as all day "follows" of sample household members and a random spot-check method of recording time expenditure. Results indicated that, in general, farm families have adequate time available to invest in the care of DPGs at the current level of two animals per household. Animal management, however, and particularly the production and preparation of recommended feed crops, falls disproportionately on the shoulders of women farmers who have the least free time to invest in the new enterprise. Time constraints are an especially serious concern for young families where the husband is employed off-farm and the wife must handle all farm work without the assistance of grown children. These same families would generally benefit the most from owning DPGs as they usually have several small children to feed but have accumulated few livestock to provide a source of protein in the diet.

Investment of time in more intensive management practices to further improve DPG performance or in a larger number of DPGs per household is possible for some families. Willingness to make this greater investment will depend on the assessment by farmers that the benefits of the DPGs compare favorably with that of other economic activities.

#### 2. The Role of Milk Products in the Diet

Research on the nutritional significance of milk products in the diet and the impact of DPG ownership on household welfare was conducted from July 1986 through June 1987 in the Hamisi and Masumbi research clusters in Western Kenya. Farmers were interviewed about changes in their diets in recent decades and a 24-hour dietary recall survey was used to collect quantified data on the types and frequencies of foods consumed, the general availability of protein in the diet, levels of milk consumption, and the amount of money expended on milk purchases.

The interviews revealed that farmers in both areas felt that protein foods had become more difficult to obtain and were being consumed less in recent years, primarily because of steep cost increases. In

addition, on-farm milk production has steadily declined due to a reduction in the size and productivity of cattle herds resulting from population pressure and increasing land scarcity.

The dietary surveys showed that the frequency with which high quality protein foods -- such as fish, meat, and beans -- were eaten was low, especially in Hamisi cluster in Kakamega District. The frequency of milk consumption, however, was high in both communities, averaging about 90 percent of the days interviewed throughout the year. In Hamisi, milk was the only high quality protein consumed on close to 50 percent of the days. Though the frequency of consumption was high, the actual amount of milk consumed was low for most families, averaging only 100-150 ml per person per day.

Since on-farm production of milk is low and erratic over the year, many farmers depend on purchases of commercial milk to meet even minimal needs. Commercial supplies are expensive, and households spent an average of Ksh 10-20 per week on milk purchases, resulting in a substantial expenditure of Ksh 500-1000 (\$30-60) per year.

These data indicate that the introduction of dairy goats in Western Kenya has a strong potential for improving the nutritional and economic welfare of small-farm households. Milk is in very high demand while local availability is limited and the cost of commercial milk is high, prohibitively so for many poorer families. Ownership of a few dairy goats, especially for households that lack productive cattle, can provide an important milk supplement to the diet while reducing expenditures on milk purchases.

Preliminary data on households participating in the 1986 on-farm research showed that ownership of two DPGs does have the potential for a positive impact on levels of milk consumption and milk purchases. In the months following the distribution of the DPGs in Masumbi cluster, for example, consumption of milk almost doubled while purchases of milk were reduced by half. In the following dry season, however, these gains were reduced as DPG milk production declined.

#### **TRAINING:**

Nkonge Mbabu, Kenyan, Ph.D., University of Missouri Department of Rural Sociology. Program began 8/84 and is expected to end 8/88.

#### **SELECTED PUBLICATIONS:**

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