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SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM

KENYA

RESEARCH HIGHLIGHTS

1986 – 1988

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

Julius Mungai

In Kenya, like many other African countries, the goat has a special importance not only as a principal source of meat, but also as a mobile "bank" for raising ready cash when the need arises. For a long time no serious scientific study of the goat was undertaken. The connotations associated with the goat were that it was vile, a principal destroyer of vegetation and a catalyst to desertification. It is only recently that the view that degradation of the habitat more often than not comes before rather than after the introduction of goats has gained strength

Due to land pressure, the Kenya government has felt the need to emphasize goats as milk producers in intensively farmed areas where the farm sizes are too small to raise enough feed to support a cow. At present, about 32% of all farms in Kenya are 1 hectare or less and this percentage is steadily rising as our population continues to soar. The principal aim in encouraging dairy goats is to provide extra meat and milk to enhance family diets as well as extra cash income in the form of off-farm product sales.

The theme of the Sessional Paper No. 1 of 1986 on "Economic Management for Renewed Growth" is on how the country can provide adequate basic needs for the rapidly rising population through accelerated economic growth between now and the year 2000. Agriculture is considered the backbone of the economy and therefore, the Kenyan farmer must lead the country to achieve this desired growth. This places heavy responsibility on the farmers, most of whom are small-scale farmers with farm sizes averaging merely 2 hectares. Therefore, application of new technologies geared towards high yielding crop and livestock are needed to intensify production.

The ninche of the Small Ruminant CRSP research is to develop and synthesize dual purpose goat technologies that are optimal for the small scale farmer. This issue of the Small Ruminant CRSP Research highlights reports work undertaken during 1985-1986. The research is multidisciplinary and encompasses breeding, systems analysis, sociology, health, economics, feed resources, nutrition and management. The designed strategies have emphasized:

1. Testing appropriate feed production and preservation techniques.
2. Developing nutritional and management strategies to match the feed requirements of the goats throughout the year.
3. Conducting economic feasibility analyses of component technologies and management practices.
4. Developing economic models of small farms in Western Kenya to assist in post-trial evaluation.
5. Determining, through on-farm evaluation under farmer management the production systems technically and economically feasible for small-scale farmers in the high-potential areas.

The research has been implemented in three stages:

1980-82: Characterizing the social, economic, and biological activities of traditional farming systems and performing on-station research in breeding, health, and nutrition of goats and in agronomy.

1983-85: Monitoring limited numbers of dual-purpose goats on farms; conducting scientist-managed, on-farm research in agronomy, goat nutrition and health management; performing on-station research on goat breeding, health, and nutrition and agronomy; and conducting preliminary cost-benefit and social feasibility analyses.

1985-90: Performing large-scale technical, economic, and social evaluation of dual-purpose goat (DPG) production systems under farmer management and continuing research activities on both farms and experiment stations (breeding at Olmagogo; health at Kabete; and sociology, economics, nutrition and management and feed production at Maseno).

The SR-CRSP Scientists have worked closely with Kenyan researchers to develop the appropriate dual purpose production systems. Highlight of implications of some of the research results include:

1. Development and multiplication of a goat suitable for producing milk as well as meat on smallholder farms in the intensive farming areas of Kenya by the Breeding/System Analysis project.

2. Studies of diseases of small stock with a view to provide diagnosis and control measures by the Animal Health project.

3. The Feed Resources, Nutrition and Management, Social and Economic studies on-farm have demonstrated the following:

   i) That dual-purpose goat production is technically feasible and can make an important contribution to the nutrition and economic welfare of smallholder families in Western Kenya. Principal constraints to adopting the technology include the scarcity and poor quality of feeds, especially in the dry season. By-products from drought-tolerant crops and low cost hay are now being used by farmers in the region.

   ii) An indigenous tree legume, *Sesbania sesban*, can be planted to provide supplemental protein for livestock, improve soil fertility, serve as a living fence, and supply firewood.

   iii) Sweet potato vines can be used as important source of supplemental protein for goats.

   iv) Analyses of the costs and benefits of component technologies and management practices have guided researchers' decisions about which of these fit farmers' needs in Kenya and also may be useful elsewhere.

   v) Developed hay baling using low cost technology to preserve feeds on farms.

In the current phase of the SR-CRSP (1986-1990) on-farm testing and evaluation of the technical feasibility of DPGs including their management practices and forage feeds, as well as their economic profitability and social acceptability are being conducted on small-scale farms in Western Kenya. What follows are research highlights for the period 1986-1988 by each project within the SR-CRSP. It outlines objectives, main accomplishments, major problems, personnel and a list of publications for the period 1986-1988 and future research priorities for 1989 and beyond.

BREEDING PROJECT

Resident Scientist: Francis Ruvuna

BREEDING A GENETICALLY IMPROVED DUAL PURPOSE GOAT ADAPTED FOR PRODUCTION IN KENYA

OBJECTIVES

Developing a dual purpose goat to be kept by Kenya Smallholders requires a breeding strategy that balances the genetic potential with the nutrition and management available. While the objective may be to maximise output for a given input (mainly forage resource), at the same time risks associated with drought, disease outbreaks and other stressing conditions must be minimised. Genetic potential of indigenous Kenya goat breeds represents a bias towards survival of the animals under adverse conditions and, therefore, productivity is usually low. An appropriate dual purpose goat requires an optimal combination of productivity traits from highly productive temperate germ plasm and fitness from the indigenous germ plasm. The F1 has been proven by the SR-CRSP in Kenya to be very suitable. Therefore, 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 by combining two indigenous breeds, East African and Galla, and temperate breeds, Toggenburg and Anglo Nubian; (2) to collect data to characterize both primary and ancillary traits of the new synthetic breed; (3) to provide goats for other SR-CRSP projects and (4) to collaborate with other SR-CRSP projects to initiate testing of the breed under farm conditions as well as under experiment station conditions. A stable breed is considered to be necessary for longterm benefits to be realised by smallholders. This composite dual purpose goat is referred to as the DPG. The breeding program being followed was detailed in Research Highlights 1980-1985 and a summary of mating plan is presented in Figure 1.

MAJOR ACCOMPLISHMENTS

1. Development and Multiplication of Breeding Stock

Detailed strategies to genetically evolve the synthetic dual purpose goat breed (DPG) were presented in Research Highlights 1980-1985. In this Highlights, only the breeding plan in presented (Figure 1) to provide a picture of the genotypic composition and the timeframe required to evolve the synthetic DPG.

The four-breed composite synthetic breed is now entering multiplication, breed stabilisation and selection phase. The current flock at Olmagogo numbers approximately 1438 head, of which 253 are East African (EA), 316 are Galla (G), 376 are F1s and 193 are DPG. The composition of the flock is being phased, as planned, to reduce the purebred indigenous and F1s and build herd size of over 1,000 DPG which is a viable number for breed development. A major collaborative has been to provide goats for on-farm research. Since 1986 a total of over 300 F1 females have been supplied to Production Systems Project for on-farm testing. The four-way crosses are now being produced in numbers and the project is at the very critical phase of breed development, stabilization and establishing progeny testing and selection programs as a part of the process of releasing the breed to private breeders and making bucks and semen available for large scale distribution.

2. On-Station Characterisation and Productivity Parameter Estimates

Data on various breeds and crosses related to productivity and fitness to the Kenya environment are continuing to be analysed to provide useful information to develop "tech packs" for utilising DPGs and improving goat production for 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); carcass analysis (Okeyo *et al*, 1985c) and use of teeth as an age indicator (Okeyo *et al.* 1987). Recently concluded data analyses on effects of pregnancy and lactation, and growth rates are summarised below.

2.1 *Effect of Pregnancy and Lactation on Body Weights*

Statistical analyses of body weights of East African and Galla does have revealed that on average, does lose 1.0 to 2.0 kg weight (that is they are in poorest condition) during long rains (april to June) and are heaviest (in good condition) during the cold, dry season (July to October). Estimated mature body weights are 30 kg for East African (EA) and 35 kg for Galla (G). Maximum weight increase due to foetal growth is approximately 6.2 kg (21%) for EA and 6.0 kg (18%) for G. Maximum weight loss during lactation is approximately 0.6 kg (2%) for EA and 1.9 kg (6%) for G. The practical implications of these results are that mating in the rainy season may result in poor fertility levels due to poor conditions of the does. During lactation/nursing it may be necessary to supplement does. Adjustment factors for pregnancy and lactation are required for analyses of irregular body weight data.

2.2 *Genetic Analyses of Growth*

Additive genetic effects and heterozygozity effects from crossing East African (EA) and Galla (G) with Toggenburg and Nubian are important for birth weight and weaning weight. The Galla provides a better maternal environment than East African, however, when these are crossed with Toggenburg and Nubian and used as F1 dams, the maternal heterosis of the EA F1s is superior. The 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).
Crossing of EA with G indigenous breeds has no significant advantage in increased birth weight or weaning weight.

3. Goat Cheese Production

One aspect that has become popular is the processing of goat milk into cheese. The Breeding Project in collaboration with FAO (Food and Agricultural Organisation), Dairy Training School, Naivasha have started processing cheese from goats' milk. Two types of cheeses (cheddar,) are being produced. Results show that the quality of goat cheese is as good as that from cows. Because the cheese is being produced using cheap local technologies it is anticipated that this technology after perfecting will be introduced to the smallholders in Western Kenya to process excess milk. Already a Women's group in Western Kenya (Bungoma) is using similar technology to process cow cheese. This is an important step in the assessment of potential alternative uses of excess goat milk by the smallholders either individually or as a cooperative.

4. Out-reach Activities

(a) The project conducted a training workshop on A.I. in goats. Over 28 participants from different parts of Kenya such as private institutions, government institutions and private farmers attended. Results from this effort indicate that AI in goats in Kenya is practical and the interest and infrastructure exist to collect and process goat semen.

(b) The project in conjuction with Ministry of Agriculture (KARI) has participated and exhibited DPGs at Nakuru show and Nairobi International show.

5. Training

C.O. Ahuya, A Kenya citizen, KARI completed his MSc. 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 Msc. students of the PI work directly with sheep and goats in Kenya).

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 completed is September, 1988. Howard received an MSc. at the University of Florida under SR-CRSP Economics Project graduate assistantship.

FUTURE PRIORITIES

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. It has been estimated, based on the data collected at Olmagogo, 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. Therefore, planned future, research activities will be biased towards breed multiplication, stabilisation and establishing progeny testing and selection programs. The activities will include:

(a) Large scale multiplications and distribution of the DPG

(b) Formation of DPG "Breed Society" which will in turn develop and establish improvement schemes by setting up multiplier herds with cooperating farmers (members) to produce elite flocks of the new breed for different production systems in Kenya.

(c) Develop and promote goat milk products (e.g. cheese) and markets at village levels and eventually at national level.

(d) Facilitate implementation of goat breeding programs at national level by introduction of routine recording, evaluation and progeny testing procedures in cooperation with private farmers.

(e) Improve on AI in goats (e.g. semen collection and handling)

(f) Adapt the DPG to other production systems in Kenya e.g. intensive dairy and semi arid extensive goat production (Ruvuna *et al.*, 1987).

COLLABORATING PERSONNEL

Principal Investigator	*Institution*
T.C. Cartwright, Professor	Texas A&M University
Host Country Co Workers	
M.A. Okeyo, Research Officer	KARI
C.O. Ahuya, Research Officer	KARI
S.M. Mkuu, Technical Officer	KARI
U.S. Co-Workers	
F. Ruvuna, Resident Scientist in Kenya	Texas A&M University
H.D. Blackburn, Research Scientist	" " "
F.J. Howard, Graduate Assistant	" " "
J.O. Sanders, Associate Professor	" " "
J.F. Baker, Assistant Professor	" " "
J.W. Bassett, Professor	" " "

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SYSTEMS ANALYSIS PROJECT

Resident Scientist: Francis Ruvuna

SYSTEMS ANALYSIS AND SYNTHESIS OF SMALL RUMINANT PRODUCTION SYSTEMS

OBJECTIVES

The major route of accomplishing improved small ruminant productivity is by developing low-cost technologies in line with the aspirations and needs of the farmer. The process requires establishing systematic research strategies of first identifying the problems, followed by development of the technologies and lastly testing and evaluation of the technologies on station and on farm. There is no single constraint to productivity, but usually several which interact in a dynamic and complex manner. The complexity makes it impossible for any one scientific discipline to predict repercussion of changes introduced into the production system. Therefore, the primary goal of the Systems Analysis Project has been the evaluation of varying production practices as they relate to the total performance of the flock. That is, the general objective has been to conduct systems analyses of the production systems, quantify biological inputs (forages, breeding, health and animal management) required to reach offtake goals and/or sort out practices into optimal combinations or packages in biological and economic terms within the feasible constraints of the smallholder. The direct effects as well as the interactions among the inputs and outputs are accounted for simultaneously.

MAJOR ACCOMPLISHMENTS

Major simulation studies have focused on the three areas related to management, nutrition and different genotypes for increased goat productivity. The results are summarised below.

1. Smallholder Weaning Strategy for Increased Goat Productivity

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. It was assumed that kids were allowed to take up to 0.5 kg of milk per day.

Simulation results with base forage (forage normally available to the farmer) revealed that 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 follow up simulation study was done to quantify flock productivity potential under early weaning and feed supplementation regimens. These regimens were management options to increase productivity of the smallholder farms in Western Kenya. Data and experience from other SR-CRSP projects were used to determine forage resource levels and quality feasible on the small holder farms.

Two goat genotypes were considered: a target genotype of 40 kg mature liveweight and 4 kg/d milk yield at peak day of lactation and an intermediate genotype of similar mature live weight but a lower milk potential of 3 kg/d.

Simulation results indicated increases of 78.4 kg in dairy doe milk per lactation and 4.5 kg in kid yearling weight under supplementation and early weaning. Does also were able to sustain longer lactations.

Flock productivity of the 40/3.0 genotype was higher than that of the 40/4.0. The 40/3.0 genotype produced an annual average of 238.3 kg sale weight and 1901 kg of dairy milk while the 40/4.0 genotype produced 198.7 kg sale weight and 1838 kg of dairy milk. In addition to meeting family needs, surplus milk sold could realize cash inflow. Together with sale weights total cash inflow could approximate KSh. 10,804.00 per annum.

The simulations demonstrated the biological feasibility of increasing productivity offtake by early weaning and supplementation. The feasible flock size may be limited by the non-biological constraints and subsequent production offtake lowered. Nevertheless, early weaning with supplementation on an individual animal basis has great potential of increasing goat ment and milk offtake levels under smallholder environment in Western Kenya.

2. Potential for Intensive Smallholder Goat Dairies in Western Kenya

In this series of simulations the interest 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 a series of simulations. Results showed that 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.

Follow up simulations on the productivity of dairy goats utilizing data collected on the Forage, Economics and Breeding Projects of the SR CRSP were performed (Cartwright, et al. 1987). Simulated productivity results of the new dual purpose breed (DPG) being developed by the Breeding project showed it was almost as productive, and more robust, than dairy goat breedtypes of higher potential. Simulated DPG flocks of 50 does produced 15,111 kg of dairy milk and 1,323 kg of sale animals per year. Depending on location and fertilizer practice, farm size required ranged from about 3 to 8 ha. Various price/cost scenarios were used to project gross income and income over costs of forage production, dairy meal supplement and anthelmintics. The approximated gross returns were of sufficient magnitude (1,000 to 10,000 KSh/ha) to encourage further economic analysis and developmental research to explore the feasibility of goat dairies as an alternative to traditional crop production for some farmers.

A major concern in the assumptions was that of a market for goat milk which is not established. The current situation would have to be resolved before the feasibility should be explored. Another assumption was that the excess kids and cull does were sold at slaughter prices. Improved DPG kids are expected to sell at much higher prices. The 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.

FUTURE RESEARCH DIRECTION

There are many questions that must be addressed related to examining and quantifying the effects of single variables varied over a range and of combinations of variables. These variables include nutritional, breeding, management and health practices as well as marketing and economics. The major effort will be to integrate the data and information from the various projects together to develop optimal sets of practices (packages) for the smallholder. Initial screening will be based on biological/physical efficiency and then, after screening, the selected sets of practices will be subjected to economic analysis by the Economics Project. That is, the general objective will be to continue conducting systems analysis simulations quantifying effects of practices, determine input required to reach production goals and/or sort out practices into optimal combinations or packages.

COLLABORATING PERSONNEL ON PROJECT ACTIVITIES

Principal Investigator	*Institution*
T.C. Cartwright	Texas A&M University
Research Scientist	
F. Ruvuna	Texas A&M University
Host Country Co-Workers	
S. Tallam	KARI
A.B. Carles	Nairobi University
C.R. Field	IPAL
U.S. Co-Workers	
H.B. Blackburn, Research Scientist	Texas A&M University
P.J. Howard, Graduate Assistant	" " "
J.O. Sanders, Associate Professor	" " "
J.K. Baker, Assistant Professor	" " "
J.W. Bassett, Professor	" " "

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ANIMAL NUTRITION AND MANAGEMENT PROJECT

Resident Scientist: Patterson Poli Semenye

OBJECTIVES

The overall objective of the Nutrition and Management Project is to develop and adapt goat production systems to the needs of smallholder in Kenya and other countries in the region by emphasizing the use of dual-purpose goats to produce meat and milk. Specific objectives are:

(i) To develop nutritional and management strategies to match the feed resources that are available through the year with the requirements of the goat, at different stages of maturity and levels of production.

(ii) On-farm evaluation firstly, under researcher managed and secondly under farmer managed to ascertain whether interventions are technically and economically feasible for smallholder farmers in western Kenya.

(iii) To multiply dual-purpose goats for on-farm evaluation

(iv) Training of participating farmers, support staff and collaborators

Research activities are based on-station at Maseno and on-farm in Kisumu, Kakamega and Siaya Districts.

MAIN ACCOMPLISHMENTS

1. Kid Nutrition

In pursuit of milk production from does to improve the nutritional status of family members, only surplus milk should be taken. Surplus milk is hereby defined as what is in excess of a kid's requirement or milk extracted following successful weaning. Once the sharing of milk is not right, and is usually in favour of man, it leads to slow growth or death of kids. For dairy goats supplemented with concentrates production of surplus milk is achieved easily unlike for goats on forage alone. Collaborating farmers in western Kenya feed their goats on forage alone for they can not afford concentrates. So for these farmers, means of making more milk available to man must be sought.

Following are results of experiments that have been conducted aimed at rational sharing of milk by man and the goat kid:

1.1 Out of the results of two trials by Brown and Nderito (1983), the optimum weaning weight was found to be 10 kg. For attainment of this weight kids consumed 60 kg of milk. Surplus milk in this production system is therefore milk in excess of 60 kg per lactation.

1.2 A follow-up experiment on the optimum weaning age, was on appropriate milking and nursing management system (Sidahmed et al 1984). In this experiment ad lib milk consumption (Treatment 1) contributed fastest growth rate of kids compared to others consuming exactly all (Treatment 2) or half (Treatment 3) of their dam's production. Although Treatment 1 kids grew faster than Treatments 2 and 3 kids it had no direct nutritional benefit to man. Despite the slow growth of Treatment 3 kids, man benefitted from it for he obtained half of the milk yield.

1.3 This experiment was aimed at closing the gap between the growth of Treatments 2 and 3 above. The strategy employed was creep feeding an appropriate forage. The experiment (Semenye et al 1986) had five treatments. The treatments were: 1-forage +total suckling+rumen liquor, 2-forage+total suckling; 3-forage+ three quarters suckling; 4-forage+one half suckling; and 5-total suckling. Due to creep feeding the results of this experiment had Treatments 3 and 4 excelling in milk offtake. Milk offtake did not affect growth of the kids. This experiment brought to light the fact that when kids are denied milk they compensate for the shortfall by higher forage intake. However, the forage must be of high nutritive value as the sweet potato leaves and succulent vines (SPV) used.

1.4 Following the success of SPV as a creep forage, it was used in another experiment (Semenye et al 1987) as a milk replacer. There was no difference in growth performance between the kids that were weaned on SPV and those with total access to their dams milk. A major and significant difference between the treatments was in milk offtake for home use. From the does whose kids were

weaned to SPV, each doe was milked 87 kg in 120 days. So by utilization of SPV, which farmers grow as a crop, the accrued side benefit was 87 kg of milk or in monetary terms KShs.587/= (1 US dollar = 18 KShs.); furthermore early weaning has the added advantage of enhancing rumen development (Semenye et al 1986). SPV is an ideal milk substitute, because of its chemical composition and because nearly all the farmers in western Kenya grow it. Sweet potatoes are grown in small plots with an estimated size range of 16 to over 50 sq meters. From the smaller plots sufficient SPV can be harvested to meet the requirements of a kid, of 30 g. DM/kg body weight/day. The chemical composition of milk and SPV are comparable in that, the moisture content and digestibility of milk are 85 and 86%, while for SPV are 80 and 72% respectively. Out of the results of the above five experiments, a rational way of taking maximum milk offtake without injuring the well being of the goat kid has been found. The recommendation to the farmers is to avail goat kids SPV ad lib from the age of two weeks until they attain 10 kg liveweight. So with the milk replacer farmers should milk three quarters of the yield, while the remaining quarter is left to the kid. Continued nursing of the kid is necessary as it enhances milk let-down and it reduces cases of mastitis through stripping. Research is underway of other suitable milk replacers such as Tylossema spp.

2. Doe nutrition

A shortage of forage on a year-round basis is a constraint limiting goat production on small farms of western Kenya. This is due to small farm sizes with a mean of 1.9 ha and a range of 0.2-9.6 ha; in addition these farms support large families in food production. Consequently, livestock are left with homestead compounds and communal properties whenever available as their only source of pasture. These pastures are not adequate for meeting both maintenance and production requirements of livestock. Infact by using the conventional stocking rate recommendations, these farms would be classified as overstocked and in danger of experiencing high mortality through starvation. Goats and other livestock therefore survive in this production system through utilization of dual purpose crops and

crop residues. The major crop in western Kenya is maize. As every farmer grows maize its stover is available in each and every farm. It however, has been shown that maize stover is only good for meeting maintenance requirements of a doe (Semenye et al 1987). Nonetheless, for this to be achieved the maize stover has to be chopped into lengths of 5cm and treated by soaking in water or sprinkling with either molasses or common table salt. These treatments enhance intake. Other crop residues available are sorghum, beans haulms, banana and mango peelings. For the peelings due to their casual and low supply no feeding strategy based on them has been researched.

For production of milk from the small mixed farms, the does have access to pastures around the homesteads and communal grounds, green maize stalks, and cut and carry fodder. As a percentage of body weight dry matter intake for the does of western Kenya farms is low. Consequently their average milk offtake per doe per day is half a litre. Inorder to increase milk yield, concentrates feeding is necessary as it facilitates higher intake. Unfortunately in this farming system, farmers have no cash to purchase concentrates. As an alternative to concentrates supplementation with protein rich forages, which farmers can produce is promising. Some farmers are already supplementing. Consequently the effect of supplementation is reflected in the large standard deviations of mean milk offtakes.

3. Side effects of supplementary forages when fed as sole diets

Following establishment of a fodder bank or hay the tendency of a farmer to feed that fodder or hay as a sole diet is very eminent. Some of the fodders and hays such as Leucaena leucocephala (leucaena) are known to have toxic effect if fed by more than 30% of the total diet. In an effort to establish, whether kids fed fresh leucaena forage from the age of two weeks would develop degrading microbes of mimosine and 3-hydroxy-4(IH)-pyridone (DHP) a trial was conducted. In this trial kids from the age of two weeks onwards were allowed to suckle and to feed fresh leucaena only. Results of this trial indicate that the kids did not develop degrading microbes as a result of having been exposed to leucaena as the only forage. Farmers therefore have been advised on this side effect of leucaena and also to know how to recognize signs of toxicity.

Sesbania sesban (sesbania), another leguminous fodder tree is known to be toxic to monogastrics. In a trial at Maseno sesbania sun dried leaf hay, when fed to bucklings exhibited signs of clinical toxicity. This meant sesbania as a sole diet has deleterious side effects to ruminants as well. Since the conclusion of this trial another trial has been started with fresh sesbania. Preliminary results of this trial indicate that fresh sesbania as a sole diet is toxic. When the trial is concluded it will give an indication of safe feeding limit of sesbania.

4. Minerals

Our work in mineral status of DPGs and forages in western Kenya has established phosphorus, sodium, potassium and zinc as deficient and copper as marginal. Other minerals not analysed in this experiment such as cobalt and molybdenum could very well be limiting animal performance. In the light of these findings a supplementation trial is planned to gauge animal response.

5. Goat multiplication

Following an out break of brucellosis and reduced funding the exercise of goat multiplication has sharply been restricted. Nonetheless 100 cross-bred maiden does (Toggenburg x SEAG) have been produced and placed on farms.

6. Technology packages (tech packs)

In preparation for the farmer managed phase of FSR which began in September 1988, tech packs have been produced to go along with the DPGs. These tech packs will be evaluated in this phase of FSR and those found to contribute positively in DPG production will be recommended for extension while others will be amended, dropped or highlight need for further research. The titles of the tech packs are:-

6.1 Nursing strategy

6.2 Sweet potato vines as a milk replacer for kids

6.3 Appropriate utilization of crop residues as feedstuffs

6.4 Feeding a DPG doe for production of milk and kids

6.5 Tethering

6.6 Mating schedule for dual purpose goats

6.7 Feedstuffs presentation

6.8 Milk and milk hygiene

6.9 Housing

6.10 Gradual weaning

6.11 Know your goat

7. On-farm performance of DPGs

Average milk offtake per doe for household use is half a litre per day in a lactation period of 100 days. Mortality rate of kids born on farms is 13%. To the age of six months there was no significant ($P>0.05$) difference in weight gain between male and female kids. After the sixth month male kids as expected gained significantly more ($P>0.05$) than the female kids. At the age of 7 months their mean liveweights were 13.1 and 13.6 kg and at 12 months 16.6 and 20.0 kg for females and males respectively (n=122).

8. On-farm monitoring exercise

8.1 In the last report mention of 200 DPGs already on-farm was made. These DPGs continue to do well. In this report I would like to share with you results of our monitoring exercise concerning a farmer from Masumbi cluster. This farmer is aged 37 and is married. The size of his landholding and other parcels he has access to is approximately 0.5 ha. What has he done with the money out of DPG sales?

a) In 1985 he sold a buckling for 150/=. Out of this sum he used 75/= to rent a plot for cultivation and the remaining 75/= for domestic purchases.

b) In 1986 he gave a doe to a relative, who was interested in acquiring a DPG. He also sold a cull doe for 500/=. From this doe's proceeds he purchased a pail for 35/=, a blanket for 100/=, food for visitors 100/=, sandals for himself 18/= and home supplies for 247/=.

c) In 1987 he sold five goats and fetched 1170/=. He used 120/= to purchase home supplies, 200/= to settle debts and 850/= was used as an initial capital for his wife to become a fishmonger.

8.2 At monthly intervals for a period of two years, one hundred and eighteen DPGs selected randomly from each cluster have been followed for a day, to determine their daily activities. Results of a day's activities are:

1. Mean time spent (minutes) resting standing 105 SD 60, resting lying 68 SD 56, ruminanting standing 37 SD 29, ruminanting lying 62 SD 44, playing 7 SD 6, browsing 138 SD 112, on fodder 118 SD 84, grazing 130 SD 101 and total duration out-doors 577 SD 105;.

2. Water intake 779 SD 717 ml;

3. Cut and carry as-fed 3 SD 2 kg;

4. Tethering rope length 4 SD 1 m, change of tethering station 2 SD 1.5) mean liveweight of observed DPGs 31 SD 5 kg.

SD = standard deviation

Table 1: On-farm inventory of DPGs

Sex	Females				Males				
Age	1-6 Mo.	7-12 Mo.	1-2 Yr.	> 2 Yr.	1-6 Mo.	7-12 Mo.	1-2 Yr.	> 2 Yr.	Total
Old Clusters									
Hamisi (23)	14	6	10	35	7	7	6	5	90
Masumbi (18)	6	-	8	15	14	1	6	3	53
Kaimosi (21)	6	5	2	34	13	7	0	11	78
New Clusters									
Muhanda (35)			30	40					70
Rabour (35)	1		35	35	3				73
Lela (11)	1		11	11					22

In brackets number of farmers

9. Out-Reach Activities

a. Project scientists have participated in and presented papers at various scientific conferences and workshops overseas and in Kenya.

b. Project scientists have given training lectures and materials on goat nutrition and management to technical assistants of the Ministry of Livestock Development (MLD), field assistants from local non-governmental organizations (NGOs), women groups and other farmers over the years.

c. Project in conjunction with other SR-CRSP projects and MLD has exhibited DPGs at the Kisumu, Siaya and Kakamega annual agricultural shows. These exhibits have attracted tremendous interest from showgoers and especially on the milk yield potential of DPGs. One question that is always asked at the shows and field days with DPGs is, "can you sell these goats or tell me where to buy some?"

10. Training

Levi Musalia was admitted for a PhD degree with the University of Florida. Due to uncertainty in the future of SR-CRSP (before extension was granted) and funding the Project did not sponsor him, as it could not guarantee financial support for approximately three academic years.

MAJOR PROBLEMS

a. Due to budgetary cuts the project could not meet its goals of producing 250 DPGs for on-farm testing and for conducting experiments in 1986/87 FY.

b. In addition to budgetary cut-backs, outbreaks of brucellosis and orf curtailed production of DPGs for on-farm testing (As a result of problems (a) and (b) above only 100 DPGs have been produced by NM for on-farm testing).

FUTURE PRIORITIES

Planned future research activities of the project include:

a. Testing of DPG technology packages under farmer managed trials in the new clusters of Muhanda, Rabuor and Lela.

b. Monitoring and testing DPG technology packages under researcher and farmer managed trials in the old clusters of Hamisi, Kaimosi and Masumbi.

c. Collection and analysis of data for writing papers for local and international journals and research reports.

d. Fostering closer links with the extension staff of the Ministry of Livestock Development through joint participation and co-sponsorship of farmers' group meetings, workshops and open days.

e. Up-dating and revising of the DPG technology packages as necessary.

f. Development of simple processing techniques to optimize the use of agricultural by products and crop residues for feeding ruminants.

g. Assessment of milk production potential of DPGs under different feeding regimes.

COLLABORATING PERSONNEL

a. Personnel Based in Kenya, 1981-88.

i Collaborators from the Ministry of Livestock Development.

Maseno Farm Manager	- M. S. Khainga, B.Sc	1981-86
	- L. Musalia, DVM, M.Sc	1984-87
Laboratory Analyst	- W. Ochieng, Dip. Agric.	1981-
	- E. Chavulimu, Lab. Technologist	1981-83
	- N. Odero, Tech. Asst.	1985-
	- C. Afande, Dip. Agri.	1986-88
	- M. Shisya, Tech. Asst.	1987-
	- D. Siamba, DVM	1988-
	- J. Muriuki DVM	1988-
	- J. Wachira DVM	1985-87

ii Winrock International
- K. J. Boor, M.Sc 1982-83
- D. L. Brown, PhD. 1981-83
- A. E. Sidahmed, PhD. 1983-85
- F. P. Semenye, PhD. 1985-(current Resident Scientist in Kenya)

iii Field Assistants and Enumerators
- A. Amuhinda, H. Kiguhi, E. Ochieng,
- E. Otieno, P. Mukhwana, B. Amwai,
- A. Astiba, J. Amangala, J. Osome,
- B. Okumu

iv Office Assistant - P. Pacha

b. Winrock Personnel Based in U.S.

Principal Investigator	- H. A. Fitzhugh, PhD.	1981-
Research data analyst	- J. Labore, PhD.	1988-
Systems analyst	- R. Hudgens, PhD.	1988-

LIST OF PUBLICATIONS

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6. Brown, D. and Nderito M. 1983. "Performance and milk requirements of Toggenburg x (Toggenburg x East African) kids weaned at two months of age or ten kilograms body weight." Proceedings of the 2nd Small Ruminant CRSP Workshop, Naivasha, Kenya.

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8. Brown, D. L., Chavulimu, E. and Fitzhugh, H. A. 1983. "Responses of lactating goats to free water restriction and diet based on sweet potato vines." Proceedings of the 2nd Small Ruminant CRSP Workshop, Naivasha, Kenya.

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10. Fitzhugh, H. A. and Sands, M. W. 1983. "Description of mixed small farm systems in western Kenya." Proceedings of the 2nd Small Ruminant CRSP Workshop, Naivasha, Kenya.

11. Fitzhugh, H. A. 1982. "Dual-purpose goat production Systems for smallholder agriculturalists." Proceedings of the 1st Small Ruminant CRSP Workshop, Kabete, Kenya.

12. Fitzhugh, H.A., J. Onim, P. Semenye and A. Sidahmed (1987). Integration of goats with crop production and other livestock production systems: Mixed farming systems in the Tropics. Fourth International Conference on Goats, March 08 to 13th, 1987 Brasilia - Brazil.

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14. Karimi, S. K., Semenye, P. P., Sidahmed, A. E., Fitzhugh H. A., and Onim, J. F. M. 19[illegible]. "Feed consumption and selection by dual-purpose goats and local goats from Masumbi cluster in Siaya District, Kenya." Proceedings of the 4th Small Ruminant CRSP Kenya Workshop.

15. Khainga, M. S., Fitzhugh, H. A., Ochieng, W. O., Sidahmed, A.E., Brown, D. and Sands, M. 1981. "SR-CRSP dual-purpose goats in western Kenya; History and Record." Proceedings of the 3rd Small Ruminant CRSP Workshop, Kabete, Kenya.

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30. Semenye, P.P., L. Musalia, K. Otieno, M. Onim and H. Fitzhugh (1987). Interaction of dual-purpose goats with subsistence crops and weeds. Proc. 6th Annual SR-CRSP Workshop, Kabete, Kenya.

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FEED RESOURCES PROJECT

Resident Scientist: Moses Onim

OBJECTIVES

The general objective of the Feed Resources Project (FRP) is to design and test feed production systems appropriate for DPG production for small-scale farms in Kenya. Specific objectives include:

1. Evaluation of feed production from by-products and residues from food crops typical to smallholder farms in W. Kenya.

2. Evaluation of the productivity of food and forage from multiple cropping systems involving mixture of food and forage crops over time (rotation) or space (intercropping).

3. Screening of forage crops which have shown potential in similar production environments in Kenya and other tropical countries.

4. Evaluation of the means of preserving forages and maintaining high nutritive values of feed surplus available in rainy season for use in dry season when feed is in short supply.

5. Evaluation of the fertilizer value of goat manure for food and feed crops.

6. Identify and support qualified candidates for graduate training in the U.S. or other academic institutions.

Research activities are based at Maseno, where various forages are screened, tested and multiplied for on-farm evaluation in Kakamega, Siaya and Kisumu districts and also for laboratory analyses.

MAIN ACCOMPLISHMENTS

1. Sesbania Germplasm Collection

The Small Ruminants Collaborative Research Support Programme (SR-CRSP) has in the past carried out a number of agronomic and nutritional studies with Sesbania. Most of these studies, however, have been on Sesbania sesban var. nubica.

In 1987 the Feed Resources Project of SR-CRSP submitted a proposal at the PANESA meeting in Arusha for a sesbania germplasm collection to widen the genetic base of the species. An exploration and collection mission was therefore organized to take place in Tanzania with funding from IDRC. The FR project participated together with ILCA, Tanzanian livestock research organization (TALIRO), and the Ugandan Forestry Department. After this mission in Tanzania, the FR project mounted a similar collection in western Kenya.

1.1 Collection in Tanzania

This started on 6 July 1987 in Dar-es-Salaam and ended on 6 September 1987. It covered the Coastal Lowlands, The Plateau (the Southern, Western and Central), and the Uplands.

A total of 161 accessions belonging to 12 species were collected from the various ecological zones of the country. The majority of the accessions belong to S. sesban (65 accessions) and S. macrantha (45 accessions) reflecting their broad distribution in Tanzania. In terms of altitudinal distribution, S. sesban var. nubica is well represented across a wide range of altitudes both below and above 1000m. Only S. kenyensis occurred at altitudes above 2000m.

1.2 Collection in Western Kenya

The collection in Western Kenya was in two phases.

The first phase started on 15 September, 1987 at Maseno Research Station covering parts of Kisumu, Siaya and Kakamega Districts. This was mainly in the lowlands at altitudes between 1140m a.s.l. at Usenge, Yimbo and 1463m at the Maseno Equator point.

During this phase a total of 33 accessions of three species were collected and most of these species were S. sesban var. nubica. The others were S. macrantha and S. quadrata.

The second phase of collection started on 5 January 1988 and was mainly towards the highlands. The collection route went through Kakamega, Webuye, Kitale, Eldoret, Kapsabet, Kaimosi, Majengo and Kima.

In this phase a total of 28 accessions of three species were collected. Again the majority were S. sesban var. nubica the rest being S. macrantha and S. quadrata.

2. Sesbania Screening

In mid 1987 a large field of Sesbania sesban var. nubica was established at the Maseno Research Station. The seeds were collected locally from the naturally growing sesbania populations at Maseno. After four months of growth, a total of 200 single plants were randomly selected and tagged for subsequent screening work.

The characters being scored from these plants include:

i. Morphological characters - eg. plant height, number of primary branches, length of mature leaf, etc.

ii. Feed quality characters - eg. palatability ranking by goats, foaminess of leaves, CP, IVDMD, etc.

iii. Soil fertility factors - eg. estimated quantity of leaf litter, number of nodules over a 30 cm length of 3 near surface roots per plant.

The screening work still continues and some of the data already collected is being fed into the computer for analysis. From the data already collected it is clear that there is a wide variation in most of the characters being scored. The number of primary branches for instance, ranges from 33 to 99 with a mean of 58 and a standard deviation of 11.90. The mean number of nodules from a 30cm length from the stem of 3 near surface roots also varies from 4 to 96. The mean weights of these nodules varies from 0.01g to 2.60 g.

3. Sesbania Toxicity Studies with Goats and Poultry

When goats were fed on a sole diet of Sesbania sesban var nubica for several months, they developed ill health and some died. Although we have not come across any published report on sesbania toxicity to ruminants, there are reports that sesbania is toxic to poultry. Both NM and FR are conducting experiments on ideal levels of feeding sesbania to goats. Toxicity studies with poultry are to help us determine the type of toxins that may be involved.

4. Forage Tree Nurseries

Legume trees have been found to enhance food production from farms through forage production and nitrogen fixation. Recommended levels of inorganic nitrogen fertilizers are not practical in small scale farming systems. Although tree legumes may not fix adequate nitrogen to boost crop production to levels comparable to those of inorganic fertilizers, they have been found to support subsistence crop production in small scale farms. Legume trees also provide quality forage for supplementation of straw-based diets and fuel wood. It is due to these properties that legume trees have been adopted for hedge row and alley cropping.

In Maseno Research Station, legume trees have been found to establish well in the field when first raised in polythene tubes in the nursery than when planted directly from the seeds. This led to the establishment of a large tree nursery in Maseno Research Station which can accommodate 10,000 seedlings. The following trees are being raised in the nursery:

1. *Sesbania* (*Sesbania sesban var nubica*)

   This tree is adapted to many areas including western Kenya. it can grow to heights of 2m. in three months. Sesbania forage is highly digestible and has a crude protein content of over 26%. Sesbania has been found to nodulate readily under acid soil conditions(PH 4.4) in Maseno area. Sheep on straw-based diet showed improved live weight gain when supplemented with sesbania hay in a trial at ILCA, Addis Ababa.

2. *Leucaena* (*Leucaena leucocephala*)

   Leucaena tree is more resistant to intensive management than sesbania. However, it requires inoculation. Its growth is slow in altitudes above 1000m. Innoculation and application of manure enhances growth.

3. *Gliricidia* (*Gliricidia sepium*)

   This tree has not performed well in Maseno compared to leucaena and sesbania. Gliricidia need to be evaluated further. In Nigeria ILCA has highly recommended gliricidia for alley cropping.

The Maseno tree nursery is also being used to raise seedlings from a wide range of sesbania seeds collected in Tanzania. This forms the backbone of sesbania germplasm evaluation. This has led to the reconstruction of the nursery.

In 1986, tree nurseries were established in three clusters

- Hamisi, Kaimosi and Masumbi. Nursery attendants were engaged in each site. The project has identified three more clusters
- Lela, Rabuor and Muhanda. In these new clusters farmers were given seeds to establish nurseries. In addition, Maseno nursery supplied over six thousand seedlings at the onset of short rains in 1988.

Training classes were held for both technical staff and farmers on method of raising and managing multi-purpose legume trees.

In the near future, Maseno Nursery may be used in the multiplication work of Calliandra and Mimosa spp. which appear to be very promising.

5. New Forage Species and Multi-Purpose Trees under Test in Maseno

The major forage legumes that FR has developed for western Kenya have been pigeon pea (Cajanus cajan), sesbania (Sesbania sesban var nubica) and leucaena (Leucaena leucocephala Lam). Gliricidia (Gliricidia sepium) however, has failed to perform well at Maseno (altitude 1500m a.s.l.). It has also been considered necessary to introduce and experiment with other forage legumes. These have included a locally well adapted and drought resistant creeper/climber - Tylosema fassoglensis, Mimosa scabrella, Calliandra calothyrus, Acacia hokii and A. polyacantha subsp. calophylla. Two major reasons for diversifying protein sources among legume forages is both to develop a feeding regime where farmers do not overfeed any particular type because of certain antinutritional factors, and also have back-up forages should there be a major pest or disease out break. The Psyllid pest out breaks in leucaena in South East Asia and Australia is a lesson we should learn from.

In a comparative replicated experiment, sesbania, mimosa, calliandra, leucaena and A. polyacantha subsp. calophylla have shown good growth rates at Maseno Research Station. Gliricidia has shown low growth rate while A. hokii has done very poorly.

Nutritive values - digestibilities, CP, fibre and palatability to goats of these legumes will be estimated.

6. DM, N. and Green Manure Yields of Leucaena, Sesbania and Pigeon Pea in a Cutting Frequency Study

There are severe shortages of good quality feeds during dry seasons in western Kenya's small holder farms. Also because land shortage is acute, farmers put alot of pressure on land by growing several crops in a year with no or little fertilizer application. Most of the land is therefore very infertile. An experiment was therefore set up to determine how much DM and N can be generated throughout the year from leucaena, sesbania and pigeon pea in a cutting frequency study. After each cutting, the biomass was weighed and incorporated into the soil of the respective plot. Cutting frequency was after every two months. Effects of green manures from these legumes were compared to incorporation of maize stover and fallow land. Soil fertility was monitored every two months, and after 12 months, a test crop of maize intercropped with food beans was planted. The treatments were replicated four times.

The DM biomass generated by each crop that was incorporated into the soil were 7793, 16659, 13603 and 4806 kg/ha for maize, leucaena, sesbania and pigeon pea respectively. The N contributed to the soil by each crop was 120, 643, 448 and 161 kg/ha for maize, leucaena, sesbania and pigeon pea respectively. These results show that of the three legumes, leucaena and sesbania generated large quantities of DM feed of good quality while pigeon pea was relatively poor. The legumes also added large amounts of N to the soil as green manure.

The dry grain yields of the test crop of maize were 6378, 6667, 6578, 5156 and 3911 kg/ha for pigeon pea, sesbania, leucaena, maize and fallow respectively. With sesbania treatment giving the highest dry maize grain yield of 6667kg/ha as compared to fallow which gave only 3911 kg/ha, this experiment shows that green manure increased maize grain yield by 2756 kg/ha over fallow (over 70% increase). The total DM biomass yields from the test crops were 16522, 18506, 18859, 14001 and 10516 kg/ha for pigeon pea, sesbania leucaena, maize and fallow respectively. Again, sesbania treatment outyielded fallow by 8343 kg/ha (over 79% increase). Green manuring is therefore shown to be effective after 12 months and should be recommended to small scale farmers where it is applicable.

7. Selecting Sweet Potatoes for Higher Tuber and Vine Yields

As we reported in the Research Highlights of 1985, sweet potatoes are widely grown in western Kenya mainly for tubers as human food. However, the use of sweet potato vines as a high quality feed is rapidly gaining popularity among farmers. However, our results show that there is a negative relationship between vine DM yields and fresh tuber yields (r2 - 0.36). Selection has therefore been focused on sweet potato varieties that combine high vine yields with good tuber yields. From a collection of 40 varieties from western Kenya, four best dual purpose varieties have been selected. Yields of the selected varieties are 18.5 and 8.4 (S.P. Mas* 2), 19.9 and 4.8 (S.P. Mas 4), 20.9 5.8 (S.P. Mas 13) and 12.1 and 10.0 mt/ha of fresh tuber and vine DM yields respectively. These varieties have been supplied to farmers in western Kenya.

The selected varieties were also considered for high vine CP values, S.P. Mas 13 and 14 have CP values of 19.1 and 21.2% respectively. Since the vines are both very palatable and digestible (75%) and have a high water content (80-85%), they constitute an excellent milk replacer for early weaning of goat kids. Nutrition and Management Project have been able to gradually start weaning goat kids on sweet potato vines from 14 days of age and finally wean them from milk at 30 days age as compared to kids on milk alone that are weaned at four months age. Sweet potato vines as a milk replacer therefore releases large quantities of milk for the farmer's family.

8. Maize Improvement for Higher Feed and Grain Yields

Maize (Zea mays) is the staple food in Kenya and it is the most widely cultivated crop in the country. In western Kenya, it is grown in 679,000 ha in the first rainy season and another 300,000 ha in the second rainy season. The average DM stover yield is estimated at 9 mt/ha. This means a total annual stover DM yield of 8.8 million mt. In the local markets in western Kenya, farmers sell 1 tonne of stover DM at Kshs 1123*. It therefore means that the value of maize stover generated in western Kenya is Kshs 9882.4 million (US$ 549 million). This crop residue constitutes, therefore, the most important cultivated feed resource in western Kenya.

An experiment was therefore initiated in 1985 to select for both maize grain and stover yields and quality of local maize populations. These were compared to maize grain and stover yields and quality of commercial maize varieties. In 1985 comparison, the mean local farmers' population performance was: DM stover yield - 9.7 mt/ha cf commercial hybrid, H512 which yielded 3.1 mt/ha. Crude protein (CP) in leaves were: local - 13.6% while H512 had 13.2%; invitro-digestibility of leaves was: locals - 57.6% while H512 had 57.1% and invitro digestibility of stover was: locals - 59.3% and H512 had 62.5%. The local maize populations had much higher digestible DM energy from stover of 5.8 mt/ha as compared to that of H512 of 1.9 mt/ha. However, the other nutritive quality parameters were the same.

On grain yields, the local double cobber populations performed much better than the commercial hybrid (H512) (3930 kg/ha cf 1159 kg/ha), giving a range of 239%. In an experiment where 12 maize varieties were compared for feed qualities and grain yields, seven seedling feed parameters significantly differed ($P < 0.01$) while only two did not differ significantly ($P < 0.05$). Grain yield differences among varieties were also very wide. These varied from 7385 kg/ha by commercial hybrid H614 (cf farmers' population - Hamisi DC of 7136 kg/ha) to 4926 kg/ha (H511).

The best maize varieties and populations that combine both high crop residue yields and quality with high grain yields have been recommended to livestock farmers in western Kenya.

* 1 US $ = Kshs. 18.00 (October, 1988)

9. Feed Preservation

9.1 Simplified Hay Baling for small scale farmers

This method was highlighted in the 1980 - 1985 research highlights. It involves the use of a wooden baling box measuring 85 cm long, 55 cm wide and 45 cm deep, a grass cutting sickle and a roll of sisal twine.

The forages to be baled are cut (harvested) and left to dry in the field for between 12 and 36 hours. These are then gathered and compressed into the wooden box in which several strings of sisal twine have been laid lengthwise and crosswise.

Once the box is full and tightly compressed, the bale is tied with the strings and removed. Each bale weighs 20 kg.

9.2 *A simplified silage making method for small scale farmers*

The conventional silage making methods are too demanding in terms of equipments involved and the scale of operations and therefore difficult to implement in small scale farms. It is in this light that the Feed Resources Project has developed a simple method which can easily be used by small scale farmers.

It involves, digging a trench measuring about 5m long, 3m wide and 1.5m deep giving a total volume of 18 cubic metres. The different crops to be ensiled are then harvested separately as they become available. These may include, Maize (Zea mays) stalks after harvesting the cobs at hardening stage, Napier grass (Pennisetum purpureum), and Sugar Cane (saccharum officinarum) tops. They are then chopped using a double-bladed hand powered chaff cutter. The chopped materials are then packed tightly into synthetic gunny bags, each crop into a separate bag. The bags containing Napier grass should be treated with 2 kg of molasses diluted with an equal amount of water and then uniformly applied on to the materials in the bag.

Alternatively jaggery sugar can be dissolved in water and used in the same way. This is because when Napier grass is harvested at the recommended stage of utilization (1m high) it is still too wet and the high moisture content would counteract the preservative action of the primary fermentation acids. The additional water soluble carbohydrates from molasses or jaggery sugar would ensure adequate fermentation with the resultant rapid drop in PH which would then preserve the silage.

The bags are then tightly knotted using sisal twines and then laid horizontally in rows inside the pre-dug trench silo. A polythene sheeting is then overlaid on top of the bags before covering with soil and then tightly compressed by trampling on it or rolling a drum full of water on top. The silo is then left undisturbed until the time when the silage is required.

The use of the gunny bags has several advantages:

i. It would be easier to ration the silage at the time of feeding if it is in small batches of known quantity.

ii. Spoilage at feed out due to aerobic deterioration would be reduced since the bags would be easier to remove and this would reduce the length of exposure to air.

iii. It would be easier to apply the desired amount of molasses to the small batches which are of known quantity than to unknown quantity (by weight) of material in a trench or pit silo.

iv. Since the different crops available on the farms for ensiling reach physiological maturity at different times, the gunny bags would allow each to be ensiled as it becomes available.

v. If any of the crops is more susceptible to spoilage, this spoilage would be confined to only a few bags containing that crop.

vi. The bags would allow the ensilage of small batches of the available forages, and

vii. The bags would be reused in ensiling several times before they get old.

9.3 Feed storage

Inspite of the opportunities offered for baling by the baling box described above, the major handicap in the area is lack of appropriate places for feed storage. Various methods of storage have been tried, for example, stacking hay outdoors, stacking hay bales outdoors, hanging hay bales on eaves of roofs and the use of multipurpose stores.

Loose hay stack

Loose hay can be stack in a raised platform to avoid ground surface water or termites from reaching the stack. The platform stands should be vermin and termite proofed eg. by using wood preservative. The use of cheap materials for construction is recommended to reduce costs. Once the hay is stack and compacted into a pyramid or conical shape, its top should be thatched to

keep off rain water. The thatch should be on a framework of twigs that can be lifted and placed back when the hay is being removed.

Stacking baled hay

Baled hay can also be stored on raised platforms and covered with a removable thatched roof. The bales should be stack to a height not more than 2.25m to allow the roof to be placed well on top. The platform should be 2.75m x 2.55m and this will accommodate about 15 bales in a single layer, each bale being 85cm x 55cm x 45cm and weighing 20 kg. A total of five layers will be adequate and this will take 75 bales giving a total of 1.5 tonnes of DM of feed.

The pitch of the roof should be steep enough to allow rain water to drip off. Light materials should be used to construct the roof eg. dry sorghum stalks or twigs of shrubs or trees.

Multipurpose store

If a farmer already has other stores such as grain cribs, these can be used for storing hay when the grains have been threshed and stored elsewhere. If new stores have to be constructed then very simple and appropriate materials should be used eg. weaved stores - two types of these are available, the fixed types and the wooven large basket types. The stores should be raised off the ground and vermin and termite proofed.
Thatch the roof with suitable but cheap and locally available materials such as papyrus reeds. These stores can be used for storing hay for part of the year and for grain during other parts of the year.

10. Teck-Packs

The FR Project prepared nine technical packages which would be used as technical guides for the SR-CRSP project field staff and agriculture and livestock extension officers in the areas where the DPG technology is being tested. The titles of the tech-packs were:

1. Pastures/Fallow lands
2. Improving soil conservation and fertility
3. Feed production from maize-based cropping systems
4. Feed production from cassava-based cropping systems
5. Sweet potato as a food and feed crop
6. Legume fodder crops and tree nurseries
7. Grass fodder crops
8. Feed conservation as hay and silage
9. Feed storage

11. Out-Reach Activities

11.1 Project scientists have participated in and presented papers at various conferences and workshops overseas and in Kenya.

11.2 Project scientists have given training lectures and materials on on-farm production, utilization and preservation of livestock feeds to MLD extension officers, field personnel from local NGOs, women groups and other farmers over the years.

11.3 In conjunction with other SR-CRSP projects and MLD, the project has exhibited various forages in fresh and preserved (hay bales form) at the Kisumu and Kakamega annual Agricultural shows.

MAJOR PROBLEMS

There is a big research information gap between extension and farmers. This is because very little research information on small-scale farming problems in Western Kenya is available. It therefore means that attempting to do research on a specific area like Feed Resources in small farms meets with many other farming problems like lack of suitable crop varieties and credits, very poor soils, etc. that need to be addressed before widespread research impact can be realized.

FUTURE PRIORITIES

The principle priority is to develop Feed Resources Packages that can provide adequate quantities and quality of feeds to the DPGs around the year under smallholder farming systems in western Kenya. Feed resources to be quantified include:

a. Feed storage on small scale farms in western Kenya.
b. Food-feed crops like maize, sorghum, pigeon pea, finger millet, sweet potato, cassava and beans, - alley cropping
c. Food crop residues and industrial by-products.
d. Soil fertility problems in small scale farms in western Kenya.
e. Introduction and screening of Multipurpose tree species (MPTs) for forage, fuelwood and soil fertility capability.

Personnel Based in Kenya

i. *Collaborators from Ministry of Livestock Development*

M. Mathuva (MSc.)	- Maseno Research Station	
K. Otieno (MSc.)	"	"
W. Ochieng (Dip. Agric)	- "	"
P. Ochola (BSc.)	- Kibos Sugar Research	"

Laboratory Analysis

J. Oduor (Lab. Technologist)	- Maseno Laboratory
S. Malanda(Lab. Technologist)	- Kibos Soils Laboratory

ii *Winrock International*

Sandra Russo, PhD	1981-83
J.F. Moses Onim, PhD	1983 - current Resident Scientist in Kenya.

iii *Field Assistants and Enumerators*

P. Amuhinda
J. Oguna
S. Sigu
E. An'gondi

iv *Winrock Personnel based in U.S.A.*

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

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ANIMAL HEALTH PROJECT

Resident Scientist: Fred. R. Rurangirwa

OBJECTIVES

The general objective of the Animal Health Project is to undertake research and training to provide long term solutions to disease problems that represent a constraint on DPG production.

Specific Objectives for the last 3 years include: (1) Identification and prevalence of pathogenic anaplasma in goats; (2) provision for immunoprophylaxis and diagnosis for contagious caprine pleuropneumonia (CCPP); (3) provision for diagnosis and immunoprophylaxis for Heartwater; (4) development of strategies for introduction of crossbred goats into areas with trypanosomiasis; (5) monitoring of goats for the presence of caprine arthritis encephalitis virus (CAEV); (6) monitoring of the health of DPGs introduced to project sites in Western Kenya and Olmagogo and determination of their health problems; (7) training of Kenyan veterinarians through M.Sc. or Ph.D programs on relevant subjects in the USA and thesis research conducted in Kenya.

MAIN ACCOMPLISHMENTS

1. Identification and Prevalence of Pathogenic Anaplasma in Goats

Anaplasma spp. have been observed in erythrocytes from goats which are anemic and in poor body condition from various sheep and goat rearing regions in Kenya. Since three *Anaplasma spp.* cause parasitemia in goats, and only *A. ovis* causes disease, identification and determination of the prevalence of the *Anaplasma spp.* was done. To detect *Anaplasma ovis*, a 9.6 kilobase pair DNA probe (pAO12A) was developed and used in conjunction with an *A. marginale* DNA probe previously derived from a portion of a gene coding for a 105,000 (Am105L) molecular weight surface protein of *A. marginale*. The 9.6 kilobase pair *A. ovis* DNA probe did not hybridize to *Babesia bovis* genomic DNA and goat leukocyte DNA. In Southern blotting, pAO12A DNA hybridized to homologous sequences present in *A. ovis* and *A. marginale* genomic DNA. *Anaplasma spp* infecting goats in Kenya were identified as *A. ovis* by (i) DNA hybridization reactions with pAO12A DNA and failure to react with a 2 kilobase pair *A. marginale* DNA probe, (ii) intraerythrocytic location of the *Anaplasma* organisms in infected goat

blood, and (iii) host specificity of the Anaplasma organisms for goats, but not for cattle. Also, using two Anaplasma DNA probes, the prevalence of A. ovis in goats from seven regions in Kenya was found to range from 22-87%. The pA012A DNA probe detected a 0.0035% A. ovis parasitemia in infected blood. This level of sensitivity makes the DNA probe suitable for use in surveillance and epidemiological studies.
This was the basis of master's thesis for one of the students (S. Shompole).

2. Immunoprophylaxis and Diagnosis for CCPP

Contagious caprine pleuropneumonia (CCPP) is a disease of major economic importance that causes high mortality in goats. The disease has been reported to cause major losses in Africa, the Middle East, the Mediterranean littoral, India and Pakistan. CCPP is the most serious disease of goats in Kenya, causing high mortality and substantial economic loss. In Kenya, this disease is mainly caused by mycoplasma species as yet unclassified called "F-38". Thus SR-CRSP focused the main activity on vaccine improvement and development of easy diagnostic tests.

Early Immunization Trails

The first immunization trial using F38 was carried out by McOwan and Minnette in 1978. They inoculated 20 goats intratracheally with a high-passage culture of F38. On contact challenge of the inoculated goats 1 month later, 11 of 20 vaccinated goats were protected, whereas all 20 control goats contracted CCPP. These initial experiments, which were not continued, provided an indication that goats could be protected against CCPP by using F38.

While investigating the effect of streptomycin in goats with natural and experimental CCPP caused by F38, it was found that goats treated with streptomycin on the 3rd day of temperature elevation ($\geq$40 C) recovered from the disease and became completely immune to reinfection with F38. Serum samples from such recovered goats caused in vitro growth inhibition of F38 organisms. This observation led to immunization of goats. First they were inoculated with sonicated F38 antigens emulsified in Freund's complete adjuvant, and 2 weeks later they were given a booster dose of F38 antigens emulsified in Freund's incomplete adjuvant. The objective of this experiment was, first of all, to induce growth-inhibiting antibody and, secondly, to assess whether goats with such antibody induced by

immunization with sonicated F38 would withstand contact challenge. The immunized goats with or without detectable growth inhibiting antibody were protected, while the controls, which had been immunized with adjuvants alone, died of CCPP. This finding strongly suggested that an inactivated F38 vaccine could be developed for CCPP.

A follow-up experiment, using mineral oil and aluminium hydroxide as separate adjuvants, was carried out. The results demonstrated that protective immunity in goats could be induced by using sonicated F38 antigens in mineral oil (Freund's incomplete) adjuvant. The immunity was present for at least 6 months after vaccination. Aluminium hydroxide, like antigen alone, provided only 20% protection. Thus, an unequivocal protection of goats against CCPP with sonicated F38 antigens in an oil adjuvant was demonstrated.

Oil based adjuvants are not usually appropriate for use in animals intended for human consumption, as the oil may track through fascial planes and spoil the meat. Freund's adjuvant is particularly unacceptable in such animals, not only because of the mineral oil, but also because the mycobacteria in the adjuvant will render animals positive to the tuberculin test, a critical drawback in any area where tuberculosis is under control. Nevertheless, use of Freund's complete and incomplete adjuvants demonstrated that F38 organisms disrupted by sonication and injected with an appropriate adjuvant would induce protective immunity in goats against CCPP.

A pilot experiment revealed that saponin could be used as an adjuvant for F38 vaccines. This finding was very important because saponin does not cause tissue damage. Thus, a series of experiments were carried out using saponin as an adjuvant to assess:

(1) immunogenic stability of F38 after lyophilization;

(2) immunogenicity after storage at 22 C and 4 C; and

(3) the duration of immunity induced by a single dose of the lyophilized F38.

Lyophilization Trials

Since lyophilized vaccines are easy to store and transport, a preliminary study was undertaken to find out if lyophilized F38 would induce protective immunity in goats against CCPP. Washed F38 cells were lyophilized in vials at a concentration of 8 mg/ml and stored at 4 C. After 36 days of storage, eight goats were immunized with 8 mg/goat in a mixture of saponin and aluminium hydroxide as adjuvants. The goats received a similar immunization 21 days later. Sixty-four days after initial immunization, the vaccinated and control goats were challenged by contact exposure. Six of the control goats and only one of eight vaccinated goats died of CCPP. These results led to the conclusion that lyophilized F38 antigens protect goats against CCPP caused by F38, when an optimal immunizing dose is used with appropriate adjuvant.

Determination of Minimum Immunizing Dose of Lyophilized F38

Seven groups of five goats each were immunized with different doses containing 0.015, 0.075, 0.15, 0.20, 0.375, 0.750, and 1.50 mg protein of lyophilized F38 using saponin as an adjuvant. An eighth group of five goats was immunized with the highest dose (1.50 mg) without adjuvant. A ninth group of control goats was immunized with saponin in phosphate-buffered saline (PBS), pH 7.4. All the goats were immunized again 4 weeks later. The immunized goats, along with control goats, were contact challenged 4 weeks after the second immunization.

The mean time for the control goats to develop pyrexia of 40 C was 14±1.5 days after exposure to infected goats, and all the control goats died of CCPP. The goats that were immunized with 1.5 mg F38 antigen without saponin had an incubation period similar to that of the control group. Two goats immunized with the lowest amount of lyophilized F38 (0.015 mg in saponin) developed pyrexia at 36 and 43 days and later died of CCPP. One goat given 0.75 mg in saponin had pyrexia at 43 days and later died of CCPP. There was no pyrexia nor any signs of disease in the goats that were immunized with ≥0.15 mg in saponin, except one of the group immunized with 0.375 mg, which had a temperature reaction 40 days after contact exposure and died of CCPP 6 days later. Supported by data in the following section and by additional experiments it seems that the minimum immunizing dose that fully protected all goats in a group was 0.15 mg.

Immunogenic Stability of Lyophilized F38 Stored at 22 C and 4 C for 3, 9 and 14 months

In order to check the stability of the antigen upon storage, antigen (lyophilized F38) was stored at 4 and 22 C for up to 14 months. Goats were immunized with two doses of the minimum immunizing dose (0.15 mg) of the antigen after storage for 3 and 14 months at 22 C and after 3, 9 and 14 months at 4 C. The immunized goats, together with corresponding controls, were challenged by contact exposure 3 weeks after the booster dose. Lyophilized F38 kept for 3, 9, and 14 months induced protective immunity in all the immunized goats. The average mean time for the non-immunized control groups of goats, at 3, 9, and 14 months, to develop pyrexia were 15, 17 and 22 days after contact exposure to the infected goats, respectively. There was no indication of CCPP in the immunized goats.

Duration of Immunity Induced by a Single Dose

Three groups of 30 goats each were immunized with single doses of 0.15, 0.30 and 1.2 mg of the lyophilized F38 containing saponin as an adjuvant. A fourth group was injected with saponin in PBS. Ten goats from each group were subsequently exposed to virulent challenge by contact 3, 6 and 12 months later. All the goats immunized with a single dose of 0.15 mg were protected. Those immunized with a single dose of 0.3 mg were protected, except in one case when at 12 months a goat reacted and died of CCPP. Two goats in the group immunized with 1.2 mg also died of CCPP - one from the group challenged at 6 months, and the other from the group challenged at 12 months.

Three major conclusions can be drawn from the results of these immunization trials: (1) Lyophilization and storage of F38 at 22 C or 4 C does not affect its immunogenicity. (2) Large quantities of lyophilized F38 can be produced and stored at 22 C or 4 C for $\leq$14 months without affecting immunogenicity. (3) Duration of immunity induced by a single minimum immunizing dose of 0.15 mg lyophilized F38 is >12 months. Thus, the vaccine developed for CCPP can be lyophilized, has a minimum dose of 0.15 mg and a shelf life of >14 months when stored at 22 C or 4 C, and induces immunity lasting over 12 months.

Besides immunization the project recognises the need for a diagnostic test for CCPP that can be used in field laboratories without the use of specialized equipment and reagents. A latex agglutination for field diagnosis of CCPP has been developed. Latex beads were sensitized with a polysaccharide isolated from a F38 culture supernatant and used in a slide agglutination test to detect serum antibodies in goats with contagious caprine pleuropneumonia. The latex agglutination test detected antibodies in the sera of goats by 22±2 (mean ± 1 sd) days after contact exposure to contagious caprine pleuropneumonia, whereas the complement-fixation test detected antibodies by 24±4 days after contact exposure. Both tests were negative with 181 sera from a farm which was free of the disease. When the same tests were done on 763 sera from two different farms with outbreaks of classical contagious caprine pleuropneumonia, 63 per cent were positive by the latex agglutination test and 23 per cent were positive by the complement-fixation test. Besides being more sensitive than complement fixation, the latex agglutination test can be performed in the field using undiluted serum or whole blood and a result obtained within two minutes.

As mentioned above, "F38" strain of mycoplasma has not yet been classified. Initial studies of the Kenyan F38 strain suggested that it might represent a new species, but further characterizations have shown the F38 group of mycoplasmas cross-react serologically with several classified mycoplasma species. Thus, classification of the F38 group of mycoplasmas, Bovine serogroup 7 and M. capricolum has presented difficulties due to serological cross-reactions, not only in the non-specific tests but also in epi-immunofluorescence and growth inhibition tests, usually considered species specific. To resolve this problem, monoclonal antibodies (MoAbs) against prototype F38 were produced. Three MoAb inhibited the in vitro growth of 13 F38 isolates from goats with CCPP but not seven heterologous mycoplasma isolates representing four different species including M. capricolum, Bovine serogroup 7, M. primatum and M. equigentalium. In contrast to results with polyclonal antisera, growth inhibition by monoclonal antibodies was specific for F38 mycoplasma isolates and constituted a reliable means of distinguishing F38 from other mycoplasmas.

3. Immunoprophylaxis and Diagnosis for Heartwater

Tick-borne protozoal and rickettsial diseases are a major constraint to livestock production in most of the tropical and sub-tropical regions of the world. Cowdria ruminantium is a rickettsia which is transmitted by ticks of genus Ambylomma and causes an infectious disease in domestic and some wild ruminants with fever, gastrointestinal and nervous signs followed by death. The disease results in high mortality especially in susceptible domestic animals introduced into heartwater endemic areas which include much of the sub-Saharan Africa nd certain Caribbean islands. The disease has a potential to spread because the vector has a world-wide geographical distribution including the American mainland. In Africa, it is ranked among the economically significant diseases like theileriosis, babesiosis, anaplasmosis and trypanosomiasis.

C. ruminantium differs from the other rickettsia in that, although blood of the animal host is infective, the organisms are not visibly detectable. The organism may multiply in the cytoplasm of the leukocytes with subsequent infection of endothelial cells. Diagnosis of the disease in animals is usually made post mortem by demonstrating the characteristic colonies of C. ruminantium in the endothelial cells by microscopic examination of Giemsa stained brain smears. In ticks, the colonies of the organism are demonstrated by light and electron microscopy. Since these procedures are unsuitable for the rapid detection of C. ruminantium in either infected live animals or vectors, immunological and epidemiological studies are limited. A more convenient method of diagnosis is needed as well as a method of prevention.

Cowdria ruminantium was partially purified by differential centrifugation of guts dissected out of infected Amblyomma variegatum ticks. DNA extracted C. ruminantium enriched fraction, as shown by animal transmission studies, was used to create a library of nearly 5,000 recombinants in the plasmid pBR 322. Eight recombinants found to contain inserts of size range 0.7 kb to 7.5 kb were differentially hybridized to DNA from goat white blood cells uninfected and infected ticks. One recombinant plasmid was selected for further characterization. If the specificity of this recombinant is proved, it will be a useful diagnostic tool as a probe in obtaining purer fractions of C. ruminantium as well as detecting the organism in ticks and animals.

Similarly, a genomic library of approximately $1x10^6$ recombinants has been created in a lambda expression vector. Approximately 60 clones have been identified on an initial screening of the library with postconvalescent serum from infected and treated goat. This serum has been shown to have antibody to C. ruminantium by fluorescent antibody test. Further work to purify and characterize the clones is in process. Identification of C. ruminantium proteins expressed in E. coli could led to a subunit vaccine.

4. Development of Strategies for Introduction of Crossbred Goats into Areas with Trypanosomiasis

Comparison by workers at the FAO Sheep and Goat Development Project of indigenous and exotic crossbred goats showed that trypanotolerance occurred in field in the indigenous goats. If this trypanotolerance is acquired and the mechanisms can be determined, then it should be possible to use it when introducing exotic crossbred goats into areas where trypanosomiasis areas have antibodies to many variable antigen types of the serodemes and these antibodies are passed to the kids in the colostrum. Subsequent exposure of the kids to trypanosomes by tsetse flies causes infection, but the disease is limited by the antibodies to some of the variable antigen types. In this way, the effects of the disease are lessened while the kids continue to make antibodies to new variable antigen types and the outward expression of this process is trypanotolerance.

The course of infection and the humoral immune response to Trypanosoma congolense clone ILNat 3.1 were studied in the test goat kids receiving colostrum from dams immunized with the surface coat of ILNat 3.1 and control kids that received colostrum from non-immunized dams. At 24-48 hrs after birth all test kids had detectable serum antibodies to the trypanosome clone. There was no difference in the prepatent period between the test and control kids when they were challenged with 10^3 T. congolense ILNat 3.1 trypanosomes 8 days after birth. Except for the first 7 days a significantly lower parasitemia was recorded in test kids than in control kids. The mean packed cell volume of test kids was not significantly different from that of control kids. The test kids gained as much weight as non-infected kids; both groups gained twice as much weight as infected control kids. Following infection all kids developed antibody to the infecting trypanosome clone. Fifteen test kids had titers equal to or

greater than 1280 compared to only two control kids. The test kids survived longer after infection compared to control kids. The conclusion is that colostrum from does immunized with the surface coat of a T. congolense clone did not prevent infection but prolonged survival of kids challenged with the same clone.

This was the basis of Master's Thesis for one of the students (D.M. Mwamachi).

5. Monitoring of Goats for the Presence of CAE

No new cases of the infection have been found in Kenya. Testing was done on blood samples from 1500 goats at Olmagogo. These samples were evaluated by a new serologic test developed at WSU. Plans are underway to test all the DPGs in Western Kenya.

6. Monitoring the Health Problems of DPGs in W. Kenya Olmagogo

The health of DPGs at Olmagogo at Naivasha is monitored regularly to identify the most common diseases of goats for recommending cost-effective control measures that would form part of management package for farmer adoption of DPGs. The following diseases are monitored: internal and external parasites, brucellosis, CCPP, CAE and Mastitis. Investigations have indicated that Haemonchus contortus is the most important single helminth in the tropics. This has been brought under control by drenching.

7. Training

Trainee	*Period*	*Degree*	*Institution*
R. Shavulimo	1983-1985	MSc.	University of Reading
E. Oluoch	1983-1985	MSc.	Washington State University
D. Mwamachi	1984-1987	MSc.	Washington State University
S. Shompole	1985-1988	MSc.	Washington State University
S. Waghela	1984 - Current	Ph.D	Washington State University
P. Shompole	1988 - Current	Ph.D	" " "
S. Kihara	1988 - Current	MSc.	" " "
R. Soi	1988 - Current	Ph.D	" " "
F. Karanu	Current	MSc.	" " "

FUTURE PRIORITIES

1) Complete heartwater project
2) Emphasize control of diseases through genetically determined resistance as in haemonchosis and trypanosomiasis.

COLLABORATING PERSONNEL

Principal Investigator	*Institution*
Travis C. McGuire DVM, Ph.D	Washington State University
On Site Coordinator	
Fred R. Rurangirwa DVM, MSc. Ph.D	Washington State University
Investigators	
S. Waghela DVM, MSc.	KARI
P. Shompole DVM, MSc.	KARI
F. Mukendi DVM	KARI
S. Kihara DVM	KARI
R. Soi DVM MSc.	KARI
F. Karanu DVM	KARI

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Shompole, S. Cloned DNA probes identify pathogenic Anaplasma spp. in goats as Anaplasma ovis. MSc. Thesis in Veterinary Science, Washington State University, 1988.

SOCIOLOGY PROJECT

Resident Scientist: Eric Reynolds (1982 - January 1986)
Thomas Conelly (1986 - August 1988)
Nkonge Mbabu (January 1989 -)

OBJECTIVES

The overall objectives of the Sociology Project are to develop a methodology and body of information that will permit assessment of the acceptability of the technological interventions and management strategies proposed for the DPGs. In addition, the project will help to evaluate whether the existing infrastructure can adequately support the widespread extension of the DPG package and, through graduate training, increase the capability of MALD/KARI to conduct sociological research related to agricultural production problems in Kenya.

Sociological input into the SR-CRSP on farm research has continued to involve the use of both formal and informal observational techniques to collect relevant data. These activities are accomplished with the assistance of SR-CRSP field enumerators. Beginning 1986, Sociology on-farm research has covered: time allocation and the organization of household labour in small-holder farming systems in Western Kenya; assessment of household dietary patterns and utilization of milk products in Western Kenya; and rapid farm characterization survey.

Sociology has continued conducting research to enhance understanding of the wider social and economic context of livestock production in Western Kenya. Since 1986, the thrust of this study has focused on the transformation process of Kenya's agrarian sector, with special interest in Western Kenya.

MAIN ACCOMPLISHMENTS

1. On-Farm Research

1.1 Time Allocation and the Organization of Household Labour in Small-Holder Farming Systems in Western Kenya

The massive male outmigration that has historically characterized Western Kenya, coupled with the absorption of childre into the formal school system has led to serious labour constraints in Western Kenya's agricultural production. In view of this situation, Sociology Project undertook a study to examine current time allocation and the organization of household labour, in order to assess its implication to the potential adoption of the dual purpose goats.

The project recorded the amount of labour spent specifically on livestock production, as well as other farm and off-farm activities in competition with livestock production. Records also categorized household division of labour on the basis of gender and age.

Study findings noted a decline of the traditional communal grazing systems and a corresponding increase in tethering animals and feeding them through the 'cut-and-carry' method. This shift in livestock management, coupled with male outmigration and increased absorption of children into the modern school system has engaged women more intensively in Western Kenya's agricultural production.

In general, farm families have adequate time available to invest in the care of DPGs at the current level of two animals per household. However, animal management, and particularly the production and preparation of recommended feed crop, falls disproportionately in the shoulders of women farmers who have least time to invest in the new enterprise. Paradoxically, the woman headed families which have the greatest needs for additional milk supplies, have correspondingly the greatest constraints to labour supply. In the final analysis therefore, adoption of the dual purpose goats in Western Kenya will depend largely on how much women in the region perceive the goats to be of value to the welfare and that of their children; and thus, justifying additional claim to the labour time.

1.2 Assessment of Household Dietary Patterns and Utililization of Milk and Milk Products in Western Kenya

The high population density in Western Kenya has encroached on grazing land, reduced herd sizes and thus, presumably diminished an important source of high protein food in form of meat and milk. Sociology Project undertook to document this change in dietary patterns by conducting a comparative study of milk production and consumption levels between those farmers who had no DPGs and those who had received the goats. Data collection on this experiment started in 1986 and continues to the present day. This long term study is intended to assess the impact of DPGs on the collaborating households through several and 'kidding cycles'.

Preliminary analysis of the data indicates that milk in the most often consumed of high protein in both Masumbi and Hamisi. Despite the regularity on milk consumption in Western Kenya the amount consumed are on average very low. In Hamisi the per capita daily milk consumption is 93 ml and in Masumbi, the amount rises to 145 ml. Assuming no cost or availability constraints, women in the research sample indicated need for as much as three times the amount of milk available to them that time. Among the households that owned DPGs, milk consumption levels rose steadily and the amount of milk purchased declined between the months of September and October 1986, as the newly distributed goats kidded and came to production.

The general conclusion arising from this study is that, there is need for more inexpensive milk in Western Kenya. Furthermore, the fact that the poorer households with the least purchasing power are the ones currently more likely to purchase milk for their daily consumption underscores the important role that the DPGS might play in providing inexpensive milk and meat to those who need it most. However, to reach this category of farm families, production cost of the DPGs must be kept to the bare minimum.

1.3 Rapid Farm Characterization Surveys

a) In 1986, sociology co-ordinated a multi-disciplinary rapid survey design to identify key characteristics of 75 households participating in a large-scale on-farm trial of DPGs. This work included setting up procedures for sampling the target communities, assisting the design of survey questions, and co-ordinating the logistics of the actual survey which was carried out in three areas of Western Kenya (Kaimosi, Hamisi, and Masumbi).

What follows is selected findings of the rapid survey. Land holdings averaged 1.90 hectares (1.30 in Hamisi, 1.81 in Kaimosi, and 2.56 in Masumbi). Number of crops grown averaged 7.2 per household (ranging from 2-12). Cash crop production was much lower on average (1.2 per household). Land left on fallow averaged 0.62 per household. Number of cattle owned per household averaged 3.1 (ranging from 0-11); that of local goats averaged 0.6 (ranging from 0-8); and that of sheep averaged 0.7 (ranging from 0-5). Number of persons in resident per household averaged 8.2 (ranging from 1-16). And adult equivalent labour months available per household per year averaged 40.5 (ranging from 12-134).

b) In 1988, SR-CRSP decided to start three new clusters to make a fresh start in evaluating the technical packages that have been developed so far. Sociology Project contributed to the development of the methodology for selecting potential collaborating farmers in the new clusters and spent time conducting interviews to select the participants.

There were interesting experiences in the selection process in Muhanda cluster, which is located in Kakamega district near Vihiga, the adaption rate for collaborating farmers was as high as 66%. In Rabuor cluster, located across Siaya and Kakamega districts between the towns of Luanda and Yala, the adaption rate for collaborating farmers was 73%. The adaption rate fell even further to 60% in Lela cluster, which is located in Kisumu district, off the Maseno-Kisumu road.

A variety of reasons were given for the reluctance to join SR-CRSP research activities. Some farmers said that problems with labour and land availability influenced their decision against dual purpose goats. A less discussed but perhaps a deeper undercurrent, indicated that farmers were afraid that the distribution of the DPGs will entail a loan; and that this would potentially place farmers at the risk of losing their lands or having their household belongings auctioned if the goats died under their care.

Despite these obstacles, persistent efforts to explain the research character of the SR-CRSP activities managed to win sufficient number of collaborating farmers in Muhanda and Kabuor clusters. As per middle July 1988, the Programme needed win 19 more farmers in Lela cluster to reach the desired goal of thirty participants in that area.

2. The Wider Social and Economic Context of Livestock Production in Western Kenya

2.1 The transformation of Kenya's Agrarian's sector: the Case of Western Kenya

Nkonge Mbabu is carrying out this study of his doctoral dissertation at the University of Missouri Columbia. The general thrust of the study is to identify the social forces that have influenced the transformation of Kenya's agrarian social structure, With special focus on Western Kenya.

The study traces the driving motor of this transformation process to the European expansionism that began in the second half of the 19th century. In the period between 1899 and 1918, Kenya's Protectorate Government took steps to remove indigenous African population from the high potential agricultural lands for the occupation of European farmers. The period between 1919 and 1939 saw the consolidation of European settler economy in Kenya, with strategies laid down to compel African men to avail themselves for wage labour on European farm.

Land laws were enforced in Central Kenya and within the Rift Valley. Labour laws were enforced in Western Kenya. This strategy to maintain Western Kenya as labour reserve has historically held back agricultural development in the region.

While the progressive farmers in Central Kenya were encouraged to enclose land for individual use, gained access to commodity market, and received limited farm credit from the colonial government in 1930s and more so in 1950s, Western Kenya did not catch as much attention from the colonial government. As a result of these historical constraints, enterprising people in Western Kenya have tended to invest in commerce rather than agriculture. As a result of this deprivation of capital in the agricultural sector, people have tended to respond to the increasing population density in the region with massive male out-migration, instead of intensification of farming activities. It is in this context that we should understand the prevailing predominance of female headed household in Western Kenya.

3. Training

3.1 Training of the MALD Collaborating Scientist

Nkonge Mbabu's doctoral programme in rural sociology has progressed well. He is expected to graduate in December 1988, and to return to work with SR-CRSP in Kenya in January 1989.

FUTURE RESEARCH PRIORITIES

a) *Collaborative Evaluation of the Impact of the Feed Resource and Goat Management Experiment in the Newly Formed Research Clusters*

- Jointly with the Feed Resource Project, Sociology will monitor farm response to and utilization of the nursery seedlings and hay baling.
- Monitor farmers' ability to use the goat management handbook provided by the Nutrition and Management Project.
- An with Economics Project, Sociology will monitor attendance and participation of the farmers in the cluster workshops.

b) *Assessment of Farmer Livestock Management Practices*

In the old clusters, this study will be a continuation of the on-going data collection to assess the long term impact of the DFGs to the welfare of smallerholder farm families. In the newly created clusters, the study will record changes that occur in the traditional livestock management practices as farmers adopt SR-CRSP livestock management recommendations. Conversely, the study will record modifications made on livestock management practices recommended by the SR-CRSP, inspired

by the traditional management practices. Hopefully, this interaction inform SR-CRSP Scientists on the possible modifications that might need to be made on technical packages, to make them more adoptable by the farmers.

c) On-Farm Milk Utilization Survey

In the old clusters, this study is proposed to continue in order to record the long-term contribution of dual purpose goats to household welfare and to better gauge seasonal and yearly variations in milk production and consumption patterns. The study will also be expanded into the newly created clusters.

COLLABORATING PERSONNEL

Title	*Name*	*Institution*	*Duties*
P.I.	Michael F. Nolan	Univ. of Missouri	1979-Current
Co-P.I.	Jere L. Gilles	Univ. of Missouri	1979-Current
Resident Scientist	Tom Conelly	Univ. of Missouri/ Winrock International	1986-1988
Collaborating Scientist	A.N. Mbabu	MALD/KARI	1983-Current
Enumerator	P. Amuhinda		
Technical Assistants	J. Atichi		1983-Current
	G. Ambogo		1986-Current

LIST OF PUBLICATIONS

1. Conelly, W.T., A.W. Mukhebi, H.A. Fitzhugh, and M.F. Nolan, 1986. "Preliminary Assessment of Household Dietary Patterns and Utilization of Milk Products in Western Kenya". Presented at the Fifth Small Ruminant CRSP Kenya Workshop, Kabete, November 4-5, 1986.

2. Conelly, W.T., H.A. Fitzhugh, and M.F. Nolan, 1986. "Time Allocation and the Organization of Household Labour in Smallholder Farming Systems in Western Kenya". Presented at the Fifth Small Ruminant CRSP Kenya Workshop, Kabete, November 4-5, 1986.

3. Conelly, W.T., A.W. Mukhebi, L. Oyugi, H.C. Knipscheer, 1987. "Household Labour Allocation in an Intensive Crop/Livestock Farming System in Western Kenya". Paper presented at the Farming Systems Research Symposium, University of Arkansas, Fayetteville, October 18-21, 1987.