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Small Ruminant Collaborative Research Support Program

External Evaluation Panel On Sight Review

Animal Science Department

Texas Agricultural Experiment Station

Texas A&M University System

September 23, 1988

Projects: Breeding Dual Purpose Goats For Tropical Areas

Analysis And Synthesis Of Sheep And Goat Production Systems

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Suggested Guideline Agenda
EEP Review Of Texas A&M SR CRSP Projects
Faculty Lounge, Kleberg Animal And Meat Science Center
September 23, 1988

8:00 - 8:30	T. C. Cartwright - Introductions and Preliminary Remarks
	Ronnie Edwards - Welcome to the Animal Science Department
	Dudley T. Smith - TAES Commitment to Sheep and Goat Research
	Jim T. Goodwin - Office of International Agricultural Programs
	Carl Menzies - The Interaction and Symbiosis between TAES and SR CRSP Research
8:30 - 9:00	The Systems Analysis Project - Explanation of Project Development, Operation and Goals
9:00 - 10:00	Simulation Model Structure, Results and Applications
10:00 - 10:30	Hands-On P.C. Use of TAES Simulation Models
10:30 - 10:45	Regionalization, Future Developments and Application
10:45 - 12:00	Questions, Responses and Discussion Of Systems Project
12:00 - 1:00	Lunch For EEP at The Faculty Club
1:00 - 1:30	The Breeding Project - Explanation of Project Development, Operation And Goals
1:30 - 2:00	Results, Applications, Future Research and Regionalization
2:00 - 3:00	Questions, Responses and Discussion of Breeding Project
3:00 - 4:00	EEP Time to Prepare Review Remarks
4:00 - 5:00	Remarks of EEP Review Team and Discussion

INTRODUCTION

The two projects being reviewed are funded by a sub-grant to the Texas Agricultural Experiment Station (TAES) from U.S. AID Title XII CRSP funds via the University of California at Davis as the Management Entity of the SR CRSP and by TAES funds. These projects, the PI, Co-Investigator and Resident Scientist are based in the Animal Science Department. The Resident Scientist, Dr. Francis Ruvuna, is posted in Kenya.

Originally there was one SR CRSP project in the Animal Science Department: Systems Analysis. In 1982, we also assumed responsibility and funding for the Kenya Breeding Project. These two projects are separate activities. For accounting convenience of the ME UCD, the funding was combined into one sub-grant, but TAES accounts for the funds and activities separately. The following reports of research of each of these projects, mostly updating results, were prepared for the EEP Sight Review.

In addition, for the Systems Analysis Project, the development and collaborative nature of this research have been chronicled to assist the EEP Review Team to evaluate the scientific merit and productivity of this project with a view toward assessing its potential for future enhancement of SR CRSP research and its application.

Listings of publications from each project are appended (Appendix A). As requested, the 1986-87 Annual Reports are included (Appendix B). Listings of the Animal Breeding Section and the Animal Science Department Faculty are Appendix C.

BREEDING PROJECT SUMMARY, 1982-1988

T. C. Cartwright, PI

H. A. Blackburn, Co-Investigator

F. Ruvuna, Resident Scientist

C. O. Ahuya, Collaborating Scientist, KARI

A. M. Okeyo, Collaborating Scientist, KARI

Texas A&M assumed responsibility for the Kenya Breeding Project in 1982. In place at that time were two barns and a flock of East African and Galla goats with a few exotics. Almost no crossbreds had been produced. No suitable breed was available that produced sufficient milk to be viable for the SR CRSP objectives in Kenya. Objectives were redefined primarily to develop a new breed of dual purpose goat (DPG) utilizing exotic dairy and indigenous breeds, adapted to Kenya smallholder production conditions. Secondary experiments were superimposed on the breeding flock to answer specific questions needed for smallholder utilization of goats. These experiments have included or continue to include:

Milking strategies (milk for kid vs dairy milk)

Growth and development characterization (weight/age, puberty, etc.)

Lactation patterns (quantity, age effects, persistency, etc.)

Carcass characterization and castration effects

Dairy milk vs weaned kid potential

Postpartum estrous cycling

AI procedures

Development of age, sex and weight correction factors

Determination of age by dentition

Grazing habits

Collaborative experiments with other projects include:

Genetic resistence/tolerance/resilience to trypanosomiasis

Genetic resistence/tolerance/resilience to internal parasites

Productivity of F1's under smallholder conditions

Use of F1 sires in farmer flocks

The current stage of breeding has progressed to inter se selection among the DPG toward optimal criteria and to systematic distribution of DPG (including possible exportation of semen and embryos) to breeders and producers under an organized selection, breeding and recording program designed for Kenya conditions.

The new DPG breed was "computer designed" for specifications that are optimal for western Kenya smallholder production based on net productivity of the flock (see "Systems" Project). These specifications are characterized by 40 kg body weight and 4.0 kg of milk at peak day of lactation for mature, unstressed does (coded as 40/4.0). In addition to these optimal selection criteria, the breeding program was developed to maximize heterosis retention and to emphasize adaptability. This plan included breeding four types of exotic-indigenous F1s (see chart next page). These F1s perform well, are well accepted and were distributed, as they became available, to other projects and breeders. The F1's are approximately 40/3.0 (unstressed mature doe body weight/peak day lactation, kg) whereas the composite synthetic is projected at 40/4.0 after selection. Doe testing and sire evaluation

programs (progeny testing) have been implemented for growth, milk production and internal parasite resistence/tolerance.

The goat facilities have been developed and considerably improved to provide very adequate AI, milking, other research facilities with a capacity to house, feed and collect data on approximately 1000 does. Construction has included barns, watering system, office and worker houses. The foundation flock of the four-breed synthetic composite is currently phasing into the inter se matings and, as the original indigenous and F1 does are phased out, will be brought up to approximately the 1000 doe capacity. Approximately 580 goats from the Breeding Project have gone to other SR CRSP projects with priority to the collaborative on farm testing based at Maseno. Approximately 130 F1 bucks have been distributed to breeders and producers.

The results of this project include:

Producing a new DPG breed foundation, a 4-breed synthetic composite

Developing genetic information related to the DPG population including heritability of production and reproduction characters and genetic aspects of disease/parasite tolerance.

Producing experimental goats for collaborative research with other projects

Developing information from experiments within the project for use in application by smallholders

Developing basic scientific information on optimal selection/breeding criteria for net worth, heterosis retention and

genetic parameters for sheep and goats. (Since this is basic scientific information, it applies in general to all species.) Results have been obtained and reported from all of the experiments except the haemonchus tolerance/resistance. Publications include 3 scientific journal articles and 26 bulletins, proceedings, progress reports or abstracts, 4 M.S. theses and 2 parts of Ph.D. dissertations.

Students directly sponsored by funds from this project include 1 B.S. and 4 M.S.; an additional 4 M.S. students conducted their research using data or methods related to this project.

Funds contributed by TAES to these projects were utilized to support relevant sheep and goat research. In addition, the large, active TAES Research Program related to sheep and goats contribute information and backup expertise for the TAMU SR CRSP Projects. At least ten persons of the Animal Science Professional Staff have primary responsibility for sheep and goats. The San Angelo Station is primarily devoted to sheep, goat and related research. In FY 87, total funding for TAES sheep and goat research projects was $4,594,785.

Inventory Of Goats At Ol Magogo - August, 1988*

East African, EA	253
Galla, G	316
Toggenburg, T**	7
Nubian, N**	1
Alpine, A**	2
T X EA F1	218
T X G F1	243
N X EA F1	85
N X G F1	81
A x EA F1	8
A x G F1	9
TN EA G 4-way	193
Other	82
TOTAL	1498

* In addition to the Ol Magogo flock, a flock of about 100 purebred Toggenburgs is maintained at the Ngeng Station and a semen bank is maintained at the Kenya AI Center.

** Bucks only.

SR CRSP KENYA BREEDING PROJECT FUTURE PLANS, 1988 ONWARD

Texas Agricultural Experiment Station, Texas A&M University System

The indigenous-exotic F1 crosses bred as interim steps in producing the new composite DPC have been productive and are popular with farmers. It is anticipated that the demand for the new breed will to be very strong. Pursuit of the primary objectives will evolve, in an overlapping sequence, as follows:

I. To complete the production of a sufficiently large number of 4-breed composites to be a genetically viable base for developing a new breed. This number is anticipated to reach several thousand but with no more than 1000 does at any one time; selection differentials will become increasing large to increase intensity of selection.

II. To select the 4-breed composite for breed establishment emphasizing:

a. Optimal weight/age or size of 40 kg mature doe - this weight has been currently attained.

b. Optimal milk potential of 4.0 kg peak day lactation - currently at 3.0 kg/day.

c. Adaptability to tropical production conditions, especially natural tolerance of internal parasites - currently in data collection phase.

d. All selection to evolve from only individual records to progeny and individual records.

III. To establish for private breeders programs of selection, breeding and recording criteria for the new DPG breeds. Also a nucleus breeding plan adapted for Kenya breeders will be designed and implemented.

IV. To distribute foundation stock for major multiplication. The foundation SR CRSP flock would be continued as a primary source of elite bucks for stud farms. Control of direction of breed development and herd-back data are absolutely essential. This is the most critical phase of the Breeding Project.

Secondary objectives will be:

I. To enhance effectiveness of AI and MOET procedures for application under Kenya conditions in order to more intensely select and effectively distribute the DPG breed. The potential for export of the DPG breed will depend on these techniques.

II. To utilize the DPG breed as a modern genetic resource in crossing and infusion programs to adapt it for

a. more intensive dairy production and

b. more extensive (semi-arid area) dual purpose production.

Egerton University and Kiboko Station locations have expressed interests in the "intensive" and "extensive" developments, respectively.

III. To collaborate with ILCA and/or other agencies and projects particularly on exploiting genetic variability for natural immunity to gastro-intestinal and hemoflagellate parasites.

IV. To provide a flock for basic data collection including growth, lactation, carcass/meat, disease, grazing behavior, nutritional and other data as the resource need becomes evident.

Training will emphasize at least one M.S. to continue to the Ph.D. level.

SYSTEMS ANALYSIS PROJECT

T. C. Cartwright, PI

H. D. Blackburn, Co-Investigator

F. Ruvuna, Resident Scientist, Texas A&M Univ., Kenya

S. K. Tallam, Collaborative Scientist, KARI, Kenya

The Systems Analysis project addresses three general constraints to livestock development in LDCs:

A. Transfer of scientific information and technologies to LDCs for practical application to sheep and goat production.

B. Transforming forage, nutrition and other local experimental data into precise quantitative projections of sheep and goat production.

C. Synchronizing changes in various components of the livestock production systems to assure enhancing the objective function of the total system; i.e., developing recommended sets of production practices (packages) for specific sets of physical economic and social conditions (i.e. specific areas).

With few exceptions, increasing offtake or efficiency of livestock production systems has been very difficult to accomplish in the United States because of the complex nature of production systems. The problems are exaggerated in LDCs because of lower levels of infrastructure, economic resources, communication, etc., but the opportunities are greater. In order to address the problems in the United States, a general trend of emphasis on whole integrated production systems has been recognized. The term usually applied to this

emphasis is systems analysis. The application of systems analysis is even more relevant for LDCs than for the United States. Texas A&M has been the leading institution in developing systems analysis for livestock applications; research was initiated under a U.S. AID 211d grant in 1973.

The key element in systems analysis is the simulation model. The first three years of the SR CRSP project devoted major effort to assessing the structure, characteristics and needs of the sheep and goat industries of SR CRSP host countries and designing, developing and programming an appropriate simulation model that would identify constraints and develop relevant solutions to them. A sheep model and a goat model have been developed, verified and validated. These models may be considerd as an accumulation and collation of existing research knowledge about growth, nutrition and reproduction of sheep and goats.

The past three years have emphasized collaboration with host counties and SR CRSP institution scientists in conducting simulated experiments and analyzing results. The simulations were designed to address specific areas.

Initially the Systems Analysis project was associated with all host countries (Morocco was not one of the initial host countries). This experience provided invaluable input resources for model development and contacts and perspectives for future applications. Activities were later concentrated on Kenya in order to make better use of limited funds. The Systems Analysis project utilized data from forage, nutrition and health projects. Data were available in Kenya from other sources (IPAL) whereas the projects in other countries

needed time to develop data bases. The SR CRSP projects in other countries have now accumulated sizable data banks.

As a result of the SR CRSP Systems Analysis project research, collaboration has been requested from KALRES (Formerly IPAL), ILCA, Cooperative Arid Lands Agriculture Research Program (Egypt and Israel), CIAT (informally to date) and a number of individuals at LDC institutions.

Research Accomplishments

Model Development

A sheep model and a goat model have been designed, developed, programmed verified and validated. The models are biololgically (cause and effect) based, comprehensive and dynamic. Either single animals or flocks may be simulated. Appropriate forage, animal and management input parameters are required to simulate a specific environment. The simulations emulate the response (performance) of a real flock placed in the given environment. All of the usual performance (growth and reproduction) values that are usually measured on a real flock are simulated.

Therefore the simulations are executed as designed experiments; i.e., experiments are simulated to test effects of varying single practices or sets of practices. The simulated data are first analyzed biologically as traditional animal production research data. The data are complete and the output is in convenient form for use by economists. Economic analysis is the major responsibility of the economics project or host country economists, but it is a joint effort involving planning, execution, analysis and interpretation.

Just as simulated data are "fed up" to economics, data are "fed back" to nutrition, health and forage projects for use in planning and interpretation. Again this is a joint effort from beginning to end.

The models and their uses have been described in detail in Texas Agricultural Experiment Station Bulletin B1559.

Results of various simulation experiments are grouped and summarized below. One of the most significant results that is not immediately evident is the feedback to projects supplying data for simulations. In every case of interaction, these projects have been modified on the basis of the systems analysis results. The importance of this feedback can be put in proper perspective by examining the systems analyses and then examining the resulting changes made in the collaborating projects (which are not reviewed here).

SIMULATION OF NOMADIC SHEEP FLOCKS IN NORTHERN KENYA IN COLLABORATION WITH IPAL(KALRES)

In the early phase of the systems analysis project links were established with the Integrated Project in Arid Lands (IPAL) in Kenya. Areas of cooperation centered around IPAL providing data for validation and the Systems project analyzing and validating with IPAL data and performing experimental simulations. At the initiation of studies no SR CRSP project had data suitable for validation. Having a well collected data set available to the systems project reduced the time of model implementation and application.

The simlations performed examined the effects of genotype, drought and controlled breeding season. Production of 9 genotypes were evaluated through the drought and recovery years. The drought served as a means of separating performance levels and recovery rates of different genotypes. The simulations indicated that a larger bodied sheep (45 kg), but with an increased milk production potential could be utilized in the IPAL study area and that it would produce more than the other genotypes tested, in terms of both milk and meat offtake. The simulation of different years provided useful insight as to how flocks respond to drought and recovery years, in terms of reproduction, deaths and performance levels. Perhaps of equal or greater importance is how the flocks respond during recovery since this determines when and how much the pastoralist can depend upon his flock for food. For a one year drought, the recovery time for most characters was 2 years for most genotypes. Several genotypes were ill-suited to this environment and as a result they never recovered from the drought.

The results obtained are a function of a specific sequence of years; for different drought situations the results could vary. However, the advantage of systems analysis is that different scenarios can be simulated and a response derived.

A management option IPAL wanted to incorporate into the production system was a controlled breeding season. Simulations were performed with a varying number of breeding seasons per year and of varying lengths. In no instance was a controlled breeding season superior to the continuous breeding season.

The IPAL project has changed its name (to Kenya Arid Lands Research Station, KALRES) and emphasis (from research to extension and application of research findings). They are continuing to apply the information obtained from the simulations in that they are now going to field test larger sheep in the nomadic production system. The KALRES project will continue monitoring their livestock in such a manner that it can be used for validation and model input. The KALRES group has expressed an interest in continuing the collaboration with the SR CRSP Systems project in that they would like to perform a similar set of simulations with goats.

DUAL PURPOSE GOAT POTENTIAL IN WESTERN AND NYANZA PROVINCES

The research goals for the simulation model have been:

1. To determine production potential of Dual Purpose Goats to smallholder production conditions in Western and Nyanza provinces. Using the model in this manner can be thought of as a substitute for conducting production experiments; i.e., the effect of different treatments have been quantitatively estimated by simulation rather than by live animal experiments that otherwise would have been impossible.
2. To determine the inputs (nutrition, genetics and management) required to obtain a required level of production.
3. To identify the critical constraints to the small holder production systems and quantify the specific effects.
4. To evaluate the effects of practices available to the small holders by examining the effects of potential perturbations, such as droughts, on recommended practices; i.e., to determine the optimal set of practices for the smallholder farm areas where the Dual Purpose does are milked and the effect of some practices being neglected or otherwise failing.
5. To generate input and output data for use in economic analysis of various sets of practices for given smallholder farm areas.

The following summary of results cover 1982-1987 DPG simulations, recommendations and changes effected after presentation of results from simulations.

A. 1982-83 Results

The systems analysis project made preliminary simulations to gain experience and to familiarize the integrated team of SR CRSP with model input requirements and output data.

The feed resource (forage production) project approximated the amount and quality of forage that could be produced by a smallholder farmer in Western Kenya for use in feeding goats. These data were used as the feed input parameters for a series of simulations.

Problems examined:

1. What level of dairy goat production will this resource support? The approach taken to initiate a series of simulations to answer this question was to examine does introduced onto the farm and kidding at equally spaced intervals. The does initially simulated were considered to be representative of Toggenburg x East African first crosses.
2. The problem of seasonal fluctuation in both amount and quality of forage (limited feed in dry season vs excess feed in wet season) produced in Western Kenya was also examined. The arbitrary decision was made to assume that a portion of the forage produced in three peak months could be shifted to the next month with some loss in amount and quality. The

simulated results of shifting of forage resource led the forage and management project to evaluate methods of storing forage (e.g., bailing box).

Summary of Findings

1. After several studies, it became evident that six does kidding at 2-month intervals could be supported; that is the simulated intake data of the six does never exceeded the amount available by any substantial amount.
2. Shifting feed to increase feed available in the dry months had marked effects.
3. Amount of milk available for family use out of the 6 does throughout the year was quantitatively documented. Roughly, 1 kilogram per day minimum was available on a regular basis. If it is assumed that, as human nutritionists recommended, a minimum of one cup (approximately 200 grams) per person (regardless of age) was consumed, 5 persons could be supplied minimal milk from a flock of six does on a regular basis. Viewed differently, the limits to which small flocks of dual purpose goats can contribute to human nutrition of large families was vividly illustrated. Alternatively, counseling toward judicious use of the available milk especially for young children and lactating women was indicated.

B. 1983-84 Results

I. Optimal Practices For Dual Purpose Goat Production In Western and Nyanza Provinces.

The general objective was to simulate a self-sustaining small farm flock of Dual Purpose Goats in order to examine production constraints and potentials. An initial step toward attaining this primary objective was to simulate four genotypes utilizing two types of management (single purpose - meat only, and dual purpose - meat and milk) given a specific set of forage values considered as reasonable estimates for the Maseno area. The single purpose practice (meat only) was to test viability of the given genotype within the system. The addition of the dual purpose treatment increased the stress load for both does and kids and was applied only after screening with the single purpose treatment.

The second step toward producing a self-sustaining farm flock was to choose a target, or an "optimal" genotype based on criteria of productivity from the previous dual purpose simulations. The target genotype was then simulated utilizing known forage parameters from the Siaya and Kakamega districts. As a result of the simulations, additional forage interventions, designed to increase the quality and/or quantity of the diet, were also simulated for each district.

Experiment 1. Viability of Goats of Different Genotypes in the Maseno Area, (three phases)

Phase 1 Objectives:

a. To examine doe viability of different genotypes for size

(growth) and milk production.

b. To successively select genotypes, based on viability of the previous simulation results in order to approximate an optimal genotype.

Phase 2 Objectives:

a. To examine viable genotypes screened from phase 1 for net productivity in dual purpose production.

b. To successively select genotypes based on net productivity in dual purpose production in order to generate a set of data on which the breeding project could base selection of a target, or optimal, genotype with acceptable viability and maximal net productivity.

Phase 3 Objectives:

a. To examine viability and net productivity of the selected target genotype screened from phase 2.

The production levels and the improved minimum body condition of the 40/4.0 goat (genetic potential for 40 kg weight and 4.0 peak day milk of a mature doe not nutritionally stressed) suggested that the genotype was more nearly optimal than other genotypes tested. Therefore the 40/4.0 became the target genotype for the Breeding Project in the development of the DPG.

Experiment II. Viability of Dual Purpose Goat Production in the Siaya and Kakamega Districts Using Stored Forage

Objectives:

1. To further examine viability and net productivity of the

target genotype utilizing different sets of forage parameters.

2. To compare viability and net productivity utilizing standing vs stored reserve forage.

Results

1. The Kakamega district, based on estimated forage production, could not support six does per farm unless feed storage was practiced.
2. The Siaya district farm could support six does without feed storage, but productivity was increased through the use of a storage intervention. The use of a feed intervention in Siaya increased the number of kids, total weaning weight and minimum doe body condition. Milk production per lactation was lower, but this was offset by the increased frequency of lactation.

Experiment III. Productivity of Dual-Purpose Goat Flocks in the Siaya and Kamega Districts Using Stored Forage and Sudan Grass as a Supplement

Objectives:

1. To compare viability and net flock productivity utilizing local feed resources, standing vs stored, and the effect of adding a small quantity of high quality forage as a feed supplement.
2. To characterize dual-purpose flock viability, net flock productivity (including dairy milk and kid sales) utilizing

local feed resources, stored and stored plus supplement.

Summary of Findings

1. A dual-purpose goat bred for a genetic potential of 40 kg body weight at maturity and a peak-day lactation of 4.0 kg milk, appeared optimal for producing under the restricted nutritional conditions of smallholders. Simulated body weights approached 40 kg during some times of the year and peak dairy milk production was approximately 1.5 kg.
2. The replacement policy mitigated doe productivity in the later years of simulation. Replacing does as needed with weaning age kids did not insure continuity of flock structure. Maintaining flock structure is an integral part of maintaining production levels; therefore other replacement provisions must be made to insure productivity. One provision tested that proved to be successful was to hold weaned doe kids until they are one year of age before sale so that they would be available for more immediate introduction to the breeding flock.
3. In Siaya total milk production and dairy milk production increased with increases in feed quantity (storage) and quality (supplementation). Dairy milk production increased 14% with an increase in feed quantity, while an increase in feed quality (supplementation) resulted in an increase of 22%. The use of a feed supplement also had the effect of stabilizing milk production levels throughout the year. Little effect of supplementation was evident in the weight

of kids sold.

4. In Kakamega, dairy milk production increased by 27% with the increase in feed quality. The yearly peaks and troughs of milk production were also stabilized with increased feed quality. Kid weight sold increased by 88%, which in turn increased total weight sold by 36%.

5. The simulations associated with objective 2 test the dual hypothesis:

   a. Dual purpose goat production is a viable enterprise for the small farmers of this area.

   b. The feed resources assumed are adequate for viable production.

The results support the acceptance of this hypothesis (which had been assumed previously, but was untested).

Some of the many questions that these results suggest are:

a. Is the storage of feed feasible? Is it an economic practice?

b. Is a small plot of dedicated land for forage production, such as Sudan grass or other forage a feasible approach to, augmenting feed quality?

c. What amount of dairy milk is required to make dual purpose goat production attractive to smallholder farmers? That is, what is the minimum number of does required per farm for economic viability? What is the minimum amount of dairy milk? What is the importance of a steady milk supply?

C. 1984-85 Results

I. Breed, Nutrition and Milk Extraction Effects on Weaning Weight and Milk Production

The impetus for this study was to generate information concerning the inputs an outputs, in terms of amount of feed consumed and offtake of meat and milk, of a dual purpose goat production system in Western Kenya. The simulation experiment utilized a 3x2x2x4 factorial design (breeds x location x nutritional regimens x miking practices for a total of 48 simulations). The three breeds were East African, Galla and dual purpose goat (DPG). The DPG is curently being developed by the SR CRSP Breeding project. The two regions were Hamisi and Siaya. Two nutritional regimes were simulated, these are referred to as: Base and Sudan grass with supplementation of pigeon pea forage. These estimates were predictions of the volume and quality of forage a farm could produce in one year, with no new technology introduced and with the integration of Sudan grass and pigeon pea into the cropping system. The four milking practices were: (1) unlimited access by the kid to its dams' milk and remainder, if any, for dairy; (2) kid takes 1/2 of the milk and 1/2 for dairy, throughout lactation; (3) kid consumes a maximum of .5 kg milk and the remainder, if any, for dairy; (4) kid consumes a maximum of .3 kg of milk and the remainder, if any, for dairy. Dairy is used here to refer to milk taken for family use or sale. The rationale for the last 2 treatments was that at some point in lactation the farmer will consider the amount of dairy milk produced not worthy of the labor required for milking, thus he will leave the total amount for the kid.

Traits evaluated for each set of alternatives examined were kid

weaning weight, kid milk consumption, dairy milk produced and feed consumed (in terms of dry matter intake). The forage parameters utilized for simulation were derived from forage production and quality analyses reported by the SR CRSP forage project for Hamisi and Siaya.

A second portion of this experiment was the evaluation of doe nutritional deficits for the DPG. This evaluation consisted of examining the fraction of maintenance, growth, lactation and gestation that was not met and the influence the deficit had on the doe's milk production compared to her potential. An additional simulation was performed which consisted of an improved diet (ID) which was designed to allow the doe to produce milk at her potential. The ID was composed of 15% protein and 68% digestibility and it replaced the base diet 2 months prior to parturition (4 periods) and lasted 3.5 months (7 periods) after parturition, after which time the base diet was resumed.

Summary of Findings

1. Incorporation of Sudan grass and pigeon peas into Base diet:
    a. Increased weaning weight by an average of 1.4 kg, 12%
    b. Increased total milk produced by an average of 21.3 kg, 28%
    c. Increased dairy milk yield by an average of 10.5 kg, 38%
2. DPG, compared to Galla and EA:
    a. Weaned heavier kids for all milking treatments, 19- 33%
    b. Produced more total milk, 48- 84%
    c. Produced more dairy milk, 82-166%

d. Had a longer dairy lactation period, 12- 27%

3. The .5 kg milking treatment appears to be near optimal, balancing kid weaning weight, total dairy milk and dairy milk yield per day.
4. The .3 kg milking treatment yields more dairy milk but kid weaning weights were unacceptably low.
5. Base and base plus sudan grass and pigeon pea diets both limit milk production potential of does because of insufficient energy and, to a lesser degree, protein.
6. Does produced almost to potential on an assumed higher quality "improved diet" (ID). The biological and economic feasibility of providing a diet approaching the assumed ID should be investigated.

II. Feasibility of Dual Purpose Goats for Small Farms of Western Kenya; A Systems Analysis of Meat and Milk Offtake Potentials and Limiting Factors

A genetic potential 40/4.0 kg for size and milk production was simulated as an optimal level for the breeding goal of an Kenyan DPG. The 40/4.0 represents genetic potentials used to characterize the DPG. The technology package simulated assumed that a joint (meat and dairy production) product was the goal of the small holder. Kids have first priority on milk production. If kid body condition falls below 75%, no milk is extracted from its dam for dairy purposes. If body condition is adequate, then half of its dam's milk production goes toward dairy production.

Another integral part of the current simulations is the assumption that Kenyan smallholders would be subsidized in the acquisition of two does; these farmers are expected to build up their respective flocks from the offspring of these two does to a specified farm flock size. The farm flock size is the main element examined in this set of simulations because of the concerns about the farm flock size necessary to meet minimal goals for family nutrition and economic viability, as well as the forage production required to sustain the flock.

Forage parameters were obtained from the estimates published by SR CRSP forage/production systems project for the Hamisi area. Availability of forage was essentially unrestricted.

Sudan grass and pigeon pea forage were added to the base feed resource to make up a second set of forages. Sudan grass and pigeon pea were designated "dedicated" forage in the sense that land must be set aside specifically, even if intercropped, to produce the higher quality sudan and pigeon pea may also provide food for the farmer.

The use of Sesbania as a selective feed supplement was also examined. If body condition of any individual fell below a minimal level required for viability, dried Sesbania leaves were made available at the rate of .5 kg/day to that particular doe or yearling. Digestibility percentage, supplied by the Management Systems Project, was assumed to be 72% and crude protein 22.1%.

Summary of Findings

Simulations using the Kenya Goat Production Systems Model support the following conclusions.

1. Sudan grass and Pigeon pea added to the basee forage, dramatically increased dairy milk (68%) and sale liveweight offtake (61%) by:

   Increasing the number of does lactating at any time

   Increasing dairy production/doe

   Increasing weaning weight/kid

   Increasing yearling weight/kid

   Increasing net doe fertility

   Decreasing mortality

2. Base forage plus Sesbania supplement can be substituted for sudan grass and pigeon pea to improve the base forage, with comparable DPG production.

3. A goal of producing 225-250 grams of mik per day for every man, woman, and child of an average farm household can be met by a 6 doe flock on improved forage.

4. An interim DPG of 40/3.0 is a viable alternative to 40/4.0. Development of a Kenyan DPG can proceed on an interim grading up basis with little loss in flock productivity.

FEEDBACK RESULTS

The Use of Simulation Results By Other SR CRSP Collaborating Projects is not reviewed here, but is summarized as follows:

1. After quantifying the importance of shifting feed to increase feed available in dry months, the feed resources project initiated experiments on conserving feeds (hay making).

initiated experiments on conserving feeds (hay making).

2. The simulations showed that it was not the feed quantity that was limiting but feed quality, in particular quality of energy, not protein, was the most limiting. Feed Resources Project has introduced other forages (sesbania, pigeon pea, sudan grass and sweet potatoe vines) in their research.
3. Simulations results on kid rearing showed .5 kg milk per day/kid was optimal. Production Systems is experimentally testing these results and are coming up with similar results.
4. Simulated data from kid-rearing strategies are being processed for economic analysis to determine the most viable economic strategy.
5. Optimal growth and milk potentials that could be sustained were simulated to be 40 kg mature weight (and associated growth) and 4.0 kg/day mature milk (peak day). The Breeding Project has now established breeding and selection criteria for the DPG as 40/4.0.

D. 1985-86 RESULTS

I. Optimal Genotypes for Morada Nova Sheep in Northeastern Brazil.

Objectives:

1. To test and extend the use of the sheep simulation model to a new environment and a new breed of sheep.
2. To use the simulation model to determine the selection criteria for the Morada Nova breed.

Summary of Findings

The model was successfully validated for this production setting using the base genotype of 40 kg mature size, 1.5 kg peak milk production, and 2.2 ovulation rate. It was estimated from data of other projects that these genetic parameters were representative of the Morada Nova breed. Experimental simulations were then performed to evaluate the impact of altering these different genetic parameters. The genetic potentials evaluated in a 3 x 3 x 3 factorial design were 30, 40 and 50 kg mature size; 1.125, 1.5 and 1.875 kg for peak milk production; and 1.65, 2.20 and 2.75 ova per ovulation.

Results showed annual eficiency of meat production for flocks in northeastern Brazil (total liveweight sold: total weight of dry matter consumed) increased when genetic potentials for ovulation rate and milk production were raised from the base, but decreased with increased genetic potential for mature size. The most efficient genotype was a mature size of 40 kg, peak milk production of 1.125 kg and an ovulation rate of 2.75; and a mature size of 30 kg, peak milk production of 1.5 and an ovulation rate of 2.75. Genotype with 50 kg

mature size were not present in the genotypic combinations ranking above the base genotype.

II. Effects of Early Weaning Kids for Dual Purpose Goat Production in Western Kenya.

Objectives:

1. To investigate the efects of early weaning on kid growth and identify early weaning practices that are biologically viable for the western Kenya smallholder's forage resources and management.

Summary of Findings

Five kid weaning practices were tested (30, 60, 90, 120 and 150 days of age) with three forage regimens (base, improved and ideal). Weaning less than 90 days of age resulted in critically low weaning weights for all three forage regimens and had significant carry over effects when yearling weights were examined. Weaning at 90 to 150 days resulted in an approximate increase in weaning weight of 2 to 3 kg for each time increment. Diets did not alter weaning weights within weaning age treatment, but did create differences at 1 year of age.

Dairy milk offtake increase with improved forage regimens (156% between base and ideal for weaning at 30 days). As time to weaning increased dairy milk production decreased from 14 to 35%.

These results indicate that smallholders have a range of ages to

wean their kids (90, 120 or 150 days). Their management can therefore be altered as the sale price differential between dairy milk and kids occurs.

III. Viability of Dual Purpose Goat Production in Western Kenya

Objectives:

1. To evaluate DPG productivity when flock sizes are altered (4, 5, or 6 head of mature does).
2. Alternate genotypes are evaluated; mature size 40 kg, genetic potential for peak milk production 3.0 and 4.0 kg.
3. To alter nutrition from base to base plus stored forage.

Summary of Findings

The simulations reults show that for the program to be viable the following are required:

1. A forage program that will increase forage quality throughout the year.
2. Management which provides sufficient care to permit individual supplementation of does.
3. Genetic potential of 40/3.0 is acceptable and should be increased to 40/4.0.
4. A flock size of 6 mature does fed a base-plus diet is required to meet minimum amounts of milk for Western Kenya families. With a flock of 6 does milk production can drop to zero for 2 months in a year. The 4 doe flocks can drop to zero for 5 1/2 months during a year.

Results 1986-87

I. Simulation of Genetic and Environmental Interactions of Three Tropical Hair Sheep Breeds for Meat Production (Brazil)

Objectives:

1. To compare the performance of three breeds of sheep when supplemented at three different levels and two different types of supplementation.
2. To compare three breeds of sheep and two quantities of supplement (200 g/day and 400 g/day).

Summary of Findings

The three levels of nutrition supplementation used were: Basic (200g/day in January, February, October, November and December), Basic plus supplementing lactating ewes in March, and Basic plus supplementing lambs in September. Two types of supplement used were napier grass and cunha legume.

The results of the simulated experiments indicated that the most critical factor limiting performance of the simulated flocks was digestible energy, and not protein, in the dry season. The simulation also showed the need for supplementing lactating ewes at the beginning of the lambing season. Both napier grass and cunha were shown to be a good source of supplementation yielding approximately the same result. Therefore, choosing which supplement to use is an economic decision and a question of availability.

Increasing the amount of napier supplement from 200g/day to 400g/day resulted in an appreciable increase in productivity of the

simulated flocks. However, the reactions of the different breeds were not of the same magnitude, which is an indication of an environment by genotype interacton. The Brazilian Somali was found to be less responsive to nutritional changes of supplementation than the Santa Ines or the Morada Nova. This buffered response is related to the fact that the Brazilian Somali is a fat rumped breed with a smaller size than the other two breeds.

The simulations indicate that none of the breeds evaluated were superior in all the environments tested. Thus, considering the wide range of environments, including the resources of individual farmers, each of these breeds has a role to serve. Clearly the choice of breeds depends, in part, on forage availability. In areas with above average forage production Santa Ines has the highest level of productivity. In harsher, more arid areas, the Brazilian Somali has a higher level of flock productivity. Finally, the Morda Nova is expected to perform well in most areas if moderately supplemented.

II. Simulation of the Effects of Parasite Infestation on the Performance of Goats in Northeastern Brazil.

Objectives:

1. To evaluate model response when the parasite component is used.
2. To design effective drenching strategies for Northeastern Brazil.

Summary of Findings

Four drenching patterns were tested using the simulation model:

1) control, in which no drench was given; 2) the recommended drench, in which drench was given 4 times per year; 3) a wet season drenching policy, in which drench was given 3 times per year; and 4) a modifiction of the recommended drench in which the goats would be drenched 4 times per year. These four drenching patterns were evaluated in years with a normal worm burden and a drier year which resulted in a lighter worm burden.

Simulations were performed to evaluate the performance of a doe from 6 months of age to 3 years of age. These does were allowed to reproduce and evaluations were done on does with singles and twins. The simulation results indicated that during the normal wet years the wet season drench and the modified 4 times per year drenching programs were the most successful in increasing kid weaning weights. In the drier year, the modified 4 times per year drench was the most successful at increasing kid weaning weights, while the recommended drench and the wet season drench responded in a similar fashion.

These experiments inspired Brazilian scientists to re-evaluate their drenching programs and to initiate, in collaboration with the Breeding/Systems Project, live animal experiments to further test model assumptions.

III. Corriedale Sheep Production Supplemented with Ryegrass Pasture in Southern Peru.

Objectives:

1. To evaluate flock performance when different classes of

sheep are supplemented on ryegrass pastures for varying lengths of time.

2. To determine the feasibility and advantages of breeding ewe lambs.

3. To perform economic analysis on simulation results to determine the profitability of simulated results.

Summary of Findings

Previous experiments have concentrated on using ryegrass pastures to finish lambs. Questions remained as to the use of these pastures for other classes of sheep. Therefore, the Range Science Project component collaborated with the Systems Project in designing a series of simulations to address if flock performance would vary when sheep would graze tame pastures. Groups of sheep supplemented were: breeding ewes prior to and during breeding; weaned lambs for 3, 5 or 7 months; the entire flock for 3 months during the driest time of the year.

Generally, supplementation increased reproductive rate, offtake per ewe and sale weight. However, these increases were not always translated into increased biological efficiency or profitability. When ewes were bred as yearlings only supplementation for 7 months was more profitable than the base treatment. Profitability of ryegrass supplementation increased when ewe lambs were bred; with the 7 month supplementation being the most proftable ($61.40 per 100 hd over yearling base treatment).

IV. Simulation of Ranching and Smallholder Goat Production Systems in Botswana.

Objecives:

1. To determine if goat productivity can be increased by altering breeding season.
2. Comparison of Tswana and Boer breeds.
3. To establish optimal levels of supplemental feeding and milk extraction policies for smallholder flocks.

Summary of Findings

In the ranching scenario both Tswana and Boer goats were evaluated when breeding seasons were altered (moved from October to September or August) and 2 and 3 breeding season per year were tested. For both breeds by moving the breeding season to August, productivity could be increased; however, it was found that preweaning mortality did increase with the August breeding season. By imposing twice a year breeding season or three kiddings in two years, reproductive performance increased and total flock productivity was enhanced; by increased number of kids sold per doe, average weight sold and biological efficiency. In all of the multiple breeding seasons tested no flock reached a state where equal proportions of does mated in each of the breeding seasons. This was due to the fluctuating forage conditions.

Simulations for the smallholder production system evaluated the use of local forage, Dolichos lablab, as a supplement for lactating

does (.25 and .50 kg/day) and for lactating does (.25 kg/day) and nursing kids (.15 kg/day). Milk extraction policies were to take 1/2 or 1/4 total milk for human consumption. Smallholders currently practice a continuous breeding season; this situation was simulated as well as breeding only in August and February.

Based on efficiency of meat and milk production the top ranking 4 practices were:

Rank	Breeding Season	Milk Extraction	Supplementation
1	Twice/Year	1/2	.5 kg lactating does
2	Continuous	1/4	.25 kg lactating does
3	Continuous	1/2	.25+.15 lactating does and nursing kids.
4	Twice/Year	1/4	.25 kg lactating does.

The diversity of alternatives is encouraging because it implies that smallholders with varying levels of resources and management skills will have the opportunuty to increase their goats' productivity.

V. Potential Productivity of Intensive Smallholder Goat Dairies in Western Kenya.

Objectives:

1. To investigate the potential of smallholder dairies from a biological and economic evaluation.
2. To determine the impact of altering genotype on performance, land resource base and altering price structures for milk and goats.

Summary of Findings

In this series of simulations the smallholder would dedicate his farm to goat production. On it a larger flock size of goats would be kept (we used a flock size of 50 mature does). Crop production on such a farm would be geared to producing forage for the goat herd. In this scenario nutritional limitations would be relaxed, therefore, it was of interest to evaluate goats with increased potentials for mature size (44, 48 and 52) and milk production (4.5, 5.0 and 5.5) to the previously selected DPG whose potential is 40/4.0. Farm sizes from 2 to 7 ha were evaluated. Prices received were varied for both milk and animal sales. The simulations indicated that the DPG being developed by the breeding project to be almost as productive, and more robust, than dairy goat breed types 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. The income from various price/cost scenarios tested were of sufficient magnitude, 1,000 to 10,000 KSh/ha, to encourage further economic analysis and development research to explore the feasibility of goat dairies as an alternative to traditional crop production for some farmers.

Simulation Methodology

This section of the report is meant to provide insight as to the procedures used in implementing the sheep and goat simulation models. Before experimental simulations are performed in a new location, the model is validated for that environment. Validation compares model behavior to actual data collected on sheep or goats. Performance characters used in validation include mature female body weights across time, growth patterns of young animals from birth to one year of age, reproduction, mortality and milk production. In setting up the model for validation the genotype, forage resource and management practices currently used in the production system are specified to the model. We use a criteria that the model must simulate within a 95% confidence interval of the actual data before we are satisfied with model performance. Once the model has simulated animal performance within the confidence interval, experimental simulations are started. Determination of which experimental simulations are performed is based on the interests of collaborators and the systems project. A good example of this was the collaboration between Texas Tech Range Project and the Systems Project. The Range scientists were interested in examining potential uses of ryegrass pastures and the Systems Project overlapped that interest with the interacting effects of breeding ewe lambs.

Conceptually this method of operation can have far reaching implications for the entire SR CRSP. Many of the CRSP projects have collected baseline data. The problem foreseen with these data is that they were collected under one specific set of conditions.

We have no basis to assume these results are global; that is, within a country as locations and management expertise change the results from controlled experiments may not be valid. However, the simulation models can fill this void. By using the data generated by SR CRSP projects for validation the simualtion model can then be used to explore different genetic, management, nutritional and health alternatives. In addition, with the simulation models it will be possible to examine production systems under a much more complete range of alterantives. That is, such factors as drought effects or increased challenge in worm burden could be evaluated. By adding economic analysis and sociological evaluations it would then be possible to generate a robust set of technology packages.

RESEARCH ACTIVITIES 1988-1990

Systems Analysis will evolve in relevance and application in the SR CRSP as:

1. The field of system analysis matures in agriculture and experience in application is gained with collaborating projects and ME and EEP mature in this area.
2. Additional data from projects accumulate (data are expected to become more and more relevant as a result of systems analysis feedback to projects).
3. Host country personnel trained and experienced in systems analysis become available on site along with appropriate computing facilities.
4. Model modifications to facilitate both user ease and simulation accuracy accumulate.

The application of systems analysis can shift from site to site with relative ease. Also, if forage data are available, collaboration can be established with scientists outside of the SR CRSP (e.g. International Agricultural Centers). Therefore it is anticipated that the Systems Analysis project will establish use of systems analysis in some locations and to conduct analyses in other locations or both. In either case, at least a consulting relationship should remain intact.

One false impression is that a proper systems analysis can be run with a set of data similar to a statistical analysis. At least 30 days of an experienced person are required to obtain a baseline (validation) for a specific area. Another 30 days is minimal time to run a set of relevant experimental simulations. Another misunder-

standing is that the model(s) can be shipped to anyone with computing facilities and they can run it. A 90-day training period is required to understand the basis of model structure, operation and input/output format.

The major activities are:

1. Kenya.
   a. Integrate dual purpose goat production into other areas (high and medium potential and arid).
   b. Examine meat goat and sheep production to identify constraints and develop production packages.
   c. Collaborate with ILCA projects in Kenya.
   d. Collaborate with KALRES project in Kenya.
   e. Develop biological model component for trypanosomiasis and haemonchosis.
2. Peru.
   a. Continue to examine effects of range management and breeding practices on total productivity.
   b. Develop packages of recommended practices and implementation policies for small holders. The production problems of Peru small holders are almost impossible to adress directly. Research data from Coops and SAIS can be used via systems analysis to address these unique problems.)

Brazil.

Systems analysis expertise should be readily established (within 2 years) in Brazil due to facilities (computers) and trained personnel. Therefore the role will be mostly consulting, updating

updating model, trouble shooting. The collaboration will be two ways.

Botswana and Southern African Center for Cooperation in Agricultural Research (SACCAR)

To examine the impact of crossbreeding systems, parasite burden and drought recovery on ranching and smallholder production systems.

Indonesia

Examine the more or less unique problems of cut-and-carry systems to identify constraints and develop packages of practices to overcome constraints. (This system is relatively easy to work with and combined with the social structure, offers some unique opportunities for large increases in productivity.)

ILCA, CIAT, KALRES, Copperative Arid Land Agriculture Research, BARD

It is anticipated that funding for complementary research and development will be developed from these sources.

Training.

It is anticipated that a Sytems Analysis training center at Texas A&M Will be developed from SR CRSP and complementary research/development programs. Such a center would increase the transfer of this technology.

Appendix A

Publications Of The TAMU SR CRSP Projects*
September, 1988

Breeding:

Journal Articles

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Appendix B

Annual Report
1986-87

Title: Systems Analysis And Synthesis Of Small Ruminant Production Systems

PI: T. C. Cartwright

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

Host Country Institutions: Kenya Agricultural Research Institute
INIPA, Peru
EMBRAPA, Brazil

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E.A.P. Figueiredo, Director of Research, CNPC, EMBRAPA
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H. D. Blackburn, Co-investigator, Research Scientist, TAES
F. C. Bryant, Professor, Texas Tech University
F. Ruvuna, Resident Scientist, Kenya, TAES
E. L. Lentz, Graduate Assistant, TAES
P. J. Howard, Graduate Assistant, TAES

Research Results:

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

Peru Systems Analyses

Discussions with the Range Science component of the Peru CRSP indicated a need to know how sheep would respond to various ryegrass supplementation practices; i.e., how to translate forage research results into optimal use by sheep. With forage data collected by Texas Tech as input parameters for the sheep simulation model, we simulated how various supplementation practices, using ryegrass pastures, would affect biological and economic aspects of sheep production on the Altiplano. Of major interest was how or if sheep should be supplemented in the dry season. Additional simulations were performed to determine how breeding ewes as lambs would affect the production system. Major results of the study showed that supplementing the flock in the dry season was not beneficial biologically or economically; the net return for such practices lost from $14.50 to $52.10 per 100 head of sheep. Lambs sold per ewe and lamb weight sold per ewe were lower when ewes were first bred as lambs, but this adverse effect could be more than overcome by supplementing ewe lambs under one year of age from April through October. This simulated experiment indicates that a profit of $53.30 per 100 head of sheep could be achieved (Blackburn, Cartwright and Bryant, 1987). This study illustrates two general points. First, it is an example of the application of systems analysis to utilize information from a specific discipline and extend it to examine practical animal production problems. Also, it illustrates how two (or more) practices can be integrated and evaluated to develop technology packages.

Brazil Systems Analyses

Two separate simulation studies were conducted in Brazil. The objective of the first study was to evaluate different drenching strategies in years with normal or below normal rainfall. Of major concern was to determine if one drenching pattern was sufficiently robust to keep parasite burden low in years of different rainfall patterns. Precipitation has a major impact on parasite load. Levels of parasite infestation were obtained from CNPC scientists. Four treatments were compared by simulation: 1) control (no drench); 2) recommended drench (RD; drench in March, June, August and December); 3) wet season drench (WSD; drench in January, March and May); and 4) four drenches per year (4D; March, April, June and December). The model simulated the performance of a doe and her offspring for 3 years within a particular rainfall pattern. The major finding of this study was that in years with average rainfall the RD and 4D treatments resulted in equivalent livestock performance; however in a drier year the 4D treatment produced kids which had a heavier weaning weight. Therefore,

the 4D treatment would seem to be equally robust but with additional advantages and should be considered as the recommended practice instead of the RD treatment.

The second simulation study was part of a dissertation (Rajab, 1987). These simulations compared how Santa Ines, Morada Nova and Brazilian Somali would respond to different levels of supplementation of different types (Napier grass and Cunha). The analysis showed, in quantitative terms, that digestible energy was a critical factor limiting performance in the dry season. The simulations also showed that if given higher level of nutrition, the Santa Ines can be the highest producing of the 3 breeds tested. The Brazilian Somali responded least to supplementation but tended to be more productive in drier forage conditions. The Morada Nova is the breed of choice if moderate amounts of supplementation are provided.

Kenya Systems Analyses

Simulations for this SR CRSP site are continuing to focus on problems that smallholders in Western Kenya face when engaged in goat production. Because the milk of each doe is to be divided between use by humans and kids, it is critical that kids receive adequate milk to assure an appropriate level of growth. Therefore, it was of interest to determine how kids would respond if weaned at 30, 60, 90, 120 and 150 days of age under 3 different levels of nutrition. It was assumed that kids were allowed to take up to 0.5 kg of milk per day. With base forage (forage normally available to the farmer) weaning could not be practiced at less than 150 days of age. With improved levels of nutrition, weaning could feasibly be done as early as 90 days of age. Because milk intake for the kid is limited (0.5 kg/day), improving nutrition did little to increase weaning weight; however yearling weights were increased approximately 100% and milk production increased from 30 to 144% (Tallam et al., 1986).

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

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

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

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

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

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

** Cross-listed with the Breeding Project.

Training:

A Workshop on systems analysis and use of The Texas A&M Sheep and Goat Models for Simulation was held in August, 1986.

Participants were:

Wolfgang Pittroff, Univ. of Hohenheim, F.R.G.
(Applications are intended for Peru and Mali)
Carlos Fierro, Mexico
(Worked in Peru on Texas Tech Range Project)
Mario Beffa, Zimbabwe
A. Eddebbarh, Morocco
Fabian Pagama, Tanzania
P. J. Howard, U.S.
E. L. Lentz, U.S.

Individual tutorial instruction on model structure, functions and use took place in U.S., Kenya, Peru and Botswana.

H. M. Rajab, a citizen of Syria, completed his Ph.D. in August, 1987 using breeding data from SR CRSP in Brazil to simulate sheep selection programs for Northeast Brazil. Mr. Rajab was funded from other sources (U.S. AID). (Rajab is also listed under Breeding Project.)

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

P. J. Howard, U.S. citizen, is working toward a Ph.D. She received minor Breeding Project funding. Expected date of completion is September, 1988. (Also listed under Breeding Project.)

Annual Report
1986-87

Title:

Genetic Improvement Of Dual Purpose Goats Under Smallholder Farming Systems

PI: T. C. Cartwright

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

Host Country Institution: Kenya Agricultural Research Institute

Personnel:

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J. Kariuki, Veterinary Officer, KARI

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J. F. Baker, Assistant Professor, TAES
J. W. Bassett, Professor, TAES

Research Results

The major thrusts of this project are 1) to genetically synthesize a new dual purpose goat breed that can thrive and produce milk and meat in Western Kenya and 2) to provide goats for other SR CRSP projects. The "computer designed" four-breed composite synthetic breed (DPG) is now entering the multiplication, breed stabilization and selection phase. Presently there are approximately 150 head of DPG; this number will increase to over 500 in 1988. The current flock at Ol Magogo numbers approximately 1,300 head. The composition of this flock is being phased, as planned, to reduce the purebred indigenous and F1s and build to a DPG herd size of over 1,000, which is a viable number for breed development, by 1989. The intermediate F1s produced in the breed formation stage have been popular for release to farmers and herders. A major collaborative effort has been to provide other SR CRSP projects with goats for research; distribution to projects include: Feed Resources (41, Maseno), Health (36, Maseno, haemonchus; 21 Kabete, heartwater; 110, Ukunda, trypanosomiasis) and Production Systems (150, Maseno).

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

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

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

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

The design of the new DPG has incorporated concepts of modern genetic use of a breed. The project includes genetic resources to adapt the DPG on the one hand for more intensive, larger or specialized goat dairies on the other hand for utilization in more arid, more extensive areas (Cartwright et al., 1986). The proposed strategies are being tested by the Systems Project.

Refereed Journals

Ruvuna, F., T. C. Cartwright, H. Blackburn, M. Okeyo and S. Chema. 1987a. Lactation performance and growth rates of kids under different milking and rearing methods in Kenya. Anim. Prod. (in press).

Ruvuna, F., T. C. Cartwright, H. Blackburn, M. Okeyo and S. Chema. 1987b. Gestation length, birth weight and pre and postweaning growth of indigenous tropical goats and their crosses with Toggenburg and Anglo Nubian in Kenya. J. of Agric. Sci. (submitted).

Ruvuna, F. and T. C. Cartwright. 1987. Developing a dual purpose goat breed in Kenya. World Anim. Rev. (submitted).

Extension Bulletins

Cartwright, T. C. 1986. Trends and potentials in developing countries for improved dairy goats. Proc. Third Dairy Goat Field Day, Prairie View International Dairy Goat Research Center. (pp 21).

Abstracts

Bogui, N. S., T. C. Cartwright and J. M. Shelton. 1987. Reproductive performance and preweaning growth of meat goats in Texas. Proc. IV Int'l Conf. on Goats II:1448.

Ruvuna, F., T. C. Cartwright, M. A. Okeyo and H. D. Blackburn. 1987c. Milk yield and growth rates of kids under different milking methods of tropical goat breeds. Proc. IV Int'l. Conf. on Goats II:1542.

Ruvuna, F., T. C. Cartwright, M. A. Okeyo, H. D. Blackburn and S. Chema. 1987d. Characterization of indigenous goats of Kenya for dual-purpose potential. I. Pre and postweaning growth. Proc. IV Int'l. Conf. of Goats II:1313.

Ruvuna, F., T. C. Cartwright, M. A. Okeyo, H. D. Blackburn and S. Chema. 1987e. Characterization of indigenous goats of Kenya for dual-purpose potential. 2. Weights and postpartum interval. Proc. IV Int'l. Conf. on Goats II:1314.

Angwenyi, G. N. and T. C. Cartwright. 1987. Effects of crossbreeding East African, Galla and Boer goats on body size, growth rate and kid survivability in Kenya. Proc. IV Int'l. Conf. on Goats II:1315.

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Ruvuna, F., T. C. Cartwright and A. M. Okeyo. 1985a*. The Kenya dual-purpose Goat: Its development and utility. Proc. 4th SR CRSP Kenya Workshop, Kakamega (pp 52).

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Ruvuna, F., A. M. Okeyo, T. C. Cartwright and G. I. Lumiti. 1985c*. Growth and suckling patterns of kids grazed with their dams. Proc. 4th SR CRSP Kenya Workshop, Kakamega (pp 64).

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Okeyo, A. M., Kayongo Male, F. Ruvuna and M. Wanyoike. 1985b*. The behaviour and feeding patterns of the East African, Galla and Toggenburg goats at Ol'Magogo. Proc. 4th SR CRSP Kenya Workshop, Kakamega (pp 75).

Okeyo, A.M., M. Wanyoike, F. Ruvuna, W. N. Gichuru, T. C. Cartwright and J. Wachira. 1985c*. Comparison of edible meat yields among different Goat breeds and Crosses at Ol'Magogo. Proc. 4th SR CRSP Kenya Workshop, Kakamega (pp 78).

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Mukhebi, A. W., R. S. Shavulimo, F. Ruvuna and F. Rurangirwa. 1985a*. Economics of internal parasite control among goats in Western Kenya. Proc. 4th SR CRSP Kenya Workshop, Kakamega (pp 160).

Mukhebi, A. W., F. Ruvuna and H. Blackburn. 1985b*. Economics of simulated pre-weaning kid rearing practices for the East African Goats in Hamisi, Western Kenya. Proc. 4th SR CRSP Kenya Workshop, Kakamega (pp 173).

Cartwright, T. C., F. Ruvuna and S. Chema. 1986. Current status and perspective for breeding the Kenya dual purpose goat. Proc. 5th SR CRSP Workshop, Kabete (in press).

Okeyo, A. M., F. Ruvuna, T.C. Cartwright and S. Gichora. 1986a. Productivity parameter estimates of Galla and East African Goats at Ol'Magogo. Proc. 5th SR CRSP Workshop, Kabete (in press).

Ruvuna, F., T. C. Cartwright, A. M. Okeyo, J. Kariuki and S. Gichora. 1986. Breeding goals towards moulding the biological components that define overall excellence of a dual purpose goat. 1986. Proc. 5th SR CRSP Workshop, Kabete (in press).

Okeyo, A. M., F. Ruvuna, T. C. Cartwright and J. N. Maleche. 1986b. Use of teething techniques to estimate age in goats. Proc. 5th SR CRSP Workshop, Kabete (in press).

Theses and Dissertations

Ahuya, C. O. 1987. Estimation of direct additive, maternal additive, heterotic and maternal heterotic effects from crossbreeding goats in Kenya. M. S. Thesis. Texas A&M Univ., College Station. (55 pages).

Training:

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

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

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

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

Annual Report of SR CRSP Special Grant*
1986-87

Title: Regionalization Of The SR CRSP Systems Analysis Project To Botswana; Systems Analysis And Synthesis Of Small Ruminant Production Systems

PIs: T. C. Cartwright
H. D. Blackburn

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

Host Country Institution: Animal Production Research Unit (APRU)
Botswana Ministry of Agriculture

Personnel:

Principal Investigators
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H. D. Blackburn, Research Scientist, TAES

Host Country Co-Workers
B. L. Addy, Coordinator, APRU
E. Senyatso, Production Officer, APRU

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* The SR CRSP grant funded approximately 50% of this project.

Research Results:

APRU has carefully collected and recorded range and livestock data for many years on parastatal farms. The emphasis now is to utilize these data to formulate recommendations to improve the productivity of smallholder flocks. Thus the Systems Analysis Project was invited to conduct analyses to provide a basis for formulating country-wide policies.

An initial on-site study was made by Dr. Blackburn in July 1987 to establish linkages with APRU scientists. As a result of this trip a working group of scientists was formed and experimental simulations were planned. It was decided that initial simulations should concentrate upon goats and not sheep. Also at this time baseline information collected by APRU scientists was summarized to use for specific location alignment of input parameters for the model simulations.

The input parameters were successfully aligned since the baseline goat model simulations were tested against two years of Botswana data and found in close correspondence. An initial experiment was simulated to determine if there was any advantage in changing the time of year for breeding; currently breeding starts in October and continues for 60 days. It was found that weaning weight could be increased and at the same time does maintain a higher body weight if breeding took place in late August or September. Various other breeding schemes (e.g., 2 or 3 breeding seasons in one or two years, respectively) were evaluated but these results are less conclusive at this time. Presently, the remaining simulations outlined by the working group in Botswana are being performed in Texas. Experimental simulations yet to be completed include evaluating a continuous breeding season; changing genotype by selecting for size, milk and ovulation rate; using various forages for supplementation; and milk division strategies.

Results from the initially planned experiments will be reported in a systems workshop in Gaborone. This workshop will include the Southern African Center For Cooperation In Agricultural Research (SACCAR) group. One more year of systems research with goats will be funded from non-SR CRSP funds. Development of a major region-wide systems project proposal in collaboration with SACCAR is anticipated.

Publications:

None to date - Report and one technical article planned.

Training:

Tutorial instruction of individual APRU personnel in Botswana in data requirements and use of systems analysis.

No formal training to date - Workshop for APRU and SACCAR planned for November, 1987

Appendix C

Animal Breeding And Genetics Section, Animal Science Department, Texas A&M University

	Special Interests
J. F. Baker	Beef Cattle Breeding; Quantitative Genetics, Genetic Mediation of Basic Biological Processes, Systems Analysis
H. D. Blackburn	Sheep and Goat Breeding, Systems Analysis, Range Science, Model Development
T. C. Cartwright	Beef Cattle, Sheep and Goat Breeding; Systems Analysis, Heterosis and Quantitative Genetics
S. K. Davis	Genetics Homologies among Domestic and Wild Species; Molecular Genetics; Population Genetics
F. Ruvuna	Goat Breeding; Statistical Analysis; Systems Analysis
J. O. Sanders	Beef Cattle, Sheep and Goat Breeding; Quantitative and Factorial Genetics; Production Systems
J. F. Taylor	Dairy Cattle Breeding; Quantitative and Statistical Genetics; Sire Evaluation; Integrated Dairy Management Systems
M. Tomaszewski	Dairy Cattle Breeding; Dairy Cattle Evaluation; Integrated Dairy Management Systems
J. W. Walter	Dairy and Beef Cattle Breeding; Quantitative and Statictical Genetics; Expert Systems

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