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PROCEEDINGS OF THE THIRD

SMALL RUMINANT CRSP

KENYA WORKSHOP

Kabete, Kenya

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Edited by the Resident Scientists in Kenya
and the Management Entity Office
Davis, California

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(Dr. Sam Chema, Presiding)

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SR-CRSP WORKSHOP PROCEEDINGS
OPENING ADDRESS

By
S.N. Muturi[1]

I am very pleased to talk to you this morning especially so soon after the decision to extend the project funding to September 1987. At this time of financial constraints, this extension must reflect favourably on the SR-CRSP concept and the quality of research being undertaken by the Collaborative Program in Kenya. We must all be further encouraged by the fact that consideration is being given to a further extension of the global SR-CRSP to 1990.

No research in Kenya can be carried out in isolation from other related activities both in research and development within the country. For viability, strong linkages need to be forged with other programmes. I am therefore pleased that, with the concurrence of the USAID Mission in Nairobi, the SR-CRSP is strengthening its collaboration with other USAID assisted research and development projects at Kiboko Range Research Station and in Kitui. Looking through the workshop programme, it is obvious that the SR-CRSP is already collaborating and writing joint papers with scientists in the University of Nairobi and others in ILCA and IPAL who are working in the arid and semi-arid areas of Kenya and Ethiopia. These are commendable interactions which should be maintained and extended.

The SR-CRSP goals and objectives as well as achievements will be elaborated during the following scientific sessions. The overall goal of the SR-CRSP in Kenya is to develop an improved goat capable of producing both meat and milk and also to develop production systems for it which are acceptable and profitable to the local inhabitants.

Although the site of implementation of this research is currently the densely populated high potential areas of Western Kenya, many aspects of these research activities are adaptable to the low potential areas where rangeland goat populations are large and human populations sparse. The health, breeding and goat nutrition and management projects offer technologies, vaccines and breeds which can be applied throughout the country. The feed resource program is investigating feed resources which can have wide application. These include forages such as pigeon pea which had proven success in the semi-arid region (Machakos and Kitui Districts). The socio-economic research activities seek to evaluate the smallholders response to on-farm packages, and provide recommendations on policies required to remove constraints to adoption. It is also looking into ways of forging stronger research/extension linkages.

A major goal of the SR-CRSP in Kenya is to insure the continuity of its activities. This is being achieved by institutional strengthening through a training programme and construction of facilities such as building office,

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[1] Director of Agriculture, Kilimo House, Nairobi, Kenya

laboratory and animal holding facilities. More than 10 Kenyan counterparts have been involved in M.Sc. and Ph.D. training programs in Animal Nutrition, Health, Breeding, Feed Resources and Rural Sociology in overseas universities.

In order to further promote continuity in the SR-CRSP activities, the Ministry will endeavour to provide, within the limits of its resources, its share of financial and material contribution. We hope to be able to put in the needed scientists and support staff to ensure that there is a strong core of Kenyans to carry on and expand on the base that is being established. To maintain local management stability, there will be minimal disturbance in the already established lines of responsibility within the Ministry. We expect that further expansion will emanate from the current bases at Maseno, Ol'Magogo and Kabete to more sites elsewhere in Kenya.

Finally, I would like to thank our guests and friends who took the time and effort to attend this workshop. Particular thanks are extended to the representatives of the American Institutions and AID Washington who traveled all the way from the U.S.A. Also my appreciation goes to the USAID Mission in Nairobi and their continued support in this and other programmes in Kenya. There are now so many scientific meetings being hosted by ILRAD that there is danger of taking their generosity for granted. I would like to express our Ministry's gratitude to the Director General of ILRAD and his staff for allowing us to use their excellent facilities.

It is now my great pleasure to declare the Third Small Ruminant CRSP Workshop formally open.

AID/S&T/AGR SUPPORT FOR INTERNATIONAL PROGRAMS

By

Dr. Charles E. Haines[1]

I'm extremely pleased to be here this morning and to be able to attend this National Scientific Meeting on Sheep and Goats. I was also interested in the remarks just made by Mr. Muturi and his encouragement to the Small Ruminant -CRSP activities here in Kenya. This program requires the continued support of the Ministry of Agriculture of the Government of Kenya to be successful and we in USAID are very grateful that the collaboration between the US and Kenyan governments has been so strong on this project.

Now, just how is the US government involved in this Small Ruminant-CRSP? The agenda indicates that I am with the Bureau of Science and Technology. This Bureau is one of nine bureaus within the US Agency for International Development - otherwise known as USAID or simply AID. The AID mission here is part of another one of the nine bureaus - the African Bureau. Each of AID's nine bureaus has a budget and fund various projects within the world regions and developing countries. The projects of the Bureau of Science and Technology attempt to supplement and complement other AID activities within developing countries and are usually designed for worldwide or regional approaches to agricultural problems instead of concentrating in only one country as a mission does. This means that a mission may have numerous projects within a country but the Bureau of Science and Technology might sponsor only one or two projects within the country or none in some countries. For example, the Small Ruminant-CRSP concentrates on problems in different parts of the world with sheep and goat production. Kenya is one of these sites! The CRSP is also functioning in the USA and four other countries. I will not point out what the SR-CRSP does in other countries because this will be covered in a later presentation. However, I wish to emphasize the world wide efforts of the Bureau of Science and Technology (S&T).

The S&T Bureau also sponsors other CRSP's which have established research sites in many different countries. At the present time there are CRSPs for Soils, Beans and Cowpeas, Peanuts, Sorghum and Millet, Human Nutrition, and Aquaculture. I should point out here that the S&T Bureau, like the other eight AID Bureaus, is subdivided in sections, divisions, or offices (see attachment A). Six of the seven CRSPs are actually funded by the Office of Agriculture in the S&T Bureau. As you might suspect, the six CRSPs are big programs for our Office of Agriculture and require a large chunk of the budget of this office. However, the largest portion of the Office of Agriculture budget is support for 13 International Research Centers scattered around the world. Approximately 25% of the core budget for these 13 International Research Centers is supplied by the Office of Agriculture. All of you should

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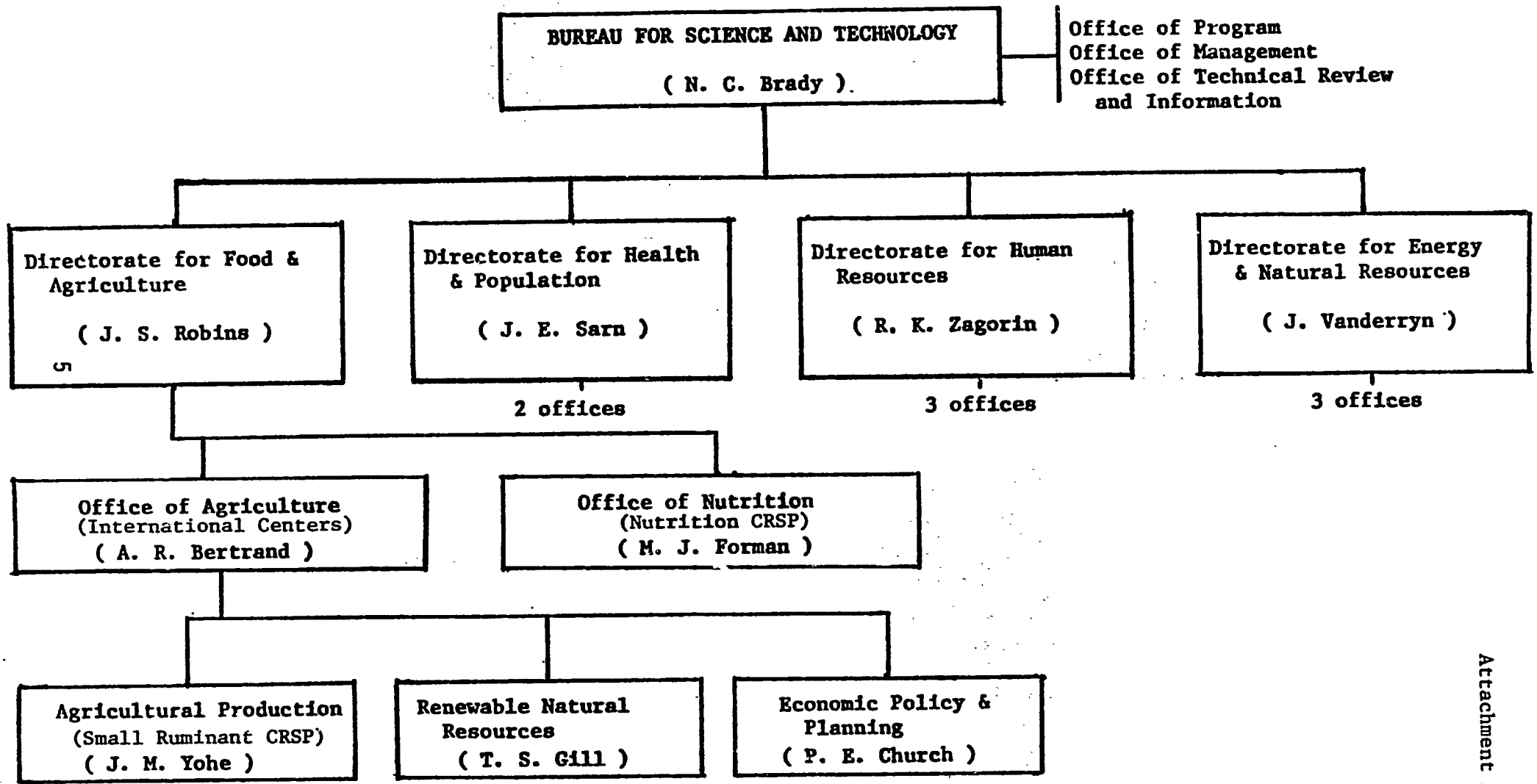
[1] Office of Agriculture Science and Technology, US/AID Washington Project Manager for SR-CRSP

be familiar with at least several of these organization-we're assembled in one of them right now and two others are ILCA and IITA. You may wonder why I failed to mention the nearby ICIPE organization because it is an International Center for Agricultural Research. Well, actually ICIPE is in a different classification so it does not receive core funding by the Office of Agriculture. However, we do support a research project at ICIPE because results from their research is appropriate for many parts of the world. Although I do not expect you to remember these details I'm attempting to make the point that the S&T Bureau funds long range projects which are world wide in scope and not for only one special area of a country or region. And, this is exactly the way that this Small Ruminant CRSP was designed in 1978.

Our Office of Agriculture also supports a few short term activities of international scope. For example, if an international congress or symposium, on some phase of Agriculture is to occur, a few appropriate scientists from developing countries might be assisted in attending the activity. We have also contributed to the expenses of international meetings which have potential for aiding agricultural development within development countries. Occasionally, we respond to direct requests for missions for short term technical assistance. The Office of Agriculture receives many requests for support to these types of activities and considers each request very carefully to determine if it meets AID objectives. As a rough estimate, the Office of Agriculture has been able to provide limited support to about 25% of these requests for short term projects.

Now, just what do I have to do with this Small Ruminant-CRSP? I am the AID Project Manager of the SR-CRSP for the Office of Agriculture within the Bureau of Science and Technology. When the Bureau approved of a project design for this CRSP in 1978 it made a contract with the University of California at Davis to manage the grant. In turn, the University of California appointed staff members to actually manage the CRSP. This group was given the title of Management Entity (ME). Very simply stated, our Office of Agriculture grants the money for this CRSP to the ME at Davis, who in turn pass these funds to the ten US participating institutions and five host countries in the CRSP. I work and react directly with the ME in numerous CRSP matters so I have close contact with Dr. Robinson, Dr. Weir or others in the ME office and must mention here that I appreciate a sincere, dedicated, professional relationship with them. I also interact with AID officials in both Washington DC and the country missions on SR-CRSP matters. So, I serve at a link between the ME and USAID in several chains. Again, I do not want to go any deeper on this subject but, I do want you to understand that a great amount of SR-CRSP paper work goes across my desk in Washington and I enjoy doing it because of your accomplishments here in Kenya. If any of you desire additional details on the overall structure of the Bureau of Science and Technology or my functions in this CRSP I'd be delighted to discuss them with you later.

In closing I must state that the program for the present meeting indicates that a lot of work on goats has been accomplished by many persons in Kenya. I wish to congratulate the Government of Kenya, all of the Small Ruminant-CRSP Scientists and administrator and others involved for the organization and sponsorship of, and participation in this meeting. This is truly a fine example of collaborative efforts! I wish that my superiors could witness this workshop and the obvious interactions between scientists and administrators of different countries.



Attachment A

OBSERVATIONS ON THE SR-CRSP IN KENYA

By
Robert C. Albin[1]
Chairman, Board of Institutional Representatives
and Host Country

Thank you Mr. Chairman, Mr. Muturi, participants and guests: I bring greetings to you from the Board of Institutional and Host Country Representatives. It is a personal honour for me to be here and to be part of this significant, national sheep and goat conference. Briefly, I want to share some background information with you regarding the Board and its functions and then present to you some of my observations on SR-CRSP/Kenya activities.

The Board was originally composed of 13 representatives, one from each participating U.S. University and Research Institution. Today, there are 10 Universities and Research Institutions. A major and significant change in Board membership occured in January of this year when Board membership was expanded to include each Host Country Representative. The SR-CRSP is active in five countries; thus, Board membership today includes 15 representatives. Dr. Chema, as the Host Country Representative for Kenya, is now a member of the Board. At this point, I want to compliment Dr. Sam Chema for his efforts, because he was instrumental in helping to make this beneficial change in Board membership.

Some of the primary functions of the Board are to:

- represent the interests of each participating host country and U.S. institution;
- to assess and review SR-CRSP programs and activities;
- to review budgetary expenditures and approve annual budgets for the allocation of funds to component projects and host country sites;
- and to approve program and project changes.

I have been a member of the Board since the early beginnings of the SR-CRSP, at Board meetings where discussions relative to the programs in Kenya were almost always present and there seemed to be many different kinds of opportunities associated with this particular country. There have been high and low points during these first years. However, my spirit and hopes for the SR-CRSP in Kenya have uplifted! Events which transpired only this past week during the many planning meetings have caused me to conclude that the SR-CRSP in Kenya could become the global bell-wether for SR-CRSP programming. The essential and vital ingredients are here:

Leadership	Collaboration
Competency	Friendship
Dedication	Mutual Respect and.....

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[1] Texas Tech University

Dr. Sam Chema, means so much to this CRSP Program.

To you research scientists in the CRSP,. Thank you for your scientific leadership!

To you, Dr. Chema, for being you!

To the U.S. principal investigators, and to the Management Entity, and to Rose Naliaka, keep up your good work!

I compliment all of you and say thanks again for your untiring efforts and the significant job that you are doing with the SR-CRSP Programs.

I leave you with this challenge:

Become our Global Leader for the SR-CRSP!
- -in effective and productive research programming,
- -in collaboration, and
- -in integration, both within Kenya and between other host country programs!

It is great to be here! Thank you.

THE ROLE OF KENYA IN THE SMALL RUMINANT COLLABORATIVE RESEARCH SUPPORT PROGRAM GLOBAL PLAN

By
William C. Weir, Associate Program Director[1]

I am happy to explain the role of the Kenyan Small Ruminant collaborative Research Support Program. First, I would like to emphasize that the Program is collaborative. This meeting is truly a demonstration of the spirit of collaboration which the CRSP Programs are meant to foster. We can all be more effective if we work together and keep each other informed.

When the Research Triangle Institute with their advisers organized the Small Ruminant CRSP, they recommended that the research should be conducted at two extensive sites and two intensive sites, one with sheep and one with goats so as to "expand the body of knowledge and extend its application to the solution of specific problems" and "to improve small ruminant food, fiber and hide production capabilities by smallholders".

As the Program was implemented Kenya was designated as one of two sites to study and evolve a management program for the smallholder in the high potential intensive area of Western Kenya. The multidisciplinary approach which has developed will be explained in more detail here during the next two days. Suffice it for now to say it involves the introduction of the dual-purpose dairy goat with emphasis more on milk, than on meat or skins.

The other intensive site is Indonesia where the goats and sheep are kept in very small flocks of about 3 animals per farm and most of the animals are housed individually. Much of the feeding is through zero grazing. While emphasis is on meat for cash, fighting sheep are also raised for sport.

One of the constraints, the SR-CRSP team has identified is long intervals between lambings because estrus is missed in the housed ewes.

On the extensive side, North Eastern Brazil was chosen as a region with many goats and hair sheep which depend almost entirely on native vegetation for their nutrients. Saturday, Dr. Chema introduced several of us to the Kitui District. I was struck by the many similarities to North Eastern Brazil. The main constraints are water, unreliable rainfall (wide deviations from mean) and unreliable sources of nutrients.

Peru is also an extensive site with emphasis on sheep and alpacas in the high altitudes of the Andes. Fiber production assumes greater importance to those producers. The manure collected from the night bomas is also greatly valued for its fertilizer for the potato patch.

A constraint on productivity is the reproductive problem - no twins at

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[1] University of California Davis, Small Ruminant Collaborative Research Support Program

high altitudes. Introducing Targhee-Finn rams is under study to try to increase twinning in the more favourable sites.

Morocco came into the program somewhat later and is a mix of both intensive and extensive areas. The range program and the sociology program are working in the extensive area of the High Atlas mountains and in the desert sagebrush site. Breeding and Nutrition are studying the prolific D'Man breed which, when kept under intensive conditions produces litters of lambs. They are crossbreeding with range sheep to produce an intermediate, more prolific range sheep.

When combined into an overall program or global plan, we hope to develop information and techniques for extending this knowledge to other sites throughout the small ruminant producing world.

Table 1: Small Ruminant CRSP Sites and Specializations

Country Site	Extensive OR Intensive	Small Ruminant Species	Emphasized Product	Special Considerations
Kenya	I	Dual-purpose Goat	Milk Meat	
Indonesia	I	Sheep and Goats	Meat (Gaming)	Zero Grazing-Housing
Brazil	E	Goats Hair Sheep	Meat Skins (milk)	Natural Vegetation
Peru	E	Sheep Alpacas (Goats)	Fiber Meat	Manure as Fertilizer
Morocco	E & I	Sheep	Meat, Skins Wool	Range Restoration

SMALL RUMINANT CRSP IN KENYA

By
H.A. Fitzhugh[1]

Four years have elapsed since the SR-CRSP started in Kenya. From the beginning, research has focused on dual-purpose goat production for small-farm systems in medium to high agricultural production areas. Dual-purpose goats produce milk for family consumption plus meat and breeding stock for sale to generate income for the family. Thus, the SR-CRSP is a practical research program directed toward the real needs of the people in Kenya.

Research Strategy

The SR-CRSP research strategy in Kenya is diagrammed in Figure 1. The initial characterization phase primarily involved surveys of small-farm systems and goat health in western Kenya during 1981-82. Systems characterization continues with case studies of small-farm families, market surveys, and on-farm evaluation of interventions to improve feed production and goat nutrition, health and management. To date, component research activities have been primarily conducted on experiment stations: the breeding research at Ol'Magogo, National Animal Research Station, Naivasha; the health research at the Veterinary Research Laboratory, Kabete; the goat nutrition-management and feed resources research at the Maseno Station. This component research has developed promising interventions which are currently being evaluated on farms of cooperators in Kakamega and Siaya Districts of Western and Nyanza provinces, respectively.

Implementation

SR-CRSP activities in Kenya are implemented through close collaboration among Kenyan and U.S. institutions:

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

Funding for the SR-CRSP is provided by the U.S. Agency for International Development through the University of California, Davis, and by the collaborating institutions, A team of experienced Kenyan and expatriate scientists is responsible for the program in Kenya. Dr. S. Chema has served since 1981 as the Site Coordinator and continues to serve as the Kenyan Representative on the SR-CRSP Board of Institutional Representatives.

In addition to research, SR-CRSP has supported training of the Kenyans, most of whom continue to participate in SR-CRSP related research activities.

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[1] Principal Investigator, Production Systems Project, Winrock International, Morrilton, AR USA.

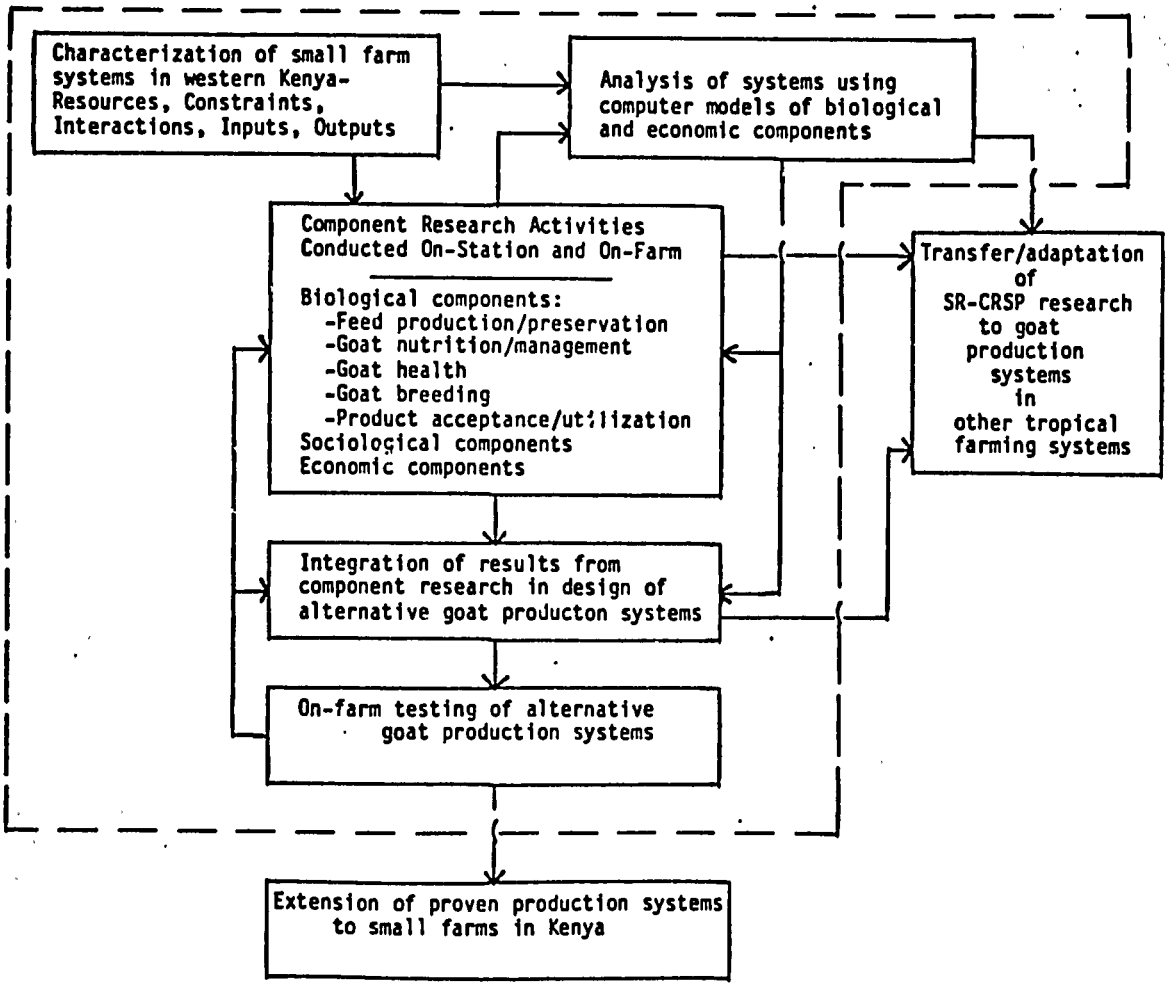
Training has included on-the-job research experience, technical short courses, and programs leading to academic degrees.

Application

SR-CRSP activities are dictated by the needs of farmers struggling to produce sufficient food and income from a limited resource base. Impact of research is measured at the level of the farm system. As an example, research to produce adequate feed for goats is designed to ensure any effect on food or cash crops is not detrimental to total farm productivity.

Evaluating research derived technologies on farms of cooperators helps ensure the social, economic, as well as technical feasibility of the technologies. Often the best package of technologies varies between farming systems in different locations. However, individual technologies based on sound research can be modified and repackaged to meet special needs of different systems. Thus, the technologies developed by the SR-CRSP in western Kenya stand to benefit small-farm families throughout Kenya and other tropical countries as well.

Figure 1. Implementation Strategy For SR-CRSP Research Activities Involving Dual-Purpose Goat Production Systems For Small Farms In Kenya[a]



[a]SR-CRSP research activities are shown inside dashed line; extension activities to be conducted by MLD and other agencies are shown outside dashed lines.

A FARMERS VIEW OF SR-CRSP

By

Philemon Odour[1]

To the Convenor of 3rd SR-CRSP workshop, the Director of Agriculture, distinguised guests, ladies and gentlemen; when I was asked by Dr. Sidahmed to give a farmers view at this workshop I was quite hesitant. Why? Because here is a situation where I was going to speak to a scientist who probably knew what I was going to talk about. However, I have accepted the challenge and here I am before you Mr. Chairman, Ladies and Gentlemen.

First, I will start by giving you the history of goats in the Masumbi Sub location in the Siaya District. Generally, the keeping of goats as domestic animals is as old as mans' settlement. Goats are probably one of the first species of animals to be tamed.

Until about 1880 the present Masumbi Sub Location was uninhabited bush infested by wild animals. It was around that time that people immigrated to the area with their herds; including goats.

The history, as narrated by the elders, suggests that goats did very well in the area. There was less grass and more short bushes and thorns.

Goats are very important animals in the entire Luo Community. They are considered sacred and are usually used for various types of sacrifices. In social life, goats are usually slaughtered in customary marriages.

Because goats multiply quickly, in order to avoid overpopulation of these small animals, people often slaughter them to provide food for friends and families. Because they are sacred animals, goats are used to conduct sacrifices for the ancestors, according to Luo traditional religions, but are detested by some of the Christian churches who prefer sheep to goats for their religious ceremonies. Goat's milk was used most by the people, particularly young children, but gradually faded away as cattle increased. Goat's meat is used locally by the majority of the people in the Masumbi Sub Location. Goats can survive in dry areas because they don't eat very much.

Goats are usually looked after in the grazing fields by old men and children. Goats, unlike cattle, are usually taken out of their boma at about noon during the rainy season, and at about ten o'clock during the dry season. The wet months, during the rainy season, are March, April and May. During this period goats have a lot to eat as there are leafy shrubs and tall grass everywhere. The dry months are December, January and February. During this period the grass is short and bushes are almost leafless and the shrubs, being perennial, aren't there at all.

Goats are taken out early and grazed along the river banks where the

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[1] Collaborator with the Maseno projects. Address Box 6 Ngiya.

bushes are leafy. Sometimes it forces the owners to fetch leafy stems from far away to feed the goats late in the evening. The feeds that can be fetched include "powo", "nyamridhi", oyieko, osiaga, etc.

Goats and other animals, in most cases, graze on communal grazing fields which are usually along the river banks and swampy plains. Usually when there are many male goats in the flock the owner often sells some of them, but in most cases the good male breed that makes the female give birth to twins, are not always sold.

In modern times some goats are sold in order to pay for fees and buy clothes for the family.

Being sacred animals in the community some are sold as per the demand for a special colour and size, in case there is a ceremony that needs that special characteristic (i.e. special goats are needed for special ceremonies.)

As the human population increases rapidly, large areas that used to be pastures are now under cultivation to produce enough crops to feed the high growing population. Thus, there is not enough pasture for cattle and many people show a lot of interest in the alternative animals that do not need large grazing fields.

In the Masumbi Sub location the experiment being carried out by the SR-CRSP with a few farmers is quite encouraging, and a good number of farmers are eagerly longing for dual-purpose Goats. They are even ready to buy them. The experiment at Masumbi was started with two farmers and now has six farmers, with 9 dual-purpose goats. The crosses from the dual-purpose goats are thirty in the whole of the sub location. The only fear is that the dual-purpose goats are probably brought from a place with a different climate and may not resist the diseases that our local goats put up with. However, it is believed that if kept under good conditions and constantly checked by disease experts there may be no problems.

Unlike sheep and cattle, there is no serious outbreak of goat diseases in this particular area, compared with the foot and mouth or rinderpest diseases in cattle. The most common goat diseases in this area is rushes, that scrapes the animal's hair, leaving the skin bare and itching. This disease is called "ALUNY" in Dholuo.

Before I conclude Mr. Chairman I would like to say the following:

1. The people in the Masumbi Sub Location in the Siaya District feel that after seeing dual-purpose goats and how they are giving milk, we would very much like the experiment to continue. Those who have milking goats now use the milk in tea and give it to the young children to drink. We have found out that goats milk is thicker than cows milk, and that very little of it can make tea for a number of people.
2. The work that has been carried out by the Maseno team on our farms, as far as management of our goats, dipping with free drugs fortnightly, goats feeds introduced (i.e. sesbania, napier grass and Sudan grass) and treatment rendered to our sick goats has really impressed the farmers, who wish the work to continue.
3. The Ministry of Agriculture and Livestock Development has paid

us constant visits for the last year which has been very helpful.

Last but not least Mr. Chairman, I would not end before I pay tribute to his Excellency, the US Ambassador to Kenya. It was only recently on the 25th of February 1984, that the US Ambassador to Kenya paid us a visit where he saw the local goats, local sheep, local cattle, dual-purpose goats and crossbred goats I spoke of. He also met and spoke to the farmers who were extremely grateful to him for having spared his most valuable time to visit them. On behalf of them and myself, whose farm he visited, I would like to thank him again.

Mr. Chairman, being a layman speaking before scientists, please excuse my boring speech and I thank you most sincerely for having invited me to address you.

SR-CRSP DUAL-PURPOSE GOATS IN WESTERN KENYA: HISTORY AND RECORD

By
M.S. Khainga[1], H.A. Fitzhugh[2], W.O. Ochieng[1],
A.E. Sidahmed[2], D. Brown[2], and M. Sands[2]

The introduction of dual purpose goats in western Kenya dates back to the 1950's (Fitzhugh, H.A., 1984: Pers. Comm.) However, accurate records of the exact time and place of introduction are not readily available. There is informatin however, that Saanens from Great Britain were placed in parts of western Kenya by church missionaries. Nevertheless, these exotic goats did not have a significant impact on the communities where they occured. In fact, it is apparent that the Saanens disappeared, although it is possible that crosses with the indiginous small East African goat still exist.

Until 1979 when the Samia Women Dairy Goat Project was inaugurated, there was no other cohesive dairy goat programme in the region. The project flock consisted of Anglo-Nubians, Saanens, Alpines and Toggenburgs from Britain and the United States. Around this same time there were dairy goats being reared in other districts of Kenya i.e. Kilifi, Nakuru, Laikipia and Machakos.

Local milk breeds such as the Galla, Nubian and Boran goats have been known to exist in the semi-arid northern Kenya region where the nomadic Boran and Rendile tribesmen live. Although the local dairy breeds have a comparatively low milk production than the exotic breeds, the milk produced has been consumed by the nomads. These nomads also milk camels and cattle in addition to the local goats.

Socio-cultural studies in western Kenya have revealed that the local small East African goat were occasionally milked and the milk given to children suffering from Kwashiokor. Such use of goat milk indicates, in part, that goat milk was considered to have health and nutritional advantage over the readily available cow milk.

The scarcity of dairy goats in western Kenya has been as a result of a nation-wide ban on importation of exotic goats after caprine arthritis encephalitis was detected in a group of imported goats from the U.S. The current stock available in this country is owned by a few dairy goat farmers, some governmental institutions and foreign aid development projects. The most prevalent dairy goat breed in Kenya is the Toggenburg which has its origin in Switzerland.

Sources of SR-CRSP Dual-Purpose Goats in Western Kenya

Most of the goats obtained by the SR-CRSP in western Kenya are crosses of Toggenburg and the local East African goat (mostly 1/2 to 3/4 Toggenburg crosses).

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[1] Ministry of Livestock Development, Kenya
[2] Winrock International: SR-CRSP

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Table 1 below shows the various sources from which the SR-CRSP purchased its dual-purpose goats. One major set-back was that some of the goat owners did not have adequate records of their goats.

Table 1
Sources and Types of SR-CRSP Foundation Goats in Western Kenya

Source	Date	Number	Breed	Age(yrs)	Sex
Njoro	May 1981	15	031; 032	4-5	F
Kilifi	Sep. 1981	13	003	2	12F: 1M*[1]
Machakos	Oct. 1981	13	031	1-2	F
Laikipia	Oct. 1981	11	331	2-3	F
Laikipia	Dec. 1982	50	031	3-4	F
Ol-Magogo	Dec. 1983	9	042; 052	1-3	8F: 1M*[2]
Kilifi	Dec. 1983	20	031; 331	3	F

Breed Code.
003 - Pure Toggenburg
331 - 3/4 Tog/1/4 E. African Goat
031 - 1/2 Tog/1/2 E. African Goat
032 - 1/2 Tog/1/2 Galla
034 - 1/2 Tog/1/2 Anglo-Nubian
052 - 1/2 Alpine/1/2 Galla
042 - Nubian/Galla

This excludes crosses born as a result of mating between dual purpose bucks and local does.

*1 This was the first breeding buck at Maseno, introduced from Mrs. Rodwells farm in Mombasa.

*2 To avoid in-breeding. A buck from Ol-Magogo was traded for the first breeding buck at Maseno.

Goats purchased from the sources shown in Table 1 were usually kept in barns at the Maseno Veterinary Farm where they were fed local feeds such as sweet potato vines, napier grass, sudan grass and other crop residues such as maize stover, sorghum stover and pigeon pea leaves before distribution to farmers. While conditioning goats on concentrates is being avoided (as in practice farmers cannot afford it), the goats kept in Maseno farm are routinely provided with mineral block. Part of the goat flock in the Vet. Farm barns are kept for breeding and nutritional experiments.

SR-CRSP Activities in Western Kenya

Since the inception of the SR-CRSP dual purpose goat research and extension programmes in Western Kenya in 1980, a progressive impact, in terms of acceptance of the dual purpose goats and their milk is noticed among the participating farmers of Kakamega and Siaya districts.

On placing dual-purpose goats in the small farms of Kakamega and Siaya Districts, several health, management and feed availability problems were encountered. Currently relevant research to improve the status of the goats in farms is being carried by several SR-CRSP projects in Western Kenya.

Research findings from the multi-disciplinary approach of the SR-CRSP research in Western Kenya are being tested or implemented at the small farm levels. So far, monitoring performance of the dual purpose goats in their new farm environments is the major on-farm activity. After undergoing basic health and nutritional care at the Veterinary Farm in Maseno, some goats are selected and distributed periodically to the respondant farmers in Kakamega and Siaya districts. High quality bucks are similarly selected and placed on some farms in these areas to upgrade the local stock and also to breed the dual-purpose goats.

On distribution the following management packages are provided to the respondent farmers:

1. Farmers are encouraged to build cheap goat sheds.
2. Farmers are instructed to milk lactating does and have controlled suckling by kids.
3. Farmers are encouraged to cut locally available forage as well as cropped forages.

The major limitation in the rate at which these goats increase in numbers has been due to the scarcity of breeding bucks on the farms coupled with inadequate health and nutrition.

Table 2 shows how the inventory of goats has changed in the foundation flock since 1981.

Table 2
Change in inventory of Maseno dual-purpose Goats herd May 1981 - March 1984

	Does		Bucks	
	AGE: 6 months	6 months	AGE: 6 months	6 months
Purchases	130	--	4	--
Births	154		69	
Deaths	43	24	2	23
To Farms	36	11	3	8
Culls	10	1	2	--
Current Inventory	80	25	10	20

The first kids born at Maseno Veterinary Farm in March 1982 from the does bought in Njoro. A controlled breeding schedule was designed so that kidding occurs at times of abundant feed availability i.e. at the start of the long rains in April and the start of the short rains in October.

In the early years (1981 to 1983) inadequate veterinary services resulted

in high mortality rates - particularly among kids. Since then the health status showed rapid improvement.

A major reason for the deaths was due to nematode infestation. It appears that tolerance to certain worm burdens is relatively lower in these crosses as compared to the local goats which seem to have struck a balance with these parasites. Fecal samples have revealed egg counts as high as 11,000 eggs/cm^2 in both dual purpose and local goats on the farms. However, death due to worm loads rarely occurs in the local goats. Coccidiosis and enterotoxemia were also found to be a cause of mortality particularly in kids under six months of age.

Table 3 shows the current SR-CRSP dual-purpose inventory in western Kenya (by March 1984).

Table 3

Location	Distribution (number of heads)			Breeds	Class		
					Kids	Does	Bucks
On-Station	1982	March 1983	1984				
Maseno R.S.	--	--	135	031,032 042,052 331,003	45	80	10
On-Farm Maseno	4	--	5	331,031 003	--	4	1
Kaimosi	4	8	13	003,331 031	2	8	3
Hamisi	4	7	21	003,031 331	9	9	3
Masumbi	4	10	20	031,331	11	7	2
Total	16	25	194		67	108	19

003 pure tog
031 1/2 tog 1/2 E.A.
331 3/4 tog 1/4 E.A.

042 Nubian/Galla
052 Alpine/Galla
032 E.A./Galla

034 Tog/Nubian

This excludes crosses born as a result of mating between dual-purpose bucks and local does.

The first group of 12 does and 12 kids were distributed to farmers in Kakamega and Siaya districts after kidding at Maseno in April 1982. A lactating doe and a kid (1 month old) were given to 2 farmers in each of the SR-CRSP sample clusters of Masumbi and Bar'ding (Siaya) and Hamisi and Kaimosi (Kakamega). 2 does and 2 kids were placed in S. Bunyore. Farmers were instructed to milk the lactating does twice (am/pm) daily and they were left to use the milk at their own discretion. Data on feed offered/refused, body

weight (biweekly), milk production and milk use were collected on a weekly basis. The second placement of goats on more farms in the clusters was in March 1983. Goats were distributed to three areas- Kaimosi 4 lactating does and 4 newly freshened kids, - Hamisi 4 lactating does and 3 kids and Masumbi 10 pregnant does.

Brown, et at., 1983, found that malnutrition, internal parasites and mastitis played important roles in the cause of mortality in the goats placed on farms. Of the 12 does and 12 kids placed on the farms in 1982, only 3 of the does and 4 kids survived, 4 does died while 5 were withdrawn and replaced by others from Maseno. 6 kids died mainly due to scouring because of internal parasite infestation.

The withdrawn does appeared very emaciated and anemic. All but two low producing, free grazing does lost substantial weight during test. The absolute milk production levels suggested that these weight losses were due to under feeding and not metabolic over achievement (Brown et at., 1983). From the 25 animals 18 does and 7 kids distributed in 1983, 10 does were withdrawn and replaced after they had lost considerable condition.

Conclusion

The dual purpose goat intervention to small holder farmers of Kakamega and Siaya districts of western Kenya has met both problems and successes. There are some tangible results being generated from the survey and the research carried out on these farms by the Production Systems Projects. The baseline survey was designed to provide an understanding of farming systems and facilitate designs for interventions. After two years of monitoring dairy goat interventions on the small farms, the acceptance of the dual-purpose goat by the respondent farmers in Western Kenya is obvious. However, many constraints need to be overcome if success is to be achieved; the most important being health and nutrition.

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COMPARISON OF GOAT AND COW MILK FOR HUMAN CONSUMPTION IN WESTERN KENYA

By
K.J. Boor[1], E. Ochieng[2] and H.A. Fitzhugh[1]

A survey of small-farm families in western Kenya indicated that over 85% felt that available milk supplies were inadequate to meet needs (Boor, Brown, and Fitzhugh, 1984). Daily milk consumption on farms with cattle averaged two to three times the amount measured on farms without cattle (Table I). Families with greater demand for milk were probably most likely to keep cows; also a home produced supply probably led to greater consumption. Perhaps even more important was the observation that most families consumed some milk each day even when a home produced supply was not available.

TABLE I. Comparison of Daily Milk Consumption on Farms With and Without Cattle

	Kakamega		Siaya	
	With	Without	With	Without
No. farms	18	22	18	22
Average, 1 liter/day[a]	1.07	.61	.65	.23
SD	.49	.28	.45	.14

a Differences in average consumption on farms with and without cattle were significant for both districts ($P<.01$).

Farmers were asked how additional milk would be used by the family. Their responses are summarized in Table II. Notable are the differences between locations, especially the high priority given milk sales by Siaya farmers.

TABLE II Proposed Uses for Additional Milk, % of Farm Families Surveyed

Product	Kakamega (34 families)		Siaya (33 families)	
	1st priority	Total	1st priority	Total
Milk in tea	67.6	88.2	24.2	78.8
Fermented milk	5.9	67.6	0.0	36.4
Feeding children	17.6	44.1	33.0	15.2
Cooking	0.0	8.8	16.7	76.7
Sell	5.9	20.6	60.6	78.7
Fresh	0.0	5.9	0.0	20.0
Butter	0.0	2.9	0.0	27.3
Feeding puppies	0.0	0.0	0.0	12.1

a These data are first priority and other proposed milk uses obtained from

1 Winrock International
2 Ministry of Agriculture and Livestock Development

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farmers claiming inadequate current milk supplies.

An objective of the SR-CRSP is to increase the supply of milk available to Kenyan families. However, this increased supply will be from goats not cattle. Will goat milk be readily accepted by Kenyan consumers? An answer to this question is directly relevant to assessing the potential for dual-purpose goats in western Kenya.

Comparisons

Cow and goat milk product comparisons by school children were presented last year (Boor et al., 1983). Results of the double-blind taste tests indicated no significant difference in preference for goat or cow milk products. The majority of students stated that they "liked" or "liked very much" fresh milk from both goats and cows. Students at one school judged that goat milk was whiter, sweeter, and creamier than the cow milk samples.

The evaluation of consumer acceptance of goat milk products was subsequently extended through field trials in Siaya and Kakamega districts. A total of 286 people ranging in age from 1 to 80 years were asked to compare goat and cow milk products (Table III).

TABLE III Results from Fresh Goat and Cow Milk Taste Comparisons

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

Twenty of these persons refused to try the milk samples. Of those refusing, 17 were women over 30 years old and 3 were teenage boys.

Goat and cow milk soured by adding orange juice were tested at Site I in Siaya. There was no difference in goat and cow milk scores ($t = .19$). Mean scores were 1.67 for sour cow milk and 1.51 for sour goat milk.

Fresh goat and cow milk were tested at both sites in Siaya and Kakamega. No difference was found between fresh goat and cow milk scores (all t values were less than .50). The low mean scores, all less than 2, indicated a high level of acceptability for both products.

One person said his goat milk sample had a "goaty" taste and two men claimed that theirs was slightly salty. Both these defects could have resulted from using goat milk obtained during very late lactation. Many respondents said the goat milk was "creamier".

Scores received in these tests were overwhelmingly 1's (like very much) and 2's (like). All average scores were less than 2, reflecting a very high level of acceptability for both types of milk samples.

Conclusions

Demand for additional supplies of milk in Kenya is strong. Most people readily accept goat milk, whether served fresh, sour, in tea, or cooked with other foods. Some people prefer goat milk to cow milk. Consumer acceptance of goat milk products will not be a constraint to the acceptance of dual-purpose goats.

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EFFECTS OF ENSILING OR DRYING ON FIVE FORAGE SPECIES IN WESTERN KENYA:

Zea Mays (Maize Stover), Pennisetum Purpuretum (Pakistan Napier Grass), Pennisetum sp. (Bana Grass), Impomea Batata (Sweet Potato Vines) and Cajanus Cajan (Pigeon Pea Leaves)

By

D.L. Brown[1], E. Chavalimu[2], H.A. Fitzhugh[3], and A.E. Sidahmed[3]

Abstract

The chemical compositions of fresh, dried and ensiled maize stover, napier grass, Bana grass, sweet potato vines and pigeon pea leaves were compared. Silage and hays preserved nutrients with equal efficiency, except for sweet potato vine silages. The sweet potato silages suffered a shift of protein into the acid detergent insoluble fraction representing a loss of 37 g plant crude protein per kg silage dry matter. Only 15 g crude protein per kg dry matter were damaged when sweet potato vines were dried. Preliminary analysis of major nutrient components indicate that the five preserved forages could form the basis of diets for lactating or growing goats.

Introduction:

A two-year study of smallholder farming in Nyanza and Western Provinces of Kenya indicated that seasonal scarcity of feed for livestock represents a limitation on small ruminant productivity that must be removed if dual-purpose goats are to provide milk and meat throughout the year (Sands et al. 1982).

Succulent preserved feeds such as silages have advantages over dried feeds in that they do not require dry weather during preparation and do not require as much supplemental water when fed to stock (Brown et al. 1983).

Dried feeds tend to suffer less spoilage than silage (if not rained on) and do not require the anaerobiosis so difficult to achieve with the small batches useful to small plot owners in western Kenya.

The hypothesis tested by this experiment is: Drying preserves more of each nutrient (other than water) from a given forage than ensiling.

Materials and Methods

Each of five forages (maize stover, Pakistan napier grass, bana grass, sweet potato vines and pigeon pea leaves) were preserved in each of the following two methods:

1. The forage was reduced by passing through a two-bladed, hand-powered silage chopper, hand packed into two nested polyethylene bags, sealed and

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[2] Ministry of Livestock Development, Kenya, Deceased

[3] Winrock International

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placed in steel barrels for protection against mechanical injury.

2. The forage was tied in bundles of not more than 200cm diameter and suspended from a shed roof. These bundles were exposed to ambient humidity and indirect sunlight. Pigeon pea leaves were dried on coffee-tray wire in layers not more than 20 cm thick. These wire screens were suspended from the shed roof in the same manner as the other drying forages.

Analytical Procedures

Each forage was preserved by each method, each forage/method combination was replicated three times. Samples were taken of the fresh forage, each of the silage batches and each of the hay bundles. Dry matter, ash and Kjeldahl nitrogen were determined by the procedures of the Association of Official Analytical Chemists (1975). Fiber components (cell walls, acid detergent residue and acid detergent nitrogen) were estimatd by the methods described by Goering and Van Soest (1970) and Van Soest and Robertson (1980). Calcium was determined by flame photometry and phosphorus by colorimetry.

Results

Nutrient contents of substrate (fresh), hay and silage of the five forage species are shown in Table 1. Visually apparent losses of dried material to leaf chatter were negligible. There was a little molding around the outside of pigeon pea leaf silage batches, but less than .5% of the ensiled material was affected. Least squares means for species and preservation methods (from two way analyses of variance) are displayed in Table 2. Mean squares for species effect, method effect, interactions and error are compiled in Table 3. Homogeneity of variance between silage and hay was tested with a two-tailed F test (Snedecor and Cochran 1980) for each variable (Table 5). Homogeneity of variance among forage species was tested by Bartlett's (1937) method (Table 6).

Discussion

Dry matter contents of hays averaged 91%, silages 25%. Pigeon pea leaves were ensiled at 40% dry matter and were recovered from the silos at 53%. This range of dry matter content probably contributed to the traces of mold observed. One would expect that molding of pigeon pea leaf silage would have become a problem if it had been held longer than the 2.5 months between the short rains harvest and the middle of the next dry season.

Crude protein contents ranged from 9% for maize stover to 30% for pigeon pea leaves. Pigeon pea leaves may be useful as a protein supplement for the tropical grasses. Cell wall contents ranged form 44% for sweet potato vines to 71% for 5-week-old Pakistan grass. Acid detergent residue varied less; from 35% for pigeon pea leaves to 47% for bana grass. All forages contained 17% or less total ash and between .19 and .30% phosphorus.

Calcium contents of pigeon pea leaves and sweet potato vines were just under 1% as expected, but the three tropical grasses (maize, bana and Pakistan) displayed calcium contents above that expected by the authors (.72, .67%, and 65%, respectively). Continued testing of similar materials will

suggest whether these results are general or reflect special analytical or sampling problems.

Acid detergent residue nitrogen (ADN) is a measure of unavailable nitrogenous substances native to plant cell walls, as well as nitrogen in heat-damaged protein. The amount of ADN present in the three grasses was small (less than .20%). Furthermore, there was no significant increase in this fraction upon drying or ensiling. Sweet potato vines and pigeon pea leaves, on the other hand, have .25% and .43% ADN when fresh. These figures increased to .48% and .60% when dried and to .85% and .57% when ensiled. Statistically, this resulted in the observed species, method and S X M effects on ADN. Biologically, these ADN figures tell us that the crude protein figures should be adjusted. Fresh sweet potato vines and pigeon pea leaf protein values drop from 17% and 32% to 15.4% and 29.3% when such adjustments are made. The useful portions of the two kinds of hay and silage crude proteins are even less (Table 4). The silage protein of sweet potato vines was most seriously damaged: (compare corrected 11.7% protein to 17.04% crude protein figure).

Silage and dried fodder exhibited similar variability with regard to all feed components except calcium (see Table 5). The calcium content of hays were more variable than silages, possibly because of sampling error or visually undetectable variation in leaf shatter.

Variablility in feed composition among forage species was homogeneous except for:

1. Pigeon pea leaves were more uniform than other feedstuffs with respect to acid detergent residue content (s^2_{pp}=.56 vs average s^2=13.22). Preparation of a single plant organ (pigeon pea leaves) probably eliminated some of the potential variation experienced in sampling the other feeds, which were prepared from whole standing plants.
2. Bana grass was more variable than the others with regard to phosphorus content. Two laboratory samples were .15% P, the other four were .21% P. Laboratory error and the restricted range of spectrophotometer readings available for phosphorus calculation were the probable sources of this unusually high variability.

Conclusions

1. The hypothesis (drying preserves more of each nutrient from a given forage than ensiling) is rejected with regard to all nutrients except sweet potato vine protein. A shift of nitrogen into the acid detergent residue of sweet potato vines upon ensiling represented a loss of 37 g protein per kg of silage dry matter. Only 15 g CP per kg dry matter is lost upon drying.

2. Preliminary analyses of major nutrient components indicate that the five preserved forages could form the basis of diets for lactating or growing dairy stock. Example, dry season diets for lactating does and growing kids are found in Tables 7 and 8.

Future Research

The next step in fitting preserved forages into smallholder production systems should be the formulation and testing of diets based on preserved

tropical grasses with pigeon pea leaf as protein supplement, a by-product such as molasses as an energy supplement and mineral salts to supply minerals that may be found to be limiting (such as potassium or magnesium). Such diets should be tested on animals in growth, maintenance and lactation.

Research and development officers should consider by-product and preserved forage rations if ingredients (e.g. molasses) and preservation methods are available and utilizable at the small farm level in their areas.

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Table 1. Nutrient contents of hay, silage and fresh material from five forage species[a]

	H_2O	DM	CP	CW	ADR	ADN	Ash	Ca	P
Maize stover (Zea mays):									
fresh	77.6	22.4	7.1	63.4	36.3	.06	6.7	.18	.52
hay	8.3	91.8	9.2	72.0	40.3	.17	9.0	.73	.21
silage	77.6	22.4	9.0	64.6	36.3	.14	8.8	.71	.22
Pakistan grass (Pennisetum purpureum):									
fresh	80.9	19.2	11.5	63.5	50.1	.14	12.6	.31	.52
hay	7.0	93.0	11.1	76.4	43.3	.19	12.6	.58	.21
silage	81.1	18.9	11.4	65.9	45.4	.21	14.8	.75	.22
Bana grass (Pennisetum sp.):									
fresh	86.2	13.8	9.9	75.0	49.7	.19	15.7	.52	.42
hay	7.1	92.9	10.8	72.8	48.4	.29	16.4	.61	.17
silage	85.4	15.6	11.2	65.9	46.2	.29	17.3	.69	.22
Sweet potato vines (Impomea batata):									
fresh	81.9	18.1	17.2	53.0	40.5	.25	8.4	.46	.70
hay	14.0	86.0	17.0	38.1	32.5	.48	10.5	.90	.24
silage	83.3	16.7	17.0	50.5	40.7	.85	9.4	.78	.22
Pigeon pea leaves (Cajanus cajan):									
fresh	59.8	40.2	31.6	59.2	27.2	.43	5.2	.87	.82
hay	7.0	93.1	29.4	51.0	34.7	.60	6.8	.78	.30
silage	47.6	52.6	30.9	54.8	34.3	.57	5.0	.85	.30

[a] H_2O (moisture) and DM (dry matter) are expressed as a percentage of sample weight. CP (crude protein), CW (cell wall), ADR (acid detergent residue), ADN (acid detergent insoluble nitrogen), ash, Ca (calcium) and P (phosphorus) are expressed as a percentage of sample dry matter.

Table 2. Least squares means

	DM	CP	CW	ADR	ADN	Ash	Ca	P
Species:								
Maize	57.1	9.1	68.3	38.3	.15	8.9	.72	.22
Pakstn	56.0	11.3	71.1	44.4	.20	13.7	.67	.22
Bana	54.3	11.0	69.4	47.3	.20	16.9	.65	.19
S.P.V.	50.4	17.0	44.3	36.6	.67	10.0	.84	.23
P.P.L.	72.8	30.1	52.9	34.5	.60	5.9	.82	.30
Method of preservation:								
hay	91.3	15.5	62.1	39.9	.33	11.1	.72	.23
silage	24.9	15.9	60.3	40.6	.40	11.1	.76	.24

H_2O (moisture) and DM (dry matter) are expressed as a percentage of sample weight. CP (crude protein), CW (cell wall), ADR (acid detergent residue), ADN (acid detergent insoluble nitrogen), ash, Ca (calcium), and P (phosphorus) are expressed as a percentage of sample dry matter.

Table 3. Mean squares

Nutrient	Species	Method	S X M	Residual
Dry matter	446.0	33150.3	332.5	11.8
Protein	443.39	1.14	.67	1.96
Cell wall	856.0	22.7	137.5	34.6
ADR	176.02	4.02	33.82	9.56
ADN	.35791	.03297	.04374	.00122
Ash	109.051	-	3.776	.426
Calcium	.0443	.0101	.0188	.0181
Phosphorus	.00159	.000465	.000952	.000385
d.f.	4	1	4	20

Table 4. Crude protein contents (corrected and uncorrected for ADN)

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

Table 5. Homogeneity of variance between silage and hay figures. Two-tailed F test.

	CW	ADR	CP	ADN	Ash	Ca	P
Hay s^2	247.45	48.63	60.42	0.0359	11.61	0.0337	0.0021
Silage s^2	91.55	24.98	69.25	0.0805	21.24	0.0101	0.0012
${}^{14}F_{14}$	1.83	2.65	1.95	1.1500	2.24	3.3400	1.7500
Status	OK	OK	OK	OK	OK	a	OK

F required = 3.05 for 14 d.f. in both numerator and denominator, $P<.05$

[a] s^2hay>s^2silage

Table 6. Homogeneity of variance among forage species. Bartlett's X^2 test. (a=5 feeds; v=5 d.f./feed)

	CW	ADR	CP	ADN	Ash	Ca	P
Maize s^2	17.22	7.24	.229	.0009	.120	.0414	.000009
Pakistan s^2	44.49	29.27	4.109	.0010	1.644	.0151	.000014
Bana s^2	21.72	2.69	1.378	.0004	.707	.0108	.00116
S.P.V. s^2	47.47	26.42	1.288	.0436	.629	.0145	.000059
P.P.L. s^2	16.16	.52	1.590	.0007	1.626	.0075	.000007
Mean s^2	29.41	13.22	1.719	.0093	.945	.0179	.0003
M[a]	2.67	19.72	6.75	2.86	8.32	4.47	52.32
M/C[b]	2.47	18.26	6.25	2.65	7.71	4.14	48.44
Status[c]	OK	PPL< mean s^2	OK	OK	OK	OK	Bana> mean s^2

[a] $M=v(a\ln(\text{mean } s^2)-\text{sum } \ln s_i^2)$ mean $s^2=\text{sum}s_i^2/a$
[b] $C=1+(a+1)/3av=1.08$
[c] X^2 required for 4 d.f. at $P<.05=9.49$

Table 7. Diet for 30kg doe lactating 1.5kg, 5%BF milk/d

	Offering kg	%DM	%refusal	DM kg	AP* g	Ca g	P g	DE Mcal
Required	-	-	10-50	1.2	178	6.5	4.6	3.14
Pakistan hay	1.63	93	40	.91	100	5.3	1.9	2.71
PPL silage	.61	53	10	.29	78	2.5	.9	.97
Ration total	2.24	-	-	1.2	178	7.8	2.8	3.68

*AP=adjusted crude protein=CP-(ADNX6.25)

Table 8. Diet for 15kg kid growing 100g/d

	Offering kg	%DM	%refusal	DM kg	AP g	Ca g	P g	DE Mcal
Required	-	-	10-40	.66	58	2	1.4	1.82
SPV silage	1.3	16.7	10	.20	23	1.6	.5	.64
Bana hay	.8	92.9	35	.46	50	2.8	.8	1.18
Ration total	2.1	-	-	.66	73	4.4	1.3	1.82

SHORT RAINS MAIZE LEAF STRIPPINGS YIELD AND FEED VALUE

By
D.L. Brown[1], S.L. Russo[1], E. Chavalimu[2],
H.A. Fitzhugh[1], and A.E. Sidahmed[1]

The feed resource base for dual-purpose goat production systems in Western Kenya includes grazing, browsing, crop residues and by-products. One such crop by-product consists of lower leaves stripped from growing maize (Zea mays L.) plants.

Mulkey et. al. (1982) reported that up to 10 leaves removed from maize 4 weeks or later after 100% tasseling provided 12.84 kg/ha forage dry matter of between 5.9% and 8.29% crude protein and 0.13% to 0.18% phosphorus with no reduction in maize yield. Alternatively, 8 leaves could be removed during the 4 weeks after tasseling to obtain 860 kg/ha of forage dry matter with 7.89% to 12.04% crude protein and 0.17% to 0.25% phosphorus.

Kayongo-Male and Abate (1982) have shown that fresh but not dry (mature) maize leaves contain sufficient protein, macroelements, and energy to support lamb gains at about 100 g/day with an intake of 770 g per day and feed conversion (dry matter intake: gain) of 8-10.

Since maize is grown on virtually all small farms in Western Kenya, the SR-CRSP Production Systems groups undertook the following experiments to assess maize leaf stripping as a source of goat feed during the short rains.

Material and Methods

Forty-two 120 m rows of Embu hybrid 512 and 42 hundred and twenty m rows of Katumani composite B maize varieties were planted at the Maseno Veterinary Farm at 0°00'00" latitude and 1,500 m elevation on October 1, 1982. The spacing used was 1 m between rows and 0.5 m between plants within rows. Each hill was planted with three seeds.

Each day, from November 16, 1982, through December 27, 1982, the 5 lowest leaves from one row of each variety were stripped off and sub-sampled for yield and dry matter analysis.

Separate dry-matter values were determined for each variety, but both dried samples gathered each day were mixed together before preparation for further analysis. (see feeding trial protocol).

Maize was harvested on January 25, 1983. Total green ear weights were measured in the field (to 1/10 kg). Two green ears from each row and the dried grain from the same two ears were weighed in the laboratory (to 1/10 g). Dry grain, dry leaf, and green leaf yields per hectare were then

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[1] Winrock International
[2] Ministry of Livestock Development, Deceased

calculated for each row.

Feeding Trial

Each day the harvested leaves were mixed together and divided as feed for 2 pregnant, lactating Toggenburg does. Mineral salt (including some Ca and P) was fed at the milk stand. Feed offered, feed refused, and feces voided were sampled daily. The daily samples were analysed separately for dry matter (residue after drying to constant weight at 70°C). Ash and Kjeldahl nitrogen were measured by the procedures of the Association of Official Analytical Chemists (1975). Fiber components were estimated by the detergent system (Van Soest and Robertson, 1980), calcium by flame photometry and phosphorus by colorimetric determination. The feeding trail continued for 38 days. The first 8 days were considered a preliminary period, the last 30 days the collection period. The observations of the 2 goats performance in selection and digestion of the maize-leaf strippings are based on this latter 30-day period, when the goats were fed materials from plants 56 to 85 days post-planting.

Because the digestibility of the plant matter eaten at maximum-intake may differ from that eaten at restricted intake, separate restricted-intake digestion and maximum-intake trials are not appropriate. This is especially true for goats consuming tropical forages. Therefore, these trials were designed to allow for selection of favoured plant parts by the goats. Digestion figures were calculated as follows:

$$D = \frac{(O - R) - F}{O - R}$$

Where;

D = Digestibility of a given component "A"

O = Quantity of a given component "A" in the offering.

R = Quantity of a given component "A" in the refusal

F = Quantity of a given component "A" in the feces.

Therefore, digestibility figures are based on the amounts and compositions of meals actually ingested, not on the composition of the offering itself.

Results

Agronomy

Dry maize grain yields were calculated in kg/ha and plotted against the number of days from planting to stripping of leaves. (Figures 1a and 1b). Optimum grain yields were obtained from Katumani composite when leaves were taken between 60 and 75 days after planting and from Hybird 512 variety when taken between 65 and 75 days. Some of the Hybrid 512 rows stripped early had yields in excess of 2000 kg/ha. Differences in soil fertility and drainage were probably responsible for the variable day-to-day responses in the Hydrid 512 plots. Dry-grain yields during the 60-75 day period was 1503.8 kg/ha for Hybrid 512 and 1096.6 kg/ha for Katumani. Leaf dry-matter yields during the

60-75 day period were 191.4 kg/ha for Hybrid 512 and 134.4 kg/ha for Katumani (Figure 2a and 2b).

Feeding Trial

Table 1 shows the apparent digestibilities of each feed fraction and chemical compositions of offerings, refusals, and feces. Dry matter, cell wall, protein, and organic matter digestibilities fall in the 60% to 65% range. Some of the apparent digestibilities of other components may have been biased by unrecorded mineral salt ingestion. Organic matter digestibilities of only 65% to 68% indicate that energy could be limiting for lactating, pregnant goats.

The chemical composition of combined samples of the 2 maize varieties did not vary signicantly with time. One exception to the temporal uniformity was the phosphorus content of stripped leaves, which increased steadily from 0.14% in the first week of stripping (days 49-55) to 0.46% during the last week (days 70-85) (Figure 3).

Table 2 shows intake, refusals, and feces on wet, dry and organic matter weight basis. Approximately one-third of offered feed was rejected by the goats, while the digestive tract apparently voided about one-third of the dry matter and organic matter ingested. This apparently digested fraction includes degraded materials that had been converted to bacteria and other metabolic matter.

Animals appeared to maintain their weight (Table 3) although conclusions regarding withdrawal of body reserves cannot be drawn without body composition data. Milk production dropped drastically during this trial (see figures 4a and 4b). Doe 17 was in her fourth month of gestation and eighth months of lactation, while Doe 23 was in her third month of gestation and seventh month of lactation. The drop in milk production is probably associated with a) inadequate nutrition, b) demands of gestation and accompanying changes in hormonal patterns (e. g., progesterones), and c) inadequate energy intake. All three factors probably contributed to the shortened lactations of both does.

Three weeks after the end of the trial, Doe 17 gave birth to a 3 kg male kid. Six weeks after the trial ended, Doe 23 gave birth to female twins, 2.5 kg each. These events support association b) above.

Conclusions

Maize-leaf strippings as a sole diet were not sufficient to maintain lactation during late pregnancy; however, they represent a valuable feed resource that could adequately meet the needs of animals in a less demanding physiological state. When mixed with higher energy feeds, leaf stripping could help meet the needs of animals similar to those reported here.

Further experimentation is needed to 1) characterize the mineral (specifically calcium, phosphorus, magnesium, and potassium,) content of leaf strippings of these and other maize varieties, 2) expand agronomic testing to long rains crops, and 3) increase the number of test animals to obtain more general and reliable information on intake, apparent digestibility, and performance.

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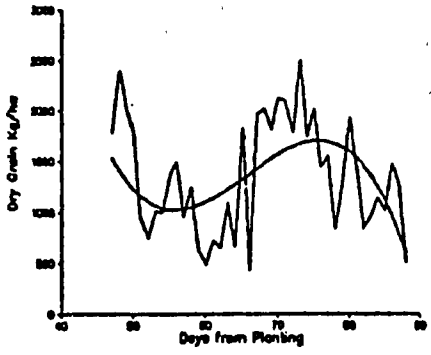
FIG. 1. DRY-GRAIN YIELD (Kg/ha):

(a) Embu 512



(b) Katumani

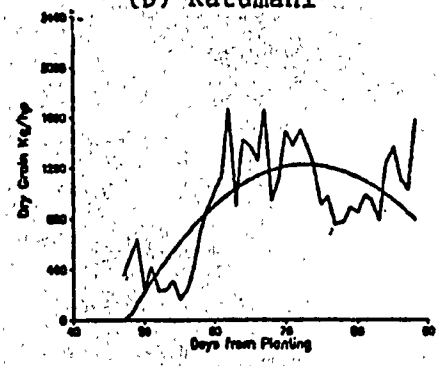
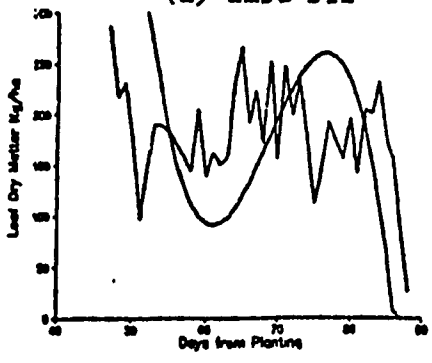


FIG. 2. DRY-LEAF YIELD (Kg/ha):

(a) Embu 512



(b) Katumani

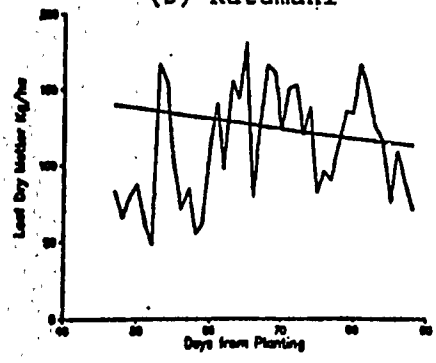


Fig. 3 Percent Phosphorus vs Day since Planting

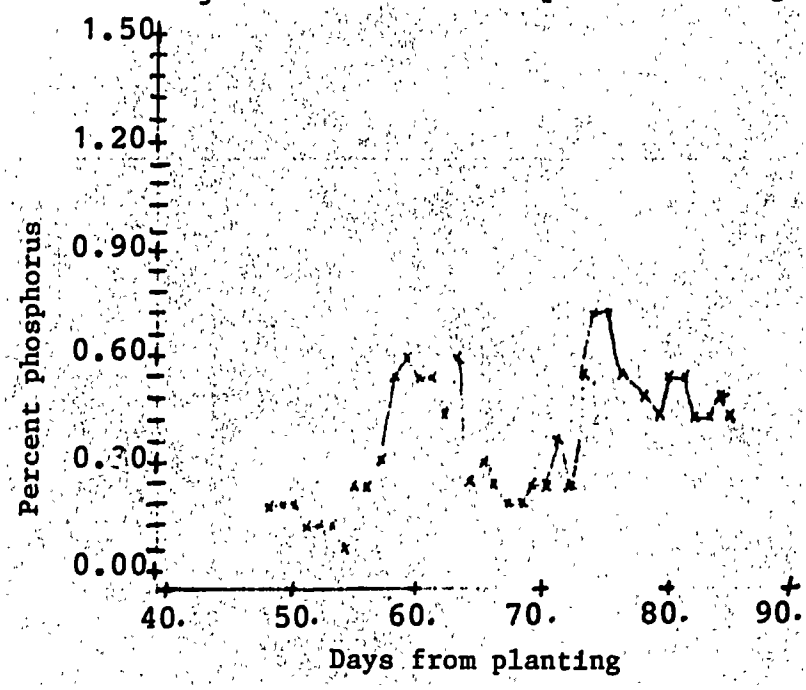


Fig. 4(a) Milk Yield vs Day after planting Goat 17

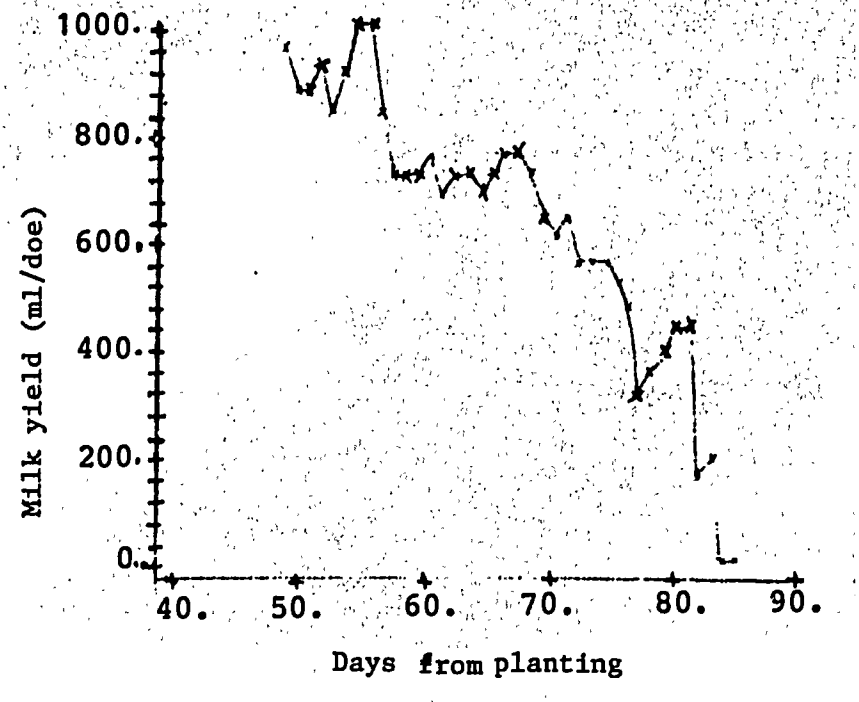


Fig. 4(b) Milk Yield vs Day after planting Goat 23

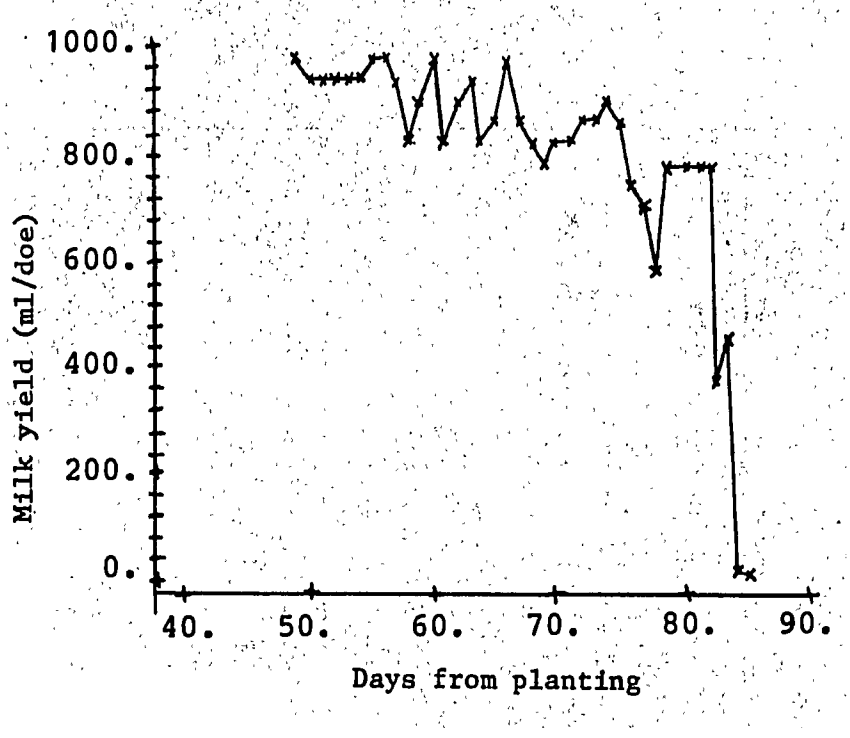


TABLE 1. Chemical composition of feeds, refusals, feces and apparent digestibilities of fractions. All figures are % of dry matter, except dry matter itself, expressed as % of fresh material.

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

* Feeding of unrecorded amounts of mineral salts affect these figures.
** Averages of 30 days sampling (days 56-85 after planting).
*** Figures from goat 17 on left, goat 23 on right.

TABLE 2. Offerings, refusals, intakes and fecal outputs, KG

Animal	Fresh				Dry Matter				Organic Matter			
Number	Offered	Refused	Intake	Feces	Offered	Refused	Intake	Feces	Offered	Refused	Intake	Feces
17	9.40	2.24	7.16	1.33	1.870	.543	1.327	.495	1.48	.405	1.075	.350
23	9.40	2.10	7.30	1.50	1.870	.452	1.418	.557	1.48	.334	1.146	.404

TABLE 3. Animal performance

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

[a] Values between parentheses show highest and lowest milk yield during the trial period.

PERFORMANCE OF DUAL-PURPOSE DOES AND KIDS UNDER DIFFERENT MILKING AND NURSING MANAGEMENT SYSTEMS

By

A.E. Sidahmed[1], M.S.Khainga[2], H.A. Fitzhugh[1] and L. Musalia[2]

The traditional husbandry of dual-purpose goats in many parts of the world (i.e. the Nubian villages of northern Sudan) permit both kid nursing and human consumption of milk. The hazards of spreading mastitis by the nursing kids are minimal among such small numbers of goats raised by each household. However, a major criticism against kid nursing in modern dairy goat husbandry is centered upon its implication on the behaviour of the lactating does (i.e. milk letdown).

The dual-purpose goat production systems project aims at establishing an improved goat rearing system in the small farms of Western Kenya. The major objective is to upgrade farmers' livelihoods by providing them with more sources of high quality food. This can be accomplished if sufficient milk production is attained for both kids and human consumption.

Material and Methods

This study is one among a series where local feed resources were provided to lactating dual-purpose goat females (1/2 to 3/4 Toggenburg x 1/2 to 1/4 East Africa crosses - 4 to 5 years old). In the present study, kids were raised to weaning weight solely on milk. In a succeeding experiment, the kids will have access to forage consumption in addition to milk. Three milking and nursing management systems were compared.

1. Hand milking twice per day (morning and evening). All kids bottle fed to satisfaction.
2. Hand milking once per day (mornings). Kids bottle fed the exact amount produced by the mothers in the mornings and suckled the evening meals.
3. Hand milking one half udder and letting the kids nurse the other half in the mornings. Reverse teats in the evenings.

All animals were assigned to the treatments 5 days after parturition. The does were fed in confinement, but left to graze only during acute feed shortage (i.e. January). Milk yield and consumption (by kids) was recorded to the nearest 25 grams twice per day. Suckled milk was estimated by difference in kid weight before and after nursing. From birth to weaning, kids were weighed daily. Weaners and does were weighed routinely every week. Based on the recomendations reported by Brown and Nderito (1983), all kids were weaned at 10 kg of body weight. The results presented here cover the first 16 weeks of lactation.

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[1] Winrock International
[2] Ministry of Agriculture and Livestock Development (MALD)

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Results and Discussion

Doe feed menu is shown in Table 1. Also, data on kidding dates, birth weights, doe body weights and milk production are presented in Tables 2 and 3. All does maintained their body weights during the trial (29.0 ± 1.4, 28.1 ± 1.3 and 31.7 ± 1.1 kg for treatments 1, 2, and 3, respectively).

The growth rates of the kids is shown in Figure 1. Dailv means for kids in treatments 1, 2 and 3 were .184, .072 and .064, respectively. The growth rate of kids on ad lib milk consumption was faster than that of kids restricted to all or half their mothers' yield. While kids in treatment 1 reached weaning weight in 52 days and consumed 77 kg of milk, those in the other treatments were not weaned during the first 4 months of their age. Milk consumption in 16 weeks was 81 kg by kids in treatment 2 and 55 in treatment 3.

Although free access to milk resulted in faster growth rate, this system cannot be applied in practice as it required more milk than produced by the mothers. Supplemented feed intake in addition to milk consumption may provide more efficient growth. This assumption was based on findings reported by Jagusch et al (1983) who investigated the metabolic efficiency of milk-fed kids. In their studies, kids under free-access milk rearing systems did not grow very fast, despite the large volume of milk consumed. This was attributed to low efficiency of ME utilization by kids caused by the high energy cost of protein synthesis.

Conclusion

Free milk consumption contributed to faster growth rate of kids compared to others consuming exactly all or half of their mother's production. However, this fast growth rate was neither efficient nor economical. Further investigation on the effect of forage supplementation to milk consumption is urgently needed. Also, the influence of different milking and nursing systems on animal health needs examination.

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Table 1. Feed Menu

Week of Lactation		GRAZING	SUDAN GRASS	COUCH GRASS	NAPIER GRASS	PIGEON PEA	S. POTATO VINES	SORGHUM STOVER	DAIRY MEAL
Nov.	4								
	5	X		X		X			
	6	X	X				X	X	
	7			X	X	X			X
Dec.	8		X		X		X		
	9				X		X		
	10		X		X		X		
	11		X		X		X		
Jan.	12		X		X	X	X	X	
	13		X		X	X	X		
	14		X			X	X		
	15	X	X				X		
	16	X	X				X	X	

Table 2. Kidding Dates, Birth Weight and Doe Body Weight*

Treatment	n	Average Kidding Date	Birth Wt. (kg)	Doe Body Wt. (kg)
1	4	October 7	2.9 ± 0.4	29.0 ± 1.4
2	4	October 13	3.1 ± 0.2	28.1 ± 1.3
3	4	October 16	3.3 ± 0.6	31.7 ± 1.1

* ± SD

Table 3. Milk Production

Treatment	Daily (g/doe) Mean	Daily (g/doe) Range	Total of 4 mos. Lactation
1	627 ± 12	455 - 1000	74.7 ± 1.4
2	662 ± 7	535 - 930	79.6 ± 0.9
3	885 ± 11	735 - 1315	106.2 ± 0.8

Table 4. Milk Consumed

Treatment	Daily (g/kid) Mean	Daily (g/kid) Range	Total (kg/kid)	Age at 10 kg BWT
1	1488 ± 186	900 - 2300	77	52 days
2	682 ± 161	500 - 800	81	4 months
3	461 ± 38	400 - 700	55	4 months

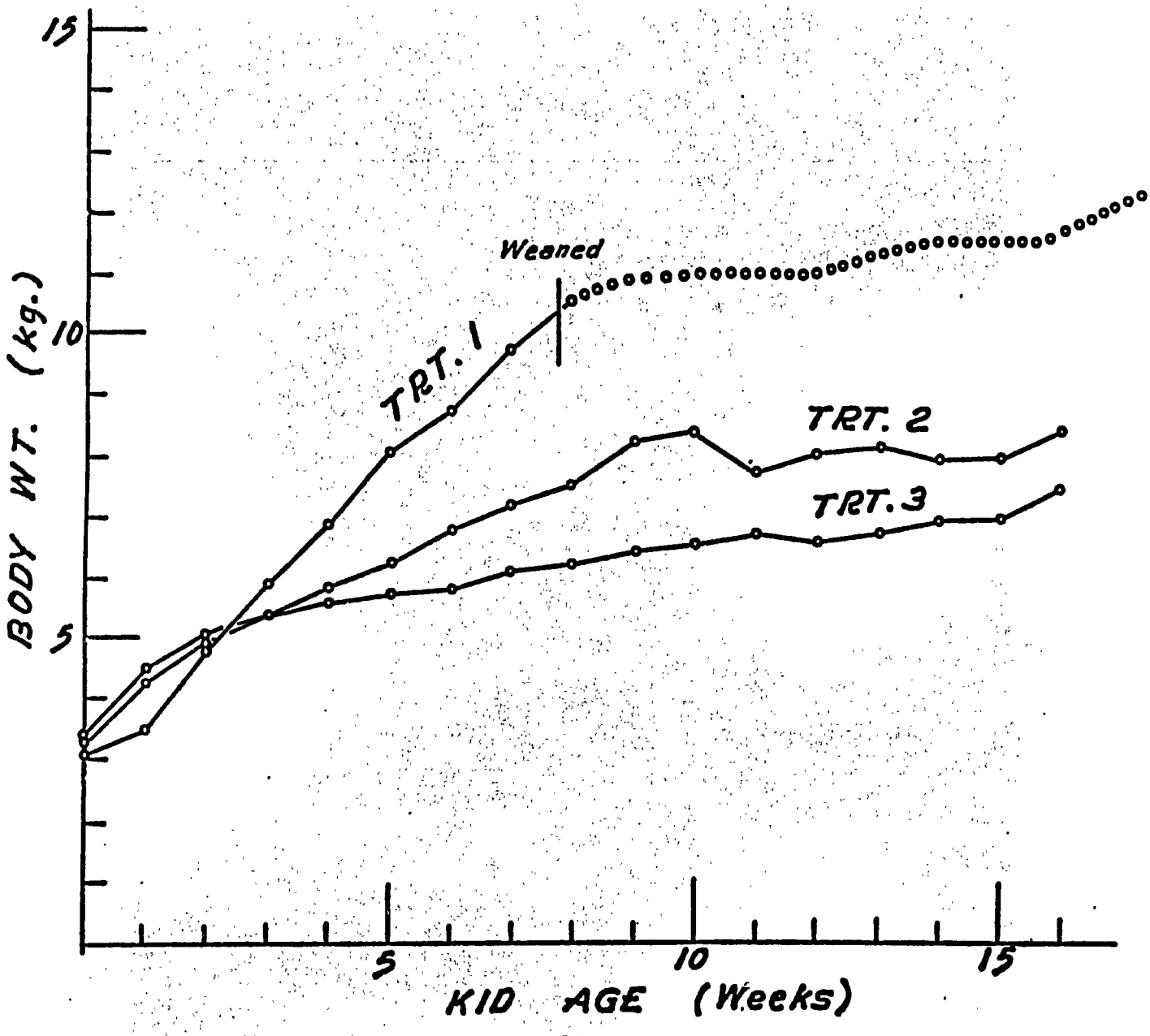

Figure 1: Growth curves for goat kids on different preweaning treatments (1 ad lib bottle fed, 2 limited bottle fed and suckled, 3 suckled half udder).

CHEMICAL COMPOSITION AND DIGESTIBILITY VALUES FOR SOME IMPORTANT FORAGE RESOURCES CONSUMED BY DUAL-PURPOSE GOATS IN WESTERN KENYA

By

A.E. Sidahmed[1], J. Reed[2], M. Butterworth[2], K. Otieno[3], and H.A. Fitzhugh[1]

Forage evaluation is important in attempts to utilize feeds for animal production. However, the important parameters investigated vary with the various characteristics of the forages (Van Soest, 1982; Van Soest et al, 1978; Horvath, 1980; and Reed, 1983). While protein concentration and digestibility can be adequate guides for the value of some forages, antiquality (i.e. tannins) or structural components (CWC, lignin, silica, etc.,) can be important for evaluation of other forages. Further, accuracy and consistency of laboratory methodologies are equally important factors for reliable interpretation of results (Pigden et al, 1980).

The objective of this study was to evaluate, through laboratory techniques - chemical and *in vitro* digestion - the quality of some important forage resources consumed by dual-purpose goats in Western Kenya.

Materials and Methods

Hand clippings of the following forages were collected from farms in Siaya District (Masumbi cluster), and from the pastures of the veterinary farm in Maseno.

I. Forage crops:

a. Grasses:

1. Bana grass (*Pennisetum Purpureum* x *P. typhoides*)
2. Couch grass *Digitaria scalanum*)
3. Pakistan hybrid (*Pennisetum derivative*)
4. Sudan grass (*Sorghum* var *Sudanese*)
5. Star grass (*Cynodon dactylon*)
6. Clone 13 (*Pennisetum* derivative)
7. Giant Pannicum (*Panicum maximum*)

b. Browse (Trees, shrubs and leguminous trees)

1. *Lantana camara*
2. Bwar (*Aspilia kilimanjaricum*)
3. Hydroctyle sp.
4. Sesbania (*Sesbania* var *nubian*)
5. Leucaena (*Leucaena Leucocephala*)
6. Mango leaves; *Mangiferu indica*
7. "Olando" leaves
8. "Powo" (*Grewia trichocarpa*)

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1 Winrock International
2 International Livestock Centre for Africa (ILCA) - Addis Ababa
3 Ministry of Livestock Development

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II. Dual-purpose (Food/forage) crops (DPC):
1. Sweet potato vines (Ipomoea batata
2. Cassava leaves (Manihot esculenta)
3. Pigeon pea (Cajanus cajan)
4. Maize leaves (Zea mays)

All of the above forage samples were collected in November (1983) during the short-rain period where most of them are generally at better nutritive and phenological stage.

Each sample was sun dried (in brown paper bags) for two days before drying at 60°C in a forced air draft oven. All samples were ground (1 mm screen) and transported to ICLA nutrition laboratory in Ethiopia (Addis Ababa) for analysis. The following methods were used;

Kjeldahl nitrogen (AOAC, 1975); detergent partitioning of dry matter including NDR, ADR, sulphuric Lignin, and Silica (VanSoest and Robertson, 1980) and in vitro apparent digestibility of dry matter - (IVADDM) (Goering and Van Soest). Acid detergent nitrogen (ADN) was calculated from Mertens' (1973) equation; ADN = 0.0193 ADR + 0.0393.

Results and Discussion

Values for crude protein (CP), fiber components (Neutral detergent residue (NDR), acid detergent residue (ADR), and sulphuric lignin), silica, ADN and ADN as a percentage of total nitrogen (TN) are shown in Table 1. CP values were lowest in grasses (11.1 ± 3.5, range 4.4 - 15.5) and highest in the browse forages (19.2 ± 5.8, range 6.6 - 22.1%). In the dual-purpose crops (DPC), CP value were 16.2 ± 5.1 and ranged between 9.5 and 24.5%. In vitro apparent digestibility of dry matter (IVADDM) values were of equal magnitude for grasses and DPC (67.8 ± 7.0 and 67.5 ± 5.8% respectively) and lower in browse forages (16.1 ± 10.2%). However, the grasses contained higher NDR concentration (58.9 ± 7.5%) than DPC and browse forages (43.3 ± 3.8 and 40.3 ± 6.9% respectively). On the other hand browse forages were higher in sulphuric lignin concentration (12.5 ± 7.1%) than DPC (9.5 ± 4.5%) and grass forages (4.6 ± 1.4%). These trends indicated that the proportions of digestible energy (indicated by IVADDM) cannot be predicted by CP, NDR or sulphuric lignin only. For example, the relationship between IVADDM and CP of the 19 feeds was poor (Figure 1) and only 10% of the variation in IVADDM was contributed by CP concentration. These conclusions agreed with reports on the complexity of factors influencing utilization of forages by ruminants (Van Soest 1982). Sidahmed (1981) and Reed (1983) reported that polyphenolic compounds (i.e. tannins and lignins) were important inhibitors in browse species. Also biogenic silica (SiO_2) above 2% was found to reduce the digestibility of organic matter in the plants (Van Soest and Jones, 1968).

McDowell (1972) suggested that maximum genetic capacity for performance in weight gain or milk yield of ruminants could be reached when digestibility exceeds 70%. It is noticed from the values reported in Table 1 that in each forage class (grasses, DPC or browse) some species have IVADDM above 70%.

" " Names in Luo Language

Therefore, these forages were suggested as the most promising feed resources in our attempts to establish adequate feed supplies for dual-purpose goat nutrition in Western Kenya. These forages (Sesbania, Sudan grass, maize leaves and bana grass) also had the lowest lignin and ADN values. Mango leaves, Bwar and giant panicum were suggested as least promising since IVADDM values were low (46, 54 and 57%) either unavailable nitrogen (ADN or lignin were very high. Also it was noticed that mango leaves were high in biogenic silica. Leucaena, pigeon pea and sweet potato vines were moderate in IVADDM values though fairly high in CP concentration and with low silica.

Conclusion

These preliminary results are useful in setting initial priorities for considering the most promising forages in our attempts to upgrade the nutrition status of dual-purpose goats on small farms in Western Kenya. However, adaptation of the most promising species to the local environment of each location (i.e. Kakamega versus Siaya) as well as the influence of diet selection and foraging behaviour of goats on feed quality must be considered.

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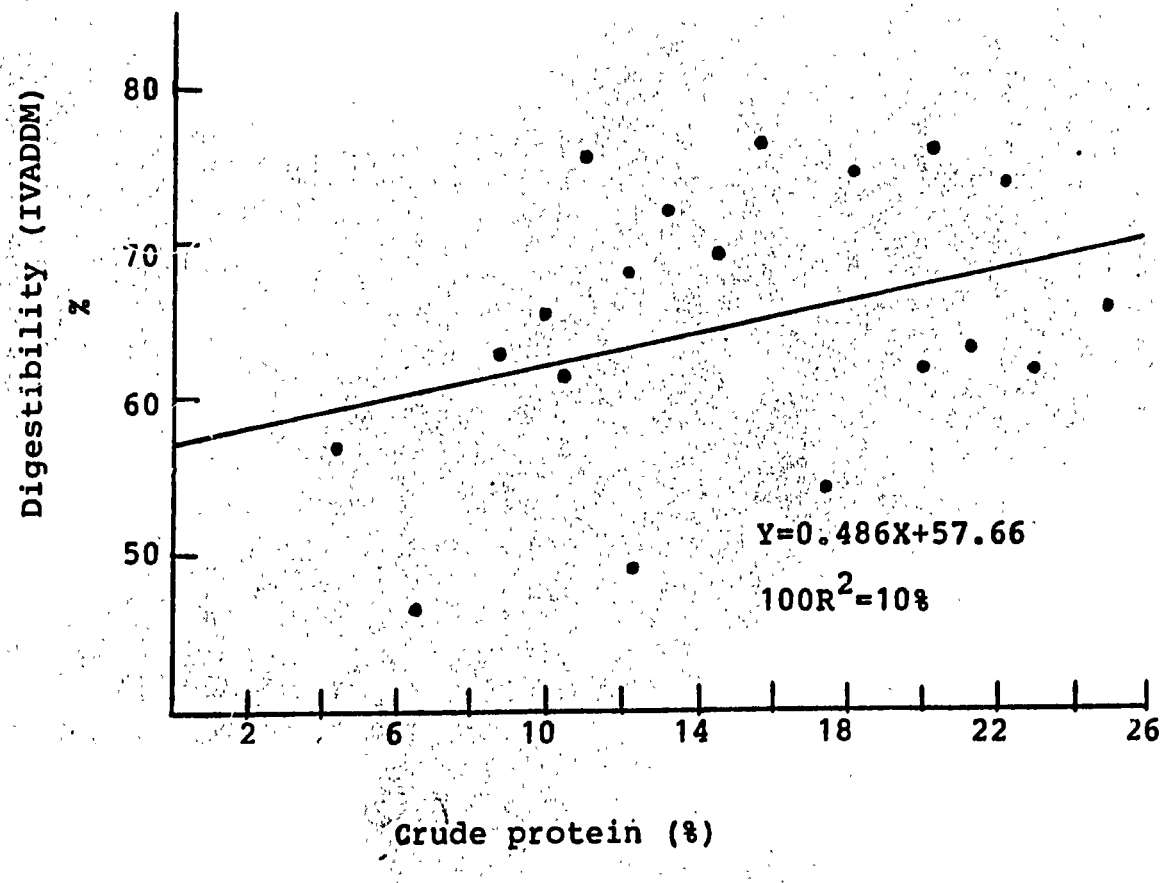
TABLE 1. DIGESTIBILITY AND CHEMICAL COMPOSITION (% OF DRY MATTER) VALUES OF VARIOUS LOCAL FORAGE RESOURCES IN WESTERN KENYA.

Item	IVADDM	CP	ADN		NDR	ADR	SULPHURIC LIGNIN	SILI
			% OF DM	% OF TN				
A) Forage crops								
a) Grasses								
1. Bana grass	76.2	15.5	1.02	41	56.0	33.1	3.1	2.8
2. Gouch grass	63.0	8.8	1.18	84	64.2	41.1	6.6	2.5
3. Napier grass	76.1	11.0	1.1	63	63.1	37.4	3.7	1.6
4. Sudan grass	72.0	13.3	1.1	50	58.9	34.6	3.9	3.1
5. Star grass	61.3	10.5	1.1	64	67.9	36.2	6,5	2.9
6. Clone 13	69.9	14.4	1.05	46	50.4	34.4	3.4	5.8
7. Giant pannicum	57.5	4.3	1.2	71	68.9	44.1	5.2	3.9
b) Browse (Trees, Shrubs & Leguminous trees):								
1. *Lantana Camara* leaves	62.6	19.8	1.3	40	45.7	44.2	24.4	1.3
2. "Bwar" leaves	53.9	17.3	1.3	46	46.2	45.5	23.5	0.3
3. Hydroctyle leaves	68.8	11.9	0.9	49	34.00	28.6	6.6	1.5
4. Sesbania leaves & twigs	74.3	22.1	0.8	23	31.3	22.4	5.7	0.4
5. Leucaena leaves	57.7	21.3	1.0	29	42.6	30.4	14.6	0.3
6. Mango leaves	46.5	6.6	1.2	>100	39.3	38.9	12.2	5.6
7. "Olando" leaves	74.9	18.1	0.8	28	32.1	21.5	7.5	0.6
8. Grewia tricocardia	49.1	12.4	1.1	54	50.6	35.2	13.3	0.5
B) Dual-purpose (Food/Forage) crops.								
1. Sweet potato vines	65.3	9.8	1.4	73	39.3	39.2	14.6	1.1
2. Cassava leaves	66.1	24.8	.89	22	39.6	25.9	8.9	0.5
3. Pigeon pea leaves	62.1	23.0	1.04	29	45.6	33.7	11.9	1.0
4. Maize leaves	76.6	20.1	.87	27	47.7	24.5	2.6	2.6

Quotes indicate names in Luo language.

Figure 1: The relationship between digestibility (IVADDM) and crude protein content of 19 local forages in Western Kenya.



MATCHING FEED RESOURCES TO REQUIREMENTS FOR DUAL-PURPOSE GOATS IN WESTERN KENYA

By
J.F.M. Onim[1], R.D. Hart[1], S. Russo[1], K. Otieno[2] and H.A. Fitzhugh[1]

Introduction

Availability of livestock feeds in Western Kenya is one of the major factors that limits populations and productivity of livestock in the various agro-ecological zones (Sands et. al. 1983; Russo et. al. 1983). The main sources of feeds in this area are:

1. Off-farm grazing on communal pastures and along road sides,
2. On-farm grazing on fallow land,
3. Fence-row cut-and-carry, and
4. Crop residues.

These sources represent the old technology. Fluctuations of the quantity and quality of feeds are mainly influenced by availability of moisture and soil fertility. Populations of large and small ruminants in these densely populated areas therefore depend primarily on the amount and quality of feeds that these areas can produce.

Utilization of feeds in the study area around the year when farmers used the old technology has been reported (Sands et al. 1983; Russo et al. 1983). A number of interventions have been recently tried to increase both the quantity and quality of feeds in these areas (Hart et al. 1984). These included the introduction of higher yielding and better quality forage crops like sudan grass (Sorghum sudanense), pigeon pea (Cajanus cajan), and Sesbania (Sesbania sesban var sesban). These forage crops have been planted both as fence-row and intercrops with food crops. Planting of food crops with higher forage producing potentials like sweet potato (Ipomoea batata), maize (Zea mays) and grain sorghum (Sorghum bicolor) have also been encouraged. Feed surpluses from these sources can be preserved as hay or silage. These interventions represent a new feed production and preservation technology in these areas.

A critical comparison of annual feed production and its demand by livestock per month in the farms between the old and new technologies should indicate the number of livestock units a given farm can support. This paper reports the results of such a study in Hamisi and Siaya in Western Kenya.

Materials and Methods

Sources, quantities of dry matter (DM), estimated contents of digestible energy (DE) and crude protein (CP) of feed generated by the old and new

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technologies in two different testing sites in Hamisi and Siaya were determined. A micro-computer nutritional budget spreadsheet technique was used in the development of this feed resource analytical framework to make quantitative measurement of the flow of materials and energy from the different feed resources. A supercalc (copyrighted software program developed by Sorcim Corporation) spreadsheet was used for this analysis. The procedure used has been described in detail in our technical report (Hart et al. 1984); however, the main steps will be briefly described in this paper.

In order to understand the factors which influence feed quantities, quality and its annual distribution, the spreadsheets begin by describing ecological environments, followed by farm resources. These preliminary nutritional budgets begin by allocating a percentage of the land resource pool to different cropping systems and fence-row areas.

One set of data was collected on a 1.0 ha and 1.5 ha farms with no goat nor feed technology in Hamisi and Siaya, respectively. Farms of similar sizes in Hamisi and Siaya were used to generate data for the new goat and feed technology. Farms with the new goat and feed technology grew sudan grass intercropped in the maize-maize cropping system; and pigeon pea was intercropped in the maize and bean intercropping system, and some were planted in the fence-rows.

Seven feed resources were included in the budgets from the full cropping systems:

1. Maize-maize - This was a monoculture of maize planted in March, followed by another monoculture of maize in September.
2. (Maize + Phaseolus beans) - maize. As in the order in (1), this was maize intercropped with Phaseolus beans in March, followed by a monoculture of maize in September.
3. A 12-month cassava crop monoculture (April to April).
4. A fence-row area assumed to be a one-meter wide strip between all farm plots.
5. A fallow area calculated on a monthly basis by subtracting all areas planted to crops or allocated to fence-row from the total available land.
6. Off-farm grazing area; and
7. Purchased feed concentrates. These are shown as zero on all farm budgets since at present time farmers do not purchase concentrates or feed supplements.

Each of the feed resources sub-budgets requires that data is entered for land area, production per area in DM units, percent CP of DM, and DE of DM. The spreadsheet then multiplies production per unit area by the area allocated to the resource unit, and percent CP and DE per DM by the DM per unit area to produce totals of DM, CP, and DE for each month of the year.

The budgets presented in this paper for both the old and new goat and feed technologies include a hay or silage unit. Hay or silage was produced by taking 50% of crop residue at the two peak harvesting periods in July and December, or from surplus sudan grass, pigeon pea, sesbania, maize leaf strippings and thinnings from these crops. The rate that farmers use this crop residue is not known; therefore, in the budget, crop residue is arbitrarily made available in equal amounts over a four-month period following

crop harvest.

The total demand from livestock on each of the farms with and without the new goat and feed technologies was calculated from separate cattle, sheep and goat herd budgets. Each herd had four females with either calves, lambs, or kids. In each of the herds, calving, lambing and kidding time occurs at a different time period for each of the four females. The energy demand for each female and each offspring was calculated by beginning with a constant maintenance requirement (e.g. 367 Mcal/month for adult cattle), based on an estimate live weight at monthly intervals, and then adding energy demand during lactation (e.g. 216 Mcal/month for lactating cows).

In designing the goat herd budget, it was assumed that a farm family would require one-liter of milk per day for home consumption throughout the year. It was also assumed that each doe could raise two kids per year, with weaning occurring at two months, first kidding at 18 months, and culling at 64 months. Mature does are assumed to produce two liters of milk per day, with one liter being consumed by the goat kids.

Results and Discussion

Results presented in table 1 show individual feed sources, total demand by livestock types, and net feed balance for each month of the year in Hamisi and Siaya, with and without new goat and feed technologies. With the old technology, Hamisi has a DE dificit of 84 Mcal in March. However, without goats in this system, the cattle and sheep on the farm have a total apparent net saving of 11,553 Mcal in a year. It should be noted that 52 % of this saving results from maize stover following harvests in the months of July and December. With the old technology Siaya experiences a DE deficit of 194 Mcal in February and runs to about zero in March. In the case of Siaya, only 36% of the total net annual DE of 14,292 Mcal are contributed by maize stover after the March and December harvests

With the new goat technology in Hamisi (table 1), total available DE in May improved from 334 to 2,061 Mcal when the old and new technologies are compared. This is despite the introduction of goats into the system. This represents a six-fold increase. In Siaya, the increase was four-fold (from 1,578 to 6,180 Mcal) for the same period of time. The extra feed in May comes from bean straw after harvesting and leaf strippings from maize. When goats were introduced into the Siaya system, there were DE deficits of 5 and 49 Mcal for the months of March and April, respectively. Feed preservation as hay or silage is practiced in the new feed technology and therefore surplus feeds can be spread out into deficit months. The deficits in March and April in Siaya (table 1) are theoretical since the January and February net savings of 201 and 98, respectively, can be utilized over this period.

In this spreadsheet software package, any section of the data can be examined more closely, with the aid of histograms or other forms of graphs. Take for example, the production and monthly demand of DE by livestock in the two technologies in Hamisi and Siaya. The supercalc package can instantly print out the graphs (figure 1). It is clear in figure 1 that if the surplus feed were preserved then even the old technology can support more livestock. And the new one many more.

As better interventions of feed production are developed, the production graph in figure 1 would keep rising higher and higher. This would call for more livestock units to be added into the system, so that the demand then rises to reduce the extra amount of total net DE. These results indicate that by carefully manipulating the farming systems practices in Western Kenya, even small peasant farms can carry more livestock without necessarily reducing food crop areas.

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Table 1. A comparison of 4 farm system nutritional budgets showing the monthly flow of digestible energy (Mcal) from different feed resources to a resource pool drawn upon by cattle, sheep and goat herds.

HAMISI 1 HA FARM; NO NEW TECHNOLOGY

Feed Resources	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MAIZE-MAIZE	0	0	0	0	0	0	2579	0	0	0	0	1353	3932
M+BEANS-M	0	0	0	0	0	63	6447	0	0	0	0	2705	9215
CASSAVA	0	0	0	0	0	0	0	0	0	0	0	0	0
FENCE/ROW	126	82	95	152	234	218	113	92	142	130	130	145	1658
FALLOW	1176	430	111	177	273	254	131	536	332	302	302	338	4363
OFF-FARM	588	382	445	710	1092	1016	525	428	664	605	605	676	7736
HAY/SIL	453	453	453	453	0	0	0	1008	1008	1008	1008	0	5844
Total Feed	2343	1347	1105	1493	1599	1550	5282	2063	2146	2045	2045	3188	26206
Net Feed	1201	195	-84	266	334	202	3873	818	942	859	893	2054	11553
Tot F Demand	1142	1152	1189	1227	1265	1348	1409	1245	1204	1186	1152	1134	14653
CATTLE	940	972	1004	1037	1069	1098	1159	940	943	947	950	954	12013
GOATS													
SHEEP	202	180	185	190	196	250	250	305	261	239	202	180	2640

HAMISI 1 HA FARM; FEED & GOAT TECHNOLOGY

Feed Resources	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MAIZE-MAIZE	0	0	470	235	1175	0	3143	141	0	0	0	2293	7457
M+BEANS-M	0	0	580	0	1305	1223	7172	580	0	0	0	3517	14377
CASSAVA	0	0	0	0	0	0	0	0	0	0	0	0	0
FENCE/ROW	126	662	95	732	234	218	113	92	142	130	130	145	2819
FALLOW	1176	430	111	177	273	254	131	536	332	302	302	338	4363
OFF-FARM	588	382	445	710	1092	1016	525	428	664	605	605	676	7736
HAY/SIL	707	707	707	707	0	0	0	1272	1272	1272	1272	0	7916
Total Feed	2597	2181	2409	2561	4079	2710	5926	3048	2410	2309	2309	4064	36605
Net Feed	591	138	367	504	2061	581	3675	934	376	221	293	2090	11833
Tot F Demand	2006	2043	2042	2057	2018	2129	2251	2114	2034	2088	2016	1974	24772
CATTLE	940	972	1004	1037	1069	1098	1159	940	943	947	950	954	12013
GOATS	864	891	853	830	753	781	842	869	830	902	864	840	10119
SHEEP	202	180	185	190	196	250	250	305	261	239	202	180	2640

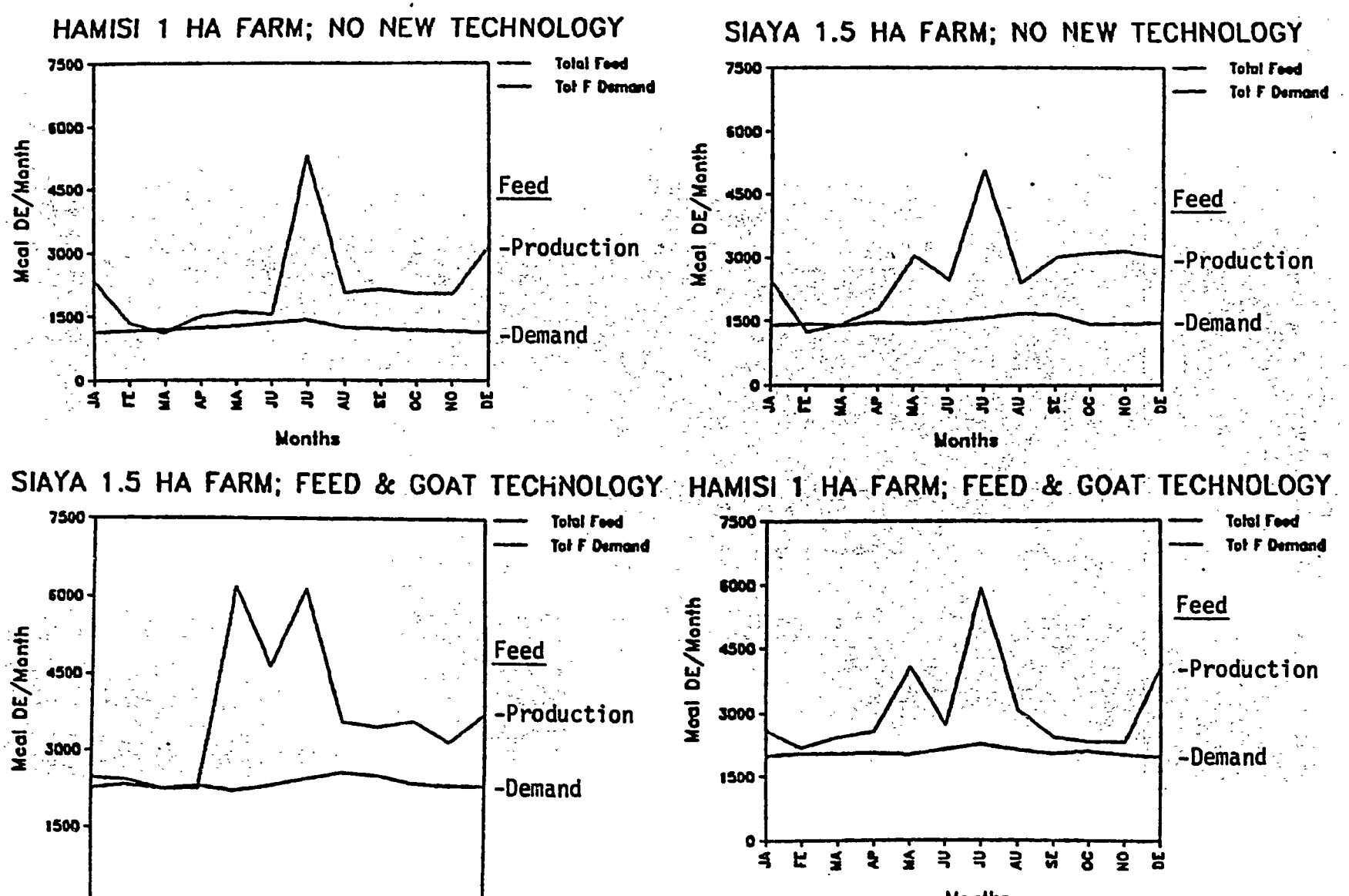
SIAYA 1.5 HA FARM; NO NEW TECHNOLOGY

Feed Resources	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MAIZE-MAIZE	0	0	0	0	0	0	3528	0	0	0	881	0	4409
M+BEANS-M	0	0	0	0	0	219	4410	0	0	0	881	0	5510
CASSAVA	0	0	0	0	0	0	0	0	0	0	0	0	0
FENCE/ROW	77	36	51	96	164	122	60	46	75	79	94	97	997
FALLOW	1084	504	449	337	573	425	211	536	697	739	874	1361	7789
OFF-FARM	1083	504	718	1348	2293	1701	844	642	1046	1109	1310	1361	13959
HAY/SIL	197	197	197	0	0	0	0	1185	1185	1185	0	197	4343
Total Feed	2441	1241	1415	1781	3030	2467	5084	2408	3003	3112	3158	3016	32157
Net Feed	1042	-194	14	311	1578	967	3511	725	1344	1682	1734	1577	14292
Tot F Demand	1399	1435	1401	1470	1452	1500	1573	1683	1659	1430	1424	1439	17865
CATTLE	947	950	954	1040	1055	1069	1138	1188	1202	940	972	1004	12459
GOATS													
SHEEP	452	485	447	430	397	431	435	495	457	490	452	435	5406

SIAYA 1.5 HA FARM; FEED & GOAT TECHNOLOGY

Feed Resources	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
MAIZE-MAIZE	0	0	376	470	1410	0	4468	141	0	0	881	564	8310
M+BEANS-M	0	0	435	0	1740	2394	5570	551	0	0	881	580	12151
CASSAVA	0	0	0	0	0	0	0	0	0	0	0	0	0
FENCE/ROW	77	1196	51	96	164	122	60	46	75	79	94	97	2157
FALLOW	1084	504	449	337	573	425	211	536	697	739	874	907	7336
OFF-FARM	1083	504	718	1348	2293	1701	844	642	1046	1109	1310	1361	13959
HAY/SIL	220	220	220	0	0	0	0	1640	1640	1640	0	220	5800
Total Feed	2464	2424	2249	2251	6180	4642	6134	3555	3458	3567	3159	3729	43813
Net Feed	201	98	-5	-49	3975	2361	3719	1003	969	1235	871	1450	15829
Tot F Demand	2263	2326	2254	2300	2205	2281	2415	2552	2489	2332	2288	2279	27984
CATTLE	947	950	954	1040	1055	1069	1138	1188	1202	940	972	1004	12459
GOATS	864	891	853	830	753	781	842	869	830	902	864	840	10119
SHEEP	452	485	447	430	397	431	435	495	457	490	452	435	5406

Figure 1. A comparison of monthly feed production and feed demand on a 1.0 HA farm in Hamisi and a 1.5 HA farm in Siaya, with and without new feed and goat technology.



POTENTIAL OF INTERCROPPING FORAGE CROPS WITH MAIZE IN WESTERN KENYA

By

J.F.M. Onim[1], R. Hart[1], K. Otieno[2] and H.A. Fitzhugh[1]

This study was conducted in some of the most densely populated parts of Kenya with population densities ranging between 300-900 people/km^2. Many farms are less than one hectare in size and farmers must augment their food production with frequent purchases. Cattle populations are decreasing as pressure on the land increases under arable crops. Although most farmers sell their cattle to raise money for various needs, others do so because they can no longer manage to feed them (Russo et al 1983; Onim et al 1983).

The main objective of the Small Ruminants Collaborative Research Support Programme (SR-CRSP) in Western Kenya is to evaluate potential for the Dual-Purpose Goat (DPG) in these heavily populated peasant farming areas. These DPGs provide the farmer with milk, meat, cash from sales and manure.

Since both quantity and quality of livestock feeds are inadequate during several months each year in Western Kenya, the Feed Resources Project (FR) has conducted several experiments to alleviate these limitations. A number of interventions have been tried to improve on-farm feed supply. One of the interventions was to investigate the potential of intercropping food and forage crops in several environments in Western Kenya. This paper reports preliminary results of this study.

Materials and Methods

Experimental Sites:

The trial was planted on farmer's fields in Siaya, Hamisi, Kaimosi and the Maseno Veterinary Research Station, using three replications per location. These environments differ widely in many aspects. Kaimosi and Hamisi are at altitudes ranging between 1500 and 2000 m, with a bimodal rainfall pattern of 1800 to 2000 mm per year. They are located in a high potential agro-ecological zone. The Maseno Veterinary Research Station is situated on the equator at an altitude of 1550 m with a lower rainfall than Kaimosi and Hamisi. Although Siaya also has a bimodal rainfall pattern, it is much drier, with annual rainfall ranging between 1000 and 1400 mm, and the altitude is between 1000 and 1400 m, with a relatively flat terrain. Siaya is considered to be a medium potential agro-ecological zone.

Methods

In October 1983, Sudan grass (*Sorghum sudanense*), pigeon pea (*Cajanus cajan*) - cultivar Kioko, and Sesbania (*Sesbania sesban* var. *nubian*) were

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1 Winrock International

2 Ministry of Agriculture and Livestock Development (MALD)

intercropped with maize (Zea mays) - Hybrid 512 in a split plot design. The main plots were fertilizer treatments (NPK 20-20-0) at the rate of 40 kg/ha of N, P_2O_5 and the sub-plots were crops and their intercropping combinations.

Maize was planted at the standard spacing of 90 cm between rows and 30 cm between plants in the row. Pigeon pea and Sesbania were then planted between these rows but only 45 cm from maize rows and within row spacing of 30 cm. between plants. Sudan grass was drilled between maize rows at the same spacing as the other forage crops. Fertilizer was applied only once at planting time.

Maize, pigeon pea and Sesbania were thinned to single plants per hill at the second weeding. The thinnings were oven dried at 80°C for 24 hours. Because various forages were ready for feeding at different times in the various treatments and environments, sampling for dry matter yield estimates were done whenever any forage was ready. Dry matter yields from each forage in one environment were accumulated until the last sampling was done at the end of the second rainy season in February, 1984. Maize grain and stover dry matter yields were also estimated when the crop matured in the various environments between mid and end of February, 1984.

Results

The experimental plots in Hamisi were destroyed by the farmers' livestock, therefore observations from this site have not been included in this paper.

In Siaya, there was a complete crop failure for maize grain yield because of a severe drought. However, dry matter stover yields of maize and forage yields were estimated. Taking the average forage yields of all crops at the Siaya environment, fertilized plots outyielded non-fertilized ones by 5.47 mt/ha, which is equivalent to 182.94% (Table 1). It was further observed that total forage yields were higher in intercroppped plots than in pure stand by 1.42 mt/ha (59.66%) and 7.89 mt/ha (155.31%) in non-fertilized and fertilized plots, respectively.

Sudan grass was severely attacked by the parasitic weed-Striga (Striga hermontheca). The yield of this grass was thus reduced, especially in non-fertilized plots, to a level where Sudan grass may not be viable in fields where Striga parasitic weed is found.

Rainfall was better at Maseno and a good crop of maize was harvested. Maize grain yields from various treatments are presented in Table 2.

The results in Table 2 indicate that intercropping reduced maize grain yields by 37% and 20% in non-fertilized plots respectively. This yield reduction was significant ($P<0.05$) for all intercropped and non-fertilized plots, and for maize/Sudan grass and maize/Sesbania plots in fertilized plots. There were, however, no significant differences between pure maize and maize/pigeon pea intercropped plots. There was also no difference in grain yields between fertilized and nonfertilized plots in maize pure stand.

Considering only forage dry matter yields at Maseno (Table 3), the difference in mean forage yields between fertilized and non-fertilized plots

was 5.96 mt/ha. This difference shows that response to compound fertilizer (NPK 20-20-0) was only 29.02%. There was, however, no response to fertilizer on maize grain yields in pure maize plots (Table 2).

Results presented in Table 3 clearly show that intercropped plots were much more productive than those where sole crops were planted. In the non-fertilized plots, intercropping increased forage yields by 12.52 mt/ha, an increase of 82.48% over sole crops. In the fertilized plots, this difference was improved to 22.98 mt/ha, giving an improvement of 138.02% over pure crops.

Rainfall in Kaimosi was higher than that received at Maseno and growth rates of both maize and Sudan grass were very fast. However, both pigeon pea and Sesbania grew much slower.

Only maize grain yields at Kaimosi are presented in Table 4. There were no significant differences ($P<0.05$) in maize grain yields between the various treatments in non-fertilized plots, except between maize/Sudan grass, maize/Sesbania and maize/Pigeon pea. In the fertilized plots, maize/pigeon pea intercrop significantly ($P<0.05$) outyielded both pure maize and maize/Sesbania intercrop. There were no significant differences between other crop combinations.

In the non-fertilized plots, maize/Sudan grass intercrop performed significantly ($P<0.05$) poorer than both maize/Sesbania and maize/pigeon pea combinations (Table 4). The non-fertilized maize/pigeon pea plot gave the second highest grain yield (2.34 mt/ha cf 2.47 mt/ha in maize/Sesbania). It should, however, be noted that though non-significantly different ($P<0.05$), pure maize yields ranked third in both fertilized and non-fertilized plots (Table 4). Considering both fertilized and non-fertilized plots, intercropped plots yielded more grains than pure maize plots by 0.35 mt/ha (18.92%).

The effect of fertilizer on forage dry matter yields in Kaimosi are presented in Table 5. These data show that fertilizer increased forage dry matter yields by 6.86 mt/ha (57.31%). Intercropping, on the other hand, increased forage dry matter yields by very large margins - 11.95 mt/ha (174.45%) and 18.27 mt/ha (166.09%) in non -fertilized and fertilized plots, respectively.

Discussion

The data presented in this paper indicate that maize grain yields responded to fertilizer application by only 0.30 mt/ha (16.81%) in Maseno and 0.63 mt/ha (35.00%) in Kaimosi. Mean of these responses is therefore 0.47 mt/ha (25.91%). These results show that the soil fertility both in Maseno and Kaimosi was fairly high. The reason seems to be that since Maseno has been a livestock station over many years, there has been a large accumulation of animal manure in the soil, thereby substantially raising the level of soil fertility. Kaimosi, on the other hand, is in a tropical rain-forest zone where land has been acquired only in the last decade or so. Again, there has been large accumulations of forest biomatter in the soils.

The overall effect of intercropping on maize grain yields showed that intercropping reduced grain yields by 0.71 mt/ha (-40.11%), but it increased yields by 0.35 mt/ha (+19.10%) in both Maseno and Kaimosi, respectively. The

mean effect is that intercropping reduced grain yields by 0.36 mt/ha (-10.51%). It is therefore interesting to note that farmers are not likely to lose significant grain yields when they intercrop their maize with high quality forage crops like Sudan grass, Sesbania and pigeon pea.

This paper further shows that the effects of fertilizer on forage yields were higher than those in maize grain yields. Fertilized plots outyielded non-fertilized ones by 5.47 mt/ha (182.94%), 5.96 mt/ha (29.02%) and 6.86 mt/ha (57.31%) in Siaya, Maseno and Kaimosi, respectively. The overall mean response to phosphates and nitrogen in all three locations was therefore 6.10 mt/ha (89.76%). These results indicate that soils in Siaya are very low in phosphates and nitrogen. It is therefore essential that fertilizers and manures be added before growing crops in the farmers' fields.

The severe attack of the Sudan grass by Striga parasitic weed further indicates that this grass may not be suitable in Siaya. This is because Striga is widespread in farmers fields in Siaya.

Intercropping also increased forage yields above pure stands of all crops. Mean of all locations in non-fertilized plots was higher by 8.63 mt/ha (105.53%) and by 16.38 mt/ha (153.14%) in fertilized plots.

These observations present an interesting option for the farmer. Either the farmer chooses to grow pure maize or intercrops it with other crops like food beans (*Phaseolus vulgaris*) or forage crops. If he chooses to intercrop with food beans, many years research in Kenya shows that he will reduce his maize yields by approximately 10% and obtain bean yields of about 0.80 mt/ha. This study suggests that the farmer may opt to intercrop maize with certain forage crops and reduce his maize grain yields by about 10% (attaining 2.5 mt/ha) but raising his forage yields by between 12.52 to 22.98 mt/ha in four months, thereby increasing productivity of his land by up to 138%. The question is - what is the value of the forage coming from intercropping compared to an alternative food crop like food beans? The choice will certainly depend on the significance a farmer places on his livestock in any given situation. Similarly, that significance will depend upon the productivity of that livestock in economic terms.

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Table 1. Effects of fertilizer and intercropping on forage yields in Siaya (mt/ha)

a) Effect of fertilizer

Crop combinations	Not fertilized	Fertilized
Maize/Sudan grass(M/SG)	2.90	13.8
Maize/Sesbania(M/S)	4.5	13.8
Maize/Pigeon pea (M/PP)	4.0	11.3
Maize (M)	4.8	10.0
Sudan grass (SG)	0.7	5.4
Sesbania (S)	2.3	3.6
Pigeon pea (PP)	1.7	1.3
Totals	20.9	59.2
Means	2.99	8.46
Difference	5.47 mt/ha (182.94%)	

b) Effect of intercropping

	intercropped		pure	
	Not fertilized	Fertilized	Not fertilized	Fertilized
Means	3.80	12.97	2.38	5.08

Intercropped higher by:

Not fertilized - 1.42 mt/ha (59.66%)

Fertilized - 7.89 mt/ha (155.31%)

Table 2. Dry maize grain yields (mt/ha) in various treatments at Maseno

Replicates	Not fertilized				Fertilized				Replicate	
	M	M/SG	M/S	M/PP	M	M/SG	M/S	M/PP	Totals	Means
1	2.68	1.25	0.98	1.75	2.34	1.52	1.75	2.61	14.88	1.86
2	2.19	0.98	1.34	1.52	2.27	2.10	1.51	2.18	14.09	1.76
3	2.61	1.91	2.60	1.75	2.79	2.00	1.99	2.18	17.83	2.23
Treatment totals	7.48	4.14	4.92	5.02	7.40	5.62	5.25	6.97	46.80	
Treatment means	2.49	1.38	1.64	1.67	2.47	1.87	1.75	2.32		1.95

Treatment means $LSD_{0.05} = 0.41$

Treatment means $LSD_{0.01} = 0.56$

Table 3. Mean combined forage dry matter yields (mt/ha) at Maseno

a) Effect of fertilizer

Crop combinations	Not fertilized	Fertilized
M/SG	28.0	38.9
M/S	28.5	39.4
M/PP	26.6	40.6
M	40.2	48.1
SG	6.0	7.2
S	8.7	9.0
PP	5.8	2.3
Totals	143.8	185.5
Means	20.54	26.50
Difference	5.96 mt/ha (29.02%)	

b) Effect of intercropping

	Intercropped		Pure	
	Not fertilized	Fertilized	Not fertilized	Fertilized
Means	27.70	39.63	15.18	16.65

Intercropped higher by:

Not fertilized - 12.52 mt/ha = 82.48%

Fertilized - 22.98 mt/ha = 138.02%

Table 4. Dry maize grain yields (mt/ha) in various treatments at Kaimosi

Replicates	Not fertilized				Fertilized				Replicate	
	M	M/SG	M/S	M/PP	M	M/SG	M/S	M/PP	Totals	Means
1	1.56	1.09	3.64	2.41	2.43	2.08	1.14	1.70	16.05	2.01
2	2.03	0.35	2.35	2.41	1.61	2.39	2.05	3.90	17.09	2.14
3	1.40	0.73	1.42	2.19	2.04	3.87	1.54	4.39	17.58	2.20
Treatment totals	4.99	2.17	7.41	7.01	6.08	8.34	4.73	9.99	50.72	2.11
Treatment means	1.66	0.72	2.47	2.34	2.03	2.78	1.58	3.33		

Treatment $LSD_{0.05}$ = 0.95

Table 5. Effects of fertilizer and intercropping on forage yields in Kaimosi (mt/ha)

a) Effect of fertilizer

Crop combinations	Not fertilized	Fertilized
M/SG	17.2	34.1
M/S	17.5	30.2
M/PP	21.7	23.5
M	10.1	23.1
SG	16.0	17.0
S	0.6	2.9
PP	0.7	1.0
Totals	83.8	131.8
Means	11.97	18.83
Difference	6.86 mt/ha	(57.31%)

b) Effect of intercropping

	intercropped		pure	
	Not fertilized	Fertilized	Not fertilized	Fertilized
Means	18.80	29.27	6.85	11.00

Intercropped higher by:

Not fertilized - 11.95 mt/ha (174.45%)

Fertilized - 18.27 mt/ha (166.09%)

BOTANICAL COMPOSITION AND CRUDE PROTEIN CONTENT OF FORAGE GRAZED AND GRAZING BEHAVIOR OF GOATS AT MASENO FARM AND SR-CRSP CLUSTERS

By

K. Otieno[1], J.F.M. Onim[1], R. Hart[2], and H.A. Fitzhugh[2]

It was established in the initial surveys that there is high land pressure of about 328 people/km^2 in Kakamega district against a population pressure of only about 185 people/km^2 in Siaya district. (Sands et al, 1982). High population pressure imposes a high demand for agricultural land with the effect that very little land is left for grazing livestock. Such a situation has occured in Kakamega district. In Siaya district land still exists for communal grazing.

The role played by the various grazing areas (roadsides and along hedges in Kakamega district and the communal lands in Siaya district) to the maintenance and production needs of dual-purpose goats was evaluated. The purpose of this study was to:

1. Survey and identify the botanical composition of the natural areas commonly grazed by the dual-purpose goats (DPG) at the Maseno farm.
2. Evaluate the crude protein content of those fodder shrubs a.d grasses preferred by the goats as an indicator to their nutritive value, and
3. Observe the grazing behaviour of these goats at the farm and carry out a "bite" count study to approximate the amount of material they consume and the species preferred.

Materials and Methods

The study was done at the Maseno Farm and in two of the SR-CRSP clusters in Kakamega district (Kaimosi and Hamisi) and one cluster in Siaya district (Masumbi).

The study consisted of:

- a determination of the botanical composition of two sites (A and B) where DPGs are usually grazed at the farm,
- a direct observation of the goats during free grazing on these sites,
- a "bite" count study, and
- a collection of leaf samples of shrubs and grasses which are grazed by the goats in the farm and clusters for crude protein analysis.

A 1 m^2 quadrat was used for sampling to determine the botanical composition of the two sites on the farm. After this, goats were initially observed for four days in the sites during their usual grazing hours to establish their times of active grazing and a list of the plants which they consumed. A preliminary "bite" count was then taken using four goats per

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site, the goats being selected randomly on the day of observation and identified by their ear tag numbers. A "bite" was taken as being the act of breaking off or of picking up a piece of forage.

Only six plant species per site were used in the study since we did not have a tally-counter to handle a large number. The six species were those that were often grazed by the goats as identified in the preliminary bite count. The actual bite count was then taken by two observers per goat per observation period (20 minutes per goat). The mean of these counts per individual plant species was then calculated from the two observations. Only one goat was observed per day for each of the four goats per site.

The observation period was planned to coincide with the active feeding times of the goats. Simulated or plucking bites were subsequently done to estimate the amount of dry matter of forage consumed by each goat.

In the clusters, a bite count could not be done as initially planned because of insufficient number of dual-purpose goats there. However, forage samples of the plant species consumed were taken for analysis. The farmers and SR-CRSP enumerators assisted in collecting both cut-and-carry plants and those preferred by the goats.

Results and Discussion

Botanical Composition

The two study sites at the farm are basically continuous paddocks which were originally under Rhodes grass (*Chroris gayana*) but due to overgrazing by cattle in the farm, they have been invaded by some other grasses and herbs consequently there is almost no Rhodes grass left. The poorer parts of field B were dominated by *Solunum incanum*. The major grasses left in the sites include *Sporobolus pyramidalis*, *Brachiaria brizantha* *Digitaria scalarum*, *Cynodon dactylon* and *Hyparrheria sp*. These grasses occupied over 60% of the vegetation cover and almost no browse was available. The results of a quadrat sampling are summarized in Table 1.

Direct Observation During Grazing and "Bite" Count

The results of the "bite" counts at the two sites is summarized in Table 2 for six selected plant species per site.

A simulated "bite" was carried out and the mean dry weights of thirty "bites" per plant species calculated (Table 3). This enabled us to express the real "bite" into mean dry weights of material consumed by the animals.

Crude Protein Analysis.

The average amount of material consumed (g) per observation time has been calculated by multiplying the mean dry weights per bite by mean number of real bites per plant species.

The percent crude protein (CP) content of some of the shrubs and grasses was determined by the Kjeldahl method (where %CP=N in sample x 6.25) and the results are shown in Table 4.

If only bites were used to estimate preference, then it is apparent (Table 2) that goats preferred Digitaria scalarum and Cynodon dactylon. This therefore suggests that estimated availability alone did not seem to influence bites. In Table 1, Cyperrus sp. had a higher percent ground cover in site A than either Cynodon dactylon or Digitaria scalarum. In site B Brachiaria brizantha had higher percent ground cover. The tendancy of goats to browse rather than graze could have had a part to play in this. A number of studies indicate that goats have a preference for browse, and that what is acceptable to one goat is sometimes not acceptable to another (Devendra et al, 1983). Thus the low lying plant species such as Cyperrus sp. were not readily available, especially when found amongst relatively taller grasses such as Cynodon dactylon. As other studies in Kenya indicate, goats significantly eat more leaves, fruits, flowers, stems and petioles than sheep (Hoppe et al, 1977). Thus the relative positioning of these above ground level per plant species may determine the plants which would receive more bites.

Most of the fodder shrubs and grasses collected in this study have reasonably high crude protein content (Table 4). Since crude protein content is significantly correlated to digestible protein content, its determination in a plant can give a reliable indication of feed value (Ibrahim, 1981). Although feeding trials are often needed to provide a more definitive reference, the collection of sufficient leaves and stems of fodder plants for such a trial would require more time, equipment, manpower and expenses than many researchers can afford.

In Table 4 the crude protein values were higher when the sample included young stems and leaves, for example, in Lantana camara, Amaranthus sp., and Sesbania sp. Although the lignin and cellulose content may also be higher in these cases due to the higher levels in stem, goats are known to digest fiber more efficiently than cattle or sheep (Devendra et al, 1983).

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Table 1. Major types of vegetation of the study sites and their approximate percent ground cover.

Plant type	Approximate % ground cover Site A	Site B
Sporobolus pyramidalis	3.64	8.04
Brachiaria brizantha	17.36	22.96
Digitaria scalarum	16.04	16.82
Chloris gayana	3.40	0.00
Glycine Sp.	10.66	0.00
Cyperus Sp.	24.00	12.00
Cyndodon dactylon	0.00	5.70
Hyparhenia Sp.	0.00	9.42
* Others	24.90	25.06

* These include - Hydrocotyle sp., Stylosanthes guyanensis, Solanum sp., Commelina sp., Trifolium sp., Argeratum conyzoides.

Table 2. Mean number of real bites per plant species per site during one observation time (20 minutes).

Plant type	Mean number of real bites Site A	Site B
Sporobolus pyramidalis	1.0	22.0
Digitaria scalarum	99.0	12.0
Chloris gayana	1.0	X
Cynodon dactylon	X	38.0
Brachiaria brizantha	38.0	29.0
Glycine Sp.	0.0	X
Hyparhenia Sp.	X	4.0
Cyperus Sp.	17.0	5.0

X = Absent at the site or not included in the bite count.

Table 3. Mean dry weights (g) of simulated bites per plant species and respective amounts consumed during observation time.

Plant Species	Mean dry weights (g) per bite	Average amount consumed (g) Site A	Site B
B. brizantha	1.16	44.0	34.00
Cyperus sp.	1.08	18.0	5.00
C. dactylon	1.33	0.0	50.00
S. pyramidalis	1.56	2.0	34.00
Hyparhenia Sp.	1.30	0.0	2.00
D. scalarum	1.17	115.0	15.00

Table 4. Crude protein content of some fodder shrubs and grasses consumed by goats (June, 1983).

Plant type	Analyzed at		% CP
Morning glory - leaves	NAHRS		17.36
Mexican thistle - leaves	"		18.31
D. Scalarum - leaves and stem tips	"		13.19
Lantana camera			
-Leaves	"		16.21
-Leaves and young stems	"		24.13
Commelina sp. - leaves and stem tips	"		26.34
Galinsoga paviflora - leaves and young stems	"		14.42
Black Jack - leaves	"		20.95
Amaranthus sp.			
-Leaves	"		29.39
-Leaves and young stalks	"		32.46
Cynodon dactylon - leaves and stem tips	"		21.69
B. brizantha - leaves and young stalks	"		16.19
Leonotis mollisima - leaves	"		25.16
Grewia trichocarpa - leaves	"		19.36
Tagetes minuta - leaves and young stalks	"		26.75
Sesbania sp.			
-Leaves	"	23.02	27.63*
-Leaves and young stalks	"	23.76	28.44*
-Seeds	KARI	34.80	

* Analyzed at KARI.
NAHRS = National Animal Husbandry Research Station, Naivasha.
KARI = Kenya Agricultural Research Institute.

IMPLICATIONS OF FAMILY LABOUR USE FOR ADOPTION OF THE DUAL-PURPOSE GOAT ENTERPRISES ON SMALL FARMS IN WESTERN KENYA

By
F.B. Nyaribo[1], A.W. Mukhebi[2] and R.M. Bernsten[2]

The labour constraint is one of the least understood constraints in the introduction and adoption of new technology. However, it is known that unemployed labour is common in rural areas due to the seasonality of activities involved in farming which are, in turn, governed by climatic factors. Labour need not be a constraint if the technology being introduced can be operated during the slack periods. But, due to the seasonality of labour and the structural characteristics of male-female labour, slack periods on the farm may not surface.

This labour utilization study was conducted in order to attempt to assess how much labour is allocated to the dual-purpose goat (DPG) enterprise on 26 farms in Siaya and Kakamega districts in Western Kenya. The months are compared to other enterprises on the farms. Interest was directed to those farms provided with a dual-purpose research goat by the Small Ruminant Collaborative Research Support Program (SR-CRSP). The study characterizes the current labour situation, with a view to identifying labour bottlenecks and their implications for the adoption of the dual-purpose goat enterprise.

The objectives of the study are thus threefold:

1. To quantify the labour supply and demand on 26 farms with dual-purpose goats.
2. To quantify labour demand for cropping and livestock activities on these farms.
3. To quantify DPG labour requirement and compare it to those of alternative farm enterprise.

Methodology

A combination of interviews and observation of labour in the fields was used to collect the data. Data were collected over a six month period for Kaimosi and Hamisi and a five month period for Masumbi cluster. This covered the long rains season (March-September 1983). Commencement of data collection depended on the location of the farms and when a dual-purpose goat was issued to farmers. In Hamisi and Kaimosi clusters, data collection thus began in March and in Masumbi cluster, monitoring began in April. The sample of farmers is a subset of the larger sample of farmers originally involved in the SR-CRSP Small Farm System Survey reported in SR-CRSP Technical Report no. 17 (Sands et al). Data were collected in questionnaire form once a week and were later verified by actual observations of different activities on the farm.

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Labour supply was basically determined by the farmer's extended family, i.e., the number of persons permanently working on the farm and hired labour. The type of labour that features prominently in the three areas of study is family labour. Labour demand was estimated by aggregating actual time spent on all crop and livestock activities including hired labour, on a monthly basis. In estimating both the supply and demand, man-equivalents labour units were assigned to different age categories, i.e., aged category of 15-55 was assigned a 1 man-day labour unit, 8-14 was assigned .5 and 56+ was assigned .75 man-day. This enabled aggregation of labour supply and demand of labour in terms of man-days on a monthly basis.

In this study, the household is defined not only as the nuclear family, but also includes the extended family, including daughters-in-law, grandchildren, uncles, aunts, and in some instances, second and third wives all living in the household. From observation and from certain surveys (Survey on Socio-Economic Evaluation of the Dual-Purpose Goat Enterprise in Small-Scale Farming in Western Kenya - Reported CRSP Proc. 1984), it appears that land is communally tilled within the extended family. Even where there are two or more wives or daughters-in-law that might have their own separate plot(s), the flow of labour and consumption of output form the farm between these subsets of the greater households is the norm. It is with this observation in mind that these data were gathered.

Results and Discussion

Household Size and Composition

Figure 1 indicates the aggregate composition of the extended family households with dual-purpose goats in 1983. This aggregate picture shows that 52% of the people lie in the 15-55 age category while the remainder fall in the "under 14 or 56+ categories.

Table 1 indicates that in Kaimosi and Hamisi (Kakamega district), the average household has about 4.3 adult workers and 4.0 dependants, while in Masumbi (Siaya district), the household has about 3.9 workers and 3.5 dependents. These data indicate a somewhat different picture from that reported in a previous study undertaken in 1980 which shows 2.05 workers and 5.90 dependents in Kakamega district, and 1.05 workers and 3.60 dependents in Siaya district (Sands et al). A possible explanation for this observation is that some of the dependents have grown into adults since 1980. It should also be pointed out that the sample in this study is small (26 farms) compared to the 80 farms in the other study.

Table 2 shows the supply and demand of labour in Hamisi cluster. The minimum labour supply per household in any given month is equal to 86 man days. In April, August, and December it goes up to 135 man-days when children are on holiday.

On the demand side, it can be seen that labour is used most in April (weeding 138 man-days) for the major crops. In spite of these activities however, there is an indication of surplus labour during the critical months (except for April with a deficit of -3 man-days) and an even larger surplus during the slack periods. These results appear to indicate a family labour surplus during every month. However, field observations show that hired, especially casual labour, is used during peak workload periods. April/weeding

and August/harvesting and field preparation for the short rains crop. The use of hired labour suggests the existence of labour shortage during some months of the year. This was not picked up in the results presented. A likely explanation is that the labour allocated to household and off-farm activities such as local marketing and other commercial activities was not included in our data.

Kaimosi

Table 3 indicates that in Kaimosi, the labour supply and demand situation is characterized by a deficit of -47 man-days in August. This is due to the usual activities of harvesting the on-set of land preparation for the short rains crop. The short rains crops included sorghum, maize and beans. All other months indicate a surplus of labour. Hired labour constitutes an average of 27% of the total labour requirement for the six month period that data were collected. This hired labour is almost exclusively used for land preparation, weeding and to some extent, harvesting.

Masumbi

In comparison to Hamisi and Kaimosi clusters, Masumbi cluster in Siaya district appears to be hard pressed for labour, with deficits occuring in April, June and August of -38, -9 and -25 man-days respectively (Table 4). These deficits again occur during peak labour demand periods, i.e. weeding in April, weeding and harvesting of beans in June, and harvesting of maize and land preparaton for the short rains crop in August. About 9% of the labour demand for weeding constitutes hired labour. This demand could have been greater were it not that in Masumbi the majority of the farmers use oxen for land preparation and weeding to some extent. Masumbi also has a lower number of working adults per household (3.9) compared to Hamisi and Kaimosi (average 4.3); it also has a higher cropped area on average (2.1 ha) as compared to Hamisi and Kaimosi (average 1.55 ha).

Labour Demand vis a vis the Dual-Purpose Goat

Table 5 summarizes annual labour use by major enterprise types in the cluster areas for 1983. From this and other illustrations in this paper, four observations can be made:

1. Labour appears to be relatively abundant, especially in Kaimosi and Hamisi clusters during most of the year.
2. Labour is constraining during a few months of the year when crop field operations such as land preparation, weeding and harvesting are at their peak.
3. The dual-purpose goat enterprise has an even labour requirement throughout the year.
4. Looking at the aggregate column in Table 5 for cattle and DPG labour, there does not seem to be a significant difference between the two categories of stock for labour use. Again, it should be pointed out tha labour requirement for household and off-farm activities were not included in reported labour demand figures. If these were taken into account, more deficits would be identified than are reported here.

With this positive picture on labour availability for the introduction

and possibly the adoption of the dual-purpose goat, three factors have to be taken into account. The first factor is in regard to land size, especially for Kaimosi and Hamisi, where farm size is decreasing while population is increasing. We would expect land to be optimally utilized. We would also expect the farmers to look for a combination of enterprises which would maximize the returns to land based on gross margin per land unit. This brings into play the second factor, which is profitability. Most farmers in these three areas, especially Hamisi are also involved in cash crops which have a sizeable labour demand. This demand could occur during those critical months when labour demand is at its peak making it a limiting factor at this time. Therefore, a competitive return to labour is also critical in the dual-purpose enterprise.

The third factor to consider is the structural characteristics mentioned earlier in this paper. From observation, women and children are given the task of taking care of smallstock, i.e. goats, sheep, including poultry. But women are also involved in all aspects of crop and livestock production in addition to household chores that require a proportionally large amount of time. Children on the other hand are away in school and therefore cannot be depended on to take care of any enterprise the whole year round.

Summary and Conclusions

It has been indicated that there are peak periods of labour demand and also slack periods during the year. This is a characteristic of agricultural production which is governed by climatic factors. The overall picture therefore shows a relative abundance of labour with constraints in April, June and August. However, since DPG labour is constant throughout the year data was collected during the lactation period and dry period), a farmer should be able to plan for his labour requirement with ease. Studies have shown that gross margin per man-day in other enterprises is substantial (Mukhebi et al). This could imply that the marginal product of labour at this time is likely to be higher than the wage rate. Therefire, it would be economical to hire additional labour during the peak labour demand periods. One other important point to keep in mind is that goat labour is residual to other activities in that they remain tethered around the homestead for a good part of the morning. Only when the field activities are completed do the farmers take the goats for grazing, watering, etc. Labour at this stage where farmers have only few DPG per household does not appear to pose a problem. However, in the long run, if the DPG numbers were to be increased, then closer attention would have to be paid to those months during which labour is a constraining factor, and in fact, the dual-purpose enterprise would have to show competitive returns to other constraining factors of production in order for it to be fully adopted by the small-scale farmer.

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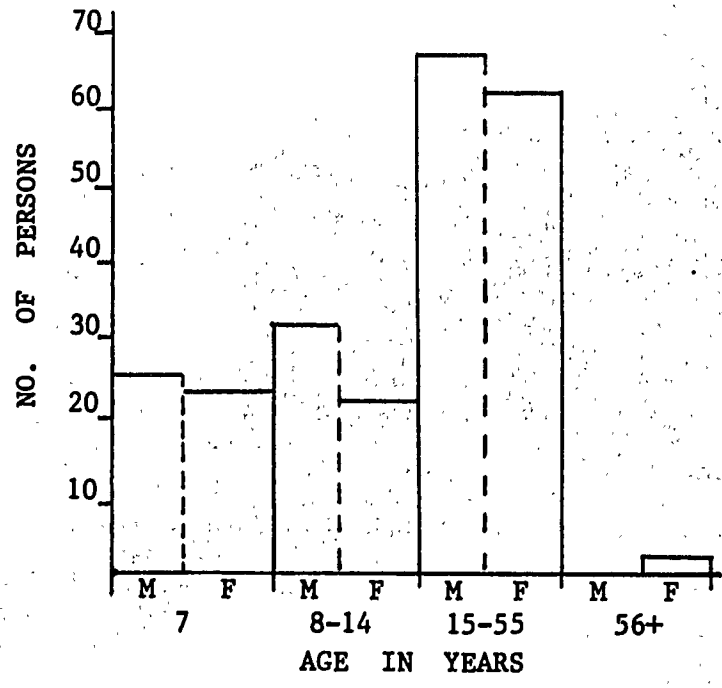
Figure 1. Aggregate composition of extended family households with DPG in cluster areas, 1983.



Source: Survey data

Table 1. Aggregate composition of extended family households with DPGs in cluster areas, 1983.

Cluster	No. of House-holds	Adults >15 Yrs M	Adults >15 Yrs F	% Household Population	Children <15 Yrs M	Children <15 Yrs F	% Household Population	Mean Adults Per HH	Mean Dependents Per HH
Kaimosi	8	22	20	59	24	14	41	4.5	4.25
Hamisi	8	22	18	55	10	22	45	4.0	3.75
Masumbi	10	19	25	54	26	11	46	3.9	3.50
Total	26	63	63		60	47		12.4	11.50
							Mean:	4.1	3.80

Source: Survey data

Table 2. Labour Supply, Demand and Deficit/Surplus, During the Long Rains Season, Hamisi Cluster, 1983

Month	Supply	Demand	Deficit/Surplus
March	86	57	+29
April	135	138	-3
May	86	83	+3
June	86	46	+40
July	86	27	+59
August	135	78	+57
September	86	43	+43
Totals	700	472	+228

Source: Survey Data

Table 3. Labour Supply Demand and Deficit/Surplus During the Long Rains Season, Kaimosi Cluster, 1983

Source: Survey Data

Month	Supply	Demand	Deficit/Surplus
March	100	91	+9
April	143	132	+11
May	100	33	+67
June	100	76	+24
July	100	13	+87
August	143	190	-47
September	100	42	+58
Total	786	577	+209

Table 4. Labour Supply, Demand and Deficit/Surplus During the Long Rains Season, Masumbi Cluster, 1983

Month	Supply	Demand	Deficit/Surplus
April	126	164	-38
May	83	34	+49
June	83	92	-9
July	83	39	+44
August	126	151	-25
September	90	46	+44
Total	591	526	+65

Source: Survey Data

Table 5. Summary of Annual Labour Use by Enterprise and Cluster, 1983

Cluster Item	Hamisi	Kaimosi	Masumbi	gregate
Cropped Area (Ha)	2.2	.9	2.1	5.2
Crops (Mandays)	336	484	401	1221
Cattle "	57	59	55	171
DPG "	70	34	70	174
Total	463	577	526	1566

Source: Survey data

INTER-SEASONAL HOUSEHOLD FOOD CONSUMPTION PATTERNS IN WESTERN KENYA

By
F.B. Nyaribo[1], R.H. Bernsten[2] and A.W. Mukhebi[2]

In a small farm system, production and consumption decisions are interdependent. Crop and livestock products may be consumed, sold to purchase food and consumer goods not produced on the farm, or to generate investment capital. Consequently, consumption behavior must be understood in order to better understand production decisions.

The household consumption survey in Western Kenya was conducted by the SR-CRSP to determine;

- the degree to which smallholders in the area are dependent on home grown produce to meet family consumption requirements,
- the effect of season on the proportion of food obtained from household production versus off farm purchases, and
- if the subsistence nature of the crop/livestock enterprise (i.e. non-availability of cash) depresses the effective demand for goat milk and as a consequence, the derived demand for the dual-purpose goat enterprise.

Initial results were reported in the Proceedings of the Second Small Ruminant CRSP Kenya Workshop (1983) based on data collected in 1981-82. This study reports 1983 results which confirm the previous study.

Farming System

The consumption survey was conducted in Kakamega and Siaya Districts in western Kenya. These Districts are generally described as high potential, with adequate rainfall to grow two crops a year. The principal crops grown are maize and beans (Sands et al, 1982). Land preparation for the long rains occurs from December through early March, with planting during February, March, and April. Immediately after harvest (August), land is prepared for the short rains crop, with rainfall beginning in September/October. In addition to rainfall, elevation affects the maturation time for maize - the staple crop. As a consequence, the cropping pattern also varies from location-to-location. For example, in the higher elevation areas of Kakamega District, a second maize crop is frequently not planted.

Data Collection

Data were collected in April and June during the long rains and in October during the short rains. Data reported in 1983 were collected in April and June 1981 and October 1982. The second round of data was collected in April, June and October 1983. Seasonal shortages were expected to occur in April, reflecting that several months had elapsed since the previous short

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[1] MALD
[2] Winrock International

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rains harvest. By June, the bean harvest (intercropped with maize) has started in Siaya District, but not in Kakamega District. This difference should be reflected in consumption patterns, with Kakamega producers more market dependent. Finally, by October when crops have been harvested, households should be most self-sufficient and least market dependent.

The consumption survey was conducted by enumerators in conjunction with the monthly monitoring being done by the Small Farm Systems Survey. A random sample of approximately 20 households in each of four clusters (villages) was selected. Each household was visited during one week in April, June, and October and asked to recall the prices and quantities of all food purchases and the quantity of food consumed by the household during the previous seven days.

Results

Results are reported in terms of aggregated food consumption (all foods and protein), maize flour consumption and protein purchases by type.

Purchased Food Aggregates:

The degree to which households are dependent on the market for food consumption items is shown in Table 1. With respect to all foods, households generally purchase a higher percent of consumed foods in April and June, compared to October. With respect to protein, household purchases in Siaya increase over the cropping season, probably reflecting the availability of cash from crop sales which facilitiates greater consumption of protein, largely milk, meat, poultry and fish.

In general, the data indicate that these households are highly market dependent throughout the year, generally obtaining less than 50% of all "food" and "protein" from own-production.

Maize Flour Consumption:

Maize is the staple food in Siaya and Kakamega Districts. In Table 2, the sources from where households obtained their maize flour are reported by district, year and month. Compared to other sources, farm-produced maize flour, as a percent of total flour consumed, is generally highest in October after the long rains harvest. Households in the category "purchased only" tend to decline inversely with those in the farm-produced maize category, with the percent in the "purchased only" category greatest in April and June.

Although these trends are evident, the data shows significant variation between clusters, districts and years. This variability indicates the importance of crop performance as a function of climatic (rainfall, elevation) and possibly disease factors which in turn affect carry over from season-to-season and the degree to which households must meet consumption requirements through market purchases.

Sources of Protein:

Major protein sources are red meat, poultry, eggs, meat and fish. Almost all of these items are purchased off-farm. Table 3 shows the percent of

households consuming at least some of each item, by cluster, year and month. Red meat/poultry and milk are the most widely purchased protein items. While meat/poultry consumption varies over the year and between years, milk purchases are significatnly more constant and purchased by a higher percent of households than any other protein type. This suggests that a significant and constant demand for milk exists. Consequently, there is likely to be a strong demand for goat milk as a substitute for cows milk, providing dual-purpose goat producers with a strong market for their products.

Conclusions

Due to the variability in results across districts and clusters and between years it is difficult to draw strong conclusions. These results do confirm several general hypotheses. First, the households in the research area are not subsistence, in the sense that they are almost totally dependent on home-produced products to meet household consumption requirements. Rather, they are highly dependent on the market. Second, the degree of market dependence varies over the year. Generally, maize purchases are highest before the crop is harvested and protein purchases are highest after the food crops are harvested. Third, milk is a widely purchased protein source, with a high and constant demand throughout the year.

In order to better understand the year-to-year and cluster-to-cluster variability in food purchases, it will be necessary to relate consumption/purchase data more closely to information about crop performance in addition to site-to-site time of harvest in each year.

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Sands, W.M., H.A. Fitzhugh. R.E. McDowell and S. Chema. 1982. Mixed Crop-Animal Systems on Small Farms in Western Kenya. Small Ruminant CRSP Technical Report No. 17.

Table 1. Purchased Food As a Percentage of Total Value of Food Consumed, Western Province, Kenya (1983)

Item	% of Households by Consumption Type			
	Kakamega District		Siaya District	
	Hamisi	Kaimosi	Ngiya	Barding
All food:				
April	[57]	77	66	36
June		58	74	52
October	52	52	55	52
Protein:				
April	[59]	69	64	31
June		58	68	48
October	57	65	76	52

Note: [ ] indicates data pooled over a 2-month period.

Table 2. Household Maize Flour Consumption, Western Province, Kenya (1982-83)

Item	% of Households by Consumption Source							
	Kakamega District				Siaya District			
	Hamisi		Kaimosi		Ngiya		Barding	
	1982	1983	1982	1983	1982	1983	1982	1983
Farm produced maize flour:								
April	10	[17]	80	10	[40]	37	60	61
June	16		75	-		-	25	-
October	40	50	70	100	80	79	75	47
Own and produced:								
April	20	-	-	-	[-]	5	-	-
June	16	-	-	21		-	25	-
October	-	-	-	-	15	-	15	-
Purchased only:								
April	70	[83]	20	90	[20]	47	30	39
June	68		75	71		74	30	67
October	55	44	30	-	5	21	10	53
Other:								
April	-	-	-	-	[40]		10	-
June	-	-	-	7			20	-
October	5	5	-	-	-		-	-

Note: [ ] indicates data has been pooled over two months.

Table 3. Household Purchases of Protein Products, Western Province, Western Kenya, (1982-83)

Item	% of Households Purchasing Various Types of Protein							
	Kakamega District				Siaya District			
	Hamisi		Kaimosi		Ngiya		Barding	
	1982	1983	1982	1983	1982	1983	1982	1983
Red meat/poultry:								
April	85	[54]	85	42	[90]	-	75	5
June	55		55	20		-	63	17
October	80	78	75	5	70	95	75	29
Own and produced:								
April	45	[21]	15	-	[10]	26	15	17
June	30		0	-		40	0	22
October	5	44	40	21	20	50	40	29
Purchased only:								
April	85	[97]	90	95	[65]	100	45	39
June	90		100	90		90	25	60
October	85	94	90	89	90	100	75	35
Other:								
April	50	[18]	5	10	[70]	-	70	5
June	30		0	-		-	50	28
October	55	17	70	26	85	5	95	-

Note: [ ] indicates data has been pooled over 2 months.

Figure 1. Mean Monthly Rainfall and Maize/Bean Cropping Activities in Kakamega District

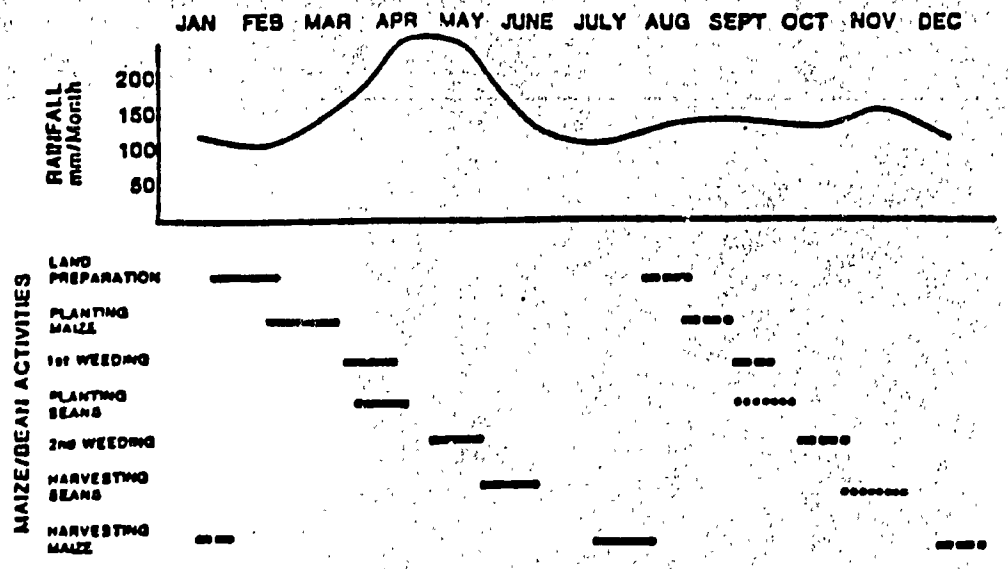
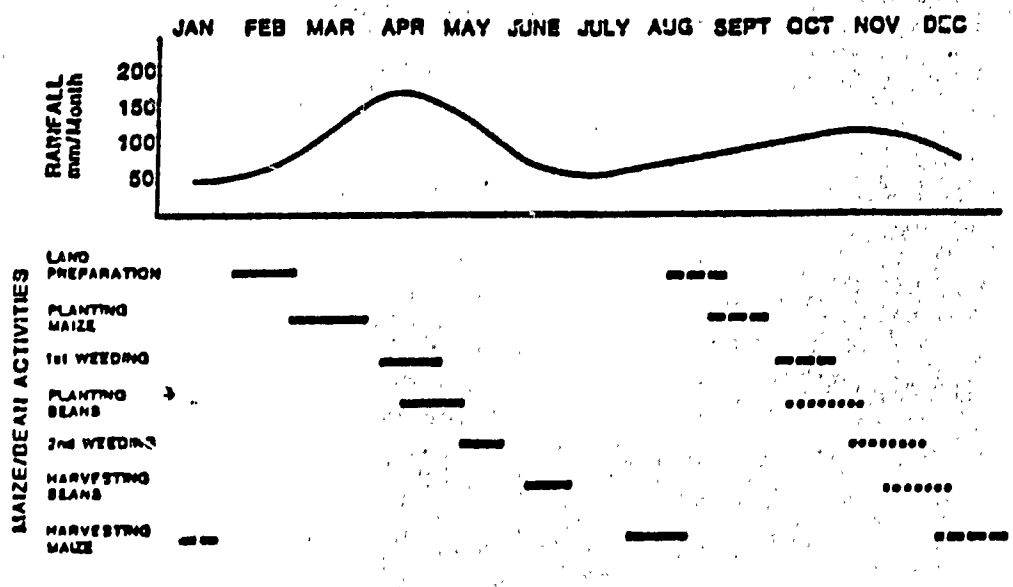


Figure 2. Mean Monthly Rainfall and Maize/Bean Cropping Activities in Siaya District



Source: Sands et al. (1982), p. 26.

A SOCIO-ECONOMIC EVALUATION OF THE DUAL PURPOSE GOAT ENTERPRISE IN SMALL-SCALE FARMING SYSTEMS IN WESTERN KENYA

By
A.W. Mukhebi[1], F.B. Nyaribo[2], R.H. Bernsten[1],
J.E. Reynolds[3] and A.N. Mbabu[2]

This paper presents a preliminary socio-economic evaluation of the short-run performance of the dual-purpose (DPG) goat enterprise in small-scale (<.8 ha farm size) farming systems in three locations in Western Kenya (Kaimosi and Hamisi in Kakamega District and Masumbi in Siaya District). The evaluation was undertaken with two aims in mind: to assess the economic benefits and costs accruing to local farmers keeping dual-purpose goats and to probe farmers' attitudes and reactions in regard to the enterprise. Thus, our discussion here deals with 'facts' derived from two different dimensions - one more 'objective' and the other more 'subjective'. From the first we assemble a picture of the economic potential of the dual-purpose goat enterpise; from the second, an appreciation of the farmers' own perceptions and experiences. For the purpose of determining the suitability of DPG production for small-scale farmers, it is as important to understand people's own impressions of what is taking place as to understand the economic factors involved.

The discussion is divided into three parts. Part I deals with economic analysis of the dual purpose goat enterprise cast into a theoretical framework for farm enterprise decision making. Part II provides a sociological evaluation of the on-farm DPG trials. The substantive findings of both these parts and their implications for DGP research are then summarized in Part III.

Part I: Economic Analysis of the Dual-Purpose Goat Enterprise

Small-Scale Farming Systems

Small-scale farming systems in Western Kenya have been characterised by previous SR-CRSP studies (Fitzhugh and Sands, 1983; Job, 1982). A model of a small-scale farm in Hamisi location is presented in Figure 1 to show the interrelatinship between the DPG enterprise and other major farm enterprises in a typical farm system.

Figure 1 shows the relationships among a household, a farm and the national economy. The household is the decision-making unit. It supplies production resources (land, labour, capital and management) to the farm. The farm produces and provides multiple crop and livestock products back to the household. The household consumes some of these products and markets others, including part of its labour stock, to the rest of the economy. The economy, in turn, supplies goods, services, and money to the household for consumption and investment into the farm.

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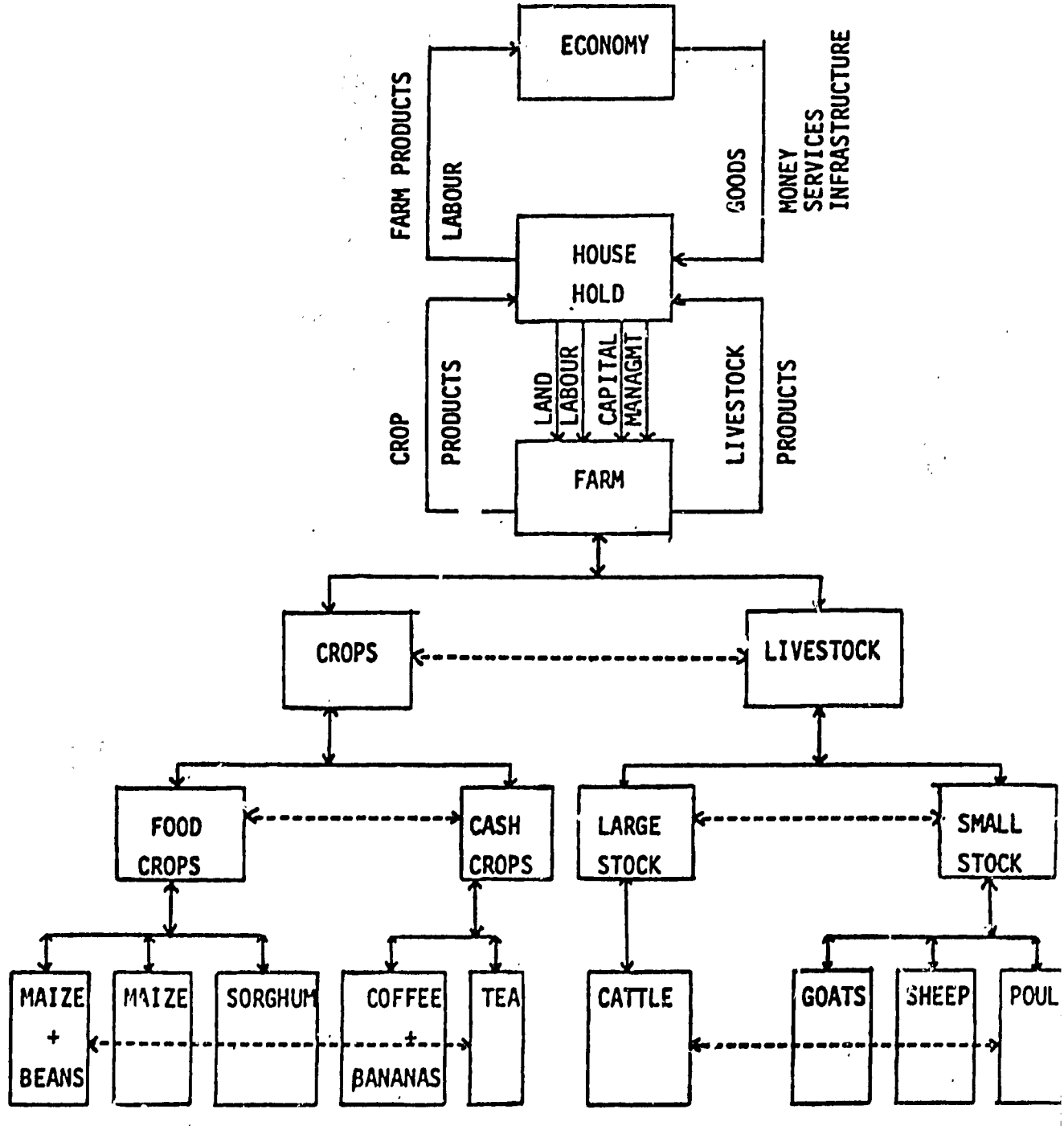
[1] Winrock International
[2] Ministry of Agriculture and Livestock Development
[3] University of Missouri



Resource and product flows

Enterprises competing for scarce resources

Figure 1: Model of A Small-scale Farm in Western Kenya

Within the farm, the figure indicates that scarce resources can be allocated to crops and/or livestock. Among crop enterprises resources can be allocated for food crops and/or cash crops in competition for the use of resouces allocated to crops. Furthermore, individual food crops compete amongst themselves, as do individual cash crops, for available resources. Among the livestock enterprises, cattle compete with smallstock for a share of resources allocated to livestock production. Finally, sheep and goats compete for the use of resources available for smallstock production.

Supplementary, Complementary and Competitive Enterprise Relationships

Two enterprises are supplementary if the production or expansion of one has no effect upon the production of the other. The enterprises are complementary if the production or expansion of one contributes to the production or expansion of the other. They are competitive when the production or expansion of one necessitates a reduction in the other.

Relationships among farm enterprises are supplementary, complementary, or competitive only with respect to a given resource. For instance, maize and DPG enterprises would be supplementary in the case of land if pigeon peas, a goat forage, were grown in hedges - places where maize would not otherwise be planted. On the other hand, maize and DPG enterprises would be complementary in the use of land if maize leaf strippings were used as a good feed with no reduction in maize yield, or when goat manure is applied as a fertilizer to the maize crop. However, maize and DPG enterprises would be competitive if land that would otherwise be used for maize production was to be used for raising pigeon pea forage for the goat enterprise. Supplementary, complementary, and competitive enterprise relationships also exist with respect to labour, captial and management resources.

Farm Enterprise Choice

When enterprises are supplementary or complementary, the choice of their production poses little problem to the farmer. One should operate both as there is nothing to loose by so doing. In fact, one should exploit such relationships to the full by expanding the enterprises until they become competitive in the use of one resource. For instance, if maize and the DPG enterprises are supplementary or complementary in the use of land, the farmer would benefit from increased production of land by operating both enterprises up to the level at which they become competitive.

When enterprises are competitive, the farmer's choice as to which one should be produced or expanded becomes more complex. The farmer's choice criteria may be many and vary over both time and space. In general, however, a farmer will produce or expand at the expense of other competing enterprises - that enterprise which yields the greatest return (or satisfaction) to the perceived most scarce resource, subject to prevailing constraints. Thus, if land is seen to be the most scarce, then those enterprises yielding the greatest return per hectare will receive first priority in the farm plan. If labour at a certain period is the resource in shortest supply, those enterprises yielding highest return to a unit of labour input will be attended to first. Similarly, if capital is the most limiting resource, available money will be allocated to those enterprises earning the greatest return per shilling spent.

The Dual-Purpose Goat Enterprise

The DGP enterprise is being introduced into smallscale farming systems in Western Kenya with the goal of providing farm households with increased milk and meat products as well as improved cash flows. Testing its adoption by farmers will depend to a large extent upon its supplementary and complementary relationship with other enterprises and its return to expended resource where it is competitive for resource use.

The evaluation of the DGP enterprise undertaken here presents and compares short-run resource returns of the enterprise in terms of gross margin (excess of enterprise gross output over variable costs) per resource unit with gross margins of other major farm enterprises in the three research sites. Also discussed here are the results of a gross margin analysis in the context of supplementary and complementary relationships between DPG and the other farm enterprises.

Methodology

Input-output data were collected from the 26 farmers who had been given trial DPGs in each of the SR-CRSP research clusters (8 in Kaimosi, 8 in Hamisi and 10 in Masumbi). Recall data were collected through single visit interviews conducted by SR-CRSP researchers with the assistance of enumerators. Secondary data were obtained from various Ministry of Agriculture reports.

Enterprise budgets and gross margins (GMs) were derived from the data by cluster. For each major enterprise, GM was calculated on a per hectare, per person-day of labour input, and per shilling of variable cost basis. The GMs were then aggregated by enterprise types (food crops, cash crops, cattle, and DPGs) by cluster.

It should be mentioned here that the GM measure of resource returns assumes a short-run planning horizon (one year) within which fixed costs are taken as sunk or already incurred. The short-run decision by the farmer is how best to utilize the already incurred costs in the form of existing buildings, land, machinery, tools, permanently hired labour, breeding herd, etc. In the short-run, an enterprise should at least cover variable costs to be viable. In the long-run (five or more years), fixed costs should be covered for the farm to remain viable; indeed, in the long-run, all costs are variable: they can be varied depending on the level of production desired.

Results and Discussion

The results of the analysis are presented in Tables 1-4. Table 1 shows results for the Kaimosi cluster. It indicates that if there were competitive relationships among the farm enterprises, cattle would have the first claim to the use of an extra unit of any of the scarce factors, followed by food crops and the DPG enterprise, in the order of their GM per resource unit. For Hamisi and Masumbi clusters, (Tables 2 and 3) the order of enterprise claim to extra resource units varies among the factors.

The overall results in Table 4 show that the DPG enterprise yields

positive returns to farm resources in each cluster and for all three clusters combined. The table also indicates that for each cluster and for all the clusters combined, resource returns (GMs) are lowest for the DPG enterprise in relation to the other enterprises. These results have vital implications for the DPG enterprise.

First, positive resource returns imply that the DPG enterprise is a profitable one, at least in the short-run. Assuming the DPG enterprise has supplementary and complementary relationships with the other enterprises for resource use, the profit levels shown in the tables are significant. For instance. for all the clusters, Table 4 indicates that a farmer with the DPG enterprise, generated in monetary terms, an extra Ksh 702/- per ha, Ksh 2.8 per person-day, or Ksh 0.5 per shilling of variable costs than he would have made without the enterprise. In fact, supplementary and complementary relationships between the DPG enterprise and the other enterprises are very apparent in current farming systems in the study areas. A farmer with a DPG enterprise has on average one doe and a kid. Field observations indicate that forage production is mainly obtained from grazing homestead pastures, roadside pastures, and other communal pastures, on land that would have minimal alternative use by the household. Labour for tending the goats is mainly residual to crop and other livestock activities and capital inputs to the goat enterprise are minimal.

However, a second point is that the low resource returns generated by the DPG enterprise imply that if the enterprise is expanded to a level where it becomes competitive with the other enterprises, it would receive the least priority in the allocation of scarce resources by the farmer, unless its resource profitability improved substantially. For instance, Table 4 shows that in all the clusters, the GM per ha and Sh of variable costs would have to increase by 139% and 360%, respectively, for the DPG enterprise to be seriously competitive for the use of these resources. Such increases are not inconceivable, bearing in mind that major research efforts are underway to substantially improve upon the goat genotype, availability and quality of forage feeds and general goat management practices. When the results of these efforts come to bear, the profitability and competitiveness of the DPG enterprise could be considerably more favourable.

Part II: Sociological Analysis of the DPG Enterprise

On-Farm DPG Trials: The Farmers' Views

Such questions as the following formed the basis of "The Farmers' Views" section of the survey instrument:

1. Do people in the household like the milk they get from the 'Maseno'* goats?
2. How is the milk used by family members?
3. Is the amount adequate for the family's daily needs?
4. What has been the reaction of the family's neighbours to these goats?

The answers obtained for these and other questions are summarised below.

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* The trial dual-purpose goats from the Maseno Research Station.

First, a few comments can be made by way of anticipating a possible criticism of the study.

It may be argued that efforts to ask participating farmers about what they think of the DPGs which have been set out on trial could yield misleading information; there is a likelihood that farmers will say what they think researchers want to hear since they are the recipients of 'free' goats. The reasoning goes that those who have received a 'gift' or 'free good' as significant as a crossbred 'grade' goat would not be inclined to be critical of their benefactors. However, it should be emphasized that the trial goats were distributed to selected farmers with the clear understanding that participants would not simply 'take' the animals and do with them as they so wished. The agreement with the farmers was that goats would be put out for use by them and their families in exchange for a certain amount of cooperation with the researchers for a period of at least one year. Farmers would cooperate in providing proper care for the animals to ensure that basic nutritional and health needs were met. Furthermore, they would assist i the regular monitoring of doe and kid performance amongst the trial goats (milk yields, growth, health problems, etc.), labour-time investments needed to keep the animals in proper condition; existing feed resources and new ones being introduced on a trial basis, and such other farm and household activities as would be required in the course of the research. It was stipulated that after a year had elapsed, the goats and any of their offspring would become the sole property of the participating farmers. Thus, the DPGs distributed for the on-farm trials were not given out as straightforward 'gifts' with no obligations attached. In fact the farmers had to be willing to incur certain 'costs' in the form of the time, effort, and patience required to care for the animals and cooperate with the Maseno research team.

Further, it should be emphasized further that conversations conducted with the 26 participating farmers were very open and detailed. Researchers took time to fully probe the responses people made and to encourage perfectly candid answers. Certainly the respondents did not hesitate to voice criticisms or misgivings about the DPG trials. Indeed, some quite strong negative reactions were recorded, especially from those who had been keeping animals which proved rather poor yielders or troublesome in other ways. It is therefore felt that the interviews provide a reliable guide to people's reactions to the DPG trials and that they did not unduly inflate their responses to impart impressions they anticipated reseachers might find agreeable.

Results

A. Goat Milk and Farmers' Families: Taste, Uses and Yields

The respondents indicated that the reaction of their families to goat milk as a food was overwhelmingly positive. When asked if those in their families liked goat milk, 80.8% of the respondents (21) replied in the affirmative. Only one farmer gave a negative response. When asked to explain their answers, most farmers reported that family members thought tht the milk tastes very good in tea, and several mentioned that family members thought that it tastes richer than cow's milk (Table 6). Milk taken from the DPGs for domestic consumption is mainly used in the preparation of tea, though in a few instances it was also reported that family members consumed it fresh or used

it in the cooking of vegetables (Table 7).

Participating farmers were also asked if they thought that the milk yield of the trial goats was adequate to supply household use together with the needs of unweaned goat kids. Some 46% of the respondents felt that yields were adequate, while about 34% felt they were not. Around 19% of the respondents had not yet had any experience milking their goats. Respondents were further queried about what they would consider an 'adequate' daily milk yield from a grade goat; that is, their views were obtained as to what ought to be the daily quantity on average through the lactation period sufficient for household needs and those of the doe's kids. The majority of respondents (about 65%) suggested amounts in the one-to-two litre range. Only a few remarked that amounts should be less than a litre (11.5%) or more than two litres (7.7%).

B. DPG Rearing: Labour, Returns, Prospects and Problems

For the 26 households involved in the trials, women more than other household members appear to assume primary responsibility for the care or maintenance of the animals. In some 46% of the respondents it was claimed that the wife/mother of the household does most of the work related to the goats. Most responsibility is assumed by husbands/fathers in about 31% of the households, while children of the household take on the burden in about 19% of the cases. However, the various duties of goat care (e.g. fetching feed and water, tethering, milking, and taking animals for drenching and dipping) are shared at least to some extent between household members in nearly 81% of the cases.

When asked whether in their experiences to date, keeping DPGs could be judged a worthwhile activity, the majority of respondents answered yes (80.8%). The reasons given in support of the answer to this question (more than one response allowed) were as follows: 'The milk is valuable' (53.8%); 'Goats are easier to keep than cows (15.4%); 'The goats are a good asset to have' (11.5%). One respondent cited the value of goat manure as fertiliser, and three respondents reported that they had not had enough experience as yet to give an answer.

Nearly 85% of those interviewed were of the opinion that DPGs could be successfully reared in the study areas (Table 14). When asked to suggest what measures might be taken to improve the chances for successful DPG rearing in their areas, the respondents gave the following comments (more than one response allowed): health measures such as dipping and drenching are required (20%); more goats should be put out on trial (17.5%); more forage/feed materials should be planted (15%); trial goats should be bred in the local areas (12.5%); special attention will be required for the DPGs (7.5%); and farmers should be given more training in the management of the goats (7.5%). A few farmers pointed out that the local climate was unfavourable to DPGs or that one had to 'trust in God'. Nil response was registered for five of those interviewed (Table 15).

Respondents were next asked to relate the main problems they have experienced in caring for the DPGs. Again, multiple responses were allowed. Disease and health-related problems were mentioned in 17% of the responses. Problems of time and money investments were cited with the same frequency.

About 14% of the responses noted the problem of inadequate feeds being available for the goats. A few farmers mentioned other problems such as poor milk yeilds from their trial goats. Eleven farmers reported that they had experienced no problems with their goats (almost 38% of the responses).

C. Wider Community Response

In addition to learning about the experiences of those keeping the trial goats, an attempt was made through the survey to find out how other people in the study communities were reacting to the trials. Participating farmers were therefore asked to comment on the reactions of their friends and neighbours to the DPGs. Responses (more than one allowed per respondent) indicated substantial public interest in the DPGs in the study communities. Many of the respondents (19 in all) reported that those around them have expressed a desire to try out the Maseno goats on their own (63.3% of the responses fell in this category). A number of people interviewed said that although people around them had first taken a negative view of the DPGs, this had changed and people now were quite positive in their attitudes (almost 27% of responses were of this sort). It was often pointed out that friends and neighbours had begun to appreciate the dual purpose goats after they had had a chance to taste the milk and found it agreeable. There have been many instances of people coming to visit participating farmers' compounds with the express purpose of sampling the 'goat milk chai' (tea). Very few reports were heard of friends and neighbours actually objecting to goat milk.

In analyzing the specific comments reported to have been made to DPG keepers (more than one could be noted per respondent) by people in their neighbourhoods, it was found that in adition to frequent queries about 'How can we get some of these goats ourselves?' (some 43% of the responses given), there was a fair level of concern in the neighborhoods about the conditions under which trial goats were being distributed. Around 32% of the responses were recorded under'specific comments heard' related to concerns about the goats being 'tied to loans'. Some 18% of the comments recorded consisted of expressions to the effect that the goats were valuable for their milk.

It is also of interest that several respondents told of how the use of goats for milk was something people practiced in the past. Various reasons were proferred as to why the practice had all but disappeared nowadays (the gradual disappearance of good milking stock through sales to outside traders, the disappearance of adequate feeds and grazing lands, or the growing emphasis on dairy cattle, for example), but older people especially in the Hamisi area were definite in their claims that 'we know goat milk from the early days - zamani' (the olden times).

D. DPGs and Other Livestock

In the last part of the interviews, farmers were asked to compare the DPGs to local cattle and goats in terms of milk production, and to local goats in terms of disease resistance, feed requirement, growth performance, and marketability.

In comparing DPGs with local cattle for milk production (more than one comment could be recorded per respondent), 11 of the respondent farmers said they thought that 'goat milk is richer than cow milk' (about 32% of the

responses); 10 were of the opinion that DPGs 'give a better milk yield than local cows' (about 29% of the responses); and 5 thought that 'local cows outyield the DPGs' (about 15%). Farmers who saw no difference in the yields, or said they did not know or had no experience, numbered only a few. The comparison of DPG grades to local goats in terms of milk production was no real issue, as respondents answered either 'of course the grade goats are superior' or 'the local goats are not even milked'.

On the question of disease resistance among DPGs and local goats, the verdict of most farmers interviewed was that no difference existed (approximately 65%). Thirty-five percent felt that local goats were superiro to DPGs in this respect.

In terms of feed requirements, most farmers (17 or 65%) could see no difference between the two types of goats. Eight farmers (31%) thought that DPGs require greater amounts of feed. No responses were recorded for two of the farmers.

Most of the respondents asserted that DPGs outperform local goats in terms of growth rates. Sixteen (61.5) of them said the DPGs 'grow faster' than local goats, while five (19%) could see no difference and three (11.5) claimed they could not judge on the basis of their experiences thus far. There were two cases of 'no response'.

Finally, respondents were asked to compare DPGs with local goats in terms of the marketability of the animals. The question was, 'Do you think that the DPG goats would be harder or easier to sell in local markets in comparison to ordinary goats?' A majority (23 or 88.5%) felt that people would prefer to buy DPG stock. Three farmers said they did not know.

Eighteen (69%) of the respondents elaborated on their answers with various comments about why DPGs would be considered preferable in local markets. Six (23%) suggested that people would want to buy DPGs because of their milk production potential versus local goats. Another six suggested that people would be more interested in buying the DPGs because goat milk had a ready local market. Five of the farmers (19%) cited the bigger size of the DPGs as the reason they would be preferred to local stock. One of the respondents was of the opinion that people would like to buy the exotic stock in preference to local animals because the former would be better for breeding purposes. Eight of the farmers (31%) did not offer further comments to explain their views on the marketability question.

An additional point should be made here. Interviewers gathered the impression that goat milk per se would find a ready market in the neighbourhoods should those keeping DOGs ever find themselves with a surplus after meeting their domestic needs. It is interesting that farmers commonly expressed the view that if they could manage to do so, they would prefer selling cow milk to their neighbours rather than goat milk in order to generate extra cash, because milk from goats was richer and a given amount could be 'stretched further' than cow milk. Assuming that the two types of milk would fetch the same price locally, it would make sense to them to keep the goat milk for their own use and sell that from cows.

Discussion

In general, the survey clearly establishes that the response of the on-farm DPG trial participants, their families, and even their neighbours to the practice of keeping DPGs is very positive. People, on the whole, like the milk and use it as much as they can to meet their domestic requirements. Judging from their experiences thus far, they see grade goats as being worthwhile vis-a-vis the time and labour commitments needed. Farmers do however recognise that there are a number of problems which should be dealt with if DPGs are to become a viable, permanent component of local smallscale farming systems. Their responses to questions about ways DPG production could be made more successful and about the problems they have encountered in raising the animals are indicative of this. The chief concerns they raise relate to keeping the animals in proper condition through the provision of adequate feed and health measures. The problem of low milk yields must also be addressed. While many of the trial participants suggested that they had been getting an adequate supply of milk from their goats, there were many too who took the opposite view. the yield problem is highlighted by the information collected on what people would consider to be a reasonable amount for a grade doe to supply daily during lactation periods. While most of the respondents cited amounts of between one and two litres, available data show that none of the on-farm trial goats have ever been able to yield daily amounts of more than a litre.

Part III: Summary and Conclusions

The socio-economic evaluation of the DPG enterprise reveals three major findings. First, the DPG enterprise yields positive short-run returns to scarce farm resources under the existing smallscale farming systems in the study areas. It is therefore a worthwhile enterprise to undertake under the currently apparent supplementary and complementary relationships it has with other major farming enterprises.

This conclusion appears to be supported by the second major finding, which is that the farmers' evaluation of the DPG enterprise is strongly favourable, as revealed by the sociological analysis of the on-farm DPG trials.

The third finding is that in all study areas, resource returns are lowest for the DPG enterprise in contrast to the other major farm enterprises. This implies that the profitability of the DPG enterprise must be improved substantially to make it an attractive alternative for the use of scarce resources if farmers are to be encouraged to keep more DPGs per farm than they currently do. The SR-CRSP research experiments should therefore be continued in the direction of improving goat genotype, availability and quality of forage feeds, and general goat management practices to improve the productivity and subsequently the profitability of DPGs. As has been demonstrated, the farmers themselves would be ready advocates of such developments.

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TABLES 1 - 4: ECONOMIC ANALYSIS OF THE DPG ENTERPRISE (26 Interviews).

Table 1. Resource Returns From Major Farm Enterprise Types, Kaimosi Cluster, 1983.

Enterprise Type	Gross Margin (Shs.) per		
	Hectare	Person-Day	Variable Cost Sh.
Food Crops[a]	2,357	26.27	1.82
Cash Crops[b]	—	—	—
Cattle (Zebu)	3,034	56.56	11.48
Dual Purpose Goats	1,227	6.13	0.87
All Enterprises	2,206	29.65	4.72

[a] Crops used as staples: maize, beans, millet, bananas, sweet potatoes.

[b] Crops grown purely for sale: e.g., cotton, coffee, tea; none of the sample farms in Kaimosi Cluster had any of these crops.

Source: Computed from survey data.

Table 2. Resource Returns From Major Farm Enterprise Types, Hamisi Cluster, 1983.

Enterprise Type	Gross Margin (Shs.) per		
	Hectare	Person-Day	Variable Cost Sh.
Food Crops[a]	1,892	22.37	2.60
Cash Crops[b]	8,184	57.16	3.55
Cattle (Zebu)	1,835	35.41	8.80
Dual Purpose Goats	463	1.49	0.29
All Enterprises	3,094	29.11	3.80

[a] Crops used as staples: maize, beans, sorghum, bananas.

[b] Crops grown purely for sale: coffee, tea.

Source: Computed from survey data.

Table 3. Resource Returns From Major Farm Enterprise Types, Masumbi Cluster, 1983.

Enterprise Type	Gross Margin (Shs.) per		
	Hectare	Person-Day	Variable Cost Sh.
Food Crops[a]	2,199	28.52	7.61
Cash Crops[b]	2,213	20.88	3.50
Cattle (Zebu)	483	15.99	3.56
Dual Purpose Goats	449	1.09	0.39
All Enterprises	1,336	16.62	3.77

[a] Crops used as staples: maize, beans, cassava, sorghum.

[b] Crops grown purely for sale: cotton.

Source: Computed from survey data.

Table 4. Summary of Resource Returns From Major Farm Enterprise Types By Cluster and Scarce Factors, Western Kenya, 1983.

	KAIMOSI			HAMISI			MASUMBI			ALL CLUSTERS		
	Gross Margin per ha	Gross Margin per p-d	Gross Margin per sh	Gross Margin per ha	Gross Margin per p-d	Gross Margin per sh	Gross Margin per ha	Gross Margin per p-d	Gross Margin per sh	Gross Margin per ha	Gross Margin per p-d	Gross Margin per sh
Food Crops[b]	2,357	26.3	1.8	1,892	22.4	2.6	2,199	28.5	7.6	2,164	26.1	4.4
Cash Crops[c]	—	—	—	8,184	57.2	3.6	2,213	20.9	3.5	3,177	24.4	2.4
Cattle (Zebu)	3,034	56.6	11.5	1,835	35.4	8.8	483	16.0	3.6	1,678	34.4	7.6
DPGs	1,227	6.1	0.9	463	1.5	0.3	449	1.1	0.4	702	2.8	0.5
All Enterprises	2,206	29.7	4.7	3,094	29.1	3.8	1,336	16.6	3.8	1,930	21.9	3.7

[a] All figures in Kenya Shillings, KSh 1 = US $0.074 (March 1984).

[b] Crops used as staples: maize, beans, sorghum, millet, sweet potatoes, cassava, bananas.

[c] Crops grown purely for sale: cotton, coffee, tea: none of the sample farms in Kaimosi had these crops.

Source: Compiled from Tables 1 - 3.

TABLES 5 - 24: ON-FARM DPG TRIALS — THE FARMERS' VIEWS (26 Interviews).

Table 5. Do Family Members Like Goat Milk?

RESPONSES	f	%
1) Yes	21	80.8
2) No	1	3.8
3) N/A	4	15.4
TOTAL	26	100.0

Table 6. Explanation of Why Goat Milk Liked.

RESPONSES*	f	%
1) Tastes very good in tea.	17	56.7
2) Tastes richer than cow milk.	9	30.0
3) N/A	4	13.3
TOTAL	30	100.0

*More than one answer allowed.

Table 7. Use of Goat Milk.

RESPONSES*	f	%
1) Making tea.	22	62.9
2) Drinking fresh.	3	8.6
3) Cooking vegetables.	3	8.6
4) No experience.	4	11.4
TOTAL	35	100.0

*More than one answer allowed.

Table 8. Could DPGs Be Successfully Reared In This Area?

RESPONSES	f	%
1) Yes.	22	84.6
2) Yes but with difficulty.	1	3.8
3) No.	2	7.7
4) Too early to tell.	1	3.8
TOTAL	26	99.9

THE PROGRAMME AND THE PUBLIC: SR-CRSP EXHIBITS AT AGRICULTURAL SHOWS

By
J.E. Reynolds[1] and A. N. Mbabu[2]

One of the activities undertaken by the Rural Sociology Project based in Maseno is the coordination of SR-CRSP informational exhibits at annual agricultural shows in the western Kenya region. Here we would like to briefly summarise the purposes behind the exhibits and make a few observations about our experiences thus far.

SR-CRSP researchers depend on the interest and cooperation of both local people and government personnel in carrying out their various projects. As such, it is important for us to communicate to people a proper understanding of what we hope to accomplish through our work and the ways we set about doing it. The agricultural shows are sponsored by the Agricultural Society of Kenya (ASK) in major centres around the country and regularly attract thousands of visitors, local residents and governmental personnel alike. The crowds come to the showgrounds to view displays, demonstrations, and arena entertainments organised by District and Provincial offices of different Kenya Government ministries, as well as parastatal bodies and private industries and commercial firms. The shows are annual events and usually last for three or four days. In 1982, the Rural Sociology team suggested to others in the Maseno SR-CRSP research group that the Kakamega and Kisumu shows in the western part of the country would provide excellent opportunities for informing a wider public about our Programme and raising people's interest in the possibilities for dual-purpose goat production on small-scale farms. It was agreed that the group would organize an information exhibit for the Kakamega show scheduled for late November 1982. Arrangements were made for our exhibit to be included as part of the Western Province Ministry of Livestock Development stand at the Kakamega showgrounds.* Our exhibit was a modest affair but we thought it was very well received by both the Provincial Livestock Development officials and the show visitors in general. As a result, it was decided to make our participation in ASK shows a regular event and we have since set up exhibits in the Kisumu Show of August and the Kakamega Show of December 1983.

The Rural Sociology team is particularly concerned with the acceptability of dual-purpose goat technologies amongst local people and a further motive in promoting the show exhibits was the belief that they would provide us with one means of guaging public reaction to SR-CRSP work. People's attitudes, whether positive or negative, would be evident through the questions and comments we received from those visiting the exhibits.

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[1] University of Missouri/SR-CRSP
[2] MALD

* The Ministries of Livestock Development and Agriculture have since been combined into one ministry, the MALD.

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Our show exhibits are organized as follows. First, a working committee of Maseno resident scientist and MALD research officers is formed well in advance of each show. Committee members represent all of the SR-CRSP projects based at Maseno. Regular meetings are held to allocate various tasks between members and check on the progress of preparations. Meetings are also held with the District and Provincial MALD personnel in charge of the Ministry's stands. Members of each SR-CRSP project assume responsibility for designing posters and other displays which provide clear and simple demonstrations of their on-going research activities. Brief information sheets on SR-CRSP activities are prepared in English and Kiswahili versions for distribution to the public, and arrangements are made to staff the exhibit with SR-CRSP and MALD personnel who will welcome visitors on each day of the show.

We feel that the quality and effectiveness of our show exhibits have improved with each round. We are particularly pleased with the results of our participation in the 1983 Kakamega Show. Here, for the first time, we were able to display a few dual-purpose goats - a buck, a doe and her kid. Milking demonstrations were given twice daily and the stand visitors were able to view some fifteen informational and pictorial posters and several forage sample displays. Hundreds of visitors toured our stand and we were interviewed by the Voice of Kenya reporters who were publicising the show. This interview was later broadcast twice on the national radio. Visitors showed a very keen interest in the goats and our activities and there were numerous of requests for further information including a number inquiries from those who wanted to purchase dual-purpose goats to keep on their own farms.

In conclusion, we feel that the show exhibits are fully realising their intended purpose of building public awareness and interest in the possibilities for dual-purpose goat production in the western Kenya region. Furthermore, taking the show exhibits as a rough measure of public acceptance of dual-purpose goat husbandry, it is apparent that it has a very high appeal amongst people in the region. Indeed, the enthusiasm shown by the many people visiting our exhibits who express a desire to purchase and raise dual-purpose gots on their now leads us to sound a note of caution. While we value the public's interest and cooperation with our Programme as conducive to our research efforts, we must guard against giving the impression that we have developed a selection of new goat production options for local farmers which are now fully tested and available to willing parties. Many people seem quick to assume that because we have "grade" goats and are already distributing some to local farms, we are in the business of livestock production innovation delivery - in the same way that the Dairy Development Project new operating in Kakamega District and elsewhere, for example, aims at promoting the use of grade cattle in zero-grazing units on small farms. Would-be goat buyers express disappointment when we have to remind them that the Maseno Station goats "are not for sale but for research" and that the goats we have placed out on local farms are "for trial".

Our experience with the show exhibits underscore the problem of what could be called our self-presentation to local farmers. It is something we have encountered in a more serious way in those communities where we are conducting on-farm investigations. This issue will be addressed more fully in another paper presented at this workshop. The challenge we face is peculiar to the SR-CRSP as a <u>research</u> rather than <u>extension</u> programme. At this stage, we must foster an understanding and acceptance of ourselves amongst local

farmers by emphasizing our role as one of researchers in quest of possible solutions to small-scale farm production constraints, and not as one of extension agents who have found the answers - in this case in the form of a dual-purpose goat technology assembly kit that is tried, certified, and ready for immediate delivery.

SEEKING THE "UDDER" TRUTH ABOUT GOATS IN WESTERN KENYA: CONVERSATIONS WITH COMMUNITY ELDERS

By
J.E. Reynolds[1]

Significant topics for investigation under the Rural Sociology component of the SR-CRSP are the former patterns of domestic production and life in the Programme's Western Kenya sites and the socio-cultural and economic changes that have taken place, especially in recent times. Ongoing and long-term work on these topics using techniques of key informant interviewing, archival review, and case study of individual families and farms has been described in the Rural Sociology workplans under the title "Historical and Ethnographic Profiles of Luo and Luhya Study Communities: Changing Lifestyles and Implications for Small Farming and Livestock Development." I should now like to give a short account of some aspects and results of this work.

Anthropologists and sociologists engaged in multi-disciplinary programmes of applied research like the SR-CRSP sometimes find that their colleagues from other fields wonder about the relevance of "the past" and "community traditions and customs" as research concerns given that there are seemingly more pressing practical problems of a technical or biological nature demanding attention. Agronomists, animal scientists and livestock breeders, for example, are understandably inclined to see the real crux of development research to lie in such questions as:

- "Does this particular hybrid have good yield characteristics?"
- "Is this animal showing good growth performance under our experimental conditions?"
- "How can we engineer a high yielding but disease-resistant small ruminant for this part of the tropics?"

With the search for urgent "here and now" answers commanding top priority on their research agenda, some technical scientists might come to adopt a somewhat dismissive attitude towards studies of the historical career of particular human communities and the patterns of belief and behaviour they have evolved. "Interesting but of no great moment" might be their judgement of such work, or they turn their attention again to what they see as the real business at hand - such as dry matter weights, protein content analysis, or things that slither about pathogenically under a microscope lens. "What difference does it make", is the implicit question, "how people lived before, or how they used to behave or believe?"

For sociocultural researchers at least, such "difference" may loom very large indeed. Consider a small item that appeared in one of Kenya's daily newpapers, the Nation of 26th November, 1982, under the heading "Goat Farmers Given a Boost". The article was reporting on an exchange in Parliament and read in part as follows:

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"An Assistant Minister for Livestock Development...said a massive campaign had been started to encourage wananchi to keep high quality dairy goats. [The Assistant Minister] said the Ministry had initiated pilot projects for goat milk in Kakamega, Busia, Siaya and Kiambu. He was answering a question from [the] Kaikipia East MP....In a supplementary question, [the member from Bahati] sought to know whether the Ministry was trying to popularise the drinking of goat milk, which, he said, was forbidden in Western Kenya.

Goat milk forbidden in Western Kenya? What a shock! By what massive oversight have we become involved with dairy goat production in a region where such enterprise flies in the face of cultural norms? Who in our Programme, whether of a biological or (worse) social scientific bent, failed in doing their ethnographic homework? Are we, perhaps in some minor way, committing the functionally equivalent act of some imaginary blunderer who sets about establishing say, a Pig-CRSP on the outskirts of Riyadh, Saudi Arabia, in order to serve the "wananchi" of that Islamic state? In the same way, one can envision a Beef Steak and Samosa CRSP to cater for the nutritional requirements of hungry Hindu "wananchi" in Hyderabad.

Conversations with Community Elders

We can retire from the field of facetious example, I hope, having made a point about the relevance of taking sociocultural questions into account in programmes of applied research involving new production strategies for local communities. Having set this as a context, let us move on for a moment to consider the very practical "here and now" concerns that arise from the assertion of the Hon. Member from Bahati during the Question Time Session in Parliament reported in the newspaper article.

In the early days of the Kenya SR-CRSP, those attached to the Rural Sociology Project submitted a short commentary on the prospects and research needs of the programme from a social science point of view (Nolan, 1982). At that time, some caution was expressed about goat milk acceptability in Western Kenya communities. But the report was admittedly preliminary in nature and it was pointed out that a fuller appreciation of the situation was in order. When full time Rural Sociology work was started in Maseno and the Programme study communities in Siaya and Kakamega, it became possible to carry out more intensive investigations. Plans were made to explore the question of goat milk in traditional diet as part of the wider historical and ethnographic work programme referred to earlier. As indicated, we are making use of "key informants" for help in this work. These individudals are identified on the basis of their long association with the communities and the rich stock of personal experience and oral history they have as a result. Also they are individuals who are open to our requests for information and it helps if they are good narrators. The SR-CRSP enumerators operating in the study communities, Peter Amuhinda, Henry Kiguhi, and Evans Otieno, and a Rural Sociology field assistant, Joseph Atichi, have aided in selecting good key informants and in spending long hours in conversation with many of them. Altogether, we have thus far carried out interview series with some fifteen informants, men and women, most in the age range of 65-80 years. We do not use any formal questionnaires in our interviews, but instead work with a set of guidelines which help to structure the conversations.

Rough notes made during interviews are later transcribed into more complete form for review and discussion between us. The informants have proven to be highly fruitful sources of information on the traditional context of commnity life as well as the dramatic transformations in the physical and social environment which they have witnessed over the course of this century.

Goat Milk: Seeking the "Udder" Truth

There seems to be little reference to the role of goat milk in Luo and Luhya communities of earlier times in the existing ethnographic literature, but it is interesting to see our key informant material in relation to what is available. A passage referring to small ruminants and traditional animal husbandry practices appears in the well-known monograph on Luhya life written by Gunther Wagner (1949) who carried out anthropological studies in what was then known as North Kavirondo District during the 1930s. It is not known whether the self-styled ethnographer MP who spoke out against goat milk in Parliamaent ever read this work, a massive tome in two volumes, but Wagner's observations only partly confirm and mostly negate his position. Wagner writes:

> "Sheep are kept mainly for sacrifical purposes; they are also valued for making gifts for trading...Although most people prefer mutton to goat's meat, there are some who refuse to eat it, and say that it makes them vomit. As a rule, sheep are not milked, nor is any use made of their wool. 'They are useless while they are alive' was the way in which one of my informants summed up the position...Goats, too, are chiefly kept for purposes of sacrifice or barter. They are milked only among the Bukusu, but to drink goat's milk is considered by them a poor man's custom. The Maragoli never milk goats, and deride the Luo and Swahili for doing so [Vol. 2, 51-2].

The position as Wagner describes it seems variable. Goat milk was at least used, if not favoured, in some communties while it was shunned completely in others. Accounts by our informants also give a varied picture of the situtiion, but one that is more complex than Wagner's. First, we are getting testimony that goat milk served and indeed to some extent still serves medicinal as well as food purposes in certain areas. It is reported to have soothing properties for skin and eye irritations, for example. Secondly, while Wagner depicted hard and fast lines between different comunities insofar as goat milk consumption was concerned (the Bukusu and Luo but not the Maragoli), we are finding a fair degree of intra-community differences in the recollections of our informants. An old Bunyore man becomes quite enthusiastic about the subject of goats and goat milk in bygone days, saying "yes, indeed people in this neighbourhood used to milk goats a lot"; the old woman from just across the valley, on the other hand, might shake her head and say that "people only used goat milk rarely."

It is noteworthy, however, that we have nowhere encountered in our conversations with elders the view that goat milk was a "prohibited substance" in any serious or widespread way. If anything, we tuned to give credence to those accounts, put forward so definitely by several of our informants, that goat milk was in the past a clear component of local diets - not in all places, perhaps, but certainly in many. We also take as plausible informants' testimony that goats and indeed livestock in general formerly played a much

more significant role in people's lives than is the case at present. A broad reconstruction, based on what we have been told (Table 1) depicts a situation in which goats have served people in the study communities not just in a single or dual purpose way, but in a markedly multipurpose capacity.

Table 1. Local Goats: Then and Now

Uses Past (CA 1900) ----------> Significance of Same Uses, Present

MILK	
Food	
Fresh	Decreased*
Soured	Decreased*
Medicinal	
Skin/Eye Irritations	Decreased
Soothes Stomach	Decreased
"Chases Out" Other Infections	Decreased
HIDES	
Clothing	Decreased*
Bedding	Decreased*
Trade (Barter)	Decreased
Trade (Sales)	Increased
Gifts	Decreased
STOCK	
Food (Meat)	Continues
Bridewealth	Continues
Trade (Barter)	Decreased
Trade (Sales)	Increased
Sacrifice/Ceremony	
Appease Ancestors	Decreased
Cleansing	Decreased
Feasts	Continues
Important Visitors	Continues
Ownership Prestige	Decreased
Gifts	Continues

* Virtually nil.

"Our goats in those days," one informant relates, "took the place of cattle for many people. They were larger, much larger, than these local goats you see now. The had bigger udders and were good milk yielders. And of course there was plenty of feed available for the animals then. People used goat milk to feed infants whose mothers had died or fallen sick; they used it with other food, after it had soured in the gourds; they used it for cooking vegetables; and young boys could get some

refreshment by "stealing" milk from goats when they were out tending the animals. Of course there were some people who didn't prefer it then and wouldn't drink it now. But this is just a matter of one's personal likes and dislikes; or maybe some people are allergic to the milk, just as people are for many other kinds of food".

With these remarks, let the case against those in the "Goat Milk is Forbidden in Western Kenya" camp be rested for the present. What is the "udder" truth of the situation? It is clearly one for continued research and some debate. I think however that those of us who have been involved in conversations with community elders in the study sites have effectively raised doubts that the situation is so simple or extreme as has been suggested by others. I would emphasize that we have done so by regarding "the past" and "community tradition" as most relevant and important subjects for research attention.

Acknowlegement

The assistane of Messrs. Peter Amnhinda, Joespeh Atichi, Henry Kiguhi and Evans Otieno in carrying out the interview work referred to in this paper is gratefully acknowledged.

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FIELD RESEARCH AND THE WESTERN KENYA STUDY COMMUNITIES: OBSERVATIONS BY THE SR-CRSP ENUMERATORS

By
J.E. Reynolds[1], P. Amuhinda[2], H. Kiguhi[2], E. Ochieng[2], E. Otieno[2], and M.F. Nolan[1]

Introduction

Of all members of the Small Ruminant - Collaborative Research Support Program (SR-CRSP) research group in Maseno, the Central Bureau of Statistics enumerators who have been seconded to the Programmme for the past three years, have had the widest experience with the survey and monitoring activities that we have conducted in the west Kenya study sites. Not only have they been assigned primary responsibility for on-farm data collection, but they have also participated in some of the coding of data collected through various investigations. Furthermore, those enumerators who have lived and worked within the study sites of Masumbi in Siaya District, and Hamisi and Kaimosi in Kakamega District, have had the most direct experience with local people's responses to the SR Programme activities, and with the dual-purpose goat (DPG) Trial which has been taking place on selected farms since early 1982.

For all of these reasons, the enumerators are in an excellent position to serve as commentators on such matters as: the effectiveness of our data collection methods, the problems that are encountered in day-to-day fieldwork activities, the on-farm goat trials, and community perceptions of and responses to SR Programme activities in general. Towards the middle of last year, therefore, each of them was asked to prepare an evaluation of the Programme based on their own experiences. These evaluations, summarized as one report (Reynolds et al 1983), were subsequently presented to the entire research group.

Four broad types of concerns were addressed in the evaluations.

1. Questionnaires and Data Elicitation

All enumerators stressed that difficulties have been encountered in trying to obtain certain kinds of information sought by researchers through various questionnaires. Information on such matters as household consumption patterns, labor-time for farm chores, crop yields, and the feeding of trial goats is inherently difficult to collect; careful probing by the investigator is required but even so, inaccuracies do occur and the resultant data must be evaluated with proper recognition of these weaknesses.

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2. Rapport with Local Farmers

Although enumerators feel they maintain basically good relations with their respondents, a variety of difficulties have been encountered, some of which seriously impinge on the task of data collection. These difficulties can be divided roughly into three sorts. First, there are those that simply arise in the course of the enumerators' regular, long-term involvement with the study communities (e.g. requests for small favors and assistance). Secondly, there are difficulties brought about by people's expectations and occasional misconceptions of SR-CRSP research; it is possible that some of these could have been avoided by a more thorough introduction of research aims and methods to the communities involved. Finally, there are difficulties that derive from respondents' negative reactions to certain lines of investigation which involve repetitive interviewing; asking the same questions over and over at frequent intervals may alienate some respondents.

3. Animal Health

Enumerators often find it difficult to inform research officers in Maseno about sick animals in a timely fashion because of poor communications. This has resulted in the death of a number of DPG which could have been avoided.

4. Collaboration Between Enumerators and Research Officers

It is the view of the enumerators that many of the problems they have encountered in the field have not been fully appreciated by those who oversee their work from Maseno. It is felt that in the past, collaboration between officers and enumerators has been too one-sided: the officers devise work plans, design questionnaires, and issue instructions; the enumerators are then expected to carry on as directed. But as the enumerators are closest to the participating farmers, have the most intimate understanding of local circumstances, and are most acquainted with the survey and monitoring instruments as they are applied in the field, the researchers would very likely benefit by soliciting their opinions and advice to a greater extent than has been the practice before.

From the time of submitting their initial evaluation last year, the enumerators have been cooperating with the Rural Sociology Project in maintaining field journals. In these accounts they regularly record developments related to SR-CRSP work in the study areas, comments of people with whom they interact, and their own observations of the Programme and the communities. Briefly discussed in what follows, are some of the important issues that come out in the journal entries.

Animal Health and Monitoring

On-farm work by the Animal Health Project team involves periodic visits to the study sites in order to supervise barrel dipping for tick control on the Maseno trial goats and other small ruminants owned by neighborhood farmers, drenching of animals to control internal parasites, and the collection of blood and faecal samples for laboratory examination as part of an effort to monitor animal health problems on local farms. Treatment of sick and injured animals is also done on occasion as deemed necessary.

While there have been good responses to the dipping, drenching and treatment activities, complaints have been registered from some cooperating farmers over the question of blood and faecal sampling. Some farmers commonly do not see the point of repeated sample collections, and think that these activities may actually harm their animals. Reaction against blood sampling has been particularly strong. People express worries that animals can develop swollen necks from the needles, or lose weight or perhaps die due to blood depletion. Although we may know that such sampling, if properly carried out, is of little or no harm to the livestock, local people have their own views, and these must be taken into account if we are to maintain good working relations with our cooperators. Thus far, we have erred in not keeping people adequately informed as to why we are doing the sampling and what results we are obtaining from the tests we run. This is evident from the fact that some people avoid the meeting place on days samples are to be collected; they stay away simply because they do not want their animals to be sampled. Misunderstanding and negative feelings might also explain why some farmers have gone so far as to claim that we are going around collecting blood in order to sell it!

Forage, Animal Care, and DPG Performance

The Feed Resources team has devoted considerable effort to on-farm activities by developing trial plots to test forage crops in various combinations and treatments. Sesbania, pigeon peas, and Sudan grass have been introduced as fencerow plantings in the study sites, and different food-forage intercropping experiments have taken place on farms of participating households. There have been some notable positive responses by people to these efforts, particularly in the case of pigeon peas in Siaya (where the crop is seen to do well under very dry conditions and has also proven to appeal as a source of human food) and of Sudan Grass in Hamisi (where it is regarded by some farmers as a good feed for both goats and cattle).

However, a certain lack of commitment is apparent amongst some farmers in the planting and caring of forage crops. Several related factors may be contributing to this situation. First of all, in none of the study areas is there a tradition of intensive animal husbandry practices. The planting of forage crops as such was not a feature of established livestock production systems; and cut-and-carry methods, though also of increasing importance these days, is generally not something people favor doing on a long-term, all-season, or concerted basis. Tethering or supervised grazing are the popular approaches to animal feeding.

A second point is the attitute common amongst local farmers that livestock, and particularly small ruminants, do not warrant substantial commitments of one's time and energy for their upkeep. Livestock are deemed important, useful, and valuable components of farming systems, yes; but there is also the widespread feeling that they should somehow be able to thrive in the given "natural" environment, meaning the graze, browse, and crop thinnings and residues that are "just available" rather than specially produced. In other words, there is some feeling amongst farmers that animals ought to be able to "look after themselves".

A further factor is the scarcity of agricultural land, especially in the Hamisi area. With available space for food crops so extremely limited,

farmers are simply not in favor of giving over very much area to anything else.

It has also been noticed that some farmers regard the planting and care of forage materials as something for the "Maseno people" to be concerned about. Our experiments do not seem to these people nearly so important as they do to us. As a result, such farmers see little sense in devoting their efforts to looking after the new forages.

Finally, the reluctance of farmers to devote more time and energy to the support of DPG's has to do with their experiences in the on-farm trials. Some co-operators have been quite disappointed. While all the cooperators were pleased at first with the idea of keeping milking goats, several of the animals proved to be very poor yielders. Daily yields of less than half a litre a day were found and in several cases cooperators got so little that they hesitated to milk at all out of fear that the does' kids would be too deprived. Also, a few of the goats that could yield reasonable amounts had lactation periods of only three or four months and farmers were forced to look elsewhere for their milk supplies. Furthermore, after lactation some of the goats did not get bred immediately but took another six months or so. All of these reasons contributed to the decline of interest on the part of some farmers to continue with a high level of labour support for the animals. They did not find very good returns for the efforts they were putting in.

Trial Goat Distribution and Availability

The enumerators in their first evaluations of the Programme last year pointed out that there were a number of misunderstandings in the study communities over the question of our trial goat placements. Our original agreement with farmers participating in the on-farm goat trials was that the animals placed would, after a year's time, become the property of these farmers. In return, we asked that people cooperate with us in the monitoring of the animals' performance and also provide good care.

However, there were many in the communities who got the impression that our goats were given out as loans, subject to repayment. Eventually neighborhood meetings or "barazas" were held in each area in order to offer public assurances that no "loans" were involved. Any other questions that local farmers had about the Programme were also dealt with. Although these meetings were very helpful, references to "loans" are still heard from time to time, and it is possible that more needs to be done to clarify the conditions under which cooperating farmers receive trial goats.

One of the things that became obvious during the "barazas" was that very many more people in the communities wanted to try DPG's out for themselves. We responded to these requests without making any firm promises, but by saying that we would do our best to make more trial goats available. We pointed out that our stock supply was very limited and that it would take time to get more animals out. About six months have gone by since the "barazas" were held, and the enumerators report that in this time they have received literally hundreds of requests by individuals seeking to know how the Maseno goats can be obtained. A number of people have asked why the Maseno officers are delaying on their "promise" to bring more goats.

Even though we tried not to commit ourselves definitely, it seems that there is now widespread expectation for us to bring in more trial goats. While all of this shows that there is certainly a great crowd of farmers willing to give DPG's a try, it also raises questions about how people in general are understanding our work on the farms. We are concerned that many may be seeing the Programme as a goat distribution project rather than as a research effort that involves some goat distribution on a trial basis. It is sometimes difficult to explain to farmers the difference between introducing a new thing "to see how it works" and introducing a new thing as "something farmers should adopt". Other projects in the area, such as poultry development, or AI for local cattle, or zero-grazing of grade cattle, have worked through government extension staff to encourage farmers to start new practices which are recommended as profitable, and people may tend to regard the introduction of DPG's in this light.

Nevertheless, we strongly feel that more trial goats should be made available in the study sites. The Maseno scientists have said to farmers that they would try to do so, and this has been interpreted as a commitment. Rightly or wrongly, people are going to be very disappointed if we fail to come through with at least a few more animals. But what is even more urgent is the supply of replacement goats to some of our cooperators who have lost trial goats through no fault of their own, and who have definitely been promised new animals. Some of these farmers have been kept waiting for many months and are openly wondering whether we are ever going to bring them.

The Programme and the Communities

In giving some of our observations on the SR-CRSP work in the study communities, we don't mean to leave the impression that local people are generally taking a negative view of the Programme and our on-farm activities. Indeed, generally we think that our participating farmers and other community residents have over the past year shown greater cooperation and receptiveness to our efforts than before.

But we think we can improve the situation still more by dealing with the kinds of problems we have identified here. They are problems which better understanding and clearer communication between researchers and local people would go a long way towards solving. To summarize, they include:

- misconceptions or mistrust about certain activities like the sampling of animals for health monitoring, or forage resource experiments and fencerow planting;
- the distribution of some trial goats of a very inferior performance level;
- confusion over the terms of trial goat placement;
- delays in supplying further trial goats to willing farmers, and especially to those cooperators who have been promised replacement goats; and
- the general difficulties that come about as a result of not keeping our aims and operations as researchers clearly defined and distinct from those of straight development or extension agents.

We like to think of the SR-CRSP Programme as one which brings us into a kind of partnership with the local people, and at times refer to our work as

"research for and with the farmer". Those in the study communities have on the whole been pleased with our approach, but we now need to build on this goodwill so that our partnership becomes even stronger and more rewarding.

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EXTENSION SERVICES AND THE SMALLHOLDER: A REPORT OF PRELIMINARY FINDINGS

By
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The SR-CRSP Rural Sociology Project is currently working on a two-part study of Livestock Development Extension Services and the smallholder farmer in western Kenya. Field investigations, completed for Part I of this study, dealt with the extension and technical personnel who operate at the Divisional level and below. Here we present a few of our preliminary findings. A fuller account will be prepared when Part II of the study, dealing with farmers' views and experiences with the extension service, has been completed.

Study Objectives

There are several reasons for our interest in the extension services, the staff who operate it and its significance to local farmers and their enterprises:

- Livestock Development field personnel should readily be able to provide information on animal health and management problems in their areas of posting.
- They are likely to be quite familiar with local farmers and their circumstances;
- The development of dual-purpose (DPE) goat production technologies in western Kenya must take into account existing livestock extension services and the capability of extension agents to support smallholders' efforts by delivering appropriate technical assistance and advice.

Procedures

Using a survey questionnaire designed with the assistance of colleagues in the Health and Economics projects, we interviewed all Livestock Development extension and technical personnel in five administrative divisions where the SR-CRSP has existing or planned study sites. The Divisions included Emuhaya, Hamisi and Vihiga in Kakamega District, Maseno in Kisumu District and Boro in Siaya District. The personnel interviewed included Veterinary Officers, Assistant Animal Production Officers, Dairy Development Officers, Animal Health Assistants and Junior Animal Health Assistants. A total of 62 interviews were conducted.

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Findings

The Sample

Out of the respondents interviewed, 86% were men. Average age of the sample group was 37 years. Nearly 80% of the respondents were married, and these had an average of about 5 children each. They reported supporting households including not only wives and children, but an average of about 1.5 other dependents as well. Over 80% of the respondents were in farming themselves and most of them (71%) on land they owned. The average length of service within their current areas of posting for the group is five years.

Briefly then, we are dealing with people who as a group are relatively mature, have heavy family responsibilities, are farmers in their own right, and who have had significant exposure to their posting assignments. We would therefore judge that their experiences and views warrant serious attention.

Levels of Staff Training

In terms of general formal education, the largest category of extension staff proved to be those who had reached Form IV level in secondary school. They constituted 37% of our sample. This frequency was followed by those who had at least completed primary education - around 34% of those interviewed. Only 14.5% of our respondents had taken their school education beyond the Form IV level. It is, of course, those who proceed through the higher secondary levels who become eligible for opportunities leading to college diplomas or university degrees, which in turn qualify people for more senior positions in Livestock Development work. Those who received professional training to the college diploma level or beyond made up almost 13% of our sample.

Job Satisfaction and Effectiveness

Asked about the terms and conditions of their employment (a question for which more than one answer was allowed), 51.3% of the respondents (58) answered that the employment was "interesting" while 14.2% indicated that it was "not interesting". About thirty five percent of the responses (39) consisted of remarks to the effect that the terms of service were not satisfactory. Low salaries and difficulties in obtaining promotion up the scale of service were points frequently cited.

Despite peoples' reservations about terms of service, 71% of the sample were willing to continue doing the same jobs. Desire to stay with the job was clearly due to the security offered by eventual pensions. Many were also holding out for the possibility of obtaining further training, which is equated to promotion opportunity. Only about one-fifth of the respondents explained their desire to stay with the job in terms of finding it personally fulfilling.

Asked to give an evaluation of their abilities to visit directly with local farmers in the field, 79% of the personnel felt that they were not able to make such visits "often enough". The most popular reason given for this perceived failure was that Livestock Development staff had too many farmers to serve across too great an area without appropriate transportation facilities. Fully 68% of those surveyed singled out lack of transport as the

most critical problem hindering the effectiveness of their work.

We have tabulated some rough statistics to indicate the enormity of the problem extension staff face in trying to serve the farming households in their areas of operation. In Maseno Division, we found a total of 15 extension workers covering a household population of 18,128. In Vihiga Division (including Emuhaya which is a new division still administered from the Vihiga Livestock Development Office), there were 23 extension staff with a possible 47,739 client households to serve. In Hamisi, there were 13 staff against 17,032 households. In Boro, a team of 11 people are catering for a possible 20,784 farming households.

When asked how many individual households they were able to visit in the course of a normal month, respondents cited figures which yielded an overall average of 23.2. Taking this as a loose measure of farm coverage, we can calculate a set of figures for individual farm visitation intervals that is of unreasonable magnitude. It would take 4.3 years, given the present staff establishment in Maseno Division, to make a complete cycle of farm visits. Likewise, it would take 4.7 years in Hamisi, 6.8 years in Boro, and 7.4 years in Vihiga/Emuhaya for their respective livestock extension staffs to tour their farming households at least once. It should be remembered that these figures relate to the total staff establishment in the Divisions. For those personnel who have received higher professional training at the diploma or degree level, of course, the ratio of staff to potential client households becomes even more disproportionate. In all the divisions surveyed, there are only 8 of these highly qualified individuals to serve 103,683 households, amounting to a distribution of approximately 12,960 households each.

Of course we are working with very approximate figures and making a number of assumptions. However, these tabulations are enough to make the point that, to put it mildly, the existing livestock extension staff finds itself overstreteched. We noted through our survey that they have coped to some degree with the impossible situation by relying on group contacts with farmers through 'barazas' and that they considered this mode of extension operation as more important in furthering their work than the individual farm visit approach. Obviously some form of effective group extension deserves a high priority in the Ministry's planning agenda.

Prospects for SR-CRSP Activities

The extension personnel respondents are almost unanimous in the view the dual purpose goats would be acceptable to the farmers with whom they conduct their work. Ninety percent of those interviewed affirmed this viewpoint. Out of a total of 41 staff who ventured an opinion on why dual-purpose goat development would be successful in their areas, most felt that the strong point was in one of the chief rationales for SR-CRSP work in Western Kenya, namely, that ever-shrinking land resources make milk production through dairy goats an attractive option to the smallholder (58.8%). Other responses (more than one could be recorded) cited the substantial interest local people were already expressing in dairy goats (21.6%) and the long established tradition of goat husbandry in the region which would facilitate dual-purpose goat technology acceptance (19.6%).

When asked about possible problems that should be anticipated if dual-

purpose goat production approaches were popularised, the most frequent response given by extension staff was that there would be a real need for extension service support. Some 53% of the responses recorded indicated how crucial it would be for field staff to provide education and technical assistance to help farmers manage exotic goats. Other responses (more than one could be recorded) cited problems including: the unavailability of feeds (11.4%); local preferences for other animals such as sheep and cattle (8.6%); financial constraints that might be obstacles to raising dual-purpose goats (8.6%); traditional prejudice against goat milk and meat (5.7%); unfavorable climate (5.7%); disease risks (5.7%); and possible lack of markets for goats and their products (1.4%).

While most of the personnel surveyed anticipated the need for strong extension service support as part of any future dual-purpose goat development programme, there is the further question of whether their background and training gives them the professional capability to provide it. When asked if they had any kind of experience with goat husbandry in general (gained either in practical ways or through classroom instruction) 64.5% of the respondents answered in the affirmative. The types of experiences respondents claimed to have had (more than one answer could be recorded per respondent) where at least some instruction in goat management had been received during training courses (31.5% of all responses) practical experience during childhood in herding the goats of parents and neighbors (19.2%); "at least some training in treating goats" (about 8.2%), "currently keeping local goats myself" (6.8%), and "have worked in a project with dairy goats" (4.1%).

When respondents were further asked to evaluate whether their previous experiences qualified them to advise farmers on the management of dairy or dual-purpose goats specifically, 76% answered in the negative. Finally, when asked if they thought further training would be required in order for them to competently advise farmers in dual-purpose goat husbandry 74.2% answered "yes" to this question while another 16.1% thought that it would be good to take a refresher course. Very few (6.5%) were of the opinion that they needed no further training, 3.2% felt they could presently treat, but not advise, on the management of dual-purpose goats.

Conclusion

In conclusion, we should reiterate that what we are presenting here are only some preliminary findings from recent field investigations covering the first part of a larger study of extension services and the smllholder in our western Kenya research areas. The data gathered thus far need to be subjected to a much fuller analysis, and the two parts of the overall study must eventually be combined into a comprehensive report.

On the basis of what we have thus far, we would make the following general points:

- Extension personnel operating in our study areas take an extremely positive view of the potential for dual-purpose goat production. They see our research efforts as most appropriate given the production constraints that currently exist on smallscale farms. Our programme makes very good sense to them.
- Any future effort to involve livestock extension staff in widespread

dual-purpose goat producton on-farm trials or dual purpose goat technology encouragement amongst smallholders cannot operate on the assumption that such staff under present conditions of service and training levels will be able to offer substantial support.

- There appears to be an extremely critical need to devise group extension strategies to help extension personnel cope with the existing and virtually hopeless disproportion between staff numbers and their potential large audience amongst the smallholder population.

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Table 1. Perceptions of job.

Response*	f	%
Job is "interesting"	58	51.3
Job is "not interesting"	16	14.2
Dissatisfaction with terms of service, e.g. salaries, promotions, etc.	39	34.5
Total	113	100.0

* N.B.: Question allowed more than one answer.

Table 2. Current levels of extension service.

Division	Total # of Extension Staff	Total # of Households*	Time required to cover households assuming 23.2 HHs/month/person (years)
Maseno	15	18,128	4.3
Vihiga-Emuhaya	23	47,739	7.4
Hamisi	13	17,032	4.7
Boro	11	20,784	6.8
Total	62	103,683	6.0

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

Table 3. Reasons why prospects for DPG development are favourable.

Reasons Cited*	f	%
Farmers are already keeping local goats; therefore easy to accomodate dairy goats.	10	19.6
People are already expressing an interest in the dairy goats.	11	21.6
The rationale -- DPGs for small-holder farmers -- is sound, especially given ever decreasing land resources.	30	58.8
Total	51	100.0

* N.B.: 41 of 62 staff responding; question allowed more than one answer.

Table 4. Problems to anticipate in DPG development.

Problems Cited*	f	%
Need to do a lot of extension work	37	52.9
Unavailability of feeds	8	11.4
Other animals (e.g., cows and sheep) are preferred by farmers	6	8.6
Financial problem to maintain such goats	6	8.6
Traditional prejudice against goat meat and/or milk	4	5.7
Diseases	4	5.7
Unfavourable climate	4	5.7
Lack of market for goats and their products	1	1.4
Total	70	100.0

* N.B.: 50 of 62 staff responding; question allowed more than one answer.

Table 5. Previous experience with goat husbandry.

Experience Cited*	f	%
At least some training in management of goats	23	31.5
Herded local goats as a child	14	19.2
At least some training in treating goats	6	8.2
Currently keeping local goats myself	5	6.8
Worked on a project with dairy goats	3	4.1
Not applicable	22	30.1
Total	73	99.9

*N.B.: Question allowed more than one answer.

Table 6. Need for further training if to advise farmers on DPG management.

Responses	f	%
Would need further training	46	74.2
Would need at least a refresher course	10	16.1
Can treat but not advise on management of DPGs	2	3.2
Need no further training	4	6.5
Total	62	100.0

PRELIMINARY STUDIES ON INDUCTION OF PROTECTIVE IMMUNITY IN GOATS AGAINST CCPP BY FREEZE-DRIED F-38 ANTIGENS

By
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Presently the vaccine against contagious caprine pleuropneumonia (CCPP) is in liquid from and must be transported to where it is needed in the field on ice in iceboxes. Besides, the shelf life is unknown. Thus, the vaccine is produce on order.

Since Lyophilized vaccines are easy to store and transport, a study was undertaken to find out if lyophilized F-38 vaccine will confer protective immunity when the vaccinated goats are challenged by contact.

F-38 strain of mycoplasma used for production monovalent CCPP vaccine was grown in Newing's tryptose broth medium and the usual processes of vaccine production (at Vet. Labs., Kabete) were followed except that Tween 20 and chloroform were excluded. Protein estimation of the vaccine was carried out by the method of Christian and Warburgh (1942). The vaccine was lyophilised in vials at a concentration of 8 mg/ml. The vials were stored at 4 C.

The freeze-dried vaccine was not used until 36 days later. Eight goats were immunized with the freeze-dried vaccine at the dose rate of 8 mg/dose. The goats received similar booster doses 21 days after the initial doses. The 8 vaccinated goats and 8 unvaccinated control goats were challenged by contact exposure 64 days after initial/first immunization.

The results are shown in Tble 1. Six controls out of 8 died of CCPP while only 2 survived. Only one vaccinated goat died of CCPP, a second one died of other causes than CCPP.

These results strongly suggest that freeze-dried F-38 antigens (vaccine) will protect if and when optimal immunizing dose together with an appropriate adjuvant are used.

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ATTEMPTS TO CHARACTERIZE F-38 PROTEIN(S) WHICH INDUCE GROWTH INHIBITING ANTIBODIES IN IMMUNIZED AND/OR INFECTED HOST

By

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Isolation and characterization of mycoplasma proteins which induce protective immunity would lead to new avenues and probably cheaper ways of producing the vaccine such as genetic engineering. Before this can be carried out the protein(s) must be identified. The identification of the proteins was achieved by surface labelling the mycoplasma (F-38) with radio-active iodine following the method of Leith et al (1983) and carrying out immuno-precipitation with antisera made in goats and/or rabbits which had specific activity against mycoplasma (F-38). The antigen(s) was identified from the radio-labelled mixture by specific precipitation and analyzed by polyacrylamide gel electrophoresis followed by authoradiography (Leith et al. 1983).

Three proteins were precipitated with growth inhibiting sera from rabbits and goats immunized with F-38 antigens and were not precipated by pre-immunization sera nor a pool of normal goat or rabbit sera. The three proteins had molecular weight range of 90,000 to 170,000. These same proteins were precipatated by sera from goats which had undergone natural infection (contact) and recovered.

The mycoplasma proteins eluted as for immunoprecipitation were run on disc polyacrylamide gels and the proteins corresponding in molecular weight to those specifically precipitated by the growth inhibiting sera were cut out. The protein bands were used to immunize rabbits. Sera from the rabbits were tested for growth inhibition. The rabbit sera from both rabbits immunized with the proteins were found to growth inhibit suggesting that the protein(s) responsible for induction of growth inhibiting antibody to F-38 in goats or rabbits had been identified.

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EVALUATION OF NEW ANTHELMINTIC FOR CONTROL OF NATURALLY OCCURRING NEMATODE INFECTIONS OF GOATS IN KENYA

By
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Nematode resistance to TBZ was of interest because a majority of Kenyan farmers rely on TBZ for parasitic control. The Ol Magogo farm with SR-CRSP goats near Naivasha has also utilized TBZ treatment and there were feelings that the drug effectiveness was not satisfactory. This situation presented an opportunity to test the ivermectin (IVOMEC(R))* which has been found very effective against nematodes and trematodes in other domestic animals (Egerton et al, 1979). Thus the study was carried out to:

1. Determine the efficacy of ivermectin (IVOMEC(R)) against mixed nematode infections in goats in Kenya.
2. Compare the efficacy of IVOMEC to that of currently used routine treatment TBZ drench.

Materials and Methods

The trial was carried out at Ol Magogo farm near Naivasha, Rift Valley Province, where the SR-CRSP Breeding Project maintains a herd of goats. The farm lies on latitude 0.37° South, Longitude 36.3° East, with an altitude of 3,281 feet above sea level. The farm receives an annual rainfall of about 750 mm per annum. The peak of the rains is March through May; August, September and October are the driest months. There may be short rains in November and December but December through February can also be quite dry.

Goats

The goats were a breeding stock consisting of three groups of does each containing about 150 head. The does were on free range during the day and were housed at night. They had free access to water, shared common grazing grounds and normal standard of management were practised. About 150 kids on the farm were also available for the trial. The breeds involved in the trial were East African, Galla and the East African/Toggenburg cross.

Collection of Fecal Samples

Individual faecal samples were taken per rectum with a plastic glove. The samples were placed in plastic faecal pot containers, labelled and stored in a cool box. The samples were transported to the Veterinary Laboratory at Kabete for processing and examination.

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Quantitative Fecal Worm Egg Counts

Fecal samples were processed and examined by sugar floatation technique (Westcott and LeaMaster, 1982) at the Helminthology Laboratory in Kabete.

About 1 gm feces of each sample was stirred with 30 ml of water and the solution passed through a fine siEve to remove debris. The solution was centrifuged for 10 minutes atr 1,500 rpm and decanted. The sediment was agitated and mixed with sugar solution (sp gr 1.27) and a 22 mm square cover glass was placed on top of each centrifuge tube full of the solution and centrifuged for 10 minutes at 1500 rpm. Each coverslip was lifted off and placed on a glass slide and the centre area examined microscopically. Total number of roundworm eggs on each slide were counted and recorded. In floatation, the eggs were recorded as Nematodirus, Trichris, Momenza and Strongyle eggs. The latter category includes eggs of gastrointestinal nematodes such as Ostertagia, Trichostrongylus, Cooperia, Haemonchus and Oesophagestomum which are difficult to differentiate in freshly prepared fecal samples.

Fecal Cultures

Larvae were cultured from pooled feces in culture jars at room temperature for two weeks. The fecal pellets were broken down and thoroughly mixed. The cultures were checked and moistened daily to avoid drying. The larvae were harvested by Baermann technique. (Manual of Veterinary Parasitological Laboratory Techniques, 1977).

Worm Recovery

Procedures for worm recovery used were those described by Westcott and Leamaster (1982). Each kid was euthanized and necropsied immediately. The abomasum was ligated at both cranial and caudal ends, cut beyond the ligatures and was placed in a container (about 20 litre steel bucket). The small intestines were ligated at its attachment to the abomasum and stripped from the mesentry to the ileocaecal junction where it was again ligated, cut and placed in a second container. The caecum and colon were placed in a third container.

Each of the three portions was opened with longitudinal incision and the contents were emptied into a container, the mucosa washed throughly with water and the washings added to the contents. The contents were allowed to settle and the supernate decanted. The sediment containing the parasites was transferred to 2 litre plastic jar and was fixed with 10% formalin for future examination. During the examination, the supernate was discarded from each container and the sediment diluted to a working volume of one litre with water. Aliquots were removed from this volume and examined using a dissecting microscope and the worms were counted as adult or early fourth stage larvae and placed in small vials of 10% formalin. Identification of parasites in each portion was accomplished by combining all aliquots from that portion petri dish, mixing thoroughly and identifying the parasites.

Experimental Design

Experiment 1

Three groups of does on natural infections of gastrointestinal nematodes were positively identified by eartags and physical characterisitics. All the animals were treated monthly with TBZ (88 mg/kg body weight). This treatment was interrupted by IVOMEC (200 meg/kg body weight) on the 4th and 7th months after commencing the experiment. Seventy-five does were randomly selected and their faecal samples taken fortnightly.

Experiment II

This work was on kids and ran concurrently with Experiment 1. The kids were divided into a treated group (100 kids) and nontreated group (50 kids). The treated group received IVOMEC monthly by subcutaneous injection. When the worm egg counts in nontreated kids reached a mean average of 350 eggs per gram (EPG), 15 kids were selected for experiment III and the remainder were placed on the IVOMEC treatment programme for the rest of the trial period.

Experiment III

Fifteen kids randomly selected from Experiment II were divided into three groups. One group was on IVOMEC treatment, another on TBZ treatment and the third was a control. Fourteen days after treatment, the kids were killed and examined for presence of nematode parasites.

Results and Discussion

Results from the larvae cultures showed that there were six genera of gastrointestinal nematodes. The genera and their percentage in the worm population are shown in Table 1. Of the six genera, Haemonchus was the dominant one ($\geq$ 90%) while other occasionally occuring genera were: Ostertagia, Tricho strongylus, Cooperia, Nematodirus and Oesophagostomum. Distribution of these genera were not affected by TBZ treatment. These results show that Haemonchus contortus in goats, like sheep (Preston and Allonby, 1978), is the most important gastrointestinal nematode. The worm egg counts (epa) on the does in Experiment 1 are shown in Table 2 and Figure 1. There were two peaks during the TBZ treatments (408 epg in June and 380 epg in September) and there were two drops (0.6 epg in June and 0.1 epg in October) occurring with IVOMEC treatment which was effective, unlike the TBZ treatments.

Results on parasite worm egg counts on the kids in Experiment 2 and 3 are shown in Tables 3 and 4, respectively. The IVOMEC treatment in Experiment 2 had an efficacy of 98.8% and 99.6% and in Experiment 3, efficacy was 100% while there was no statistically significant difference between TBZ treated animals and control animals. Table 5 shows the gastrointestinal nematodes recovered in Experiment 3. The IVOMEC treatment was 100% efficacious and TBZ treatment was only 22.7% and below. These results clearly show that there were TBZ resistant nematodes in this area and that IVOMEC was efficacious even on the TBZ resistant nematodes. The potency of IVOMEC remained for four weeks and signs of reinfection appeared on the sixth week (Figure 1). Thus, the prophylactic application of IVOMEC on goats should be at least after four week and not later than six weeks.

In Figure 2, the significant rainfall in April was associated with a significant rise in epg. The rise in epg was followed by a marked drop in epg over a period of six weeks. This reaction was a sign of resistance manifested by the goats. The three breed of goats has a similar trend of infection and there was no statistically significant difference among the breeds except on the first visit in March and tenth visit in July. On both occasions, the goats were picking up infection and they showed a different degree of susceptibility. It is clear that the East African breed of goats had the highest resistance, then Galla, and least was the East African/Toggenburg cross.

These preliminary findings agree with similar observations by Ruvuna et al (1982) who showed that the East African breed showed marked reduced kid mortality. More work to establish differences in natural susceptibility and resistance among the goat breeds in the country is necessary. Reduced susceptibility of the East African goat may be of importance in relationship to production and performance studies in breeding programs.

Acknowledgements

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Table 1. Total number of 3rd stage larvae harvested and their percentage in population from larval cultures in Experiment 1.

	ABOMASUM						S/INTESTINE		L/INTESTINE				TOTAL
	H. Contortus		*O. Circumcincta*		*T. axei*		*N. Spathiger*		*C. Curticei*		*O. venulogum*		
Month	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
March	203	92.69	3	1.37	4	1.83	5	2.28	0	0	4	1.83	219
April	330	98.50	0	0	3	0.90	2	0.60	0	0	0	0	335
May	184	95.81	1	0.52	1	0.52	0	0	4	2.08	2	1.04	192
June	-	-	-	-	-	-	-	-	-	-	-	-	-
July	122	95.32	0	0	3	2.34	3	2.34	0	0	0	0	128
August	317	96.65	4	1.22	5	1.52	0	0	2	0.61	0	0	328
September	156	95.71	1	0.61	2	1.23	0	0	4	2.45	0	0	63

Table 2. Total and Mean parasite eggs in fecal samples examined from March to November (TBZ - 88 mg/kg)
(IVOMEC-200 mcg/kg)

MONTH	SMAPLING	TREATMENT	TOTAL E.P.G.	MEAN E.P.G.
March	1	T	5834	89.8
	2		9355	173.2
APRIL	3		29610	429.1
	4	B	19184	319.7
MAY	5		13890	239.5
	6	Z	9346	155.8
JUNE	7		25717	408.2
	8	IVOMEC	37	0.6
JULY	9		106	1.9
	10		8335	135.6
AUGUST	11	T	17460	245.9
	12	B	18039	254.1
SEPTEMBER	13		17009	253.8
	14	Z	27768	380.4
OCTOBER	15	IVOMEC	8	0.1
	16		49	0.7
NOVEMBER	17		3925	54.5
	18		22442	334.9

Table 3. Mean number of parasite eggs in fecal samples examined from kids treated with ivermectin (200 mcg/kg) and controls.

Sampling	Control (Nontreated)	Treated	% Reduction(Efficac
1	389.3	-	-
2	413.8	5	98.8
3	405.9	1.7	99.6

* Efficacy = (mean number of eggs in control minus mean number of eggs in treated) divided by mean number of eggs in control kids.

TABLE 4. Mean number of Parasite eggs in fecal samples examined from different treatment regimes (TBZ - 88 mg/kg)
(IVOMEC - 200 mg/kg)

GROUP	MEAN E.P.G.	% REDUCTION (EFFICACY)*
CONTROL	278.8	-
TBZ	254.8	8.2
IVOMEC	0	100

* Efficacy = (mean number of eggs in control minus mean number of eggs in treated) divided by mean number of eggs in control kids.

TABLE 5

Mean Number of Nematodes recovered and the Percentage Reduction after Different Treatment Regimes

Nematode	Treatment Groups				
	Control	Thiabendazole		Ivermectin	
	No.	No.	% Redu.	No.	% Reduction
Haemonchus contortus	62.6	50.8	18.78	0	100
Ostertagia circumcinta	2.6	2.2.	15.39	0	100
Trichostrongylus axei	6.2	3.2	48.39	0	100
Nematodirus spathiger	1.8	0.8	55.56	0	100
Oesophagostomum venulosum	1.6	1	37.5	0	100
TOTAL	74.8	57.8	22.72	0	100

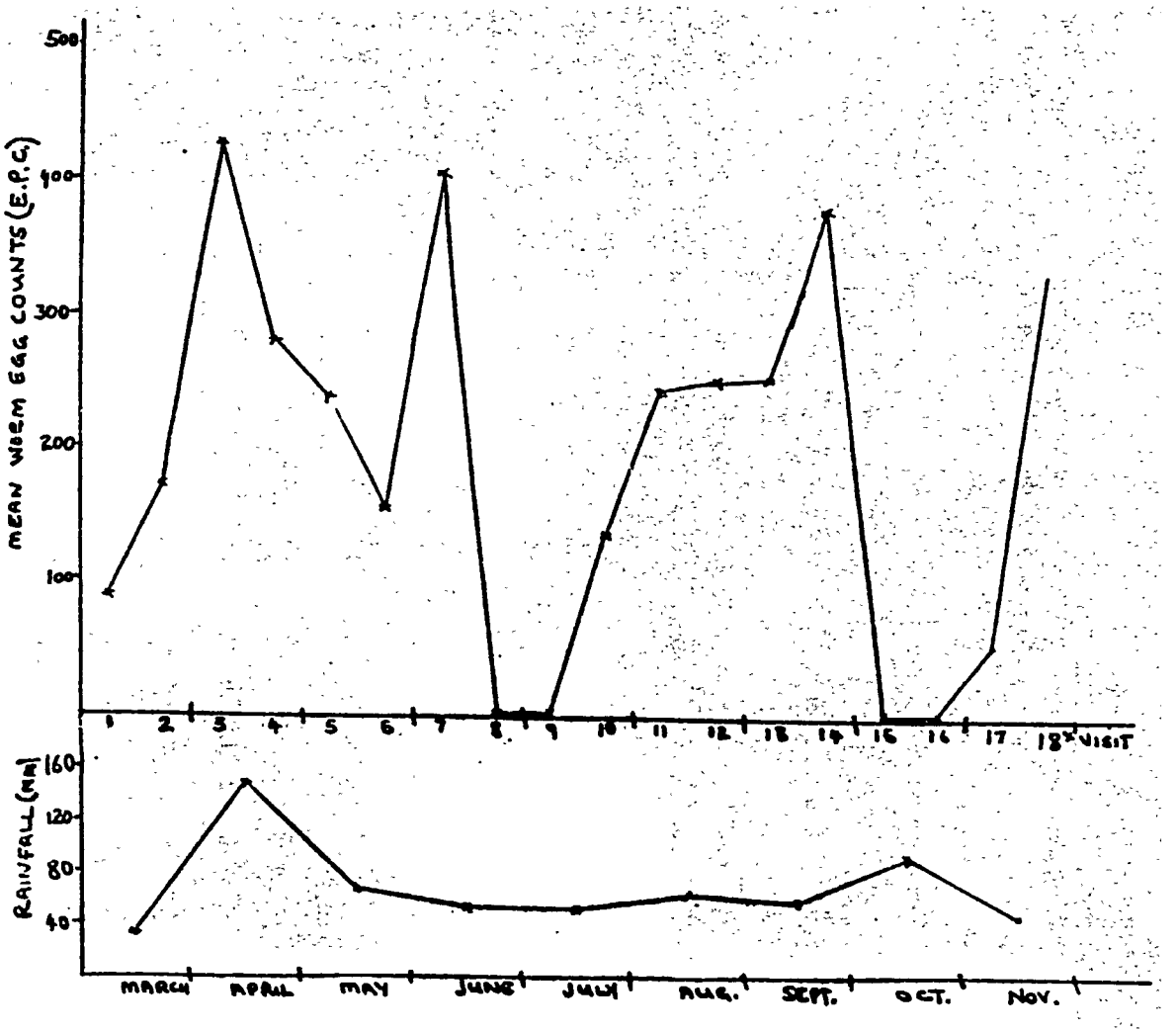

Figure 1. Mean of parasite eggs in fecal samples from does and their relationship to rainfall.

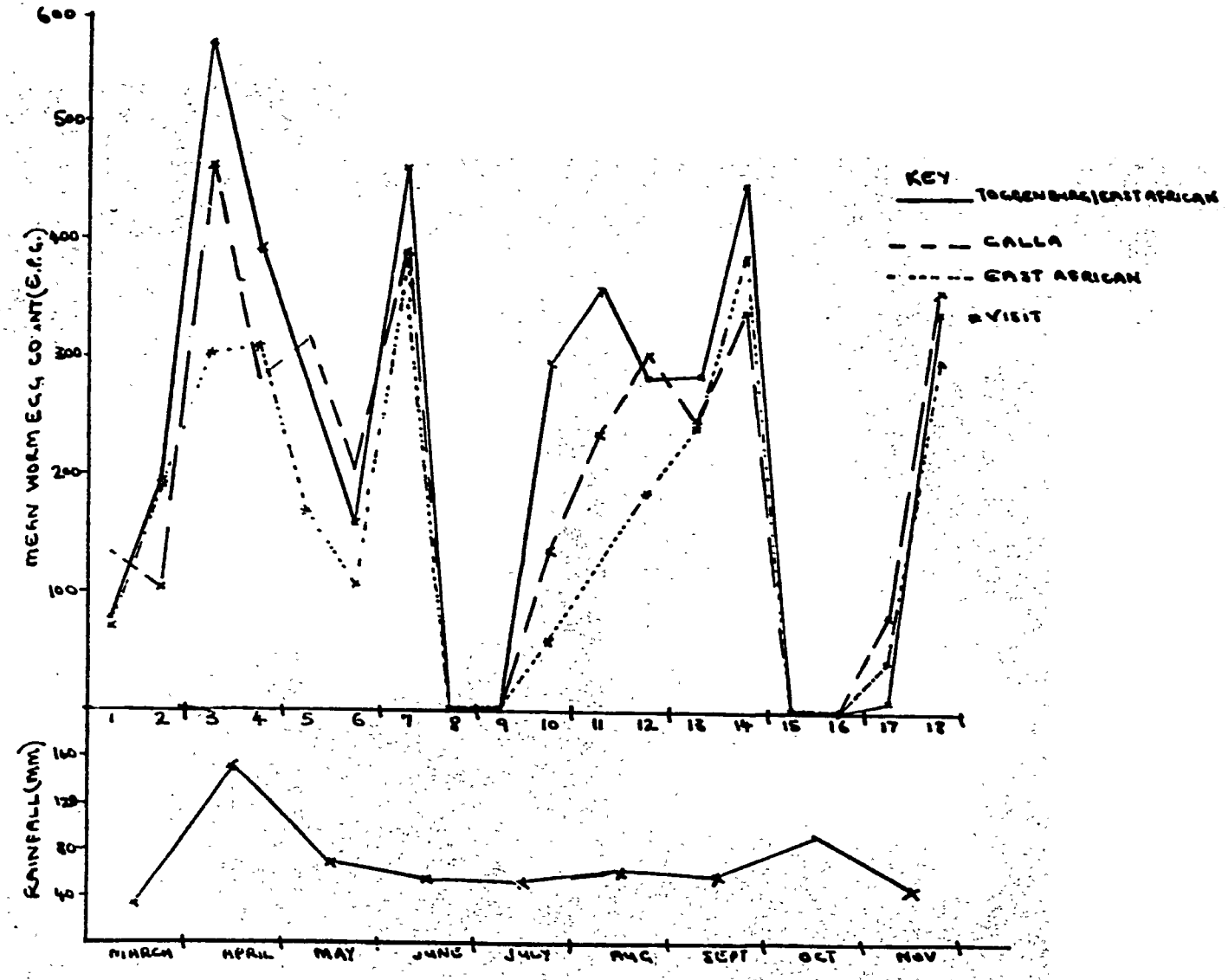

Figure 2. Mean of parasite eggs in fecal samples from three breeds and their relationship to rainfall.

BLOOD SELENIUM CONCENTRATION OF SHEEP AND GOATS FROM SELECTED AREAS OF KENYA

By
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Selenium has been shown to be an important micro-element for animal health and nutrition (Schwarz and Foltz, 1957). A diet deficient in seleneium will lead to disorders such as muscular dystrophy, unthriftness and infertility in animals, particularly when there are low Vitamin E levels (Scott, 1973). On the other hand, excess selenium is hepatotoxic, neurotoxic, retards growth, causes muscular weakness and is teratogenic (Scott, 1973).

To date, little has been done to investigate the status of this important element in small ruminants in Kenya. The purpose of the present study was to determine locations of selenium deficiency, adequacy or excess in selected areas of Kenya where grazing of small ruminants predominate. This was carried out by analysis of sheep and goat blood as well as soil and forage for selenium levels.

Materials and Methods

The areas selected for study were Naivasha, Kajiado, Machakos and parts of Siaya, Maseno and Kakamega. These areas were chosen for the survey mainly because of their high small ruminant populations and their varying climatic and ecological conditions. In addition, the four areas are situated in different parts of Kenya and hence the findings would reflect selenium status in those parts of the country. In the Maseno-Kakamega-Siaya area, the study was conducted in animal clusters which had been chosen by combinations of random number tables, human population numbers and ecological figures (SR-CRSP Report, 1981). Most of the goats sampled were Toggenburg crosses while sheep were mainly East African fat-tailed with a few red Masai. In Naivasha, the study was conducted on animals owned by the UNDG/FAO Sheep and Goat Project. Most of the goats wre Toggenburg crosses while most sheep were East African fat-tailed and a few red Masai.

In Machakos, animals from four divisions were sampled: Machakos Central, Kangundo, Kilome and Yatta. All goats sampled were the East African breed while sheep were mainly East African fat-tailed and red Masai. In Kajiado, sampling was conducted in bomas (enclosed homes). Here most goats were also East African and the sheep, red Masai. Husbandry practices in the areas of study varied. In Kakamega District, the animals were principally tethered to browsing areas during the day and confined to bomas at night. In Machakos, Kajiado, Maseno and Naivasha, sheep and goats were herded to grazing areas during the day and confined to bomas at night.

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Sampling Procedure

Two hundred animals, 100 sheep and 100 goats, were sampled from each area. Each area was sampled two times, once during the wet season and once in the dry season. All age groups of both sexes of sheep and goats were sampled. The percentage of the animals sampled depended upon the number that was present on the farm. Where very few animals were present, all would be sampled. Where no facility to confine the animals was available, they were caught one by one and sampled without bias as to age or sex. Approximately 10 mls of blood were collected into preheparinized 15 mls vacutainers from each sheep and goat by jugular puncture. Blood samples were refrigerated at approximately + 4°C until selenium assay on the whole blood was performed. The sampled animals were not ear tagged for identification in next season sampling but samping in both the dry and wet seasons was conducted in the same pool of animals. Thirty soil, 30 browse and 30 pasture samples were also taken from the area where the animals grazed. Browse plants were differentiated from pasture plants by close observation of the feeding behaviour of the animals. For example, sheep were observed to feed on Themade triandra more than goats. Information from the herders as to what plants were preferred was also utilized. Forage samples were stored in a cool but dry place until they were dry. They were then crushed and ground. Soil samples were also ground. No forage or soil samples were taken from Kajiado. Blood, forage and soil samples were prepared and analysed by use of acid digestin and hydride evolution atomic absorption spectrophotometry method as described by Inhat and Miller (1977) and Cox et al (1981). Statistical analysis was carried out using student-t test (Steel and Torrie, 1980).

Results

Table 1 shows the percentage of animals with very low levels of blood selenium (< 0.05 ppm) in the four areas survey. Yatta division of Machakos had the highest percentage (76%) of sheep with the lowest blood selenium levels, followed by Kangundo and Kilome, each with 20% of the sheep exhibiting low levels in the wet season. As in the wet season, Yatta division still had the highest percentage (40%) of sheep with the lowest blood selenium levels in the dry season. Goats were not as low in blood selenium levels when compared to sheep in both season; however, a similar trend as sheep was observed (Table 1). In both species, there were more animals with very low blood selenium levels in the wet season than in the dry season, with the exception of Maseno and Kakamega where more animals with very low blood selenium levels were observed in the dry than in the wet season.

Table 2 shows selenium levels for the pasture and browse forage. The mean selenium levels in the pasture samples during the wet season was lower than the mean selenium levels in pasture samples during the wet season ($p<0.05$). Similarly, the mean selenium levels in the browse samples during the wet season was lower than the mean selenium levels in the browse samples in the dry season but the difference between selenium levels in the browse samples in the wet and the dry seasons was not significant. Difference between pasture and browse selenium levels both in the dry and wet season were statistically significant ($p<0.05$). The mean selenium levels of soil samples were 0.268 ppm, 0.04 ppm and 0.43 ppm for Machakos, Naivasha and Maseno-Kakamega-Siaya areas, respectively. Soil samples from Kangudo in Machakos had the lowest mean selenium levels (0.22 ppm) while the highest mean selenium was

obtained in soil samples from Siaya (0.48 ppm).

Discussion

Results of this study have revealed areas with goats and sheep having very low (<0.05 ppm) blood selenium levels. The results indicate that large areas of Machakos, which extend from Kangundo to Yatta and Kilome had high percentages of animals with blood selenium levels below the critical levels of 0.05 ppm below which deficiency signs might occur (Blood et al, 1980). The observed low blood selenium levels during the wet season may be due to intake of low selenium diet in this season while the lower blood selenium levels observed in the sheep than in the goats may be due to the different feeding habits of both sheep and goats.

The mean values of forage selenium concentrations did not differ significantly from the values reported previously by Bergh (1973) and Floslie et al (1980). There was little relationship between forage selenium and soil selenium levels. This lack of close relationship may be due to the fact that selenium is present in the soil in different chemical forms that may not be readily available to plants (Lakin, 1961).

Although many animals had blood selenium levels which are usually accompanied by selenium responsive diseases, none of the animals manifested signs of these diseases. It is difficult to explain this discrepancy. It is possible that the lower established blood selenium level of 0.05 ppm may not be applicable to East African sheep and goats. Further work to establish this level is needed. Furthermore, factors such as Vitamin E and total protein could influence the occurrence of selenium deficiency signs (Hogue et al, 1962). Vitamin E can act synergistically with low selenium levels to prevent clinical signs associated with selenium deficiency from appearing (Hopkins et al, 1964). These parameters need further investigation.

In conclusion, this work has shown that large area of Kenya, particularly in Machakos District, are apparently low in selenium. Studies on the effects of economic importance of apparently low selenium levels in apparently clinically normal sheep and goats require further investigation.

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Table 1. Percentage of Sheep and Goats With Very Low Levels of Blood Selenium in Both Wet and Dry Seasons.

Area	N	Sheep		Goats	
		Wet Season	Dry Season	Wet Season	Dry Season
Machakos					
Kangundo	25	20	20	0	0
Kilome	25	20	8	4	0
Yatta	25	76	40	12	16
Central	25	0	0	4	0
Maseno	22	9	32	10	16
Kakamega	25	4	20	10	25
Siaya	20	15	10	5	5
Naivasha	100	5	4	8	6
Kajiado	100	10	3	6	0

N = Number of samples analysed.

Table 2. Selenium Content in Forage Sampled from Naivasha, Machakos and Maseno-Kakamega-Siaya Area in the Wet and Dry Seasons.

	N	Pasture Forage		Browse Forage	
		Wet Season	Dry Season	Wet Season	Dry Season
Naivasha	30	0.16 ± 0.05 (0.08-0.28)	0.24 ± 0.11 (0.07-0.44)	0.30 ± 0.08 (0.18-0.41)	0.36 ± 0.09 (0.18-0.54)
Machakos	30	0.25 ± 0.08 (0.15-0.43)	0.31 ± 0.09 (0.19-0.15)	0.27 ± 0.19 (0.03-0.63)	0.33 ± 0.20 (0.05-0.66)
Maseno/Kakamega/Siaya	30	0.19 ± 0.09 (0.05-0.37)	0.20 ± 0.08 (0.08-0.37)	0.23 ± 0.10 (0.07-0.44)	0.28 ± 0.12 (0.99-0.46)

N = Number of samples analyzed

Mean ± SD: Range in Parenthesis

HEALTH PROBLEMS IN GOATS IN WESTERN KENYA

By
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In June 1983, a health monitoring activity was initiated to identify the most common diseases affecting dual-purpose goats and recommend cost-effective control measures which would form a part of the management package for farmers with dual-purpose goats.

The health monitoring exercise continues. Therefore, this report only represents work done between June 1983 and February 1984.

Materials and Methods

Materials:

Sites: Monitoring was based on four sites scattered over Western Kenya, namely, Masumbi in Siaya District, Hamisi and Kaimosi in Kakamega District, and Maseno Research Station in Kisumu District.

Animals: The animals used in this exercise included all dual-purpose goats on all the sites as indicated in Table 1. They consisted of East African x Toggenburg, Galla x Toggenburg, and a small number of Anglo Nubian x East African crosses.

Sampling and Samples:

Two methods were adopted for sampling:

1. Routine Sampling: Based on the findings of the 1980/81 health survey (Abinanti, 1982), it was necessary to routinely monitor the following diseases:

   - internal and external parasites
   - brucellosis
   - contagious caprine pleuropneumonia
   - caprine arthritis encephalitis
   - mastitis

   Internal parasites were monitored on a monthly basis. Ten gm of faeces were collected in plastic containers from each goat and submitted to the Investigatio Laboratory at Kericho where differential egg counts were carried out using modified McMaster technique (Whitlock, 1960). Five mls of blood in EDTA bottles from each goat were submitted for the determination of packed cell volume (PCV).

   Every three months, 10 mls of serum from each goat were submitted to the serology laboratory at Kabete for testing for brucellosis,

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contagious caprine pleuropneumonia and caprine arthritis encephalitis.

2. Clinical cases - followup: Every sick goat on all the four sites was reported to the Veterinary Officer at Maseno. A clinical examination was then conducted and necessary samples were submitted to the laboratory for confirmatory of diagnosis. Treatment was then administered. All dead animals were autopsied and specimens taken were submitted to the laboratory. Each field staff maintained a diary for health recording.

Results

Table 2 summarises the laboratory results for helminthology and haematology. In the differential egg counts strongyles, strongloides, tapeworms and coccidia were identified. Out of a total of 743 faecal samples submitted to the laboratory, 345 (46.4%) were positive for strongyles, while 192 (25.8%) wre positie for strongyloides; 34 samples (4.6%) showed the presence of tapeworm eggs. One hundred and fifty-seven samples (21.1%) had more than 500 eggs per gram of the strongyles; 105 samples (14.1%) of the strongyloides also had counts above 500 and similarly, 8 (1.1%) for tapeworms.

Out of 365 samples of whole blood analysed, 32 (8.8%) had a packed cell volume below 20. The overall mean was 28.6.

Figure 1 represents the overall monthly pattern for the strongyles. The figure indicates that the percentage of animals infected rose from 27% in July 1983 to a peak of 73% in December 1983 and began a decline in January 1984. The proportion of animals with an egg count above 500 rose in a similar pattern. In Figure 2, the prevalence of strongyles in the sites are represented.

Table 3 shows the infectious diseases that were diagnosed during the study. They have been classified as bacterial, viral, fungal and parasitic.

Bacterial

Mastitis: A total of 18 cases (36%) of mastitis in 50 lactating does confirmed in the laboratory were caused by *E. coli*, *Streptococcus agalactiae*, *S. dysagalactiae*, *Staphylococcus aureus* and *Bacillus coagulans*.

Pneumonia: A total of 35 cases were diagnosed, mostly in young goats of pre-weaning age. A mortality rate of 2.2% was associated with pneumonia. The causitive agents wer mainly: *Pasteurella haemolytica*, *Klebsiella sp.*, *E. coli* and *Corynebacteria pyogenes*.

Brucellosis: A total of 152 serum samples were submitted to the laboratory. Three were positive on SAT and negative on CFT and RBPT. The sample animals showed negative SAT on repeated testing.

Contagious Caprine Pleuropneumonia: All 152 serum samples submitted to the laboratory proved to be negative.

Viral

Orf (Contagious ecthyma): This was the only viral condition, occuring in 4 goats from Masumbi.

Caprine Arthritis Encephalitis: All 152 serum samples submitted to the laboratory were negative.

Fungal

Streptothricosis occurred in 3 animals during the study period.

Ectoparasites

Sarcoptic mange: An incidence of 11.8% was recorded with a mortality rate of 0.74%.

Fleas: There were occasional massive infestations with ctenocephalides. A quantitative study was not carried out.

Ticks: A fairly low infestation has been recorded in a separate study (Khainga, 1983).

Table 4 summarises the non-infectious conditions categorised as metabolic, poisoning, abortions and wounds/trauma.

Metabolic

Mineral Deficiency: A total of 12 cases (8.8%) were recorded and found exclusively in lactating does. A mortality rate of 2.9% occurred. There was no conclusive laboratory confirmation, but, based on therapeutic responses, magnesium, calcium and phosphorous were highly suspected.

Malnutrition: Seven cases (5.2%) of malnutrition occurred. The diagnosis was based on the animals' responses to an improved diet, from natural pasture to concentrates and high protein pigeon pea, vines, sudan grass and mineral licks. 2 animals (1.5%) died from malnutrition.

Poisoning

Plant poisoning: A total of 3 cases (2.2%) occured and all died as a result. In all cases, the diagnosis was based on the history of having eaten a poisonous cassava and the findings of the postmortem lesions.

Abortions

Five cases (10%) occured. All cases were negative on bacteriology and serology for brucellosis.

Wounds/Trauma

Accidents causing fractures and barbed wire wounds accounted for 3 (2.2%) of the cases.

Discussion

From the results of the differential egg counts, it is quite apparent that the strongyles are dominant. Investigations done elsewhere (Allonby, 1975) have indicated that Haemonchus contortus is the most important single helminth economically in the tropics. This has been supported by faecal cultures done from goats in Naivasha (Njanja, 1984). It can be assumed that Haemonchus contortus is responsible for the high proporcions of animals with strongyle eggs. Throughout the eight month study period, all goats were on a three week drenching schedule with a broad spectrum anthelmintic (Nilzan^{R}). It is interesting that at no time was helminthiasis completely eliminated, even in the drier months from July to September 1983 when the challenge in the environment should have been low-coupled with the drenching. The PCV was monitored as an indicator of anaemia caused by helminthosis. Except for the 32 animals (8.8%) that showed a PCV below 20%, a mean of 28.6% for the herd was within the normal range (Amakiri, 1981).

Among the infectious conditions, bacterial pneumonias and mastitis had the highest incidence rate. An incidence rate of 36% for mastitis is high and calls for further investigations into the hygiene of the milking procedure. Pneumonia was mostly observed in the young of pre-weaning age. It would appear that adults have acquired some immunity to these bacteria. The fact that pneumoia from Masumbi and Maseno were caused by the same aetiological agents, indicates that these bacteria may be widespread in the environment. As the monitoring continues, preventive measures for mastitis and pneumonia should be contemplated. The viral and funal diseases did not appear to be persistent problems. Although mange was also not a persistent problem, it could cause more loss in economic terms if it is not detected early and treated.

In the various categories of non-infectious diseases, one that seemed most outstanding was the metabolic diseases. Mineral deficiency diagnosis was arrived at exclusively from clinical manifestations, and dramatic responses to therapy with electrolytes. It was observed only in the lactating does. Magnesium and calcium-phosphorous complex was regarded as the cause. Malnutrition was observed mostly in lactating does on the farms and was associated with poor feeding regimes by the farmers. Plant poisoning was in all cases caused by the poisonous variety of cassava. All goats that died had a previous history of eating this plant. There was no established cause of abortion. Bacteriology and serology were negative for brucellosis. There were cases of barbed wire cuts and fractures with a fairly low incidence (2.2%).

The present study has revealed to some extent the dynamism of some diseases such as helminthiasis, mastitis, pneumonias and mineral deficiencies. Further monitoring may indicate variations from one location to another and the seasonal pattern of the diseases. These changing patterns must be monitored for effective prophylactic interventions of the known diseases and detection of the emergent ones.

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TABLE 1 : CHANGE IN INVENTORY OF SR - CRSP HERD 1981-1984

	DOES		BUCKS	
	>6MONTHS	<6M	>6M	<6M
PURCHASE	130	-	4	-
BIRTHS	154		69	
DEATHS	43	24	2	23
ON-FARMS	36	11	3	8
CULLED	10	1	2	-
CURRENT INVENTORY	80	25	10	20

MONTH	TOTAL SAMPLES	NO. + VE	NO 500 EPG	MEAN	RANGE	
1983 - JULY	92	25(12.2)	11(12.2)	282	00-9200	STONGYLES (ST)
	II	2(2.2	0	5.4	00-400	STRONGYLOIDES (S)
	II	4(4.4)	0	0	0	TAPEWORMS (T)
	-	-	-	-	-	PCV (P)
AUGUST	III	30(27.0)	11(9.9)	450.0	100-2100	ST
	III	0	0	0	0	S
	III	0	0	0	0	T
	-	-	-	-	-	PCV
SEPTEMBER	79	23(29.1)	8(10.1)	495.7	100-4500	ST
	79	3(3.8)	0	6.3	100-300	S
	79	8(10.1)	0	10.1	100-200	T
	-	-	-	-	-	P
OCTOBER	36	16(44.4)	7(19.4)	350.0	100-900	ST
	36	0	0	0	0	S
	36	0	0	0	0	T
	-	-	-	-	-	PCV
NOVEMBER	93	44(47.3)	23(24.7)	750	100-3000	ST
	93	32(34.4)	20(21.1)	668.8	100-3100	S
	93	1(1.1)	1(1.1)	5.4	0-500	T
	77		<20=13(16.9)	28.4	10-46	PCV
DECEMBER	78	57(73.1)	29(37.2)	535.1	100-5600	ST
	78	37(47.4)	13(16.7)	467.6	100-1900	S
	78	6(7.7)	3(3.9)	29.5	100-700	T
	-	-	-	-	-	P
1984 JANUARY	122	71(58.2)	32(26.2)	330.3	100-4900	ST
	122	60(49.2)	36(29.5)	487. 7	100-4400	S
	122	7(5.7)	6(4.9)	79.5	100-4900	T
	143		< 20=12(8.4)	29.3	10-42	PCV
FEBRUARY	132	79(59.8)	36(27.3)	485 .5	100-4200	ST
	132	58(43.9)	36(27.3)	419.4	100-8000	S
	132	8(6.1)	1(0.8)	31.8	100-2600	T
	145	-	< 20=7(4.8)	28.1	10-41	PCV

TABLE 2 - MONTHLY MEANS FOR DIFFERENTIAL EGG COUNTS AND THE MEANS FOR PACKED CELL VOLUME.

TABLE 3

INFECTIOUS DISEASES

I.	MASENO	MASUMBI	HAMISI	KAIMOSI	TOTAL OUT OF 136 GOATS	MORTAL
BACTERIAL						
1) MASTITIS	17	-	1	-	18/50 - 36.0% (50 DOES)	-
2) PNEUMONIAS	30	5	-	-	35/136 - 25.7%	3/130 - 2
3) BRUCELLOSIS	2 (SAT)	1(SAT)			3/136 -2.2%	-
II. VIRAL						
1) ORF (CONTAGIOUS ECTHYMA)	-	4	-	-	4/136 -2.9%	-
III. FUNGAL						
1) STREPTOTRICOSIS	1	-	2	-	3/136-2.2%	-
IV ECTOPARASITES						
1) MANGE - SARCOPTES	13	2	-	-	16/136 - 11.8%	1/136 - 0

TABLE 4 NON - INFECTIOUS DISEASES

	MASENO	MASUMBI	HAMISI	KAIMOSI	TOTAL	MORTALITY
I METABOLIC						
1) MINERAL DEFICIENCY	6	2	3	1	$\frac{12}{136}$ -8.8%	$\frac{4}{136}$ - 2.9%
2) MALNUTRITION	3	2	1	1	$\frac{7}{136}$ -5.2%	$\frac{2}{136}$ - 1.5%
II POISONING						
1) PLANT POISONING	1	1	1	-	$\frac{3}{136}$ -2.2%	$\frac{3}{136}$ - 2.2%
III ABORTION						
1) NON-SPECIFIC CAUSES	3	1	1	-	$\frac{5}{50}$ -10.0% (50 DOES)	-
IV WOUNDS/ TRAUMA	2	-	-	1	$\frac{3}{136}$ -2.2%	-

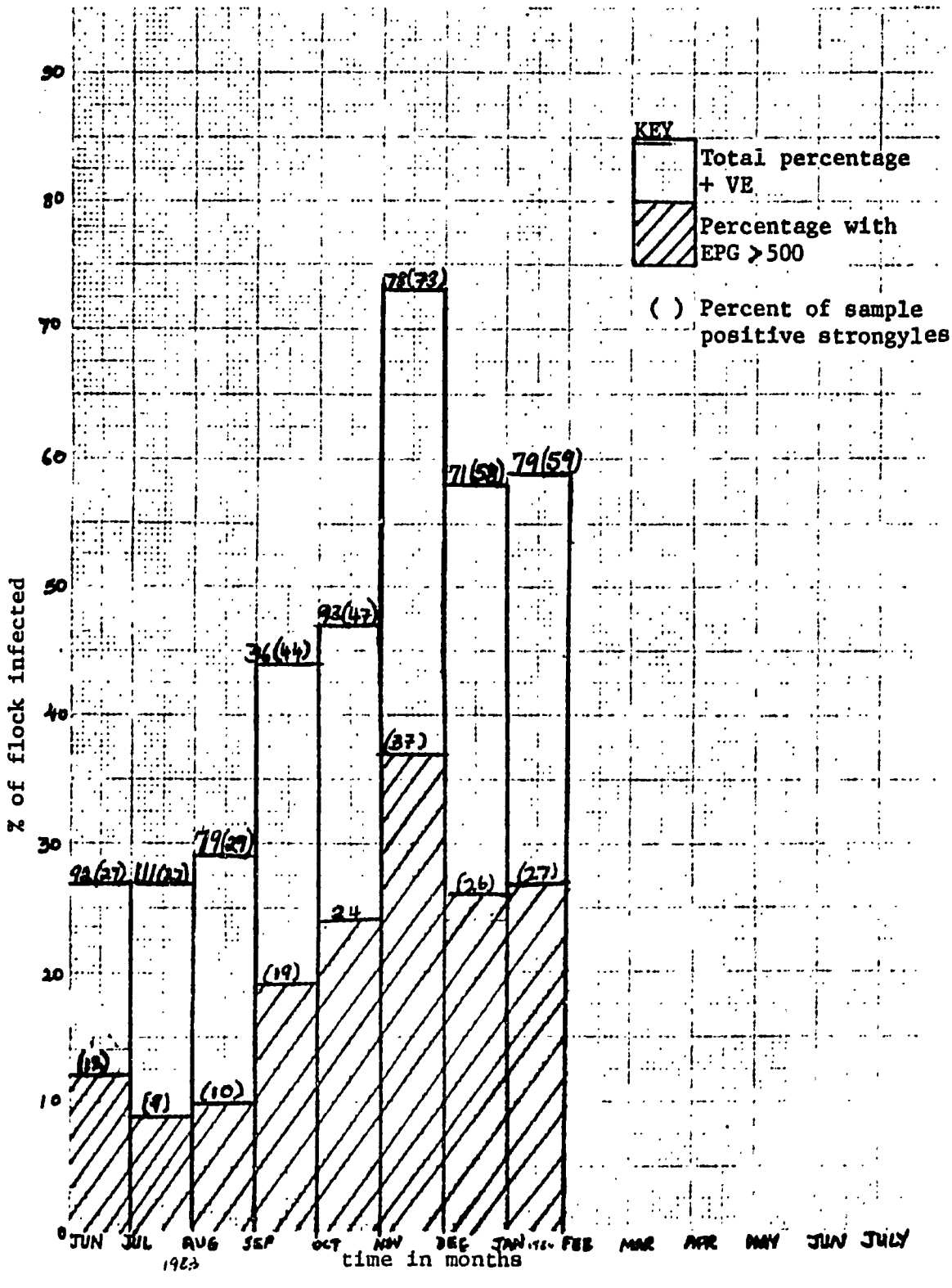

Figure 1. Monthly egg counts for strongyles.

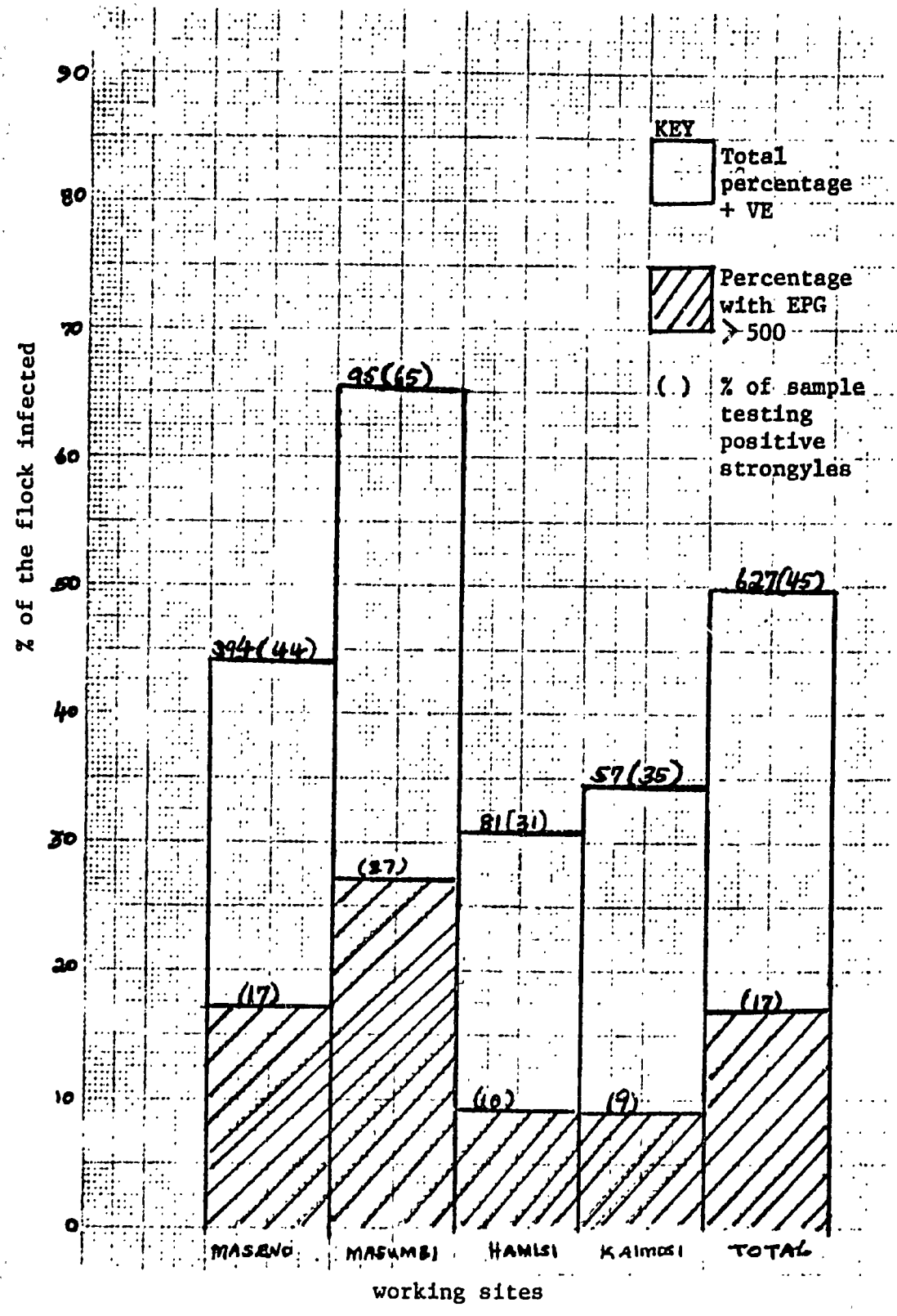

Figure 2. Mean EPG for strongyles for the working sites.

COMPARISON OF THE ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA) WITH COMPLEMENT FIXATION AND INDIRECT FLUORESCENT ANTIBODY AS DIAGNOSTIC TESTS FOR CONTAGIOUS CAPRINE PLEUROPNEUMONIA IN KENYA

By
J.K. Bari[1], S. Waghela[1] and R. Heinonen[2]

Contagious caprine pleuropneumonia (CCPP) caused by mycoplasma, is one of the most economically important diseases of goats in Kenya due to its high morbidity and mortality rates (Mettam, 1929: MacOwan, 1976a). Thus, early diagnosis of this disease is essential so that preventive and/or curative measures can be instituted. This necessitates the availability of a specific and sensitive method for the diagnosis of acute and/or chronic infections in goats. CFT (MacOwan, 1976b) has been the method used for this purpose. Recently, passive hemagglutination test (Muttomi and Rurangirwa, 1983) has also been reported to be as sensitive or even more so than CFT.

In this study, ELISA was developed and its sensitivty and specifity compared to the CFT and IFAT with the aim of adapting it to the diagnosis of CCPP.

Materials and Methods

Organisms and Culture Conditions

Two mycoplasma strains isolated in Kenya were used in the study: *Mycoplasma* species *strain F38* (MacOwan, 1976b) and *M. mycoides* subsp *mycoides* strain G290 (Kibor, 1983). Cultures were grown in Newings tryptose broth (MacOwan, 1976a). The broth was inoculated with log phase mycoplasma cultures at the ratio 1:10 culture to broth and incubated at 37° C for 72 hours. The cultures were harvested by ultracentrifugation at 38,000xg for 30 minutes (Horowitz and Cassel, 1978). The cell suspension was estimated for its protein content by the method of Warburg and Christian (1942) and stored at -20° C.

Preparation of Antigens

For the ELISA antigen, a lysate was produced from the cell suspension by ultrasonication for 4 minutes in an ice-bath using an MSE ultrasonicator and the sonicated antigen stored at -20° C. CFT antigen was prepared using the method of MacOwan (1976a)

Mycoplasma colonies were used as the antigen for IFAT. The colonies were grown on Newing's tryptose agar plates incubated at 37° C for 72 hours. The plates were examined for the presence of the colonies before use.

Production of Rabbit Antigoat Immunoglobulins

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Purified goat IgG was homogenized with an equal volume of Complete Freund's Adjuvant (CFA). The immunization procedure consisted of the toe pad injection supplemented by intramuscular followed by subcutaneous inoculations (Stalheim et al, 1976). The rabbits were bled seven days after the last inoculation and presence of antigoat immunoglobulins checked by double immunodiffusion (Onchterlony, 1962). Booster inoculations, where necessary, consisted of 1.0 ml purified goat IgG without the adjuvant intravenously into marginal ear vein.

Immunoglobulins from rabbits were fractioned by precipitation with saturated ammonium sulphate (SAS) solution followed by passage through DEAE cellulose (DE 52) column (Stalheim et al, 1976). Presence of IgG in the fraction was checked by immunoelectrophoresis (Weir, 1978). The fractions with high protein content were pooled and stored at -20° C.

Preparation of Conjugates

Rabbit antigoat IgG was conjugated to alkaline phosphatase (Sigma Chemical Company, St. Louis, US) by an adaptation of the method described by Clark and Adams (1977).

Labelling rabbit antigoat IgG with fluorescein isothiocyanate (FITC) was done using the dialysis method of Clark and Shepard (1963). The conjugate was purified by passing it through sephadex G25 column followed by DE52 colummn (Pharmacia Ltd.). The fractions with activity were pooled and concentrated by Dialysis in aquacide IIA (Calbiochem., San Diego, California) and estimated for F/P ratio before storage in small aliquots at -20°C.

Optimization of Test Parameters

The detailed procedure for determining the working dilutions of antigens and conjugates have been described elsewhere (Bari, 1984).

Sources of Sera

The serum samples were divided into three groups:

Group 1: These were from CCPP vaccine trials. The goats had been inoculated with a bivalent non-viable vaccine preparation containing mycoplasmas strains F38 and G290 and challenged by in-contact with goats infected with strain F38.

Group 2: Goats in this group were challeged by in-contact with goats infected with strain G290.

Group 3: These were field samples from areas suspected of CCPP outbreak in Mweiga, Kenya and a few samples submitted from Yemen.

Serological Test Procedures

ELISA: The ELISA procedure used was a modification of the method described by Ansari et al (1982). Sonicated antigen was diluted in carbonate-bicarbonate buffer, pH 9.6 and 200 ul of diluted antigen added to each well of flat-bottomed microtitre plates (Dynatesh Laboratories, Alexandria, Virginia). The plates were incubated overnight before washing by flooding with PBS (pH 7.4) to which was added 0.05 percent tween 20 (PBS-Tween). The

washing step was done three times with three minutes per wash. Doubling dilution of test sera was done with PBS containing 0.05 percent tween 20, 2 percent polyvinylpyrrolidone (PVP) and 0.2% bovine serum albumin (BSA), (hereafter referred to as "diluent buffer"). The plates were incubated for two hours at 37° C and washed with PBS-Tween as described before.

Optimal dilution of conjugate was made with diluent buffer and 200 ul added to each well and plates incubated for a further two hours at 37° C. The washing step was done and enzyme substrate (p-nitrophenyl phosphate disodium) tables (Sigma Chemical Company, St. Louis) were dissolved in 10% diethanolamine buffer (pH 9.8) at the ratio of 1 mg/ml 200 ul of the substrate solution was added to each well and plates incubaged at room temperature in subdued light for one hour. The colour reaction was read immediately in a Titertek Multiskan ELISA reader (Flow Laboratory, Inc.) at an absorbance wavelength of 405 nm. Positive, negative and conjugate controls were routinely included on each plate. The end point was the highest serum dilution that had 1.5 times the reactivity of the mean absorabce of the negative serum.

CFT: The CFT procedure used was an adaptation of the method used by MacOwan (1976a). Doubling dilutions of test sera in veronal buffer were made in round-bottomed plates using microdiluters. Appropriate dilution of antigen was added followed by complement. The plates were sealed with selotape and incubated at 37° C for one hour. Sensitized red blood cells (2.8%) were added and plates incubated at 37° C for 30 minutes. The reaction mixture was centrifuged at 1,000xg for five minutes before reading the results. The titre was the highest dilution of serum which gave 50% hemolysis.

IFAT: A modification of the method described by Rosendal and Black (1972) was used. Approximately 0.5x0.5cm agar blocks were cut from Newing's agar plates with colonies. The blocks were placed on clean slides with the colony side upwards and adhered to the slide by a thin coat of nail vanish around the block. About 30 ul of serum, diluted 1:[illegible] in distilled water was added to each block and slides incubated in a moist chamber at room temperature for 30 minutes. The slides were washed twice for 15 minutes per wash in PBS, pH 7.2. After drying, 30 ul of conjugate diluted 1:20 in PBS, pH 7.2, to which has been added 0.2% BSA (PBS-BSA) was added to each block and incubated for 30 minutes as before. They were washed as described before.

Afer the last washing in buffer, the slides were rinsed for one minute in distilled water and dried. They were examined by use of a Leitz Dialux 20 EB incident light microscope equipped with a HBO 50W mercury vapour lamp BG12 exciter filter and K510/530 suppression filter. The intensity of fluorescence was judged according to the following scale: -, 1+, 2+, 3+ and 4+.

Results

Optimal Working Dilutions of ELISA Antigen and Conjugate

Antigen: The absorbence (OD) values decreased with increasing dilution of both positive and negative serum. The absorbance pattern was the same for the four dilutions of antigen used (1:200; 1:400; 1:600; 1:800). The highest absorbance values for the positive serum were shown by antigen dilution of 1:600. This dilution also had the lowest OD values for

negative serum and was taken as the optimal dilution of antigen which allowed maximum use of the antigen without comprimising on the sensitivity of the test and was used in all subsequent tests.

Conjugate: Low dilutions of conjugate resulted in high non-specific absorbance values with negative serum and also a rapid hydrolysis of the substrate. Conjugate diluted 1:1200 had the highest OD values for positive serum and lowest values for negative serum and was used in all subsequent tests.

Reproducibility of ELISA

The reproducibility and interexperimental variation was evaluated by repeated assays performed on 15 different days for positive and negative control sera. Mean absorbance for the positive sera was 0.796 with a standard deviation (SD) of 0.052. Mean absorbance for negative sera was 0.268 and SD of 0.030. The positive/negative ratio of the mean of control sera was 2.97.

When both the positive and negative sera were diluted serially, the OD values of the positive sera decreased with increasing dilution of serum but levelled off in the last wells (Figure 1). The OD values of negative serum were elevated in the first two wells (serum dilution up to 1:20) but subsequently the values were relatively constant at all dilutions. The OD values of negative serum were higher than those of negative antigen (uninoculated broth with positive serum) (Figure 1).

Absorbance values were elevated for both the positive and negative sera at the outer row of wells. To obtain titres of the test sera, a sample/negative (S/N) ratio was calculated for each sample. The end point was the highest dilution of serum that showed an S/N ratio of 1.5. Due to the background reaction at low dilutions of sera, a cut-off titre of $\geq$ 1:40 was regarded as positive. Low titres ($\leq$ 1:40) were regarded as negative. The titres obtained for the positive sera on assays performed on different days never varied by more than twofold.

Development of IFAT

The unfixed colonies gave a clear distinction between the positive and negative samples. The peripheral areas of some colonies were, however, rinsed away during washing in buffer but this did not reduce the intensity of fluorescence. Conjugate diluted 1:20 and serum 1:40 resulted in best distinction between the positive and negative sera and were used in subsequent tests.

Serology

1. Mycoplasma Strain F38 Vaccine Trials
   a. Vaccinated Goats (strain F38)
      Following vaccination and before challenge, the serological results were variable and inconsistent. After incontact challenge, two of the 11 goats had positive ELISA titres ($\geq$ 1:40) by day seven. Six had positive titres by day 14 and by day 21, all the vaccinated goats had positive titres. Both ELISA and CFT showed the same trand of serological response. The mean log

titres increased gradually, reaching the peak by day 21 for CFT and day 28 for ELISA and then declined rapidly (Figure 2). The ELISA antibody levels were significantly higher than the CFT levels after day 21 ($P < 0.05$) but the high ELISA titres correspond to high CFT titres. There was a positive correlation between the mean ELISA $\log_{10}$ titres and the mean CFT $\log_{10}$ titres ($r=0.89$; Figure 3).

The IFAT screening showed a similar trend of serological response, with two goats showing a 1+ fluorescence by day 7 post challenge while peak fluorescence (2+ to 3+) was reached by day 21-28 which correspond to the peak titres shown by CFT and ELISA.

The sera were tested against strain G290 for any cross-reactions in the three tests. Four of the 11 goats (36%) had positive ELISA titres. The corresponding homologous titres, however, were higher than the heterologous titres. At the peak of serological response, the homologous titres were at least four times the heterologous titres. No appreciable cross reactions were observed in CFT and IFAT.

b. Experimentally inoculated goats (strain F38)
Seven of the 10 inoculcated goats (70%) had positive ELISA titres, 4 (40%) had positive CFT tites while IFAT was able to detect 6 goats (60%). By day 29 post infection, 5 of the goats has died while the rest survived the infection. The five goats which survived the infection had ELISA titres $\geq$ 1:40.

c. In-contact control goats (F38)
All the goats in this group succumbed to the infection. By the time of death, 7 of the 9 goats (78%) had positive ELISA titres while both CFT and IFAT could detect antibodies in only four goats (44%).

2. Mycoplasma Strain G290 Vaccine Trials

a. Vaccinated goats (strain G290)
Figure 4 shows the mean $\log_{10}$ titres of the goats following incontact challenge with strain G290. Both ELISA and CFT showed the same trend of serological response. The mean log titres increased gradually reaching the peak by day 45 post challenge and then declined rapidly. There was a close correlation between ELISA and CFT. The ELISA titres were, however, significantly higher than the CFT titres ($P < 0.05$).

IFAT screening had a similar trend of serological response. Peak fluorescence was observed from day 35-45 which corresponds to the time of peak titres in both ELISA and CFT. However, two goats were negative in IFAT throughout the experiment.

There was high level cross-reactions with strain F38 antigen in all the three tests. Heterologous titres were generally equal to or twofold the homologous titres.

b. Experimentally inoculated goats (strain G290)
Five of the nine goats died before developing antibodies detectable by any of the tests. The surviving four goats were positive in ELISA and IFAT while three were positive in CFT. Like in the vaccinated goats there was high level cross-reaction with strain F38 with heterologous tites being higher than the homologous titres in all the tests.

c. In-contact control goats
All nine goats died before they had developed detectable antibodies agains both the homologous and heterologous antigens.

3. Field Sera
Nineteen field sera from two geographically different areas suspected of CCPP outbreaks were tested. Ten of 14 samples from Mweiga, Kenya were positive for strain F38 antibodies in the three tests while the other four were negative. Antibodies were also detected against strain G290 in all tests but at a lower level. One lung sample submitted from the region was culturally positive for strain F38.

Three of five samples from Yemen were positive for strain F38 in all the three tests while one was positive in ELISA and CFT and one positive only in ELISA. No appreciable antibody levels were detected against strain G290. Two of three lung samples submitted along with the sera were culturally positive for strain F38.

A comparison was made on the relationship among the three tests in determination of CCPP antibody status of the field serum samples (Table 1). When the field samples were taken together, there was 89.5% agreement and about 10.5% disagreement. ELISA was the most sensitive of the tests. One sample was positive in ELISA alone while one was positive in ELISA and IFAT but negative in CFT.

Discussion

The diagnosis of CCPP in Kenya has, for a long time, been based on cultural isolation of the causative agent. This has mainly been centred at the Veterinary Research Laboratory, Kabete and Kenya Agricultural Research Insitute (KARI), Muguga. The rest of the laboratories throughout the country are ill-equipped to undertake mycoplasma isolation work. Even in the two equipped laboratories, isolation and identification of the causative agent from materials submitted from the field (usually lung and pleural fluid) has not always been successful.

The CFT has been accepted as a reasonable accurate standard of reference for comparison with other methods of diagnosis of mycoplasmal infections (Priestley, 1951). In the recent past, it has been the main test used to assess the antibody response in CCPP in Kenya (MacOwqn and Minette, 1976).

In the present study, the ELISA has been demonstrated to be a sensitive and reliable test for detection of antibody response to CCPP. The ELISA titres correlated very well with CFT titres and IFAT. High ELISA titres corresponded with high CFT titres and peak of fluorescent. With regard to the field samples, there was close to 90% agreement in determination of antibody

status in CCP outbreaks. The 10% disagreement was due to one sample positive in ELISA and IFAT and one sample positive in ELISA only (Table 1).

The ELISA was more sensitive but less specific compared to CFT and IFAT. The high sensitivity of ELISA was shown by the fact that the assay was able to detect antibodies in more goats in the experimental group and in the field samples and ELISA titres were significantly higher than CFT titres. This sensitivity of ELISA demonstrated in this study agrees with the finding of Horowitz and Cassel (1978), Onoviran and Taylor-Robinson (1979) and Busolo et al (1980).

The high sensitivity of ELISA is probably due to the fact that ELISA measures the total amount of antibody bound to the antigen (Hill and Matsen, 1983) and not just a functional subgroup of antibody such as that which gives rise to agglutination or complement fixation.

Cross reactions were observed against strain G290 antigen in goats challenged with strain F38. The heterologous titres were, however, always lower than the homologous titres. This cross-reaction in ELISA is probably due to the fact that the goats were vaccinated with a bivalent vaccine (comprising strains F38 and G290) backed by the high sensitivity of the assay. Of interest was the high level of cross-reaction against strain F38 antigen in goats challenged with strain G290. This level of cross-reaction was observed in all the three tests. The reason for this extensive cross-reaction is not clear. Probably there was a mix-up of cultures used in inoculation of the goats. This speculation is given support by the fact that strain F38 was consistently isolated from these goats (Heinonen, personal communication). It is also possible that the two strains are one and the same.

The specificity of IFAT demonstrated in this study supports the findings of Baas and Jasper (1972) who reported that agar block technique of immunofluorescence was specific and useful for identification of mycoplasmas grown on agar. For the purpose of identification and classification of new isolates of mycoplasma, we recommend the combined use of growth inhibition and IFAT. Rinsing away of peripheral areas of colonies during washing in buffer, also observed by Rosendal and Black (1972) did not reduce the intensity of fluorescence.

The serum samples from Mweiga had antibodies against strains F38 and G290 detectable in all the three tests. However, only strain F38 was isolated from the lung sample submitted. This supports the findings by MacOwan andMinette (1977a; 1977b) that strain F38 is the strain commonly isolated from field cases in Kenya. Finding antibodies against both strains F38 and G290, however, supports the speculation that CCPP outbreask in Kenya occur as mixed infections. On the other hand, sera from Yemen were only positive for antibodies against strain F38 and the strain was isolated from two of the three lung samples submitted. There is every reason to believe that the outbreak in Yemen was caused by strain F38. The strain has also been reported in Sudan (Harbi, 1982) indicating that strain F38 is not restricted to Kenya.

Serological tests used in mycoplasmology are reported to be incapable of detecting antibodies in acute disease (Turner, 1962; Muthomi and Rurangirwa, 1983). Their view is supported by this study in that in-contact challenge

goats against strain G290 had no detectable antibodies in the three tests up to the time of death.

Failure of serological tests to detect antibodies in acute CCPP can be explained by one or two factors. First, in acute disease the course of infection could be too short for the animals to develop humoral antibodies such that the goats succumb to the disease before they develop antibodies. Second, the goats could develop antibodies which for one reason or another cannot be detected by present serological tests. This is true of mycoplasma circulating antigens which could "eclipse" antibodies as suggested by Muthomi and Rurangirwa (1983).

The criteria for expressing the ELISA results depend on whether the sera are screened at a fixed dilution or titrated to an end-point. Various methods have been used to determine the cut-off point between the positive and negative OD values (Voller, 1980; Smith and Witter, 1982; Adler et al, 1981). In the present study, a S/N ratio was calculated for each sample. This reduced the day to day variations in absorbance values which are inherent in ELISA (Kalish et al, 1983; Synder et al, 1982). Thus, the S/N ratio allowed to normalize the absorbance values obtained from different batches of plates thus making the results to be compared on an equal basis.

In conclusion, the microplate ELISA was found easy to perform and uses small quantities of reagents. The high agreement with CFT and IFAT combined with the advantages of ease and rapidity, and high sensitivity compensate for any occasional nonspecific results that may arise using the ELISA. For some applications it may be desirable to confirm and ensure specificity by such alternative procedures as CFT and IFAT.

ELISA has the added advantage that readings can be made visually without the use of an expensive spectrophotometer. This maes the assay ideal for use in the field and in poorly equipped laboratories. For a Kenyan situation, the plates can be precoated with the required antigen and, together with the other reagents, supplied in the form of a package to Veterinary Investigation Laboratories (VILs) for field use.

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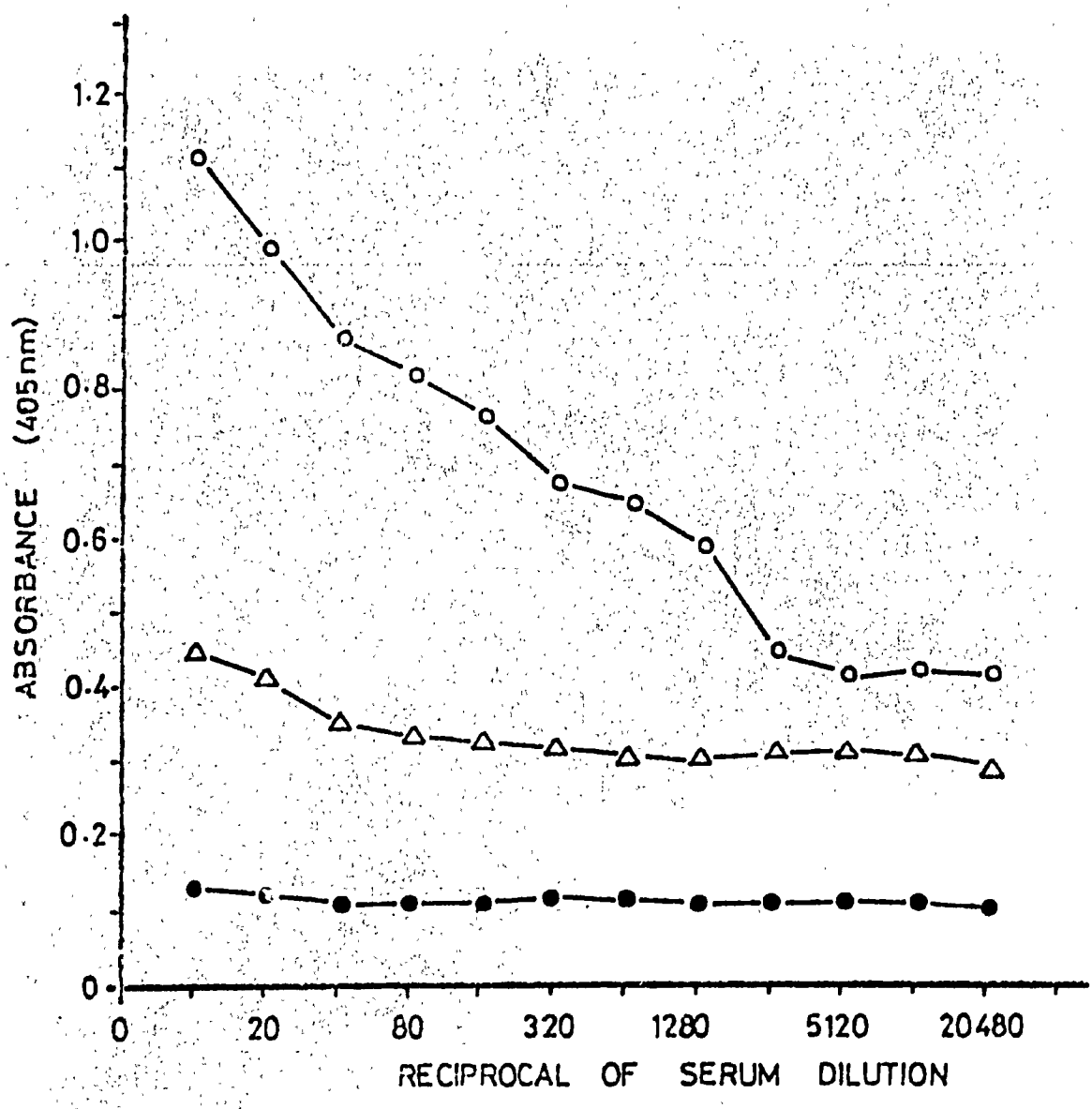

Figure 1: Mean ELISA absorbance values at 405 nm for 10 tests with positive and negative control sera and negative antigen.

o——o positive serum, Δ——Δ negative serum

●——● negative antigen (sterile broth medium)

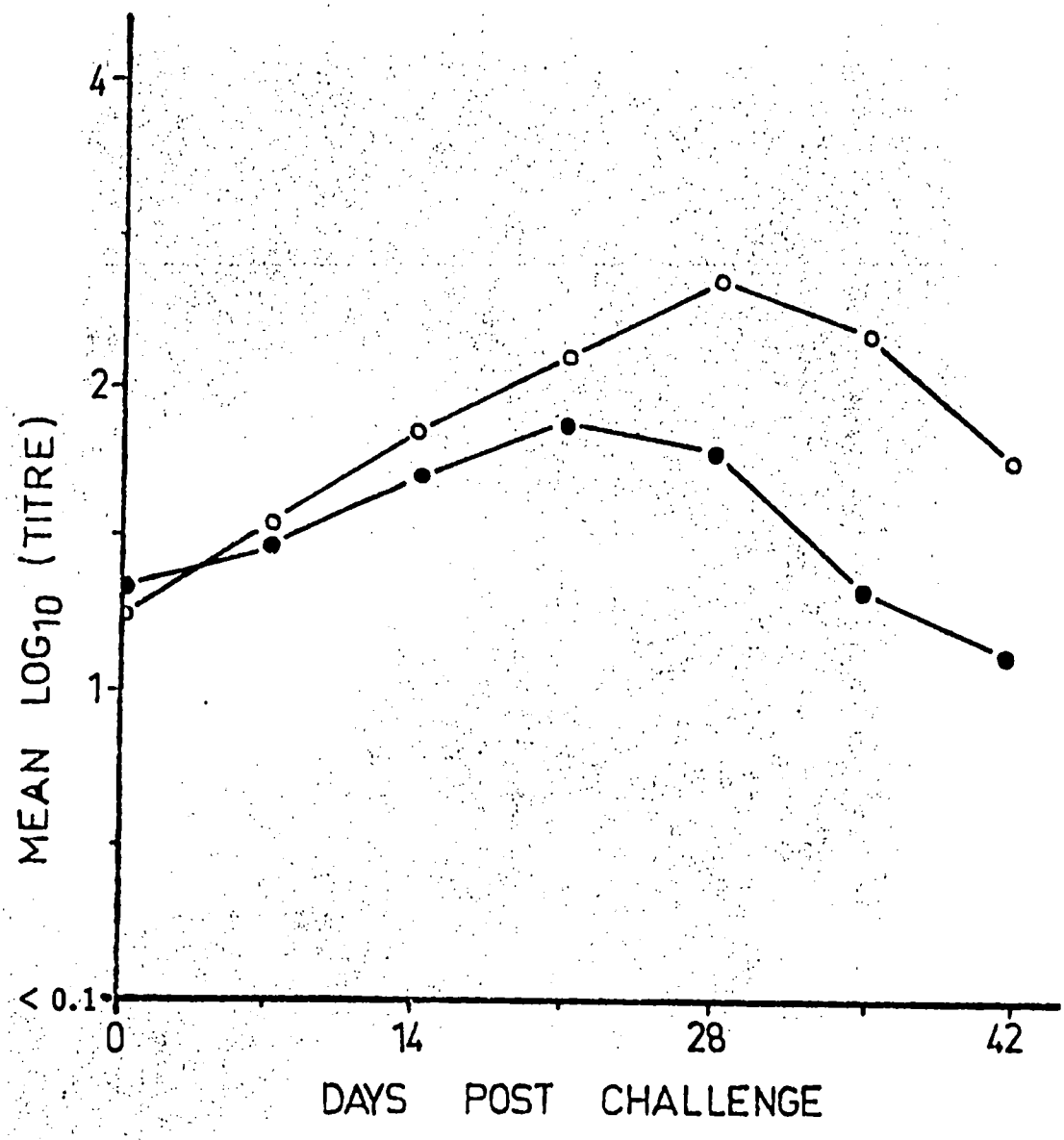

Figure 2: The serological response of vaccinated goats after intercontact challenge with F38 strain of mycoplasma.

o——o ELISA ●——● CFT

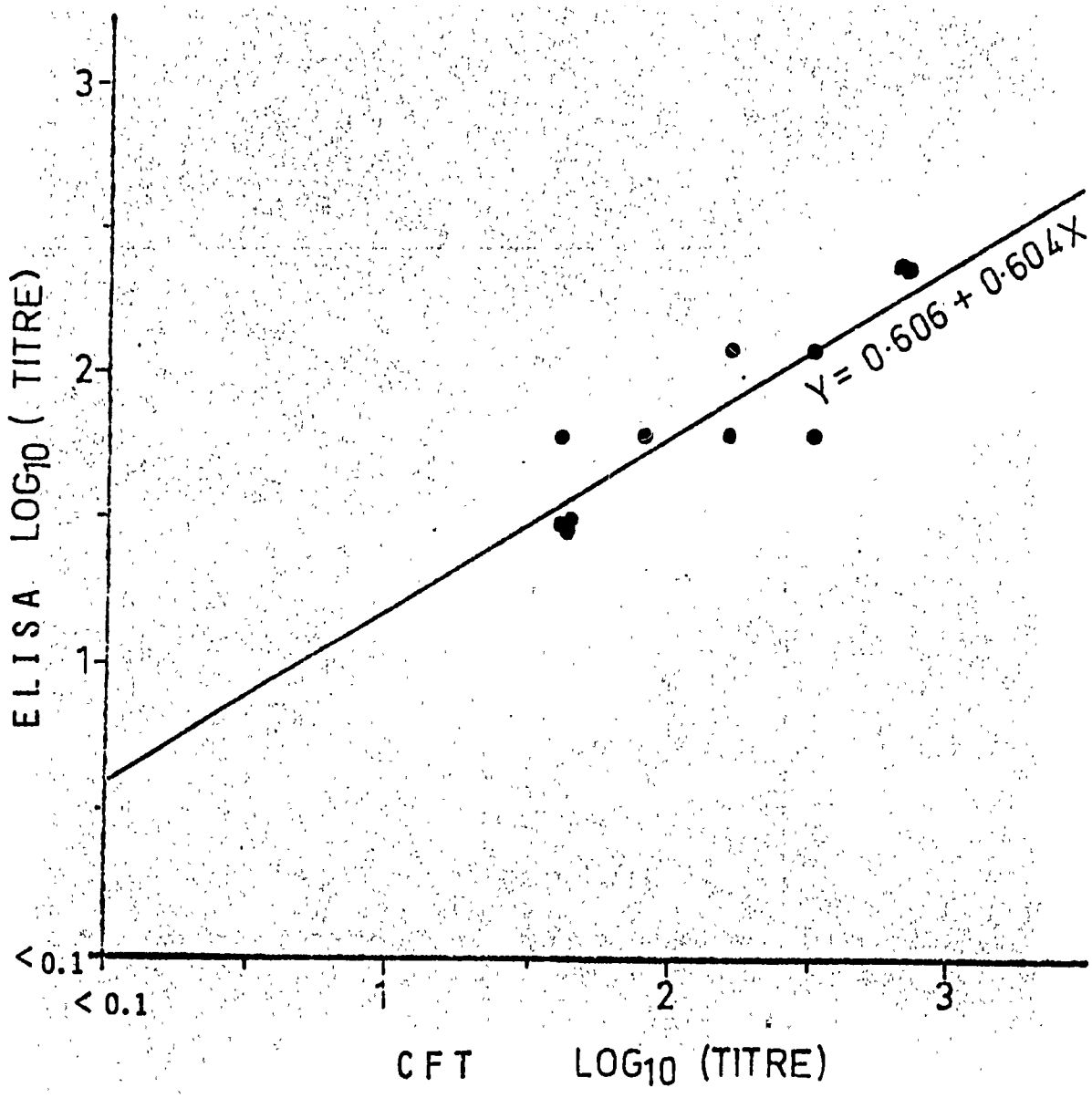

Figure 3: Scatter diagram for the correlation of peak log10 titres between ELISA and CFT of sera from vaccinated goats after in-contact challenge with F38 strain of mycoplasma.

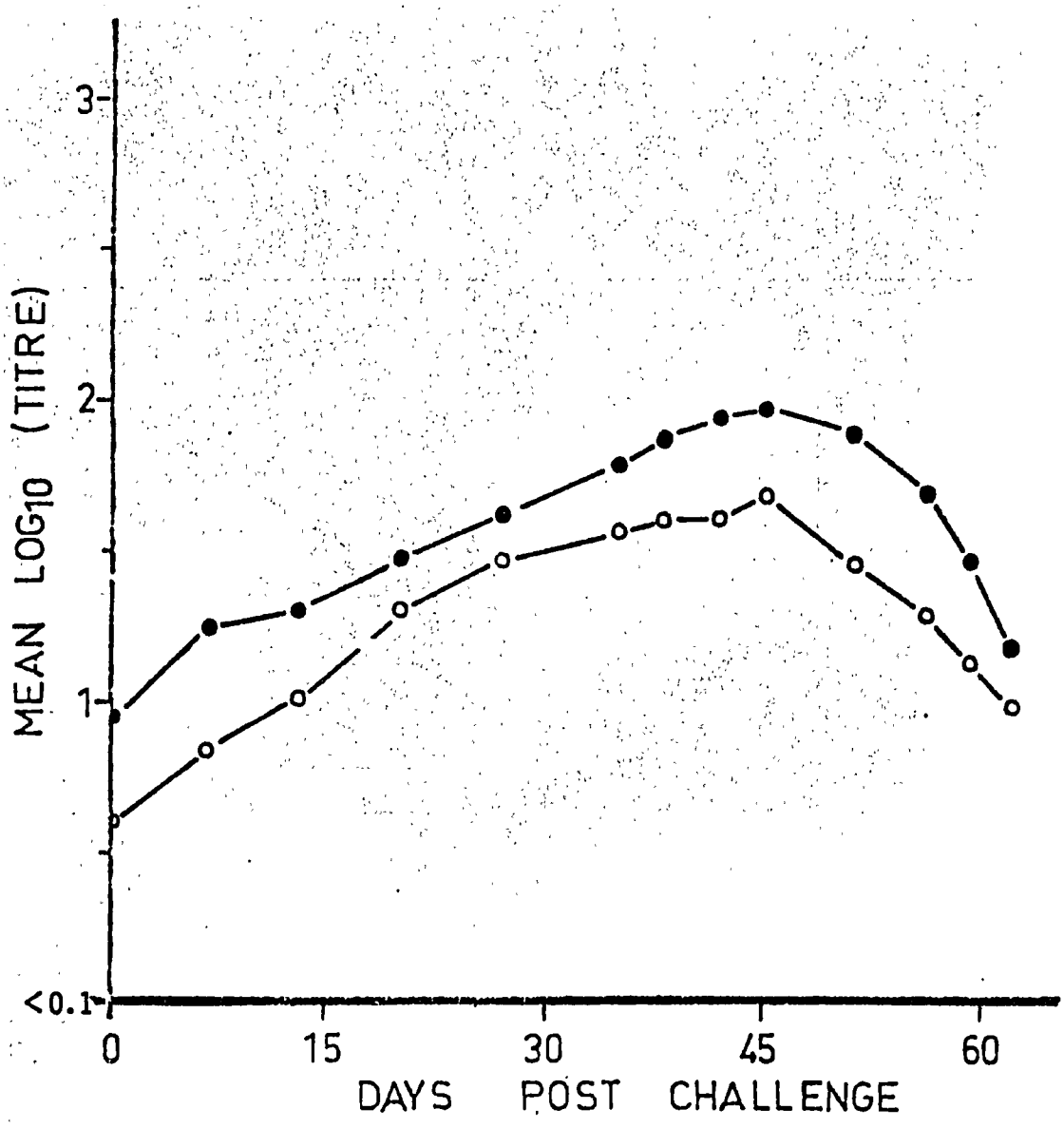

Figure 4: The serological response of vaccinated goats after in-contact challenge with G290 strain of mycoplasma.

●——● ELISA o——o CFT

Table 1. Comparison of ELISA, CFT and IFAT in Detection of CCPP Antibody Status in Field Serum Samples using Indicated Cut-Off Levels* between Positive and Negative.

Comparison Among Tests	Fraction of Total		% of Total
Agreement:			
Positive by all 3 tests	13		
		17/19	89.5
Negative by all 3 tests	4		
Disagreement:			
Positive by ELISA and CFT only	0/19		0
Positive by ELISA and IFAT only	1/19		5.3
Positive by CFT and IFAT only	0/19		0
Positive by ELISA only	1/19		5.3
Positive by CFT only	0/19		0
Positive by IFAT only	0/19		0

* Cut-Off levels between positive and negative:
ELISA: Positive $\geq$ 1:40, Negative < 1:40
CFT: Positive $\geq$ 1:32, Negative < 1:32
IFAT: Positive $\geq$ 1+ , Negative < 1+

TICK SURVEY ON GOATS AND SHEEP IN SIAYA AND KAKAMEGA DISTRICTS, KENYA

By
E.N. Mwangi[1], P.D. Sayer[2], J.C. Njanja[1], J.F. Bell[2]

Tick borne diseases constitute a major constraint to animal production in Kenya. Ticks are responsible for the transmission of Heartwater and Nairobi sheep diseases, both of which are responsible for high mortality rates in goats and sheep. Little work has been reported that identifies and quantifies ticks and their effects on sheep and goats. This paper reports on a survey of tick populations on sheep and goats from randomly selected smallholder farms in the western part of Kenya which was carried out in the period October 1980 and October 1981. Three visits were made to almost all farms at intervals of 3-4 months. Seasonal effects on tick populations were demonstrable.

Materials and Methods:

Fig. 1 shows the location of the areas of study. The survey was carried out in Siaya and Kakamega districts of Nyanza and Western Provinces of Kenya, respectively. In Siaya District, four locations were visited, namely West Alego, South Sakwa, North Sakwa and North Gem, (see figure 1) in which thirty-nine farms were covered. A total of 468 East African goats and 230 sheep of various types including Red Maasai and Fat tail were examined.

In Kakamega District, the three locations visited were Marama, South Kabras and Isukha, covering a total of 30 farms. Tick numbers were monitored on 275 goats and 159 sheep. Animals were ear-tagged for identification. Ticks were collected and transported live to Kabete, where the species, numbers, stages of development and sex were recorded. Tick infestation was recorded as follows:

0	=	No ticks
1	=	1 - 10 ticks
2	=	11 - 50 ticks
3	=	51 - 100 ticks
4	=	100 ticks and over

The times of the three visits were as follows:

Visit 1: November 1980 - January 1981
Visit 2: March 1981 - May 1981
Visit 3: July 1981 - October 1981

At each visit a questionnaire concerning animal health and activities on the farm was administered. This included a series of questions concerning tick control by dipping or spraying practices. The data were analyzed and comparisons were made to find out whether there were significant differences

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in tick numbers between locations, seasons and host species using the chi-square test according to Bailey (1981). The P value used for all comparisons was 0.001.

Results

Ticks were collected from 281 goats and 144 sheep from Siaya and 79 goats and 41 sheep from Kakamega. No ticks were found on the remainder of the animals.

Six species of ticks were found on sheep and goats in the survey. These were Rhipicephalus appendiculatus, R. evertsi, Boophilus decoloratus, Amblyomma variegatum and two unidentified species, a Rhipicephalus and an Amblyomma species. Figure 2 shows the proportions that these six species found on goats and sheep for each district. R. appendiculatus was the most abundant tick in both districts and on both hosts, followed by R. evertsi and A. variegatum.

Table 1 shows the percentage of goats and sheep with various tick numbers for the locations studied in Siaya and Kakamega Districts. The Chi-square test showed that there were real differences between the locations.

Table 2 shows the percentage of goats and sheep with various numbers of ticks in the Siaya and Kakamega districts at different times of the year. There was no significant difference in tick load between the host species.

It was found that the seasons played a role in determining tick load for animals in South Sakwa, West Alego, and Isukha locations but not for South Kabras, North Gem and Marama. The effect of seasons in North Sakwa was not investigated because the number of animals sampled was too small.

The male: female ratios, based on the ticks which were submitted for identification were 1.3:1, 1.9:1, 1:4.6 and 2.7:1 for R. appendiculatus, R. evertsi, B. decoloratus, and A. variegatum respectively.

Only nine of the 69 farms visited (14%) claimed to be practising regular tick control by dipping or hand spraying, while 14 (20%) dipped their goats occasionally. Twenty-seven (29%) used hand picking and/or the application of kerosene. A few used pyrethrum impregnated grease when ticks were noticed. Eight farmers (12%) stated that no tick control was carried out at all on sheep or goats and 14 (20%) dipped only their cattle. Only 11 farmers claimed that there was no accessible dip in their area and for 5 of these a dip was under construction. There were frequent complaints that the available communal dips had not been functional for up to a year either through lack of acaricide or due to structural faults. No attempt was made to confirm the validity of these complaints.

Discussion

The differences found in tick load between locations could be explained by climatic factors. According to Pratt and Gwynne (1977), Siaya district lies in zone III, which has 900-1200 mm of rain per year, whicle Kakamega is in zone II which has 1500-2150 mm of rain per year. Walker (1974) states the R. appendiculatus and R. evertsi thrive in moist wooded or bushed grassland as

found in Siaya, and may be found in forest margins as in Kakamega.

The season was found to have an effect on three locations, namely West Alego, South Sakwa and Isukha. However, ticks have been known to exhibit seasonality in areas where the rainfall pattern is mono-modal. Siaya and Kakamega districts are in zone which have a bi-modal type of rainfall, and so ticks would be expected to be present throughout the year as found in South Kabras, North Gem and Marama locations.

Although sheep were found to carry more ticks than goats based on the ticks submitted to the laboratory, there was no significant difference between the tick loads on the two hosts.

Except for B. decoloratur, more male than female ticks were found in this study. A similar finding was reported in cattle in Tanzania for R. appendiculatus, A. variegatum and R. evertsi, (FAO Report, 1977).

The absence of R. pulchellus, Hyalomma rufipes and A. gemma in these two districts confirms that they require much drier conditions as reported by Walker (1974). Those species were found to be abundant on goats near Isiolo, Kenya (Mwangi et al, unpublished data).

Besides disease transmission, heavy tick infestations are irritating and may be debilitating. In some areas of Africa, tick paralysis is a serious cause of animal loss. However, the level of infestation recorded from Siaya and Kakamega during the survey in sheep and goats is unlikely to be the cause of significant direct damage.

Knowledgements

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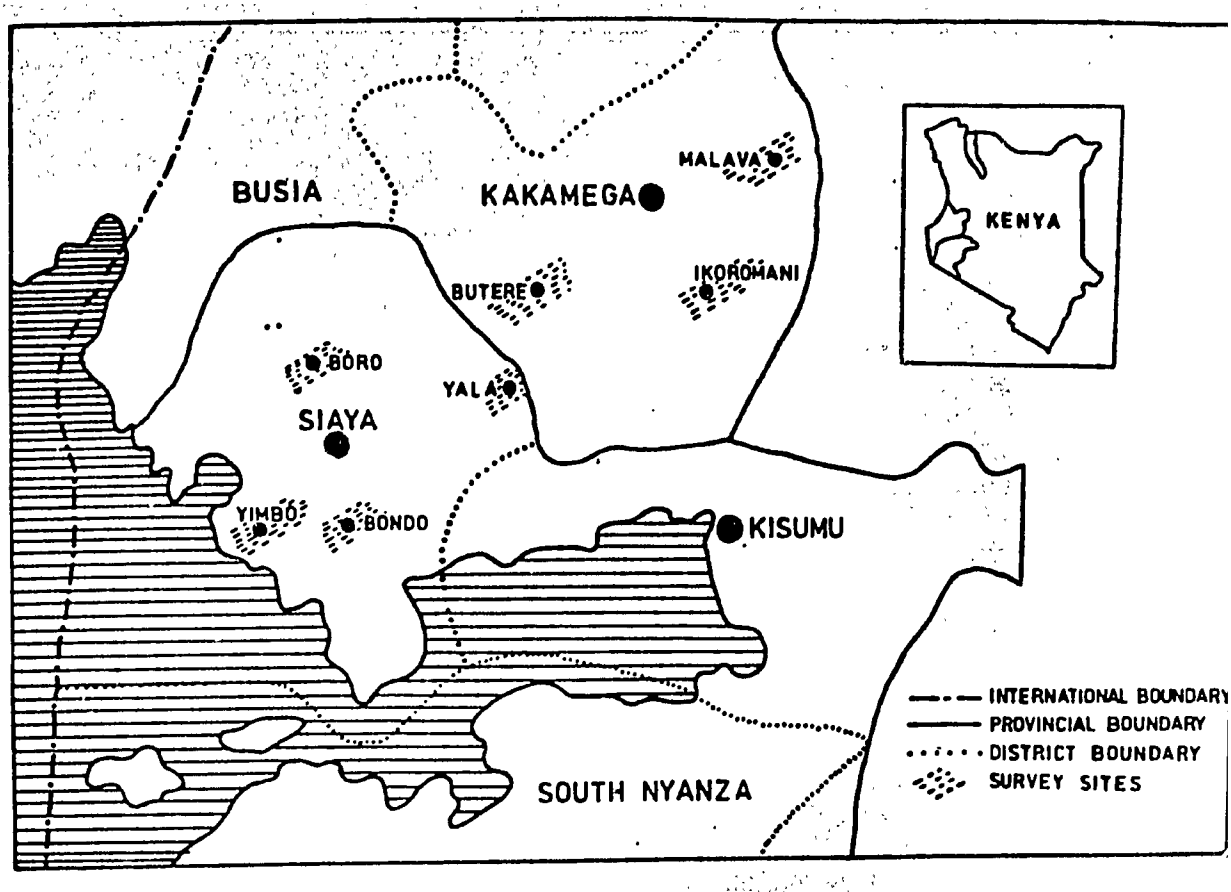

Fig. I showing Siaya and Kakamega districts (Kenya)

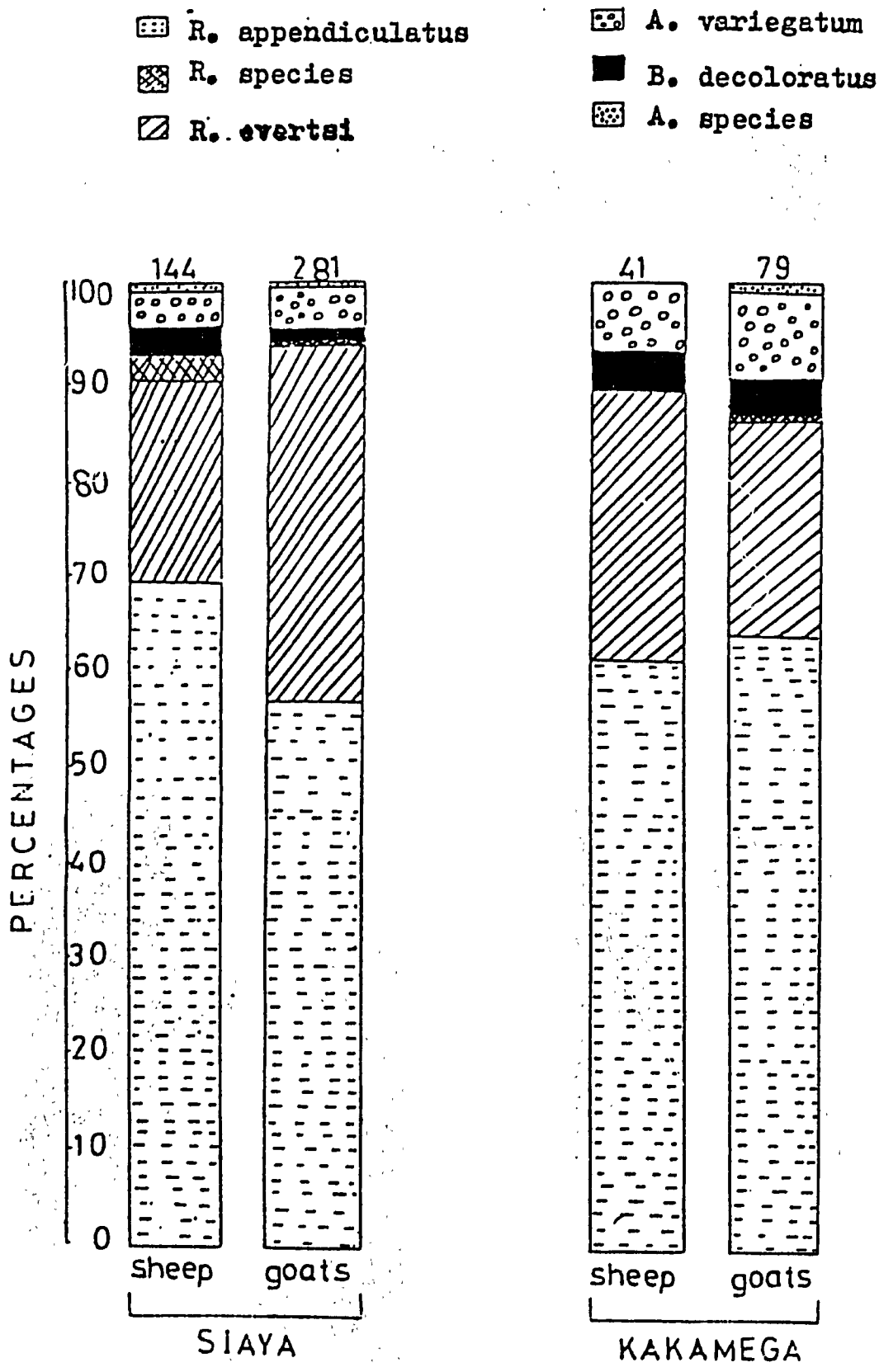

Figure II

Percentage of different species of ticks found on sheep and goats in Siaya and Kakamega districts. The total numbers of animals are shown above each histogram.

TABLE 1

The percentage of sheep and goats with various tick numbers for the locations in Siaya and Kakamega districts.

	GOATS					SHEEP				
	Number of ticks					Number of ticks				
	0	1-10	11-50	51-100	100	0	1-10	11-50	51-100	100
North Gem	22.9	56.1	1.7	2.3	1.2	16.7	64.3	11.9	7.1	0
North Sakwa	23.1	69.3	7.6	0	0	5.3	78.9	15.8	0	0
South Sakwa	2.0	57.1	35.1	5.0	0.8	2.2	62.3	23.3	1.0	0
West Alego	9.3	78.2	12.5	0	0	12.3	81.5	6.2	0	2.2
Isukha	42.2	57.8	0	0	0	19.3	78.0	2.5	0	0
South Kabras	90.0	10.0	0	0	0	93.3	6.7	0	0	0
Marama	52.1	45.7	2.2	0	0	34.5	62.1	3.4	0	0

TABLE 2

Percentage of goats and sheep with various tick numbers in the Siaya and Kakamega districts at different times.

	Number of Ticks	KAKAMEGA Goats	KAKAMEGA Sheep	SIAYA Goats	SIAYA Sheep
VISIT 1: (November 1980-Jan. 1981)	0	48.8	46.8	5.0	3.9
	1- 10	50	50.6	48.7	60.4
	11- 50	1.7	2.6	37.8	21.8
	51-100	0	0	7.0	11.9
	100	0	0	1.5	2.0
VISIT 2: (March 1981 - May 1981)	0	77.0	81.8	15.2	12.5
	1- 10	23.0	18.2	78.6	84.7
	11- 50	0	0	6.2	2.8
	51-100	0	0	0	0
	100	0	0	0	0
VISIT 3: (July 1981 to October 1981)	0	76.4	77.8	6.5	8.8
	1- 10	23.6	22.2	67.7	73.7
	11- 50	0	0	35.8	17.5
	51-100	0	0	0	0
	100	0	0	0	0

SEROLOGICAL CHARACTERISTICS OF MYCOPLASMA F38 STRAINS AND OTHER MYCOPLASMA SPECIES ISOLATED FROM CAPRINE PLEUROPNEUMONIA

By
A.C. Kibor[1] and P.G. Waiyaki[2]

Mycoplasma are important aetiological agents of certain economically important diseases of goats. Such diseases caused by Mycoplasma include Contagious agalactia (CA), Contagious Caprine Pleuropneumonia (CCPP), Serofibrinous peritonitis, arthritis and Martitis (Longley, 1951; Turner, 1959, Cottew, 1979, Cordy et al, 1955; BarMosle and Rapapport, 1978, 1979; MacOwant and Minette, 1976). Of these diseases, CCPP is the most widespread and is responsible for a large proportion of goat loss every year, particularly in tropical countries (Cottew, 1979). The aetiological agents of CCPP in Kenya are Mycoplasma mycoides ss. mycoides (LC) represented by F30 and Mycoplasma species F38. Mycoplasma species F38 has been associated with over 80% of the documented CCPP outbreaks in Kenya (MacOwan and Minette, 1977). To date, the F38 group of Mycoplasma has not been fully characterized (Erno et al, 1979). Thus, a study was initiated to investigate the level of serological cross reactions between the F38 strains and other mycoplasma already well characterized, which were isolated from CCP cases in Kenya.

Materials and Methods

Antisera:

Reference antisera against the type strains for caprine and ovine Mycoplasma were prepared in albino rabbits as described by Erno et al (1973). The type strains (Table 1) were obtained from the Mycoplasma Reference Laboratory in Aarhus, Denmark.

Growth Inhibition Test:

This was performed by the agar-well method (Black, 1973). Medium BE (modified Hayflick) was used for growing the strains. The procedures followed were described by Erno et al, (1978) and Freundt et al, (1979).

Indirect Epi-Immunofluorescence Test:

The method of Delgiudice et al, (1967) using unfixed colonies was employed for all the strains except those belonging to M. ovipneumoniae which were fixed. In fixation of the M. ovipneumoniae colonies, the agar media to be used were first refrigerated at 4°C for seven days. Following this, they were innoculated and incubated at 37°C for three days. They were removed and kept for a further three days at 22°C. Fixation was achieved by adding two ml of 95% ethyl alcohol and leaving at 22°C for 90 minutes. The alcohol was poured off and the plates were further kept for five days at 22°C. They were then washed with distilled water to remove the

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alcohol. The procedures followed were those described by Erno et al, (1978).

The method of Erno and Salih (1980) was used. Medium B (modified Hayflick) agar plates were used for growth of the strains to be used as the antigens. The agar plates were heavily inoculated with the cultures and incubated for four days at 37°C in a moist chamber containing 8% CO_2. Agar blocks measuring 1 cm^2 with dense growth of Mycoplasma were cut and placed in a tube containing 2 ml medium B broth. The blocks and the medium were mixed by vigorous shaking for 3 minutes and left to stand at 20°C for one hour. The suspension was used as the "antigen". A well 7 mm in diameter was pushed out in the centre of an uninoculated agar plate using a stainless steel cylinder. The well was filled with the antigen using a pasteur pipette. Then, one to four antiserum-impregnated discs were placed on the agar surface at a distance of exactly 1 cm from the rim of the central well. The plates were incubated at 37°C for three days in a humid 8% CO_2 atmosphere. They were examined for bands of precipitation against a dark background using obliquely transmitted light. The examinations were repeated after five, seven and ten days.

Results

Growth Inhibition:

Seventeen strains of F38 were inhibited by homologous antisera and heterologous antisera to Leach's bovine serogroup 7 only (Table 2). Inhibition in both cases was total and in three tests antisera to Leach's bovine serogroup 7 gave wider zones of inhibition than homologous antisera. The four *Mycoplasma mycoides* subsp. *mycoides* (LC) strains were inhibted by antisera to Y-goat and PG1 (Table 2). While eight strains of *M. arginini* were inhibited by antisera to *M. arginini* (Table 3) and five strains were inhibited by antisera to *M. ovipneumoniae*. Two of these strains were partially inhibited by antisera to *M. dispar* (Table 3).

Indirect Epi-immunofluorescence:

Results obtained in this test were similar to those for the growth inhibition test (Tables 4 and 5). All the F38 strains flouresced in the presence of homologous antisera and heterologous antisera to PG 50 (Table 3). In some occasions weak flourescence was demonstrated with antisera to *M. capricolum*. The four strains of *M. mycoides* subsp. *mycoides* (LC) flouresced in the presence of antisera to Y-goat and PG1. While the eight strains of *M. arginini* fluoresced in the presence of antisera to G230 (Table 5). The five strains of *M. ovipneumoniae* flouresced in the presence of antisera to Y-98, and two weakly reacted with antisera to *M. dispar* (Table 5).

Growth precipitation test:

Two way cross reactions between heterologous antisera and antigens were demonstrated in this test (Table 6). This was particularly so among *M. mycoides* subsp. *mycoides*, *M. mycoides* subsp *Capri*, *M. capricolum*, F38 and Leach bovine serogroup 7. Four common antigens were demonstrated between these species in this test. Reactions between homologous antigens and antisera showed the presence of more precipitin bands than with heterologous antisera or antigens.

The incubation period for reactions between F38 antigens, homologous and heterologous antisera was seven days while reactions with the other antigens, required only three days to occur. Cross-reactions occurred between all the eight strains of M. arginini and Caprine/ovine serogroup 5 (Goat 145) in this test also. Two strains of M. ovipneumoniae cross reacted weakly with antisera to M. dispar.

Discussion

Two way cross reactions were observed between the F38 strains and Leach's bovine serogroup 7 when tested in two serologic tests normally used to identify Mycoplasma, i.e. growth inhibition and indirect epi-immunofluorescent tests. All the F38 strains tested reacted with antisera to Leach's bovine serogroup 7 in both tests. This raises a problem with regard to the final identification of F38. For this reason additional tests are required in order to conclusively identify this Mycoplasma.

Other two cross reactions were demonstrated between M. mycoides subsp. mycoides, M. mycoides subsp. capri, M. capricolum, Leach's bovine serogroup 7 and F38 in the growth precipitation test. All the above mentioned species shared four common antigens. These findings agree with those of Erno and Salih (1980) who demonstrated that these species shared some common antigens when tested in this test. It was however observed that more precipitin bands formed when homologous antigens and antisera were reacted. The presence of shared antigens between these species, most of which are pathogenic to goats is significant, especially if these antigens are found to induce cross-protective antibodies. The demonstration of cross-reactions between some species of Mycoplasma (F38 and PG50), (PG1 and Y-goat) using growth inhibition and indirect epi-immunofluorescent antibody tests in this study raises questions as to the validity of these tests in the identification of different species of Mycoplasma.

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TABLE 1

MYCOPLASMA REFERENCE STRAINS

Species / Serogroup	Reference Strain
M. mycoides subsp. mycoides	PG1
M. mycoides subsp. mycoides	Y-goat
M. mycoides subsp. capr.	PG3
Bovine serogroup 7	PG50
M. Capricolum	California Kid
M. Arginini	G230
Caprine serogroup 5	Goat 145
M. gallinarum	PG16
M. dispar	462/2
M. ovipneumoniae	Y-98

TABLE 2

GROWTH INHIBITION TESTS FOR MYCOPLASMA MYCOIDES SUBSP. MYCOIDES AND THE F38 STRAINS

Species / Serogroup	Number Strains	ANTISERA					
		PG1	Y-Goat	PG3	F38	PG50	California Kid
M. mycoides subsp. mycoides	4	+	+	-	-	-	-
F38	17	-	-	-	+	+	-

+ inhibition

- no inhibition

TABLE 3

GROWTH INHIBITION TESTS FOR MYCOPLASMA ARGININI AND MYCOPLASMA OVIPNEUMONIAE

Species / Serogroup	Number Strains	ANTISERA				
		G230	Goat 145	PG16	462/2	Y-98
M. arginini	8	+	-	-	-	-
M. ovipneumoniae	5	-	-	-	+[a] -	+

+ inhibition

- no inhibition

[a] two strains partially inhibited by M. dispar antiserum

TABLE 4

INDIRECT EPI-IMMUNOFLUORESCENCE TESTS FOR MYCOPLASMA MYCOIDES SUBSP. MYCOIDES AND THE F38 STRAINS

Species / Serogroup	Number Strains	ANTISERA					
		PG1	Y-Goat	PG3	F38	PG50	California Kid
M. mycoides subsp. mycoides (LC type)	4	+	+	-	-	-	-
F38	17	-	-	-	+	+	+[a]

+ indicates fluorescence

- indicates no fluorescence

a slight fluorescence with few F38 strains

TABLE 5

INDIRECT EPI-IMMUNOFLUORESCENT TESTS FOR MYCOPLASMA ARGININI AND MYCOPLASMA OVIPNEUMONIAE

Species / Serogroup	Number	ANTISERA				
		G230	Goat 145	PG16	462/2	Y-98
M. arginini	8	+	-	-	-	-
M. ovipneumoniae	5	-	-	-	+[a] -	-

+ Fluorescence

- No fluorescence

[a] Some slight fluorescence with 2 M. ovipneumoniae strains

TABLE 6

GROWTH PRECIPITATION TESTS FOR CAPRINE MYCOPLASMA ISOLATED IN KENYA

Species/Serogroup	Number of Strains	ANTISERA									
		PG1	Y-GOAT	PG3	F38	PG50	Calif Kid	G#230	Goat-145	462/2	Y-98
Mycoplasma mycoides ss.mycoides	4	+	+	+	+	+	+	-	-	-	-
F38	17	+	+	+	+	+	+	-	-	-	-
Mycoplasma arginini	8	-	-	-	-	-	-	+	+	-	-
Mycoplasma Ovipneumonire	5	-	-	-	-	-	-	-	-	(+)	+

+ = Precipitin bands present

(+)= Presence of a faint band

- = No bands present

A STRATEGY FOR BREEDING DUAL-PURPOSE GOATS FOR KENYA

T.C. Cartwright[1]

Although there are many goats in Kenya and many of these are milked as well as utilized for meat, there is no breed or type present that has the genetic potentials required for more intensive dual-purpose utilization. Therefore, the SR-CRSP established a breeding project to breed a goat that met the requirements for dual-purpose goat production in Kenya. The strategy in developing this breeding project included consideration of: (1) biological constraints, (2) basic production functions, (3) breeding goals, (4) strategy based on genetic principles and (5) a strategy adapted specifically for Kenya.

Biological Constraints

The biological constraints can be partially overcome (e.g. use of feed supplement and vaccines) but generally set the limits and objectives. The major constraints considered were:

1. Nutrition - quantity, quality and seasonality
2. Disease/parasites - mortality and morbidity
3. Breeding - adaptability and production potential

The supply of nutrients for dual-purpose goats is assumed to be feasible only from local forages. The number and productivity of goats is limited by the quantity available each day, its protein content and digestibility and the extent to which the forage produced in the flush seasons can be stored for use during the dry season. Also, goats can gain and mobilize body stores in response to seasonal changes. Only limited amounts of forage can be stored by smallholders and the survive mechanism based on body fat stores is much more limited for goats than for eep. Therefore, the seasonality of production and quality of forage must be included at least as a main limiting factor.

Although management, dipping, vaccination and other treatments may be applied, the expenses and availability of materials and skills of the smallholder limit these practices.

Therefore, a practical breeding program must provide a strategy for coping with these limitations as well as breeding for productivity. The breeding must include adaptability and synchronizing the genetic potential for production characters with the available feeding supply and prevailing production conditions.

Basic Production Functions

The basic functions that must be incorporated into consideration of breeding and selecting dual-purpose goats for smallholders are:

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- o growth
- o reproduction and lactation
- o survival

Growth and lactation require nutrient inputs above maintenance and if nutrients are marginal or submarginal, create stresses which in turn affect survival. Therefore, a reasonable balance of genetic potential for growth and lactation must be obtained with the nutrition available. While the objective is to maximize the output for a given input (forage resource), at the same time risks associated with drought, disease outbreaks and other stressing conditions must be minimized. Further, the objectives must be feasible and practicle.

Genetic Strategy

In order to effectively accomplish genetic objectives, a strategy guided by basic quantitative genetic principles must be designed. These principles may be summarized as follows:

1. Establish limited selection criteria and concentrate on one type in order to maximize numbers and selection effectiveness.
2. Direct selection and breeding toward production requirements of specific area to increase adaptability.
3. Exploit breed selection, to the extent that breeds with desired traits exist, to most quickly and effectively attain the desired production levels.
4. Exploit heterosis by hybridization and incorporate as many breeds as feasible in order to maximize heterosis retention. Heterosis level tends to be proportional to degree to genetic diversity among breeds (e.g. exotic vs indigenous) and heterosis retention tends to be proportional to number of breeds involved.
5. Maximize the selection differential among individuals within each breed by taking growth and milk data, computing estimated breeding value based on individual, repeated and progeny records of dams and sires, and applying appropriate correction factors.
6. Apply consistent selection criteria to limited number of traits (milk, growth and survivability) using objective methods.

Adapting the basic principles and available genetic resources to develop a logical effective breeding strategy for Kenya, the following program was designed:

1. Improve within feasible, practical limits the production environment for nutrition, health and management practices. The extent of these improvements is limited, but nevertheless critical for dual-purpose goat production. These inputs must be low cost and feasible for the smallholder. (Other SR-CRSP projects have responsibility for implementing these improvements.)
2. Exploit the immediate gains needed in milk potential by importing germ plasm of existing dairy breeds of the U.S. and Europe. The breeds chosen are Toggenburg, Nubian and Alpine. The importations are via semen and bucks available through other sources.
3. Exploit the adaptability of the indigenous East African and Galla breeds while sacrificing as little milk potential as feasible by screening the

populations of these breeds in Kenya for high milking strains and further selecting the highest producing individuals available within these strains.

4. Crossbreed the exotic males on the indigenous females and utilize the F^1s and other crosses as the basis for breed development.
5. Conduct research to evaluate the various crosses for milk production, growth and survivability (adaptability). Also research will be concurrently conducted to refine selection criteria, correction factors, data recording and breeding value evaluation procedures.
6. Develop a synthetic breed based on the crossbred foundation as outlined (tentatively) in figure 1.
7. Establish elite flocks of synthetics and continue selection under practical (prevailing) production conditions. In order to effectively utilize data for continued improvement through selection, a record keeping program, possibly involving selected farmers, will be developed. Artificial insemination and embryo transfer will be employed as feasible and as needed to test and promulgate elite sires and dams.
8. Establish a breeding scheme to distribute "elite" sires to farmers, assist farmers with recordkeeping and recover sires identified with proven, outstanding performance. This phase of the program is only at the conceptual level and no definite mechanism or details have been developed.

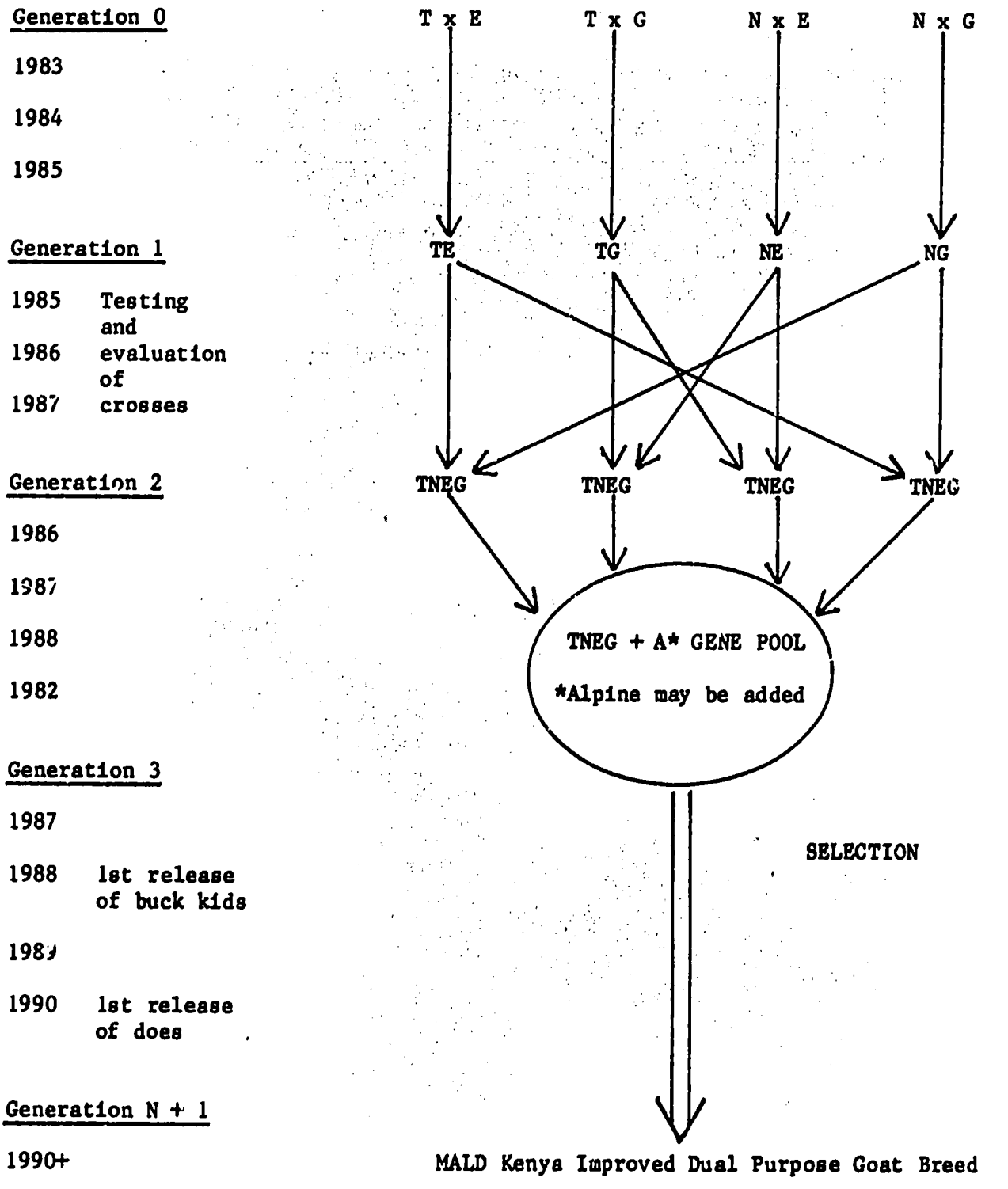

FIGURE 1. SR CRSP BREEDING PROJECT PLAN FOR A KENYA IMPROVED DUAL PURPOSE SYNTHETIC GOAT BREED.

EFFECTS OF PARTIAL SUCKLING ON LACTATION PERFORMANCE OF GALLA AND EAST AFRICAN GOATS AND THE GROWTH RATES OF THE KIDS

By
F. Ruvuna[1] T.C. Cartwright[1], A.M. Okeyo[2], W. Muhuyi[2], C. Ahuya[2] and J. Kitilit[2]

Introduction

Major constraints to increased animal production in smallholder farms in Western Kenya presented at the SR-CRSP workshop by Fitzhugh and Sands (1983), summarized one major constraint as "increased milk production by cattle and goats will require improved genotypes capable of producing sufficient milk to meet needs of young stock with a surplus for human consumption. Suitable cattle genotypes are available in limited number but improved goat genotypes are essentially unavailable to the smallholder". The Breeding Project has and continues to focus on developing these types of goat genotypes that can produce sufficient milk and are capable of s .viving in the smallholder environment. Some of the first phases of the breeding work are contained in the SR-CRSP report by Ruvuna et al. (1983).

Under the smallholder production system there is need to increase the amount of milk available to the family and yet have enough left for the kids to grow. More milk to the family might mean less milk available to the kids, leading to retarded kid growth and higher mortality. Thus, every attempt to strike a balance between milk available to the family and that to sustain satisfactory rearing of the offspring is of great importance. The goal of the present study was to find a feasible suckling method which would increase milk available to the family and at the same time sustain satisfactory live weight gains of the kids.

The cbjectives of the study were:

- o to determine the effect of different milking procedures on amount of milk available to the family,
- o to determine the effect of restricted milk on kid growth, and
- o to report further on milk yield potential of Galla & East African goats and kid growth rates.

The milking procedures considered in the study were designed to consider the smallholder interest to maximize milk available to the family, to have enough milk left to sustain growth of the kids and to have a milking method that is easy to use.

Materials and Methods

Two experiments were conducted on East African (EA) and Galla (G) does

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that freshened September - November, 1983, at Ol Magogo breeding station. All does that kidded to twins were excluded from the experiments.

In Experiment 1 there were approximately 105 EA and Galla does which were randomly assigned to the following 3 treatments; whereby the treatment represented 3 different milking procedures:

Treatment 1 (KA): Each doe was milked daily in the absence of the kid both in the morning and evening to get a.m. and p.m. milk yield, respectively. The only amount of milk available for the growth of the kids was that suckled after milking. Pre- and post-suckling weights of kids were recorded to determine the amount of residual milk consumed by each kid.

Treatment 2(KP): Each doe was milked daily, a.m. and p.m. in the presence of the kid; i.e. each kid was tied in front of the mother while milking. After milking was over each kid was released to suckle. Pre- and post-suckling weights of each kid were recorded to determine residual milk consumed by each kid.

Treatment 3(OW): Each doe was milked in the absence of the kid, once a week on Tuesday morning (a.m.) and Thursday evening (p.m.). A weekly milk yield was obtained by multiplying a day's yield by 7. Kids were allowed to suckle all the milk the remaining six days of each week of lactation.

In Experiment 2 approximately 45 Galla does were randomly assigned to 3 treatments comprising of 3 milking procedures:

Treatment 1 (HUM): Half of the udder was milked both morning and evening while the kid suckled the other half. Pre- and post-suckling weights of kids were recorded to determine milk consumed by each kid.

Treatment 2 (MMO): Does were milked every morning (a.m.) only. In the evenings (p.m.) the kids were left to suckle all the milk. Pre- and post-suckling weights of the kids were recorded.

Treatment 3 (WSW): Weigh-suckle-weigh technique was used. Kids were allowed to suckle all the milk both a.m. and p.m. Pre- and post-suckling weights of kids were recorded to determine amount of the milk suckled.

Both experiments ran for approximately 12 weeks (84 days). Measurement of milk yield started in second week of lactation because the present management procedures at the station is to let kids have access to all the milk in the first week of lactation. Kid growth was monitored by recording biweekly weights.

During the experiment if a doe developed mastitis or its' kid became

sick, both were removed from the experiment. This restriction created an imbalance in the data used in the final analysis across the period of the experiments.

Results and Discussion

Results of milk yield from Experiment 1 are presented in Table 1. Comparison of milk yield from the three methods indicated KP method exceeded the other methods followed, in order, by KA and OW. Over the 12 weeks of lactation KP outyielded OW and KA by 14.7 kg and 10.2 kg respectively. On mean weekly milk yield basis, KP, KA and OW yielded 3.23, 2.30 and 1.89 kg per week, respectively. These results seem to suggest that milking once a week underestimates milk yield potential of the indigenous Gall and East African does. The higher KP milk yield than KA may be attributed to the presence of the kid which stimulated milk let down of the mothers.

Assuming that the doe milk yield from each milking technique represented potential milk available for consumption by the family, the results suggest that the KP milking method would provide about .9 kg of milk per week more to the family than KA, and 1.3 kg per week more than OW. The very small amount of milk available to the family from OW (1.9 kg/week) resulted from milking only once a week, and all the milk was left for the kids to suckle for the remaining six days.

Comparison of the milking methods in terms of milk available to the kids favored OW since all the milk was left for kids to suckle except once a week when milking of does was done. The KP method provided the least residual milk to the kids, about a mean of 2.3 kg/week over the 12 weeks of lactation, followed by KA with an average of approximately 2.7 kg/week of lactation. The small amount of residual milk in KP might be attributed to the presence of the kids during milking which stimulated milk let down thus, little residual milk was left for suckling after the milking.

Table 2 and Figure 1 show the effect of restricting milk on the growth of kids. By the 12th week of lactation the kids which had access to most of the milk from their mothers (OW), had an average weight of 11.7 kg as compared to the kids in KA with 8.6 kg and KP with 7.1 kg. The average daily gains to 84 days of age for OW, KA and KP kids were 110 gm/day, 70 gm/day and 51 gm/day, respectively. These results indicate clearly the effect of restricting milk on growth rates of the kids. Of interest to note is the interaction of growth rate of kids from the different milking procedures by period of lactation. At the start of lactation very little difference in growth of kids among the milking methods existed, which became more pronounced with advancing state of lactation. A clear illustration is shown in Figure 1 where, after the 6th week, the growth rate in KA was greater than in KP with the difference becoming greater in the late stage of lactation. Though the results suggest that the KP method potentially would provide the most milk to the family, it left the least milk for the kids to suckle, resulting in a slow growth rate. Thus, there seems to be a need to find a milking technique that will strike a balance between milk to the family and milk for the kids growth. A sort of "Index" using some economic weightings based on optimizing milk to family and milk to kids for appropriate growth might help in selecting a future method for milking goats by smallholders.

Table 1. Milk yield, milk suckled and total milk production of Galla and East African breeds in Experiment 1. *

Lactation Week	RID ABSENT (RA)			RID PRESENT (RP)			ONCE WEEKLY (OW)
	Doe Milk Yield (kg)	Residual Milk Suckled (kg)	Total Milk (kg)	Doe Milk Yield (kg)	Residual Milk Suckled (kg)	Total Milk (kg)	Doe Milk (kg)
2	(35) 2.87±.82	3.20±.62	6.07±.50	(42) 3.26±1.55	3.13±1.09	6.39±1.74	(33) 1.64±.82
3	(35) 3.40±.84	2.43±.32	5.83±1.07	(42) 3.15±1.05	2.95±.80	6.10±1.05	(33) 2.03±1.26
4	(35) 2.00±.95	2.44±.36	4.44±1.03	(42) 3.31±.99	2.72±.67	6.03±1.19	(33) 2.18±1.18
5	(35) 1.96±.82	2.87±1.15	4.83±1.23	(38) 3.30±.99	2.50±.53	5.80±1.22	(33) 1.93±.76
6	(35) 2.45±.93	2.82±1.04	5.27±.85	(37) 3.44±1.07	2.26±.48	5.70±1.22	(33) 2.45±1.06
7	(35) 2.38±1.23	2.76±1.19	5.14±1.10	(33) 3.41±1.18	2.08±.45	5.49±1.29	(33) 2.06±.87
8	(35) 2.21±1.11	3.09±1.37	5.30±1.16	(34) 3.36±.98	1.92±.43	5.28±.98	(33) 1.71±.71
9	(35) 2.37±1.08	2.71±1.15	5.08±.82	(33) 3.35±.94	1.83±.38	5.18±.90	(33) 1.86±.86
10	(35) 2.21±.99	2.64±1.29	4.85±1.24	(33) 3.12±.91	1.74±.35	4.86±.92	(31) 2.07±1.01
11	(27) 1.84±.73	2.59±.84	4.43±.88	(29) 2.89±.87	1.80±.33	4.69±1.01	(27) 1.54±.77
12	(25) 1.56±.61	2.21±.52	3.77±.83	(21) 2.90±.84	1.98±.34	4.88±.95	(28) 1.32±.69
TOTAL	25.25	29.76	55.01	35.49	24.91	60.40	20.79
MEAN	2.30	2.71	5.00	3.23	2.26	5.49	1.89

Table 2. Weights of kids on suckling regime of Experiment 1.*

Age (weeks)	KID ABSENT (KA) Weight (kg)	KID PRESENT (KP) Weight (kg)	ONCE WEEK (OW) Weight (kg)
0 (Birth)	(35) 2.73±.63	(42) 2.78±.59	(33) 2.76±.60
2	(35) 3.65±.63	(42) 4.02±.69	(33) 4.79±1.08
4	(35) 4.23±.85	(42) 4.73±.94	(33) 6.17±1.23
6	(35) 5.06±1.24	(37) 5.39±1.09	(33) 7.36±1.39
8	(35) 6.44±1.17	(34) 6.05±1.28	(33) 8.84±1.43
10	(35) 7.32±1.29	(33) 6.76±1.53	(31) 10.21±1.29
12	(25) 8.58±1.34	(21) 7.07±1.64	(28) 11.68±1.28
Daily Gain to 84 days of age	.070	.051	.110

*Values in brackets indicate number of records.

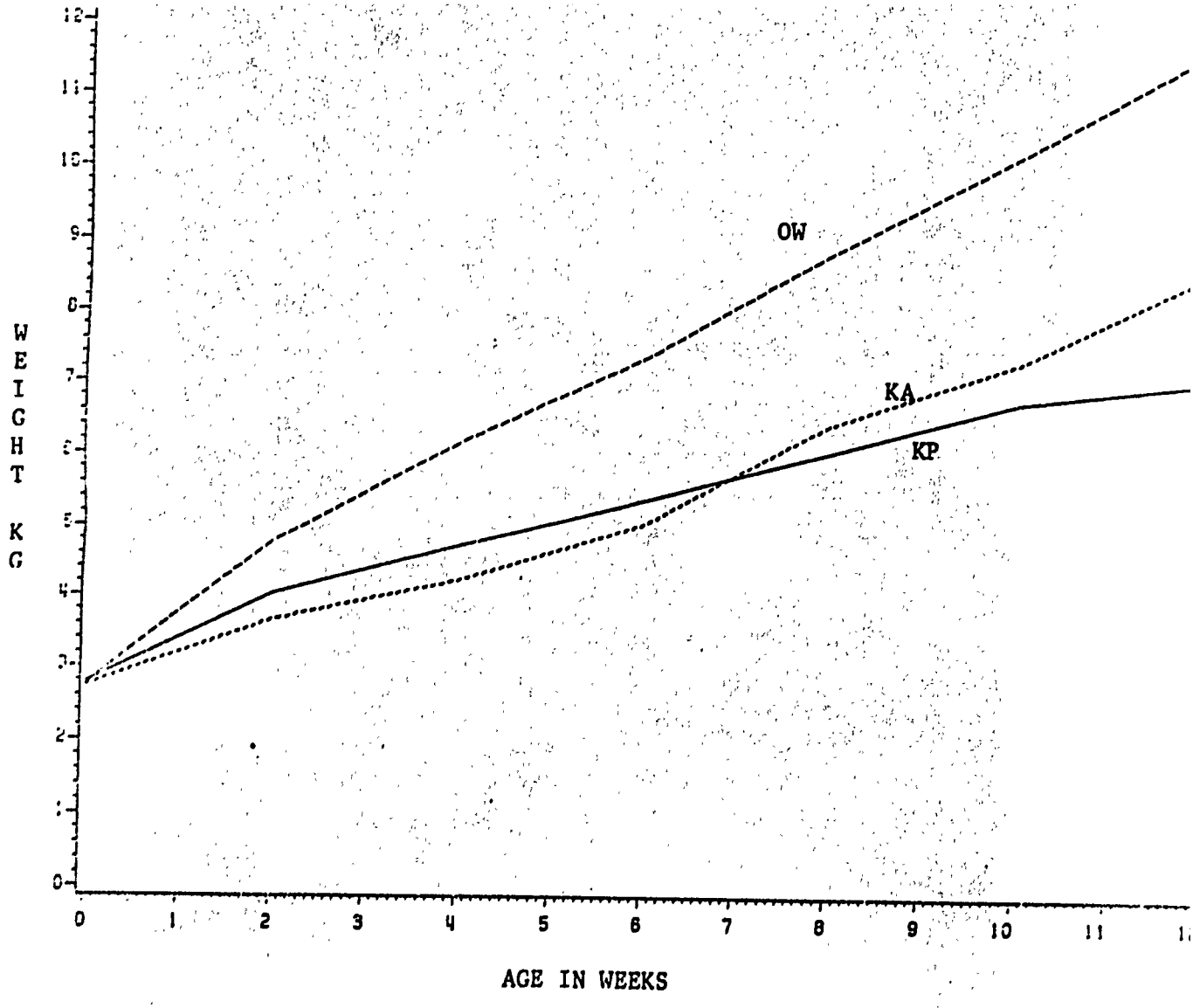

Figure 1. Effects of suckling regime on pre-weaning growth of kids. (OW- once per week, KA- kid absent, KP- kid present)

Table 3 shows milk yield from Experiment 2. Assuming that doe milk yield represented total potential milk available to the family for consumption, the three methods, HUM and MMO provided on average, respectively, 1.1 kg/week and 0.96 kg/week over 12 weeks of lactation. On the basis of milk available to the kids the residual milk suckled (kg/week) from HUM, MMO and WSW was, respectively, 1.66 2.01 and 2.97. These results seem to suggest that on the basis of milk available for family consumption HUM provided the most and WSW provided the least. On the other hand, considering milk available to kids which is translated into the growth of kids, WSW exceeded the other methods and HUM provided the least milk.

Table 4 and Figure 2 show the growth of kids from the three milking procedures, which give some indirect measure of the amount of milk available to the kids. The kids in the WSW method with no milk restriction weighed 8.3 kg at 12 weeks of age compared to 7.1 kg and 6.8 kg from MMO and HUM, respectively. The differences are also shown in the average daily gains to 12 weeks of age. The average daily gains to 12 weeks of age from WSW, MMO and HUM were, respectively, 68 gms, 51 gms and 49 gms. Again, it is interesting to note the interaction between growth rate by stage of lactation (Figure 2).

Table 5 shows the results of pre-weaning daily gains and weight of kids from purebred indigenous goats and crosses with Toggenburg and Anglo-Nubian breeds. The results clearly show superiority of crosses over the indigenous in weight at 12 weeks of age and daily weight gain to 84 days of age. There was very little difference between Galla and East African, with a slight advantage in weight favoring the Galla breed. The crosses showed much higher weights and daily gains compared to the local purebreds. However, there was a very small difference between the Toggenburg and Anglo-Nubian crosses with a slight advantage by Toggenburg crosses. On the average the crosses were approximately 2 kgs heavier by 12 weeks of age and gained about 20 gms/day more than the indigenous purebreds. However, the results should be interpreted with caution as the pre-weaning weights were confounded with milking methods.

Results of milk yield of pure-bred Galla, East African and Toggenburg does are presented in Table 6 and Figure 3. Only milk yield of Galla and East African does in KA and KP milking procedures were summarized in this table and figure. Thus, the milk yields should be interpreted with caution as they were confounded with the milking procedures.

For 12 weeks of lactation the average daily milk yield of East African, Galla and Toggenburg breeds were, respectively, 385 gms, 409 gms and 800 gms. The milk yield range was 0 to 1200 gms/day for East African, 50 to 1500 gms/day for Galla and 400 to 1700 gms/day for Toggenburg. The Toggenburg does averaged approximately twice as much milk per day as the indigenous purebreds, indicating clearly the superiority of the temperate breed over the local breeds for milk production. The large variation and range in milk yield in the indigenous purebreds suggested that there is enough variation to warrant selection and/or screening or improved milk yield in the indigenous breeds.

Conclusion

1. Milking in the presence of the kids increased does' milk yield. This could be attributed to the stimulation of milk let down by the kids

Table 3. Effects of suckling regime on lactation performance of Galla.

	HALF UDDER MILKING (HUM)			MILK MORNING ONLY (MMO)			WEIGH-SUCKLE-WEIGH (WSW)
Lactation Week	Doe Milk Yield (kg)	Half Udder Milk Suckled (kg)	Total Milk (kg)	Doe Milk Yield (kg)	Milk Suckled (kg)	Total Milk (kg)	Milk Suckled (kg)
2	(15) 1.47±.31	2.43±.47	3.90±.70	(17) 1.54±.47	2.62±.77	4.16±.92	(10) 4.58±1.13
3	(15) 1.51±.49	2.37±.58	3.88±.99	(17) 1.25±.51	2.64±1.06	3.89±1.27	(10) 3.78±1.11
4	(15) 1.53±.53	2.14±.52	3.68±.90	(14) 1.22±.43	2.72±1.09	3.94±1.10	(10) 3.22±.85
5	(15) 1.43±.31	2.25±.79	3.67±1.01	(14) 1.25±.45	2.61±.86	3.86±.90	(10) 3.22±1.28
6	(11) 1.25±.37	2.25±.78	3.50±1.07	(13) 1.16±.46	2.86±.98	4.02±1.17	(10) 3.64±1.21
7	(9) 1.08±.29	2.06±.99	3.14±1.26	(12) .99±.39	2.60±1.01	3.59±1.01	(10) 4.24±1.42
8	(8) 1.00±.32	1.30±.44	2.30±.73	(12) .78±.33	1.73±1.07	2.51±1.26	(10) 2.84±.80
9	(8) .82±.26	.98±.26	1.80±.49	(12) .67±.27	1.31±.52	1.98±.75	(9) 1.12±.53
10	(8) .89±.34	.69±.14	1.58±.44	(10) .66±.34	1.15±.37	1.81±.55	(9) 1.85±.90
11	(8) .91±.25	.75±.17	1.66±.42	(10) .62±.33	.96±.15	1.58±.36	(9) 1.44±.45
12	(8) .67±.17	.69±.16	1.36±.31	(9) .44±.14	.86±.14	1.30±.15	(9) 1.74±.87
TOTAL	12.12	18.25	30.47	10.58	22.06	32.64	32.67
MEAN	1.1	1.66	2.77	.96	2.01	2.97	2.97

Table 4. Effects of suckling regime on pre-weaning growth of Galla kids.*

Age (Weeks)	HALF UDDER MILKING (HUM) Weight (kg)	MILKING MORNING ONLY (MMO) Weight (kg)	WEIGH-SUCKLE-WEIGH (WSW) Weight (kg)
0 (Birth)	(15) 2.74±.60	(17) 2.81±.67	(10) 2.63±.59
2	(15) 4.34±.78	(17) 4.10±.81	(10) 4.46±1.05
4	(15) 5.05±.75	(14) 4.82±1.09	(10) 5.43±1.11
6	(11) 5.47±.85	(14) 5.14±1.31	(10) 6.09±1.33
8	(8) 6.11±.87	(12) 5.14±1.31	(10) 7.23±1.48
10	(8) 6.42±.87	(9) 7.00±1.61	(9) 8.07±1.28
12	6.81±1.09	7.14±1.64	8.29±1.34
Average Daily Gain to 84 Days of Age	.049	.051	.068

* Value in brackets indicate number of records.

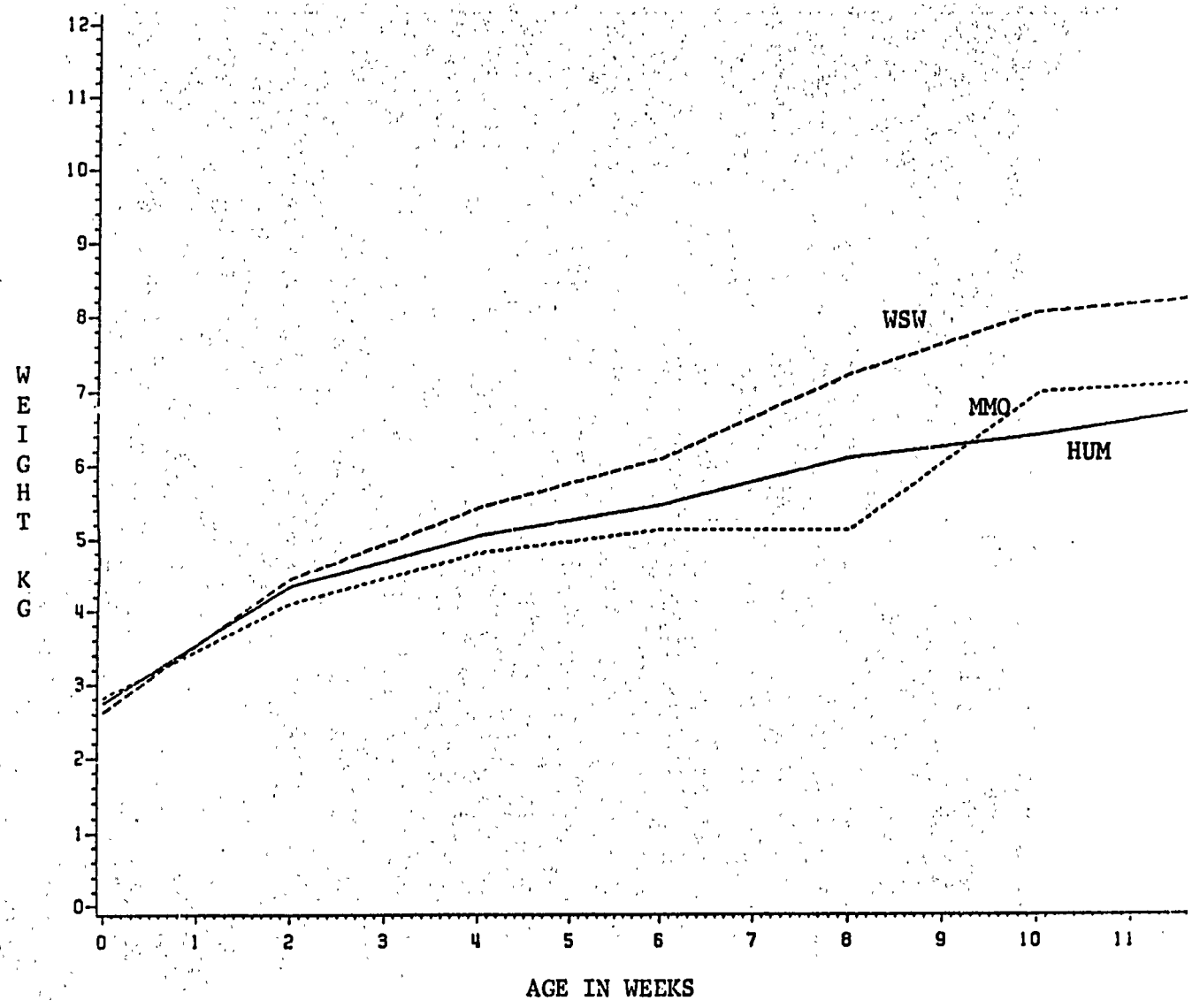

Figure 2. Effects of suckling regime on pre-weaning growth of kids. (WSW- weigh suckle weigh, MMO- morning milk only, HUM- half udder milk)

Table 5. Pre-weaning weights (kg) of Galla, East African and crosses at different stages of growth.

Stage of Growth (weeks) of Age	EA	G	TxEA	TxG	NxEA	NxG
0 (Birth)	2.22±.53	2.74±.63	2.44±.57	3.21±.56	2.30±.48	2.86±.57
2	3.62±.63	4.27±.86	3.99±.62	4.91±1.32	4.12±.67	4.09±.78
4	4.44±.94	5.06±.96	4.79±.93	6.01±1.66	5.12±1.06	5.24±.90
6	5.05±1.27	5.52±1.14	5.66±1.15	6.91±1.85	5.99±1.33	6.37±1.31
8	6.07±1.74	6.60±1.35	6.74±1.42	7.89±1.55	6.84±1.51	7.24±1.71
10	6.82±1.82	7.18±1.28	7.94±1.57	8.81±1.79	7.96±1.53	8.25±1.78
12	7.40±2.18	7.48±1.44	9.29±2.11	10.34±1.76	9.18±1.82	9.33±2.15
n	35	35	55	25	20	20
Average Daily Gain to 84 Days of Age	.062	.057	.082	.084	.082	.076

EA = East African G = Galla

T = Toggenburg N = Anglo Nubian

Table 6. Weekly average milk yield (kg) of East African, Galla and Toggenburg breeds.*

Week of Lactation	East African	Galla	Toggenburg
2	(417) 2.97±1.37	(463) 3.24±1.15	(867) 6.07±2.07
3	(470) 3.29±1.07	(441) 3.09±.79	(831) 5.82±1.70
4	(361) 2.53±1.05	(424) 2.97±.80	(830) 5.81±1.67
5	(364) 2.55±.96	(397) 2.78±.76	(791) 5.54±1.42
6	(411) 2.88±1.03	(430) 3.01±.99	(761) 5.33±1.34
7	(401) 2.81±1.15	(456) 3.19±1.22	(794) 5.56±1.35
8	(383) 2.68±1.06	(420) 2.94±1.07	(809) 5.66±1.51
9	(404) 2.83±.99	(423) 2.96±1.09	(834) 5.84±1.72
10	(381) 2.67±.97	(377) 2.64±.97	(807) 5.65±1.71
11	(321) 2.25±.90	(351) 2.46±.61	(751) 5.26±1.60
12	(317) 2.22±.83	(320) 2.24±.62	(717) 5.02±1.81
TOTAL	29.63	31.52	61.56
AVERAGE	(385) 2.69	(409) 2.87	(800) 5.60
n	40	15	15

* Figures in brackets indicate average daily milk yield (gm)

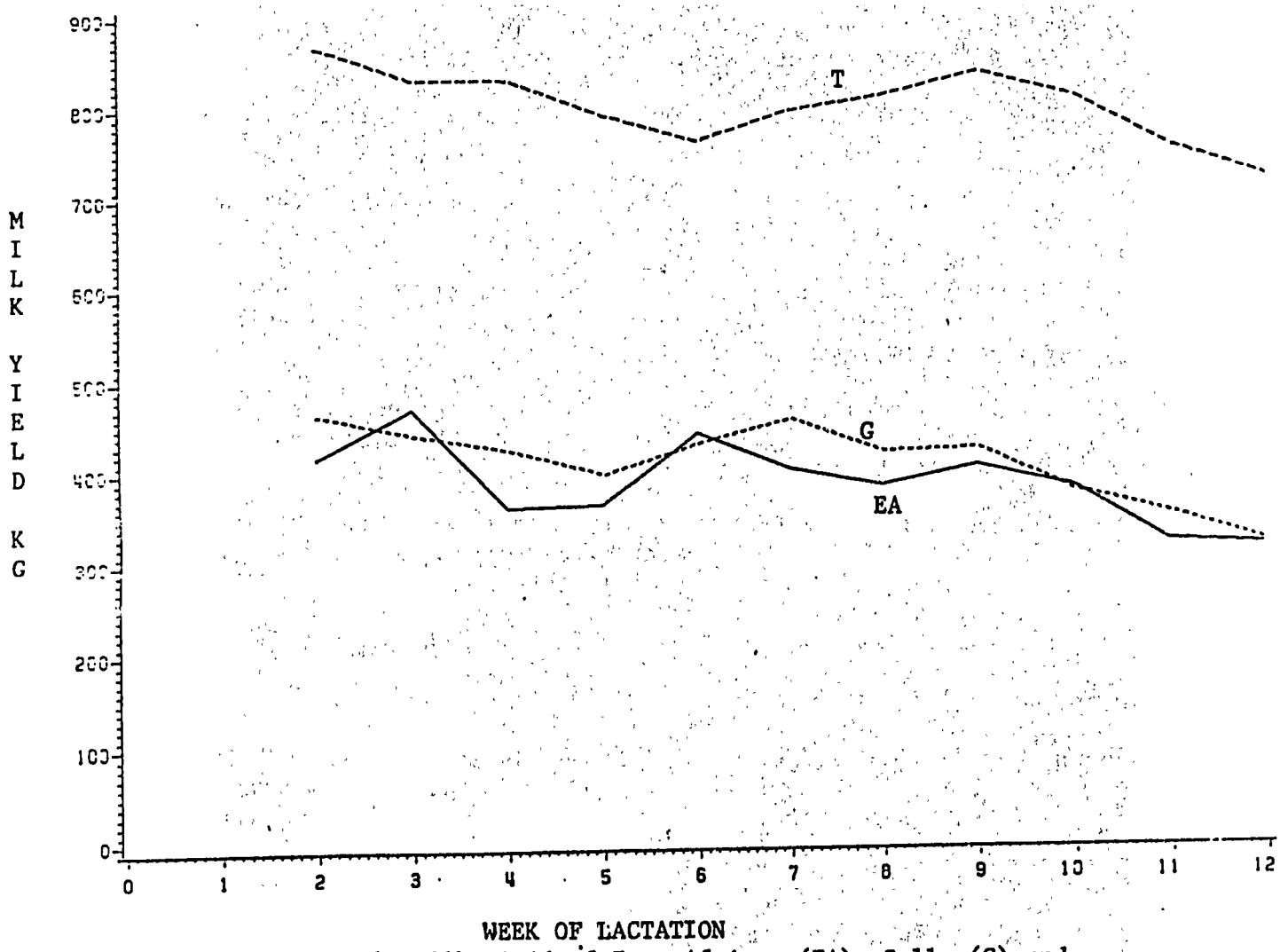

Figure 3. Average daily milk yield of East African (EA), Galla (G) and Toggenburg (T) breeds.

presence.

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

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

4. Restricting milk available to the kids reduced their growth rates thus indirectly affecting their maturing rate.

5. No milking procedure proved to be superior, in all the criteria used, to select an appropriate method for the smallholder for milking goats. There is a need to use an optimizing technique including socio-economic weightings of milk for the family consumption relative to the amount of milk to sustain growth of the kids.

6. Possible goat milking procedures for the smallholder that showed promise for further investigation are:
   - milking when kid absent and residual suckling (KA),
   - milking half udder while kid suckling other half (HUM),
   - milking morning only and suckle all milk in the evening (MMO), and
   - weigh-suckle weigh (WSW).

7. Pre-weaning daily gain to 84 days of age suggested crosses of Toggenburg and Anglo-Nubian were superior to the purebred indigenous breeds, East African and Galla for growth rate.

8. Average daily milk yield for East African, Galla and Toggenburg were 385, 409 and 800 gms, respectively. There was sufficient variation to warrant continued screening of milking strains in the indigenous breeds. However, the results should be interpreted with caution as the milk yield was confounded with milking procedures.

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THE CONCEPT OF SYSTEMS ANALYSIS AND ITS APPLICATION TO EXAMINING PRACTICAL PROBLEMS IN KENYA

By
T.C. Cartwright[1]

General systems theory has developed into a discipline with variations and applications in many fields such as operations research and bioengineering. A major objective of applications is to account for and understand the correlations, feed-backs and trade-offs in complex systems.

Systems analysis, in current usage, implies a description of the structure and functions, along with the rates and flows of materials and their controls, of a bounded system with a mathematical model and its employment to analyze cause and effect relations and effects of changes of inputs of the systems.

The types of systems and mathematical models vary considerably. The Kenya sheep and goat models are characterized as follows:

- Bounds include a flock or set of flocks; i.e. the system is comprised of a flock or a set of flocks.
- The level of the model is the individual animal.
- Mathematical functions are based on biological relationship (vs. arbitrary mathematical curve fitting).
- The models are general and programmed so that they are adapted to different breeds or types, production areas, and management practices by use of specific breed-area-management parameters.
- Animal performance is simulated through time as a response to the environment.
- Driven by nutrition.
- Mediated by genetic potentials or limits.
- Simulates and outputs production measures of individuals and flock on a 15-day time step.

Applications may be useful in several different systems analysis approaches:

1. To determine the response (production) of a given flock (or individual or part of a flock) to a given specific set of production conditions and practices. This use can be thought of as a substitute for conducting production experiments; i.e., the effect of different treatments can be estimated by simulation rather than by live animal experiments, thus extending resources and "conducting" experiments that otherwise would be impossible.
2. To determine the inputs (nutrition, genetics and management) required to obtain a given level of required nutrition.
3. To identify the critical constraints to a production system and quantify the specific effects.
4. To evaluate the effects of practices available to, or recommended for,

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producers taken singly and in various combinations (packages) and to examine the effects of potential perturbations, such as droughts, on recommended practices; i.e., to determine the optimal set of practices for a given farm area where the 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 farm areas.
6. To provide a systematic, organized method of determining data that must be collected from experiments in order to logically project results for producer application.

A CONCEPTUAL OVERVIEW OF THE SR-CRSP GOAT PRODUCTION MODEL

By
H.D. Blackburn[1], T.C. Cartwright[1], A.B. Carles[2], F. Ruvuna[1]

Goat production in Kenya utilizes a wide array of production resources and includes intensive, extensive and nomadic production systems. Within each of these production systems there are numerous decisions and options to consider, the desired outcome of which is the maximization, within certain constraints, of goat products (meat and milk). How are researchers, administrators, extension personnel and producers to determine the effect of these options on the total production system where there are many interacting trade-offs? The most logical methodology which can attempt to answer these questions is systems analysis.

Systems analysis is a method of organizing information about the individual biological components of the goat (or flock of goats) into a unified structure and then using the structure or model to examine how the goat will react in different production situations. Without such a model to interrelate the different biological components it would be difficult to determine how factors affecting one part of the goat or flock could affect another seemingly unrelated biological process within the goat or flock.

By using a systems analysis approach it is possible to test numerous options. These may include the response of different breeds in a production environment or the effects of supplemental feeding and controlled breeding seasons. Employing conventional experimentation to examine the effects of a large number of options would require a large commitment of labor, time and financial resources which would be quite limiting.

A goal in our systems analysis project is to quantify and characterize the biological interactions which occur within the goat and program these in mathematical terms into a computer model. This model enables researchers to examine how goats responded to changing environmental conditions or how different breeds or types of goats respond to the same environment where the environment consists of the physical and managerial conditions of the production system. The model was constructed in such a ay that almost any production situation can be simulated, if the proper forage (diet), managerial and breed parameters are specified.

As stated earlier, the computer program developed integrates the different biological components (age, maturity, lactational status, etc.) of a goat into a unit (or animal). A conceptual overview of the model can be seen in figure 1. A description of the symbols used in figure 1 is given in table 1. Model inputs are aligned on the left side, and all model outputs are on the right side of the diagram (figure 1). The flow of protein and energy can be followed from the nutrient pool to the various levels where nutrients are used. The flow of nutrients is determined by the physiological status of the

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animal being simulated. The physiological status is altered by the auxiliaries: age, lactation status, sex, gestation status, maturity and body condition. The physiological status for any 2 animals will be different if they are of different ages, sexes or have had different nutritional backgrounds so that body condition is different. These factors exert a force over the physiological status which in turn determines where nutrients flow and the amount of nutrients which are divided between the various requirements.

The model simulates one animal at a time, on a 15 day time step. That is, all biological factors are updated every 15th day. If we assume we have a mature goat which is lactating but not pregnant we can follow the activity of the model as this doe would be simulated. First her physiological status determines the level of the available feed that she will consume; the feed consumed will go into the nutrient pool. Protein and energy from the feed will leave the nutrient pool and be divided between lactation, maintenance and body stores. The other levels such as fiber, gestation and growth have been shut off by the controlling auxiliary physiological status. If the doe is not able to consume sufficient feed, she will catabolize her body weight to provide protein, energy or both to meet her maintenance requirements and lactation requirements. If there is still a nutritional deficiency, production will be decreased proportionally to represent the deficit.

With the conceptual operation and structure of the model in mind, it is necessary to examine how the model is structured in the computer program. Figure 2 demonstrates the structure of the models major categories. These are; INPUT, the reading of information supplied to the model; periods simulated (PS) the length of time simulated; SAVEFL, saving the flock to be used at a later date; OUTFLK, printing out the individuals of the flock after the simulation is complete; RUNSUM, a summary of the information generated by the model; BIOLOGY, the biological computations carried out in the model; and MANAGE, the management changes which occur in the course of a simulation. Two of the most important subroutines in the model are BIOLOGY and MANAGE. Therefore the subroutines involved, or "called", from these two major subroutines are shown in figures 3 and 4. Their names are self explanatory as to their function.

A listing of the classes of animals which are simulated is given in table 2. All simulated animals are classified according to biological and management criteria which are determined by the simulator. For example, goats can be divided into classes on the basis of age only. The divisions by age will then be dependent upon the production system being simulated. By placing animals into the various classes listed, different management operations can be carried out on a particular class. For example, we may wish to simulate the effects of supplemental feeding of nursing kids but not the remainder of the flock; the manner in which the classes are structured allows us to do this. A listing to further indicate information that is simulated and accounted for in each animal, within a class, is given in table 5. The record is divided into several categories: A) identification, each animal is assigned a number at birth and is placed in a class specifying management group, pasture and supplementation (if any); B) phenotype, in this section the simulated goat's physical attributes are kept and updated with time; C) the phenotype for females keeps track of the doe's reproductive performance past and present, and the amount of milk she produces; D) pointers refer to the

arrangement of goats between flocks and within flocks and designate how the records of individual goats are connected together in a array (this procedure allows for a more efficient computer use by speeding up the computation time of a simulation); E) sort keys, the individuals within a flock of goats are categorized into smaller sections by the sort keys. For example, if the class nursing doe kids have 3 different age groups the animals of each age group will appear together on the simulation output. This procedure facilitates monitoring the growth, gestation or lactation patterns of a group of goats.

The user is required to provide the model with three types of data for simulations: genetic potentials of the goats, feed resource specification, and management practices. The items are referred to as input parameters. The genetic potential parameters specified are mature weight, maturing rate, potential peak milk production level, seasonality of breeding and ovulation rate. The feed resource is specified on a 15 day (1 period) basis. Four items must be specified for each period: digestibility and crude protein of the forage diet, availability of forage (which contains the crude protein and digestibility of the diet) expressed in kg/head/day, and the crude protein, digestibility and amount of any supplement fed. The management practices currently being used in the system or those which are to be tested must also be specified. These include: breeding season, weaning policy, sales policy, flock health program, selection/culling practices, dairy practices and supplemental feeding.

Before experimental simulations are performed, a baseline validation should be performed for the base production system simulated. A baseline validation compares how closely the model simulated the actual production of goats observed in real life. To perform a validation the input parameters must be supplied to the model. Of course, animal performance data (growth rates, doe body weights, milk production levels, reproductive rate and mortality rates) must be available, at least in part, for comparison. These performance data should have been collected at the same time that forage parameters were collected so that it is possible to examine the animals response to fluxuations in the forage resource. Upon successful completion of the validation, experimental simulations may begin.

The goat model was constructed so that it can be used for several types of simulations. Its primary function is to simulate any type of goat experiment which evaluates animal performance in terms of body weight, milk production, reproductive performance and production efficiency (output/input). Such use results in the reduction in the cost of research, time required to obtain results and identification of key area (production constraints) for live animal research. Model results quantify the animals' response to changes in the production system, increased feed resources or production from different breeds of goats.

The model can be used to develop production strategies to improve productivity. For example, the goats response to interventions, such as supplementation, breed alternatives and health treatments can be tested and synthesized into production packages which include one or more of the tested interventions. Further analyses can then be done testing the trade-offs between production packages.

Output from the model, in terms of protein and energy, can be used to

evaluate potential changes in the nutrition available to the owner.

Model results provide estimates of dry matter consumed by the goat flock. This information can be used to determine the portion of biomass utilized and how this use relates to stocking rate.

Because of the number of different options the goat model can simulate, the output is very useful in economic analysis. It is capable of providing economists information on the amount of feed consumed and the off-take in terms of meat and milk. This information can be used in linear programs which evaluate entire farm enterprises.

In this paper the general structure of the goat model has been described. From this description it is evident that the model is very flexible in terms of the genetic, environmental and management options which can be simulated. This flexibility increases the types of production environments in which the model can be used. For example, the model can be used in the very high potential areas of western Kenya or the extensive nomadic production system of northern Kenya. Flexibility of this order has important ramifications in terms of model use. Simulations can be performed for very diverse areas of the country to determine what alterations in environment or in management will have a positive impact on goat production.

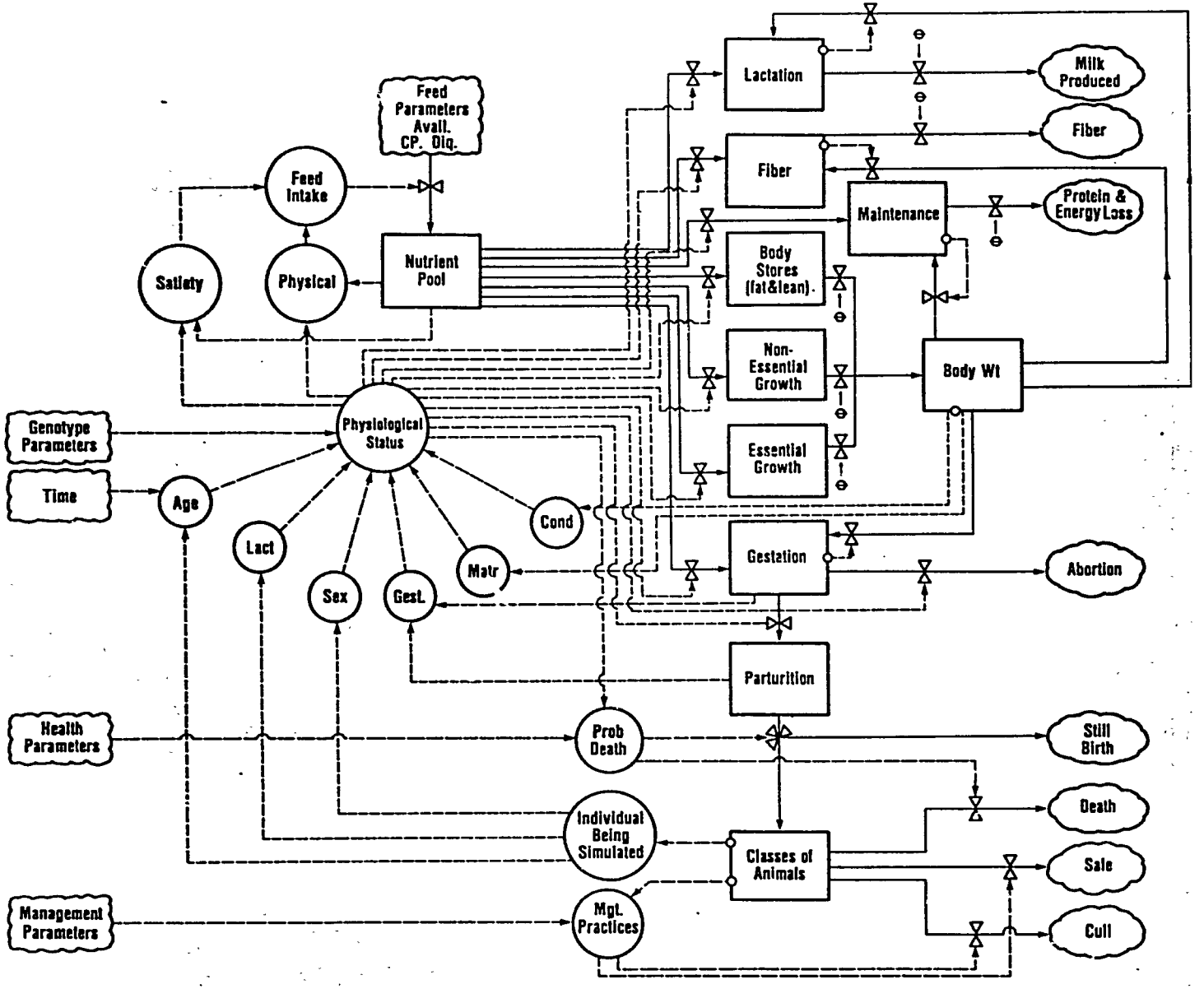

Figure 1. A conceptual overview of the goat model.

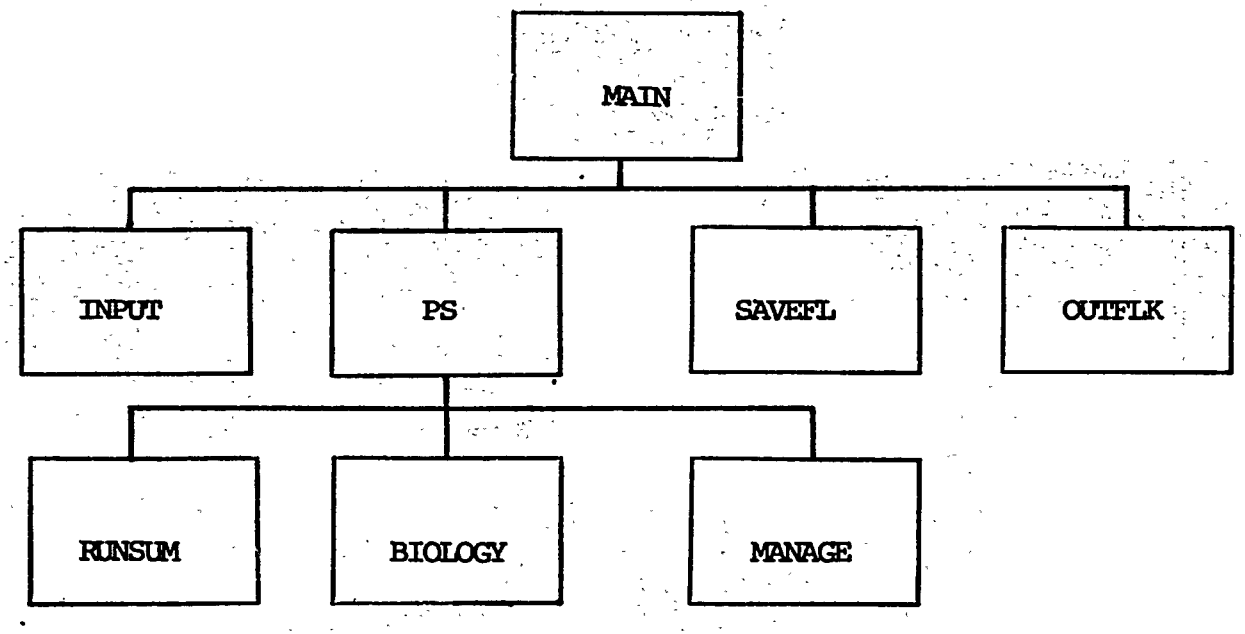

Figure 2. The hiearchical structure of major subroutines in the goat computer model.

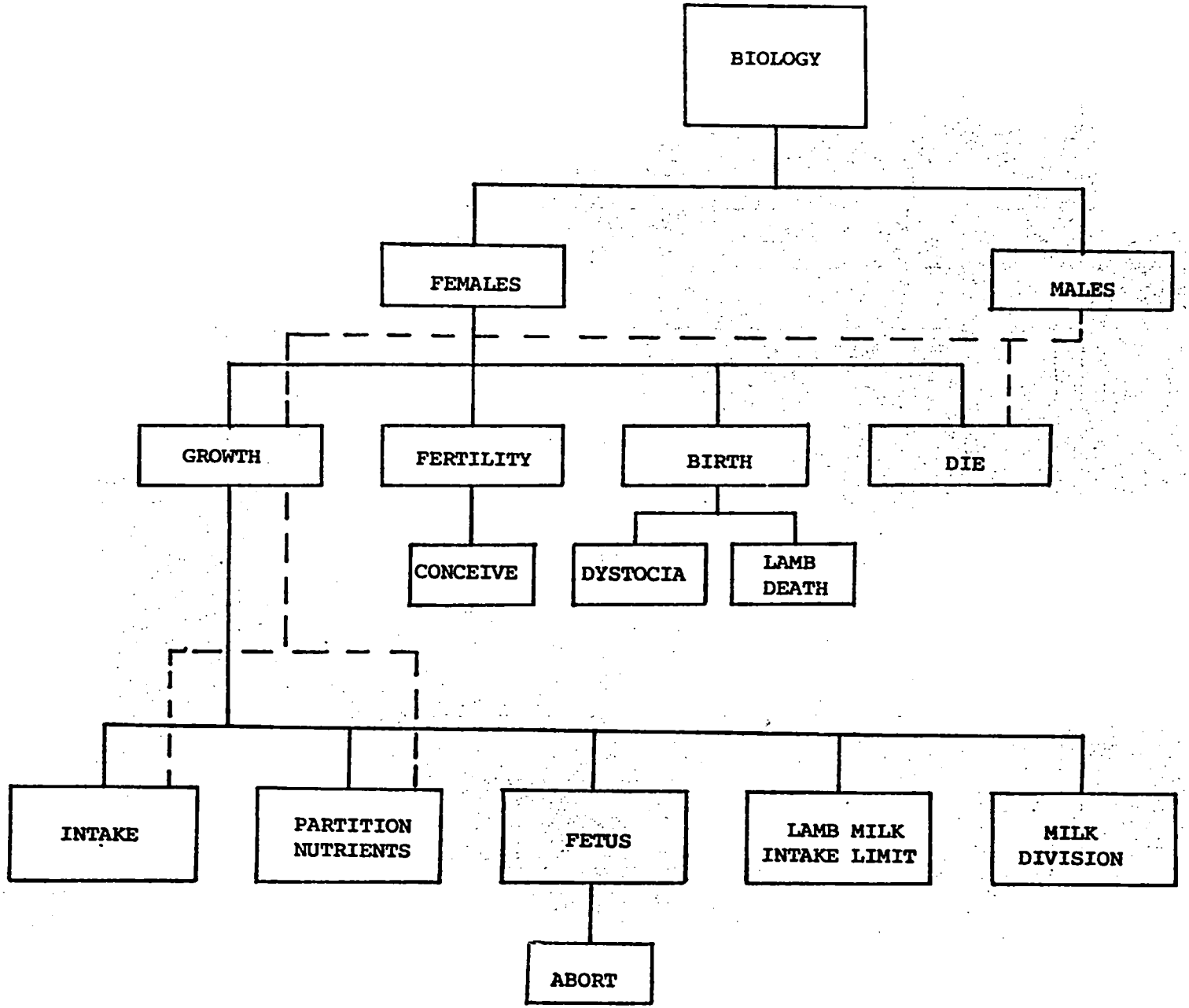

Figure 3. Conceptual structure of the Biology subroutine and the subroutines which are called from it.

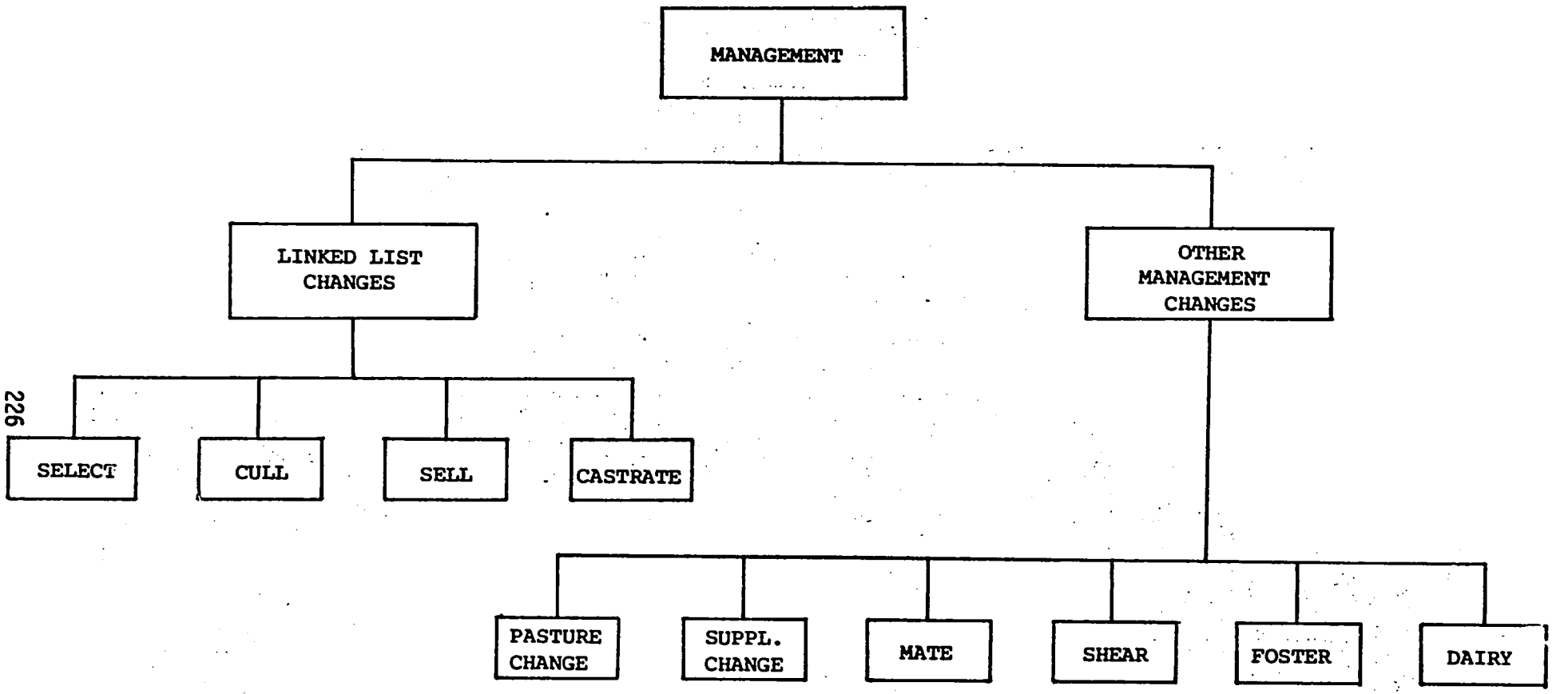

Figure 4. The Management subroutine and the subroutines which are called from it.

TABLE 1. A LIST OF SYMBOLS USED IN THE CONCEPTUAL FLOWCHART.

Symbol	Description of Symbols
	Input parameters; information supplied to the model.
	Output from the model. These are offtakes (kilograms of animals sold or milk used for human consumption) or losses from the system.
	Levels, which hold protein and energy in various forms; forage, lean weight, and fat weight.
	Auxiliary variables; controls which determine the rate of flow of protein and energy from one level to another.
	The path of protein and energy between levels.
	Information links between auxiliaries and valves and feedback from levels to auxiliaries.
	Valves controlling the rate of flow of materials.
	Constants which control the flow rate through the valves.

TABLE 2. ANIMAL CLASSES WHICH CAN BE SIMULATED IN THE GOAT MODEL

Animal Classes
1. Sale Doe Kids
2. Sale Does
3. Breeding Does
4. Replacement Doe Kids
5. Nursing Doe Kids
6. Aged Wethers
7. Wether Kids
8. Nursing Wether Kids
9. Sale Bucks
10. Breeding Bucks
11. Replacement Buck Kids
12. Nursing Buck Kids
13. Female Fetuses
14. Male Fetuses

TABLE 3. RECORD OF INFORMATION STORED AND UPDATED ON EVERY SIMULATED ANIMAL

Animal Record

A. Identification

1. ID
2. Breed
3. Class
4. Management group
5. Pasture
6. Supplement

B. Phenotype (all animals)

1. Weight (W)
2. Structural size (WM)
3. Weight of lean (WL)
4. Empty body weight (EBW)
5. Fleece weight (FW)
6. Rumen fill (FILL)
7. Change in W
8. Gain in WM
9. Change in WL
10. Change in EBW
11. Change in FILL
12. Change in FW
13. Dry matter intake
14. Metabolizable energy intake
15. Crude protein intake

C. Phenotype (females only)

1. Cycling/pregnancy status
2. Lactation/nursing status
3. Lactation capacity used last period
4. Periods since lambing/dystocia
5. Number of parturitions
6. Milk production
7. Fraction milk extracted (dairy use)

D. Pointers

1. Next animal in flock
2. Previous animal in flock
3. Next of same class (w/i flock)
4. Previous of same class (w/i flock)
5. Next of same management group (w/i flock)
6. Previous of same management group (w/i flock)
7. Last fetal offspring or next older fetal sibling
8. Last nursing offspring or next older nursing sibling

E. Sort Keys

1. Age group
2. Gestation period
3. Lactation period

* w/i, within flock

SYSTEMS ANALYSIS OF OPTIONAL PRACTICES FOR DUAL-PURPOSE GOAT PRODUCTION IN WESTERN AND NYANZA PROVINCES

By
T.C. Cartwright[1], R. Hart[2], H. Blackburn[1], F. Ruvuna[1], S. Tallam[3] and P. Howard[1]

The adoption of dual-purpose goats on small farms has the potential of improving the nutrition and income profile of small farm families in Kenya. Sands et al. (1982), identified five constraints to dual-purpose goat production on Kenyan small farms. Two of the constraints to dual-purpose goat production can be directly examined with simulation procedures. the first of these was the lack of an appropriate genotype for dual purpose (meat and milk) goat production. A second constraint was the availability of forages of sufficient quality to sustain dual purpose goat production.

Working within the current framework of information these two constraints have been examined via systems analysis. The first component, animal genotype, was examined utilizing preliminary data from the SR-CRSP Breeding Project. For the next component, feed resources, the SR-CRSP Forage Resource Project supplied preliminary data. The simulations utilizing both sources of input data are termed prospective in the sense that the primary purpose of the simulations was to provide "feed back" information (prospects) to the breeding and forage projects. This feed back information aided each project in the refinement of project goals and organization of future work plans. The next phase of systems analysis will be directed toward the synthesis of technology packages that offer optional husbandry practices to small farmers that are acceptable and tend to maximize their returns (O/I, Output/Input).

Assumptions

Assumptions made for the systems analyses of the genotype and forage questions are as follows:

1. Year around production of milk for family use, based on a lactation length of 150 days, requires a farm flock size of six does (Cartwright, et al 1983).
2. The minimum amount of feed per doe per day, was required to be no less than 2/3 kg.
3. Endo and ectoparasite and disease controls are adequate; i.e., health is not a severely limiting factor of production.
4. Replacement policy for does is on an as required basis; female kids are only kept when mature doe flock size falls below six due to death or culling. Mature does are sold at 9 years of age.

These assumptions were made on the basis of the following scenario. A small farmer was provided a set of six bred does of a particular genotype that had been raised under good husbandry practices; i.e., the does were allowed to

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develop to their potential in size and milk production. These bred does were used to produce kids and milk to supply the small farmer with milk for home use and kids for consumptio or sale at weaning. The small farmer also receives and will continue to receive the necessary backstopping to insure an adequate health program. Replacement does must be obtained from kids of does maintained by the farmer. The replacement does' productivity is a result of their genotype interacting with the nutrition they receive; i.e., to the extent that nutrition is limited, then development of size and milk production are also limited. The replacement does are the animals of most interest, because these are the individuals around which a self-sustaining farm flock must be built. The simulations were accomplished as described above and the productivity of replacement does are reported here.

General Objective

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 the application of the Single Animal Version (SAV) model 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 with the SAV model 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.

Once it was demonstrated by using the SAV that production was possible under the above assumed conditions the next step was to use the Flock Model (FM). The SAV simulations are more suitable for analyzing the nutritional constraints and quantifying deficiences; therefore it was used in the preliminary studies. The FM simulates herd dynamics as well as individual biology. The FM utilized the target genotype identified in the SAV simulations and the forage parameters for Siaya and Kakamega districts in the setting of a self-sustaining small farm flock initially composed of six mature does and their kids.

The forage data were supplied by the Feed Resource Project as the best estimates currently available (see earlier systems analysis in the 1983 Kenya Scientific Reports). These forage parameters were utilized for simulation. The monthly forage production values were used, as were two interventions in forage production. These three sets of forage parameters are designated as: (1) standing forage from traditional production practices, (2) excess, traditionally produced forage stored in a stack and fed in subsequent months, in this case corn stover and (3) the stacked forage plus the use of specially grown Sudan grass, cut for hay at a very early stage of maturity and fed as a

limited, high quality supplement.

Sets of simulations conducted for systems analyses are listed as three "designed experiments"; a summary of information on objectives, model type, feed resource, and management follows:

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

Ia. Format: Single animal Version (SAV), Maseno area forage estimates, single purpose (meat only) management, genotypes (mature size/milk potential): 50/6.0, 45/4.5, 35/3.0, and 30/2.,0 (see protocol below).

Objectives:
1. To examine doe viability of different genotypes for size (growth) and milk production.
2. To successively select genotypes, based on viability of the previous simulation results in order to approximate an optimal genotype.

Ib. Format: SAV, Maseno area forage estimates, dual purpose management, genotypes: 50/6.0, 45/4.5, 35/3.0, and 30/2.0.

Objectives:
1. To examine viable genotypes screened from Ia. for net productivity in dual purpose production.
2. To successively select genotypes based on net productivity in dual purpose production in order to generate a set of data on which to base selection of a target, or optimal, genotype with acceptable viability and maximal net productivity.

Ic. Format: SAV, Maseno area forage estimates, dual purpose management, genotype - 40/4.0.

Objective:
1. To examine viability and net productivity of the selected target genotype screened from Ib.

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

Ia. Format: SAV, forage parameters from the Siaya and Kakamega districts, dual purpose management, genotype - 40/4.0 (target genotype).

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.

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

Ia. Format: Flock model (FM), forage parameters for the Siaya and Kakamega districts, dual-purpose management, genotype - 40/4.0.

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.

Although not considered definitive at this time, the simulations associated with objective III 2 test the dual hypothesis:

1. Dual purpose goat production is a viable enterprise for the small farmers of this area.
2. The feed resources assumed are adequate for viable production.

Experimental Protocol For Simulations

Simulation procedures require input parameters characterizing the genetic potential of a individual animal and periodic forage values. The genotype or genetic potential mediates or limits weight, milking ability, maturing rate and growth rate. For ease of identification, a genotype or breedtype is represented by a doe's mature weight (kg) and daily milk potential (kg/d). For example, 40/4.0 represents a breedtype that has a potential for a doe to weight 40 kg and to produce 4.0 kg of milk at peak day if nutrition and other environmental effects are not limiting.

Forage quality and quantity estimates are input to correspond to 24 periods (15 days per period) during the year. Forage availability is on a per head basis, in this case it is assumed that .67 kg of dry matter per mature doe is the lower limit of availability per day acceptable for viable production. Flock size is set to be six mature does; if the minimum of .67 kg of dry matter can not be met for a 15 day period, then a flock of six does is considered to be nonviable.

Data from Hart et al. (1982) described maize stover yields, bean aftermath yields and rain patterns for the Maseno area. From the rainfall pattern, availability of natural vegetation was estimated on a per head basis. Then maize stover and bean aftermath were added into the calculations to obtain total forage available per head per day.

Forage values for the Siaya and Kakamega districts were supplied by the SR CRSP Forage Resources Project. Total dry matter available (kg), total crude protein available (kg) and digestible energy (Mcal) were collected by month for representative farms within each district. Conversion of the forage data led to calculations of kilograms per head for availability, percent crude protein and digestibility.

To take advantage of periods of excess forage within the cropping system it was assumed that the maize stover could be stored for a maximum of three months. Digestibility was decreased 2% the first month of storage and 1% thereafter. Crude protein was handled in a similar manner. Availability was

decreased 10% with each additional month of storage.

Supplementation with Sudan grass was in addition to the stored forage resource. After discussing alternatives for storing Sudan grass with the SR CRSP Forage Resource Project, it was decided that growing a very limited amount of dedicated Sudan grass, cutting it at a very early stage of maturity, dry curing and storing under a roof would provide the best quality supplement with the least additional disruption to the current farming system. Sudan grass hay was then considered to be fed at the rate of .25 kg per doe per day when the crude protein of the feed fell below 7%. (This option was assumed for simulation purposes without an experimental data base).

Once animal and forage input parameters were determined, the SAV model was run for 80 periods (period=15 days) or slightly more than 3 years. Information from the second, third and fourth kids was averaged together to build input parameters for a kid that had been raised on a doe receiving the given forage parameters. The information averaged was total body weight, structural size at ten periods of age, weight of lean tissue, empty body weight, weight of fat and change in empty body weight. The first kid was not included in this averaging process because of the variation of first kids.

Since kids were born during different periods of the year and doe age increased with each kid, the averaging process reduced variability. The averaged information was simulated for an additional 2 periods (1 mo), starting in the 8th period. Kid information was then picked up at the end of the 2 periods when the kid was 12 periods (6 mo) of age. This information then forms the basis for the individual that serves as a replacement animal for small farmers.

Simulations were for 120 periods (5 years) utilizing the replacement doe in the SAV. All kid weights were recorded, as were all milk production data. Dry matter consumption of the kid was also recorded. Doe age and period of birth were recorded for each kidding. Kid weights were then averaged over all kiddings, as was milk production per lactation.

Doe body weight, empty body weight, weight of body fat and dry matter consumption were collected for the last 24 periods (year) of simulation. A doe's body condition score could then be calculated as empty body weight divided by structural size (EBW/WM).

RESULTS

Experiment I. Variability of Goat Production In The Maseno Area

Figure 1 illustrates the feed resource estimated for the Maseno area. Availability ranges from 3.0 kg per doe per day, as an upper limit to a lower limit of .75 kg in February. Percent crude protein ranges from 7.4% to 13.5% and digestibility ranges from 45.0% to 60.0%. Bean aftermath is available in May and November, while maize stover is available in December-January and August-September.

Table 1 indicates that the prospective genotypes of phase Ia are all viable under the practice of single purpose management (meat only). Escalating the management practices to include dairy milk production negates

the viability of the 30/2.0 genotype in phase Ib. Kids of this genotype do not receive sufficient milk to survive and grow, if half is taken for dairy production, therefore dual purpose management is not considered possible with this genotype and it was eliminated.

Doe body weights for the last 24 periods of a five year simulation of dual purpose management, phase Ib, are presented in figure 2. Fluctuations in weight are a function of feed quality and quantity, and reproductive status. For example, the 45/4.5 genotype doe was nursing a three month old kid in June, weaned the kid in July, gave birth again in September, weaned a second kid in February and conceived again in March.

Minimum doe body condition score (EBW/WM) is a measure of critical interest since it is closely related to health and survival under stressful conditions. Generally minimum body condition coincides with the period of the year of most limited forage availability and/or lactation stress. February through March are the times when availability of forage becomes the limiting factor in increased productivity (figure 2). Of the two larger genotypes, the ones sufficiently productive to be considered for dual-purpose, the 45/4.5 genotype generally stayed in better body conditon. However minimum body condition of the 45/4.5 doe reached marginal levels of 67% (EBW/WM) at times.

Average milk yield per period of lactation is shown in figure 3. A distinct difference can be seen between the milk yields of the 35/3.0 vs 45/4.5 and 50/6.0 does. Clearly, the feed resource is adequate to support milk potentials at the higher levels. The close correspondence of the curves for the 50/6.0 and 45/4.5 does lead to the conclusion that the 50/6.0 doe does not produce at a higher level than the 45/4.5 doe; this obwervation is born out by the kid growth curves.

Figure 3 shows average kid growth per period by genotype. The similarity of the 50/6.0 and 45/4.5 curves is to be expected given the very small difference in the milk production curves.

These results, summarized in table 1, lead to the decision that the 45/4.5 doe was as productive as the 50/6.0 utilizing the "Maseno" forage resource estimates and that the 45/4.5 doe was more likely to cope and survive due to higher body condition. Since the level of health care simulated was higher than can be expected on a long term basis, it was decided that an additional "cushion" in body condition should be allowed and a 40/4.0 genotype was tentatively selected as optimal.

The 40/4.0 genotype is intermediate in net productivity to the 45/4.5 and 35/3.0 genotypes. Does of the 40/4.0 genotype produced 6.1 kids in five years with an average weaning weight of 13.8 kg. Average milk production per lactation was 115 kg, of this half is available for human consumption. Minimum doe body condition score for the 40/4.0 doe was 77% compared with the score of 68% for the 45/4.5 genotype.

Conclusions Experiment I

Under single purpose management all genotypes are viable. The 30/2.0 genotype, kids most often with the least amount of total weaning weight and milk. The 50/6.0 genotype produces the greatest number of kids, the highest

weaning weights, and most milk offtake but exhibits the lowest doe body condition of 59% (death is likely to occur at 60% due to debilitation). The 35/3.0 and 45/4.5 genotypes exhibit similar levels of weaning weight and milk offtake. The 45/4.5 does show a higher minimum body condition.

Escalation to dual purpose management negates the 30/2.0 genotype because kids do not receive sufficient milk to survive. The added stress reduces the performance of the 50/6.0 genotype to the point where productivity almost matches that of the 45/4.5 genotype.

Indications of "best" performance under dual purpose management are given by the 45/4.5 genotype. But since minimum doe body condition scores are critical to survival, a higher minimum doe body condition score is needed to insure survival. An intermediate genotype of 40/4.0 represents a trade-off between productivity and body condition (survival). Net productivity of the 40/4.0 genotype is intermediate to the 45/4.5 and 35/3.0 genotypes, while minimum doe body condition is the highest.

The intermediate production levels and the improved minimum body condition scores tend to corroborate that the genotype of 40/4.0 is more nearly optimal than other genotypes tested.

Experiment II. Viability of Dual-Purpose Goat Production on Small Farms

The choice of a target genotype in the previous experiment and the use of forage estimates for two districts in Kenya form the basis of the following simulations using the SAV.

The SR-CRSP Forage Resource Project supplied information on forage dry matter and quality for two types of farms, one in the Siaya district and the other in the Kakamega district. The Siaya farm was 1.5 Ha in size, while the Kakamega farm size was 1.0 Ha.

Forage availability per doe per day was the determining factor in the number of does to simulate per farm. Dry matter information for the Kakamega farm indicated that only three does could be supported without some sort of feed intervention. Three does are not consistent with the goal of year round milk production for family use. Previous simulation results utilizing 150 day lactations showed that six does are needed for year round milk production. The Siaya farm forage dry matter production per month could support six does without a feed intervention.

The feed intervention simulated was that maize stover, the crop residue with the most promise and yield, would be stored in a manner similar to stacking hay. This method of storage requires little additional input for small farmers and provides a source of feed during times of need.

Quality and quantity of the stored feed decreases with the increase in storage time. Storage of forage in Siaya occured in the months of August and September. Since the Kakamega district farm had less feed available during particular months it was necessary to store feed from September through November. The same feed intervention, stacking maize stover, was used in both districts but the length of application was longer in Kakamega district.

Siaya was, therfore, simulated under two conditions: one utilized only standing forage traditionally produced; the second was an intervention in the form of adding stored forage. Simulation using only the standing resource base in Kakamega resulted in a nonviable flock; i.e., six does require the use of the stored forage intervention, in this case stored maize stover.

Kakamega

Availability per doe per day of dry matter is presented in figure 4 for the Kakamega district. Availability of dry matter is limiting in February, May and June. Digestibility ranges from 45% to 55% (figure 4). Digestibility is higher in the months of feeding stored forage than would be possible without the use of stored feed. Crude protein ranges from 4% to almost 17%. With the feeding of stored forage, crude protein decreases over that available otherwise.

Doe body weight fluctuations are presented in figure 5. Fluctuations in body weight are a function of feed quality and quantity as well as reproductive status. Doe body weight increases with the growth in conceptus, decreases with kidding and lactation, and finally starts to pick up again at weaning. Dry matter consumption is limited by availability in February, May and June.

Figure 6 is representative of doe productivity. Average peak daily milk yield is just under 1.5 kg, while total average milk production is 117 kg per lactation (.87 kg/d average). Kid growth, averaged over 6 kiddings, shows an average weaning wight of 13.9 kg and a relatively flat body weight gain curve from the end of period 5 to end of period 9 (2.5 to 5 months of age).

Siaya

The Siaya simulations illustrate the importance of the use of stored feed as a possible means of increasing small farm productivity. Dry matter availability is not limiting in July under traditional production practices (figure 7). Storing a portion of the excess feed for two months and using the stored feed during this same time period, allows for added productivity. Forage quality is affected with the use of stored feed in August and September. Digestibility is increased, while crude protein is decreased.

Doe body weights are shown in figure 8. Again, doe body weight is a function of forage availability, quality and reproductive status. Doe dry matter consumption is also a function of forage availability, quality and reproductive status. During February , March and October both simulations for Siaya show that availability is limiting.

Doe productivity (milk and kid production), as seen in figure 9 was affected by the feed intervention. Does on standing forage, produced 142 kg of milk vs 115 kg for does on stored forage (table 3), but the does on stored forage produced 6 kids, one more than the does on just standing forage. This additional kid caused total milk production from all lactations to be almost equal for the forage resource used. The kid growth curves illustrate that the lower milk yield affected kid growth, but the difference between the two curves at period 9 was less than 2 kg per kid.

Conclusions Experiment II

Simulation results for the Siaya and Kakamega districts are summarized in table 3. The Kakamega district forage estimates can not support six does per farm without an intervention in the means of storing feed. The Siaya district can support six does without a feed intervention, but productivity is increased through the use of a feed intervention. The use of a feed intervention in Siaya increased the number of kids, the total weaning weight and minimum doe body condition. Milk production per lactation is lower but this is offset by the increased frequency of lactation.

Experiment III. Productin of Dual Purpose Goat Flocks on Small Farms

Previous simulations utilized the SAV model. SAV has a limited capability to take into account the stochastic nature of real life situations. Probability is applied to specific functions in the Flock Model (FM) to more closely approximate actual conditons in any given situation.

A total of five simulations, using the FM, were made for the Siaya and Kakamega districts. Siaya was simulated using only standing forage, stored forage or stored forage plus a limited amount of additional supplement in the form of dry Sudan Hay. The Kakamega forage resource did not allow for simulation of only standing forage; therefore only two simulations, stored forage and supplemented forage, were done for Kakamega. The supplement consisted of dried Sudan grass cut at a very young stage of maturity. The supplement was fed at the rate of .25 kg per doe per day, during any 15-day period when crude protein content of the ration fell below 7%. In Siaya the supplement was fed during the months of July through August and again in January. Feed quality was somewhat lower in Kakamega and therfore the Sudan supplement was fed for a longer period of time: June through November and again in January.

Siaya

The Siaya simulations show that viable production was possible with the use of only standing forage but that productivity increased measurably with the addition of stored feed (table 4). Figure 10 illustrated average doe body weights for the three situations. The cyclic loss and gain the doe body weight was decreased with the addition of stored feed indicating less stress. Average doe body weights were similar for the stored feed plus supplement and the stored feed treatments.

Milk production for home consumption is of prime importance in measuring flock productivity of dual purpose goats. Figure 11 is a summary of milk production for year 5 of the entire flock on standing forage. Total milk production was at a high in April, following a cyclical low in December. This cyclic milk production pattern can be predicted by the bunching of births in the wet and dry months. The milk available for human consumption varied with time of year, number of births, number of stillbirths and stage of lactation of the does. Dairy milk production followed the total milk production pattern.

Year 10 for the same feed situation shows a different picture (figure 11), because replacements were not sufficient to sustain milking doe numbers

without a lag. The reason for the lag was because it was assumed that doe kids were sold at weaning until a replacement was needed. Keeping doe kids until one year of age before selling would solve the lag problem but would stress the forage supply. Total milk production was lower showing only a slight cyclic effect. Births were reduced in year 10 by the smaller number of mature does and the increase in stillbirths as a percent of total births. Dairy milk production, by the end of December was equal to the total milk production because of kid deaths and/or stillbirths.

Feed storage alters the milk production picture for Siaya. In year 5 there were two definite troughs in milk production, one in late August, the other in April (figure 12). Births during the year were partly responsible for these troughs with production from year 4 of greater importance when 11 kids were born.

Year 10 showed the same cyclic pattern to milk production (figure 12). Dairy milk production approached that of total milk production because of the number of stillbirths, almost 50% of all births were stillbirths.

Increasing feed quality and quantity with the addition of a limited amount of high quality supplements did not eliminate the cyclic pattern of milk production, but the low troughs were much less severe (figure 13). The amount of total milk produced increased, even as the amount of dairy milk production stayed the same. This apparent discrepancy was due to the fact that all the kids born lived and therefore kids consumed more milk. In year 10, the number of mature does had decreased and the number of births fallen off; each had the effect of lowering milk production. Total milk production and dairy milk production were one and the same from late May to December because of the absence of live kids; of the two kids born, only one was alive in December.

Kakamega

The two simulations utilizing forage parameters for the Kakamega district are shown in table 3. Average doe body weight was slightly higher with the use of supplementation than with stored forage alone (figure 14). During late May and June, as well as in February, dry matter consumption was limited by availability, but otherwise the supplementation tended to increase intake.

Live births were responsible for the peak milk production in November-December of year 5 using stored forage (figure 15). Fifty percent of live births occurred in September-October, with the remaining births taking place in the spring. Zero milk production took place in early September. Year 10 milk production is a reflection of mature doe numbers and the birth rate. There were no does in lactation from late September to early February.

The use of supplementation reduced the bunching of kidding and smoothed out milk production throughout the year. Year 5 milk production is smoother, with births distributed across the production year (figure 16). Year 10 milk production is lower than year 5, with births spread throughout the year. Age structure of the doe flock was responsible for the lower milk production in year 10 but the difference was much less pronounced than without the supplementation.

Conclusions Experiment III

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, appears optimal for producing under the restricted nutritional conditions of small holders. Simulated body weights approached 40 kg during some times of the year but peak daily milk production is approximately 1.5 kg.

The replacement policy mitigates doe productivity in the later years of simulation. Replacing does as needed with weaning age kids does not insure continuity of flock structure. Maintaining flock structure is a integral part of maintaining production levels; therefore other replacement provisions must be made to insure productivity. One such provision might be to hold weaned doe kids until they are one year of age before sale or introduction to the breeding flock.

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 quantity, while an increase in quality (supplementation) resulted in a increase of 22%. The use of a feed supplement also had the effect of smoothing milk production levels throughout the year. Little effect of supplementation was evident in the weight of kids sold.

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

These results must now be examined by the Economics and Sociology Projects in order to base recommendations for use by small farmers or for further research.

Some questions that these results suggest, among many others are:

1. Is the storage of feed feasible? Is it an economic practice?
2. Is a small plot of dedicated land for forage production, such as Sudan grass, a feasible approach to augmenting feed quality?
3. What amount of dairy milk is required to make dual purpose goat production attractive to small holder farmers? That is - what is the minimum number of does per farm? The minimum amount of dairy milk? The importance of a steady milk supply?
4. What approach to a doe replacement policy is most reasonable?

TABLE 1. SIMULATED AVERAGE LIFETIME PRODUCTION OF 5-YEAR-OLD DOES OF 4 GENOTYPES RAISED ON MASENO AREA FORAGES.

	Mature Size/Milk Potential							
	50/6.0		45/4.5		35/3.0		30/2.0	
Item	S[a]	D[b]	S	D	S	D	S	D
No. Kids	7.5	6	7	6	7.5	6.5	8	0
Av. Wean Wt., kg	22.7	17.2	21.1	17.1	18.9	12.0	15.8	0
Av. Milk Per Lactation, kg	128	157	120	149	113	98	87	0
Doe Condition, Minimum %	59	67	74	68	67	63	71	0

a. S : Single Purpose Management, meat only
b. D : Dual Purpose Management

TABLE 2. AVERAGE LIFETIME PRODUCTION OF A 5-YEAR-ODL DOE WITH A MATURE SIZE POTENTIAL OF 40 KG AND A MATURE MILK POTENTIAL OF 4.0 KG PER DAY.

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

TABLE 3. SIMULATED TEN YEAR FARM FLOCK AVERAGES WITH A MATURE SIZE POTENTIAL OF 40 KG AND A MATURE MILK POTENTIAL OF 4.0 KG PER DAY.

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

a. S: Standing Forage
b. ST: Stored Forage
c. SS: Stored Forage Plus Supplementation

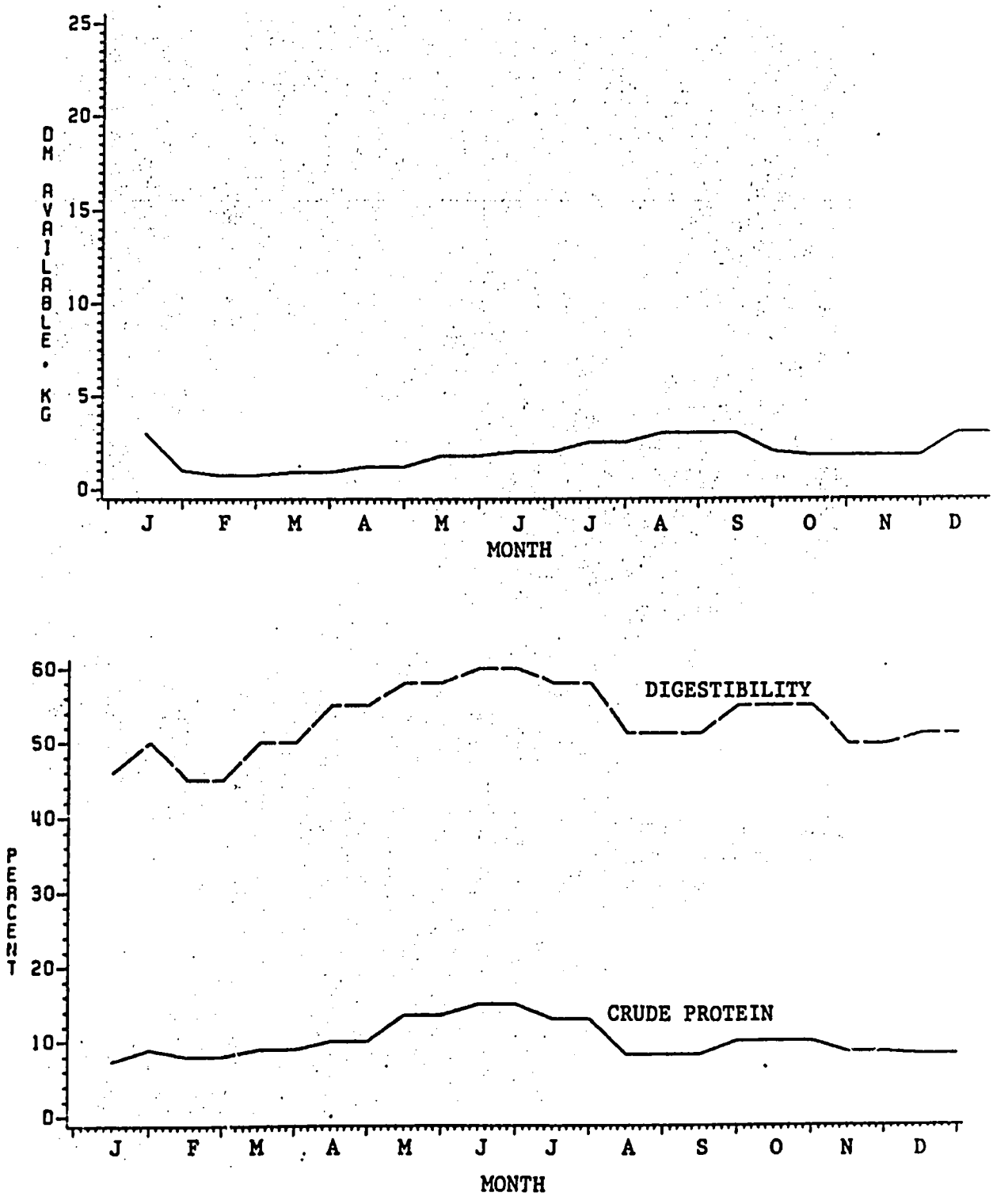


Figure 1. Dry matter available per doe based on rainfall patterns, corn stover yields and bean aftermath. Crude protien and digestibility of available forage. Based on Maseno forage estimates.

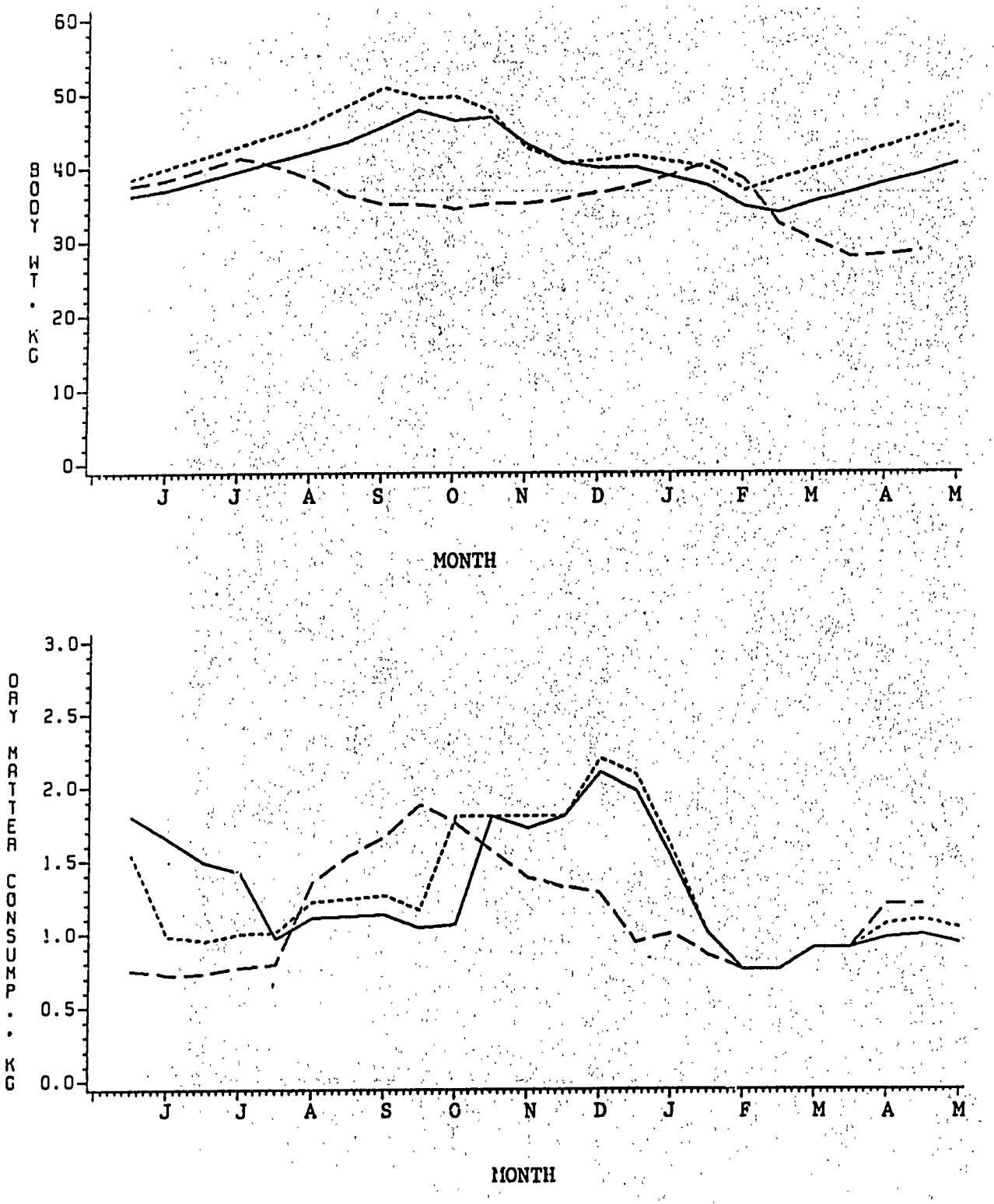


Figure 2. Doe body weights and dry matter consumption for three genotypes: 50/6.0 (···), 45/4.5 (——) and 35/3.0 (---); based on Maseno forage estimates.

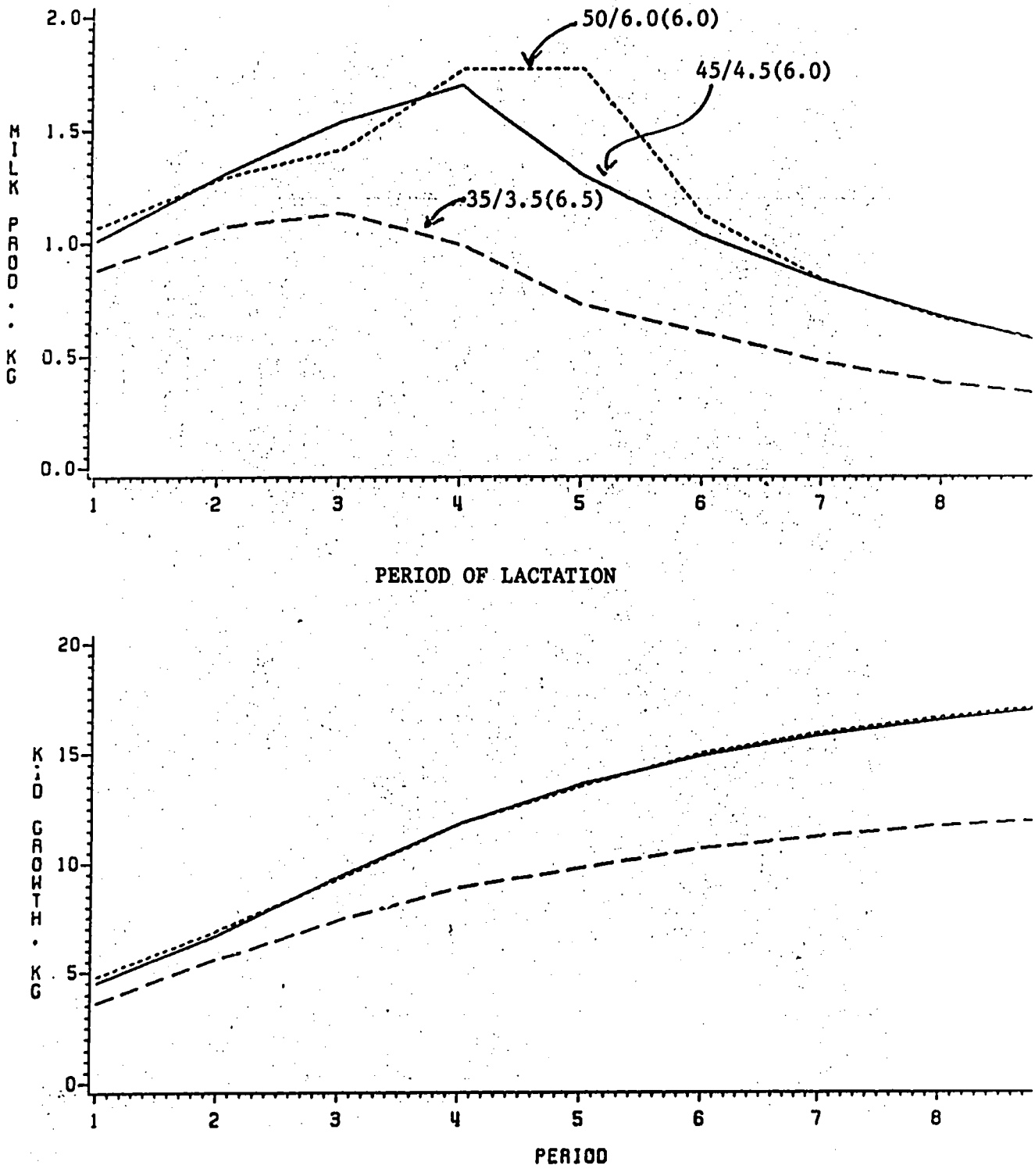


Figure 3. Milk production and kid growth averaged over all kiddings for three genotypes: 50/6.0 (···), 45/4.5 (——) and 35/3.0 (---); for Maseno forage estimates. Number of kiddings in parentheses.

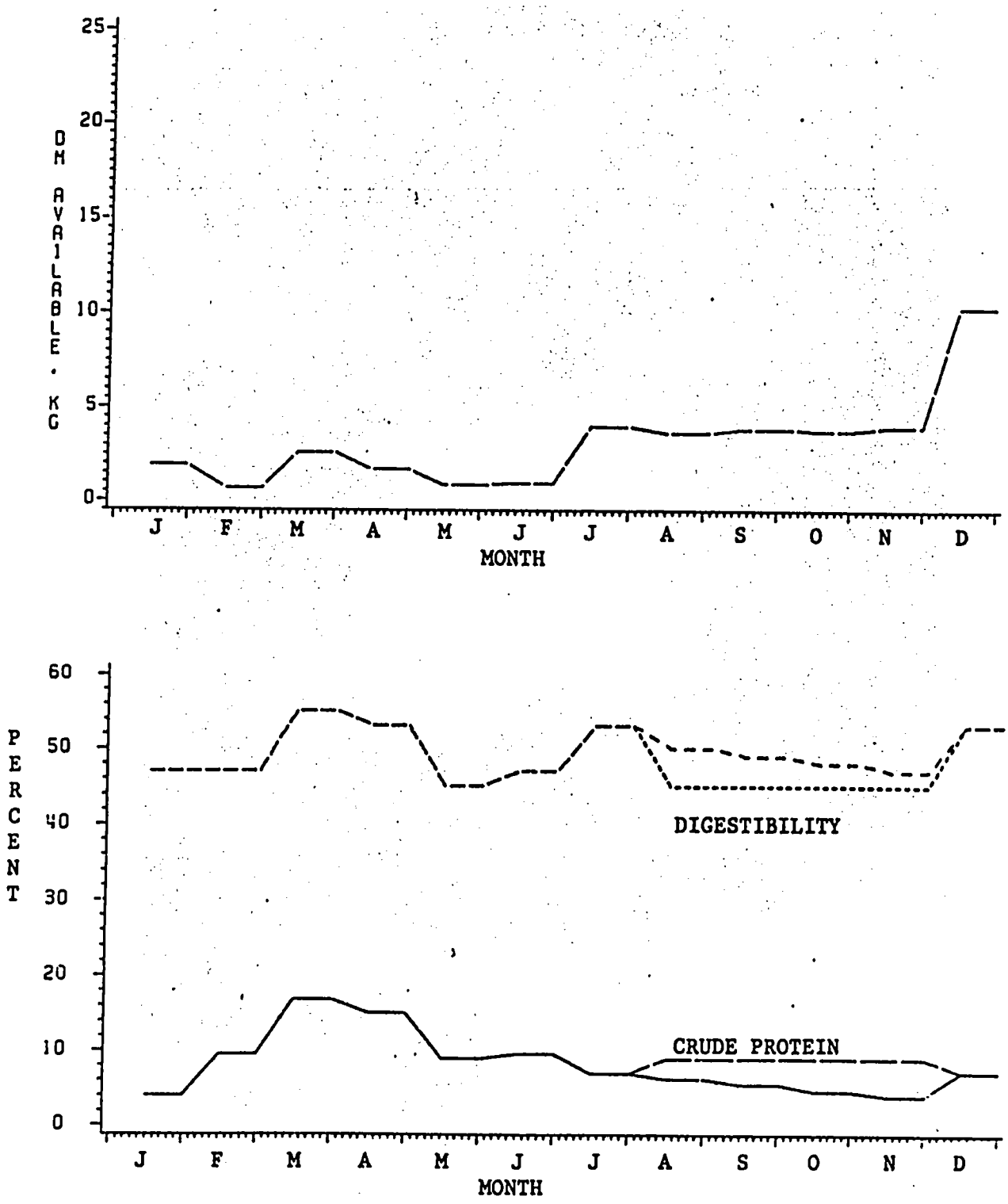


Figure 4. Dry matter availability per doe for a Kakamega farm utilizing stored forage. Crude protein and digestibility of the available forage.

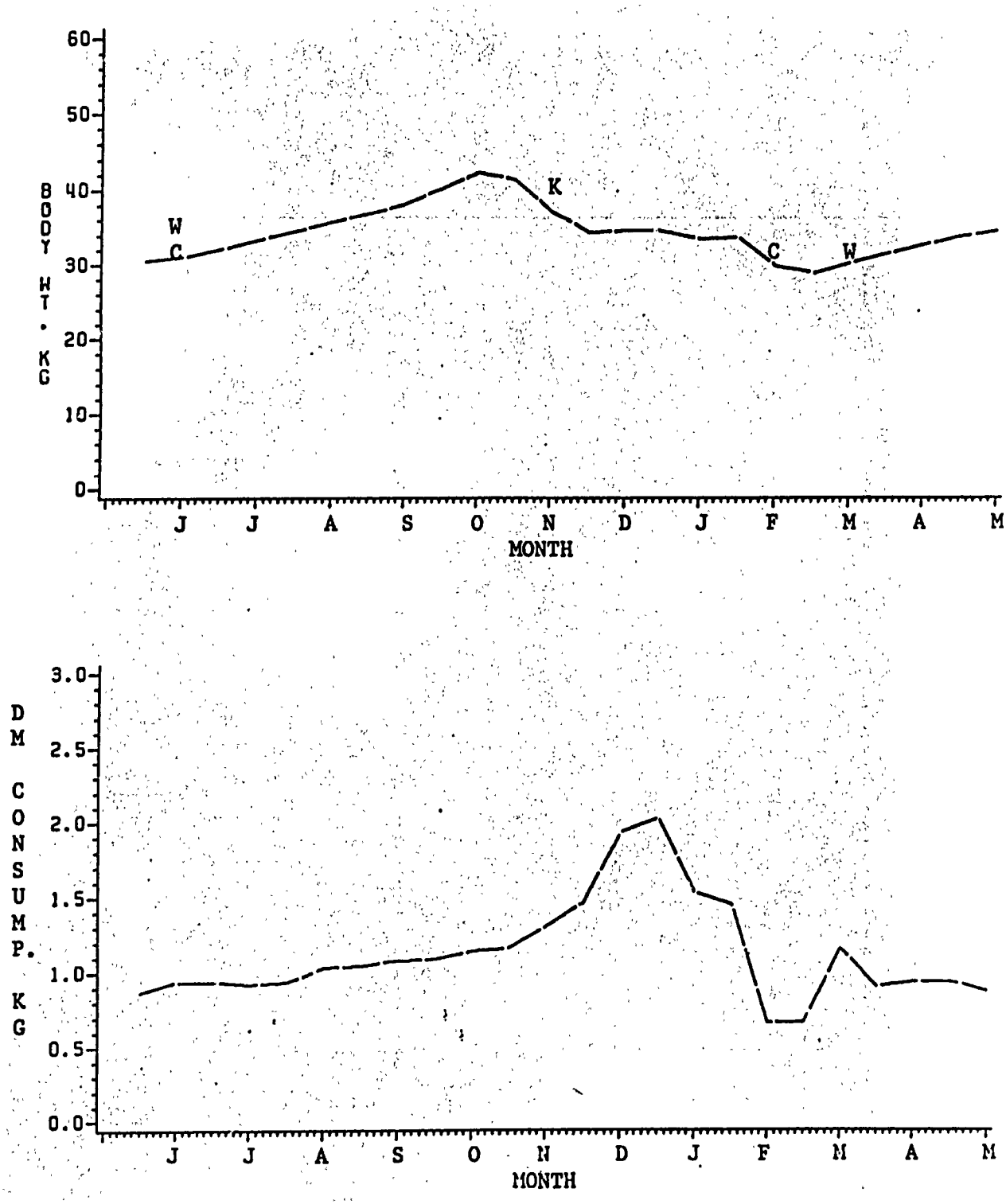


Figure 5. Doe body weight and dry matter consumption for a Kakamega farm utilizing stored forage. (C-conception, K-kidding, W-weaning)

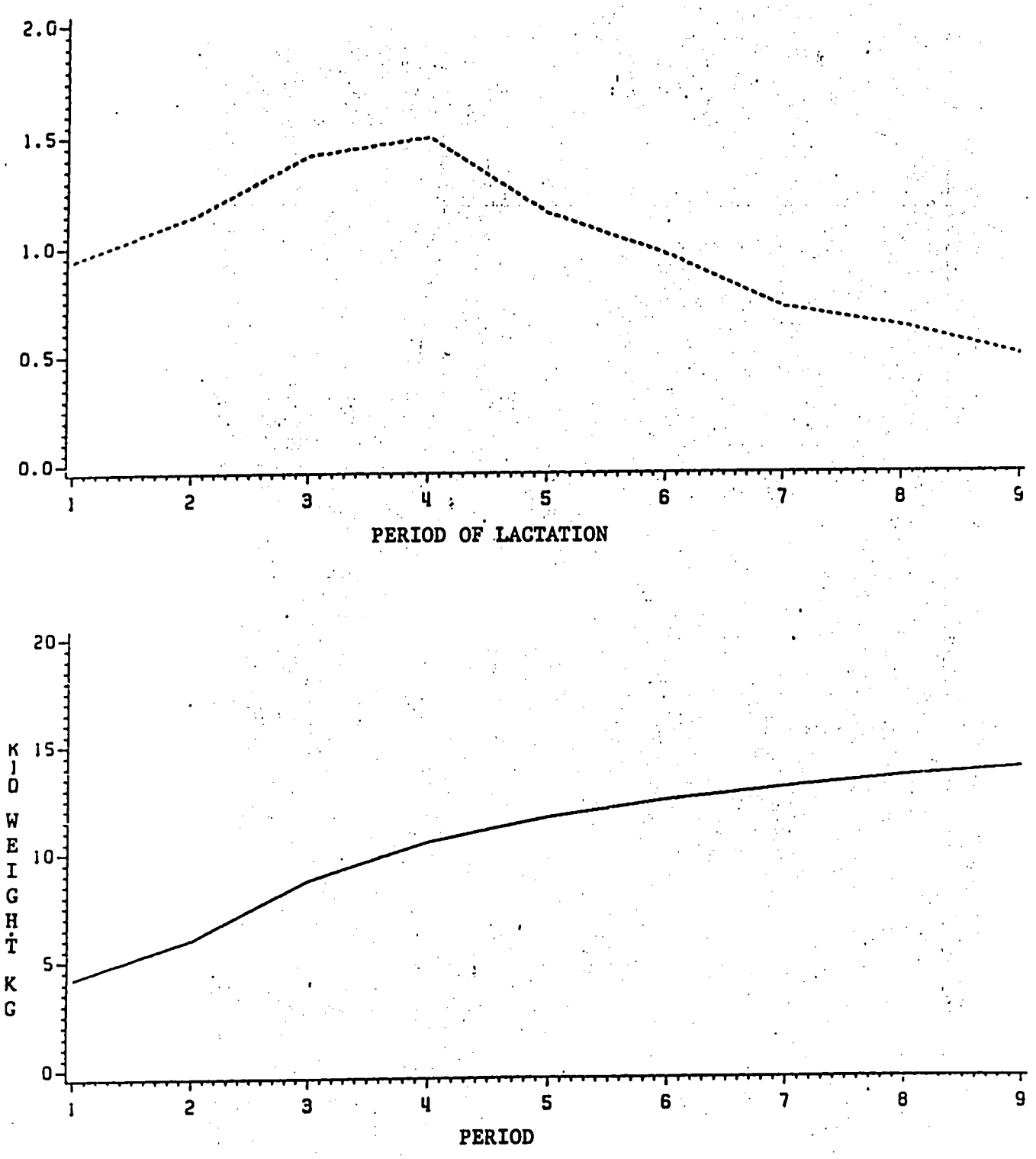


Figure 6. Milk production and kid growth averaged over six kiddings for a Kakamega farm utilizing stored forage.

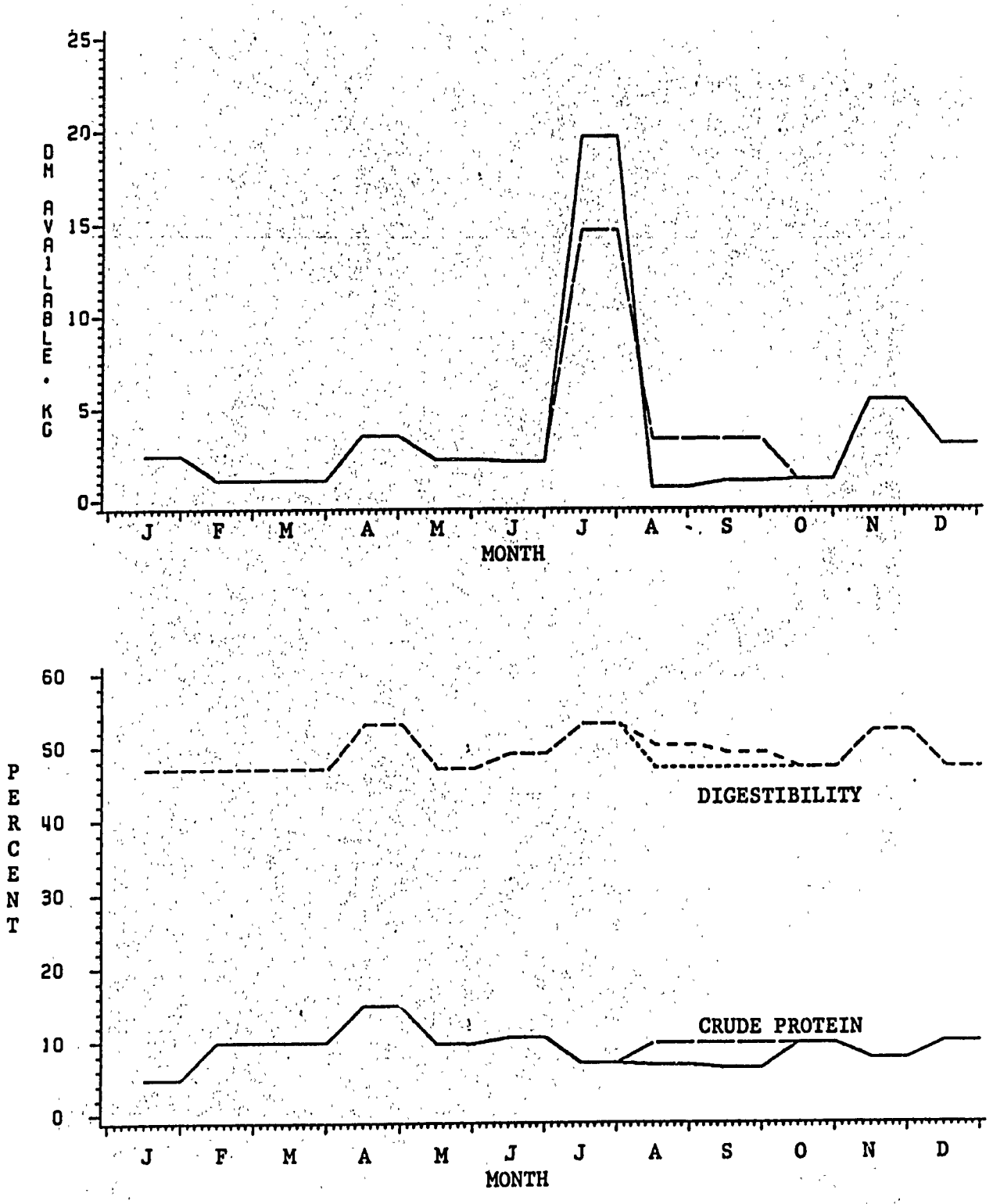


Figure 7. Dry matter availability per doe for a Siaya farm utilizing only standing forage or stored forage. Crude protien and digestibility of available forage.

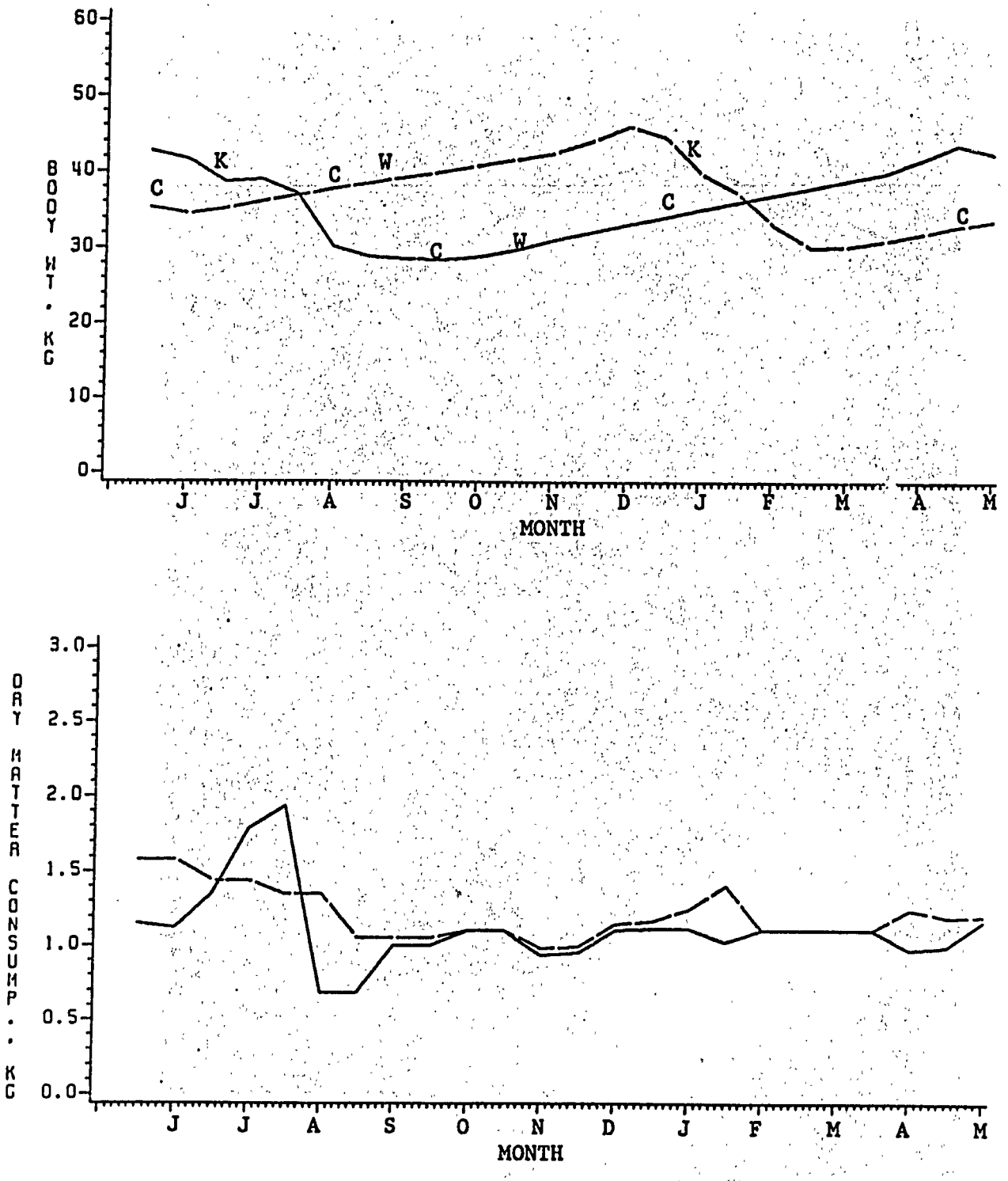


Figure 8. Doe body weight and dry matter consumption for a Siaya farm utilizing only standing forage (---) or stored forage(——). (C-conception, K-kidding, W-weaning).

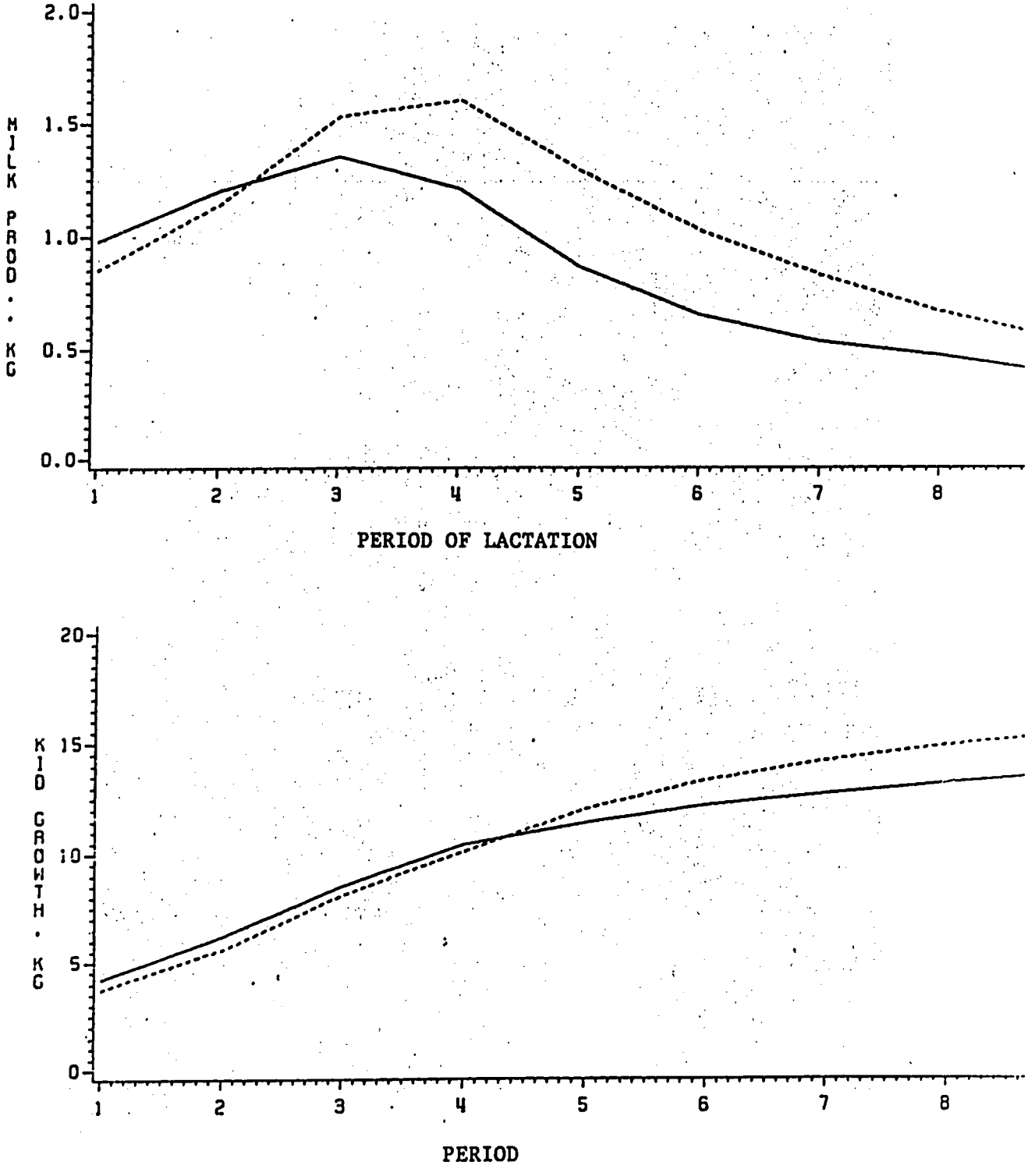


Figure 9. Milk production and kid growth averaged over the total number of kiddings for a Siaya farm utilizing only standing forage (---) or stored forage (——). Number of kids in parentheses.

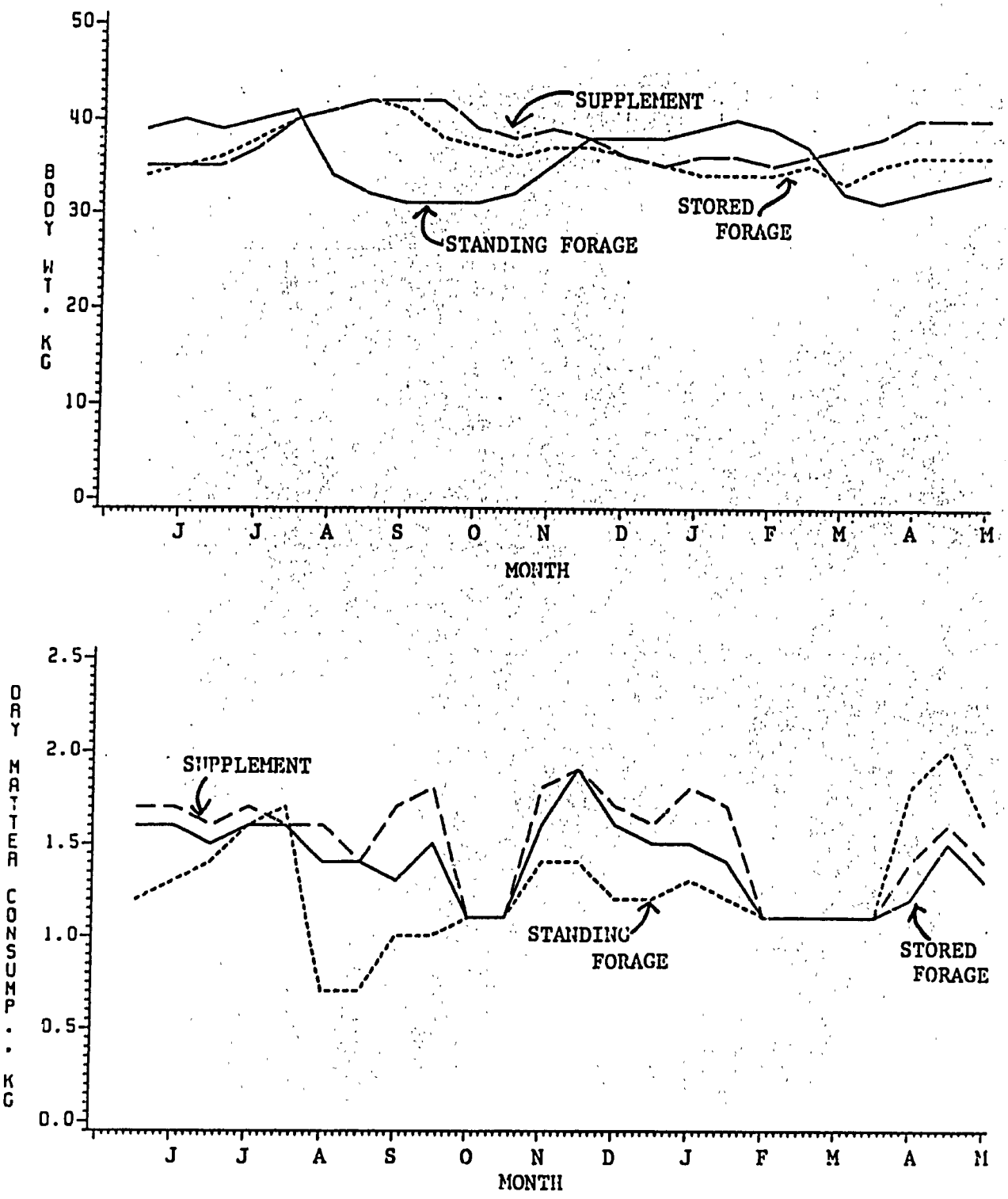
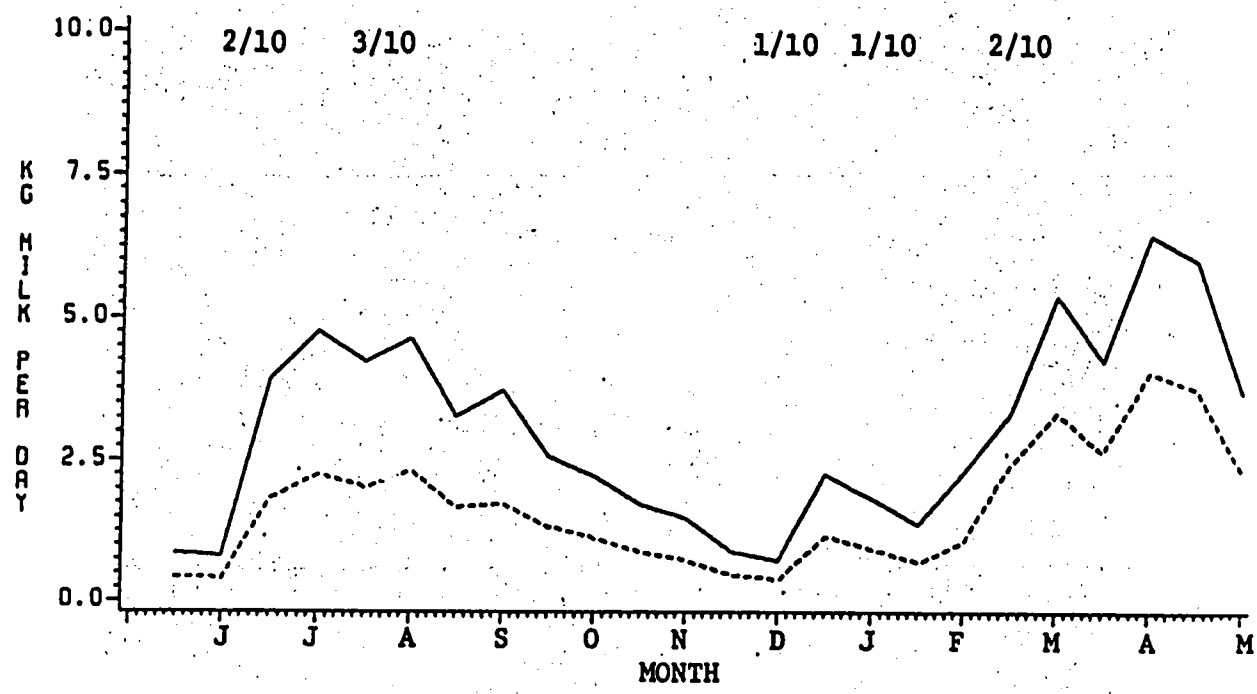


Figure 10. Doe body weights and dry matter consumption for a Siaya farm utilizing only standing forage, stored forage or stored forage plus supplementation.



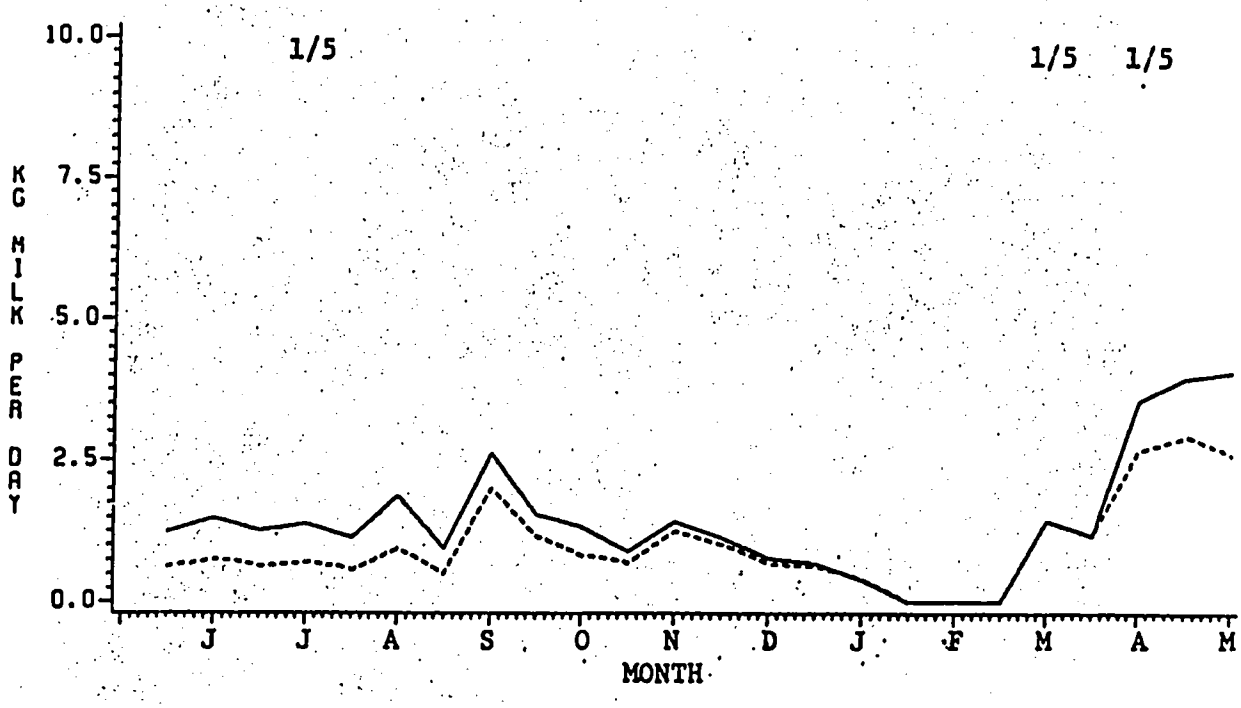


Figure 11. Total flock milk production for a Siaya farm utilizing only standing forage in year 5 (top) and in year 10 (bottom). Total milk production (——), dairy milk production (---), live/total births.

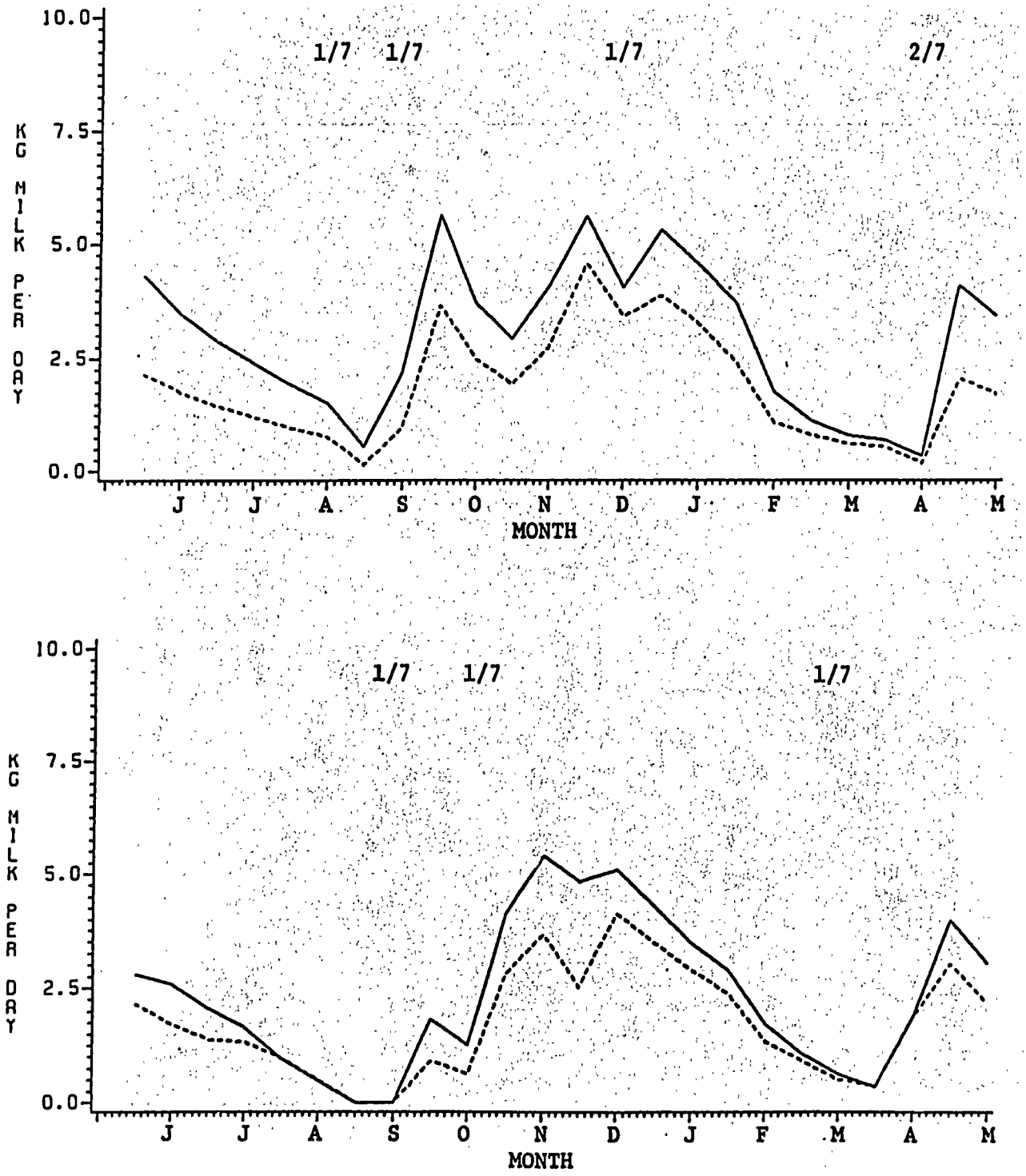


Figure 12. Total flock milk production for a Siaya farm utilizing stored forage in year 5 (top) and in year 10 (bottom). Total milk production (——), dairy milk production (---), live/total births.

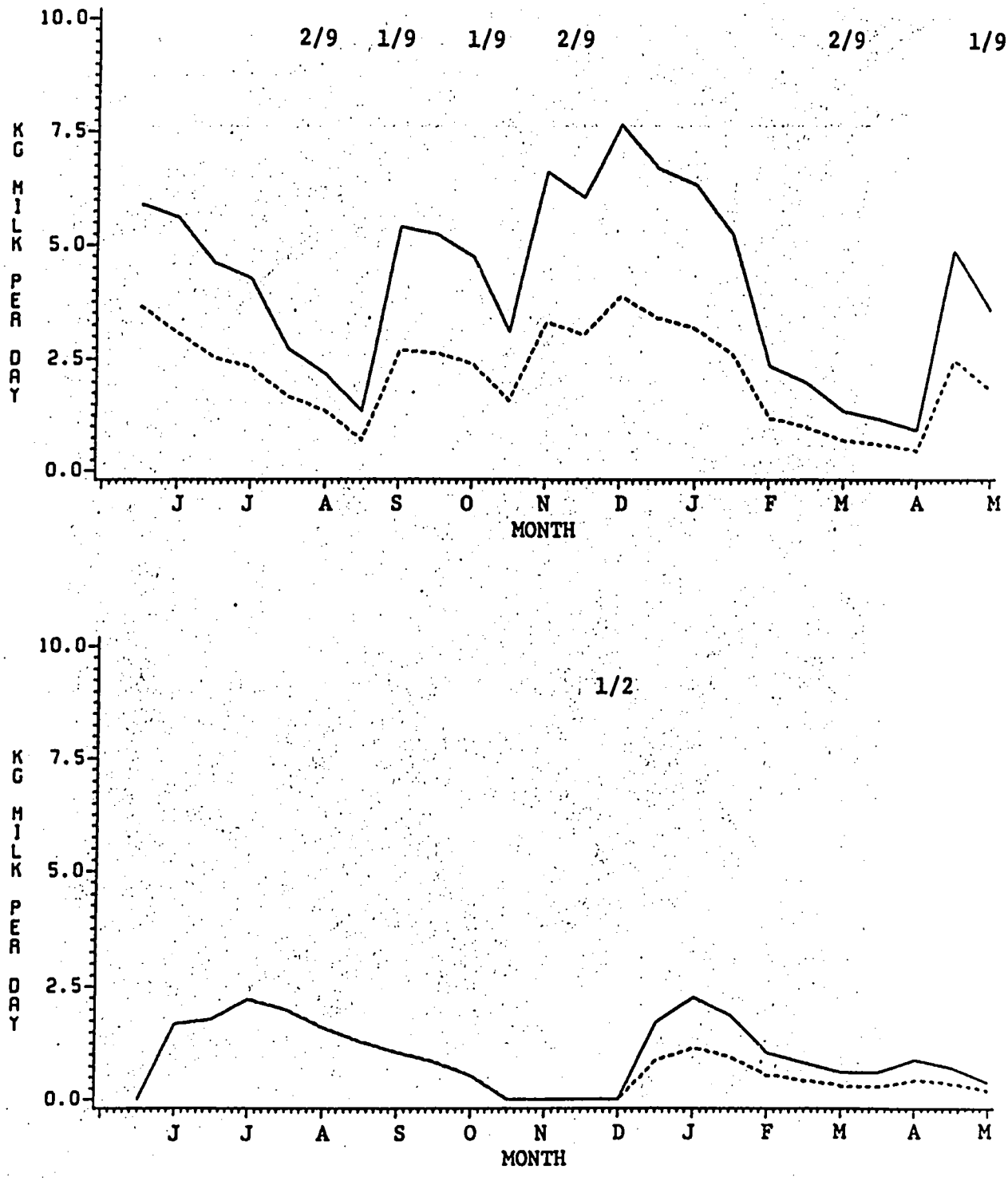


Figure 13. Total flock milk production for a Siaya farm utilizing stored forage plus supplementation in year 5 (top) and in year 10 (bottom). Total milk production (——), dairy milk production (---), live/total births.

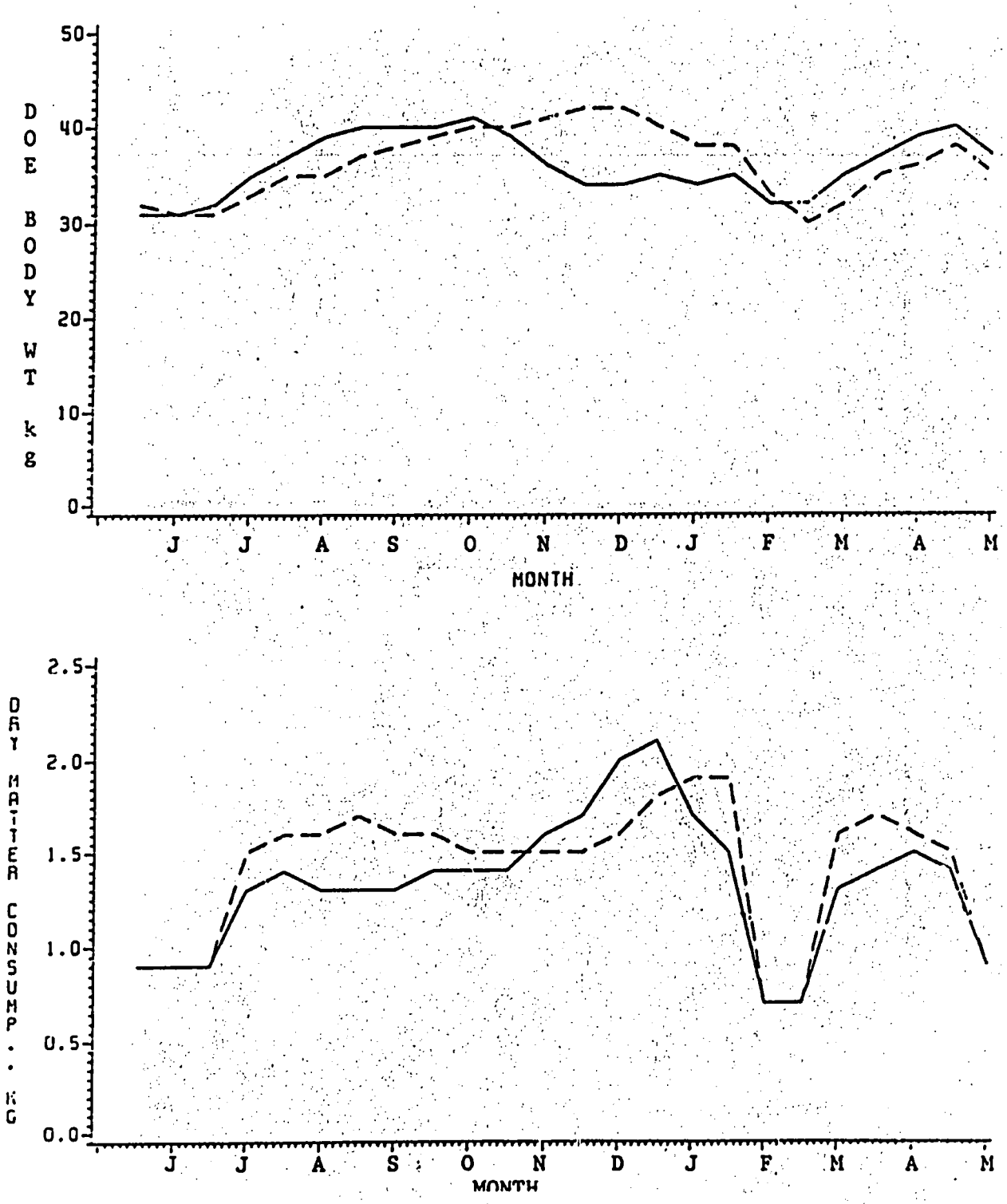


Figure 14. Doe body weights and dry matter consumption for a Kakamega farm utilizing stored forage and stored forage plus supplementation.

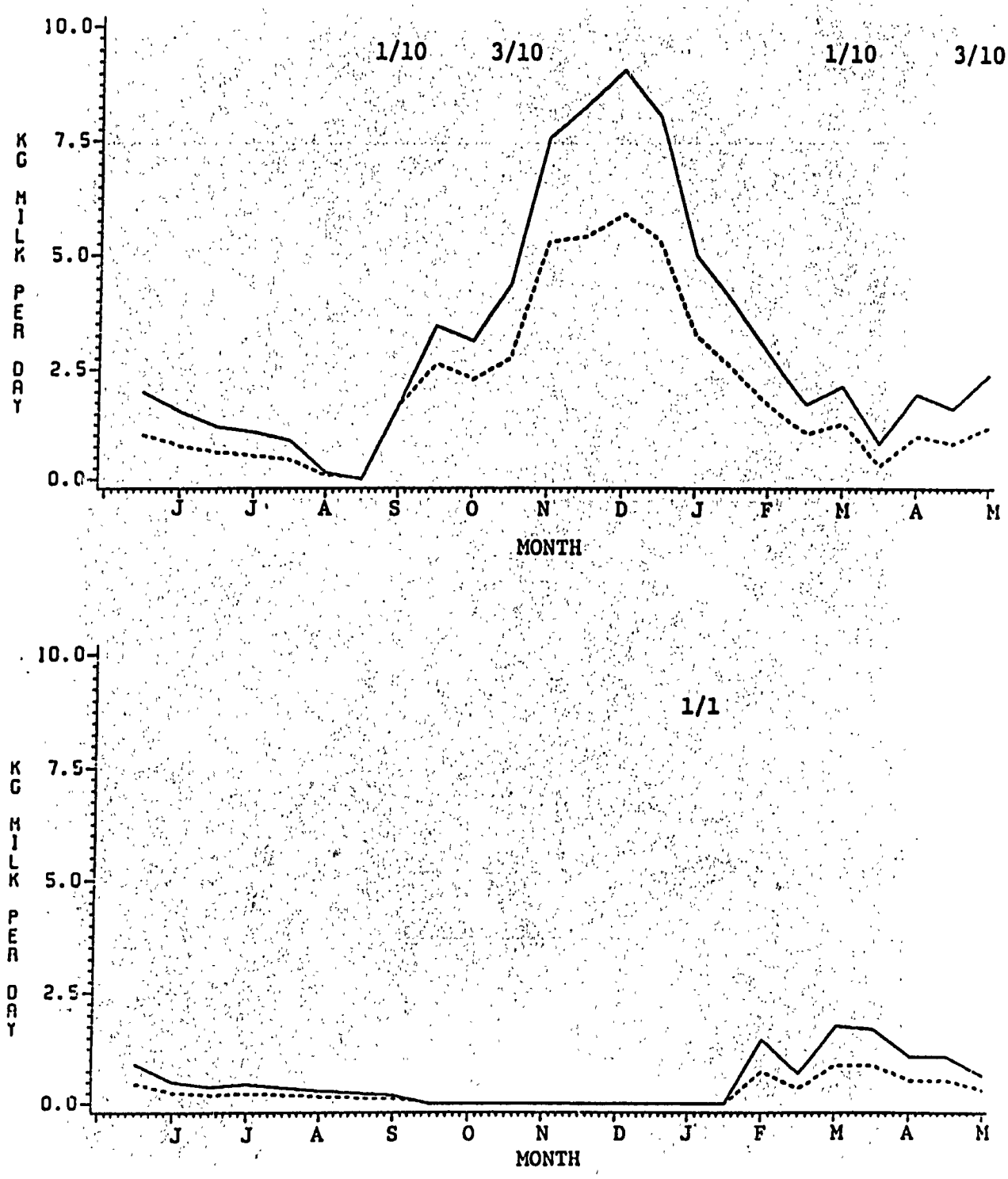


Figure 15. Total flock milk production for a Kakamega farm utilizing stored forage in year 5 (top) and in year 10 (bottom). Total milk production (——), dairy milk production (---), live/total births.

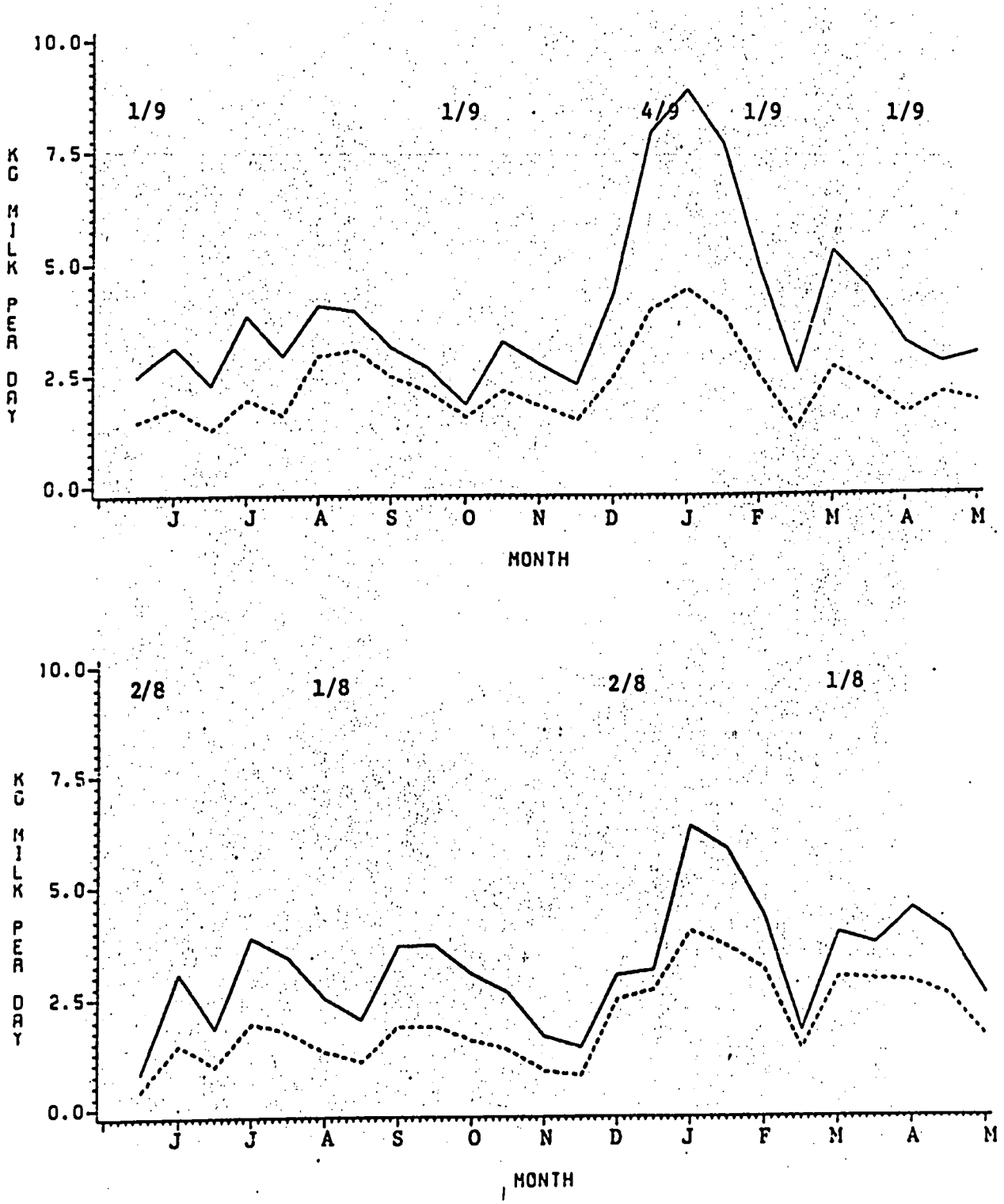


Figure 16. Total flock milk production for a Kakamega farm utilizing stored forage plus supplementation in year 5 (top) and in year 10 (bottom). Total milk production (——), dairy milk production (---), live/total births.

A SIMULATION OF GENETIC ENVIRONMENTAL INTERACTIONS OF SHEEP PRODUCTIVITY IN NORTHERN KENYA

By
H.D. Blackburn[1], T.C. Cartwright[1], C.R. Field[2] and A.B. Carles[3]

Sheep production in northern Kenya is an integral part of survival strategies of the nomadic peoples inhabiting this area. Increased sheep productivity would result in lessening the nutritional stress these people face. The environment and production system form a complex and fragile interaction, so alterations implemented to increase productivity could easily have unanticipated, counter productive effects; however, because of the dependence on these sheep, it is imperative that suggested changes in the production system have a positive impact on sheep production and the environment. Correctly predicting which changes can accomplish these goals is difficult in terms of traditional approaches to research. Scientists are faced with limited budgets, physical resources and time. One methodology which provides scientists, administrators and economists with the means of examining the inputs, outputs and interrelated biological factors is systems analysis. This methodology allows the simultaneous examination of management interventions; therefore relieving researchers of two constraints: physical resources and time from when the experiment is conceived to it's completion.

The Integrated Project in Arid Lands (IPAL) is developing management plans for northern Kenya which consider environmental, livestock and human factors. To aid in the development, data collected in Olturot were made available to the SR-CRSP Systems Analysis Project (Texas A&M University and Kenya MALD). The data included forage (diet) parameters collected in the area as well as sheep performance data. These data provided input parameters for the area and also served as a comparison for baseline validation.

Before performing any experimental simulations, the model and inputs were validated against a set of real data from the IPAL study area. Validation is a comparison of the sheep's actual performance with the simulated performance. How closely the simulated results follow the actual magnitude and fluxuations determines the confidence that can be placed in the simulation results.

The model was set to simulate Somali Blackhead sheep with a mature weight (WMA) of 35 kg, the genetic potential for milk production at the peak day of lactation (GMLKL) was set at 1.30 kg. Both of these values were obtained from published and unpublished sources. The forage parameters (crude protein, digestibility and availability) were obtained from IPAL personnel.

Validation

Three areas of sheep performance were used in the validation process. These were ewe body weight fluxuations, milk production level and lamb growth

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rate. Figure 1 shows actual and simulated ewe body weights for 1979. Empty body weight (EBW) and full body weight (W) were compared to the actual ewe weights. It is necessary to compare all three curves in Figure 1 because actual ewe weights were recorded in the morning, after the ewes were enclosed all night in the boma and therefore represent a shrunk weight.

Lamb mortality is expressed as lambs weaned/lambs born (Table 2). This measure provides a quantification of the severity of the drought. As expected, survival rates decreased during the drought and then increased during the recovery years. What was not expected was the uniform response of all genotypes. The exception to this was the genotype 30/1.75 which had lower survival rates during the recovery years. At this point in the analysis, it is becoming evident that the heavy milking small mature sized sheep are not as productive as other genotypes in these environments.

The offtake of meat and milk was expressed on a per ewe basis (Table 3). All lambs were sold when they reached 1 year of age; the term sold implies that the animals were either sold or consumed by the producer. Ewes were culled from the flock on the basis of age, not lambing for 2 1/2 years and a random 2% cull. For 1979, heavier mature weights produced more kg of lamb/ewe. An exception to this was the base genotype (35/1.30) which produced at the level of the 45 kg ewes. The high level of production of this genotype was due to its high reproductive performance. During the drought, lamb offtake decreased. However, the full extent of the drought was not observed until year one of recovery, which had lower levels of offtake than during the drought year. The delay is a direct response to the reduced reproductive rate and higher mortalities which occured in the drought year. The existence of this time lag may be an important consideration when planning relief to drought stricken areas. The offtake from the 30 kg mature size group was the lowest, and it also had the slowest recovery from the drought. The 30/1.75 was the lowest producing genotype and did not show a recovery from the drought.

The total weight sold/ewe (Table 3) follows the same pattern and ranking exhibited in the lamb sold/ewe. The magnitudes are larger because cull ewe weights are included.

Dairy production/ewe, for human consumption, is 1/4 the total milk production (Table 3). As with other measures of offtake, a decrease in milk production occured during the drought and the first year of recovery, indicating that there is a time lag effect influencing milk production. Ewes with a small mature size (30 kg) produced the least amount of milk. However, the difference between this and the other genotypes was not as great as it was for the offtake of meat. Within a mature size there appears to be an optimum level for milk production. For example, the genotypes 35/1.30 and 45/1.75 produced the most or nearly the most milk within their mature sizes. This implies that milk production level should be matched with mature size to optimize biological efficiency.

A partial measure of production efficiency is available for analysis at this time (Table 4). The efficiency of meat production is expressed as the ratio of kilograms of protein from animals sold to dry matter consumed by the entire flock. As a group, sheep with a mature size of 30 kg have lower efficiencies than the other two groups. However, in the first year of

recovery, the limitations tended to cause all genotypes to be very similar. There are several instances where the mature sizes of 35 and 45 kg are comparable. The efficiency of the 35 kg group did not drop as far as the 45 kg group during drought and recovery. The 35/1.75 genotype apparently had a higher milk potential than was compatible with its body size, and due to this lack of balance was least efficient in all environments.

Several conclusions from the validation procedure can be made: there is close agreement between the patterns of actual and simulated results; the magnitude of any specific difference is not great; and simulations follow major seasonal fluctuations. The IPAL data set further demonstrates that limited experimental numbers, with major production characteristics measured along with forage parameters, can be succcessfully utilized for validation and systems analysis. This is a critical point if data from smallholder production systems are to be used in validation.

Experimental Simulations

With the model validated for the Olturot sheep flock, experimental simulations were then performed with confidence. There are several production alternatives which are feasible to implement in the IPAL study area. These include the utilization of other breeds which have different growth and milk production potentials, supplemental feeding during dry or critical months (when lambing occurs), control of breeding season, or a systematic removal of excess males and cull females. Of these options we chose to first test how breeds with different growth and milk production traits would perform and affect overall flock productivity. If new breeds or improved strains are introduced to the area it is important to know how the new breeds or strains would respond to both good and poor (drought) conditions. Therefore the experiment was designed to be a study of genetic and environmental interactions. Genotypes or breeds were altered for 2 characteristics: body size and milk production. Three different sizes and 3 milk production levels were tested (Table 1). Because of the experiments factorial design simulations were performed on 9 genotypes; i.e., each weights was simulated in combination with each milk production level. In the analysis each gentoypic combination will be designated by the mature weight potential of a ewe and the peak day of milk production during lactation of a mature ewe. These values represent genetic potentials of ewes at maturity with nonrestrictive nutrition and are used only to designate genetic potentials; actual size and milk production of ewes are almost always below these values. Sheep with a mature size of 35 kg and a milk production potential of 1.30 kg/d are designated as 35/1.30. Three environments were simulated with each of the 9 genotypes, resulting in a total of 27 simulations being performed. The environments were simulated by altering the forage parameters used in the model. The environments simulated were:

1. 1979, a good year by regional standards, utilizing actual data collected by IPAL:
2. drought, a year of reduced forage quality and quantity on offer and
3. recovery, a year to determine how the breedtypes recover from the drought. The recovery year was a return to the 1979 forage parameters; a second recovery year is a continuation of 1979 forage parameters for two years.

Results

Reproductive performance of the flock is expressed as the number of lambs weaned/ewe bred (Table 2). In general there was a decrease in reproduction during the drought and an increase during the recovery years. For this character, the Somali Blackhead (35/1.30) expressed a clear advantage over other genotypes in 1979. However this genotype was more sensitive in reacting to drought than other genotypic combinations tested. This reaction was due to a greater number of ewes nursing lambs in 1979 which in turn caused the ewes to be in lower body condition. the 35/1.30 had one of the quickest rates of recovery from the drought (as seen in years 1 and 2 of recovery). The genotypes 45/1.30 and 45/1.75 also showed comparable recovery rates. The sheep with mature size of 30 kg hd the lowest reproductive performance. The 30/1.75 had a low reproductive rate in the environments tested.

For the greatest part of the year there is consistent agreement between the simulated and actual weights. Both simulated weights and actual weights started the year at a high level, decreased during the long dry season and then increased as the short rains began. The greatest divergence between actual and simulated weights occured in the last 3 months of 1979. At first inspection the decrease in actual weight does not appear to be logical, because the crude protein and digestibility were increasing. An explanation for this response is that 40% of the actual ewes gave birth and/or were lactating at this time; therefore lambing and lactational stress caused the reduction in actual weights. Sixteen percent of the ewes in the simulated flock gave birth during this time, therefore the weight increase and decrease were not as great as in the actual data. To further substantiate the agreement between simulated and actual ewe weights, the weights of simulated ewes lambing in September and October were plotted against the actual data. Figure 2 clearly shows that simulated ewes in a similar reproductive phase as the actual ewes display the same pattern of weight loss.

Milk Production

The actual and simulated average lactation curves are given in Figure 3. Both of these curves are averaged over the entire year. For the actual curve there were only three months in which lactation was initiated: April, May and November. There were 4 ewe records for April and May and 3 for November.

In general, the simulated and actual lactation curves remain in close proximity of one another. Initial and ending points of lactation are extremely close. However, the decrease and following increase of actual milk production did not occur in the simulated lactation curve. The cause of this increase is not clearly explainable, for feed quality does not significantly change during this time. The prospect of the fluxuation in the actual data being caused by individual variation as reflected in small sample size cannot be overlooked as a possible cause of the fluxuation.

Lamb Growth

One of the final products of this system is lambs produced. A comparison of the least squares means of actual lamb weight and simulated weight averaged over the year was made (Figure 4). There is extremely close agreement between

actual and simulated weights up to 300 days of age. The close agreement between the actual and simulated data for preweaning, birth to 10 periods (150 days of age), growth has additional implications. The close agreement based on a larger sample size indicates that real milk production levels for actual and simulated ewes were more similar than indicated.

Reproduction

The IPAL flock had a 130% lamb crop (live lambs born/ewe) for 1979. The simulated flock had a 132% lamb crop. Further estimates of reproductive efficiency were not obtainable from the actual data. Additional simulated output indicated that lambs weaned/ewe in the flock was 120% while lambs weaned/lambs born, a measure of lamb survival, was 76.4%. The actual reproductive rate was higher than the regional average due to IPAL ewes receiving higher levels of management (e.g. drenching and dipping): simulated lamb survival to weaning is closer to the regional mean.

Summary

1. The validations performed showed that the input parameters and the model closely simulated actual data.

2. In terms of reproduction, offtake of meat and milk, and production efficiency, the 30 kg sheep were not as productive as sheep with a mature size of 35 and 45 kg.

3. Sheep currently in the area are approximately of the 35/1.30 genotype. These simulation results indicate that:

   a. Increased milk production for this size (35) would be counter-productive.
   b. Increased size (greater than 35) would increase productivity if milk production was also appropriately increased (greater than 1.30). The increases should both be moderate.

4. With the genotypes of interest narrowed, further simulations dealing with management alternatives can be initiated.

5. The simulations performed provide quantitative values of the offtake of meat and milk which can be extended for use in economic analysis and other uses.

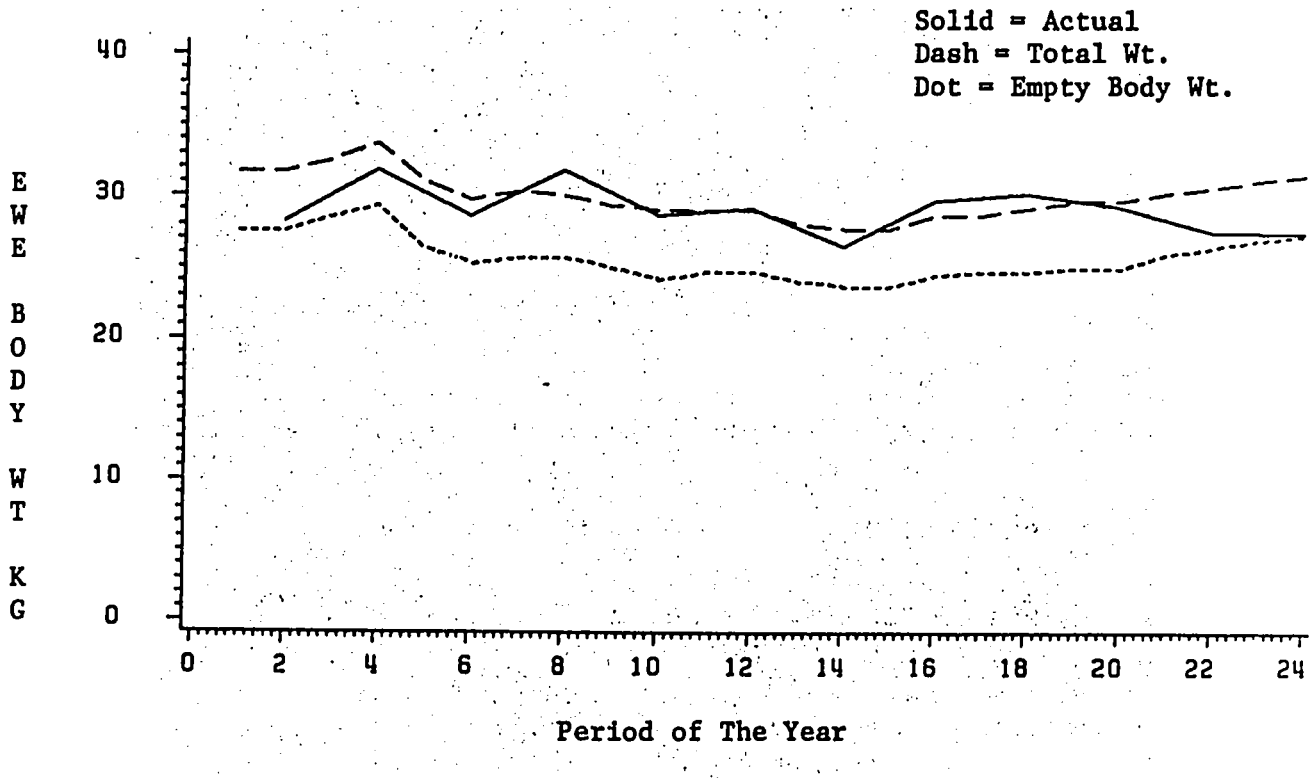

Figure 1. Validation of 1979 actual and simulated ewe body weights.

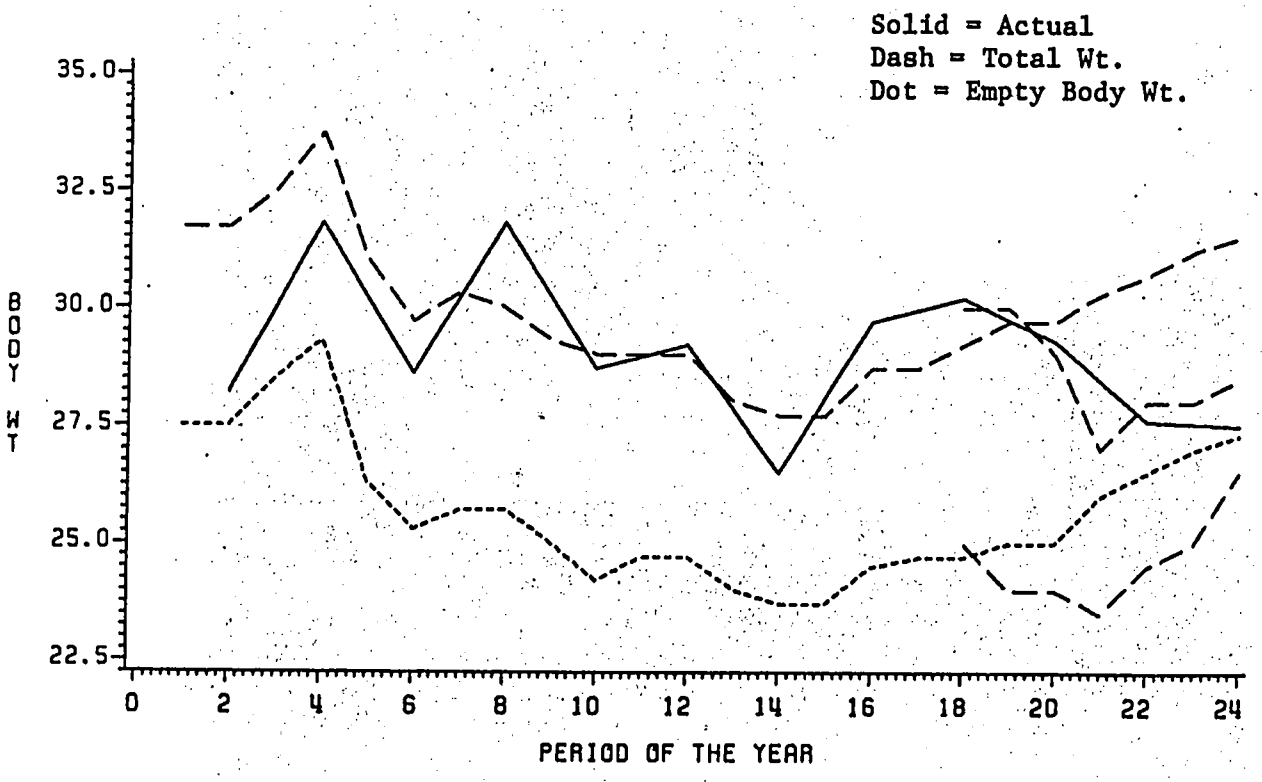

Figure 2. Validation of 1979 actual and simulated ewe body weights. Divergent dashed curves are simulated ewes lambing in period 18.

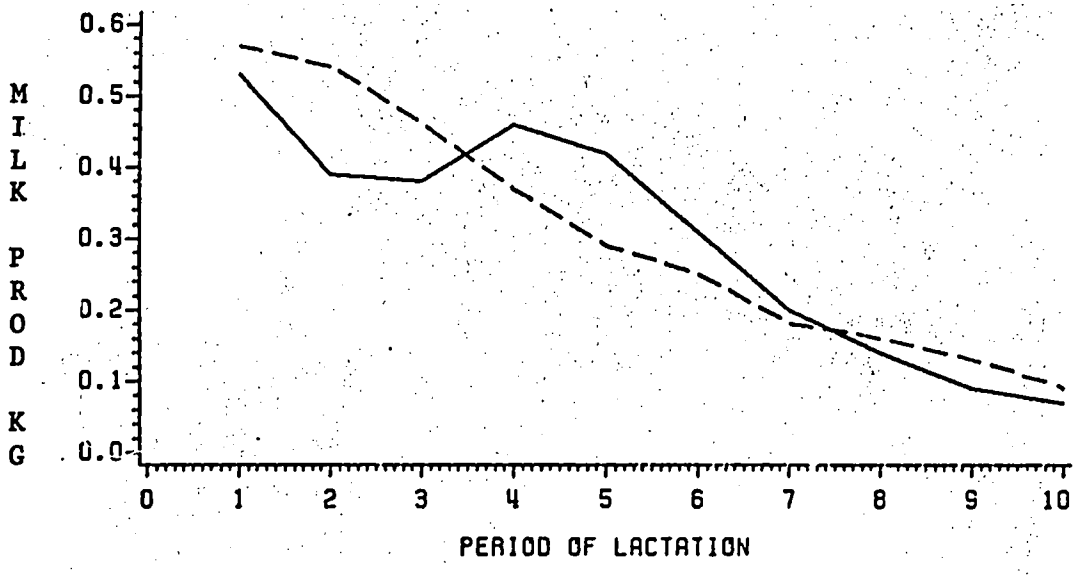

Figure 3. The 1979 average actual (solid line) and simulated (dashed line) lactation curves.

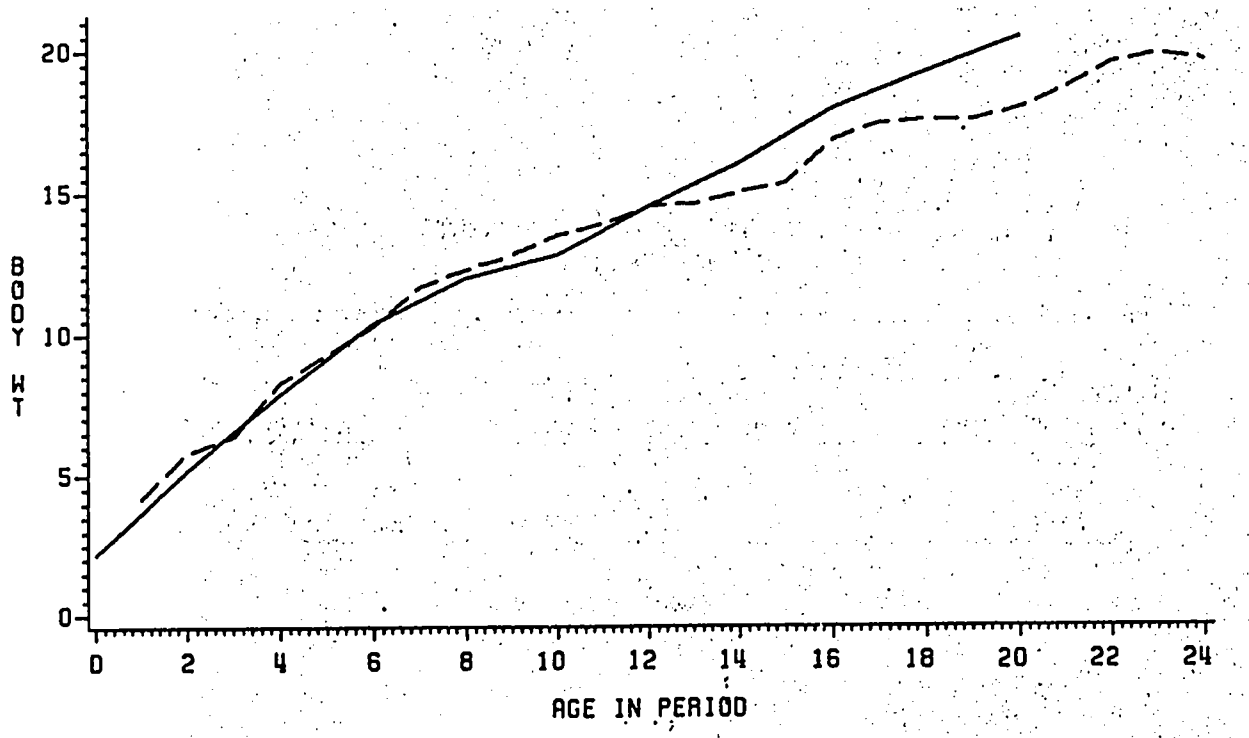

Figure 4. Validation of 1979 actual (solid line) and simulated (dashed line) lamb weights.

TABLE 1. THE GENOTYPES AND ENVIRONMENTS SIMULATED IN THE EXPERIMENT

Genotypes		
Mature Size Potential, (WMA)	Potential Milk Production (GMLKL)	Environments
30 kg	.90 kg	1979, a base year
35 kg	1.30 kg	Drought Year
45 kg	1.75 kg	Recovery Year 1&2

TABLE 2. FLOCK REPRODUCTIVE PERFORMANCE

Character	Year	GMLKL	WMA = 30			WMA = 35			WMA = 45		
			.90	1.30	1.75	.90	1.30	1.75	.90	1.30	1.75
Lambs Weaned/ Ewe, %											
	1979		103.0	99.0	88.0	110.0	120.0	105.0	109.0	114.0	109.0
	Drought		79.2	76.5	69.6	80.9	71.3	78.9	73.0	81.1	76.6
	Year 1 Recovery		80.8	77.3	56.3	100.9	92.3	78.8	97.4	103.1	85.7
	Year 2 Recovery		84.8	97.0	94.4	92.6	107.7	111.3	85.5	106.6	111.0
Lambs Weaned/ Lambs Born, %											
	1979		75.0	74.0	78.0	76.0	76.0	75.0	74.0	78.2	77.0
	Drought		57.0	54.7	53.2	58.6	52.2	55.1	53.9	56.4	51.6
	Year 1 Recovery		77.9	30.1	68.6	84.6	83.7	82.7	81.7	86.3	82.7
	Year 2 Recovery		84.8	82.4	78.5	83.2	85.2	85.5	80.5	86.4	81.4

TABLE 3. OFFTAKE OF MEAT AND MILK ON A PER EWE BASIS

Character	Year	GMLKL	WMA = 30			WMA = 35			WMA = 45		
			.90	1.30	1.75	.90	1.30	1.75	.90	1.30	1.75
Lamb Sold/ Ewe, kg	1979		8.8	7.3	6.1	10.3	13.5	9.9	13.1	13.8	13.6
	Drought		6.6	6.1	4.4	8.5	7.7	7.1	9.5	10.9	11.5
	Year 1 Recovery		4.1	3.7	3.3	4.8	4.8	5.3	4.5	6.0	6.5
	Year 2 Recovery		4.9	5.1	2.6	8.9	8.3	6.2	9.2	12.2	13.6
Total Weight Sold/Ewe[a], kg	1979		15.0	13.5	12.3	16.9	19.2	15.7	20.8	21.0	20.3
	Drought		11.6	10.7	8.9	13.8	12.4	10.6	14.8	17.5	16.7
	Year 1 Recovery		10.2	9.6	7.7	11.3	11.5	11.3	12.3	12.0	13.0
	Year 2 Recovery		11.5	11.7	8.8	16.7	14.4	11.5	19.0	20.2	23.3
Dairy Milk/ Ewe/Year, kg	1979		21.0	21.0	22.5	25.5	31.5	30.0	25.5	31.5	34.5
	Drought		19.5	19.5	19.5	21.0	25.5	27.0	19.5	22.5	30.0
	Year 1 Recovery		16.5	18.0	18.0	18.0	19.5	21.0	21.0	24.0	27.0
	Year 2 Recovery		15.0	16.5	18.0	18.0	21.0	21.0	19.5	24.0	31.5

[a]Weight of lamb + cull ewes.

TABLE 4. EFFICIENCY OF MEAT PRODUCTION.

Character	Year	GMLKL	WMA = 30			WMA = 35			WMA = 45		
			.90	1.30	1.75	.90	1.30	1.75	.90	1.30	1.75
Animals sold/Dry matter consumed[a]	1979		.3762	.4295	.3809	.5442	.4868	.4790	.5353	.5650	.5906
	Drought		.4681	.4362	.3745	.5360	.5022	.4227	.5477	.6036	.6057
	Year 1 Recovery		.3961	.3833	.3347	.4104	.3926	.4076	.4129	.3791	.4279
	Year 2 Recovery		.4431	.4531	.3691	.5805	.4966	.4048	.6190	.6038	.6668

[a]Weight Lamb Sold + Weight Of Cull Ewes Sold/Dry Matter Intake Of The Entire Flock. All efficiencies have been multiplied by 100.

INTRODUCTION OF SYSTEMS ANALYSIS CONCEPTS IN AGRICULTURAL EDUCATION

By
A.B. Carles[1]

The papers presented in this session on Systems Analysis have demonstrated a variety of ways in which systems analysis concepts and techniques may improve livestock productivity.

A major area that has not yet been touched on is education. In the Agriculture and Veterinary Schools of the University of Nairobi, the exposure of students to the philosophy and concepts of systems occurs sporadically in many disciplines. However, the Department of Animal Production has a shortcourse entirely devoted to this introduction and it was thought that some example of the way in which the students are introduced to this subject would be relevant.

Not infrequently, systems analysis is viewed as too complex for consideration at any stage before fairly advanced postgraduate work. This is largely due to a misconception - namely that the study of SYSTEMS requires both very complex techniques and sophisticated computerisation. This is as much a misconeption as it would be to consider that the science of physics always requires the advanced and complex techniques associated with astrophysics. In physics there are simple and very useful concepts that can be appreciated at a much earlier level. This is equally true of systems analysis. There is much benefit in an appreciation of some of the concepts at an early stage, and these can be presented descriptively, with minimum quantification. It is in the development of the quantitative aspects of systems analysis that the subject becomes complex.

The introduction of some of these concepts will be illustrated by taking two of these concepts, describing the way they are presented to the students, and showing how, even at this simple level, an understanding of these two assists in making a very common decision required in the management of many pastoral systems - namely, whether the conservation of energy at the time of excess forage, by making hay, will improve the productivity of the systems. The conventional wisdom most frequently gives the answer 'yes". However, when the relationships between the components of the system have been clarified, by the consideration of the concept of energy flow through the system and when the constraints imposed upon the performance of the systems by the concept of its boundary are understood, on many occasions, the answer should be 'no'.

Figure 1 describes the flow of energy through the components of this pastoral system . When all energy pathways have been considered, it is apparent that there are two parts of the system where energy may be stored in a form available for use by the sheep - the first is by conservation of forage (in this case as hay) and second is by the animal in its own body reserves. In general terms, there is no reason for assuming that either one of these is

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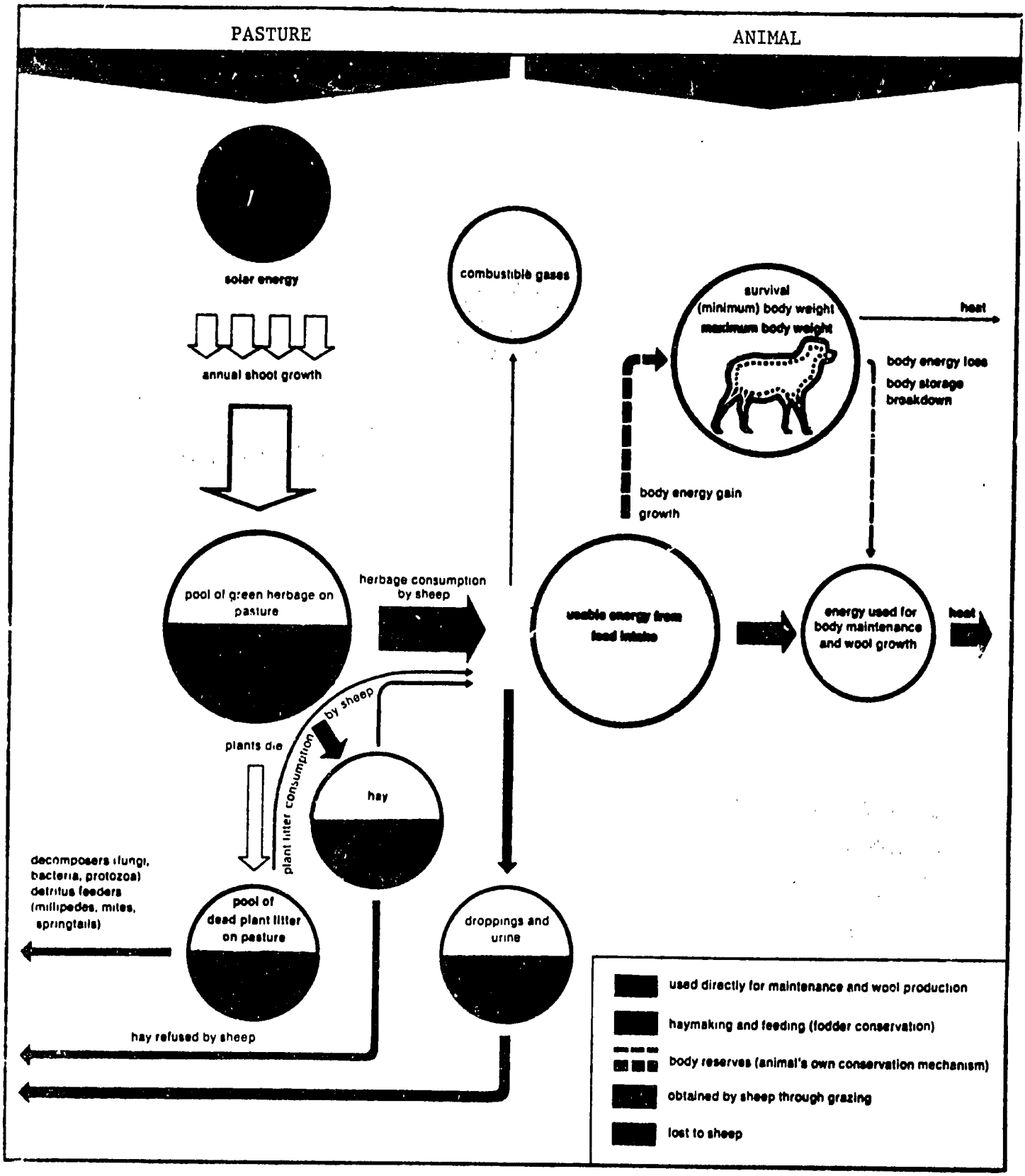
always the most effective.

Before reaching a conclusion, there is another system's concept that is important to apply, namely the constraints imposed by the boundary of the system . The amount of pasture available to this flock of sheep is limited. If hay is made, then an area on the farm must be set side for this, and the pasture available (for this time) is less. If hay is not made, then there is more pasture available. This could have two effects upon the sheep flock. Either the flock can be enlarged, or the sheep will conserve more in their body reserves, or both could occur to lesser degrees. Thus, at the end of the season of pasture growth the biomass of the flock from the systems that did not set aside pasture for hay should certainly be greater than the flock that did. During the dry season, weight loss will undoubtedly be greater for the flock that is not fed hay. However, if this flock entered the dry seasons with greater body weights, it is conceivable that they could still end up a little heavier at the end of the dry season. Even were this not to occur, the flock biomass could still be greater if the numbers are greater. In terms of flock productivity, it is the flock biomass at the end point that is the most relevant measure.

The conclusion that is drawn for the students is that if an attempt to answer a problem concerning a production system (sheep on pasture), is answered by only considering one part of the system (the pastoral components) then an answer that can be quite correct for that part alone (hay making) may well be wrong for the whole system. Thus, in order to avoid this pitfall, an understanding of the systems approach and some of its basic concepts is needed. It is true that the usefulness of this approach is greatly increased when quantification of the relationships is included, which invariably necessitates computerisation because of the complexity. But there is still much benefit in applying the concepts qualitatively.

FLOW OF ENERGY IN A WOOL-PRODUCING GRAZING SYSTEM THAT INCLUDES FODDER CONSERVATION



TYPES AND PRODUCTIVITY OF INDIGENOUS AFRICAN SMALL RUMINANTS

By
R.T. Wilson[1]

While it is probably not correct to speak of breeds in relation to African small ruminants, there are clearly identifiable types. These have been selected over centuries, perhaps over millenia, for adaptability to local environmental conditions and in response to the production requirements of their owners.

In the case of sheep, these types fall into three main groups which have been classified as thin tailed, fat tailed and fat rumped. Most authorities are more or less happy with this classification although some attempts to introduce ear length, limb length and tail length as factors of classification have also been made. Until recently, very little work on blood groups or karyotypes had been done but there is now more interest in these aspects and we may expect in the near future some light to be thrown on the relationships of one type of sheep to another.

There is less agreement over the classification of goats and several different constructs have been proposed. The two principal of these are based on ear length (long eared or short eared) or size (large, small or dwarf). The generally unsatisfactory nature of this type of classification is exemplified in the name applied to most goats in the East Africa region which are commonly called "small" although there is considerable variation. This might be expected in such a large population spread over such a wide area and such a wide range of ecological zones.

Sheep

A number of the varieties of African sheep are shown in Table 1. The table also indicates their major production aptitudes and the general type of environment in which they are found.

The Black Moor (or Maure) and Zhagawa types are examples of the Thin-tailed West African group. While producing meat, they are kept for their hair, probably producing about 200 g per year of this commodity. The hair is used for weaving and tent-making. This indicates that a greater number of mature male castrates than is usual in traditional flocks are kept in these areas. Flock structure is an aspect of productivity which until recently has perhaps received less attention than it deserves. Manipulation of flock structure is practised by almost all societies who keep small ruminants. Table 2 illustrates how different societies with different production objectives manipulate flock structure to achieve these objectives.

The "median" flock structure of the Baqqara is one in which meat is the sole or major product. The Baqqara flocks are comprised of sheep of the Thin-

International Livestock Centre for Africa (ILCA)

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tailed Northern Sudan group whose products are said to be milk (up to 2.5 kg per day); meat and skins. The Baqqara use these sheep almost entirely for meat, obtaining milk from their cattle and goats.

In an attempt to assess productivity on a comparable basis, ILCA is using a system of "Productivity Indices". Currently, these have the disadvantage that only the potential for meat production is included in the index. Three indices are used:

Index I Liveweight of young (kg) produced per breeding female per year

Index II $\frac{\text{Index I}}{\text{Female Liveweight (kg)}}$

Index III $\frac{\text{Index I}}{\text{Female Liveweight}^{0.75}\text{ (kg)}}$

Index I is more precisely calculated as:

$$\frac{\text{Weight of litter at weaning}}{\text{Subsequent parturition interval}} \times 365$$

Indices II and III, being resource based (the weight of the dam taken into account) are perhaps better indicators of productivity than Index I. Where young die before weaning (all young in the case of multiple births) all indices are, of course, zero.

Some examples of indices used for comparative purposes across countries are given in Table 3. It is also possible to compare between species. While individual indices are useful indicators of productivity, the differences in flock structures may make a cumulative flock index more useful in some cases.

In addition to milk other forms of productivity which might be included in an index are hair and wool. One of the few truly native wooled breeds is the Macina, restricted to the flood plain of the Niger river in Mali and to a comparatively narrow strip of land on both banks downstream as far as Niamey. This sheep yields about 700 g of greasy wool per year in two clips. Males outyield females by about 1.5 times, recognition of this fact by the owners being reflected in flock structure. The wet season growth rate, as can be seen from Table 4, is about 20% greater in males but 50% greater in females, presumably due to the extra energy available to them at this time over reproductive and lactation requirements.

East African Fat-tailed sheep are the typical sheep of the Afar lowlands of Ethiopia. Table 2 demonstrated the effects of management on population structure. It is also possible that management affects not only litter size, but can certainly affect the parturition interval. The Masai is also a Fat-Tailed sheep (the cultural preferences of the Masai people for fat meat is evident here) which has an artifically long parturition interval due to the management practices of its owners. Where no human intervention in breeding is practiced, parturition intervals in both sheep and goats tend to be about nine months. Parturition interval and litter size (some data are shown in Table 5) have an influence on Production Indices as do weights at weaning and the pre-weaning mortality.

In West Africa, Sahel sheep of the West African group are often crossed with the Djallonke sheep. This seems to be a type particularly liked by agro-pastoralists for smallholder fattening. High Productivity Indices can be obtained from greatly accelerated growth rates and from lowered death rates under this system of management. The potential for rapid growth is clearly shown in Table 6.

Sheep are not very important in the humid zones but a few dwarf types can be found. These are trypanotolerant and more prolific than the larger dry-adapted types with litter sizes averaging about 1.25 lambs. In common with other species of trypanotolerant animals it has recently been demonstrated that on a comparative basis (that is, for Indices II and III), this type of sheep is equally as productive as other African races.

In general in Africa there is presently little reason to attempt "improvement" by the use of non-African breeds. However, in favourable climatic areas, such as the East African highlands and in Zimbabwe, there may be some justification. One such example is the use of the Dorset Horn on the Fat-rumped Blackhead Persian to increase prolificacy and growth rates of this meat type. When climatic or management conditions are ideal, a straight introduction of exotics might be considered.

Goats

Some types of goats, their normal areas of distribution and their production aptitudes are shown in Table 7. Goat productivity varies in a manner similar to that for sheep, with type of animal, environment and management being major variables in the Productivity Indices.

The Sahel goat is a large type with medium length ears and, except for this latter characteristic, similar to the Sudan Desert goat. Some Productivity Indices for the Sahel goat are shown in Table 8. The effects of the different variables can clearly be seen. Note in Table 8 that flock (probably due to individual management ability), in this case is the greatest source of variation. It is also worth commentng at this point that goats giving birth to twins have higher Productivity Indices than those giving birth to singles. This is not always the case with sheep due to the high death rate of twin lambs and the slower growth rate of the remaining twin.

Skins amd milk, in addition to meat, are important products of goats. The Red Sokoto or Chevre Rousse de Maradi as its common names imply, is a deep red goat which has been selected for the quality of its skin. In the high-class leather trade, these skins are known as "Morocco". The Mubende, usually black in colour, is a goat from the uplands of Uganda which has also been selected for its skin quality.

The best known producer of milk is the Nubian. This goat is found along the Nile and in most of the urban areas of Sudan. Its yield is said to be up to two litres per day in addition to that ingested by the kids. The dwarf Abysinnian, a goat probably originating in south Arabia across the Red Sea from Ethiopia, is also used by the Afar for milk. Its yield is probably low but total flock output is increased as the owners reduce the number of males and keep a relatively high proportion of breeding females, (as has already been seen in Table 2 for sheep).

The Small East African is mainly a meat type: the true Forest or West African Dwarf goat is exclusively so, even the skin of this latter being eaten. The West African is a very prolific type with mean litter sizes in excess of 1.5 kids in the forest zone which, with parturition intervals of about 260 days, gives an annual reproductive rate of 2.2 kids.

There have been the usual attempts to improve indigenous goats for milk, meat or fibre production. These have usually failed except where artificial conditions are created for the purebred exotics and crossbred offspring. Possibilities of improvement of milk or meat do exist by the use of the better indigenous breeds such as the Boran or Galla of northern Kenya or the Boer from southern Africa.

Improvement Pathways

Recent analyses have shown the possibilities of improving both species of small ruminants. Figure 1 shows a possible system which, in its early stages, makes use of the identified variations in productivity within the traditional system. While this has not yet been given any practical application, it should be a perfectly feasible proposition as all husbandry practices are already being used by some owners within the system . Once these have been identified and the best breeding stock selected for further reproduction, progress to higher output should not be a too difficult process.

Table 1 Some types of African sheep and their production aptitudes

Type	Country/Zone	Female mature wt(kg)	Production aptitudes
Black Moor/Zhagawa	Mauritania/Chad/Sudan: arid desert fringe	35	Meat, Hair
Sudan Desert	Sudan: arid desert fringe	50	Meat, Milk (Skin)
Sahel (West African Fellata)	Mali/Niger/Chad: Sahel, northern semi-arid	40	Meat (Skin)
Macina	Mali: Niger flood plain	35	Wool, Meat
East African Fat-tailed	Ethiopia: semi-arid	30	Milk (Meat)
Masai	Kenya: upland semi-arid	35	Fat meat (Skin)
Sahel x Forest/Nilotic	Mali: semi-arid/sub-humid	45	Meat - supplementary fed
Blackhead Persian/Dorper	Kenya: upland semi-arid	40	Meat - cross-breeding

Table 2 Examples of management objectives related to sheep flock structures (per cent of total animals)

Country/Ethnic Group	Use	Females		Males	
		Total	"Breeding"[a)]	Total	Castrates
Ethiopia/Afar	Milk	92.2	61.4	7.8	0.0
Niger/Twareg	Milk(Meat)	81.8	63.9	18.2	4.7
Mauritania/Moor	Meat/Hair	78.1	58.6	21.9	6.2
Sudan/Baqqara	Meat	77.8	57.7	22.2	0.0
Mali/Fulani	Meat/Wool	74.5	55.9	25.5	11.3
Chad/Arab	Meat/Milk	73.3	53.7	26.7	"few"
Upper Volta/Fulani	Meat/Milk	70.5	47.6	29.5	?
Kenya/Masai	Meat(Fat)	68.6	54.2	31.4	15.4

Note: a) over 10 months of age

Table 3 Examples of sheep Productivity Indices for three countries

Index	Country		
	Sudan	Mali	Kenya
I (kg)	25.3	29.5	14.6
II (g)	861	888	512
III (kg)	1.99	2.31	1.24

Table 4 Wool production in Macina sheep (mean of three years' data)

Sex	Production		
	Dry season	Wet season	Total for year
Males			
Total (g)	468	377	836
g/day	2.2	2.5	2.3
Females			
Total (g)	263	281	534
g/day	1.2	1.9	1.5
All sheep			
Total (g)	366	392	685
g/day	1.7	2.2	1.9

Table 5 Reproduction data for sheep in four semi-arid areas

Parameter	Country and Ethnic Group			
	Sudan Baqqara	Ethiopia Afar	Mali Bambara	Kenya Masai
Litter size (No)	1.09	1.03	1.05	1.05
Parturition interval (days)	260	315	250	306
Number of young/year	1.53	1.20	1.53	1.25

Table 6 Weight for age (kg) data for intensively fed compared with range fed sheep in West Africa

Age range (months)	Intensively managed			Range grazing
	$\bar{x}$	s.d.	range	$\bar{x}$
<15	32.4	10.6	15.0 - 61.0	18.3
15 - 21	38.0	9.5	20.6 - 55.0	27.3
22 - 27	40.2	8.4	25.0 - 60.0	31.5
28 - 33	53.5	9.2	44.0 - 75.0	34.8
>33	52.9	9.0	47.0 - 63.6	44.8

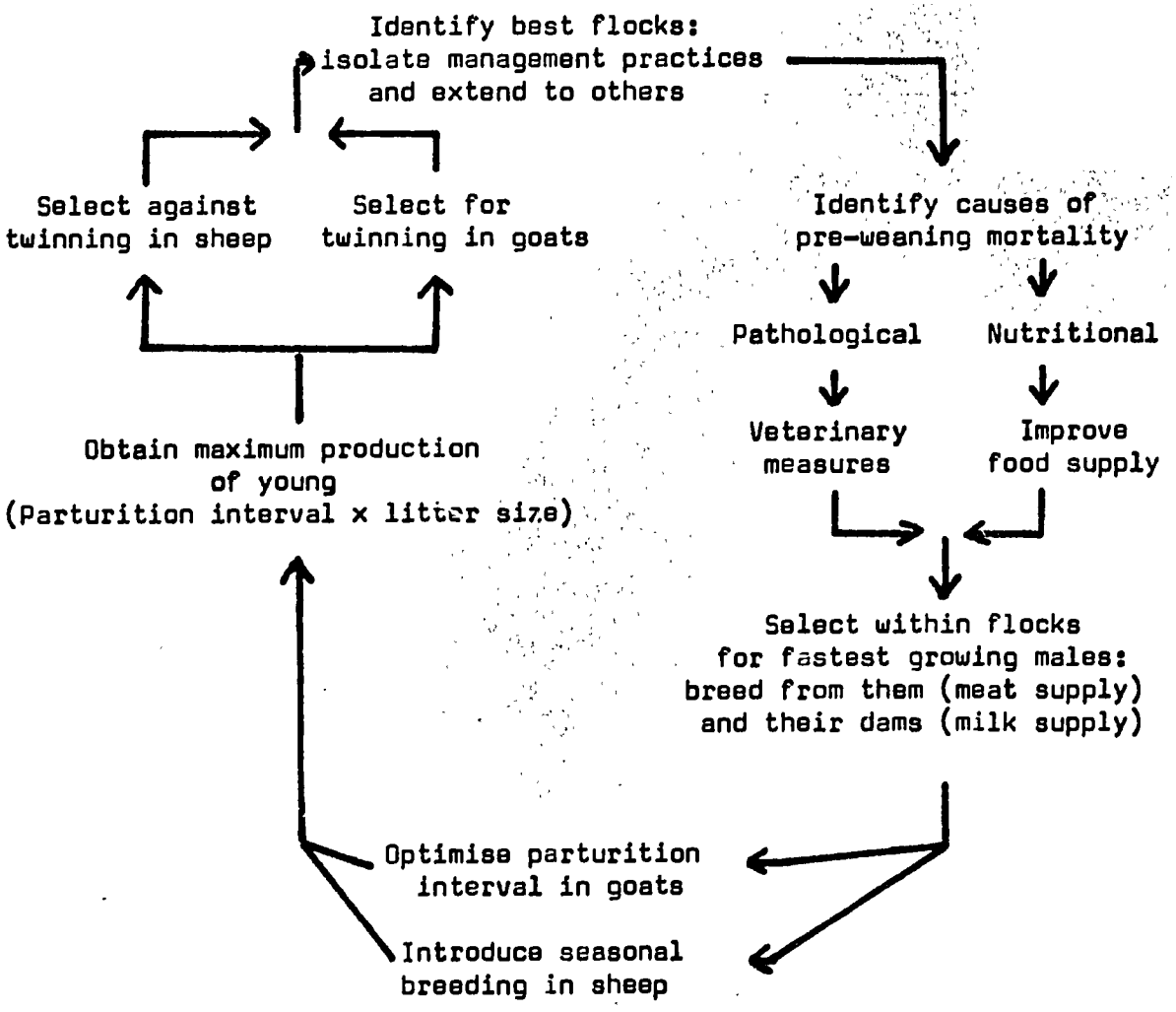
Table 7 Principal types of goats in semi-arid Africa and their production aptitudes

Type	Country/Zone	Female mature wt(kg)	Production aptitude
Sudan Desert/Sahel	Senegal to Sudan: arid and semi-arid	35	Meat, Milk
Maradi/Red Sokoto	Niger/Nigeria: southern semi-arid	30	Skin, Milk and Meat
Nubian	Sudan: riverine and urban	50	Milk
Abyssinian	Ethiopia: arid/semi-arid	30	Milk
Small East African	Kenya: upland semi-arid	35	Milk, Meat
Mubende	Uganda: upland semi-arid	30	Skin, Meat
Boer, Boran	Kenya: upland semi-arid	45	Meat - cross-breeding

Table 8 Least squares estimates of Production Indices for goats in an agro-pastoral system in Mali

Variable		Index I (kg)	Index II (g)	Index III (kg)
Overall Mean		18.7	565	1.5
Sex:	male	19.4	577	1.5
	female	18.0	553	1.4
Parity:	1	12.6	427	1.1
	2	17.2	558	1.4
	3	19.3	624	1.6
	4	21.3	645	1.7
	>4	19.4	593	1.5
Birth type:	single	17.5	508	1.3
	twin	24.0	753	1.9
Season:	best	20.8	660	1.7
	worst	18.0	522	1.4
System:	dry	13.2	447	1.1
	irrigated	24.1	683	1.8
Flock:	best	+12.7	+420	+1.0
	worst	- 7.1	-288	-0.7

Figure 1 Potential improvement pathways for sheep and goat flocks on Masai group ranch



SMALLSTOCK USE OF RESERVED GRAZING AREAS ON MERUESHI GROUP RANCH

By
M. de Souza[1] and P.N. de Leeuw[1]

The International Livestock Centre for Africa's (ILCA) research programme on range livestock systems in Kenya is conducted among Maasai pastoralists in the semi-arid rangelands of Kajiado District. A basic feature of this research is the development and introduction of innovations aimed at improving livestock productivity and human welfare. A necessary prerequisite towards this aim is an understanding of the potential and constraints of the existing production processes which are affected by social, economic and technical factors.

This research, carried out by an inter-disciplinary team, covers an area of 1,600 sq km comprising three group ranches: Olkarkar, Merueshi and Mbirikani. The site was also selected to enable a study of the impact on production and welfare, of the group ranch form of territorial organization (ILCA, 1982a).

The role and importance of smallstock in the Maasai system has been covered in studies on productivity, breeding and health, acquisition and disposal (ILCA, 1982b). This paper focuses on smallstock use of reserved grazing areas, which are located in proximity to homesteads within the communal area comprising the ranch. Each reserved grazing area is managed individually or jointly by households.

Traditionally, Maasai homesteads contained many households. These large concentrations of people offered security against raiding parties and predators. Apart from this, scarcity of permanent water sources, which prevailed even after the former ceased to be a threat, resulted in heavy concentrations of people and livestock in proximity to water sources. Rapid depletion of grazing resources, caused by heavy livestock concentrations, necessitated frequent mobility.

At this time, areas were reserved in proximity to homesteads for the use of the homesteads' calves. This was to ensure that grazing and water for calves was available in proximity to the homestead, hence maximising the time spent on feeding and avoiding competition in grazing resources from adult stock. As a result of frequent mobility of households, these reserved areas were temporary features. According to older Maasai informants, smallstock rearing was then a relatively new phenomenon and hence they were not given access to grazing in reserved areas.

When group ranch members acquired legal and exclusive rights to ranch resources, they feared that prohibition of inter-ranch mobility could be a problem during localized droughts. In response to this, the traditional function of reserved areas was modified to accomodate requirements of

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[1] International Livestock Centre for Africa (ILCA)

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smallstock and adult cattle, particularly in the dry season. The objective was, that with careful management of reserved areas, grazing resources in proximity to water sources and homesteads could last for the duration of the dry season, thereby pre-empting the need to shift. This is considered particularly important in the dry season when livestock energy resources would deplete even further with extensive walking. It was believed that these objectives could be achieved if reserved areas were managed individually rather than communally, thereby relating management to the needs of specific household herds and placing the responsibility for conservation of resources on individual households.

After the introduction of group ranches, homesteads split and spread out in relation to increased permanent water facilities, which also allowed households to become more sedentary. Reserved areas were accordingly relocated in relation to homesteads.

The main data base used in this paper was a questionnaire (administered fortnightly by enumerators to 22 of 36 households in Merueshi Group Ranch) on movements of herds. The data covers the period June 1981 to July 1983 (ILCA, 1981). The questionnaire was used to elicit information on how animals were divided for herding, where herds and flocks were grazed and watered and who did the herding. The data was supplemented by discussions with producers and herders and with field observations.

Smallstock in Merueshi

Distribution of Smallstock among Households

There were 1,342 sheep and 963 goats in Merueshi with sheep comprising about 60% and goats, 40% of the flocks (ILCA Census, 1983). Sheep breeds vary with the indigenous Maasai breed being dominant, followed by the Somali Blackhead and then to a lesser extent, other breeds and crossbreeds. The only goat breed in the ranch is the small East African. Flocks are comprised of 10% males, 23% castrates and 67% females (King et al, 1982). Flock sizes of over 100 head constitute more than 50% of the flock with only a few being less than 50 head. The average flock size is 134 head.

In general, smallstock are more evenly distributed among producers than cattle. While the three largest producers own close to 60% of the cattle, they have only a quarter of the smallstock. Thus, the smaller producers own proportionally more smallstock than cattle and consequently, smallstock/cattle ratios decline with increasing herd size (Table 1).

Flock Divisions for Daily Grazing

Each household herds its own sheep and goats together as a single unit, regardless of flock size. Flocks are split into two groups based on age. Young suckling kids and lambs are kept within the compound of the homestead, either free to roam or within fenced enclosures. When older, but before weaning, they join the adult flock or occasionally, join young calves for grazing. These two groupings offer protection to the young smallstock from predators and from getting lost. Nevertheless, losses do occur and because of this, flock owners prefer their own children or children of very close relatives to do the herding in order to avoid disputes over liability for

losses and to ensure that good care is provided to the flock.

Grazing Management Objectives

The maintenance of minimal distances between the homestead (where livestock are enclosed at night), water sources and grazing areas are considered to be the basis of good management. An extensive daily grazing orbit is considered poor management as it reduces grazing time, particularly since smallstock are slow walkers. When smallstock use reserved areas, grazing can begin 0.5 km from the homestead rather than 3-5 km when communal areas are used.

Other management considerations are that the probability of attacks by predators increase further away from the settled areas. This is particularly a problem for sheep which are easily disoriented in unfamiliar surroundings which can result in loss. An advantage of grazing nearer the settled areas is that the trodden grass and sparser vegetation surrounding these areas is ideal for smallstock because seed dispersal from tall grass irritates the eyes and sharp and thorny grasses puncture feet. Finally, it is the generally prescribed role of young children, aged 6-9 years, who are unable to walk long distances, to herd smallstock. All these grazing management objectives serve to reinforce the need for smallstock grazing facilities in proximity to homesteads.

Location of Reserved Areas

Location of Homesteads and Water Facilities

Homesteads are residential units accomodating one or more families or households. They comprise fenced enclosures which are subdivided with pens for stock and huts for people. Maasai in Merueshi consider the locations of their homesteads to be permanent. However, they may move to new homesteads constructed some 100 meters from the orignal site, on the build-up of ectoparasitic infestation or the accumulation of dung.

Figure 1 shows that reserved grazing areas and homesteads are clustered in the vicinity of permanent water facilities, i.e. the water-pipeline along the western border of the ranch and boreholes and shallow wells along the Kiboko river. All homesteads are located within a 5 km limit to water.

Location and Access to Reserved Areas

Figure 1 also shows that reserved areas (13) are located in proximity to homesteads (ole Pasha, 1983). These areas cover approximately 4,500 ha or about 20% of the ranch, and range in size from 100-800 ha; the larger ones being situated in the west which reflects of the drier conditions there in comparison to the east.

Nine of these 13 reserved areas are utilized by sample producers. Two are managed autonomously by single producers with the others being shared by more than one. Although the former would be preferable, producers opt to share in order to avoid a situation whereby the ranch is overly intersected by reserved areas, entailing much circumvention by livestock and hence more walking. Producers negotiate with one another the joint use of reserved areas

when shfting occurs due to dry conditions.

Utilization of Reserved Areas

Utilization by Smallstock and Other Stock

Smallstock rely on reserved areas for 40-50% of their total grazing. However, this accounts for only 16% of the total aggregate grazing pressure (kg live biomass ha^{-1}) with adult cattle accounting for 51% and calves for 33 percent.

Although adult cattle rely largely on communal grazing, their share of reserved resources is high because they account for the major share of the total ranch biomass. While smallstock constitute only 6% of the total biomass, their proportional use of reserved grazing on the ranch (at 16% of total use) is relatively high.

Seasonal Utilization of Reserved Areas

An analysis of grazing location frequencies revealed that calves graze in reserved areas all year round at a high rate (Table 2). In smallstock grazing, there is much greater seasonal fluctuation, with higher use in dry than in wet seasons. Frequency of use was particularly low during the good short rains in 1982/83. Apparently, sufficient forage was available in communal grazing areas in proximity to homesteads during these rains and the following five months. During the same period, declining use is even more pronounced for adult cattle. From June 1981 to October 1982, adult cattle were grazing in reserved areas 19% of the time. The proportion declined to barely 4% from November 1982 to June 1983. Measured forage production generated by these rains was high and carried over into the long rains in 1983.

Management of Reserved Areas

Sub-Division within Reserved Areas

According to Maasai informants, the basic objective in the management of reserved grazing areas is that grazing resources are used in a manner to ensure conservation and annual regeneration. In order that this be achieved, reserved areas are subdivided internally for systematic use. The example given in Appendix I of one particular reserved area on the ranch shows how it is subdivided and used seasonally by different age and stock classes. All reserved areas on the ranch are subdivided - their number, size and use related to variatio in vegetation and terrain, total number of livestock using the area and management interests and choices of producers.

Special Areas for Smallstock

Of particular importance for smallstock are what the Maasai refer to as Enkusero, which are characteristic of black cotton soil, that tends to become rather sloppy when wet and certain bushes and grasses the Maasai consider to be particularly good for smallstock such as *Chloris pycnothrix*, *Rumex usambarensis* and *Commelina bengalensis*. These are salty species with the latter having good water retention properties, and hence particularly suitable

for smallstock that tend to water less frequently than cattle. An especially important feature of Enkusero is that they are free from Tribulus terristris, a thorny herb which easily punctures the feet and irritates the eyes of smallstock, particularly in the dry season when the grass is dry and brittle. Furthermore, many areas of the ranch are plagued by this species and hence the added importance of reserving Enkusero for smallstock.

All households on the ranch have access to Enkusero which are mainly located within reserved areas (Figure 1, Appendix I) or near the homestead, hence ensuring facility and usually exclusivity of use as well.

Summary

This paper which is part of a wider study on the Maasai Livestock Production System of the ILCA Kenya Programme, describes the manner in which Maasai manage and maintain reserved grazing areas in order to minimize the amount of time that smallstock have to walk, thereby maximizing the time spent on feeding and to provide smallstock with the best possible grazing conditions.

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Table 1 Distribution of Cattle and Smallstock in Merueshi Ranch [1/]

Cattle ownership Class	No of HH [2/]	Ratio [3/] SS/Cattle	Proportion (%) [4/] Total Cattle	Total SS
Less 49	6	2.5	4	13
50 - 99	6	1.4	13	22
100 - 199	6	1.3	27	41
Over 200	3	0.4	56	24

1/ Based on 21 households. One of the households does not have any smallstock on the ranch.

2/ Number of households per class of cattle ownership.

3/ Ratio derived from total number of smallstock and cattle per ownership class.

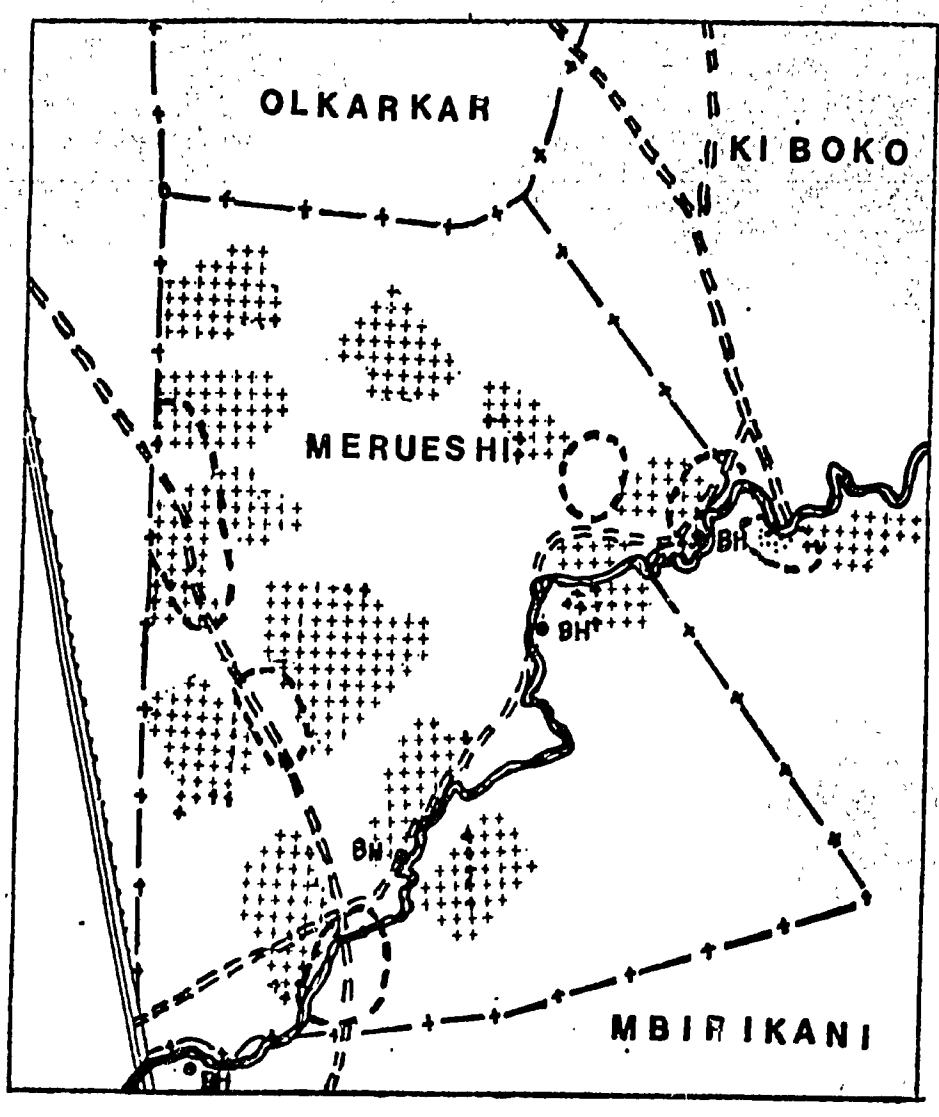
4/ Proportion (%) derived from total households.

Table 2 Seasonal use of reserved areas by stock classes in Merueshi Ranch

Seasons	Calves	Small-stock	Cattle
	(Per cent*)		
Long dry (June-Nov. 1981)	85	56	17
Short rains (Dec-Jan 81/82)	89	83	26
Short dry (Feb-March 82)	89	83	32
Long rains (April-May 82)	87	60	16
Long dry (June-Oct 82)	93	61	15
Short rains (Nov-Jan 82/83)	88	32	0
Short dry (Feb-March 83)	80	60	7
Long rains (April-June 83)	76	45	7
Average frequencies	85	57	15

* shows proportion of the grazing occuring in reserved areas.

Figure 1. Homestead clusters, water facilities and reserved grazing areas



KEY

-+-+- Ranch boundary

Road

Water pipeline

==== Tracks

Kiboko river

Homestead clusters

+++++ Reserved grazing areas

BH Borehole

Wells

Scale: 1:200 000

Appendix I: Case Study Showing Seasonal Use of a Reserved Grazing Area in Merueshi Group Ranch.

This is one of six case studies of reserved grazing areas on Merueshi group ranch which were carried out in order to understand use at a micro level.

The information in this study is based on unstructured interviews with the household head, who owns this reserved area, his senior wife and his children who herd livestock within it. Field observations of different stock classes within the reserved area supplemented the above information. Additionally, since this household in one of the 22 sample households on the ranch referred to already, recurrent information on reserved area use was covered in the herd movement questionnaire administered by an enumerator every fortnight.

The format followed in trying to understand the use of reserved areas was to ask informants to describe and explain what typically occurs within their reserved area every month, during a normal year. The preference was to begin the calendar of use in September which was believed by informants to be the month when most calves are dropped.

The sketch map of the reserved area which is approximately 300 ha, shows that it is divided into four main sections, some of which are further subdividied and reserved for the exclusive use of specific age classes or species of livestock (Figure 2).

Suckling calves, kids and lambs are kept in Section Ia, an area that surrounds the homestead. Section Ib is reserved for older suckling calves and Section Ic, the Enkusero for smallstock.

Section II contains a pan for rainwater which can hold water for up to 4 months and which belongs to the owner of the reserved area. The vegetation in this area is used only marginally by livestock en route to water. Its main function is to protect the area from excessive grazing.

Section III is subdivided into three sections, with all livestock utilizing IIIa. Additionaly, IIIb where commiphra is the dominant vegetation is reserved for smallstock and IIIc, where cordia is dominant, is reserved for calves. Section III is the largest in the reserved area being used by all livestock and for the longest duration.

Section IV, a rocky and generally unfavourable area, is the smallest section being kept for adult cattle as a last reserve to be used if the rains are delayed. If the rains fall on time, then this section may not be used at all, or it may be used until grass in the communal areas is green. Its use depends on the relative conditions in the reserved area and communal grazing areas.

Calendar of Reserved Area Use

	Long Dry Season
June - Sept.	Just before the rains. Most calves are dropped. All other cattle are grazing within IIIa and watering at

the pipeline. Smallstock always follow the paths that cattle have taken so that the latter may shorten and breakdown the grass for them. However, they do not walk as far as the cattle in this section.

Short Rains

October — It begins to rain. Water accumulates in the pan in section II. By this time, adult cattle may have moved to IV. They water at the pan every day. On days when it is raining, the cattle graze outside the reserved area to avoid trampling on the newly sprouted grass. As it becomes green outside the reserved area, cattle are driven to the communal grazing areas. Young suckling kids and lambs along with the youngest suckling calves are penned or left to roam near the homestead. The older suckling calves nibble on the grass in Ib. Adult smallstock are in the Enkusero, Ic. They water at the pan every third day and sometimes graze outside the reserved area.

November — Most kids and lambs are dropped. There is a lot of rain. Grass is green. All adult cattle graze outside the reserved area. Apart from a few times young calves continue within the reserved area. Smallstock are released late in the mornings, because it is very green and they can feed just outside the homestead on the newly sprouted vegetation. All livestock water at the pan.

December — Calves born in September are still suckling. They are not put in Ib at 4 months. The other livestock continue with the pattern of November until it becomes dry again.

Short-Dry Season

January-February — A few calves are dropped. Kids and lambs are dropped.

March — The calves, now 7 months old, are driven to IIIc where they remain until it is expected to rain again in April. The cattle are grazing outside the reserved area. Smallstock are in the Enkusero.

Long Rains

April — It usually rains. The older suckling calves remain in Ib. The older and stronger calves from IIIc are selected to join the adult cattle that move to IV where they graze and drink in the pan as it fills up.

May — All livestock, apart from the sucklers and young weaners, are removed from the reserved area to allow the grass to grow. Smallstock are still in the Enkusero although they go outside as well.

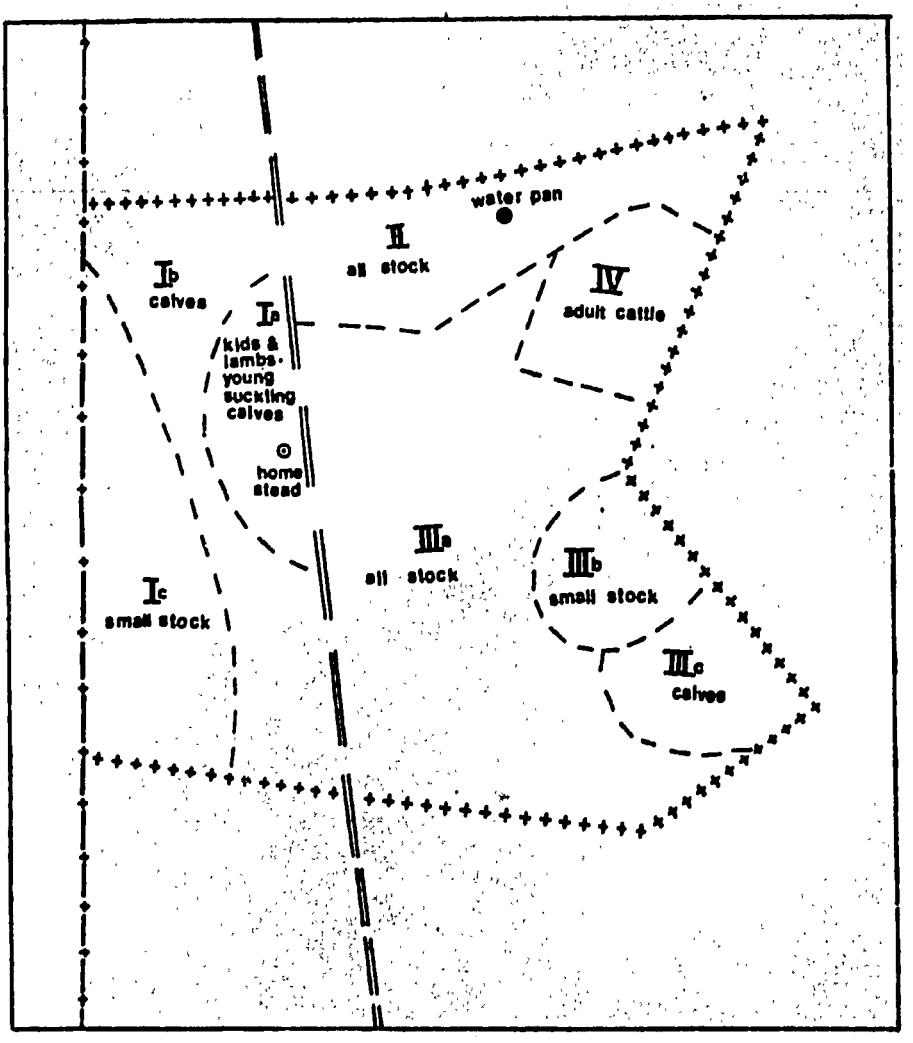
Long-Dry Season

June	Cattle grazing in the communal areas continue, with watering on alternate days.
July	Smallstock move to IIIb, an area that slopes and where the grass does not grow high. Cattle continue as in June.
August	Cattle return to the reserved area to IIIa. Smallstock continue in IIIb where they eat fallen leaves.

Acknowledgements

Fieldwork on reserved areas was carried out with the assistance of Peter Lembuya who was interpreter and discussant. He also participated in observations and drew sketch maps of reserved areas.

Figure 2 A Reserved grazing area



KEY

-+-+- Ranch boundary

+++++ Reserved grazing area boundary

----- Sub-divisions

===== Track

Scale: 1:75,000

MANAGEMENT PROPOSALS FOR SHEEP AND GOATS IN THE WESTERN MARSABIT DISTRICT OF KENYA[1]

By
C.R. Field, J. Crees, G. Njiru and T. Rutagwenda

For the past eight years, the Integrated Project in Arid Lands (IPAL) has been carrying out applied research in the Western Marsabit District of Kenya with the following objectives:

- To understand and explain the causes of desert encroachment.
- To develop a management strategy which integrates the main components of the system for the restoration of range fertility, the long term conservation of the range and the sustained yield of products for human use.

Livestock are almost the only source of subsistence for pastoral nomads in the area. The most numerous category of livestock is sheep and goats which together number 107,500 animals in an area of 11,300 Km^2, i.e. a density of a little less than 10 Km^2. However, they comprise only 21% of the total weight of livestock; the bulk of which are camels and cattle. Goats comprise 60% of all smallstock. Nevertheless, because of their large numbers, smallstock have a significant impact on the rangeland. Furthermore, because of their small size and high metabolic rate, they require proportionately more food per unit weight than cattle or camels. This is offset to a certain extent by relatively higher rates of productivity in terms of flock increase, liveweight gain and in the case of goats, at least, milk.

Smallstock therefore form a very important component of the livestock economy and special emphasis on understanding their role has been made in the IPAL livestock program. Much of the baseline data on smallstock in the IPAL study area have been described in earlier SR-CRSP workshops (Field, 1982; Smith et al 1982; Caries et al, 1983; Lamprey and Field, 1983; Schwartz et al, 1983) and summarized in UNESCO/IPAL (1983). This paper is a summary of IPAL's management recommendations based on the research findings and pertaining specifically to smallstock. It should be borne in mind however that these recommendations form part of the overall strategy for livestock and indeed the conservation and productivity of the area as a whole. It is the hope and intention of the Project to implement these recommendations in Phase IV of the Project which begins in July 1984.

The principal objectives of smallstock management are:

- To arrest the contribution of smallstock to the declining productivity of the range and thereby help to restore its fertility.
- To restore smallstock productivity to contribute to the substinence needs of the people and to help end their dependence on external food aid.

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- To develop the smallstock resource to assist the people to contribute significantly to the national economy on a sustained basis and thereby improve their standard of living.

The principal methods required to achieve the stated objectives are:

- The introduction of an improved grazing program.
- The improvement of smallstock husbandry and disease control to increase productivity.
- The development of a viable marketing system for smallstock and a unit to utilize their by-products.
- The establishment of smallstock demonstration and training units.

Detailed Management Procedures

The Introduction of an Improved Grazing Program.

Within the proposed management area it is clear that the existing use of the range is in need of considerable revision in order to rest over utilized range and to bring into use pasture which has hitherto been under utilized.

Methods for determining carrying capacity for 25 range units in Western Marsabit District have been described (Lamprey and Field, 1983).

Sheep and goats are found in mixed flocks in the average ratio of 1:1.5. It is unlikely that in the near future this ratio will alter greatly or that there will be sufficient herdsmen to permit separation of the flocks. For this reason, the estimated stocking rate of sheep is taken as 67% of the carrying capacity for goats, i.e. 55,337 animals. This gives a total carrying capacity of 137,930 animals. Currently the stocking rate is 78% of this figure which allows for a 22% increase.

The rangeland has been divided into northern and sourthern units based on Kargi and Korr which are approximately equal size. Presently, the following animals occupy these areas:

	Sheep	Goats
Northern Area	22,082	33,123
Southern Area	20,937	31,405

These animals have been allocated proportionately to each range unit depending on its carrying capacity.

Daily occupancies have also been calculated and in certain cases, some units are shared by both northern and southern populations. A grazing cycle and calendar have been developed which involve the dispersal of smallstock over a wider area which should lead to a more equitable use of the range. The cycle and calendar are guidelines and are flexible so that they can respond to fluctuating conditions of the range such as rainfall and water availability.

In each population it will be necessary to have about twenty mobile camps or "fora", each numbering between 2,500 and 3,000 smallstock. These localized high densities of animals will have both advantages and disadvantages. For instance:

Advantages

- They will be easier to protect with security.
- There will be brief but heavy grazing which will tend to eliminate some of the unpalatable plant species.
- Less material will be required for the construction of night enclosures.
- They will be easier to provide with veterinary, marketing and advisory services.

Disadvantages

- It will be necessary to develop adequate water supplies for the larger concentrations of smallstock.
- There will be greater risk of disease spreading rapidly through the population.

There will however be a net benefit due to improvement in range condition, feed quantity and quality and ultimately, in the health and production of the animals.

The development of this grazing scheme for smallstock will be dependent on the availability of water resources as well as security. For this reason, it is likely to be the last of the main livestock grazing developments and should only be implemented once it can be demonstrated that security has been achieved.

The Improvement of Smallstock Husbandry

There are three main aspects of husbandry that require attention, namely, quality of the stock, control of breeding and improvement in nutrition.

Quality of the stock

In the more arid region of East Africa, livestock are represented by small breeds of apparently poor quality, e.g., the Small East African goat. In the absence of long-term studies to compare different breeds under the same environmental conditions, the reasons for this remain open to debate. However, there appears to be some wisdom in the choice of small breeds by shepherds living in arid areas. For example:

- In terms of drought, small breeds require less forage on a per capita basis.
- More animals of small size may be kept on a given rangeland.
- In times of high mortality through starvation, there is a greater chance of the minimum herd surviving for breeding purposes.
- The recovery rate of a depleted flock is faster if there are many small animals rather than a few large ones.
- Growth rates of animals on poor pastures may be very slow and it is doubtful whether the larger breeds would reach their full growth potential.

Nevertheless, larger livestock breeds under improved range management

have the potential to produce increased yields of meat and milk.

It is believed that the grazing program will provide livestock with better pasture, making possible either the stocking of more individuals of the original breeds or the stocking of fewer individuals of improved breeds. In recommending the introduction of new breed(s), the following considerations are taken into account:

- They should be chosen from existing breeds in the arid zone with proven ability to survive under similar conditions of drought and limited forage and water.
- They should be more productive than the existing livestock under similar conditions of food availability.
- They should be tolerant of indigenous chronic diseases.
- They should not exacerbate the existing problems of range degradation.

In the case of smallstock, the introduction of a nucleus of Galla stud bucks from North-Eastern Province where they are larger, is recommended. No immediate changes in the breed of sheep are foreseen although selection within the existing stock is strongly recommended.

Control of breeding.

At present, there is very little control over breeding with respect to either the males used, the age at first conception or the seasons of breeding. This yields poor quality stock and parturitions during seasons of low forage quantity and quality when the chances of survivial of the neonate are minimal. The following recommendations are made in this respect:

- All poor quality males in excess of requirements be castrated and sold.
- All young males which do not come from a genetic line of high-yield performance should be castrated before they reach sexual maturity.
- All old males should be culled.
- The scheme should keep a reserve supply of stud males for hire should they be needed.
- All breeding males should be fitted with aprons to prevent insemination until they are required.

The rationale behind the decision whether or not to adopt controlled breeding depends upon the lifestyle or strategy adopted by the pastoralist. Traditionally, he was dependent on his livestock for milk but there is a trend towards a mixed diet involving a higher proportion of cereals as a source of carbohydrate. This should be encouraged up to a point as milk is a poor source of energy although an excellent source of protein.

The traditional system optimizes milk yields from goats in terms of quantity and availability throughout the year for subsistence consumption. Sheep, being poor milk producers, are raised principally for meat and fat. There is no attempt to accelerate reproduction by shortening the breeding interval.

In a simulation study, Smith et al (1982) used data from our Ngurnit goat flocks to determine among other things the optimum seasons for kidding with

regard to milk yield and kid survivial. If one half of the does conceive in May and the other half in September, they will kid in October and February and be weaned in March and July. Milk will be available for all but two months of the year and kids will grow under favorable conditions.

Sheep raised for meat should conceive in the dry season, lamb in December and be weaned in April when forage is good. This will give strong, fast-growing lambs. The kidding and lambing interval will be 12 months.

The modern system involves forfeiting some milk offtake to maximize growth of the offspring and increase rates of reproduction by reducing the breeding interval.

The kidding and lambing interval would be reduced from twelve to eight months. Inevitably, some parturitions will occur in dry seasons which are suboptimal for growth of the neonate but this should not be a problem if it is allowed to suckle freely.

In order to adopt this second strategy on a sustained basis, adequate nutrition which may involve some supplementation is a necessary prerequisite.

The improvement of nutrition

The effective implementation of the grazing program will lead to an improvement in the nutritional status of livestock through an increase in the quantity and quality of available forage. Nevertheless, additional measures will sometimes be necessary.

Intensive food supplementation. Lactating animals and weaners are particularly vulnerable to shortages in range forage. Owing to problems of feed transport to remote areas, it is recommended that naturally occuring concentrated food be harvested.

The most suitable feed for this purpose is provided by the seed pods of *Acacia tortilis*. These pods should be harvested in areas not used by livestock and stored until times of shortage when they may be required for supplementation.

Careful storage will be necessary as pods may be spoiled by fungi if harvested while still green or by brucid beetles if harvested from the ground after they have ripened and fallen. They will need to be dried throroughly and routinely and treated to prevent infestation with insect pests.

Mineral supplementation of smallstock pastured on mountains will also be necessary.

Extensive food supplementation

This is recommended for two situations: as grazing insurance for stock during drought and for holding and fattening animals destined for market.

Before the equilibrium of stocking rates is reached, there is always a risk of the scheme facing a prolonged drought. Under these circumstances, shepherds should be encouraged to use an area set aside primarily as an insurance against drought. Such an area (about 4,000 Km^2) exists to the

southeast of Marsabit Mountain owing to insecurity and insufficient water. A similar but smaller area is used to the northwest by nomads in times of drought. Opening these areas will require water development, but they would then be closed by law to grazing except when the grazing committees make a unanimous decision to use them.

Animals suitable for market are likely to be available in large numbers during dry seasons and drought. It is proposed to hold and fatten them until suitable market prices are offered, probably during the next wet season.

It is not a contradiction to use the drought reserves for fattening since in normal years, some use of the range is necessary to prevent the pasture from becoming mature, fibrous and unpalatable.

Adequate milk supplies for smallstock

When a pastoralist has insufficient food for his family, he is obliged to deprive suckling animals of the necessary milk for normal growth and disease resistence. Shepherds need to be educated through extension and demonstration of the long-term implication for the family herds if suckling animals are deprived of an adequate maternal milk supply. A suggested alternative would be to encourage shepherds to sell more castrated animals for cash with which to purchase energy-rich cereals for home consumption, thereby relieving their lactating animals of the dual burden of supporting both their offspring and the needs of their owners on a diminishing resource.

Smallstock owners who adopt the second breeding strategy outlined earlier which depends on a good maternal milk supply for young animals in order to reduce the breeding interval, will find this particularly essential.

Smallstock Disease Control

In the absence thus far of information on the long-term consequences, it is recommended that the disease-control component of the management plan be modest in the beginning. As success is achieved with the grazing management programme and marketing, there will be increasing justification for expansion of veterinary activities.

Veterinary centres

The veterinary activities of the management plan should be conducted and supervised by two veterinary officers based at Korr and Kargi with necessary support facilities. Their responsibilities should include:

- Diagnosing and monitoring diseases in pastoral livestock.
- Extension and education of the pastoralists in ways in which they can improve the health of their herds.
- Conducting local emergency ring-vaccination campaigns in the event of epidemic disease outbreaks.
- Providing a limited veterinary clinical service for the livestock owners.

Field assistants attached to the veterinary centres would be continuously present with the herds in the grazing areas; they would have monitoring and extension duties and they would have responsibility for first reaction to any

emergency arising.

Public relations

The provision of veterinary services could be a potent incentive to persuade pastoral livestock owners to cooperate in a grazing management programme. It is proposed that cooperating smallstock owners be given:

- Free enterotoxaemia vaccine on an elective basis.
- Assistance with spraying livestock against ticks in the vicinity of waterpoints.
- Free access or access at much reduced rates to the veterinary clinical service provided from Korr and Kargi. Access would be facilitated through a weekly visit by the veterinary officer to approved water points, or to places where livestock camps are constructed.

Veterinary extension and education

The general development and rehabilitation of the project area will depend to a large extent on the education of the pastoralists. It should be an objective of the veterinary component of the management plan to achieve its greatest effect on smallstock health through extension and demonstration to the owners. This effort should be aimed primarily at owners cooperating in the plan, but others must also be made aware of the lessons to be learned. The extension and demonstration effort will be based on project-owned flocks in the grazing areas which will be at the core of continuous monitoring activities.

Specific recommendations for the control of smallstock diseases are indicated below.

Disaster prevention

A first priority is to reduce the risk, both real and as perceived by the smallstock owners, of sudden and serious loss due to epidemic disease. It is therefore proposed that a policy of massive free ring-vaccination be adopted in the face of outbreaks of 1) caprine pleuropneumonia, since a more effective vaccine has recently become available and 2) haemorrhagic septicaemia. There would be a case for adding other diseases to the list should they arise.

Helminthiasis

Gastro-intestinal roundworms appear to be by far the major health problem of smallstock in the project area, but most specifically on the peripheral subhumid highland areas. To avoid the veterinary centres from being too involved with retail trade, it is recommended that suitable traders be encouraged to stock effective anthelmintics, e.g, "Panacur" (fenbendazole 2.5%, Hoechst) or Ranide (Rafoxanide Merck, Sharpe Dohme) which has been found to be very effective. The extension programme will advise the following dosing strategy: 1) pregnant sheep and goats two weeks before parturition and again four to six weeks afterwards at least; 2) for the flock as a whole, one dose at the beginning and the end of the rains. For lambs and kids the first dose should be four to six weeks after grazing begins if rain has fallen during this period. The second dose should be three months after grazing begins.

Ticks

Acaricide treatment of smallstock should be left to the initiative of the stockowners as they would appear to be locally and intermittently necessary. For example, in the past month, approximately 2,500 smallstock have been sprayed at Gatab, Mt. Kulal by joint IPAL and communal efforts, while at other times, there is a reduced need. Machakos type plunge dips using a 200 litre petrol drum and a cement drainage apron should be constructed at smallstock centres as they are more economical both in time and cost than spraying by hand.

Brucellosis

While generally considered to be an important disease, the evidence acquired by IPAL does not show brucellosis as having great significance in smallstock except possibly in goats in certain localities. The incidence in smallstock has not been related to that in the human population. Pending further investigation, it is recommended that the veterinary service include the epidemiology of the disease in the extension programme giving specific advice where problems occur and make use of vaccine as may be indicated.

Pneumonia

Exposure leading to pneumonia has been observed as a major cause of mortality among infant kids and lambs in wet weather. It also affects older smallstock if other stress such as malnutrition is present. Extension programmes should include advice to keep animals protected from wind and rain.

Diarrhea

It has been noted that diarrhoea occurs more frequently in pens with muddy floors and is often associated with apparently secondary coccidial infections. Advice through the extension programme is necessary.

Coenurus cerebralis.

This often fatal disease to smallstock may in some areas contribute significantly to overall production losses. The correct method of disposal of infected tissues should be explained to shepherds through veterinary extension.

To date investigational and clinical work to date has been fairly comprehensive but nevertheless has not found satisfactory answers to some of the problems; indicated further directions in which investigation is required; and by chance, not met with certain diseases that records from other sources show to be significant.

It is most important that a continuing investigational capacity be maintained by the Project, in cooperation with the veterinary service of the management project to elucidate the answers to the following problems.

- Trypanosomiasis: The significance, if any, of trypanosomiasis in smallstock.
- Brucellosis: There are indications for wider surveys to establish the

significance and incidence of Brucella abortus and B. melitensis and to establish the number and severity of resulting human infections.

- Pneumonia: Problems of pneumonia following exposure to wet and cold weather conditions suggest a need for trials with alternative types of pens for young kids and lambs. An ideal design would be cheap, wind and waterproof above and on three sides, moveable and easily cleaned. An annex to a human home would give some benefit from the warmth of a fire. Sometimes there is a high mortality of sheep at the onset of the rains, and more needs to be known about the causes of such outbreaks before control measures can be recommended.
- Foot abscesses: Severe although not fatal, outbreaks of foot abscesses in kids and lambs have been observed in wet weather. The aetiology and predisposing factors have not been established.

Although the development phase of the Project is not scheduled to begin until July 1984, some progress has already been achieved in the veterinary sector. For approximately eighteen months, veterinary clinics have been held by IPAL veterinarians at seven centres in western Marsabit District. These are held at least monthly, but at three of the centres more regular assistance is available (Ngurunit, Marsabit and Kulal lie in the subhumid zone where disease challenge to smallstock is more serious).

More recently, Project veterinarians have been accompanied by extension officers who help explain to stock owners the correct way of prevention and cure of the diseases encountered.

Since October, this Programme has been substantially boosted with the secondment of a Kenyan government veterinarian to the Project.

Smallstock Marketing

In an integrated programme of this nature, it is essential that lifting production constraints (e.g. through improved nutrition and disease control), be accompanied by a parallel removal of the constraints to offtake lest the gain in productivity be immediately lost through overpopulation and more severe overgrazing.

The problems of smallstock marketing have been investigated through questioning shepherds and traders and through the trial marketing of 250 Project animals at Marsabit, Maralal and Nairobi.

There is a need for a constant movement of goods and supplies within the management area. This may be achieved partly through providing basic essential supplies such as maize meal, milk, meat and other foodstuffs. It would relieve the need to keep livestock around settlements to provide subsistence food requirements.

At present, smallscale retail traders are unable to do so consistently because of a lack of sufficient working capital, lack of supplies, a poor road network, and the lack of adequate training in business. Facilities to promote a more commercial attitude and to encourage the substitution of money in functions traditionally provided by livestock are also lacking. These include:

- Investment opportunities providing better or more secure returns than livestock.
- Saving facilities such as banks.
- A reasonable exchange ratio for livestock and their products and the goods which pastoralists wish to purchase.

The following measures should be taken to improve the situation with regard to smallstock marketing as a whole:

- Market places. These should be set up in seven major centres in the area so that each should be on a specific day of the week to allow traders from all parts of the country to attend auctions.
- The number of animals offered at each market and the average prices should be daily broadcast in the vernacular radio services. This should be integrated with a national price reporting system on the national service. Prices of smallstock at the major markets of Isiolo, Marsabit, Maralal, Nairobi and Nanyuki should also be broadcast regularly on the vernacular radio services so that pastoralists are well informed and know what price to ask. Attempts should be made to provide information on the activities at markets in the area to all the major markets mentioned above. This may be achieved by individual letters sent weekly to the main smallstock traders in the area, or through radio, newspapers, public notices and any other appropriate media.
- Traders from the major centres should be encouraged to come and buy animals, especially on auction days and even help to transport them or to arrange transport or trekking in the initial stages.
- Loans should be made available to traders. The Agricultural Finance Corporation (AFC), the District Joint Loans Board and commercial banks should be encouraged to give smallstock purchase loans to the livestock purchasing section of the grazing committees. Traders from the area who deal in smallstock and who follow reasonable pricing policies should be provided with security by the Project, on condition that livestock bought remain within the surveillance of the Project until sold. Records of the smallstock purchases of traders should be kept for this purpose and also for the purpose of tracking offtake rates.
- Since smallstock can be trucked satisfactorily from Marsabit or Kulal southwards to the major centres, it is only necessary to provide trekking routes with water and adequate grazing within the area.

Smallstock By-Products

Livestock by-products are a relatively under-exploited resource. For this reason, it is proposed that a small unit be established under consultant guidance for the more efficient use of by-products. This unit will also provide training and demonstration. It is recommended that the unit be established at Logiogo because of the availability of water and good communications with Marsabit, the Kenya highlands and the management area including the drought reserve.

The major underexploited resource from smallstock is properly tanned hides. It is therefore proposed that the unit should include a tanning shed which could utilize tannin from the bark of *Acacia seyal* which is abundant and

regenerating near to Loglogo, or Kerosene which has the advantage of requiring very little water.

Smallstock Demonstration and Extension Units

An essential element of the training and extension programme will be the live demonstation to the people of the benefits of sound range management, animal husbandry and animal health.

Considerable interest has been shown by some Rendille in the experiments being conducted with livestock by IPAL, to the extent of their purchasing male animals from the Project for breeding purposes.

It is proposed that two smallstock demonstration units (one each in the northern and southern ranges), be established for the purpose of educating the pastoralists in these benefits. The units which will be operated and supervised by the project will accompany the grazing herds wherever they move. They will consist of a group of animals receiving a certain management input (treatment flock), compared with a flock not receiving input (control). Examples of specific inputs which should be demonstrated are:

- A comparison between the performance of improved Galla and small East African goats.
- Seasonal breeding for milk or meat.
- Feed supplementation with *Acacia tortilis* pods.
- Disease control of helminths.

Since it is expected that livestock owners will require precise information on performance, it will be necessary to carefully monitor all aspects of input and production, including the cost-benefit ratio. Careful control of such work will be necessary and this can be achieved by trained scientific assistants who should preferably be of pastoral origin and fluent in the local language(s).

The demonstration flocks may require 1,120 goats and 720 sheep or approximately twice the present stock holding of the project.

Conclusions

It is important to remember that these recommendatoins are only part of an integrated plan for range rehabilitation and sustained productivity and should not be treated in isolation from the other components. This plan is based on eight years of research involving more than fifty scientific contributors (UNESCO/IPAL, 1983).

There has been a deliberate attempt to emphasize and build on the beneficial aspects of the traditional system while eliminating the harmful ones.

Although the task is considerable, it lies mostly within the scope of traditional pastoral life and does not require large scale input of modern technology. Instead, the main need is for the education of and understanding by the pastoralist and a willingness to contribute manpower which is abundantly available. In this way, it is hoped a land use strategy will be

created which will remain viable long after the present scientists have left the field.

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USE OF OESOPHAGEAL FISTULA TO STUDY THE DIET PREFERENCE AND NUTRITIVE VALUE OF FORAGES FOR SHEEP AND GOATS IN SOUTH-WESTERN MARSABIT DISTRICT

By
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Abstract:

Oesophageal-fistulated (OF) sheep and goats were used to collect diet samples for determining the preference index (PI) of forage species and diet quality. This was carried out in different range units of IPAL study area where rainfall is unreliable both in time and space.

Fistula samples collected beween March and June 1983 in two range units were analysed for botanical composition, chemical analysis and digestibility. Comparison of the *in vitro* digestibility (IVDMD) and Nylon-bag digestibility of dry matter (NBDMD) methods for evaluating the nutritive value of these fistula samples was made. Crude protein, detergent fibre and ash contents of the fistula samples are reported.

Preference Index rating for each plant species is shown and is used to identify those species which are threatened with depletion. Percent contribution of each plant species to the diets of sheep, goats and camels are reported to show dietary overlap and possible competition between livestock species.

Introduction

The major objective of UNESCO-Integrated Project in Arid Lands (IPAL) was to formulate sound resource management plans for the Rendille Pastoralists of Marsabit District, northern Kenya. One of these plans was for grazing resource management and improvement. But before this could be done, information on the animal's diet preference and trends in diet quality throughout the year was required as the data base. Knowledge on the animal's diet preference is required for optimal forage allocation to the different livestock species and game compatible with the grazing resource in different range units. But a problem basic to animal nutrition and range management existed and that is to determine precisely the representative sample of the diet of an animal grazing freely in the range. Food ingested by grazing livestock are commonly assessed by means of oesophageally fistulated animals (Cook *et al.*, 1958; Van Dyne and Torell, 1964; and Theurer 1970).

The objective of this study was to determine the botanical composition and the nutritive value of diets collected by sheep and goats throughout the year. Also data from camels and cattle are included for comparison as they are normally grazed together in the same locality.

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Materials and Methods

Digestibility was evaluated using in-vitro and nylon-bag techniques (Tilley and Terry 1963; Van Dyne, 1962). Data collected between March and July 1983 in two range units are reported in this paper.

Study Area

The IPAL study area (23,000 K^2) has been classified by the Range Ecologists into 25 range units. The details of these range units have been described in the "Resource Management Plan for the Rendille Area of northern Kenya" (UNESCO-IPAL 1982). This paper reports data collected in range units 13 and 20.

Indigofera/Heliotropium with Acacia Dwarf Shrubland (Range Unit 13)

Occupies area adjoining Korr, Ilaut and Baio, and average annual rainfall between 190 mm and 250 mm. The vegetation attributes varies from an open Indigofera spinosa, Heliotropium albohispidium with hardly any tree cover, in heavily utilized areas, to an Acacia reficiens bushland with Indigofera/Heliotropium understorey in more woody areas. Other dwarf shrubs are Barleria eranthemoides, Indigofera cliffordiana and Sericocomopsis hildebrandtii.

Acacia Woodland (Range Unite 20)

Occurs on the footslopes of the Ndoto and Ol'Donyo Mara mountains at an average elevation of about 650 m a.s.l.; annual rainfall of about 400 mm around Ngurunit. This unit consists mainly of Acacia tortilis woodland with Duosperma eremophilum understorey in the footslopes around Ngurunit in South-Western Marsabit.

Animals

Two mature local sheep and goats as well as camels and cows were oesphageally fistulated and fitted with cannulae late 1982 and early 1983. These animals healed up after 2-3 months and thereafter with proper cleaning with disinfectant and regular clinical checks there were no major problems. Also two wethers and two goats were rumen fistulated and retained at Ngurunit station for nylon-bag digestibility trials of th fistula samples. These animals accepted the sample collection bags after a short period of training.

The use of animals was also prompted by the need to reduce the number of samples for chemical analyses and subsequently, the cost of analyses in terms of chemicals and technician time.

Sample Collection and Separation

Oesophageal fistula samples were collected fortnightly using screen-bottomed collection bags to allow drainage of excess saliva. One hour collection period was allowed except for cattle whose fistula tended to constrict after half hour. Fistula samples were separated by hand, sorted into different forage species and each species was weighed (fresh and air dried). For ease of identification of forage species, each fistulated sheep

and goat were followed throughout the collection period and the plant species and plant part it selected was recorded. Whenever there was difficulty in identification, a dissecting microscope was used to examine the extrusa closely. Finally, each separated forage species from each animal for single collection was bulked and mixed thoroughly before analyses. At each range unit at least six fistula samples per animal were collected.

Preference Index (PI) Calculation

Relative availability of each forage species and botanical composition in each grazed site in each range unit was estimated from 32 one square meter quadrats. Data on relative availability and percentage of the different plant species in the extrusa was used to calculate preference index values as proposed by Taylor (1973) as follows:

$$\text{Preference Index (PI)} = \frac{\text{\% in diet} - \text{relative availability (\%) in 1 m}^2\text{quadrat}}{\text{\% in diet} + \text{relative availability (\%) in 1 m}^2\text{quadrat}} \times 10$$

There % in diet and % in available forage refer to the proportion of a given forage species in the diet and the forage on offer respectively. The index has a scale from - 10 to + 10 indicating relative preference. A value about zero would indicate consumption in proportion to availability.

Chemical Analysis

Air-dry fistula samples were milled with a hammer-mill to pass through a 1 mm screen. Macro-Kjeldahl method (AOAC, 1975) was used in determining CP content. Detergent fibre components were analysed according to Georing and Van Soest (1970).

Digestibility

Two-stage *in vitro* digestibility procedure of Tilley and Terry (1963) was used to determine the digestibility of diet samples with rumen fluid from sheep as inoculum. Also 2 g (in duplicate) of the same samples were weighed into nylon-bags (indigestible fabrics) and immersed into the digesta of the rumen of fistulated sheep and goats for 48 hours. After 48 hrs, the nylon-bags with samples were removed, washed and oven-dried at 60 C. The net loss in weight of the samples after 48 hours retention represents the digested portion and was used to calculate the NBDMD. Standard samples were included in a run to correct for the variation between batches of samples. Nylon-bag digestibility technique was developed with a view to replace the *in vitro* with it as it is more appropriate in the field conditions.

Results and Discussion

Tables 1 and 2 show results of botanical composition in the diet of camels, sheep, goats and cattle as percent weight in Range Unit 20 and 13, respectively. The relative preference index (PI) values for forage species in the diet of livestock were calculated and reported on Tables 3 and 4.

Acacia Woodland (Range Unit 20)

In this Range Unit, sheep selected diets containing 59.1% grasses, 24.3% dwarf shrubs, 13.8% trees and large shrubs and 1.8% herbs. On the other hand,

goats selected diets containing 29.3% grasses, 1.4% herbs, 18.8 dwarf shrubs and 43.1% trees and large shrubs. The preference index values were highest in trees and large shrubs for goats (PI= + 3.9) and in grasses for sheep (PI= +3.5) which shows little overlap between the two species and hence ample grazing compatibility. On the contrary camels show similar forage preference with goats, while cattle and sheep also prefer one class of forage.

Goats preference was directed towards Hibiscus micranthus (+3), Grossandra nilotica (+6) and Cucumis spp (+8) in the dwarf shrubs and herbs class. Whereas sheep showed higher preference for Cucumis spp (+6.0), Grossandra nilotica (+8.6), and Ocimum spp (+5.0) in the dwarf shrubs/herbs class and Aristida mutabilis (+7.6), Cenchrus ciliaris (+8.7) Tetrapogon spp (+9.7) and Sporobolus fimbriatus (+6.3) in the grasses group.

Indigofera/Heliotropium with Acacia Dwarf Shrubland (Range Unit 13)

Dietary composition for goats and sheep in this range unit were 11.4% versus 7.4% for trees and large shrubs, 57.4% versus 34.1% for dwarf shrubs, 11.9% versus 11.6% for herbs, and 18.9% versus 46.9 for grasses, respectively. Most of the preferred dwarf shrubs by goats were Indigofera spinosa (PI= +8.9) Kedrostis gijef (+3.4), Sericocomopsis hildebrandtii (+4.2) and herb were Tribulus terrestris (+6.3), Grossandra spp (+3.8) and Abutilon fagrianum (+2.0); and no major preference for a particular grass species. Sheep preferred same dwarf shrubs as goats, but showed preference for herbs, Blepharis linariifolia (+5.4), Grossandra spp (+6.5), Euphorbia inaequalateria (+9.6) and Tribulus terrestris (+4.1). Range Unit 13 was generally of low inavailable biomass which was reflected in the high forage preference index values for all livestock species.

Chemical Composition

In Range Unit 20, the mean crude protein content of diet samples was 21.2% 19.4%, 22.3% and 10.9% for camel, goats, sheep and cattle, respectively (Table 5). These samples were collected in March following a 59.6 mm of rainfall in February. On the other hand, the CP content of samples from Range Unit 13 were 14.5%, 19.5% 17.9% and 12.9% for camels, goats, sheep and cattle, respectively (Table 6). Except for cattle, the livestock generally had a lower CP intake than in Range Unit 20. Dietary composition of cattle was mainly grass which accounts for the lower CP content. The diets of goats and sheep contained high CP in both range units.

What remains to be determined in these studies however, is whether there is addition of urea-nitrogen in saliva despite the use of screened-bottomed collection bags. Urea recyling through saliva, across the rumen epithelium and the wall of the lower GIT of ruminant has been documented (Bailey and Balch, 1961; Somers 1961; Cosimano and Leng 1972). Also Emmanuel et al (1976) reports increased urea recycling from 47% to 86% of the total urea turnover; as dietary protein content in the camels decreased from 13.6% to 6.1%. In the future, an attempt to investigate the possible urea recycling through saliva by these animals will be conducted.

Digestibility

In vitro digestibility of dry matter of the fistula samples collected

from Range Unit 20 were 37.7%, 47.1%, 48.9% and 54.2% for camels, goats, sheep and cattle, respectively (Table 5). The nylon-bag digestibility of dry matter of the same samples were higher (51.4%, 49.8%, 60.7% and 66.6% for camels, goats, sheep and cattle, respectively). Except for the samples from goats, the nylon-bag digestibility values were higher than the *in vitro* digestibility values. However, it should be pointed out that these samples are only exposed to the rumen fermentation and not the acid-pepsin stage as is the case in *in vitro*. However, between animal variation in digestibility values of the two techniques, may also be due to inoculum source, substrate or length of fermentation time.

Conclusion

From the results of the two range units, it appears that the botanical compositon of the livestock diets varied between the two range units. For example *Duosperma eremophilum* contributed 20.3% and 7.0% to the diet of sheep and goats in unit 20 and none in unit 13. The dietary composition also varied among livestock species with some overlap. Dietary overlap between livestock species may indicate competition but animal performance results, though not included here, will be used to confirm this.

Preference indexes (PI) which takes into account forage availability are very useful tools in grazing resources management. In most cases, the forages that have high PI values were threatened with depletion. PI values were also used to assess range condition, i.e. the PI values in Unit 13 were higher than those of unit 20 indicating poorer range condition in the former.

Cost of chemical analysis of samples was very much reduced unlike when hand-clipping of the forages observed to have been eaten by the animals.

Nylon-bag digestibility values were higher than IVDMD. However, the relatively low IVDMD values of diets collected by camel, sheep and goats were partially due to high lignin contents. The fact that these animals have consumed browse must be considered also, as many shrub contain large proportions of anti-quality factors, for example, tannin (Reed 1983).

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Table 1. Percent botanical composition by weight in the diets of camels, goats, sheep and cattle in acacia woodland range unit 20.

	Camels	Goats	Sheep	Cattle	% Availability*	Parts of plant consumed
Trees and Large Shrubs						
Acacia senegal	<0.1	0.8	-	-	NA	young twigs and leaves
Acacia tortilis leaves	0.3	2.5	-	-	NA	leaves + twigs
Acacia tortilis pods	-	1.5	4.8	-	NA	pods (fallen)
Boscia Coriacea	<0.1	-	-	-	NA	leaves
Cadaba farinosa	12.3	-	-	-	NA	leaves + tips of twigs
Commiphora boivinieana	-	4.8	-	-	NA	succulent twigs + leaves
Commiphora paolii	2.2	-	-	-	NA	leaves and buds
Commiphora ply	0.2	-	-	-	NA	leaves and buds
Cordia sinensis	<0.1	2.2	3.4	-	NA	leaves, twigs and fruits
Euphorbia cuneata	0.1	-	-	-	NA	twigs with leaves
Grewia bicolor	<0.1	10.3	-	-	NA	leaves
Grewia tenax	1.6	10.6	0.9	-	NA	leaves, few twigs
Grewia villosa	-	8.8	-	-	NA	leaves and twigs
"Lpekenyi"	6.7	0.4	1.2	-	NA	young shoots, and leaves
Maerua crassifolia	2.2	-	3.5	-	NA	leaves and twigs
Psychotria kerkii	0.1	1.1	-	-	NA	shoots and leaves
Salvadora persica	0.3	-	-	-	NA	twigs and leaves
Terminalia orbicularis	0.1	-	-	-	NA	leaves
Terminalia graveolens	8.8	-	-	-	NA	leaves + few shoots
TOTAL	35.2	43.1	13.8	-	18.7	
Dwarf Shrubs						
Barleria prionites	0.5	-	3.9	-	2.3	leaves, flowers, stem
Barleria proxima	1.4	-	-	-	2.0	leaves, flowers, stem
Dicoperma cinerophilum	46.0	7.0	20.3	-	21.1	leaves and buds
Heliotropium sp.	-	0.2	-	-	2.0	leaves + bit of stem
Hibiscus Micranthus	-	8.2	-	-	4.3	young twigs and leaves
Indigofera Cliffordiana	11.5	3.0	-	-	5.4	tops of plant
Indigofera spinosa	0.5	0.1	-	-	1.9	tops of plant
Kedrostis gijef	2.6	-	-	-	0.9	whole plant
Seriocomopsis hildebrandtii	0.1	0.3	-	-	T	leaves
Ocimum sp.	-	-	0.1	-	0.03	flowers and leaves
Vernonia sp.	0.1	-	-	-	0.8	whole plant
TOTAL	62.7	18.8	24.3	-	40.7	
Herbs						
Abutilon fagrianum	0.1	-	-	-	0.8	leaves, few shoots
Crossandra nilotica	-	0.4	1.4	-	0.1	leaves and growing points
Cucumis sp.	0.2	1.0	0.4	-	0.1	leaves fruits
Pupalia lappacea	0.1	-	-	-	0.3	whole plant without fruit
TOTAL	0.4	1.4	1.8	-	1.3	

Table 1 continued.

Forage Species	Camels	Goats	Sheep	Cattle	% Availability*	Parts of plant consumed
Grasses						
Aristida adscensionis	0.7	1.2	-	18.0	1.2	whole plant
Aristida Pallabilis	-	4.2	9.1	23.2	1.2	whole plant
Cenchrus Ciliaris	-	3.0	4.6	3.2	0.3	whole plant
Digitaria velutera	-	10.0	23.9	32.7	10.8	whole plant
Chloris Virgata	-	2.7	0.6	-	2.3	whole plant
Sporobolus fimbriatus	-	2.0	11.9	15.7	2.6	whole plant
Tetrapogon sp.	-	4.5	7.0	5.2	0.09	whole plant
Grass litter	-	0.7	2.0	-	9.7	
Bracharia lacrsioides	-	1.0	-	-	0.4	whole plant
TOTAL	0.7	29.3	59.1	90.0	28.6	
Unidentified	-	4.6	1.0	2.0		
TOTAL	100	100	100	100	89.3	

* % Availability does not add up to 100% because there are some plant species which were in quadrat but were not picked by the animals. Refers also to Table 3.

NA - Availability of individual species in the trees and large shrubs class not calculated but total available in the range unit is included. Refers also to Table 3.

Table 2. Percent botanical composition by weight in the diets of camels, goats, sheep, and cattle grazing on Indigofera/Heliotropium with Acadia Dwarf Shrubland. Unit 13.

Forage Species	Camels	Goats	Sheep	Cattle	% Availability	Parts of plant consumed
Trees and large Shrubs						
Acacia reficiens	9.0	5.4	2.1	-	NA	young twigs and leaves
Cadaba granulosa	7.8	-	0.7	-	NA	buds and leaves
Commiphora flaviflora	-	0.2		-	NA	leaves, buds
Commiphora paolii	-	4.1		-	NA	leaves, buds
Cordia Crenata	-	0.9	1.3	-	NA	leaves and regrowth
Euphorbia Cuneata	-	-	1.8	-	NA	leaves, growing points
Lycium Europaeum	8.5	-	0.5	-	NA	leaves; young stem
Maerua Crassifolia	6.0	0.8	1.0	-	NA	leaves and twigs
TOTAL	31.3	11.4	7.4	-	3.2	
Dwarf Shrubs						
Boerhavia sp.	1.5	0.2	-	-	0.2	leaves, flowers stem
[illegible]	7.2	-	-	11.2	1.8	leaves + twigs
[illegible]	8.9	-	0.5	-	1.2	tops of plant
[illegible]	13.9	3.2	2.2	-	4.9	tops of plant
[illegible]	24.9	29.5	2.9	-	1.7	tops of plant
[illegible]	-	14.5	18.7	-	7.1	leaves + tendrils
[illegible]	8.2	10.0	17.8	2.9	4.2	leaves
TOTAL	64.6	57.4	34.1	14.1	20.1	
Herbs						
Aquilaria [illegible]	-	5.2	-	-	-	leaves + shoots
Blepharis linariifolia	-	-	2.4	-	0.7	whole when young points
Crotalaria sp.	-	4.5	6.8	-	2.0	leaves + growing points
Euphorbia inaequilatera	-	-	1.2	-	0.02	whole plant
Tribulus terrestris	-	2.2	1.2	-	0.5	leaves, flowers, stem
TOTAL	-	11.9	11.6	-	6.2	
Grasses						
Aristida adscensionis	-	4.6	10.2	19.5	6.5	whole plant
Aristida mutabilis	-	-	11.6	25.2	12.0	whole plant
Cenchrus ciliaris	-	-	3.0	2.0	2.4	whole plant
Chloris virgata	-	-	3.9	-	0.8	whole plant
Dactyloctenium aegyptium	2.8	-	6.8	13.0	6.0	leaves + sheath
Leptothrium senegalense	1.3	5.8	5.8	17.6	16.4	whole plant
Tragus berteronianus	-	-	3.8	8.3	3.6	whole plant
Grass litter	-	0.4	1.0	-	18.2	-
Leaf litter	-	6.2	-	-	0.6	-
Sedge	-	1.9	-	-	0.6	whole plant
Digitaria sp.	-	-	0.8	-	0.8	whole plant
Unidentified	-					
TOTAL	4.1	18.9	46.9	85.6	67.9	
Unidentified	-	0.4	7.0	0.3		
TOTAL	100	100	100	100	97.4	

Table 3. Relative preference index values for forage species in the diets of camels, goats, sheep and cattle in Acacia woodland range. Unit 20.

Forage Species	Camels	Goats	Sheep	Cattle
Trees and large Shrubs				
Acacia senegal				
Acacia tortilis leaves				
Acacia tortilis pods				
Boscia coriacea				
Cadaba farinosa				
Commiphora boliviana				
Commiphora paolii				
Commiphora PY				
Cordia sinensis				
Euphorbia cuneata				
Grewia bicolor				
Grewia tenax				
Grewia villosa				
"Lpukenyi"				
Maerua Crassifolia				
Psychotria kirkii				
Salvadora persica				
Terminalia orbicularis				
Terminalia prunioides				
Class PI	+ 3.0	+ 3.9	- 1.5	-10.0
Dwarf Shrubs				
Barleria prionitis	- 5.0	-10.0	- 0.5	10
Barleria proxima	- 2.0	-10.0	-10.0	-10
Duosperma eremophilum	+ 3.7	- 5.0	- 0.20	-10
Heliotropium sp.	-	- 8.0	-10.0	-10
Hibiscus micranthus	-	+ 3.0	-10.0	-10
Indigofera cliffordiana	+ 3.6	- 2.0	-10.0	-10
Indigofera spinosa	- 5.8	- 9.0	-10.0	-10
Kedrustis gijef	+ 2.0	-10.0	-10.0	-10
Solanocarpus hildebrandtii	+10.0	+10.0	-10.0	-10
Solanum sp.	-10.0	-10.0	+ 5.0	-10
Vernonia sp.	- 7.7	-10.0	-10.0	
Class PI	+ 2.1	- 3.0	- 2.5	
Herbs				
Abutilon fagirianum	- 0.7	-10.0	-10.0	-10
Grossandra nilotica	-10.0	+ 6.0	+ 8.6	-10
Cucumis sp.	+ 3.3	+ 8.0	+ 6.0	-10
Pupalia lappacea	- 5.0	-10.0	-10.0	-10
Class PI	- 5.2	+ 0.3	+ 1.6	-
Grasses				
Aristida adscensionis	- 2.6	+ 1.0	-10	+ 8.7
Aristida mutabilis	-10.0	+ 5.5	+ 7.6	+ 9.0
Cenchrus Ciliaris	-10.0	+ 8.0	+ 8.7	+ 8.2
Digitaria Veluteria	-10.0	- 0.3	+ 3.7	+ 5.2
Chloris virgata	-10.0	- 0.8	- 5.8	-10.0
Sporobolus fimbriatus	-10.0	- 1.3	+ 6.3	+ 7.2
Tetrapogon sp.	-10.0	+ 9.6	+ 9.7	+ 9.6
Grass litter	-10.0	- 8.6	- 6.5	-10.0
Bracharia leersioides	-10.0	+ 4.3	-10.0	-10.0
Class PI	- 9.5	+ 0.1	+ 3.5	+ 5.5

Table 4. Relative preference index values for forage species in the diets of camels, goats, sheep and cattle in Indigofera/Heliotropium with Acacia Dwarf Shrubland. Unit 13.

Forage Species	Camels	Goats	Sheep	Cattle
Trees and Large Shrubs				
Acacia reficiens				
Cadaba glandulosa				
Commiphora flaviflora				
Commiphora paolii				
Cordia Creneata				
Euphorbia Cuneata				
Lycium Europaeum				
Maerua Crassifolia				
Class PI	+ 8.4	+ 5.6	+ 3.9	-10.0
Dwarf Shrubs				
Barleria sp.	+ 7.6	+ 1.0	-10.0	-10.0
Duosperma eremophilum	+ 6.0	-10.0	-10.0	+ 7.2
Heliotropium albohispidum	+ 7.6	-10.0	- 4.1	-10.0
Indigofera cliffordiana	+ 4.7	+ 2.1	- 3.8	-10.0
Indigofera spinosa	+ 8.7	+ 8.9	+ 2.6	-10.0
Kedrostis gijef	-	+ 3.4	+ 2.0	-
Sericocomopsis hildebrandtii	+ 3.6	+ 4.2	+ 6.0	+ 4.2
Class PI	+ 5.3	+ 4.8	+ 2.6	- 1.7
Herbs				
Abutilon fagiranum	-10.0	+ 2.0	-10	-10
Blepharis linariifolia	-10.0	-10.0	+ 5.4	-10.0
Crossandra sp.	-10.0	+ 3.8	+ 6.5	-10.0
Euphorbia inaequilatera	-10.0	-10.0	+ 9.6	-10.0
Tribulus terrestris	-10.0	+ 6.3	+ 4.1	-10.0
Class PI	-10.0	+ 3.1	+ 3.0	-10.0
Grasses				
Aristida adscensionis	-10.0	- 1.7	+ 2.2	+ 5.0
Aristida mutabilis	-10.0	-10.0	- 0.1	+ 5.0
Cenchrus ciliaris	-10.0	-10.0	+ 0.1	- 0.9
Chloris virgata	-10	-10	+ 6.0	+ 9.0
Dactyloctenium aegyptium	- 3.6	-10.0	+ 0.6	+ 3.8
Leptothrium senegalense	- 8.5	- 4.7	- 4.7	+ 0.3
Tragus berteronianus	-10.0	-10.0	+ 0.2	+ 3.9
Digitaria sp.	-10.0	-10.0	+ 7.9	-10.0
Sedge	-10.0	+ 2.6	-10.0	-10.0
Leaf litter				
Grass litter	-10.0	- 9.6	- 9.0	-10.0
Class PI	- 8.8	- 5.6	- 1.8	+ 8.6

Table 5. Chemical composition and digestibility of fistula samples from camels, goats, sheep and cattle grazing in Acacia woodland (Unit 20) in March and April 1983.

Dates:	2/3 - 9/3	16/3 - 25/3	30/3 - 6/4	13/4 - 20/4	$\bar{X}$
Camel					
CP%	23.3	27.4	18.2	16.2	21.2
IVDMD%	36.1	44.4	33.2	37.1	37.7
NBDMD%	52.1	61.9	45.8	45.8	51.4
NDF%	54.3	46.5	69.5	60.3	57.6
ADF%	38.2	40.4	58.6	45.6	45.7
ADL%	17.6	11.4	16.9	17.4	15.8
Ash%	1.0	0.8	0.8	0.3	0.7
Goat					
CP%	24.3	24.9	15.8	12.9	19.4
IVDMD%	47.6	40.0	52.3	48.5	47.1
NBDMD%	59.0	37.0	48.3	54.9	49.8
NDF%	58.5	53.3	67.9	63.5	60.8
ADF%	44.3	38.2	38.9	47.3	42.2
ADL%	12.2	18.0	7.5	12.9	12.6
Ash%	1.6	1.2	4.7	0.8	2.1
Sheep					
CP%	28.0	23.3	18.0	20.2	22.3
IVDMD%	55.2	49.9	49.0	41.5	48.9
NBDMD	66.6	62.8	64.6	49.0	60.7
NDF%	55.1	56.5	53.2	-	54.9
ADF%	42.5	45.1	35.5	-	41.0
ADL%	12.0	12.3	6.9	-	10.4
Ash%	2.9	2.3	3.0	-	2.7
Cattle					
CP%	-	-	-	10.9	10.9
IVDMD%	-	-	-	54.2	54.2
NBDMD	-	-	-	66.6	66.6
NDF%	-	-	-	67.5	67.5
ADF%	-	-	-	44.6	44.6
ADL%	-	-	-	6.7	6.7
Ash%	-	-	-	4.0	4.0

Table 6. Chemical composition and digestibility of fistula samples from camels, goats, sheep and cattle grazing in Unit 13 in May and June.

Dates:	14/5 - 27/5	30/5 - 4/6	14/6 - 20/6	21/6 - 24/6	$\bar{X}$
Camels					
CP%	14.4	13.8	14.0	15.7	14.5
IVDMD%	-	-	-	-	-
NDF%	57.0	67.2	71.1	66.6	65.5
ADF%	46.9	57.0	54.6	53.9	53.1
ADL%	15.3	17.1	16.7	19.8	17.2
ASH%	7.2	0.4	0.4	1.1	2.2
GOATS					
CP%	20.4	16.7	17.0	17.8	17.9
IVDMD%	-	-	-	-	-
NDF%	59.5	41.0	50.9	48.5	49.9
ADF%	49.3	35.5	34.3	37.1	39.0
ADL%	15.6	11.1	8.9	8.8	11.1
ASH%	3.7	5.1	2.1	2.5	3.3
SHEEP					
CP%	19.9	19.8	20.8	17.5	19.5
IVDMD	-	-	-	-	-
NDF%	60.6	57.6	50.7	58.5	56.8
ADF%	46.9	37.2	40.3	37.9	40.6
ADL	10.3	5.2	9.5	8.2	8.3
ASH%	4.4	3.6	1.8	3.2	3.2
Cattle					
CP%	16.8	12.3	11.6	11.0	12.9
IVDMD%	-	-	-	-	-
NDF%	59.6	68.6	73.8	67.6	67.4
ADF%	39.7	46.4	49.3	48.3	45.9
ADL%	8.7	6.8	8.3	7.6	7.8
ASH%	5.8	3.4	2.5	2.9	3.6

N.B. IVDMD results were not ready at the time of writing.

FORAGE MANAGEMENT FOR MILK GOATS

By
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Introduction

There are eleven womens' groups in Trans Nzoia District. Among these groups, the Birunda Womens' Group has been outstanding in fodder development for goat-milk production. The FAO/UN Pre-Extension Forage Evaluation Project situated at the National Agricultural Research Station in Kitale has taken a keen interest in the Birunda Womens' Group Goat Project which is situated only four kilometres from Kitale-Bungoma/Saboti road junction. The Birunda Project is on a 1.25 ha. plot and was started in 1981. In September 1982, it received aid in the form of 20 mature goats and other inputs from C.A.R.E., Kenya. These goats have now multiplied to 57. They are crosses of Toggenburg and Anglo-Nubian.

The project is manned by the women themselves under technical advice of C.A.R.E. and the FAO/UN Pre-Extension Forage Evaluation Project of the National Agricultural Research Station in Kitale.

The major objective of starting this project was to make the families of the members of the women groups' self-sufficient in milk production. Initially, the goats were to be kept at a communal parlour at the womens' group centre until the 18 months agreement between C.A.R.E. and the womens' group terminated. At the end of this period each woman would get two goats which she can keep on her farm. The group can, as well, sell the goats to outsiders.

Forage Development at Birunda Centre

With the help of the FAO/UN Pre-extension Project at the National Agricultural Research Station, Kitale, the Birunda Centre has been able to establish eight types of high yielding fodders. These include:

1. Bana Grass
2. Pakistan hybrid or Bajra
3. Giant panicum
4. Giant setaria
5. Silverleaf desmodium
6. *Stylosanthes guyanensis*
7. *Stylosanthes scabra*
8. *Leucaena leucocephala*

All the grasses have a small strip interplanted with silverleaf desmodium. The women established small plots of 32 m x 30 m each, except Leucaena which was 12 m x 10 m.

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Establishment of Forages

All the fodders were established in April 1982 at the beginning of the rains. The conventional tillage practices were used in the field preparation. The women got rid of all the rhizomatous weeds including couch (*Digitaria scalarum*) and others such as Kikuyu grass.

Pakistan Hybrid Napier

During establishment of napier splits were used.

Bana/Desmodium uncinatum

The legume was planted two weeks earlier at a seed rate of 1.5 kg/ha and napier was followed by planting in the same rows to avoid trampling on legumes when cutting napier grass, avoid wastage and also to facilitate easy weeding. The napier was planted at a spacing of 1 x 0.5 m using 3.5 bags of single super phosphate per hectare (SSP/ha.). The napier was allowed to remain in the field for 3 months after which it was cut for the first time to feed to the goats. It was thereafter cut every 4 weeks.

Desmodium and Stylosanthes

These were planted in pure stand at a seed rate of 3 kg/ha using 3.5 bags of (SSP/ha.) for each plot.

Giant Panicum and Giant Setaria

These were established using root splits at a spacing of 0.5 x 0.5 m with SSP/ha. of 3.5 bags of 50 kg. each.

Management of Forages

All the napier was cut every four weeks and given to the goats. After cutting the napier is not weeded until after 8 to 10 weeks. The goats' dung is applied at a rate of 10 tonnes per hectare during the rainy season per year. Applying at the beginning of rains gives the dung an ample period to decompose in a form that is useable by the forage.

The legumes (*Desmodium* and *Stylosanthes*) were grazed after five weeks since they are slow in growing. Grazing is done for only 30 to 45 minutes in the evening. The grazing is done in such a way that the rotation period is 5 weeks. This is treated as part of the supplementation. The legumes are also supplied with 10 tonnes per hectare of goats' dung at the beginning of the rains.

Leucaena being a tree legume with a slow growth rate was only browsed for the first time after 8 months. Thereafter it was grazed every 4 months. Browsing on leucaena was done only in the mornings for about 15 minutes. However, after two weeks leucaena was reduced to bare sticks due to their high palatability.

Giant panicum and Giant setaria were grazed for the first time after 3 months and thereafter every 4 weeks. Weeding is done after 8 to 10 weeks. After weeding, 8 tonnes of goats dung is applied per hectare.

When napier is cut a stubble of 15 to 20 cm is left from ground level while with Giant panicum and Giant setaria a stubble of 10 to 15 cm is left from ground level. These heights of stubbles allow quicker establishment of rosette crops.

Drought Resistance

All fodders or forages planted have prominent root systems and they are resistant to drought, therefore they stay green throughout the dry season. Therefore, they were used as emergency and supplementary feeds during the dry season when leys have failed to produce any green matter.

Forage Utilization by the Goat

On small scale farms where the feed supply is most often the limiting factor to realising the production potential of the dual-purpose cow, the goat may be a possible alternative. The goat being a smaller animal will more easily meet its nutrient requirements for maintenance and production potential.

At present goats may be making the most efficient use of the marginal land which is unimportant for other agricultural uses. However with scarcity of land in other high potential areas for larger ruminants, goats will play a part as a source of small but nevertheless significant supply of animal proteins of high biological value in the form of meat and milk, particularly for the low income classes of rural people.

As the number of small ruminants increases in the productive areas of Kenya due to improved management, disease and health control, a greater supply of feeds of the right quality will be required calling for intensified pasture and fodder production systems. There will be a need therefore, to identify and characterise forage materials that can provide enough herbage of good quality in order to meet the goats' requirements.

Systems of goat feeding is involved. Most of the feeds available on the farm like those aforementioned and other identified feeds will have to be described for optimal productivity of the goat. Presently the goat feeding system is focused entirely on natural grazing and browse sometimes supplemented with small quantities of household refuse. Such a system is characterised by limited quantity and quality of the nutrients available. An intensive feeding system is particularly appropriate for the high producing dairy goat with its greater demand for nutrients. Perhaps such a system can best be described through the experience of one of the goat rearing womens' group such as the Birunda Womens' Group.

Experience of the Birunda Womens' Group

Since it was realised that the keeping of goats will demand a feed supply, the first task the womens' group did was to request for some planting materials which would form the basis of any future feeding programme. The National Agricultural Research Station, Kitale provided the materials and its staff physically assisted in the planting. The total area under fodders is about 0.8 ha. and as has been mentioned, a host of fodders were planted which included fodder grasses, fodder legumes and fodder shrubs. The inclusion of

legumes with the other fodders was a means of improving both the herbage productivity and quality. The production of the goat will depend greatly on these two factors.

The feeding practice adopted by the Birunda Womens' Group involves rotationally grazing the fodder in the morning and evening hours for a few minutes. The rest of the time the goats graze and browse on the natural pastures and browse shrubs from the rest of the farm.

A notable feature from this feeding practice is that the goats had a preference of some forages over others. Observations indicated that the goats had a high preference for Giant Setaria, Leucaena, Desmodium and Bana. In fact Giant Setaria, Bana/desmodium mixture, pure stand of Desmodium and style had the highest score for palatability during the rainy season. However, during the dry season most of the fodders were not preferred by the goats. Notable were Giant Panicum and Bana. The latter tended to overmature faster and became very stemmy for the goats to eat, but after chopping it and feeding the goats in the stall, there was a marked increase in palatability.

Stylosanthese pure stands were found to be stemmy during the dry season but the chopped material of this fodder fed inside the stall proved to be a very good supplement to the outside grazing. Bana grass was also found to be an excellent feed if chopped and fed in the stall during the dry and wet season.

Since the goats could not acquire all their nutrients from these feeds particularly in the dry season, a supplementary feed composed of ground maize grains and ground sunflower heads-with-seeds was provided inside the stall in the evenings. The women obtain other extra feeding stuff from the neighbourhood such as banana leaves and maize stover. Mineral salts (Dairy lick) was provided mixed together with the maize/sunflower meal. The supply of water from a bore hole next to the stall was adequate during the wet season but the bore hole may at times dry off forcing the women to draw water for the goats from a neighbouring farm.

It can be seen that fodders have a big role to play towards increasing goat productivity. The fodders are particularly useful during the dry season when other leys have failed to produce adequate herbage. It will be vital in the future for other promising forages to be identified and incorporated into the current goat feeding practices. There is need to exploit other feeds such as Lupins, Russian Comfreys, farm and industrial by-products which are currently utilized by ruminant cows.

The Animal Production/Nutrition Section at the National Agricultural Research Station, Kitale has already earmarked some feeding trials based on locally available materials. One of the trials (by E.M. Kiruiro) is set to determine the performance of dual-purpose crossbred goats when fed on varying levels of Napier and Sweet potato vines. The trial will attempt to find optimal levels of these fodders that can sustain a high productivity of the goat in terms of meat and milk.

The collaboration of the Forage Agronomy Section and the FAO/Forage Plant development Project based at National Agricultural Research Station, Kitale, will provide other ecologically and agronomically adapted materials that can

be used for feeding the goats. It can be seen from the foregoing that a goat production system will focus more or less on forage production, management and utilization systems based on fodders integrated with farm by-products as exemplified by the Birunda Womens' Goat Project.

It must be borne in mind that such a viable project can only aim at exploiting the goat's potential if other goat management practices are followed. In the Birunda Project the management of the goat in terms of health control, disease control and other routine practices such as dipping the goats against external parasites, drenching against flukes and worms, clipping of hooves and maintenance of hygienic condition especially inside the stall are carefully followed, thanks to C.A.R.E. who have been responsible for assisting the project in this respect. In fact, their assistance has greatly help reduce the goat mortality while increasing the birthrate. From the original 20 mature goats obtained in 1982, the project currently has 57 goats. These achievements are also attributed to the cooperative attitudes in an even bigger project than the Birunda Womens' Group Goat Project.

MARKETING OF SHEEP AND GOATS FROM MARSABIT DISTRICT

By
G.K. Njiru[1]

Over the past four years, a study on constraints to livestock marketing was undertaken amongst the Rendille, a tribe occupying the southwestern quarter of Marsabit District. The study, done in collaboration with UNESCO's Arid Lands Project (IPAL), had the following objectives:

- To examine the structure and functioning of the livestock marketing system among the Rendille.
- To make recommendations on how best to improve the system to facilitate a high level of offtake.

An increase in the level of commercial sales was seen as necessary to improve the standard of living of the Rendille by making more money available to them and to reduce grazing pressure, especially after the introduction of a health and range development programme intended to increase livestock productivity (Lusigi, 1983).

This paper describes the sheep and goat marketing system and its constraints in Marsabit District. It will also suggest how these constraints can be removed to facilitate a higher level of offtake.

To the extent that Rendille conditions are similar to those in other parts of Marsabit and the dry rangelands of northeastern Kenya, these results could be generalised to such areas. Such generalisations must however be made with caution because market conditions depend on a number of variables including distance from demand centres, peoples' attitudes, and the level of commercialisation of an economy. These variables can change drastically over short distances or from one ethnic group to another.

Methods Used

A large proportion of the time between January 1980 and April 1982 was spent in the study area. During this period, the Rendille were observed in their villages (manyattas), while herding, at sales functions and at shopping centres. Formal and informal discussions with pastoralists, traders, and government officers, including the administration of questionnaires were undertaken. All markets where sheep and goats from the area are sent by traders and pastoralists were studied. Trekking animals to such markets and even participation in them through actual sales of IPAL livestock in some of cases were also undertaken.

Outlets For Sale of Sheep and Goats Open to the Rendille Pastoralist

A pastoralist wishing to sell goats or sheep has about four options open

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to him.

The first option involves selling the animal to other pastoralists who may need them for slaughter in a ceremony, for food, or who may have some money to spare and would like to invest in smallstock. While in some such sales the prices are determined by market forces, in others, social and cultural considerations are predominant so that the price may be higher or lower than the market price. At times, the animal owner cannot even refuse a request that it be exchanged for another which he may or may not desire without being viewed as anti-social. The latter type of exchanges are valued more for their social implications than the monetary gain such as creating obligations and extending social relationships.

The second option involves taking the animal to the nearest trading centre, slaughtering it, and selling the meat. This is not a lucrative option because there are few buyers and much begging occurs. Thus, rarely is more than half the meat sold. A large portion is begged away by friends and relatives. Sale of such meat does not involve weighing except in larger centres such as Marsabit. Price is negotiated according to the cuts so that, for instance, a hind leg may sell for X shillings and a front one Y shillings. With the exception of Marsabit and two other centres (Kargi and Laisamis) there are no stablished butcheries and meat is sold slaughter.

The third option involves selling the animal to the local butcher or hotel owner. As there are few established butchers and hotels with the exception of Marsabit, Kargi and Laisamis, the number of livestock involved is very small. Where butchers operate, pastoralists prefer to sell to them because of the slightly higher prices they receive than can be negotiated from local traders.

Finally, the most popular option is selling the animal to a livestock trader. There are four types of livestock traders operating in the area. These can be grouped as:

a. Local traders who, in addition to buying and selling cattle, sheep and goats, also own shops where they sell foodstuffs, household goods, clothing, etc. About 37 such traders are licensed to operate among the Rendille.

b. Itinerant traders who move on foot with donkeys and/or camels, buying animals and skins for cash or exchanging them with other animals or manufactured goods and foodstuffs. Numbering between ten and fifteen, these traders have no permanent residence in the area, usually coming from Samburu district to the south.

c. Large interdistrict traders who come and set up camp at one centre and buy large numbers of smallstock. These traders are not common because they experience much opposition from local traders due to offering higher prices. The arrangement preferred by local traders is for such traders to come and purchase smallstock from them.

d. The Livestock Marketing Division (LMD) which has been buying cattle in Marsabit district for many years.

As most sales are not recorded, it is difficult to estimate the number of livestock involved and the importance of each channel. A survey conducted in the Rendille area through interviews with 33 of the 37 traders operating there and a compilation of local inspected slaughter and sales to itinerant traders from chiefs in 1980 are shown in Table 1.

Table 1. Sale of Sheep and Goats Through Various Channels in Rendille Territory - 1980

	Goats		Sheep	
	no.	% of total	no.	% of total
Local slaughter	1,353	16.2	208	7.4
Sales to traders with shops	5,489	65.7	2,030	72.6
Sales to itinerant traders & at Marsabit market	1,507	18.1	558	20.0
Livestock Marketing Division and Kenya Meat Commission	0	--	0	--
Total Sales	8,349	100	2,769	100

Source: Survey data.

The figures show that local traders with shops control the major portion of the sheep and goat trade. Sales to itinerant traders and sales at Marsabit are the next in importance. Local slaughter is also important especially for goats but plays a rather insignificant role in respect to sheep sales.

The activities of the major livestock trade outlets are further discussed below.

Local Slaughter

This involves slaughter of animals to provide meat for sale at the trading centres in the area. Most of these centres are, however, populated by local pastoralists, each of whom is a livestock owner more or less dependent on his own herds for his meat supply. A significant market for meat exists only where there is a large concentration of traders, mission workers, primary school teachers, policemen and government workers. In such places, a constant number of animals are slaughtered every day with peak slaughter occuring on weekends and at the end of the month. Although retail meat prices are controlled in Kenya, the practice of selling meat by cuts means that such control prices cannot be enforced.

Lack of butcheries and the very hot climate where uncooled meat spoils in a matter of hours limits the expansion of these enterprises. The buying power of the people limits the prices that can be charged. Given the low prices, it does not pay to invest in buildings and cooling facilities. This in turn restricts the number of animals that can be slaughtered per day. As we did not have weighing machines, it was difficult to estimate the actual prices at which meat was sold on a weight basis. Nevertheless, prices varied with demand, carcass quality, and whether the slaughtered animal was a sheep or a goat, with the former commanding a slightly lower price. A rough estimate would put the prices at between 50% and 80% of the prices received at Marsabit

butcheries. Despite this, such 'butchers' were able to offer prices that were 10-15% better than those offered by local smallstock traders. This was partly because they wanted the better quality animals and had to pay a higher price to obtain them. In addition, they bought animals for immediate slaughter and did not incur costs such as losses through deaths, hiring herdsmen, and transportation to markets, which the local traders must incur.

Sales to Itinerant Traders

It was difficult to monitor the activities of this group since they tend to stay away from the trading centres and specialise in more remote areas. These individuals are independent small traders who buy smallstock in the study area and later take them out of the district for sale to butchers and the larger interdistrict traders. None are licensed to operate in Marsabit district and they are responsible for illegal movement of animals out of the district whether or not quarantine restrictions have been imposed.

Aware that their activities were illegal, the itinerant traders were hostile to any interviews and the few we could trace denied that they were traders, despite their being known by the locals as such. Estimates on the numbers of animals bought by them had to be gathered from local informants including some chiefs who had monitored their activities. They are, however, very popular with pastoralists because they offer better prices than local traders and are said to be less arrogant.[1] The prices they offer lie between those offered by local butchers and local traders with the latter being the lowest. Local traders dislike them because of the competition they cause, and are most vocal in their condemnation of the illegal nature of these trader's activities. They rightly point out that uncontrolled movement of livestock spreads livestock diseases. However, many of the local traders also occasionally move animals to other districts without a movement permit and their complaint is not genuine. Particularly in Laisamis and South Horr the activities of these itinerant traders often force local traders to raise prices in order to get animals. It appears that because they are mobile, itinerant traders are most suited to the nomadic conditions in the district. That they are able to pay better prices than local traders lends credence to this view. It is unfortunate that this type of trader is actively discouraged by the District Trade Office which insists on the possession of at least a semi-permanent building before it can grant a trade license to anyone (Personal Communication, District Trade Officer, 1981).

Livestock Marketing Division and Kenya Meat Commission (KMC)

Until 1983, the LMD and KMC did not play a major role in smallstock trade. In 1983, LMD purchased over 4,000 head of smallstock from Marsabit. Most of these animals came from North Horr and Marsabit town. The purchases scheduled in Rendille territory never took place since the LMD was ordered to stop buying after purchasing less than fifty animals.[2] The LMD was, however,

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[1] Rendille often complain that local traders who are mostly of Somali origin are very rude to them.

[2] There was a general freeze on government expenditure in the early part of 1983. This applied to the entire country and was not restricted to Marsabit District.

paying prices of Ksh 6.50 per kg liveweight, well above any prices that pastoralists and local traders could get for their animals from other buyers in Marsabit. The response to these prices was very good and should LMD continue buying smallstock at such prices, both traders and pastoralists will be encouraged to market large numbers of animals. A survey carried out by this researcher in March 1983 at Marsabit, Maralal, Kariobangi and Ogata Rongai showed that such prices were only bettered by high quality animals in Nairobi and could not be achieved in other markets. This was true despite the costs incurred for transport and other expenses involved by taking animals for sale away from Marsabit.

In his recent visit to Marsabit (February 1984), His Excellency the President directed the KMC to purchase Marsabit animals. If the prices are good, such a move by KMC would greatly improve the market for smallstock and other livestock in the district.

Traders with Shops in the Study Area

As shown in Table 1, these traders control about 73% of the sheep and 66% of the goat trade in the study area. Because they are licensed and are easy to locate, they were much easier to study than were itinerant traders.

Small traders buy smallstock from pastoralists who bring them to their shops over periods ranging from a few months to one year. Upon accumulating a sizeable herd they prepare to sell them. Several options are available. Traders can take the animals to Marsabit or Isiolo and sell them to a larger interdistrict trader there; or they can take the animals to Isiolo, Marsabit, Nairobi, Mombasa, or some other large town and sell to meat wholesalers and butchers or the KMC and even export them. The KMC and meat wholesalers slaughter the animals and sell the meat to butchers for subsequent sale to meat consumers. Some institutional costumers such as schools, colleges, and prisons are supplied directly by the KMC and meat wholesalers.

While the channels are are summarized in Figure 1, the most common channel is: pastoralist ----------> small trader ----------> large trader--->

meat wholesaler----------> butcher ----------> consumer.

Most large traders are located in Isiolo and Maralal while meat wholesalers are located in the larger municipalities. Hence, it is only the first step when animals in Rendille territory move from pastoralist to small trader. Table 2 shows the major destinations and proportions of small trader's smallstock that were sent there.

Table 2 indicates that about 86% of the goats and 73% of the sheep sold by small traders were exported from the district. The proportion is likely to be larger because some animals sold at Marsabit and falling under 'others' were sold to large traders who later transported them out of the district. When asked who they sold their stock to, 33 traders responded by saying, 1) a few big traders outside Marsabit (38%); 2) any buyer at markets outside Marsabit (58%) or 3) traders who come for them at the shop (4%).

Large traders take the lion's share of small traders offerings, particularly when it is realised that some of those selling to any buyer might

Figure 1. Marketing channels for sheep and goats from Rendille Territory, Marsabit District, 1983.

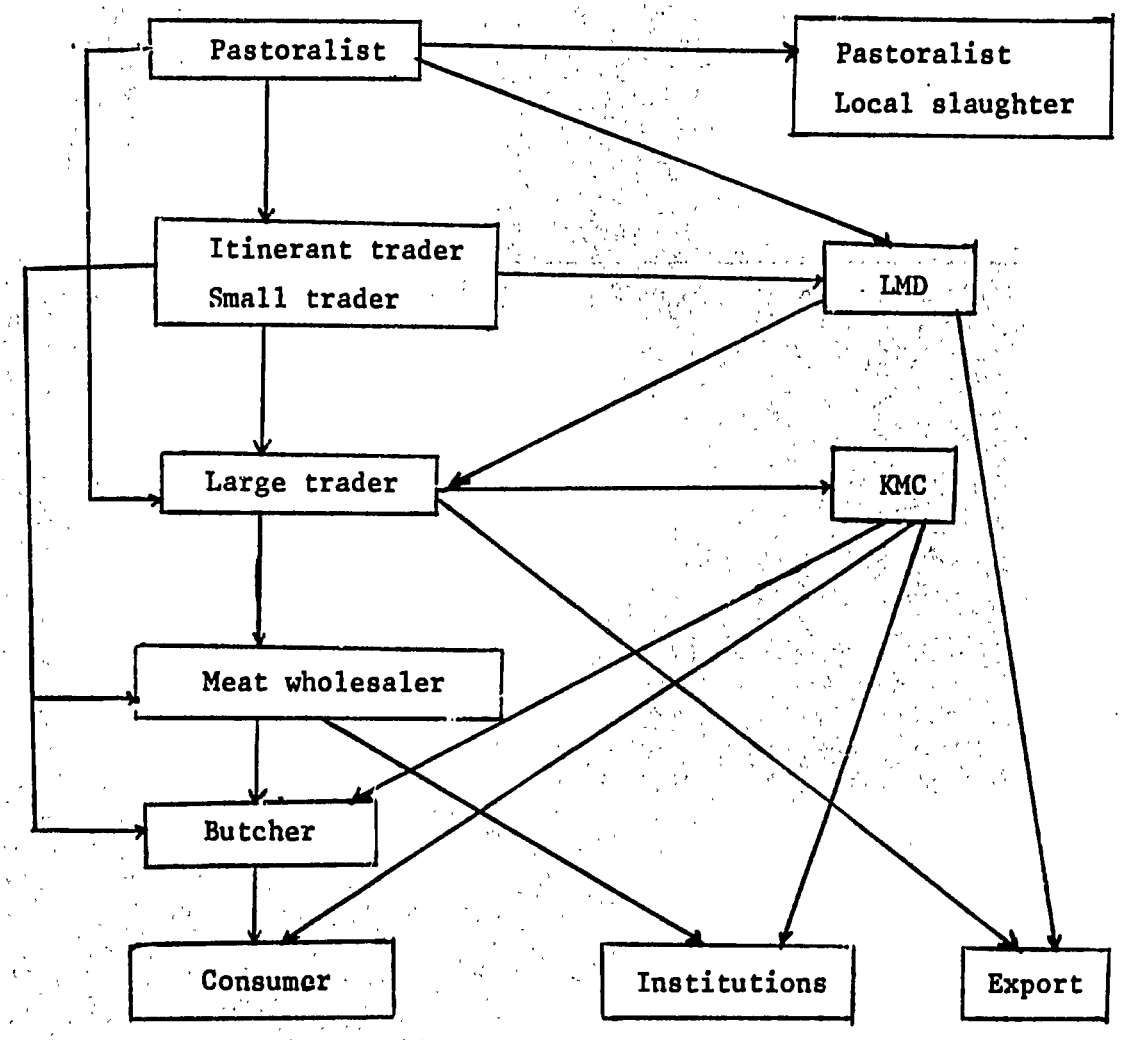

Table 2. Proportion of Small Trader's Sheep and Goats Going to Various Destinations from Marsabit District, 1980.

	Goats		Sheep	
Town	no.	% of total	no.	% of tota
Isiolo	1,132	23.6	325	22.0
Nairobi	1,720	35.9	680	46.1
Baragoi	633	13.2	22	1.4
Meru	642	13.4	60	3.9
Marsabit	420	8.8	330	22.3
Others	239	5.0	57	3.9
Total	4,786	100.0	1,474	100.0

Source: Survey data.

still end up selling some animals to these same large traders. Most of those selling to any buyer were the ones who took their animals to Nairobi where meat wholesalers are the predominant buyers.

Constraints to Raised Offtake

Low Prices

A major complaint often heard from pastoralists is that prices paid for their animals are so low there is little incentive to sell. This is partly true in that prices for livestock products are very low while the price for cereals, sugar, clothes and other goods are much higher than elsewhere in Kenya. This is due to the costs of transport and a poor distribution network. The point is well illustrated by the fact that in 1980, the farmgate price paid for smallstock per kg liveweight was only about 20 cents above the price of one kilo of locally ground maize meal.

There is a general belief that traders can afford to pay better prices but push prices down to increase their margins. In an attempt to test the validity of this statement, we tried to record each trader's costs and returns. This proved to be extremly difficult for a number of reasons. First, since most herding labour involved family participation which provided livestock, milk, clothing and food, and it was difficult to estimate its monetary worth. At the same time many of these costs were shared with animals belongings to the trader's subsistence herd or other traders which were herded together with the trade animals. For these reasons, it was not possible to estimate the costs that related to each trader's trading flock. However, we were able to calculate the costs for the average trading flock of 140 smallstock comprising 80 goats and 60 sheep. The following assumptions were made:

a. The trader bought the animals in the dry seasons of July to October and December to March and sold them in April to July after the animals had gained weight from the April-May long rains flush. Thus, he had the animals for 12 months.

b. One herdsman was employed for a salary (in kind or cash) of Ksh 200/month.

c. The probability that the animals would be sent to the market by truck at 15 Ksh/- per animal or walked there on foot at 5 Ksh/- an animal was .5 either way.[3] This gives an expected transportation cost of 10 Ksh/- per animal.

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[3] i) In the 1980 survey, the number of traders transporting their smallstock to the market by truck was slightly less than that of those trekking them.

ii) Lorry transport to Isiolo and beyond was about 15Ksh/- per animal.

iii) Costs per animal per trek depend on the number of animals involved. The cost of 5 Ksh/- was for a herd of 1,200 head of smallstock monitored from Korr to Isiolo over a one month period.

d. Losses from diseases, theft, etc. were on average 10% of the animals initially purchased.

e. The average purchase of 140 smallstock in 1980 by each trader was representative of other years.

Table 3 shows the average costs and returns for such a trader in 1980.

Table 3. Average Costs and Returns for a Trader's Herd of 140 Head of Smallstock, Marsabit District - 1980

Item	Cost/Return (Ksh)	
	Sheep	Goats
Revenue from sale per animal	146	160
Purchase price per animal	93.50	97.50
Herding costs	17.15	17.15
Losses from disease/theft/etc. at 10% of purchased animal	9.35	9.75
Transportation costs	10.00	10.00
Total Costs	130.00	134.40
Trader's margin, revenue-costs	16.00	25.60
Returns on traders money (%)	12.30	19.10

Source: Survey data.

Availability of Markets

Only 9.1% of the traders in the area thought that the market for sheep and goats inside Marsabit district was good. The remainder believed that the best markets were outside the district. Thus, large proportion preferred to sell their animals in Isiolo, Nairobi, Meru or Baragoi. Taking animals to these markets had the following disadvantages:

- The distances involved were large and the transportation costs high.
- Due to poor communications it was difficult to get information on supply, demand and prices in order to supply animals at the right time.
- The risks of animal loss from diseases and from long periods of waiting to get a buyer at these markets were very high.

The cumulative effect of all this was that the costs and risks of carrying trade were much higher than if the markets were located within the district.

Buying the animals from pastoralists also poses some problems. Except at Marsabit town, there are no market places where sheep and goats can be bought and sold. Pastoralists bring animals to the trading centres when they have a need for money. A trader wanting more animals than the trickle which is offered for sale in this manner has to go looking for them in Manyattas. This is an expensive and difficult undertaking as the animals are widely dispersed over the range and the people herding them often do not have authority to sell an animal so that consultations with owners in distant Manyattas may be

necessary.

As a result, most traders depend on the trickle which is brought irregularly by pastoralists and take long periods to buy a given number of animals. Because of the isolaged nature of each transaction other pastoralists do not know how much was paid and may keep from selling animals for fear of getting poor prices even when prices are high.

The establishment of market places in each centre and the setting of market days would greatly ease the problem of acquiring animals. Price information could also be gathered easily thus enabling pastoralists to respond quickly to any increase in price due to a surge in demand.

These margins of 12% and 19% for sheep and goats are fair given the high risks, the hard work involved, and the returns to trading in other sectors of the economy. Of course, the more efficient traders make higher margins by keeping the animals for a shorter period, controlling losses and looking for better prices, but traders cannot be accused of exploiting pastoralists at these rates of return.

Asked how the price paid to pastorlaists could be raised, 60% of the traders interviewed were of the opinion that the only way that prices paid for pastoralist animals could be improved was through the establishment of a sure market for smallstock in the district. A further 15% thought that it was the poor conditions of the animals that lead to poor prices. Hence, if this could be improved, traders would be able and willing to pay higher prices.

It was noted that even at these relatively low prices, there was no shortage of animals for sale. As long as they were patient, traders were able to buy as many animals as they wanted. Indeed, 75% of a sample of pastoral households from the area interviewed a year later indicated that there were long periods when they want to sell animals but cannot get a buyer.

Asked to give the reasons why they were unable to expand so that they could take all the animals available for sale in their areas, the interviewed traders gave the following answers: lack of markets (42.5%), lack of capital (39.4%), transportation problems (36.4%) and high losses from death (27.3%). Since these traders control a major share of the market and hold the key to its expansion, it is useful to look at these problems.

Lack of Capital

It is not surprising that many traders identified lack of capital as a major constraint to expansion. A large proportion were sole proprietorships (72.7%) and family businesses (15.2%) dependent only on their owners' resources for capital. Table 4 shows the value of smallstock purchases in 1980. As can be seen from the table, 57.5% of all traders spent less than Ksh 10,000 and only 18.2% spent more than Ksh 40,000.

This problem is further compounded by no financial institutions in the area which can lend money. The District Joint Loans Board is the main source of loans but gives very small ones of less than Ksh 10,000. Regardless, only 27.3% of the traders had ever received these loans, and all claimed that they were inadequate.

Table 4. Value of Smallstock Purchased by Traders in Rendille Territory, Marsabit District - 1980.

Value - Ksh	% of Traders
0.....	27.2
1.....5,000	12.1
5001.....10,000	18.2
25,000.....30,000	6.0
30,001.....35,000	9.1
35,001.....40,000	9.1
Over 40,001	18.2

Source: Survey data.

Borrowing from banks and other financial institutions outside the district is a remote possibility. However, lack of acceptable security and the transport difficulties faced by bank officials who may want to go and visit a trader's business have thus far proved unsurmountable. Only one trader has had a loan from a Bank in Nanyuki and this was negotiated while he was working with the government. In 1980, the cost of buying, herding and selling a lorry-load of 180 head of smallstock was over Ksh 20,000. This meant that many of those wishing to sell their animals further than Isiolo where trekking was possible could only do so if they combined their herds to make a lorry-load. It was often difficult to find a willing partner and this forced them to sell animals to larger traders at lower levels of profit per head than they could have received elsewhere.

With low turnover and profit per unit, the process of capital formation is extremely slow, justifying the traders complaints of lack of capital.

Transportation Problems

Two types of problems fall in this category:

a. Because of inadequate watering facilities on the routes to the various markets, trekking animals is only possible after the rains. The ample water available from pools which gather on the surface along the route, enables the animals to move over the large expanses without wells. This means that animals must be kept for a long period and cannot be sold at other times unless a truck, which was three times more expensive, could be hired.

b. For those wanting to take their animals to the market by truck, there were few lorries available in the study area for hire. In fact, no traders working among the Rendille has his own lorry and obtaining one to carry smallstock is difficult. The state of the roads is also so poor outside the Marsabit-Isiolo highway that large parts of the study area are inaccessible during the wet season to ordinary lorries. An inexperienced driver can also cause high livestock losses.

High Losses from Deaths

The loss of trade animals varies from year to year with climate, luck and the effectiveness of the herdsmen. Because pastoralists often sell sick animals, the probability of a disease outbreak in traders' herds is very high. Indeed, many try as much as possible to separate trade animals from their subsistence herd. On the other hand, losses from disease, predators, theft or accidents are quite high even for ordinary flocks in the area. Traders idicated that losses from less than 5% to 30% of the animals were quite possible. The risk of drought deaths is even higher for traders who usually buy animals hoping that the rains will fall. Drought losses are a common feature of Marsabit pastoralism. Even when there is no drought, lack of water over most of the area places a constraint on grazing.

This is a general problem over the area. During the dry season, animals are forced to congregate near the few waterholes. The immediate environs of such waterholes becomes overgrazed and the animals lose condition from malnutrition and disease to which the weakened animals are more susceptible.

Recommendations

Markets

The above discussion indicates that lack of a market for smallstock in the study area is a major constraint to trade. To overcome this problem, it is recommended that market places for livestock be established in each trading centre and that market days for each centre be designated so that anyone wishing to buy or sell animals can go there. It is further recommended that once or twice a year, large auctions which the KMC and LMD should attend together with other large traders, be encouraged. The Livestock Marketing Officer and the County Council of Marsabit should explore ways and means of publicizng and popularising these auctions to attract large buyers. Eventually, this should remove the need for each small trader to take his animals to Isiolo and other urban centres.

The establishment of market places and market days should begin immediately. Past experience at Laisamis where several thousand head of smallstock had been brought for the LMD purchases in 1983 (which never took place) indicates that the idea of auctions can easily catch on. During the 1950s, auctions or trade fairs where traders were encouraged to bring goods to sell to pastoralists proved popular (Sobania, 1979).

Market Information

Information on the prices of livestock and market conditions in Meru, Isiolo, Baragoi, Nairobi and any other markets of interest to traders in the study area should be broadcast regularly on the Rendille radio. This should give both the traders and pastoralists information with which to plan their sales strategies in Marsabit and other markets.

Itinerant Traders

These traders are adapted to trade in nomadic conditions because they are mobile and do not require much captial. The present policy of discouraging this type of trade should be reversed. The establishment of viable markets could help spread this form of trade by decreasing the distances travelled for the sale of the animals produced.

Cooperatives

In each trading centre, livestock marking cooperatives should be established to allow competition among traders and to try and raise prices paid to pastoralists. The cooperative officer should watch these very carefully to avoid the problems of corruption and misappropriation of funds. Presently, funds from various sources are available to cooperatives. This can help inject some money into the system. The cooperatives should, however, not be allowed to become monopolies as this can lead to problems should they later fail.

Transportation

Whether or not new markets develop to cater to all traders within the

district, those who buy smallstock must be able to trek them out of the district for most of the year. To facilitate this process, trekking facilities (rest places) and water should be provided between Marsabit and Isiolo at regular intervals.

The number of roads that are passable for a large part of the year should be increased so that at least the major centres of Korr, Kargi and Illaut are accessible at all times. As road building is expensive, attention should be concentrated on those sections that become impassable due to flooding.

The scarcity of lorries for hire can be solved if ways to finance their purchase by the larger and more enterprising traders are devised. Improving the state of the roads would help encourage transporters from other parts of the country to go to these places at reasonable charges.

Trading Capital

Lack of money to expand business has also been identified as a constraint. It is recommended that the district Livestock Marketing Officer liase with the managers of the new Commercial Bank about to be opened in Marsabit, the AFC and any other relevant credit institutions to see how short term working capital could be provided to marketing cooperatives and livestock traders. Traders should be encouraged to seek loans to expand business from any available sources.

The county council and the District Development Committee which will now be controlling government funds allocation should also divise more effective ways of helping traders other than the District Joint Loans Board, or increase the amount of loan that individual traders get from this Board.

The provision of supplementary feeds to animals just before being sold could greatly improve the livestock market price, particularly during the drier years. Financing of such finishing operations by AFC and other credit institutions should be tried to see whether they are cost effective.

Reduction of Losses

Currently, the mortality rate for both trader and pastoralist herds are very high. Efforts should be made to improve the delivery of veterinary services to the livestock owners in the area. Regular monthly clinics at all the major livestock concentration centres have been shown to be very effective (Rutagwenda, 1983). The benefits arising from an effective health programme are not very substantial because nutritional stress is at times more constraining than disease. However, in good years disease free animals will be able to build up better reserves for the inevitable poor years.

Nutrition stress in the dry periods could be further reduced if dams and wells were well distributed so that in dry periods animals were more evenly distributed over the range. At present large concentration of livestock around the few waterpoints deplete grazing and increase such stress.

Conclusion

These recommendations have been accepted by the Kenya government as the

basis for a new development project in Marsabit west. Future work will involve supervision of their implementation and monitoring the effectiveness of these interventions in practice. We plan to be very flexible so that anything that does not have the intended results will be substituted with better or more workable alternatives.

The authors wish to thank Mr. Joseph Atichi, Rural Sociolocy Field Assistant, for his help in collecting some of the data upon which this report is based.

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THE LEVELS OF FERTILITY IN A HERD OF RENDILLE GOATS

By
A.B. Carles[1], H.J. Schwartz[1], and C.R. Field[2]

Introduction

The Integrated Project in Arid Lands (IPAL) was established by UNESCO in 1976, with the aim of finding direct solutions to the most urgent environmental problems associated with desert encroachment and the degradation of arid lands. A study area was chosen between Marsabit and Lake Turkana. A major component of this ecosystem is the small ruminants and so a programme was set up to study their contribution to the performance of the ecosystem. The initial objective was to monitor the levels of the major traits of the performance of the sheep and goats, and the main factors affecting these. During the latter phase of these investigations, a health programme was introduced into the study, and its effects upon performance monitored as well. This ended in February, 1982.

This paper will present the results of the studies on the fertility of one of the herds of goats.

Materials and Methods

The description of the environment, the experimental animals, and the management systems which were monitored have been described by Carles, Schwartz and Field (1983).

The parameters chosen for describing the levels of fertility were age at first kidding, kidding interval, and litter size. An analysis of variance was possible for kidding interval, and the techniques required for non-orthogonal data were applied, using the computer programme SYSNOVA (Seebeck, 1975). The sources of variation examined were as follows:

Continuous variables:

1. The yield and length of the lactation that occurred within the kidding interval.
2. The weight loss that occurred during the 26 weeks following the onset of the same lactation as in (1).
3. The season of the first kidding, measured in two ways - the time (in weeks) from the previous rainy period to kidding, and the time from kidding to the next rainy period. A rainy period being defined as three consecutive fortnight periods with rain falling in each, and the level in the first period exceeding 9 mm.
4. Weight change during the month preceeding the second conception.
5. Weight at the second conception.

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[1] University of Nairobi
[2] Integrated Project in Arid Lands

Classification variables:

1. Age: defined by the number of visible permanent incisors (1 to 4 pairs), as the date of birth was unknown for 96% of the females.
2. The period during which the first conception occurred - the period being the time from the onset of one rainy period to the onset of the succeeding one.
3. Abortions: present or absent, during the kidding interval.
4. Health program: present or absent, during the kidding interval.

Results and Discussion

Only four does of known age kidded during the period of observations; for these the ages at first kidding were 94, 100, 128 and 132 weeks. The late age of first breeding, despite being run with bucks the whole time, is very striking.

Litter size, over a total of 209 births, was 1.0, and the least squares mean for the kidding interval was 66.4 weeks. These levels for kidding interval and litter size give a reproductive rate of 0.78 live births per breeding female per annum. It is possible that this figure needs adjustment to give a reproductive rate for all mature females, as barren females and those with single births only, have not been considered, although most of these had shorter periods available for breeding due to earlier deaths.

Even though reproductive performance is very much affected by lag effects, it would be reasonable to suppose that with three and a half year's observations, encompassing extremes of both wet and dry years, that the general level observed would be a fair estimate of the mean. In which case it is clear that the capacity for increase of this head at Ngurunit is much more limited than would be expected.

The analysis of variance of kidding interval is given in Table 1. Effects that were tested and found non significant, were age (as described by dentition), previous lactation yield, season of kidding previous to the second conception, weight change in the month preceeding second conception and weight at second conception.

The coefficient for weight loss was 1.042 wks per kg loss. The mean level of weight loss observed [± 50] was 3.113± 3.732 kg. which would give a change of 15.5 wks in kidding interval over a weight loss of the mean ± 2SDs. As this represents a change of some 23% of the adjusted mean this would be one of the major sources of variation, which is not surprising for a semi-arid environment.

The other three significant sources of variation are all involved in interactions and these are illustrated in Fig. 1. In the case of the interaction between the abortion class and conception period this is almost certainly attributable to the situation for the first period. The estimates of kidding interval for those animals aborting whose first conception occurred in this period is based on just two observations, and these were the most extreme kidding intervals of the data set. It is clear that abortions do contribute to an increase in kidding interval but the sample size is too small for any general estimates to be made. Of the 106 kidding intervals analysed, 14 were affected by abortion giving an overall rate of 13% so it is certainly

an important factor. Even though brucellosis is known to be widespread, tests for its presence in cases of abortions indicated that there were also other major causes and the most likely candidate would be weight loss.

The levels of kidding interval for does not experiencing abortion, indicate a trend for a decreasing interval, across the conception periods 1 to 5. There does not appear to be any association with rainfall pattern, and so the most likely explanation would be the effect of increasing age as initially the does were predominantly yearlings. Adjustment for age was attempted by including dentition classes in the model, but these could well have been too crude.

The interaction between lactation length and conception period is principally attributable to a high positive coefficient for the first period (0.618) and a negative coefficient for the second (-0.285); all the other coefficients were positive and ranging from 0.056 to 0.440 weeks per week of lactation. Both interactions appear to be caused by extreme observations (1 & 2 for the 1st and 2nd period respectively). For the others the positive coefficient is as expected. While lactation length has been as independent variable in the analysis, it is possible that it is dependent upon kidding interval.

Conclusion

The reproductive rate for this herd was very low. The age structure was not typical, with a bias towards young females. This may have been a major cause, but if it was not, then fertility would be the major constraint to productivity.

The other main effects were mostly associated with lactation. The stresses operating during lactation frequently caused body weight losses up to 20% of the weight at kidding, which were associated with a marked increase in kidding interval.

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Table 1

The Analyses of Variance and Covariance of Kidding Interval

Source of Variation	DF	Mean Square	F
Previous lactation length (A)	1	424	4.66 *
Previous lactation weight loss	1	243	2.67 NS
Period of first conception (B)	4	421	4.63 ***
Abortion (C)	1	631	6.93 *
B x A	4	207	2.27 NS
B x C	3	262	2.88 *
Residual	91	36	

Proportion of variance accounted for 0.579

x $P < 0.05$ xxx $P < 0.005$

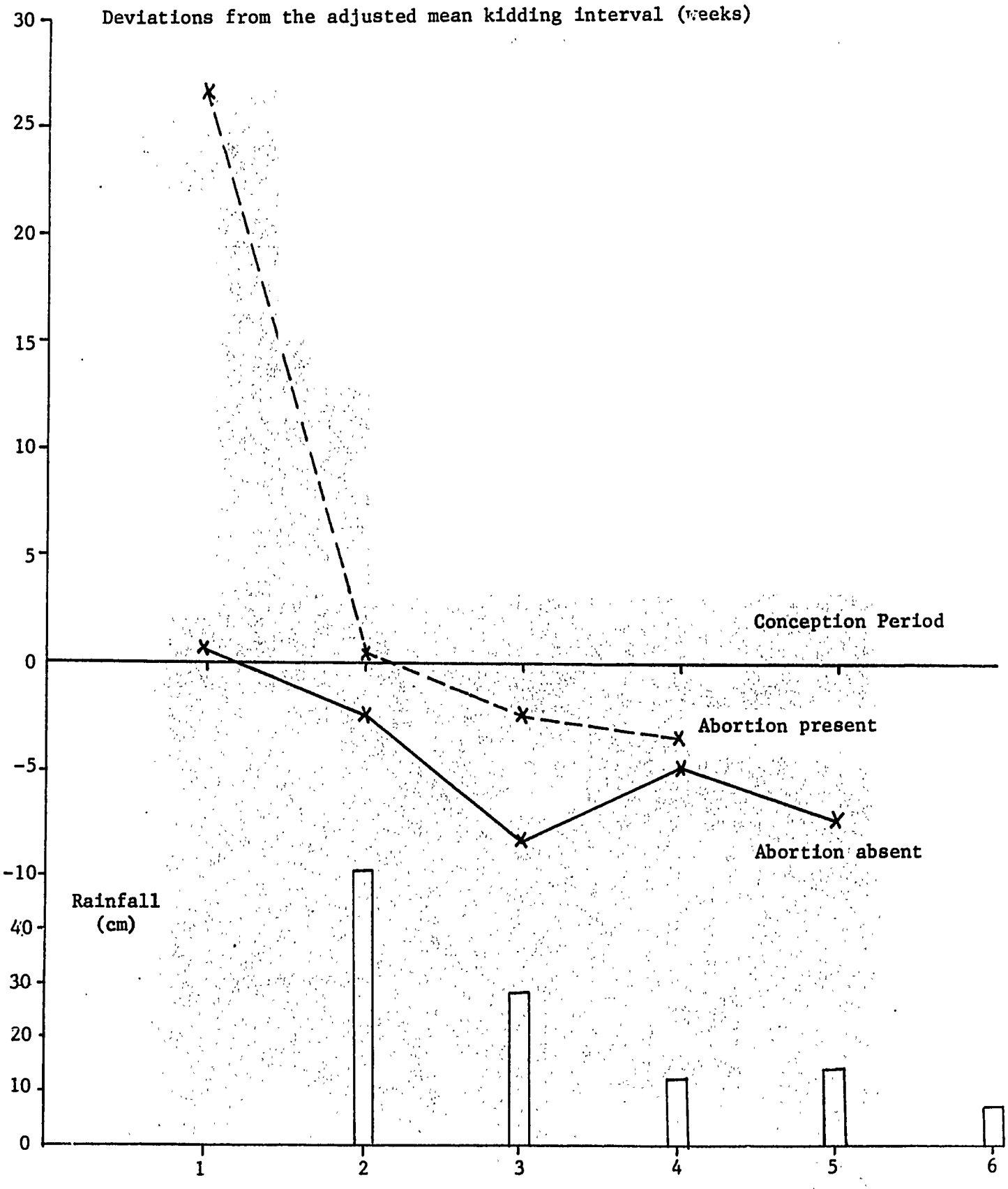

FIGURE 1. The levels of rainfall within conception periods, and the effects of conception period and abortion upon kidding interval.

PENETRABLE FRACTION OF FECES FROM SHEEP, GOATS AND CATTLE AT NRRS-KIBOKO

By
R.M. Hansen[1], S.B. Shaabani[1] and D.L. Whittington[1]

Herbivore feces are a mixture of the nondigested fraction of the diet with endogenous constituents (excretion products from the body such as digestive juices, cell detritus, microbes and their residues, intact cells, and cells in various stages of disintegration). Microscopic analysis of feces indicates that the nondigested fraction of the digesta comprise essentially solid plant fragments such as epidermis, sclerenchyma and vascular tissue. As plants mature, the digestible fraction of forage decreases. Presumably, endogenous substances in the feces are soluble and/or are smaller size particles which can pass through holes if an appropriate sieve size is used (Moir, 1982). An appropriate size for holes in a screen or filter would be that which separates nondigested solid particles from endogenous materials.

The purpose of this study was to determine if nylon cloth of the type believed to give reliable rumen digestion indexes for forages would be satisfactory for separating the endogenous substances in the feces of sheep, goats and cattle from the nondigested fragments. Our hypothesis was that the rumen digestion idexes of esophageal samples would be significantly correlated with the fraction in feces that would penetrate the same nylon cloth.

Procedures

Paired samples of esophageal and fecal material was obtained from sheep, goats and cattle grazing bushed grasslands at the National Range Research Station (NRRS-Kiboko). These paired samples were obtained from about 2 km southwest of the NRRS-Kiboko headquarters during the wet and dry seasons 1982 and 1983. After a 7 day period of grazing an area esophageal and fecal samples were taken from the same animal on the same day.

There were 12 pairs of samples for sheep, 16 pairs for goats and 22 pairs for cattle. The dry weight rumen digestion indexes (RDI) were determined for each esophageal sample by suspending the samples in nylon bags in the rumens of cattle for 48 hours. The nylon bags were 5 x 10 cm in size and were made of material having 50 threads per cm. Discernible holes or pores though the material could not be seen using 400X magnification. The standard procedures of Van Dyne (1962) and Quinton (1972) were followed using the nylon bag procedure.

The fecal samples were placed in nylon bags made the same size and of the same material as was used in the rumen digestion tests. These samples were tied on weighted nylon cords in the same way as the esophageal samples had been weighted and arranged for rumen digestion. The fecal samples were placed in buckets of tap water and washed 4 times each day for 48 hours to estimate

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[1] National Range Research Station-Kiboko (NRRS)

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the penetrable fraction (PF).

About 2 g of material was used in the nylon bags to measure dry weight losses of the esophageal and fecal samples. The paired samples were dried at 65 C and ground over a 1 mm screen. The oven dry weights (65 C) were taken for each sample before and after treatments.

After removal the nylon bags and their contents from the rumens or from the buckets owater, the samples were washed and rinsed with tap water in a bucket until no color in the wash water was seen. The bags plus their residues were oven dried at 65 C until no further weight loss before weighing to the nearest 0.01 g.

Results

The mean (± SE) rumen digestion indexes were: 68.9 ± 1.6% for sheep; 66.7 ± 1.4% for goats; and 72.0 ± 1.4$ for cattle. The mean (± SE) penetrable fraction of the feces were: 83.8 ± 1.12% for sheep; 85.1 ± 1.4% for goats; and 72.8 ± 1.0 for cattle. The coefficients of variation (CV) for the rumen digestion indexes and penetrable fractions, respectively were: 7.8 and 4.6 for sheep, 8.5 and 6.7 for goats and 9.2 and 6.6 for cattle. There was absolutely no significant correlation between rumen digestion indexes and the penetrable fraction of the paired esophageal and fecal samples of sheep, goats and cattle.

Discussion

Several studies show that trends in the chemical and/or fiber fractions of herbivore feces are associated with the corresponding values in the ingesta (Jarrige, 1965; Erasmus et al, 1978; Holochek et al, 1982). Fecal sampling is a relatively inexpensive, simple procedure compared to fistula sampling or stomach sampling (Holochek et al, 1982). The majority of studies which attempted to estimate dietary quality from feces have shown that there was at best only a low correlation between corresponding esophageal and fecal values. Perusal of the procedures used in most of these studies suggests that comparable samples of diet and feces were not obtained. Holochek et al (1982) found that cattle diets dominated by forbs and shrubs were not as closely correlated for fecal nitrogen and *in vitro* digestion of feces as were cattle diets dominated by grasses.

The penetrable fraction of feces in this study may not have related to the rumen digestion indexes for several reasons. Esophageal collections from steers in this study probably averaged about 500 g dry weight and those of sheep and goats proportionately less. It is likely that the values for one esophageal sample taken during less than an hour of grazing time per day is not comparable with the same values in feces. However, Jarrige (1965) reported the composition of sheep feces was more variable than that of corresponding forages. We believe more research is needed before values obtained from the analysis of herbivore feces can be used to estimate quality in diets.

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SURGICAL TECHNIQUE FOR OESOPHAGEAL FISTULATION

By
C. F. D'Souza[1]

The surgical technique for performing the oesophageal fistulation operation will be described with special reference to the goat (Caprine species).

Selection of Animals

a. The animals used for fistulation should be healthy and preferably in good body condition.
b. These animals should be accustomed to the environment, feed and to being handled.
c. Once the required number of animals have been selected, it is best to house them together and feed them on the diet they will receive after the operation.
d. Fistulation should be carried out 4-5 weeks before the animals are to be used for feed collection.
e. Normally, one extra fistulate is produced for every four or five animals to be used.

Pre-Operative Period

The animals should be kept off feed and water for 24-48 hours prior to the actual operation. Animals are examined clinically to determine health status and ability to withstand anaesthesia. The oesophageal cannula/plug is placed in a mild disinfectant solution.

Anaesthesia

Experience has shown the following anaesthetic to give satisfactory analgesia and muscle relaxation for up to 3/4 to 1 hour in goats:

1. Xylazine (Rompun[R] (Bayer) at a dose rate of 0.3-0.5 mg/Kg. b. wt. given intramuscularly. (0.2 ml/10 kg. b. wt. or 0.6 ml/30 Kg. goat).
2. Local anaesthetic infiltration (2% Lignocaine (2% Hostacaine[R]) if necessary. In my experience this has not been found necessary.

The animal is anaesthetised and prior to complete anaesthesia (after 10-15 minutes), the left side of the neck is washed with warm water and mild disinfectant, scrubbed with soap and the operation site shaved. The operation site is approximately midway between the larynx and the proximal part of the sternum and just on the left side of the midline. The area is shaved (approximately 4" x 4"), washed and swabbed with surgical spirit.

The anaesthetised animal is placed in right lateral recumbency, preferably on a table with a small sandbag (or padding) placed below the extended neck to elevate the operation site and oesophagus so that the head is

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slightly lower. The animal is restrained by confinement of all limbs and held by assistants if necessary. The patient is now stomach tubed using a soft pliable stomach tube. A foal stomach tube is excellent for this purpose.

The operation site is reswabbed with surgical spirit. At this stage the operator scrubs up and prepares for aseptic surgery. Sterile gloves are preferred. Sterile surgical instruments and swabs are used and the entire operation is carried out as aseptically as possible under field conditions.

Surgical Technique

A longitudinal skin incision, about 4-5 cm long, is made midway between the larynx and proximal sternum and slightly ventral to the jugular groove. The incision length is determined by the size of the plug and should be such that the stem of the plug fits easily into the hole ("stoma").
The oesophagus is reached by extending the incision to the underlying subcutaneous fascia and thence bluntly through the muscles or between the muscles of the neck (medial margin of the steno-cephalicus and lateral margin of the omo-hyoideus muscle).

Care is taken to avoid the major blood vessels, especially Jugular Vein, Carotid Artery and nerves (Vaso-sympathetic Nerve Trunk).

Location of the oesophagus is facilitated by the presence of the stomach tube in the oesophagus. At this stage the deep dissection is extended to the full length of the skin incision. An assistant manipulates the stomach tube while the surgeon guides it so that it protrudes with the wall of the oesophagus stretched over it. By cutting through the wall into the stomach tube with a single stroke of the scalpel, it is easy to find the lumen without interrupted dissection of the layers of the oesophageal wall. This also aids quicker healing. The edge of the incision is immediately grasped with a pair of Allis Tissue Forceps to prevent the mucous membrane from slipping away from the muscular layer.

The oesophageal incision is enlarged by cutting with scissors until it is the same size as the skin incision and the cut edges of the oesophagus are clamped to the skin at convenient points using Allis Tissue Forceps.

The "stoma" is then made by suturing the cut edges of the oesophageal mucous membrane directly to the skin - omitting the muscle and subcutaneous tissue - using a simple continous suture pattern. Inclusion of muscle and subcutaneous tissue causes swelling and "proud" flesh to develop. A non-absorbable, non-capillary synthetic suture material, size 2-0 (Nylon, Dermilene, Surgilon or Vetafil) is used. Simple interrupted stay sutures at the corners are also useful in case of suture breakdown.

After suturing, the size of the fistula may be checked by inserting the plug temporarily.

Antibiotic ointment is applied to the sutured wound edges of the "stoma" and the cannula is gently inserted (intramammary tubes found suitable). The ointment also serves as a lubricant. The plug is then fitted on to the protruding screw and clamped down by the winged butterfly nut. This is firmly secured by a split pin.

The stomach tube is now withdrawn and the animal allowed to recover from anaesthesia. The stomach tube, besides assisting in easy location of the oesophagus, serves the more useful function of keeping the operation site remarkably free from contamination due to regurgitation and also serves to automatically relieve any potential bloat problems.

Usually the animals are up and eating within 30 minutes or sooner. Some animals stand up immediately after the operation.

An intramuscular injection of penicillin/streptomycin is given when the animal has recovered from anaesthesia. (5ml Combiotic[R] i.e., 1,000,000 I.U. of Procaine Penicillin and 1.25g Dihydrostreptomycin). Antibiotic spray (Terramycin[R] Oxytetracyline spray) is applied around the wound.

Post-Operative Care

1. Antibiotic cover to prevent secondary bacterial infection for a further four days (5ml Combiotic I/M for 5 days).

2. It is advisable to disturb the plugs as little as possible. However, daily cleaning of the fistula, cannula and plug is beneficial. This is accomplished by washing with warm water (plus a mild disinfectant and re-inserting the cannula/plug (preferably with antibiotic ointment for the first few days). The position of the cannula (wing length of different sizes) is changed each day to avoid pressure being applied on the same spot continuously.

3. Some seepage down the front of the oesophageal fistula is inevitable. Therefore the area around the fistula should be washed with warm water (plus a mild disinfectant daily and sprayed with an antibiotic spray for the first few days).

4. The animals should be kept under close observation for signs of distress, anorexia, excess swelling, signs of obstruction or blockage at the plug, etc.

5. Rough feeds (hard grass nuts, concentrates, old coarse hay) should be avoided for the first few days. Softer feeds are preferable.

6. Sutures are removed 10-14 days after the operation at which time complete healing has usually occurred.

Some General Problems That May Arise

1. Secondary bacterial infection. Usually this is not a problem provided adequate antibiotic cover is given.

2. Blockages of the throat (at the fistula) occur from time to time with oesophageal fistulates. The usual signs of blockage (or of a lost plug) include presence of saliva in the water bowl or on the ground, saliva oozing from around the plug, swollen areas around the plug and strands of food protruding from the fistula.

   With careful observation and a little experience, blockages are easy to

spot. These animals should be attended immediately. Remove the plug and the offending material, wash the area around the fistula and replace the plug.

3. Animals that tend to block regularly may have a loose plug. These should be tightened, or if different size plugs are available, a slightly larger one may solve the problem.

4. Animals can and do remove the plugs with their front legs. However, the plugs are usually removed by scratching on fences, bushes or riding another animal. Careful observation is therefore necessary.

5. Occasionally, plugs get stuck down the throat. These should be gently retrieved using the fingers or artery forceps if necessary.

6. It is very rare to lose a plug down an animal's oesophagus. If this occurs, the plug usually lodges in the rumen where it does no harm. We have lost one steel cannula in this way and the animal has shown no ill-effects for over a year.

7. Some animals develop chronic ulcers and rings of fibrous tissue around the fistulae. These fistulae close rapidly on removal of the plug. Treat using antibiotic ointment or smaller plugs.

8. If the holes close or constrict excessively, they may be enlarged by making a longitudinal incision at the edge of the fistula with scissors or scalpel.

9. Conversely, some animals develop chronically enlarging fistulae. These may stabilize over a long period but such animals usually lose condition rapidly. This may be rectified by partial surgical closure.

10. If the plug is out for any length of time (usually more than sixty minutes) the fistula will start to close. It is possible to re-open the fistula by inserting a finger and rotating it gently until the plug will fit again. A local anaesthetic may be necessary.

Results

The operation has been carried out on ten cattle belonging to the International Livestock Centre for Africa (ILCA) at Emali. All operations were completely successful with the fistulated animals being used for sampling procedures thereafter.

Fistulation on twelve goats (six Small East African and six Galla goats) belonging to the Small Ruminant Collaborative Research Support Programme (SR-CRSP) have also been carried out. Here again there was a hundred percent success rate.

Acknowledgements:

I am especially grateful to my close friend and colleague, Dr. S. Varma ("Vijay") for demonstrating the technique initially whilst allowing me to participate. His teaching experience and professional expertise has always

instilled more confidence in me, thereby making subsequent operations all the more easy to perform. I would also like to thank Miss Nancy Ngugi for typing this paper.

THE VALUE OF A CHANCRE REACTION IN TRYPANOSOMAL SERODEME ANALYSIS

By
R.H. Dwinger[1], S.K. Moloo[1], and M. Murray[1]

Animal African trypanosomiasis is caused by three species of trypanosomes: T. congolense, T. vivax and T. brucei. Each of these species consists of an unknown number of antigenically different trypanosome populations (serodemes). To assess the possibility of vaccination, it is essential to determine the number of serodemes which exist. We have been examining the feasibility of using the chancre reaction which is induced by the establishment of trypanosomes in the skin following the successful feed of an infected tsetse fly to characterise serodemes. The basis for this work was that cattle and goats primed by cyclical (tsetse) infection with one clone of T. congolense are immune to cyclical challenge with a homologous but not a heterologous clone. Thus, immune animals fail to develop a skin reaction (chancre) and do not become infected, whereas, on heterologous challenge, chancres appear followed by parasitaemia. Experiments in goats have now confirmed that the chancre can be used to distinguish serodemes of T. congolense, provided the animals are properly primed. This is also true for T. brucei but not for T. vivax. However, problems were encountered when attempts were made to prime goats with more than one serodeme. Thus, when goats were cyclically infected with four serodemes of T. congolense, either simultaneously or at four day intervals, adequate priming was not always achieved. In fact, goats superinfected 8 to 12 days after primary infection did not develop chancres and subsequently were completely susceptible to homologous cyclical challenge.

A possible explanation of this "interference phenomenon" was that the primary infection had activated a non-specific response which limited parasite growth at the level of the skin with the result that chancres did not develop and the animals did not become infected.

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