

Norwegian Centre for International Agricultural Development
NORAGRIC
Agricultural University of Norway

Improved Feeding of Dairy Cattle and Goats
in Hot Tropical Areas
TAN 510

Final Report on Phase I
1982 - 1986
and
Prospectives and Strategies
for Phase II
1987 - 1991

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BIBLIOTEKET
Postboks 2
N-1432 AS-NLH

NORAD sponsored project at Sokoine University of Agriculture
Morogoro, Tanzania

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PREFACE

"Improved Feeding of Dairy Cattle and Goats in Hot Tropical Areas" (TAN 510) is a NORAD-sponsored project carried out at Sokoine University of Agriculture, Morogoro, Tanzania during the period 1982-1985(86). The year 1986 activities represents a continuation of TAN 510 and at the same time a transition period between the activities of TAN 510 and TAN 064. Therefore, the activities of 1986 are included in the Final Report named as Phase I 1982-1986, while TAN 064 is named as Phase II 1987-1991. The project was initiated and executed jointly by the Department of Animal Nutrition, Agricultural University of Norway (AUN), Norway and the Department of Animal Science and Production, Sokoine University of Agriculture (SUA), Tanzania (which was until June, 1984, the Faculty of Agriculture, Forestry and Veterinary Science, University of Dar-es-Salaam).

This report gives a brief outline of the activities within the frame of TAN 510. A major part of the resources were, particularly during the first years, centered on developing research facilities in terms of cattle and goat herds, animal buildings as well as necessary machinery and equipment for forage production and conservation at Morogoro. The project also enabled undergraduate and postgraduate students to carry out research for their degree work. A considerable amount of information and experience has thus been obtained, and the publications generated from these studies are listed in the report.

The experience from the project has focussed attention on the important link between higher education and research activities and also the need for a multidisciplinary approach in agricultural research. As an example we can mention the utilization of the leguminous tree Leucaena leucocephala in feed trials where close contact with Faculty of Forestry was found necessary.

During the period of TAN 510 NORAD has provided NOK 1.476.500 which was used for the salary of the Norwegian project coordinator, investment in buildings, equipment etc, and imports

running costs of the project. Sokoine University of Agriculture has contributed by providing available experimental animals and buildings as well as labour for research work. A most significant contribution was made possible by allowing the income generated through sale of dairy products from the project to be used for financing running expenses. Thus, the project became partly self-financing.

The research facilities established under TAN 510 should be a valuable base for future research at Morogoro. Therefore, based on experiences and results from the project, this report also includes some suggestions and proposals for the future work in this field.

The activities of TAN 510 have been administered jointly by AUN and SUA through the project leaders and coordinators. Professors A. Ekern and O. Syrstad were the project leaders from AUN while professors M.L. Kyomo, M. Mgheni and L.A. Mtenga acted as project leaders from SUA during their respective tenures as department head. The important role of running the project was carried out by the project coordinators Mr. L.O. Eik (AUN 1982-84), Mr. O.H. Evjen Olsen (AUN 1985) and Dr. N.A. Urrio (SUA 1982-86). The day to day field activities were led by Mr. J. Maimbi (SUA). The final report is written by Prof. A. Ekern, AUN and Dr. N.A. Urrio, SUA.

We take this opportunity to thank the above staff and all staff members of the Agricultural University of Norway and Sokoine University of Agriculture and other persons elsewhere who have contributed to the project for a fruitful joint research effort. The financial support from the Norwegian Agency for International Development (NORAD) is highly appreciated.

Morogoro/As August 1987

Muze Mgheni, prof.	Asmund Ekern, prof.	Ola Syrstad, prof.
Head Department of	Project leader	Project leader
Animal Science and	Department of Animal	NORAGRIC (AUN)
Production (SUA)	Science (AUN)	

CONTENT

	page
PART I THE DEVELOPMENT AND ACHIEVEMENTS OF TAN 510	1
1. Background and objectives	1
2. Organization and personnel	1
3. Development of experimental herds and research facilities	3
A. Cattle	3
B. Small ruminants	4
C. Buildings and equipment	6
D. Fodder production and conservation	7
4. Research activities	10
5. Production and economy	13
6. List of publications	14
PART II FUTURE PERSPECTIVES AND STRATEGIES DURING PHASE II 1987-1991	16
1. Basis for advice and proposals for future work	16
2. Proposed management systems and research activities for dairy cattle	16
A. Objectives	16
a. General objectives	16
b. Specific research objectives	17
c. Specific extension objectives	19
B. Implementation of the management system for the cattle herd at Magadu	19
a. Dairy cattle herd at Magadu. Numbers of animals and breeds	19
b. Feeding regime	20
c. Basis for estimation of feed requirements and land area required for forage production	21
d. Facilities for cattle research	23
e. Time frame	23
3. Proposed management system and research facilities for dairy goats at Magadu	24
A. Background and objectives	24
a. General objectives	24
b. Specific research objectives	24
c. Specific extension objectives	25

	page
B. Implementation of management systems for dairy goats	25
a. Herd size and management	25
b. Feeding and management regime	27
c. Basis for estimation of feed requirement	29
d. Special measures for controlling internal parasites	30
e. Specific improvements of research facilities	31

PART I DEVELOPMENT AND ACHIEVEMENT OF TAN 510

1. Background and objectives

Animal production in the tropics is mainly based on pasture. The availability of natural pasture is, however, variable due to periods of ample rain followed by periods of prolonged droughts. During the latter periods the quantity and quality of herbage is not able to support animal production. Supplementary feeding is therefore necessary in order to maintain milk production throughout the year. Concentrates which consists of mainly grain are the most common feed used for supplementary feeding in tropical areas like Tanzania. Because the animals thus consume grain which may be used for human food, alternative feed supplements would ease the problems of such competition.

The main objective of the project TAN 510 was therefore to study the possibility of improving dairy production from cattle and goats by means of cultivation and conservation of forages during the rainy season for storage and supplementary feeding during the following dry season. The studies carried out at SUA, Morogoro, Tanzania can systematically be listed as follows:

- * Establishment of forage plots for fodder production
- * Conservation of forages by means of drying and ensiling
- * Studies on the effect of harvest time and conservation method on the nutritive value of forages
- * The use of conserved feed for supplementary feeding of dairy cattle and goats
- * The use of sheep in nutrition experiments
- * Goat breeding programmes for milk and meat production

2. Organization and personnel

The project was financed by the Norwegian Agency for International Development (NORAD) through the International Development Programmes at the AUN. The professional supervision and running of the project was carried out by the project leaders and project coordinators respectively. In addition, an

advisory team at AUN guided the project by giving professional advice from time to time. The following personnel participated in the first phase of the project:

- Project Leaders** : Prof. A. Ekern AUN
 Prof. M.L. Kyomo SUA
 Prof. M. Mgheni SUA
 Prof. L.A. Mtenga SUA
- Project Coordinators** : Dr. N.A. Urio SUA
 Mr. L.O. Eik AUN 1982-1985
 Mr. O.H. Evjen AUN 1985
- Professional Researchers** : Prof. O. Syrstad AUN
 Prof. J.A. Kategile SUA
 Prof. A.B. Lwoga SUA
 Dr. L.L. Lulandala SUA
 Dr. J. Nedkvitne AUN
 Prof. F. Sundstøl AUN
- Postgraduate Students** : Mr. O.H. Evjen AUN
 Mr. E. Skaara AUN
 Mrs. E. Ndemanisho SUA
 Mr. S.V. Sarwatt SUA
 Mr. A.O. Aboud SUA
 Mr. R.S. Kidunda SUA
 Mr. R.N. Mero SUA
 Mr. D. Sendalo SUA
 Mr. R.A. Shoo SUA
- Undergraduate Students (Special Projects)**
 Mr. S.M. Leshongo SUA
 Mr. E.S. Mngulwi SUA
 Mr. E. Vanganyegela SUA
- Technical assistants** : Mr. J. Maimbi - Senior Field
 officer
 Mr. P. Mihalu - Field assistant
 Mr. Hamza Juma - Field assistant

3. Development of experimental herds and research facilities

A. Cattle

In March 1984, the project acquired 30 pregnant mature cows from the University farm, and these became the nucleus of the dairy herd at Magadu. These animals were of mixed age and breeds dominated mainly by Friesians and a few Jerseys and Ayrshires. The performance of these animals has been impressive in terms of milk production, while the mortality rates of heifer calves used for herd build up have been very low as shown in the tables below.

Lactation summaries for cows at Magadu farm 1984-1986

	1984/85	1985/86
No of animals	27	13
Average lactation length (days)	383	302
Average lactation yield (kg)	4155	3541

Number of calves born and their mortality rates at Magadu farm 1984-1986

	1984	1985	1986
Total No of calves born alive	26	12	21
Females	13	8	15
Males	13	4	6
Still births	2	2	1
Mortality rates (% of calves born alive)	0	8	9

Survival rates among cows and heifers at Magadu farm 1984-1986

	1984 Mature cows	1984 Heifer calves	1985 Heifer calves	1986 Heifer calves
No born/acquired	30	13	8	15
No surviving up to December 1986	12	10	4	11

During 1984 the farm was unfortunately struck by an outbreak of lumpy skin disease (LSD), which particularly affected the more mature animals. In addition, in 1985 there was an outbreak of Foot and Mouth Disease (FMD) which had catastrophic effects both on production of milk and on animal health and performance. These two diseases had never occurred on the SUA farm before. A vaccination programme for the diseases has now been initiated, and the diseases are well under control. Nearly all the deaths recorded in the cattle herd were associated with these diseases. The target for the cattle herd is to stabilize the number at 60 milking animals. In order to achieve this goal in the shortest time, plans have been worked out to purchase extra heifers in addition to raising replacement heifers at Magadu. In the future, any heifers in excess of the replacement heifers needed will be sold to farmers. It must be pointed out here that the animals at the SUA farm have good genetic potential for milk production and in the future the farm could be a good source of high genetic potential heifers for farmers. Being a herd which should also be used for research purposes, it has been decided to maintain only two breeds at Magadu i.e. Friesians and Ayrshires.

B. Small ruminants

In 1983 a group of 21 Norwegian goat kids, about 2 weeks old, were imported to Tanzania. The group was comprised of 16 females and 5 males. Another batch of 37 females and 5 males was added in 1984, making a total of 53 females and 10 male kids as an opening stock of the Norwegian goats. The principal objective behind this import from Norway was to create a nucleus population of dairy goats that could be used for both nutrition and crossbreeding studies.

The crossbreeding part of the project initially aimed at the development of five main genetic groups i.e. pure Norwegian, 3/4 Norwegian, 1/2 Norwegian, 1/4 Norwegian, and pure local as base populations for comparative performance studies. The primary intention of this plan was to find an optimum proportion of local and exotic inheritance for a dual purpose goat under Tanzanian conditions, and thereby develop a strategy for

breeding of goats exploiting both local and exotic genetic resources. It has lately been agreed, however, that the number of genetic lines should initially be limited to only two base groups, i.e. pure Norwegian and 1/2 Norwegian crosses in order to reduce the complexity of mating plans and allow for rapid expansion of the 1/2 cross line as well as maintaining a reasonable rate of replacement of the pure Norwegian line.

The performance of the dairy goats in the first two years was impressive. The average milk yield per goat per day was close to 1,5 litres the first year, inspite the fact that the goats were bred too early for Morogoro conditions. In the following year further progress was made and a number of goats produced to 3 litres of milk per day. In 1985/86 this progress, however, declined drastically. There was high mortality in young kids and among the bucks. Lack of adequate practical experience on the management of temperate dairy goats under a tropical environment may be among the most important reasons for this turn of events. Poor disease and parasites control strategies as well as improper feeding regimes accounted for most of the deaths. Nevertheless, substantial improvement has been made on this aspect in close cooperation with the Department of Microbiology and Parasitology and the Department of Veterinary Medicine at SUA.

In December 1985 two Norwegian bucks were sent to Livestock Training Institute (LITI), Tengeru as part of the extension programme and a number crossbreds have already been produced at that station. Other stations included in the extension programme were Dongobesh and Uyole Agricultural Centre. The programme for these stations, however, had to be delayed until the disease problems were solved. These programmes will be resumed during Phase II. In addition the extension programme will be extended to Mgeta village near Morogoro for which elaborate plans have already been worked out.

Originally meat goat and sheep were not included in the dairy project. However, a herd of such animals was already available at the University. Therefore, it was decided to utilize these

animals for general studies in ruminant nutrition. Thus, it was possible to include studies on mineral supplementation on growth rates and carcass characteristics in growing small ruminants. In the future it will be possible to include excess crossbred bucks from the dairy breeding programme into meat production studies as need arises.

C. Buildings and equipment

Prior to the initiation of the project TAN 510 there were five animal sheds at Magadu which had partially been abandoned as a result of the failure of an earlier attempt to establish a dairy farm at Magadu. The earlier project was financed partly by DANIDA who was mainly responsible for construction of the milking parlour, which includes installment for feeding, milk and feed storage rooms etc. These facilities had been mostly out of use since 1977. The calf rearing house had been converted into a piggery unit and the hay shed was turned into a temporary poultry house. Under project TAN 510, the piggery house was reconstructed into a goat house capable of holding about 150-200 goats. The house was partitioned into several pens suitable for individual/or group feeding regimes. The milking parlour for goats was renovated and put into use and one of the store rooms adjacent to it was made into a kid rearing room. The milking parlour for dairy cattle was completed under DANIDA assistance in 1984 and was put into use for the first time under project TAN 510. Temporary calf pens were constructed in the hay shed which had been turned into a poultry house. These functioned very well and will be constructed into a permanent calf rearing unit under Phase II of the project. A cow feeding shed capable of holding 63 cows under individual feeding arrangement was renovated and put into use. The path leading from this shed to the milking parlour which was hitherto muddy and difficult to cross, was filled with gravel and concrete drainage channels were constructed. This made accessibility very satisfactory. The area surrounding these barns was fenced for better handling and control of the animals.

All the animal houses were repaired or rebuilt and made suitable for keeping animals under feeding and/or breeding research studies.

Equipment in terms of working tools and machinery was imported from Norway. This considerably improved the efficiency of running the project. The Department of Animal Science owned two old tractors which were in bad shape due to the lack of spare parts. The tractors have been put into operation again by importing spare parts and tyres which were scarce in Tanzania. Towards the end of 1985, a new tractor and a flail forage harvester were purchased. This considerably improved forage production capacity. Also, a two wheel hay mover was imported. This machine was very useful for harvest of grass for direct feeding and hay-making and was also effective in general cutting and cleaning of the surroundings at Magadu. In addition, a number of hand tools were also provided for the project. These included wheel barrows, milk cans, milk buckets, balances, and building materials such as nails, hinges, netting, fencing wire. Laboratory chemicals and glassware were imported to enhance research activities. Veterinary drugs were imported to supplement local supplies and freezing facilities for storage of these drugs were provided.

D. Fodder production and conservation

Improved feeding of both dairy cattle and goats is based on fodder production and conservation. This can thus be regarded as the backbone of the project. Natural grasslands in Tanzania tend to be of low feeding value because they are dominated by early-flowering grasses which have low protein values and low digestibility once they mature. In addition, the amount of legumes occurring naturally is too low to supply a useful amount of protein to the sward. Particularly for high producing animals it is, therefore, necessary to improve fodder production and conservation. Careful consideration of the whole soil-climate-management environment is necessary before choosing a new grass or legume for a pasture. Some species can be expected to thrive under conditions where other species may fail completely. At the onset of the project, about twenty

different species of forage plants were established on small plots of 50 m² for evaluation of their suitability for forage production and feeding. From these studies the following were identified as the most suitable forage species for Morogoro conditions:

- * Grass species suitable for cut and carry method - Tripsacom laxum (Guatamala grass)
- Pennisetum purpureum (Elephant or Napier grass)

- * Grass species suitable for haymaking and grazing - Chloris gayana (Rhodes grass)
- Brachiaria spp.

- * Leguminous forage suitable for stall feeding and grazing - Leucaena leucocephala

- * Legume species suitable for inclusion in pasture leys - Microptilium atropurpureum (Siratro)
- Desmodium intortum, and Desmodium uncinatum
- Calopogonium muconoides

One of the major constraints in establishing pasture is the availability of seeds. Establishment from seed is the least laborious method, but this is not feasible with some species eg. Brachiaria spp. and Pennisetum puripureum, which do not produce viable seed and which must be established vegetatively, using splits or setts. Among the grass species identified as suitable, species Chloris gayana was the only one for which seeds could be obtained. Even for this species, however, seed viability was rather low. Although it was planned to establish about 15 ha with this grass, so far only 7 ha have been successfully established. For further expansion seeds will have to be harvested from the established field. It is anticipated that availability of irrigation facilities will greatly ease establishment of the other species which have to be propagated using splits or setts. An area of about 2 ha was

planted with Guatamala and Elephant grass, and this has been very valuable feed for goats.

Special consideration has been given to the leguminous tree, Leucaena leucocephala. This tree seems to have very high potential because it is a legume capable of fixing considerable amounts of nitrogen, and it has a rapid and continuous growth throughout the year even during the dry season. The leaves, bark and branches have high protein content and are very palatable, particularly to goats. With close cooperation with the Department of Forestry Biology about 10.000 trees have been planted, and it is planned to expand production of such forage to produce sufficient fodder for goats and cattle throughout the year.

Silage making is one of the promising methods for forage conservation. Maize and sorghum were the only species used in the project, except for the ensiling studies where also Chloris gayana was included. Both species were very valuable as they are easy to establish and give very high forage yield per ha. The crops were ensiled in three big trench siloes (each 3.5 m wide, 25 m long and 2 m deep) dug into the ground near the cow feeding shed at Magadu. The pits were made with self supporting walls out of the natural hard soil without use of concrete. The quality of the silage was somewhat variable throughout the first phase. From practical experience it appears that the trench siloes used were too large as it took too much time to fill them. It appears therefore, that it would be better to have several small siloes which can be filled and sealed within the shortest time possible. It also appears that concrete walls would be an advantage in order to minimize soil contamination from the walls which tend to erode with time.

Hay making was only carried out on a limited scale mainly due to the lack of adequate forage. Hay made from Chloris gayana and mixed with Siratro gave promising results. Hay was also made from Brachiaria plots, and this species seemed to be preferred by cattle. It is planned to expand the acreage for

this species using splits. Hay making was improved by the use of the hay mower.

4. Research activities

The research activities include various aspects of plant species selections, forage production, conservation and utilization. They are listed under the following headings:

i. Evaluating plant species for pasture production

Studies on evaluation of plant species for pasture production in terms of productivity and adaptability comprise two M.Sc. projects by Mr. R.S. Kidunda and Mr. E. Mtengeti and two special projects (undergraduate) by Mr. S.M. Leshongo and Mr. E.S. Mngulwi. Based on the results obtained, some of the most promising and suitable species for Morogoro conditions were identified. This work has to be continued in order to find species which can tolerate grazing and harvesting and be hardy enough for more permanent pasture. (Publication no 3 section 6).

ii. Forage production and utilization

Most of the work done so far comprises observations made on the yield and quality of forages grown at Morogoro. These observations were part of the M.Sc. thesis of Mr. O.H. Evjen Olsen and Mr. E. Skåra. The results from their measurements and observations are presented together with a literature review and discussion of some major problems related to dry season feeding in Tanzania. (Publication no 6 section 6).

iii. Studies on supplementing grass hay with legumes

Grass hays are generally low in protein. Therefore grass/legume mixtures may represent a better quality forage with a higher nutritive value. As part of his M.Sc. programme R.N. Mero studied the effect of supplementing Chloris gayana hay harvested at three different stages of growth with the legume Microptilum atropurpureum (Siratro) on voluntary intake and digestibility in small ruminants. He also included measures of forage yield and composition. (Publication no 4 section 6).

iv. Studies on ensiling of forages

If forages are to be used as supplementary feeding during the dry season some form of conservation has to be applied. Drying during the rainy season is one possibility. Ensiling may be an alternative and is systematically been included in the Ph. D. study of Mr. S.V. Sarwatt. The study includes: ensiling of maize, sorghum and Chloris gayana (grass) in small laboratory siloes, in bigger experimental siloes (sufficient feeds for digestibility studies) and in small pit siloes dug into the ground. Furthermore, the ensiling is done with and without additives of urea and/or molasses. Also, chemical composition and feeding values of the resulting silage are being studied using small ruminants as experimental animals. Such studies are combining systematic methodology with applied approaches to an important problem in Tanzania.

v. Studies using Leucaena leucocephala as feed for ruminants

Leucaena leucocephala is a leguminous tree high in protein which can be harvested at intervals throughout the year. The studies include feeding of leucaena as a high quality feed supplement to dairy goats, supplementation of feed for goat kids with leucaena and/or grass hay and the effect of replacing concentrates with leucaena. Part of the studies have been undertaken by the two Norwegian coordinators Mr. L.O. Eik and Mr. O.H. Evjen. One special B.Sc. project, by Mr. V.R.M. Muhikambele and one M.Sc. project by Mr. R. Shoo have been completed. (Publication nos 5 and 8 section 6). In addition a Ph. D. project by Mrs. E. Ndemaniho is in progress.

vi. Mineral status of soils and forages and need for animal supplementation

Minerals are essential for animal health and performance. Because of indications of mineral shortages in the goat herd, this problem was studied experimentally despite not being specifically mentioned in the original plans. The problem is, however, of general nutritional significance

for animal growth as well as for meat and dairy production. The study includes the link between mineral status of soils, forages and need for animal supplementation. The study was a M.Sc. project by Mr. D. Sendalo. (Publication no 9 section 6).

vii. Studies on some economic traits in Norwegian and Tanzanian x Saanen goats

The observations of milk yield and composition, growth rates of kids, kidding percentage etc. of pure Norwegian goats and Tanzanian X Saanen goats kept at SUA were used for analysis of some economic traits in goat production. The results were presented at the 12th Scientific Conference of the Tanzanian Society of Animal production, Arusha, Sept. 1985. (Publication no 2 section 6).

viii. Studies on semen quality of Norwegian, Tanzanian and crossbred bucks

After the import of Norwegian goats it is of interest to know how Norwegian bucks respond to high temperatures in Tanzania with regards to semen quality. The study covered about 30 pure Norwegian, Tanzanian and crossbred bucks. The study was a M.Sc. project by Mr. A.O. Aboud. (Publication no 1 section 6).

ix. Studies on various aspect of goat and cow milk quality

Studies on milk obtained from the goat and cow herd at Magadu were carried out by the dairy technology laboratory, SUA. The study includes milk composition, milk hygiene and adulteration as well as production of butter and ghee from milk produced at Morogoro. The full paper appears in the Proceedings of Tanzanian Society of Animal Production vol. 12, 1985 by Mrs. R. Ryoba and Mr. K.K. Hansen. (Publication no 7 section 6).

5. Production and economy

From 1982 through 1985, the project received annual grants from NORAD, administered by the International Development Programmes at AUN and from 1986 through NORAGRIC. The NORAD grants were used as follows:

- * Import of tractor, flail forage harvester, hay mower for forage production
- * Import of other equipment and tools for the project
- * Import of 63 Norwegian goat kids
- * Partly financing reconstruction of animal housing
- * Salary for the project coordinator
- * Partly financing the running costs of the project

The NORAD grants for the project were as follows:

Year	Amount of grant
1982	NOK 200 000
1983	" 367 500
1984	" 379 000
<u>1985</u>	<u>" 530 000</u>
<u>Total grant</u>	<u>NOK 1 476 500</u>

On the Tanzania side all the personnel involved in the project received their salaries directly from SUA. In addition, SUA provided the initial buildings for the animals as well as providing 30 pregnant cows as the opening stock for the dairy herd. The Tanzania X Saanen crossbred goats used in the project as well as the Blackhead persian lambs were provided by SUA. The SUA administration agreed that all the income from the sales of the dairy products be reinvested in the project to assist in the daily running of the project in terms of paying for casual labour and animal feeds. To some extent this made the running of the project self financing. It is anticipated that with the expansion of the dairy herd in Phase II, this income will substantially assist in paying the running expenses and that the grant from NORAD could be used for purchasing those items that are scarce in Tanzania.

The income from the project was mainly through sales of liquid milk, butter and ghee, as well as sales of bull calves and

meat from culled animals. The monthly and yearly breakdown of the incomes are as shown below (Tz shs.).

Month	1984	1985	1986
January	-	64 542.00	53 660.00
February	-	75 885.00	39 890.00
March	-	68 545.00	42 700.00
April	7 106.00	46 845.00	53 670.00
May	23 231.20	61 327.50	52 366.50
June	14 569.00	40 855.00	30 429.00
July	28 824.50	55 380.00	96 738.50
August	61 575.00	77 656.50	77 620.00
September	80 250.00	73 250.50	109 155.00
October	115 290.00	62 050.00	102 870.00
November	81 655.00	66 545.00	93 305.00
December	96 917.00	118 384.00	82 912.50
Yearly totals	509 417.70	811 266.00	835 317.50
Grand total		2 156 001.20	

The outbreak of Foot and Mouth Disease and Lumpy Skin disease drastically affected production and income. A number of old cows died and some had to be culled, which retarded the herd build-up. The prospects for the future are however promising as, through experience, we have managed to keep the major constraints under control.

6. List of publications

The following work based on the research activities during Phase I are summarized in a separate publication from NORAGRIC:

1. Aboud, A.A.O. (1987). Semen quality in Norwegian and local Tanzanian bucks. M.Sc. Thesis, SUA, Morogoro, 1987.
2. Eik, L.O., Mtenga, L.A. and Olsen, O.H.E. (1985). Preliminary results on some economic traits in Norwegian and Tanzanian X Saanen goats. Paper presented to the 12th Scientific Conference of the Tanzanian Society of Animal Production. Arusha 24-27 Sept. 1985.

3. Kidunda, R.S. (1987). The yield and nutritive value of some grasses and legumes at different stages of growth. M.Sc. Thesis, SUA, Morogoro, 1987.
4. Mero, R.N. (1986). The effect of supplementing Chloris gayana with Microptilium atropurpureum on dry matter digestibility and voluntary intake. M.Sc. Thesis, SUA, Morogoro, 1986.
5. Muhikambele, V.R.M. (1984). The effect of substituting kapok oil cake with dried leucaena leaves in concentrate rations on the apparent digestibility of Brachiaria brizantha hay to sheep. B.Sc. Special project, SUA, Morogoro, 1984.
6. Olsen, O.H.E. and Skåra, E. (1985). Forage production and utilization for supplementary feeding of ruminants during the dry season in Tanzania. M.Sc. Thesis AUN, As, 1985.
7. Ryoba, R. and Hansen, K.K. (1985). Preliminary results on composition of goats milk compared to cows milk. Proceedings TSAP vol 12, 154-155.
8. Sendalo, D. (1986). Mineral status of soils and forages and effect of mineral supplementation on performance of BhP lambs in Morogoro. M.Sc. Thesis, SUA, Morogoro, 1986.
9. Shoo, R.A. (1986). Supplementation of grazing young goat kids with Leucaena leucocephala and/or grass hay. M.Sc. Thesis, SUA, Morogoro, 1986.

PART II FUTURE PERSPECTIVES AND STRATEGIES DURING PHASE II
1987-1991

1. Basis for advice and proposals for future work

During Phase I of TAN 510 (1982-86), suitable research facilities were established for studying various aspects of fodder production and conservation as well as for carrying out applied research in the field of ruminant nutrition and breeding. The initial research studies were carried out by those persons directly involved in the project and by students during their special project and degree-research activities. Practical experience gained from these studies have uncovered a great need for further work along the lines followed in TAN 510. Based on these experiences and information obtained elsewhere, we have tried to summarize some of the ideas about the perspectives and strategies for future work which may be considered and eventually implemented.

The overall objectives for Phase II of the project should be, through research, education and extension, to establish a base at Sokoine University of Agriculture, Morogoro, to assist in the development of an efficient and economical milk and meat production in dairy cattle and goats in Tanzania. A programme, including management systems for dairy cattle and goats and research activities, is proposed as a guideline for future activities. This programme is divided into two parts, one for dairy cattle and one for dairy goats, respectively.

2. Proposed management systems and research activities for dairy cattle

A. Objectives

a. General objectives

The main objectives regarding the Magadu dairy cattle research herd are:

- * Provide a base for applied research and advice on improved feeding and management of dairy cattle under Tanzanian conditions.

- * Carry out applied research and give advice to the extension service in Tanzania.
- * Provide educational facilities for students at all levels as well as serve as a demonstration unit for improved dairy production in Tanzania.
- * Provide valuable training in modern dairy production for staff and personnel at the Department of Animal Science and Production, SUA.

b. Specific research objectives

i) Objective 1: To find practical ways to increase the use of forages in milk production under Tanzanian conditions.

Background: A large part of the current milk production in Tanzania is highly dependent on concentrates which are expensive and to some extent not available. Efforts have to be made to find practical ways of increasing the use of forages which can be locally grown and which will enable an efficient milk production to be sustained and further developed.

Main areas of research: To reach this objective the following areas of research are proposed:

- * Pasture improvement.
 - Continue the identification of suitable grasses, legumes and grass/legume mixtures for pasture improvement.
 - Establishment of pastures for dairy cattle studies.
 - Grazing and pasture management.
 - Seed production of identified suitable grasses and legumes.
- * Conservation of forages as silage and hay.
 - Identification of forages suitable for silage and hay conservation.
 - Methods of conservation of forages as silages and hays

both at small scale and large scale levels.

* Feeding experiments.

- Effects of feeding improved grass and grass/legume pastures on milk yield and the need for concentrate supplementation.
- Effects of feeding silages and hays to dairy cattle on milk yield and the need for concentrates.

ii) Objective 2: To find methods of calf and heifer rearing to reduce mortality and increase growth rates.

Background: Two major constraints facing dairy production under Tanzanian conditions are the high frequency of mortality and the low growth rate among calves. Phase I of the project showed that improved feeding and management can greatly reduce calf mortality rates and increase calf growth rates. The aim of Phase II is, therefore, to systematize these research findings and find practical ways of solving these problems under Tanzanian conditions.

Main areas of research: To reach this objective the following areas of research are proposed:

- * Composition of calf diets from birth to weaning. The main parameters for research will be the use of skimmed vs. whole milk, level of feeding, and the use of concentrates vs. forages.
- * Feeding from weaning to maturity.
- * Trials on the influence the veterinary procedures have on the control of internal parasites in the rearing of calves and heifers.

iii) Objective 3: To seek a better utilization of milk and milk processing and the use of milk byproducts.

Background: Milk production in a hot environment imposes problems of storage and utilization. Efforts have to be made to find practical methods in milk processing and the use of

milk by-products under Tanzanian conditions. Good cooperation with the dairy technology section at the Department of Animal Science and Production was developed during Phase I. This cooperation will continue.

c. Specific extension objectives

Integration of research, education and extension is vital.

Objective: To establish mutual links between the research at Magadu and extension so that experience, findings and technologies from work at Magadu can be tested at the farm level as well as to increase the awareness of actual problems experienced by farmers among the researchers.

Implementation: An extension programme involving the dairy cattle will be initiated, primarily in connection with the ongoing FAO and International Development Research Centre (IDRC) projects in the Moshi area. Dr. Urrio, SUA, has coordinated the latter project.

The information that is generated through the research will be published in simple leaflets for distribution to extension workers and farmers.

B. Implementation of the management system for the cattle herd at Magadu

To reach the above set of objectives the following management system for the cattle herd at Magadu should be implemented:

a. Dairy cattle herd at Magadu. Numbers of animals and breeds

The current number of cows in milk at Magadu is about 25. These are primarily of Friesian origin, with some Ayrshires and a few Jerseys. To reach the objectives set for Phase II, more cows are needed in order to carry out proper studies. The establishment of a herd of 60 dairy cows is suggested. It is also advisable to keep only two breeds; i.e. Friesians and Ayrshires. Bulls should be kept for mating purposes. Heifers should be raised as replacements. Excess heifers may be sold. Excess bull calves may be sold for breeding purposes after

weaning. There should be two breeding seasons during the year, January-March, and June-August.

The following herd projection can be expected with a stable number of 60 dairy cows:

Breed	Ayrshire and Friesian
Cows in milk	60
Calving percentage	75
Age at first mating	20-21 months
Age at first calving	29-30 months
Bull:cow ratio	1:15
Mortality rates	
Calves	10%
Adults	10%
Production life of cow	5 years
Culling rates of cows	20%
Herd numbers	
Cows	60 animals
Calves 0-1 yrs	45 "
Heifers 1-2 yrs	20 "
Heifers 2-3 yrs	18 "
<u>Bulls</u>	<u>4 "</u>
<u>Total</u>	<u>147 animals</u>

b. Feeding regime

The feeding regime will vary depending on the research operations in progress.

For the period 1987 to 1988 the main feeding regime will be:

Maize/Sorghum silage

Concentrates

Hay

+ some grazing

For the period 1988-1991 grazing should be a more integral part of the feeding regime as a result of the pasture establishment programme.

c. Bases for estimation of feed requirement and land area required for forage production

i) Herd data

Feed requirements for the various types of cattle are based on the following herd data:

* Dairy cows

450 kg liveweight

12 kg milk produced/day

* Calves

0-6 months

0.6-0.7 kg liveweight gain/day

* Heifers

6-30 months

0.4-0.5 kg liveweight gain/day

* Bulls

Maintenance

Liveweight 800-900 kg

ii) Average daily rations

The need for feed is based on the following average daily consumption of feed dry matter (DM), metabolizable energy (ME) and digestible crude protein (DCP):

	kg DM	ME (Mcal)	DCP g
<u>Dairy cows</u>			
Maize/sorghum silage 210	7.0	16.1	
Hay 30	1.0	2.1	
Concentrates	4.0	11.6	580
<u>Replacement heifers (6-30 months)</u>			
Maize/sorghum silage	3.0-5.5	6.9-12.7	90-165
Hay	0.5-1.0	1.0-2.0	15-40
Concentrates	2.0-2.5	8.7-7.3	290-365
<u>Bulls</u>			
Maize/sorghum silage	6.0	13.8	180
Hay	1.0	2.1	20
Concentrates	2.0	5.8	290
<u>Calves 0-26 months</u>			
Hay	0-3.0		
Concentrates	0-1.5		

iii) Total yearly requirements for feed for the cattle herd
Based on the number of animals, production levels and feeding regime given in chapters a-c, the following amount of various feeds are required per year (kg DM):

Maize/Sorghum silage	254 000 kg DM
Hay	38 000 "
Concentrates	118 000 "
Minerals	3 800 kg

iv) Land area required

Agricultural land required for forage production is based on a yield of 15 tons DM/ha for maize and sorghum and 3 tons/ha for hay at harvest. Corrections have to be made for losses during harvest and storage which increase the land requirement by 30% for maize/sorghum and 20% for hay making. Based on these assumptions the following area for forage production is required:

1987-1989

Maize/sorghum silage	22 ha
Hay (Chloris gayana)	13 "
Elephant/Guatamala grass (Irrigated area)	1 "
Total area	<u>36 ha</u>

1991

Pasture	<u>20 ha</u>
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d. Facilities for cattle research

The necessary facilities for handling the herd of 60 dairy cows, 4 bulls and herd replacements are available at Magadu.

The following modifications have to be made:

- * The calf house has to be improved for raising approximately 45 calves yearly.
- * The storage capacity for concentrates and hay has to be enlarged.

e. Time frame

An estimated time frame for the main activities is presented below:

	1987	1988	1989	1990	1991
<u>i. General</u>					
Purchase of extra cows	x				
Establishment of pasture	x	x	x		
Establishment of facilities	x				
<u>ii. Research</u>					
Silage/hay	x	x	x		
Identification of pasture species	x	x	x	x	x
Calf rearing	x	x	x	x	x
<u>iii. Extension</u>	As soon as possible depending on progress made in i and ii				

3. Proposed management system and research activities for dairy goats at Magadu

A. Background and objectives

The main objective of the goat part of the project TAN 510 was to increase milk production from goats in Tanzania. Little attention has previously been given to goats as milk producers despite the fact that the supply of milk and milk products in Tanzania is insufficient to meet the country's needs. Local goats are primarily used for meat. Therefore, high yield dairy breeds such as Norwegian goats should be used for cross-breeding in order to improve milk production in local goats.

Dairy goats are often more suitable than cows for use in nutritional studies involving ruminants. Due to the smaller size and less feed required, they may be kept in sufficient numbers even where feed supplies are scarce.

a. General objectives

The main objectives of establishing a dairy goat herd at Magadu are almost identical to those for dairy cattle:

- * Provide a base for carrying out applied research and advice on improved feeding and management of dairy goats under Tanzanian conditions
- * Carry out applied research and give advice to the extension service in Tanzania
- * Provide educational facilities for students at all levels
- * Provide valuable training for staff and personnel at the Department for Animal Science and Production, SUA.

b. Specific research objectives

i. Objectives related to feeding

- * To investigate Leucaena leucocephala as a forage for goats.

This should be one of the main lines of study during Phase II

- * To find other forages for supplementary feeding to replace concentrates
- * To further develop the kid rearing programme.

ii. Objectives related to breeding

- * To compare pure Norwegian, pure local Tanzanian and crossbred goats in terms of production, mortality etc
- * To find the most suitable dual purpose type of goat under village conditions
- * To supply breeding goats to farmers in Tanzania

iii. Objectives related to management

- * To develop improved management techniques
- * To develop suitable housing for small scale farming systems
- * To develop suitable stall feeding systems

c. Specific extension objectives

Also in goat production, integration of research, education and extension is vital.

Objectives:

- * To initiate a goat extension programme in the Mgeta area, Morogoro district
- * At a later stage to initiate extension programmes also in Dongobesh and at Uyole, Mbeya and LITI, Tenguru
- * To produce leaflets and other information materials for guidance of extension workers and practical goat farmers.

B. Implementation of management systems for dairy goats

To achieve the above objectives the following management system for the goat herds should be implemented:

a. Herd size and management

The whole dairy goat unit at Magadu should carry 100-120 adult dairy goats and sufficient young stock for replacements. The herd should be comprised of Norwegian goats, local Tanzanian dairy goats and crossbred animals of these two. It is very important to keep sufficient numbers and a distribution among breeds suitable for research needs. Goats are expected to be culled after an average of 5 lactations which gives a 20% replacement rate.

In addition to the Magadu herd, a flock of about 300 other goats (mainly meat goats) and sheep at the University should be used for general nutritional studies also in the future. The management system for these goat and sheep herds should be mainly grazing. For the Magadu dairy goat herd, management should aim at maintaining the herd at the following levels:

Kidding percentage	80%
Average No. of kids/goat	1.5
Mortality:	
Kids 0-1 yr.	20%
Yearlings	10%
Mature goats 2-8 yrs	5%
Age at first kidding	1 1/2-2 years
Age at culling	5-8 years

Herd size and composition:

Mature goats	100 animals
Kids 0-1 yr.	120 "
Yearlings 1-2 yrs.	
Females	48 "
<u>Males</u>	<u>10 "</u>
<u>Total</u>	<u>278 animals</u>

- * Of the 48 female yearlings, it is proposed that about 2/3 should be bred for kidding at Magadu every year. This would allow some selection to be made.
- * The male kids not needed for breeding, should be removed from Magadu after weaning at approximately 2-4 months. These male kids together with excess female kids should be either:
 - used for the extension project
 - used for breeding at the University farm
 - sold to farmers
 - slaughtered for meat
- * Import of breeding bucks should be considered at intervals according to breeding plans.

b. Feeding and management regime

The feeding regime may vary according to the aim of the research studies. However, some general guidelines may be drawn:

- * There is a great need for increased forage production with grasses such as Elephant and Guatemala grass. For continuous supply of herbage from these species throughout the year, a small irrigation system would improve production of forage for the great number of experimental animals at Magadu. Furthermore, irrigation should not create any conflict with the study of small scale farm feeding and management systems.
- * The feeding and management system should include partial grazing. Due to the high pressure of internal parasites more intensive systems of grazing may be questioned.
- * The "cut and carry" system should be included as a part of the feeding/management system studied.
- * Silages and hay should be included in the research studies of supplementary feeding.
- * Studies on Leucaena leucocephala will continue during Phase II. Provisions are made for production of leucaena for nutritional studies with dairy goats which include a Ph.D. research project in progress. Although leucaena is a highly nutritious, protein and mineral rich forage, it also contains a toxic amino acid. Thus, effort must be made to identify acceptable levels of leucaena in diets for goats.
- * Studies on mineral supplements should be included in the feeding/management studies.
- * The management system should allow for the use of a rotational housing system or at least to allow for thorough disinfection of all animal houses from time to time.
Concrete floors or packed soil would help minimize worm infection.
- * Grazing around the Magadu housing area should be avoided due to worm infection pressure. Measures should be taken to control worm infections at all levels. A vaccination

programme also including routine checks should be implemented.

i. Feeding of goat kids up to weaning

- 0-3 weeks: Suckling day and night
3-8 weeks: Suckling during day time only

The goat kids can be weaned at 8 weeks of age, if their liveweight is 2.5 x birthweight. All goat kids should be weaned at 16 weeks of age at the latest. From 3 weeks onwards, the kids should be kept in separate pens during the night and fed as follows:

- Concentrates and Leucaena in restricted amounts
- Guatemala/Elephant grass ad.lib.
- Clean water, salt and minerals ad.lib.

During the daytime they should follow the herd for grazing.

ii. Feeding of replacement stock (2-4 months - 2 years)

Bucks:

- Concentrate (max 0.5 kg/animal/day)
- Restricted amount of Leucaena (not more than 40% of DM intake)
- Guatemala/Elephant grass ad.lib.
- Clean water, salt and minerals ad.lib.

Females:

The aim is an average liveweight of at least 75% of mature body weight after first kidding at the age of 2 years. (For pure Norwegians goats at least 35 - 40 kg.)

- Concentrates, max 0.3 kg/animal/day
- Restricted amount of Leucaena (not more than 40% of DM intake)
- Guatemala/Elephant grass ad.lib.
- Clean water, salt and minerals ad.lib.

During the daytime they will follow the herd for grazing.

iii. Feeding of dairy goats

For 1987:

- Concentrates, dry period 0.5 kg/animal/day
lactation 0.8 " " "
- Restricted amount of Leucaena (not more than 40% of DM intake)
- Guatemala/Elephant grass ad.lib.
- Clean water, salt and minerals ad.lib.

The herd should be grazing between 8 a.m. and 1 p.m. From week 1 prior to kidding to week 3 after kidding the mothers should be stallfed only. Until the kids are weaned the dams should be milked only in the morning.

Each goat should kid only once a year after a dry period of minimum three months. There should be two mating seasons: February-March and August-September, that also results in two kidding seasons. Animals which fail to conceive in one season should be mated again the following season. Animals failing to conceive in two consecutive seasons should be culled.

c. Basis for estimation of feed requirement

i) Herd data

Number of goats:	Dairy goats	120
	Goat kids 0-1 yr	100
	Yearlings 1-2 yrs	60
Estimated feed intake:	4% of liveweight.	
Estimated liveweight:	Dairy goats	45 kg
	Goat kids	15 kg
	Yearlings	25 kg

ii) Composition of feed rations

Dairy goats	40% Leucaena
	35% Elephant/Guatemala grass
	25% Concentrate
Goat kids	50% Milk/concentrate
	15% Hay
	15% Elephant/Guatemala grass
	20% Leucaena
Yearlings	40% Leucaena
	40% Elephant/Guatemala grass
	20% Concentrate

iii) Total yearly feed requirements for the goat herd

Based on the number of goats, feeding regime etc., as given above, the following total yearly feed requirements are estimated as kg dry matter (kg DM). For Leucaena it is assumed that the goats consume approximately 50% of the feed offered, and for hay 80%. Accordingly, the following feeds should be required per year for the goat herd (kg DM):

Leucaena	67.000 kg DM
Elephant/Guatamala grass	60.000 "
Hay	4.000 "
Concentrates + milk	35.000 "
Mineral	1.000 kg

Based on an yield of 3000 kg hay/ha with 20% refusals about 2 ha land is needed for hay production for the goats.

d. Special measures for controlling internal parasites

Internal parasites represent a serious problem, especially for young kids. This was experienced during Phase I. Special attention should be given parasite control in the following areas:

- * Proper supplementary feeding will reduce but not eliminate the problems of internal parasites
- * Animal houses should be kept dry and clean, and be properly disinfected once a year

- * Vaccination programmes and regular veterinary control should be established

e. Specific improvements of research facilities

The necessary facilities to handle the dairy goat herd are available at Magadu. Some modifications are needed to secure sufficient forage production and to relieve the pressure from internal parasites.

- * An irrigation system should be built for cultivation of Elephant grass and Guatamala grass near Magadu
- * The corral made for goats should be provided with concrete floor to reduce parasite infections