

EXPANSION OF PASTURE AND RANGELAND

ACTIVITIES IN TANZANIA

(24 th August - 6 th October 1975)

by L.A. EDYE

G.G. BOUDET

Draft report

Project n° URT/72/027/C/01/12

United Nations
Development Programme

Food and Agriculture
Organization

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Table of contents

	Page
1. Introduction	1
2. Background	
2.1 Geography, Topography and climate	3
2.2 Population	3
2.3 Agriculture and its economy	3
2.4 Government policy	4
2.5 Government livestock services	6
2.6 Government livestock research organisation	8
2.7 Draft third Five-year Development Plan 1975-80	9
3. Pasture environments	12
3.1 Topography	12
3.2 Climate	12
3.3 Ecological-climatic regions	16
3.4 Soils	18
3.5 Vegetation	19
3.6 Tse-tse flies and the environment	23
3.7 Tanzania land-use	23
3.8 National Herd distribution	25
4. Current pasture and rangeland activities	27
4.1 Research programme	27
4.2 Previous research centres	36
4.3 Comments on research programme	36
4.4 Training	39
4.5 Extension	41
4.6 Conferences, committees and other organisations	41
5. Reorganisation of pasture and Rangeland activities	44
5.1 Introduction	44
5.2 Natural Pasture Development Institute	46
5.21 Objectives	46

5.22 Regional organization	47
5.23 Location	48
5.24 Staff activities	49
5.25 Guidelines for research and development (phase I)	51
5.251 Regional range management	51
5.252 Regional sown pasture agronomy	55
5.253 Seed production	57
5.254 Extension activities	59
5.3 Training	60
5.31 Post-graduates	60
5.32 Graduates	61
5.33 Diploma courses	61
5.34 Certificate courses	62
5.4 Extension	63
6. Summary and recommendations	65
Annex I	A 1
1. Itinerary	A 1
2. Interviews	A 1
3. Documents consulted-Bibliography	B 1
Annex II	B 5
1. Background and supporting information justification of the project	B 6
2. Description of the project	B 6
2.1 Institutional frame work	B 6
2.2 Provision for Government follow-up	B 7
2.3 Other related activities	B 7
2.4 Future UNDP assistance	B 7
2.5 Objectives of the project	B 7
2.6 Work plan	B 7
3. Description of UNDP inputs	B 9
3.1 Assignment of international staff	B 9
3.2 Consultants	B 10
3.3 Support personnel	B 11
3.4 Training provisions	B 12
3.5 UNDP supplies and Equipment	B 12

3.51 Expendable equipment	B 13
3.52 Non-expendable equipment	B 13
3.53 Capital developments	B 14
3.54 Maintenance	B 14
3.55 Travel	B 14
3.56 Grand total	B 15
3.6 Description of Government Inputs	B 17
3.61 Local staff	B 17
3.62 Buildings, farms, equipment and supplies	B 18

1. INTRODUCTION

1.1 The Livestock industry of Tanzania has contributed relatively little to the monetary economy of Tanzania in comparison to the contribution from cash crops such as cotton, coffee and sisal. Until recently, the development of the livestock industry has been neglected by comparison with the research and development that has gone into cash crops.

1.2 In recent years greater emphasis has been placed on the need to increase livestock products to obtain self-sufficiency in dairy production and increased standards of human nutrition. Initially, much effort and progress has been made in the control of animal diseases and in the genetic improvement of local breeds of livestock. It is now being increasingly realized that additional production can only be achieved by improving the quality of feed available to animals.

1.3 Natural pastures provide the cheapest means of producing livestock products. Tanzania is richly endowed with pasture grasses, legumes and browsed plants, yet the Republic has barely begun to develop its grassland potential.

1.4 To encourage an awareness of the potential for increased animal production through applying improved methods of pasture management and utilisation, a UNDP/FAO Project (URT 72/027/C/01/12) was commenced in 1973 with the appointment of a specialist in Pasture agronomy and range management.

1.5 It soon became apparent that there was a need to expand this project and so the Tanzanian Government requested UNDP/FAO to provide two consultants for six weeks each who will, together with officials from the Ministry of Agriculture and the FAO expert in pasture agronomy, examine the existing programme and advise upon expansion.

Their terms of reference will be:

- a) Examine the existing programme of research in grazing land management and use;
- b) Recommend the organization and methods for updating and improving the programme including the necessary vegetation surveys and methodology;
- c) Examine the programme for extending research results to the users of grazing land and recommend the changes needed to expedite extension activities;

- d) Determine requirements for training range technicians and ranch technicians and suggest proper approaches to training;
- e) Explore the need and possibilities for establishing a National Pasture Research Institute and make recommendations for its organization including staffing;
- f) Prepare a project document reflecting the findings and recommendations of the mission. The draft project document will be prepared prior to the departure of the consultants from Tanzania so that it can be fully discussed with the Government.

The two consultants, Mr. L.A. Edye, Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Tropical Agronomy, Australia, and Mr. G.G. Boudet, Veterinary Medicine and Animal Breeding Institute for Tropical Countries (IEMVT), Pasture and Range Surveys Department, 94700 Maisons-Alfort, France, were accompanied throughout their mission by Mr. R. Dalebroux, UNDP/FAO Pasture Agronomist for Project URT/72/027/C/01/12 in Tanzania.

It is with pleasure that we present our report and we wish to acknowledge the help we received from the many people we interviewed to make this report possible.

We especially wish to thank Mr. Raymond Dalebroux, for his untiring assistance and consultation throughout the mission and particularly for his help in compiling the report in Dar es Salaam.

2 BACKGROUND

2.1 Geography, Topography and Climate

2.11 Tanzania is an agricultural nation located in East Africa, south of the equator. It has a total area of 93.7 million ha. of which 5.3 million ha. are covered by lakes and rivers. The mainland is divided into three main topographical regions:

- Coastal strip-generally below 300m altitude varying from 15 to 70 km wide.
- Central plateau-averages 1,000 to 1,300 m altitude covering much of the country.
- Highlands-to over 2000m altitude on the southern and northern borders.

2.12 The climate of Tanzania is of the equatorial type, although there are considerable modifications caused mainly by altitude. In general there are two rainy seasons, the short rains and the long rains. The long rains are usually at their peak from January to March in the South and from March to May in the North. The short rains are generally centred in the months of October to December. More details on the climate are given in section 3.

2.2 Population

2.21 The population of Tanzania is now about 15 million people and growing at an annual rate of about 3 per cent. Ninety per cent of the people are engaged in agriculture with smallholder farming traditionally the dominant element. Overall population density is 16 persons per square kilometre of land area, but much of the population is concentrated in the more fertile agricultural areas.

2.3 Agriculture and its Economy

2.31 The Gross Domestic Product (GDP) in 1973 is estimated to have been T.Shs. 11,257 million (US\$ 1,577 million). The gross value of agricultural production is estimated to be 40% of G.D.P. or T.Shs. 4,502.8 million (US\$ 630.8 million)

2.32 In 1973 agricultural exports earned T.Shs. 1,828 million or 81.7% of Tanzanian export receipts, and the overall balance on current account was a deficit of T.Shs. 712.7 million.

2.33 In 1973 the cattle sold through the markets were valued at T.Shs. 134.2 million. In 1972 export of meat and meat products were valued at T.Shs. 42.0 million and hides and skins at T.Shs. 36.0 million.

2.34 The value of dairy products imports in 1973 was T.Shs. 69.2 million. The dominant feature of the commercial dairy sector is a large milk deficit filled by reconstituted or recombined milk made from imported milk solids. The non-commercial dairy sector is made up of peasant farmers with a few cows which barely produce sufficient milk for calfrearing and family needs. Total milk production is estimated at 491 million litres.

2.4 Government Policy

2.41 Agricultural development in Tanzania at the national level is based on five year plans. The Second Five-year Plan (1969-74) set forth guiding principles for agricultural policy aimed at improving the nutritional status of the mass of people and to increase self-sufficiency. The plan gave primary attention to rural development and to the strengthening of Ujamaa Villages as well as through co-operative ventures. The Plan aimed at increasing the productivity of livestock by increasing the head off take percentage, increasing the average carcass weight, developing large scale dairy farms and encouraging goat, sheep, pork and poultry production. Within this framework of objectives some 67 Projects were planned for implementation during the five-year period.

Ujamaa

2.42 Since the Arusha Declaration of 1967, the main vehicle for rural development in Tanzania has been the Ujamaa Village programme. Starting from the traditional African concept of the extended family as the basic unit of social and economic life. From the economic and agricultural stand-point, it provides a structure to facilitate the establishment of rural education and the

introduction and teaching of improved methods of crop and animal production as well as the provision of rural credit.

Ranching Associations

2.43 The Range Development and Management Act 1964 (Act No.51) enables the Range Development Commission to propose to the Minister responsible that Ranching Associations be formed after adequate consultation with prospective members. The proposal to the Minister must include

- a description of the proposed ranchland, and its boundaries
- a description of any proposed water rights
- a description of any works required for the rehabilitation, development, conservation and improvement of the National Resources of Rangelands.
- an estimate of the number of prospective members and of the existing stock units of the prospective members
- a propose ranch management scheme with topographical maps showing pasture type and bush and the location of settlements and watering facilities.
- an estimate of the maximum number of authorized stock units for the proposed ranchland

The 1964 Act covered the Masailand Range Development Area but in 1968 it was extended to 6 additional districts covering areas of Gogoland and Sukumaland. The Act is designed to facilitate progress and increase livestock production in the traditional breeding areas. These areas cover approximately 14.8 million ha. containing a population over 1.5 million people and a cattle population estimated at more than 4 million head.

Regional Decentralisation

2.44 In order to provide more effective support in rural development and to gear development programmes directly to local needs and conditions, many government functions were decentralised during 1972. The regional and district administrations are now directly responsible for development planning, plan

implementation and the day to day direction and supervision of civil servants of all ministries who have been posted at the regional or district level.

2.45 Regional Administrations report directly to the Office of the Prime Minister and Second Vice President. With the assistance of other ministries, the Office of the Prime Minister is responsible for co-ordinating their planning and budgeting.

2.46 Within the Regions, District Development Corporations (D.D.C's) undertake agricultural and industrial development.

Parastatal Corporations and Authorities

2.47 In agriculture as in other sections of the economy, larger scale enterprises are operated by government through parastatal bodies. These are corporations and authorities generally wholly owned by the Government and managed as commercial organisations under Boards of Directors appointed by Government.

2.5 Government Livestock Services

Ministry of Agriculture

2.51 The reorganisation of the Ministry of Agriculture in 1973 created four Divisions : Livestock Development, Crop Development, Manpower Development and Planning and Marketing.

2.52 The Livestock Development Division is responsible for ensuring that all livestock programmes are technically feasible and co-ordinated for developing and extending improved annual management techniques, for research and technical services and for managing selected livestock operations that contribute to the National Development.

LIDA

2.53 In June 1974, the Government established a parastatal authority-The Tanzania Livestock Development Authority (LIDA)- which will undertake livestock production and provide a number

of services to the livestock industry. Initially it will operate through five subsidiary companies: the National Agriculture Company Ltd. NACO (cattle ranching); National Dairy Farming Company Ltd. (DAFCO); Tanzania Livestock Marketing Company Ltd. (livestock marketing); the Tanzania Meat Processing Company Ltd. TMPC (meat plant operation); and Tanzania Dairies Ltd. T.D.L. (dairy plant operation). The main function of LIDA will be to control, co-ordinate and assist its subsidiary companies and to ensure that these function efficiently. It will be given certain regulatory functions covering the industry as a whole particularly in the fields of grading, quality control and marketing.

Manpower Training

2.54 Training for both farmers and extension staff up to diploma level is the responsibility of the Manpower Development Division of the Ministry of Agriculture. Project and Farm management personnel for parastatal farms are normally selected from the ranks of the Ministry staff or from various parastatal organisations. Most personnel at the operational level are trained at Morogoro, Mpwapwa and Tengeru institutes up to certificate level, and at Egerton College in Kenya up to the diploma level. Professional staff are educated at the Faculty of Agriculture of the University of Dar-es-Salaam (located at Morogoro), and at the University of Nairobi, in case of veterinary professionals. Post-graduate courses leading to the award of M.Sc and Ph.D. degrees are available at Morogoro within the departments of Crop Production, Animal Production, Soil Science and Agricultural Chemistry, Agricultural Engineering and Land Planning, and Rural Economy under bilateral programmes, farm managers, undergraduates and post-graduates are trained overseas. Constraints on manpower development are lack of funds, rapid turnover of personnel at the various institutions of learning, lack of library facilities and books in general.

Extension Services

2.55 Field extension work is administered by the 20 Regional Livestock Development Officers under the Regional Development Directors. There are also Field Officers, mostly diploma holders,

specialising in animal production and animal health. The Field Officers and Assistant Field Officers together with the less qualified Field Assistants have direct contact with farmers. Extension work is carried out at the village level. At present there are no extension workers in pasture utilisation or range management at village level. Large scale parastatal farming corporations generally provide their own technical expertise.

Bilateral and International Technical Support

2.56 The Government of Tanzania is currently receiving technical support in a number of fields related to livestock production. The Governments of the Nordic countries, Sweden, Netherlands and New Zealand have separately undertaken projects to assist the Dairy Industry in Tanzania. The New Zealand Government also provides a two-man dairy teaching and management team for the Ministry of Agriculture Research and Training Institute at Tenggeru. UNDP/FAO have provided technical support teams for the Tanzanian Rural Development Bank, for the development of intensive feeding methods for livestock, for pasture agronomy and for the Second Livestock Development Project. USAID provides research teams for the Masailand Development Scheme and the Tsetse Research Project at Tanga.

Government Livestock

2.6 Research Organisation

2.61 The Livestock Development Division of the Ministry of Agriculture is responsible for research in Animal Diseases Livestock Production and Tsetse Fly Control. The research groups comprise a sub-section of the Research and Disease Control Section.

2.62 Animal Disease Research is undertaken at the Animal Diseases Institute (Central Veterinary Laboratory) Temeke, Dar es Salaam and its supporting veterinary investigation centres (VIC's) at Arusha, Mwanza, Tabora, Mpwapwa and Iringa.

2.63 Livestock production research is undertaken at the Research and Training Institute Mpwawa and at its Livestock Research Centres (L.R.C.'s) at Tanga, Kongwa, West Kilimanjaro and Malya. Sub-stations or Livestock Experimental Stations (L.E.S.'s) are located at Twambe, Sao Hill, Mabuki, West Kilimanjaro and Mivumoni (near Tanga). At the headquarters for livestock production research there are departments for Animal Breeding, Reproductive Physiology, Nutrition, Animal Management, Special Services (statistician and economist), Training and Pastures.

2.64 Pasture research activities were transferred from the Crop Development Division to the Livestock Development Division in 1973. Prior to this, pasture research was in progress at Lyaungu, Maruku, Ukiriguru Ilonga, Chambezi and Iringa. The Manpower Division of the Ministry of Agriculture undertakes some research at Tengere and Ukiriguru. Other Tanzanian organisations involved in pasture research include the Faculty of Agriculture at Morogoro and the Tanzania Sisal Corporation at their Azimio Ranch and Kange Dairy near Tanga.

2.65 Research on the control of Tsetse fly by the sterile male technique is in progress near Tanga under a USAID Project. Sterile males of Glossina morsitans, the most common vector of trypanosomiasis are being reared under laboratory conditions for eventual release in a field test site.

2.7 Draft Third Five-year Development Plan 1975-80

2.71 The organisations responsible for the implementation of the Third Five-year Plan are the Ministry of Agriculture through its Livestock Development Division, the Tanzania Livestock Development Authority (LIDA), other parastatal such as the Tanzania Sisal Corporation (TSC) and the District Development Corporations (DDC's).

2.72 The main responsibility of the Livestock Development Division is to ensure that all plans are co-ordinated, technically feasible and effectively implemented. Specialised projects such as the Second Livestock Development Project and the Phase I Dairy Development Project shall be placed in the Ministry of Agriculture.

2.73 The draft of the Third Five-year Plan (1975-80) for the development of the Livestock Industry provides for the improvement and completion of on-going projects from the Second Five-year Plan (1969-74) as well as providing for increased manpower development and additional research in livestock diseases, livestock production, and pasture and fodder production and utilisation. Some of the main projects are briefly mentioned below.

Second Livestock Development Project (beef production)

2.74 Under this project 11 NACO, 4 DDC's and 22 Ujamaa ranches shall be developed as well as improved and additional slaughter houses. Estimated cost T.Shs. 176.0 million. Total area involved is 609,200 ha.

Phase I Dairy Development and Animal Health Project

2.75 Under this project 35 large scale dairy farms (parastatal organisations) and 50 Ujamaa dairy farms will be established. Estimated cost T.Shs. 155.5 million. The total area involved over 24 large scale farms already committed to the project is 70,400 ha.

Research Projects

2.76 Some of the main research Projects that will be undertaken by the Livestock Development Division during the Third Five-year plan are listed below. The list is by no means complete.

- (i) The feed value agricultural byproducts
FAO/UNDP Project URT 72/020 T.Shs. 2.54 million/-
- (ii) Pasture Agronomy FAO/UNDP URT 72/027 T.Shs. 720,066/-
- (iii) Livestock nutrition and management T.Shs. 900,000/-
- (iv) Livestock breeding T.Shs. 500,000/-
- (v) Improvement of local goats and sheep T.Shs. 200,000/-
- (vi) Improvement of tick control FAO/UNDP Project URT 72/009.
T.Shs. 2.8 million/-
- (vii) Tsetse Control. USAID Project T.Shs. 1.6 million/-

Research Facilities

2.77 The Livestock Development Division intend to provide additional facilities including buildings, equipment and transport for the following research activities and centres. Again, the list is by no means complete.

- (i) Pasture Research T.Shs. 3.5 million/-
- (ii) Livestock Research Centres already existing T.Shs. 3.0 m./-
- (iii) Additional Livestock Research centres T.Shs. 2.0 m./-
- (iv) Livestock Experiment Stations (existing ones and two new stations) T.Shs. 1.5 m./-
- (v) Bacterial Vaccine Laboratory Temcke T.Shs. 1.2 m./-
- (vi) Foot and Mouth Disease Laboratory T.Shs. 500,000/-
- (vii) General Virus Vaccine Laboratory T.Shs. 500,000/-
- (viii) National Artificial Insemination Scheme T.Shs. 27.8 m./-

Disease Control Measures

2.78 Some of the main disease control projects to be undertaken by the Livestock Development Division will involve an expenditure of over T.Shs. 28.8 m./-

PASTURE ENVIRONMENTS

3.1 Topography

3.11 Tanzania is strategically just south of the equator from 1° to 12° south latitude and from 29° to 40° eastern longitude and has a total land area of 88.4 million ha. with more than 87 million ha. on the mainland.

3.12 The flat coastal plain extends for 880 km along the Indian Ocean and varies between 16 and 56 km in width. Behind the Coastal plain, most of the country lies on a plateau varying in altitude between 1000 to 1500 m above sea level. Mountainous areas occur in the northeast and southeast of the country. In the northeast is Mt. Kilimanjaro, Africa's highest mountain (over 6,000 m.) and in the south-west near Mbeya are the Kitulo and Njombe highlands. In the west, the plateau falls to the Rift Valley containing lakes Nyasa, Tanganyika and Victoria.

3.2 Climate

3.21 The long term average monthly rainfall and maximum and minimum temperatures for Tanzania have been summarized by the East African Meteorological Department. The meteorological stations are identified by registration numbers: the first two figures indicate the North Polar distance of the latitude forming the northern edge of the degree square in which the station is situated; the two figures immediately following indicate the meridian of longitude forming the western edge of the degree square; the final three figures indicate the station number within the degree square (see Table 2). The quickest way to trace a recording station in the index is to determine the degree square in which the station is situated and locate all the stations in that degree square. The meteorological data for Tanzania are greatly influenced by the altitude and the latitude of the station.

Temperature

3.22 The average monthly maximum and minimum temperatures and the average annual maximum and minimum temperatures are given in table 1 for stations with more than seven years of records.

Table Mean Temperature (T°C)

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1 Kongwa	Max.	30.2	30.1	30.3	29.2	28.5	28.1	27.5	28.5	30.0	31.5	32.4	31.1	29.8
	Min.	16.5	16.4	16.4	16.0	14.0	11.5	10.8	11.6	13.2	14.6	16.4	17.3	14.6
2 Dodoma	Max.	29.3	29.2	29.0	28.6	27.9	27.2	26.6	27.3	29.2	30.6	31.6	30.4	28.9
	Min.	18.3	18.1	18.0	17.6	16.1	13.8	13.0	13.8	14.9	16.4	17.9	18.5	16.3
3 Mpwapwa	Max.	28.9	28.8	28.2	26.7	25.5	24.9	24.8	25.6	27.3	29.1	30.2	29.5	27.5
	Min.	16.3	16.3	16.2	17.1	16.7	15.1	14.1	13.8	13.9	14.6	15.6	16.1	15.5
4 Iringa	Max.	24.8	25.1	24.9	24.3	23.8	23.0	21.3	23.3	25.3	27.1	27.8	25.9	24.7
	Min.	14.7	14.6	14.6	14.7	13.8	11.8	11.2	11.6	12.4	13.6	14.7	14.8	13.5
5 Singida	Max.	27.9	28.3	27.3	26.8	26.2	25.8	25.8	26.8	28.3	29.2	29.5	28.1	27.5
	Min.	15.3	15.4	15.2	15.4	14.2	12.8	12.2	12.5	13.6	15.0	15.8	15.7	14.4
7 Same	Max.	31.5	32.3	31.6	29.1	26.8	26.3	25.6	26.6	28.3	29.9	30.4	30.3	29.1
	Min.	19.2	19.2	19.4	19.0	17.4	15.8	15.1	14.9	15.6	17.1	18.5	19.2	17.5
8 Mombo	Max.	34.1	33.8	33.7	30.4	28.3	27.8	27.4	28.5	30.0	31.2	32.3	33.3	30.9
	Min.	20.2	20.5	20.9	20.8	19.3	17.5	16.7	16.4	16.7	18.0	19.4	20.2	13.9
9 Morogoro	Max.	31.8	31.9	31.3	29.6	28.3	27.4	27.4	28.3	29.7	31.2	31.9	31.9	30.1
	Min.	21.1	20.8	20.8	20.4	18.6	15.8	15.1	15.7	16.6	17.6	19.2	20.7	18.5
10 Dar es Salaam	Max.	31.8	31.7	31.3	30.5	29.3	28.9	28.9	28.8	29.1	29.9	30.6	31.1	30.2
	Min.	25.3	25.3	24.2	23.2	22.2	20.3	19.3	19.7	20.2	21.5	23.2	24.7	22.4
3 Musoma	Max.	28.1	28.3	28.2	27.7	27.9	27.8	27.7	27.8	28.3	28.9	28.3	27.7	28.1
	Min.	18.5	18.8	18.8	18.5	18.0	17.4	17.1	17.5	18.2	18.8	18.5	18.4	18.2
4 Ukiriguru	Max.	28.1	28.4	28.4	27.7	27.8	28.5	28.7	29.2	30.2	30.1	28.5	27.8	28.6
	Min.	17.9	18.0	18.0	18.0	17.4	16.0	15.3	15.4	17.2	18.5	18.5	18.1	17.4
5 Kigoma	Max.	26.8	27.1	27.3	27.4	28.2	28.2	28.2	29.1	29.6	28.9	26.7	26.3	27.8
	Min.	19.6	19.6	19.5	19.5	19.3	17.8	17.2	18.4	19.7	20.3	19.6	19.4	19.2
6 Mwanza	Max.	27.1	27.3	27.5	27.2	27.5	27.9	27.8	27.9	28.3	28.0	27.4	26.7	27.5
	Min.	18.3	18.3	18.4	18.3	17.9	16.3	15.3	16.4	17.8	18.4	18.5	18.2	17.7
8 Arusha	Max.	29.2	29.4	28.1	25.4	22.7	21.5	21.2	22.6	24.5	26.6	27.2	27.7	25.5
	Min.	15.4	15.9	16.9	17.1	15.9	14.3	13.8	13.8	14.1	15.4	16.4	16.1	15.4
10 Moshi	Max.	32.9	33.3	32.2	29.4	26.7	25.9	25.5	26.5	28.6	30.7	31.7	31.9	29.6
	Min.	17.5	17.8	18.7	19.2	18.3	16.7	15.7	15.5	15.7	16.8	17.7	17.6	17.3
1 Tabora	Max.	27.7	28.0	28.1	27.8	27.9	28.0	28.2	29.3	31.0	32.1	30.9	28.1	28.9
	Min.	17.5	17.4	17.4	17.2	16.3	14.7	14.4	15.7	17.4	18.9	18.9	17.7	17.0
2 Mbeya	Max.	23.0	23.0	23.0	22.6	21.9	21.1	21.2	22.4	25.1	26.8	26.5	24.2	23.4
	Min.	14.1	13.9	13.8	12.9	10.9	8.6	7.8	8.8	10.8	12.5	13.6	13.9	11.8
4 Lyamungu	Max.	28.4	28.7	27.5	24.7	22.1	21.2	20.6	21.7	23.8	25.9	26.9	27.3	24.9
	Min.	13.9	14.1	14.8	15.7	15.1	13.8	12.8	12.8	12.7	12.9	14.0	14.2	13.9
5 Bukoba	Max.	26.3	26.4	26.1	25.7	25.5	25.5	25.3	25.3	25.8	26.1	26.0	25.9	25.3
	Min.	16.0	16.2	16.3	16.7	16.7	15.9	15.2	15.4	15.7	16.2	16.5	16.1	16.1
7 Tanga	Max.	30.8	31.1	21.4	30.6	29.2	28.4	27.9	27.8	28.2	29.3	30.2	30.7	29.6
	Min.	24.4	24.4	24.3	23.7	22.8	21.6	20.8	20.6	20.9	21.8	22.9	23.0	22.6

On the lowlands, the average annual maximum and minimum temperatures vary between 30°C to 22.5°C; on the plateau, the average maximum temperatures range from 26 ° to 29°C and the average minimum temperatures from 15° to 17°C; in the highlands the average annual maximum and minimum temperatures vary between 23° to 11°C and occasionally frosts are experienced in the cooler months.

3.23 Temperatures decrease with altitude at an approximately rate of 1.7°C for every 1000 ft or 5.6°C for each 1000 m. From this relationship, it is possible to estimate the temperature for any green site in close proximity to a meteorological station by hindering the difference in altitude between the two sites

$$T_2 = T_1 \pm 1.7 (\text{x thousand feet})$$

$$T_2 = T_1 \pm 5.6 (\text{x thousand metres})$$

Rainfall

3.24 The average annual rainfall (mm) and the average monthly rainfalls are given in table 2 for stations with more than seven years of records. The rainfall is highest during January to March in the South and during March to May in the North. This difference is due to north-south movements of the Equatorial Trough. The northern movement of the trough brings with it the first or long wet season rains that are derived from cool and unstable southeasterly air streams laden with moisture accumulated over the Indian Ocean. The southerly movement of the trough is associated with north-easterly air streams that are largely continental in origin and are warmer and drier. The southerly movement of the trough causes a second wet season of shorter duration and less rainfall. Two peaks of rainfall occur in the northern areas and a single rainfall peak in the southern areas. The length of the dry season varies throughout Tanzania but is longest in the central plateau regions: any month receiving less than 40 mm of rain can be regarded as a dry month.

Tab. 2 Rainfall (average in mm)

List	Station	Number	Altitude (metres)	Nb of years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	Kongwa	96.36.013	900	18	118	108	102	65	6	0	0	1	1	1	18	119	541
2	Dodoma	96.35.001	1,350	44	144	116	118	51	4	1	0	0	1	4	21	106	567
3	Mpwapwa	96.36.000	1,110	42	145	137	149	85	24	2	1	0	2	6	34	122	709
4	Iringa	97.35.014	1,615	7	145	129	153	58	5	0	0	2	1	19	37	157	708
5	Singida	94.34.001	1,475	42	140	123	121	75	14	1	0	0	2	5	45	141	669
6	Kibaya	96.36.000	1,434	26	70	72	123	112	38	2	1	1	2	10	40	110	583
7	Same	94.37.003	846	37	43	60	85	121	67	8	6	11	13	29	52	69	565
8	Mombo	94.38.039	405	14	53	46	97	132	88	28	18	15	27	26	63	64	658
9	Morogoro	96.37.052	505	15	93	88	115	178	48	17	13	7	13	33	60	80	747
10	Handeni	95.38.007	665	44	81	88	137	166	112	26	15	20	28	52	61	86	874
11	Kilosa	96.37.001	483	49	124	130	182	212	71	13	6	13	15	33	95	139	1,036
12	Dar es Salaam	96.39.000	10	62	69	63	120	278	199	37	32	25	29	49	82	89	1,072
13	Musoma	91.33.000	1,130	50	61	71	121	174	108	22	23	21	27	41	84	70	824
14	Ukiriguru	92.33.004	1,180	34	95	91	129	148	69	8	1	11	24	49	127	120	873
15	Kigoma	94.29.004	870	34	130	121	151	156	52	5	2	2	16	53	130	152	970
16	Mwanza	92.32.009	1,122	22	97	104	151	179	76	11	14	27	31	79	137	163	1,070
17	Tongoru	93.36.027	1,260	19	59	61	143	365	145	30	15	13	12	47	93	101	1,086
18	Arusha	93.36.013	1,350	38	59	74	160	343	156	26	25	13	14	33	104	108	1,116
19	Monduli	93.36.014	1,560	36	68	91	148	223	94	11	3	4	5	21	90	107	866
20	Moshi	93.37.004	800	50	39	44	116	287	162	31	13	13	13	35	53	50	858
21	Tabora	95.32.000	1,245	63	132	133	165	130	26	2	0	1	6	16	104	172	887
22	Mbeya	98.33.001	1,730	40	199	171	162	114	15	1	0	1	2	14	56	167	905
23	Mbeya-Irambo	98.33.010	2,010	23	253	242	278	286	58	2	0	0	7	22	91	233	1,475
24	Lyamungu	93.37.021	1,230	36	44	64	113	524	443	112	62	36	33	37	93	75	1,637
25	Bukoba	91.32.002	1,125	51	145	162	246	372	318	81	51	77	108	137	184	191	2,074
26	Korogwe	95.38.008	288	38	48	34	96	250	259	60	40	48	56	71	63	52	1,079
27	Tanga	95.39.000	10	43	30	39	116	231	291	82	66	71	78	102	121	77	1,307

3.3 Ecological-Climatic Regions

3.31 The main climate factors influencing the type and distribution of the nature vegetation and the potential of the region for pasture development are temperature, the amount of rainfall and its seasonal distribution and the length of the dry season.

3.32 To simplify the approach to pasture development, three broad ecological-climatic regions are described which are further divided into a total of seven sub-regions. The rainfall and altitude for selected meteorological stations within these regions are summarized in table 3. A brief description of each region and sub-region is given below.

Semi-arid to sub-humid Region

3.33 The average annual rainfall is less than 800 mm and the length of the dry season is generally greater than five months. This region is divided into plateau and lowland sub-regions by the 800 m contour line.

- Semi-arid to sub-humid plateau: located in the central and northern part of the country and includes Masailand, Serengeti, parts of Shinyanga, Iringa, Same, Kongwa and Manyara and West Kilimanjaro ranches.
- Semi-arid to sub-humid lowland: includes Morogoro and Mkeeta and Mzeri ranches.

Humid Region

3.34 The average annual rainfall varies from 800 to 1100 mm and the length of the dry season ranges from 4 to 6 months. With increases in altitude the rainfall and temperature tend to decrease while the length of the dry season increases. This region is divided into plateau and lowland sub-regions by the 800 m contour line.

- Humid Plateau North-Eastern Zone: includes the Tengeru Research and Training Institute and the Rongai dairy farm.
- Humid Plateau South-Western Zone: extends from Mara to Mbeya and includes Mwanza, Sumbawanga, Kalambo and Usungu ranches.

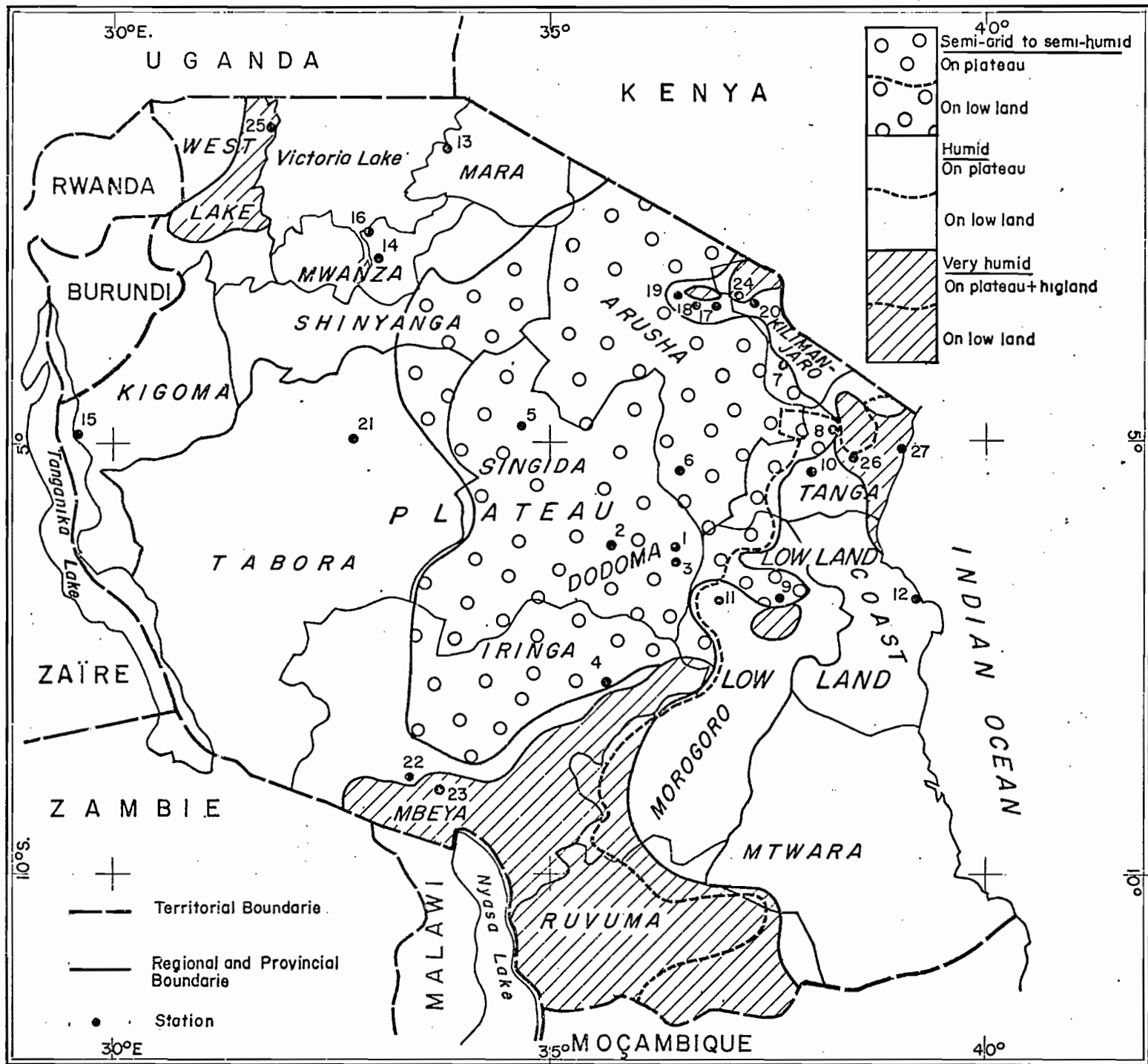


Table 3. Ecological Characteristics

Station	List	Altitude (metres)	Mean T°C Max/Min	Annual rainfall (mm)	Months 40mm (less)	Eco-Climatical areas	Vegetation
Kongwa	1	900	29.8/14.6	541	7	semi-arid to semi-humid on plateau	Bushland,
Dodoma	2	1350	28.9/16.3	567	7		Thickets
Mpwapwa	3	1110	27.5/15.5	709	7		+ grass-
Iringa	4	1615	24.7/13.5	708	7		land
Singida	5	1475	27.5/14.4	669	6		
Kibaya	6	1434	-	583	6		
Same	7	846	29.1/17.5	565	5		
Mombo	8	405	30.9/18.9	658	5	semi-arid to	Bushland
Morogoro	9	505	30.1/18.5	747	5	semi-humid on low-land	Woodland
Handeni	10	566	-	874	4	humid	Wooded
Kilosa	11	483	-	1036	5	on low land	grassland
Dar es Salaam	12	10	30.2/22.4	1072	4		
Musoma	13	1130	28.1/18.2	824	4	humid on plateau	woodland
Ukiriguru	14	1180	28.6/17.4	873	4		+ induced
Kigoma	15	870	27.8/19.2	970	4		vegetation
Mwanza	16	1122	27.5/17.7	1070	4		by
Tengeru	17	1260	-	1086	4		cultivation
Arusha	18	1350	25.5/15.4	1116	5		
Monduli	19	1560	-	866	5		
Moshi	20	800	29.6/17.3	858	5		
Tabora	21	1245	28.9/17.0	887	6		
Mbeya	22	1730	23.4/11.8	905	6		
Mbeya-Irambo	23	2010	-	1475	5	very humid, highland	
Lyamungu	24	1230	24.9/13.9	1637	3	very humid, plateau	induced
Bukoba	25	1125	25.8/16.1	2074	0		vegetation on forest
Korogwe	26	288	-	1079	1	very humid,	
Tanga	27	10	29.6/22.6	1307	2	lowland	

- Humid Lowlands: includes the Southern coastal plain and extends to Kilosa, Ruvu and Ngerengere and Kebaha farms are in this sub-region.

Very Humid Region

3.35 The average annual rainfall is more than 1000 mm. There is no dry season in the western zone; a short dry season of less than three months in the eastern zone; and a dry season of up to five months in the southern highlands. The region is divided into three sub-regions.

- Very Humid Highlands: altitude greater than 1800 m. Includes Meru and Kilimanjaro Mountains in the north, Njombe and Livingstone mountains in the south and the Kitulo farm and the Mbeya Research and Training Institute.
- Very Humid Plateau: located around the highlands and includes the Lyamungu Research and Training Institute.
- Very Humid Lowlands: located in the north and south coastal plain and includes Azimio ranch and the Tanga Livestock Research Centre in the northern Tanga region.

3.4 Soils

3.41 Little is known about soil types and the distribution of soils in Tanzania. Only a brief and sketchy outline is possible for each of the three ecological-climatic Regions defined above.

Semi-arid to sub-humid Region

3.42 Semi-arid reddish-brown soils occur most frequently and vertisols are generally found in topographic depressions. Undifferentiated ferruginous tropical soils develop on sandy parent materials and undifferentiated halomorphic soils occur in sedimentary depressions around lakes. Brown calcareous and calcimorphic soils are restricted to volcanic tuff, ash or lacustrine sediments around Kilimanjaro, Meru and Ngorongoro mountains.

Humid Region

3.43 Ferruginous tropical soils occur most frequently and vertisols are found in the topographic depressions. Vertisols are restricted to sandy sediments or colluvial

parent material. Eutrophic brown soils and calcimorphic soils occur around Mount Kilimanjaro.

Very Humid Region

3.44 Ferrisols occur frequently on the lowlands and ferruginous tropical soils develop on sandy parent materials. Eutrophic brown soils occur on Mount Kilimanjaro volcanic ash and lava. Humic ferrisols occur in the southern highlands.

3.5 Vegetation

3.51 The vegetation has been characterized by physiognomical aspects and the most important attributes are the form and relative contribution of woody plants and grasses in the nature vegetation. The floristic composition of the vegetation in terms of woody plants and grass also gives an indication of the range type and its value for grazing.

Physiognomic Classification

3.52 The main vegetation types are:

- Bushland: an assemblage of woody plants, mostly of shrubby habit; having a shrub canopy of less than 6 m in height, and a canopy cover of more than 20%.
- Bushland thicket: an extreme form where the woody plants form a closed stand through which man or the larger ungulates can pass only with extreme difficulty. This land has little value for grazing.
- Woodland: a stand of trees up to 18 m in height with an open or continuous but not thickly interlaced canopy, sometimes with shrubs interspersed, and a canopy cover of more than 20%. Grasses and herbs dominate the ground cover.
- Grassland: land dominated by grasses and occasionally other herbs; sometimes with widely scattered or grouped trees and shrubs, the canopy cover of which does not exceed 2%.

Sub-types can be classified according to the following criteria:

- Height: giant = over 300 cm; tall = 300-150 cm; medium height = 150-100 cm; short = 1 meter- 50 cm.
- Genera of dominant grasses, dominance by annual grasses or other herbs.
- Degree of swampiness: seasonally flooded or seasonally water logged.
- Wooded grassland: is a grassland with a scattered or grouped trees, the trees always conspicuous, but having a canopy cover of less than 20%, but more than 2%. A 2% canopy cover is the division between wooded grassland and the populations of trees per hectare for mean crown-diameters of 2, 4 and 8 m are, respectively 50, 12 and 3. A 20% canopy cover, is the division between wooded grassland and woodland or bushland, and the populations of woody plants per hectare, trees or shrubs, for mean cover diameters of 2, 4 and 8 m are 500, 125 and 30.

Vegetation distribution and floristic composition

3.53 Semi-arid to sub-humid plateau

The physiognomic vegetation type is bushland while thickets are common on skeletal soils with low fertility. Edaphic grassland occur on vertisols and brown volcanic soils. The species occurring in this region include:

- Woody plants: *Acacia drepanolobium*
Acacia tortilis
Adamsonia digitata
Bauhinia fassoglensis
Boscia angustifolia
Commiphora spp
Grewia bicolor

Most of the woody species are browsed by cattle and goats particularly *Bauhinia* and *Grewia*.

- Grasses: *Cenchrus ciliaris*
Cynodon dactylon
Panicum massaiense

The following grasses occur on vertisols:

- Themeda triandra*
Cynodon plectostachyus
Pennisetum mezianum

3.54 Semi-arid to sub-humid Lowland

Woody plants: combretum spp and specially *Acacia nigrescens*
in depressions.

Grasses: are dominated by *Themeda triandra* with
Chrysopogon aucheri
Hyparrhenia dissoluta
Hyparrhenia filipendula

3.55 Humid Plateau

The physiognomical aspect of the vegetation is a woodland with the dominant tree *Brachystegia spiciformis* (Miombo) and an understorey with a lot of tall grass:

Hyparrhenia dissoluta
Hyparrhenia filipendula
Hyparrhenia rufa
Loudetia simplex

After tilling the soil the fallows bear a lot of common weeds but also some palatable annual grass:

Dactyloctenium aegyptium
Digitaria longiflora
Eleusine indica
Setaria verticillata
Rhynchelytrum repens

3.56 Humid lowland

The physiognomical aspect of vegetation is usually a wooded grassland. The main grasses are:

Panicum maximum
Hyparrhenia dissoluta
Hyparrhenia filipendula
Digitaria sp.
Cynodon dactylon

with *Heteropogon contortus* on stony soils
Cynodon plectostachyus in depressions
and *Stylosanthes fructicosa* on sandy soils

Some rough grasses appear with overgrazing; such as:

Sporobolus pyramidalis

but after tilling the soil palatable grasses will cover the ground such as:

Brachiaria cf ruzizensis

Woody plants are numerous and include:

Acacia spp.

Combretum spp.

Podocarpus sp.

3.57 Very Humid Highlands

Vegetation is generally an open grassland dominated by the perennial grasses such as:

Pennisetum schimperi

3.58 Very Humid Plateau

An induced vegetation with *Cynodon dactylon* is grazed on follows after small holder farmers have destroyed the forest for cropping bananas, coffee and maize.

3.59 Very Humid Lowland

The main forest is generally cleared and the soils cultivated for sisal and coconut plantations. The induced vegetation that follows includes a lot of weeds such as: *Hyptis* sp and bush regrowth.

The grass cover is dominated by:

Heteropogon contortus on stony soils

and *Cynodon dactylon*

Digitaria mombasana

Urochloa paniculoides on sandy soils

Tall grasses are localized on loamy soils and include:

Hyparrhenia dissoluta

Hyparrhenia filipendula

Hyparrhenia rufa

Panicum maximum

3.6 Tse-Tse Flies and the Environment

3.61 Seven species of tse-tse flies are found in Tanzania and they infest over 60% of the total area of the country. In these infested areas or "fly belts" trypanosomiasis; the disease transmitted by tse-tse, keeps human settlement sparse and the domestic livestock population extremely low.

Tse-tse flies infest forest, woodland, thicket or shrub: they cannot breed in open country devoid of trees or shrubs.

Each species requires a certain type of vegetation.

The tse-tse Glossina swynnertoni is confined to the northern part of the semi-arid to sub-humid plateau.

G. austeni and G. pallides are largely distributed through the humid to very dry lowlands and also in the north-eastern and south-western zones of the humid plateau.

G. palpalis is confined to the shores of lakes Tanganyika and Victoria.

G. longipennis is confined to the very humid northern highlands and G. brevipalpis to the very humid southern highlands near Mbeya.

The common tse-tse, Glossina morsitans lives mainly in the "miombo" woodland on south-western humid plateau and also in wooded grassland on lowland humid coastal plain.

3.7 Tanzania Land use (table 4)

3.71 Small holder cultivation is confined to 4.6% of the country and large scale agriculture to 0.7% with 574,000 hectares under coffee, tea, sugar, sisal, spice, wheat and NARCO ranches. These parastatal ranches are occupying about 252,000 hectares. Rough grazing land occupies 43,843,000 ha or 50.3% of the country.

Land not in agriculture use includes:

high altitude forest	0.4%
woods and forests	42.6%
rocks, snow, ice,	
swamps and urban use	1.4%

Table 4 Tanzania land use

Eco-climatical areas	cultivation (1000ha)		rough grazing		area size	
	smallholders	large scale	1000 ha	per cent	1000 ha	per cent
<u>Semi-arid to sub-humid</u>						
2/3 Arusha	94	15	5,066		5,410	
Singida	157	-	2,762		4,877	
Dodoma	317	36	3,141		4,083	
Iringa	236	2	3,192		5,662	
1/2 Shinyanga	169	-	1,487		2,508	
	<u>973</u>	<u>53</u>	<u>15,648</u>	35.6	<u>22,560</u>	25.9
<u>Humid plateau</u>						
1/2 West Lake	122	21	1,033		1,420	
1/2 Shinyanga	169	-	1,487		2,508	
Mwanza	408	-	968		1,945	
Mara	206	-	1,828		2,150	
Kigoma	281	-	930		3,661	
Tabora	219	5	3,496		12,058	
1/2 Mbeya	124	1	2,280		4,108	
1/2 Kilimanjaro	54	32	468		653	
1/3 Arusha	47	8	2,532		2,705	
	<u>1,630</u>	<u>67</u>	<u>15,022</u>	34.2	<u>31,208</u>	35.7
<u>Humid lowland</u>						
1/2 Tanga	103	65	896		1,324	
Morogoro	220	161	2,453		7,219	
Coast	194	59	2,492		3,340	
Mtwara	308	50	2,623		8,179	
	<u>825</u>	<u>335</u>	<u>8,464</u>	19.3	<u>20,062</u>	22.9
<u>Very humid highland</u>						
1/2 West Lake	122	21	1,033		1,420	
1/2 Mbeya	124	1	2,280		4,108	
1/2 Kilimanjaro	54	32	468		653	
Ruvuma	118	-	32		6,054	
	<u>418</u>	<u>54</u>	<u>3,813</u>	8.6	<u>12,235</u>	14.0
<u>Very humid lowland</u>						
1/2 Tanga	103	65	896	2.0	1,324	1.5
	<u>3,949</u>	<u>574</u>	<u>43,843</u>	99.7	<u>87,389</u>	100.0

3.8 National Herd Distribution

3.81 The national cattle herd has been recently (1972) estimated at 9,422,000 units though some previous estimations reached 13,000,000 head. State ranches have only 100,000 cattle units. The livestock population includes more than 4,500,000 goats and 2,800,000 sheep. The annual off take is estimated by the amount of sold skins to 1,047,000 units or 12 to 15% of the national cattle herd with 15 to 19% of females. The growth rate of the national herd is no more than 2.2%.

The cattle herd (table 5) is irregularly distributed through the country as follows:

- 4,000,000 units in semi-arid to sub-humid region
- 4,500,000 units in humid plateau
- 241,000 units in humid lowland
- 478,000 units in very humid highland
- 104,000 units in very humid lowland

More than 90% of the national herd is confined to semi-arid, to sub-humid region and the humid plateau.

The general stocking rate is relatively high with 9.2 ha per head overall the country (total area) and 4.5 ha per head for the total rough grazing area. The distribution of the cattle is such that the stocking rate is much higher in some regions than in others.

Semi-arid to sub-humid: 5.5 ha per head of all land and 3.8 ha per head on the rough grazing land

Humid plateau: 6.8 ha per head of all land and 3.3 ha per head on the rough grazing land

Humid lowland: 83.2 ha per head of all land and 35.1 ha per head on the rough grazing land

Very humid highland: 25.5 ha per head of all land and 7.9 ha per head on the rough grazing land

Very humid lowland: 12.7 ha per head of all land and 8.6 ha per head on the rough grazing land

The cattle are mostly concentrated on the semi-arid to sub-humid region and the humid plateau in the west of the country.

Table 5. Beef cattle herd (in thousand units)

Area	x	Herd size	per cent	off take	per cent off take
<u>Semi-arid to sub-humid</u>					
2/3 Arusha		1,586		98.2	6.2
Singida		778		40.0	5.1
Dodoma		773		91.0	11.8
Iringa		239		23.1	9.7
1/2 Shinyanga		691		90.4	13.1
		<u>4,067</u>	43.1		
<u>Humid/plateau</u>					
1/2 West Lake		114		19.7	17.3
1/2 Shinyanga		691		90.4	13.1
Mwanza		874		163.1	18.7
Mara		770		62.6	8.1
Kigoma		80		0.5	0.6
Tahora		873		77.9	8.9
1/2 Mbeya		214		15.5	7.2
1/2 Kilimanjaro		124		57.1	45.8
1/3 Arusha		792		49.1	6.2
		<u>4,532</u>	48.1		
<u>Humid/lowland</u>					
1/2 Tanga		104		25.8	24.7
Morogoro		114		15.8	13.8
Coast		14		9.0	64.3
Mtwara		9		0.3	3.3
		<u>241</u>	2.5		
<u>Very humid/highland</u>					
1/2 West Lake		114		19.7	17.3
1/2 Mbeya		214		15.5	7.2
1/2 Kilimanjaro		124		57.1	45.8
Ruvuma		26		0.5	1.9
		<u>478</u>	5.0		
<u>Very humid/lowland</u>					
1/2 Tanga		<u>104</u>	1.1	25.8	24.7
<u>Mainland</u>					
		9,422	99.8		

4 CURRENT PASTURE AND RANGELAND ACTIVITIES

4.1 Research Programme

Ministry of Agriculture

4.11 The reorganisation of the Ministry of Agriculture in 1973 created the Livestock Development Division with responsibilities for research and livestock diseases and livestock production including pasture, forage and range utilisation. Prior to 1973 these responsibilities were split between three or more Divisions and there was no definite Livestock Development Policy. At present, pasture research activities are administratively attached to the Livestock Production Research unit at Mpwapwa which is supported by a country-wide series of Research Centres and Experiment Stations. Some pasture research is undertaken by the Crop Development Division at their Agricultural Research Institutes at Ukiriguru, Lyamungu and Maruku. The Manpower Development Division conducts some pasture research at the Research and Training Institutes at Tengeru and Mbcya.

Morogoro University Campus

4.12 Most of the current research activity is directed towards crops and soil science. The Animal Science Department has some pasture introduction plots and is undertaking digestibility and feed supplement trials for dairy cattle. There is a Rhizobium unit within the Soil Science Department screening Rhizobium strains for effective symbiosis with grain legumes.

Research Centres

4.13 The pasture research recently completed and still in progress at the various centres can be conveniently grouped into the Ecological Climatic Regions described in Section 3.3 as follows:

Semi-arid to sub-humid Plateau - Mpwapwa, Kongwa, Ardaï near Monduli and Miwaleni near Moshi.

Semi-arid to sub-humid lowland - Morogoro

Humid Plateau - Agricultural Research Institute Ukiriguru near Mwanza and Tengeru Research and Training Institute near Arusha.

Humid Lowlands - Kibaha farm near Dar es Salaam

Very humid Highlands - Mbeya Research and Training Institute
(Nordic Project) and Kitulo near Mbeya.

Very Humid Plateau - Agricultural Research Institutes at Lya-
mungu near Moshi, and Maruku near Bukoba.

Very Humid Lowlands - Tanga Livestock Research Centre and Azimio
Farm (Tanzania Sisal Corporation) near Tanga.

The research programme at each of the above centres is briefly outlined below:

4.14 Semi-arid to Sub-humid Plateau

4.141 Mpwapwa (since 1905)

- natural pastures: (since Staples 1942) at Ilolo farm, rotational grazing with 2 stocking rate (1ha/beast and 1.5 ha/beast) and fenced Rhodes grass pastures reclaimed from bush and thicket. One third of each paddock is sown to maize for silage. No fertilizer is applied. Stock can be carried at 1.5 ha/beast.

- sown pastures: -observation plots with 15 legumes and 13 grasses (175 in 1948) and dry matter records from several cut per year. The highest yielding introductions are:

grasses Cenchrus ciliaris var. Molopo, Mpwapwa and Kongwa (11 to 13 t DM per ha)

legumes Stylosanthes guyanensis (4 to 13 t DM per ha)

Clitoria ternatea (9t DM per ha)

-observation plots with grass/legumes mixtures (6 legumes and 4 grass)

4.142 Kongwa (since 1947)

- natural pastures: stocking rate trials (since 1967) on nature pastures. 4 stocking rates (from 2.4 to 6 ha/steer) on a 4 year burning cycle and with bush clearing by hands. Records include monthly liveweights and botanical composition in per cent (bushes, annual grasses, perennial grasses, herbs, weeds, bare soil)

The results of the stocking rate trial for the second lot of steers over a 20 month period from March 1970 to October 1971 are given below:

<u>Stocking rate</u> (ha/head)	<u>Liveweight (mean)</u> kg/head		<u>gain</u> kg/head	<u>gain</u> per ha/year
	3/70	10/71		
2.4	260	422	162	13.3
3.6	260	434	174	9.5
4.9	260	404	144	5.9
6.0	260	445	185	6.0

The liveweight gain per head at a stocking rate of 4.9 ha per beast seems erroneous because it is the lowest of all stocking rates.

A similar result occurred with a third lot of steers over a 12 month period January to December 1973. The monthly cumulative liveweight curves also show that the animals at this stocking have the lowest liveweights throughout the period. It seems that the results at this stocking rate are reflecting paddock differences rather than the treatment effect.

The cumulative liveweight curves for the remaining three stocking rates show that the steers grazed at 6.0 ha per beast maintain liveweight through the dry season (June to November) and gain liveweight one month earlier (December) whereas steers at the higher stocking rates lose liveweight during the dry season and immediately after the start of the growing season in December.

Steers grazed at 6.0 ha per beast had a liveweight advantage of 60 kg per head over steers at the highest stocking rate by the end of the second growing season.

In this trial the dry matter yield of the pasture is not recorded. At optimum stocking rates one would expect that 50 to 75 per cent of the potential pasture yield would be consumed; cattle consume about 2.5 kg dry matter per day per 100 kg liveweight.

bush control trials (from 1966 to 78) with time and frequency of burning and grazed by cattle or goats or mixed herds.

Botanical composition records but not liveweight records.

- Sown pastures (since 1953): observation plots with 59 grass and 19 legumes. The most promising accessions are:

- grasses: *Cenchrus ciliaris*
Brachiaria brizantha
Cynodon plectostachyus
Andropogon gayanus
- legumes: *Leucaena leucocephala*

4.143 - Ardai demonstration and training centre

-natural pastures (1972 to 1974): grazing trials with 3 stocking rate (1 or 3 or 5 ha/beast) and 3 grazing system (rotation, continuous, boma).

-sown pastures: only observation plots on a range of grasses and legumes. Only *Leucaena leucocephala* has survived.

4.144 - Miwaleni-Kahe Kenafe farm

-Sown pastures: *Medicago sativa* and *Chloris gayana* under irrigation; hay yield: 1500 kg/ha/month (18 t/ha/year)
seed yield: 40 kg/ha.

4.15. Semi-arid to sub-humid Lowland

4.151 The research activities of the University at Morogoro have been mentioned in section 4.12 above.

4.16 Humid Plateau

4.161 Ukiriguru

- Sown pastures: observation plots for seed production are just being maintained for 4 grass and 6 legumes.

4.162 Tengeru

Agricultural Research centre for crop production and pastures since 1967. Main pasture research workers in this station were Anderson G.D.; Naveh Z. (1965-67). Size of the station: 380 ha.

- Natural pastures (no trials): induced vegetation on fallows, include the grasses *Cynodon dactylon*

- Cynodon plectostachyus*
- Hyparrhenia* spp.

and weeds: *argemone mexicana*

Bidens pilosa

Lantana spp.

Solanum spp.

- Sown pastures: multiplication plots for seed production. 18 grasses and 24 legumes on 75 and 150 square metres plot. (30 grasses and 22 legumes in 1967). Best results obtained from:

<u>Grasses</u>	<u>legumes</u>
<i>Brachiaria brizantha</i>	<i>Desmodium intortum</i>
<i>Chloris gayana</i>	<i>Desmodium sandwichense</i>
<i>Panicum maximum</i>	<i>Glycine wightii</i>
<i>Setaria splendida</i>	<i>Leucaema leucocephala</i>
<i>Sorghum sudanense</i>	<i>Medicago sativa</i>
<i>Tripsacum laxum</i>	<i>Macroptilium atropurpureum</i>
	<i>Pueraria phaseoloides</i>

- Pure stand pastures: *Medicago sativa* (some ha) with irrigation

4.163 - Mbeya-Uyole experimental station (Nordic Project)

- Natural pastures: induced vegetation following small holder cultivation, densely settled.
- Sown pastures: observation plots (soil pH=6). *Medicago sativa*: irregular behaviour (lack of copper). Sugar beet: best yield (= 8 t/ha DM). Nursery establishment in December for planting of seedlings. Standing crop remains succulent in the field during dry season and can be harvested for feeding cattle.

Grass x legume mixture (with phosphate fertilizing):

Chloris gayana x *Desmodium uncinatum*

Pennisetum purpureum x *Desmodium uncinatum*

3 cuts per year: 25 t/ha DM (14 t without fertilizer-8 t without *Desmodium*).

Some leaves are frosted in July, but stay on the field as dry standing crop. Minimum average for July 7.8°C. *Desmodium intortum* is more productive than *Uncinatum* in dry matter but less seed production.

- Seed production: *Desmodium uncinatum* is cut once in the rainy season for fodder production, and harvested with combine-

harvester in dry season for seed production (yield seed: 400 kg/ha).

- Pure stand pastures: *Chloris gayana* invaded in 3 years by Congo signal = *Cynodon plectostachyus*.
invaded by weeds: weeds control by MCPH spray.

Cynodon plectostachyus used for grazing and hay or silage production.

- Green manure legumes: *Lupinus* sp.

Crotalaria sp. cf. *juncea*

4.17 Humid Lowlands

4.171- Kibaha Dairy Farm (pasture research application)

- Natural pastures: bush cleared to produce an induced wooded grassland with palatable grasses including *Digitaria* sp. and *Hyparrhenia* spp. The bush is controlled by hand.
- Sown pastures and forage crops: maize crops and *Chloris gayana* sown between rows. *Stylosanthes guyanensis* has volunteered in the natural pastures.

4.18 Very humid Highlands

4.181- Kitulo sheep and dairy farm (from May 1965: a UNDP/FAO six years project). Since 1974, a New Zealand bilateral assistance project).

- Natural pastures: *Pennisetum clandestinum* (Kikuyu) sward mixed with weeds and unpalatable tussocks grass (for sheep grazing).

- Sown pastures: temperate grass/legume mixture:

Lolium perenne/*Dactylis glomerata*/*Trifolium repens* (white clover)

sown after tilling to elimination of Kikuyu (because it is regarded as too aggressive) and fertilizing with triple superphosphate: 125 kg/ha and Amino sulphate: 125 kg/ha. Management rotation grazing with electric fence. Carrying capacity estimated at one beast to 2 ha.

4.19 (a) Very Humid Plateau

4.19(a) 1-Lyamungu (Senga C., pasture field officer).

The results of the research may be applicable to banana and coffee cultivation areas.

- Natural pastures (no trials): *Cynodon dactylon* for dairy cattle grazing.
- Sown pastures: observation plots (since 1969) 93 species and strains, best settlement with:

<u>Grass</u>	<u>Legumes</u>
<i>Cenchrus ciliaris</i>	<i>Centrosema pubescens</i>
<i>Panicum maximum</i>	<i>Desmodium intortum</i>
<i>Pennisetum purpureum</i>	<i>Desmodium sandwichense</i>
<i>Setaria splendida</i>	<i>Glycine wightii</i>
	<i>Medicago sativa</i>

Grass/legume mixtures (since 1971) with 4 replicates, 3 or 4 cuts per year and 3 grasses x 11 legumes; no fertilizers.

Best results (till Jan. 1975) in DM, tonnes per hectare are given in the table below:

Dry Matter Yield of some grass/legumes mixtures over nearly four years (1971/75)

Mixture	No. of cuts	Total yield 1971/75			Average annual yield
		Total	Grass	legume	
		<u>Tonnes/ha</u>			<u>tonnes/ha</u>
<u><i>Cenchrus Ciliaris</i></u>					
<i>Desmodium uncinatum</i>	11	74.8	60.5	14.3	25
<i>Desmodium intortum</i>	11	75.4	37.3	38.1	25
<u><i>Setaria splendida</i></u>					
<i>Desmodium uncinatum</i>	11	54.1	43.3	10.8	18
<i>Glycine wightii</i>	11	60.2	48.7	11.5	20
<i>Desmodium intortum</i>	11	65.8	31.9	33.9	22
<u><i>Tripsacum laxum</i></u>					
<i>Desmodium uncinatum</i>	11	69.7	57.6	12.1	23
<i>Desmodium intortum</i>	11	69.2	37.4	31.8	23

Best mixtures seems to be:

- Desmodium intortum x Cenchrus ciliaris (for grazing)
- Desmodium intortum x Setaria splendida (for grazing)
- Desmodium intortum x Tripsacum laxum (for cutting)

- Fodder yield trial with Desmodium intortum (since 1973), 6, 8, 10 and 12 week cutting intervals and 4 replicates over 6 months, best results were obtained with the 10 weekly cutting interval.
(20 t DM/ha)
- Fertilizer trial: a farm yard manure trial on Cenchrus ciliaris with 0, 4, 6 and 8 t manure per ha, gave no statistically significant difference over 3 years and 18 cuts.
A NPK fertilizer trial was laid out mid of 1974 on Cenchrus ciliaris, but there is not enough datas yet.
- Coffee and legume interplanting (since 1971): with 9 legumes in a three year old coffee stand, and with 4 replicated.

Legume cover crop	Legume DM yield t/ha	No cuts	Clean coffee (kg/ha)	
			Third year	3 year mean
Control (nil)	-	-	205	722
Desmodium intortum	8.8	4	68	773
Desmodium uncinatum	6.9	4	205	718
Indigofera endecaphylla	5.5	4	85	838
Pueraria phascoloides	3.6	4	60	677

Desmodium uncinatum can be grown in between coffee rows and obtain high forage yield without decreasing the coffee yield (see mean and 3rd year yield of coffee).

4.19(a) 2 Maruku Research and Training Institute (near Bukoba)

The institute has been transferred to the Crop Development Division. A Field Officer is in charge of the pasture work.

- Natural pastures: a study of burning, slashing and grazing is in progress. Records grass composition.
- Sown pastures: observation plots:
best results from:

<u>Grass</u>	<u>Legumes</u>
Pennisetum purpureum	Desmodium intortum
Setaria splendida	Desmodium uncinatum
Tripsacum laxum	Stylosanthes guyanensis

4.19(b) Very Humid Lowlands4.19(b) Tanga Livestock Research Centre

- Natural pastures: grazing trials (since 1972), 7 paddocks of 0,2ha each (50 x 40 metres) with 42 days rotation. 3 replicates: fertilizer 100 kg/ha triple superphosphate nil, manure. Stocking rate: (with weaners, 80 kg liveweight) from 500 to 1,000 kg lw/ha.

Weeds (Hyptis suaveolens, Lantana spp, Sida acuta, Solanum incanum) slashed every 3 months.

Native grasses: Cynodon dactylon, Digitaria mombasana, Heteropogon contortus, Panicum maximum and Urochloa panicoides.

Records, botanical composition: no difference between nil, fertilizers and manure. Triple superphosphate increase local legumes: Stylosanthes fructicosa and unpalatable legumes.

- Sown pastures: observation plots: 19 legumes, 2 grass-
Best results with:

<u>grasses</u>	<u>legumes</u>
Andropogon gayanus	Glycine wightii
Chloris gayana	Macroptilium atropurpureum
Panicum maximum	Pueraria phaseoloides
	Stylosanthes guyanensis

- Pure stand pastures: Chloris gayana for hay
Panicum maximum for green forage
Stylosanthes guyanensis for grazing
- Improved pasture: Pueraria phaseoloides sown in furrows in natural pasture but choked by Hyparrhenia spp canopy

4.19(b) 2 Azimio Farm Tanzania Sisal Corporation (applied results)

- Natural pastures: bush cleared by hand; bush control by mechanical slashing every 3 months.

- Sown pastures: *Cynodon plectostachyus* in depression
grassland

Chloris gayana on uplands after maize crop.

4.20 Previous Research Centres

Other stations with pasture activities in the past includes:

- Semi-arid to sub-humid Plateau

Mwadi; 25 km NE Shinyanga (from March 1970 to October 1971)

observation plots: 17 grass, 13 legumes

Rangeland survey and maps

134 ha fenced into 9 paddocks

Malya; 80 km SE Mwanza

West Kilimanjaro; observation plots

- Humid Plateau

Urambo; 100 km W Tabora; about 1953.

natural pastures: Miombo woodland and Mbugas, with grassland in the depressions.

- Very Humid Highlands

Ithem-Sao Hill; natural pastures with *Themodatriandra* and *Loudetia* simplex on clay soils.

Burning at the end of dry season (October) or bush clearing by hand and mowing

4.3 Comments on Research Programme4.31 Sown Pastures

The agronomic procedures for investigating sown pastures at Lyamungu is of high standard and is a pattern for all research centres.

The approach at Lyamungu is outlined below.

First: Observation plots

Introduction of exotic species with observation on: vigour, leafiness, greenness, earliness in growth, phenologic stages (flowering and seed maturity) and drought, pest and disease resistance.

Second: Yield Potentialities

Dry matter production: by standing crop; by different cutting intervals, over a three year period.

Crude protein content: for the different cutting intervals.

Third: Plant-animal relation; carrying capacity assessment.

Fourth: Fertilizers response investigation.

Fifth: Pasture management: implantation, crop association, pasture mixtures.

Sixth: Necessary adjustments and proposals for extension purposes in different ways (smallholder farmers, large scale farms, traditional breeders).

Additional investigation should include the effect of edaphic factors (mainly soil fertility level) on pasture productivity in the Kilimanjaro Very Humid Plateau Region and the identification of individual nutrient deficiencies through pot and field experimentation. These investigations would involve additional staff.

At most research centres there were no studies of grass/legume mixtures under grazing. There seems to be a reluctance to move from observation plots into pasture mixtures under grazing as a means of selecting adapted pasture plants. One observation plot has been maintained for more than eight years.

4.32 Natural Pastures

For natural pastures, the first requirement is a range land survey but it is realised that this is a complicated procedure.

Generally, range management and range improvement trials are carried out before the necessary investigations of site heterogeneity and a potential productivity assessment.

Bush control trials with burning and cattle or goat grazing are carried out without a previous statistically investigation on site uniformity.

After ten years or more, botanical analyses do not give any significant trend in the vegetational successions. In addition, the relative contribution of woody plants is not assessed by a measure of canopy cover but by the number of stems, association with the percentage of herbs, grass and weeds. Rainfall variations, year by year is not recorded though its effect dominates seasonal changes in vegetation.

Lack of site uniformity can also interfere with stocking rate trials and their interpretation as discussed in section 4.142. These site problems appear to be more pronounced in semi-arid areas with small differences in drainage and the moisture relationship of soils can have a big effect on plant and animal production.

4.4 Training

University of Dar es Salaam

4.41 The Faculty of Agriculture and Forestry of the University of Dar es Salaam has the sole responsibility for degrees and higher degree training in Tanzania. The faculty was first established in 1969 at Morogoro, some 200 km from the main campus at Dar es Salaam in the semi-arid to sub-humid low region. At present, the recurrent expenditure of the Faculty is T.Shs. 20 m/-per annum and the total lecturer/research establishment is 81. The Faculty has six departments viz. Crop Science, Animal Science, Agricultural Chemistry and Soil Science, Agricultural Engineering and Land Planning, Rural Economy and Agricultural Extension and Forestry. First degrees are offered in Agriculture and Forestry (3 years each with an annual intake of 70 to 80 and 20 to 25 undergraduates, respectively). Veterinary and Food Science Degrees are expected to be offered in 1976 or 1977. At present the total student body numbers 750 including 20 postgraduate students. The Faculty can award Msc. and PhD degrees.

4.42 The Agriculture and Forestry Faculty has received generous support from DANIDA, NORAD, UNDP/FAO; the Ford Foundation and the West German DAAD organisation in providing experienced teaching staff. The Faculty also receives British short-term lectures and External Examiners through the Inter-University Council for Higher Education Overseas (I.U.C.) which is based in London. The Japanese Government has provided the Faculty with one staffmember.

4.43 A number of research programmes within the Faculty are in collaboration with International Centres such as the International Maize and Wheat Improvement Centre (CIMMYT) Mexico, The International Institute of Tropical Agriculture (IITA) Ibadan Nigeria, the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) Hyderabad, India, and the International Development Research Centre (IDRC) Ottawa, Canada.

4.44 The provision for pasture and rangeland training in the syllabus is as follows: The Crop Science Department gives a Pasture Agronomy Course in second year comprising 10 lecture hours and 5 hours practical to all Agriculture students. In third year it is possible to select an "option stream" within each Department. The only third year course on pastures is given by the Animal Science Department and comprises 20 lecture hours and 20 hours practical on "Range Management and Utilization". Third year options are available for most of the scientific disciplines that are necessary to support a national pasture development and research programme. The appropriate options available in the different Departments include: Plant Breeding and genetics (Crop Science), Animal Physiology and Reproduction (Animal Science), Pedology and Soil Survey, Soil Chemistry, Soil Physics, Soil Biology, Soil Fertility and Soil Management, and Plant Nutrition (Soil Science Department).

The Crop Science Department is undertaking Rhizobium studies on crop legumes but not on pasture legumes.

Ministry of Agriculture

4.45 The Ministry of Agriculture, Manpower Development Division conducts Certificate Courses in Veterinary Science, Animal Husbandry, Dairy Husbandry and Range Management at a number of Research and Training Institutes throughout Tanzania located at Mbeya, Mwanza, Tengeru, Kibaha and Mpwapwa. The certificate courses are of one year duration and all courses include some training in pasture agronomy and rangeland management.

4.46 A one year Diploma Course in Ranch Management is available at the Mkata-Morogoro Training Institute to provide more specialized training than is available in the Certificate Courses. The Diploma course candidates are in-service officers with either a certificate in Veterinary Science or Animal Husbandry or Range Management and at least two years practical experience in the field. The curriculum of the Diploma course includes lectures and practical work in range management, animal husbandry, ranch economic organization and ranch development. The Mkata-Morogoro Institute was established in 1973. Prior to this, Diploma Courses in Ranch Management were undertaken at Egerton College, Kenya.

Overseas Tours

4.47 Bilateral training programmes with a number of different countries enable farm managers, diplomats, undergraduates and graduates to receive additional training and experience overseas.

4.5 Extension

4.51 Field extension sciences for Animal Disease Control in the Livestock Development Division is administered from the headquarters in Dar es Salaam through Regional Livestock Officers (20 altogether), District Livestock Development Officers and Livestock Development Centres (formerly Veterinary Centres). Most of the extension workers have diplomas or certificates in Veterinary Science or Animal Husbandry with some knowledge of animal production and management but very little knowledge on pasture and range utilisation. Apparently the Crop Development Division has a similar regional and district extension service in the crop producing regions.

4.52 The Livestock Research Centres and Livestock Experimental stations associated with the Livestock Production Research Centre at Mpwapwa are primarily concerned with research activities rather than extension.

4.53 Tanzania has only a small number of Graduates and Diplomates that have specialized in Pasture Agronomy or Range Management, and these officers are mainly located at the Research and Training Institutes or at Research Centres or Experimental Stations. A few are employed as Ranch Managers for parastatal Companies. There are no extension workers that have specialized in pasture or rangeland management.

4.6 Conferences, Committees, and Other Organizations

The Tanzania Society of Animal Production

4.61 The Society was inaugurated in May 1973 when it held its first scientific conference. A second Conference was held in May 1974. The Society receives papers on all aspects of pasture and animal production and livestock breeding and the Proceedings are published.

Ministry of Agriculture

4.62 The Livestock Development Division arranges separate annual conferences for Senior Livestock Research Officers and Senior Livestock Development Officers to consider policy and administrative matters and to review progress reports on research projects. Research proposals are considered by the Livestock Production Research Committee which submits its recommendations to the Ministerial Livestock Research Committee.

East African Animal Industry Research Co-ordinating Committee

4.63 This Committee is responsible for co-ordinating activities in Animal Production within the three partner states.

Tanzania National Scientific Research Council

4.64 The Council was established to encourage and foster all research activities in Tanzania including animal production and health research. The Council can make funds available for promising research projects on a merit basis. The Council is in contact with several International Organizations which fund research projects.

East African Agriculture and Forestry Research Organization

4.65 The East African Agriculture and Forestry Research Organization (EAAFRO) is an international research organization serving the three East African countries, Kenya, Tanzania and Uganda. EAAFRO was first established at Nairobi in 1948 and is responsible for undertaking research in the fields of agriculture and forestry that are: (i) common to at least two East African countries; (ii) require longer-term investigations or more intensive study; (iii) require highly specialized and expensive equipment. Most of the EAAFRO research programmes on crops such as maize, sorghum, bulrush millet, finger millet, sugar cane, grain legumes and horticultural crops including coffee. A small section undertakes research on animal nutrition and management and range utilization and another section maintains the East African Herbarium. Other activities include the East African Plant Quarantine Service and pu-

blication of the East African Agricultural and Forestry Journal.

East African Veterinary Research Organization

4.66 The East African Veterinary Research Organization (EAVRO) shares the same research station with EAAFRO at Muguga, some 28 km north-west of Nairobi. EAVRO is responsible for research on animal physiology and genetics among other activities.

4.67 Joint EAAFRO and EAVRO activities include the Library which is the largest and most complete library for agriculture and ancillary sciences in East Africa. The library services within Kenya, Tanzania and Uganda includes: (i) inter-library loans; (ii) Reprographic service and (iii) Reference-bibliographic service. Address P O Box 30148 Nairobi, Kenya.

International Livestock Centre for Africa

4.68 An International Livestock Centre for Africa (ILCA) is being established near Addis Ababa, Ethiopia. The centre's purpose is to increase production of tropical Africa's 130 million cattle, 100 million sheep and 80 million goats. It is still in the process of devising its research strategy and buildings are expected to be completed in 1975. The tentative arrangements are that research will be concentrated in Ethiopia and Kenya in East Africa and Nigeria and Mali in West Africa. Proposed budget for 1975 is US\$ 1,885,000.

Address P O Box 5689 Addis Ababa, Ethiopia.

Serengeti Research Institute

4.69 The Serengeti Research Institute for wild life and range utilization is located in Serengeti Game Park, Arusha District, Tanzania and attached to the Ministry of Natural Resources. The Institute collaborates in the Man and Biosphere (MAB) UNESCO Programme. The Serengeti Institute provides some training for undergraduate and postgraduate students from the University of Dar es Salaam.

5. REORGANISATION OF PASTURE AND RANGELAND ACTIVITIES

5.1 Introduction

General

5.11 The livestock industry has contributed very little to the monetary economy of Tanzania in comparison to the contribution from cash crops such as cotton, coffee and sisal. Until recently the development of the livestock industry has been neglected by comparison with the research and development that has gone into cash crops.

5.12 In recent years greater emphasis has been placed on the need to increase livestock products to obtain self-sufficiency in dairy production and increased standards of human nutrition through increased meat production. While much effort and progress has initially gone into disease control and genetic improvement through the introduction of more productive exotic breeds, it is now being realized that increased production can only be guaranteed by improving the quality of feed available to the animal.

5.13 Natural pastures provide the cheapest means of producing livestock products. Tanzania is richly endowed with natural pasture grasses, legumes and browsed plants. The Republic has provided a number of pasture species that are now cultivated throughout the tropics of the world such as Biloela buffel grass (Cenchrus ciliaris) from Dodoma and "Cooper" Glycine (Glycine wightii) from Kongwa.

5.14 Tanzania has barely begun to develop its grassland potential. Now is an appropriate time to review the progress in the research, training and extension activities of pasture scientists and to suggest what reorganization of activities and additional inputs are necessary to encourage and expedite the development of this natural resource.

Research

5.15 A considerable amount of pasture research has already been undertaken in Tanzania (see reviews by Ayre-Smith Beale and Skerman 1968 (a) and van Rensburg 1969) and in other tropical countries of the world. A great deal is already known about the pasture technology and livestock potential for the range of tropical pasture environments discussed in section 3.3. Emphasis should now be placed on adapting this knowledge to suit edaphic and socio-economic conditions in Tanzania. Research results are of little economic value unless they lead to commercial application and increased livestock production. Developing countries can ill afford research that does not lead to practical achievements. Research application and development will not flourish until there is a central co-ordinating Institute that will maintain the continuity of effort necessary to encourage the development of individual expertise in pasture and range sciences.

Training

5.16 In common with many other developing countries, there is a shortage of trained staff in pasture and range management to undertake the tremendous task of the improvement of livestock production from natural and improved pastures. The situation is being remedied by the Diploma Course in Ranch Management at the Mkata-Morogoro Training Institute. The undergraduate and postgraduate training at Morogoro University is inadequate to produce specialists in pasture and range management and the position will not improve while the responsibility is split between the Crop Science and Animal Science Departments. Animal Production from pasture requires a sound knowledge of the soil-plant-animal ecosystem which cannot be adequately covered by separate Departments. A central Pasture Institute could assist in training of post graduates in Pasture Sciences.

Extension

5.17 There has been no effective extension work on sown pasture, forage and range utilization in Tanzania. With a few exceptions

there is little evidence of the use of improved pasture species in grazed pastures or of improved management techniques for natural pastures. The exceptions are the use of Setaria splendida and elephant grass by smallholders on the Mt. Kilimanjaro slopes, the use of Rhodes grass on some state dairy farms, the occasional use of irrigated lucerne (Medicago sativa) and temperate pastures based on Trifolium repens in the very humid highlands at Kitulo. There is little or no extension of management techniques for natural grasslands including the recognition of desirable nature browse shrubs and their management. A regional pasture extension service should be established as soon as suitable trained personnel is available.

5.2 National Pasture Development Institute

Objectives

5.21 There is a need for a central Institute to co-ordinate research and extension activities on pastures, forage crops and rangeland utilization in Tanzania. It is proposed that this Institute be known as the "National Pasture Development Institute" (NPDI) because its main objective should be the development of the Republic's pasture resources through the application of research. The NPDI should be attached to the Livestock Development Division of the Ministry of Agriculture and complement the research activities of the Animal Production and Management Institute at Mwapwa and the Central Veterinary Laboratory at Temeke.

Immediate Objectives

1. To apply existing research knowledge on tropical pasture development and range management in the major Ecological Climate Regions.
2. To survey range resources including the type, distribution and potential productivity in each major region as an aid to national ranch development (LIDA, Ranch Associations and Ujamaa villages)
3. To investigate the effect of soil type fertilizer and existing natural pastures on the establishment and productivity of improved pasture legumes.

4. To train local Agricultural Science graduates in pasture research and extension activities.
5. To establish a pasture seed industry in Tanzania (grasses and legumes) for both local use and export trade. (the seed industry should be taken over by a parastatal company once suitable technology has been developed).
6. To establish a regional pasture extension service.

Long-Range Objectives

1. To increase total livestock production and the efficiency of production, particularly dairying and beef fattening, through the application of research results.
2. To develop standards of expertise in pasture and range sciences in Tanzania that attain international recognition.
3. To complete a National Range Resources Map including the type productivity management and methods of range improvement.
4. To develop improved cultivars and management practices for sown pastures and maintain a register of cultivars and genetic resources (including introductions and selections of endemic species).

Regional Organization

5.22 The organization of pasture development and research for a country like Tanzania with a large area of land of varying rainfall, topography and ecological extremes, is best done from a central headquarters with research centres and sub-stations located in the major ecological environments. Based on existing livestock numbers, the area available for pastoral development and potential for development of the different Ecological-Climate Regions (Section 3), the following field facilities are recommended:

Research Centres

Humid Lowlands	near Dar es Salaam
Humid Plateau	near Tabora
Semi-arid to sub-humid Plateau	KONGWA

Substations

Very Humid Highlands	Sao Hill
Very Humid Plateau	Lyamungu
Very Humid Lowlands	Tanga
Humid Plateau	Ukiriguru (to be maintained until a research centre is established near Tabora)

All of the major Ecological-Climatic regions are represented except for the semi-arid to sub-humid lowlands which is adequately serviced by the Faculty of Agriculture at Morogoro and the Humid-Plateau in the north-eastern zone which is serviced by the Tengeru Research and Training Institute.

The NPDI staff should collaborate with the University and with bilateral teams undertaking pasture research and development work at: Kitulo in the very humid highland (New Zealand Aid); Uyole near Mbeya in the south-western humid plateau (Nordic Project) and Monduli in the northern semi-arid to sub-humid region (USAID Project).

Location of Headquarters and Facilities

5.23 The headquarters establishment should include a central laboratory with facilities for chemical analysis and an associated field station of 1,000 ha. The central laboratory and field station should be within 30 to 50 km of one another if not on the same site.

The location of the headquarters of the NPDI requires detailed consideration; a site near Dar es Salaam is suggested for the following reasons:

1. Ready access to the headquarters of the Ministry of Agriculture, Ministry of Lands, Housing and Urban Development (for maps, aerial photographs etc.) LIDA,

the University of Dar es Salaam and the East African Meteorological Department at Dar es Salaam.

2. Conveniently situated in relation to the Faculty of Agriculture at Morogoro.
3. Well supplied with communications, transport and servicing facilities (particularly for scientific equipment)
4. Representative of the vast humid-lowland region which has the greatest potential for future development with an adequate infra-structure already in existence.
5. Access to a computer

Research Stations: an area of at least 500 ha with housing and field laboratory facilities. Complete control over station management and livestock is essential.

Sub-stations: sufficient land (approximately 25 ha) for small plot experiments with office and laboratory facilities and access to livestock for defoliation of experiments.

5.24 Staff Activities

5.241 A brief outline of the professional and technical staff required during the establishment (Phase I) and expansion (Phase II) of the NPDI is given below. The establishment of the Institute should be over a period of five years. After three years, the progress of the Institute should be reviewed by a joint UNDP/FAO mission before proceeding to Phase II. Although the project will be revised at this stage, we felt that it is desirable to give some indication of the likely staff requirements for Phase II so as to ensure sufficient time for the training of local research staff. It is envisaged the Institute would largely train the research staff required for Phase I and that the University of Dar es Salaam would provide postgraduate training for the research officers required for Phase II.

5.242 Phase I (years 1 to 3)

At Dar es Salaam Headquarters

- International Staff

Pasture Agronomist (Project Leader)-Sown pastures

Range Management and Survey Specialist
 Seed Agronomist—Tropical pasture seed production
 Agricultural Extension Specialist Tropical Pastures

- Local Research Staff

2 Pasture Agronomists
 2 Range Management and Survey
 1 Plant Introduction and seed production
 1 Seed Agronomist
 2 Pasture Extension

- Technical Staff

10 Field Officers or Assistant Field Officers

During Phase I, the headquarters staff will need some assistance from the National Soil Survey Centre at Mlingano and the Central Veterinary Laboratory at Temeke for soil and plant analyses respectively. Close contact and collaboration should also be maintained with the Morogoro Faculty of Agriculture and Forestry and the Surveys and Mapping Division of the Ministry of Lands, Housing and Urban Development.

At Kongwa Research Centre

1 Research Officer
 1 Field Officer Sown Pastures
 1 Field Officer Range Management
 2 Assistant Field Officers

At Tabora Research Centre

1 Research Officer
 1 Field Officer Sown Pastures
 1 Field Officer Range Management
 2 Assistant Field Officers

Sub-stations

At each sub-station, Ukiriguru, Lyamungu, Tanga and there should be:
 1 Field Officer
 1 Assistant Field Officer

5.243 Phase II (years 3 to 8)At Dar es Salaam Headquarters

- Local Research Staff

- 1 Pasture Agronomist
- 1 Range Management and Survey
- 1 Soil Pedologist
- 1 Soil Chemistry and Soil Fertility
- 1 Plant Nutrition
- 1 Pasture Evaluation (nutritive value)
- 1 Rhizobium microbiologist
- 1 Taxonomist (responsible for a herbarium)
- 1 Statistician
- 1 Librarian
- 1 Cartographer-Geographer

- Technical Staff

- 15 Field Officers or Assistant Field Officers

5.24 Guidelines for Research and Development (Phase I)5.251 Regional Range Management5.251 A-General objectives

There is need for a general assessment of the national range resources. The aims of the range research workers should be:

- i) Identification of main range types by ecological and phytosociological methods, (edaphic and ecological location, botanical composition and physiognomical aspects, relative contribution of woody plants and grasses)
- ii) The potential productivity of the main range types (grasses, legumes, herbs, browse) by dry standing crop and yield of dry matter productivity at several cutting intervals.
- iii) Range management
 - Stocking rate assessments
 - Selective bush control by burning, slashing or mixed herd grazing
 - Preservation of desirable browse at densities insufficient to harbour tse tse fly.

iv) Adequate seasonal exploitation and periodical rest in order to preserve the potential productivity of palatable plants at the best stages of feed value.

v) Range improvement

Incorporation of valuable grasses and particularly legumes or other plants into ranges:

Technology of establishment (oversowings, furrow strips, pure stand, etc.)

Location of the improved pastures (edaphic and topographic effects) in order to use the most productive sites in the landscape.

Exploitation of the improved pastures (all through the year, during the dry season only, by night grazing, or for protein supplementation by hand feeding).

These technical approaches should be moved towards:

1. Immediate objectives

Local investigations and expertise for Narco ranches and dairy farms, ranching associations and ujamaa villages rangelands with up to date mapping at the 1/50.000, 1/100.000 or 1/125.000 according to the existing base-map facilities at the "surveys and mapping division" (maps, aerial photographs, mosaics and printlaydowns).

- Locals development proposals with accompanying research surveys and monitoring of:
 - i) The authorized stocking rate
 - ii) The range management scheme
 - iii) The range improvement activities

2. Long-term objectives

To obtain general background knowledge for national rangeland resources on: 1) botanical evolution trends under grazing and particularly "key forage species" (grasses, legumes, herbs and browse) which feeding value and management proposals. Records are required on:

- Increasers: less desirable species of grass and forbs tending to replace the dominant preferred species under grazing
- Decreasers: good forage species tending to lessen under grazing

- Invaders: unpalatable grasses, weeds, bush and tree species tending to invade the overgrazed rangelands.

- ii) General range management schemes .
- iii) General range improvement proposals
- iv) General mapping of "national range resources" giving the location and the size of the main range types at the 1/250.000 scale for regional purposes and at the 1/1.000.000 for national purposes. The help of photo-interpretation, remote sensing and satellite imagery is needed for setting up such maps.

5.251 B- General Methodology

Existing Range Surveys are restricted to bush control trials and stocking rate trials with vegetational succession records at Kongwa pasture research station.

Tanzania Range Surveys should be carried out on the proposed Research Centres located in semi-arid plateau, humid plateau, humid coastal region and proposed sub-stations located in humid plateau, very humid highlands, very humid plateau, very humid lowland.

This will provide the necessary expertise to undertake investigations throughout the country.

Range surveys have to include:

- i) range types and range site identification by general ecophysiological method using as the first step simplified rank scale.
- ii) ecological data for range site characteristics: topographical location, soil characteristics, agroclimatological characteristics by reference to nearby meteorological recording stations (rainfall data, temperature data in meteorological screen, ground level and 20 cm underground level; evaporation data; theoretical evapo-transpiration, balance calculations) and substations (rainfall data)
- iii) Potential productivity assessment: by drying standing crop estimation and reference to Research Centre and sub-station data (main species drying standing crop productivity compared with yield production under each month or each two months cutting intervals).

iv) Seasonal feeding value by references to main species feeding value recorded at the Research Centres and sub-stations by samples analysis from each month or each two months cut, or standing crop grass production, or products of browse (leaves at different stages, fruits etc.). Fodder analysis must include: dry matter content, ash, crude fiber, crude protein, mineral component: Ca, P, K, Na and trace elements: Cu, Co, Mg, Mn, Fe.

v) Range management trials on selective bush control, periodical rest and rotational grazing with grazing trials carried out in the 3 main stations with 10 weaners on 10 ha paddocks.

Liveweight records must be done each month

Pasture yield production assessed by cutting intervals according to seasonal grazing rhythm in permanent enclosures and moving cages with grazed and refused data; Vegetational succession trends should be monitored at the end of each rainy season.

Enclosures and monitoring plots have to be selected by statistical methods including sampling error calculations by trust interval method and Chi^2 tests to analyse the data.

vi) Range improvement trials on the best potential fertile range sites in collaboration work with the Pasture Agronomist. Range improvements should be carried out for nightly grazing paddocks, standing crop reserve and forage wind breaks.

Herbs, bush legumes and succulent plants have to be checked for these purposes and particularly in the semi-arid area: *Atriplex* spp

Kochia spp

Leucocna leucocephala

Opuntia ficus inermis

5.252 Regional Sown Pasture AgronomyA. General Objectives

The aims of sown pasture agronomists should be:

- i) to increase annual production efficiency from pastures by the use of sown pasture species that overcome the deficiencies of natural pasture species. Sown pasture species can be established on cultivated land or introduced into natural pastures by a variety of methods
- ii) to study the adaptation of sown pasture species to a range of climate and edaphic environments so that improved pastures can be recommended for each of the Ecological-climatic regions of Tanzania. Particular attention should be directed to legumes because of their key role in improving pasture production and quality and in improving soil fertility through nitrogen fixation.
- iii) The fertility building and erosion preventing properties of sown pastures particularly in crop rotations and in reclaiming overgrazed range needs to be emphasised.
- iv) Attention must be focused on the ecology of sown pasture species and their response to management factors such as fertilizer rate, stocking rate, time and frequency of grazing and the effect of fire to achieve greater understanding of the inter-relating factors that control plant and animal performance. Most important attributes are persistence and high production under a wide range of management conditions.
- v) Sown pasture species have to be evaluated in terms of their yield and feeding value to animals. Under some circumstances it may be more economic to provide mineral supplements to animals rather than fertilize pastures. In any case, the minimum fertilizer requirements for satisfactory plant and animal production need to be determined. Stylosanthes species are well known for their tolerance to low soil phosphorus levels.

Immediate objectives

- i) to recommend sown pasture species for the large scale improvement of natural pastures for Narco ranches, dairy farms, ranching associations and Ujamaa Villages, for all types and class of livestock.
- ii) to determine the economics of milk production and beef fattening on complete sown pastures receiving fertilizer and reduce dependence on concentrate feeding.
- iii) to determine the climatic, edaphic and biological factors limiting the production of sown legumes
- iv) to determine the effect of sown grass legume mixtures on bush regrowth in the major ecological-climatic zones

Long term objectives

- i) to improve animal production through the development and use of better pasture plants, economical fertilizer rates and improved grazing systems to maximize the utilization of pastures and forage crops.
- ii) to measure the response of animals to sown pastures in terms of stocking rate, liveweight gain, age at turn off, carcass weight, reproductive efficiency etc.
- iii) to select improved cultivars of important pasture legumes and grasses that are native to Tanzania through a study of the natural variation that exists in species such as Glycine wightii, Chloris gayana and Cenchrus ciliaris.

B. General Methodology

The general methodology for the study and development of improved tropical and sub-tropical pastures has been discussed in detail in the book "Some Concepts and Methods for the Study of Sub-tropical Pastures". Bulletin No. 47 Commonwealth Bureau of Pastures and Field Crops (1964). This book is now in print for a revised second Edition which more fully covers Tropical Pastures. The revised edition is recommended as a standard text for research workers studying sown pastures species in tropical environments.

5.253 Seed Production

A. General Objectives

- (i) To introduce and multiply seed of pasture legume and grass cultivars and forage crops adapted to each of the Ecological-Climatic Regions defined in Section 3.3
- (ii) To determine the most suitable areas in Tanzania for mechanised pasture seed production. It may be necessary to have two sites to cover the full range of species but it is unlikely that any more than three are required. Irrigation facilities would be an advantage but not essential if suitable areas are selected.
- (iii) To determine suitable agronomic practices for seed production including fertilizer rates, cultural practices, etc.
- (iv) To introduce mechanical methods of sowing, harvesting, cleaning, processing and packaging seed for distribution.
- (v) To collaborate with Parastatal companies likely to be interested in pasture seed production.

B. General Methodology

The existing technology for tropical pasture seed production has been recently reviewed by Humphreys (1974) (FAO Rome MI/F 3897/E) This publication adequately covers suitable techniques for the different species.

It is recommended that seed of the following pasture species be produced in Tanzania for each of the Ecological-Climatic regions. Initially emphasis should be placed on the production of legumes for oversowing into natural pastures. Many of the natural pastures in Tanzania already contain highly desirable pasture grasses. Initial emphasis should also be placed on forage crops particularly for the dairy industry.

Semi-arid to sub-humid Region

Legumes: *Stylosanthes scabra* CPI 40292

Stylosanthes hamata cv Verano

Stylosanthes humilis cv Lawson

Macroptilium atropurpureum cv Siratro

Glycine wightii cv Cooper

Leucaena leucocephala cv Peru

Grasses: Cenchrus ciliaris cv Kongwa
 Cenchrus ciliaris cv Bilocla
 Chloris gayana
 Cynodon plectostachyus

Humid Plateau

Legumes: Glycine wightii cv Cooper
 Glycine wightii cv Malawi
 Macroptilium atropurpureum cv Siratro
 Stylosanthes scabra CPI 40292
 Stylosanthes hamata cv Merano
 Leucaena leucocephala cv Peru
 Lab-lab purpureus cv Tongai

Grasses: Setaria anceps cv Mandi
 Panicum maximum cv Gatton
 Chloris gayana
 Cynodon plectostachyus
 Pennisetum purpureum

Humid Lowlands

Legumes: Stylosanthes guyanensis cv Cook
 Pueraria phascoloides
 Centrema pubescens
 Leucaena leucocephala cv Peru

Grasses: Brachiaria decumbens
 Panicum maximum (Guinea grass)
 Pennisetum purpureum
 Chloris gayana cv Callide
 Cynodon plectostachyus

Very humid highlands

Legumes: Trifolium repens
 Trifolium semipilosum cv Safari
 medicago sativa

grasses: Setaria anceps cv Narok
 Pennisetum clandestinum

Very Humid PlateauLegumes: Desmodium intortum cv green leaf

Glycine wightii cv Tinaroo

Leucaena leucocephala cv Peru

Grasses: Setaria anceps cv Nandu

Setaria splendida

Pennisetum purpureum

Guatemala grass

Lab-lab purpureus cv Ronigai

Humid LowlandsLegumes: Pueraria phaseoloides

Stylobanthes guyanensis cv Scheffield

Centrosema pubescens

Leucaena leucocephala cv Peru

Grasses: Brachiaria decumbens

Panicum maximum (Guinea grass)

Pennisetum purpureum

Vegetative material of Brachiaria mutica (para grass) should be provided for swamp areas in each of the above Ecological-Climatic Regions.

5.254 Extension ActivitiesA. General Objectives

- i) to review existing knowledge on tropical pasture development and range management in Tanzania and other tropical countries with similar environments and with an advanced pasture technology.
- ii) to develop appropriate extension methods for the different types of pastoral enterprises such as Parastatal companies, smallholders, traditional pastoralists etc.
- iii) to devise a programme for the establishment of a regional extension net work and prepare suitable material and demonstrations for regional extension purposes.

B. General Methodology

Modern approaches to extension theory and practice must be modified to suit the local socio-economic circumstances. The local counterparts must suggest suitable methods of conveying information to the different pastoral sectors. The problems confronting agricultural and pastoral extension services in Tanzania need to be defined so that effective methods can be developed.

5.3 Training

5.31 Post-graduates

5.311 The post-graduate training courses and facilities at Morogoro Faculty of Agriculture and Forestry are inadequate for specialization in Pasture Agronomy and Range Management but seem reasonably adequate to train supporting scientists in Plant Nutrition, Soil Science, Animal Nutrition.

5.312 There is a need for an expert in post-graduate training in pasture and range management and animal production to assist the Morogoro Faculty in surveying the demand and facilities required for appropriate training in pasture sciences in Tanzania. There is a need to strengthen and broaden the scope of the course work in pasture sciences at both undergraduate and post graduate level.

5.313 Initially the National Pasture Development Institute should train its own local scientists in Pasture Agronomy and Range Management. Once the Institute is well established (say after 5 to 8 years) it could assist in the training of post-graduates by offering research facilities and projects and by the staff giving a short series of specialist lectures to post-graduate students on a casual basis.

5.314 The National Pasture Development Institute should have no other commitment to training as its activities must be fully directed towards national pasture development through the application of research results. However, it is expected that the NPDI would indirectly influence training in pasture and range management in Tanzania by providing practical examples of science at work for the Republic.

5.32 Graduates

5.321 It is estimated that Tanzania has an immediate need for about 85 graduates in pasture and range management. The existing situation and suggested needs are indicated below.

<u>Activity</u>	<u>Employment 1975⁺</u>		<u>Estimated requirements</u>
	<u>Tanzanian</u>	<u>Expatriate</u>	
Research	1	6	30*
Training	1	5	20
Extension	0	0	25
Production	0	2	10
<u>Total</u>	<u>2</u>	<u>13</u>	<u>85</u>

+ Graduates in Animal Production and Management not included

* Includes both pasture and supporting scientists for a National Pasture Development Institute and Regional Research Centre Network.

5.322 The existing number and local content engaged in pasture and rangeland activities is completely inadequate for a country the size of Tanzania with a wide range of Ecological-Climatic environments.

5.323 There is a need to strengthen and broaden the undergraduate course work in pasture sciences at the Morogoro University so that an adequate number of appropriately trained people are available for pasture research development and extension.

5.33 Diploma Courses

5.331 At present the one year in service diploma courses available in Tanzania to service the Livestock industries are Animal Production and Husbandry at Mboya, Animal Health at Mpwapwa, Meat Hygiene at Dar es Salaam and Range Management at Mkata. The Range Management diploma is specifically orientated towards producing Ranch Managers for the Parastatal Companies and is not orientated towards producing technical personnel and extension officers.

5.332 Egerton Agricultural College Kenya

This College has offered places for about six Tanzanian students each year to study in particular: the Range Management curriculum. In general Kenya does not receive as much rainfall as Tanzania and Kenya has much more extensive semi-arid range areas. As the main range areas of Kenya are adjacent to similar areas in Tanzania the past practice has been to train Tanzanian students at Egerton College to cover the fields of range management, extension education and direction for Tanzania's beef, sheep and goat production industries.

5.333 Because Tanzania generally receives a higher rainfall than Kenya, there is a need for greater emphasis on sown pastures particularly for dairying, in this country than in Kenya. There is a need for a more balanced indication in sown pasture and range management studies for Tanzanians together with practical examples of pasture and range land improvement in the different Ecological-Climatic regions of Tanzania.

5.334 Proposed Diploma in Pasture Agronomy and Range Management (Tanzania)

It is recommended that consideration be given to establish an insertive one year Diploma course in Pasture Agronomy and Rangeland Management in Tanzania to provide appropriate training and personnel for Tanzania's future needs. This diploma course would complement those already existing to service the Livestock Industry of Tanzania.

The best location for the Pasture Agronomy and Rangeland Diploma College would be in the higher rainfall regions of Tanzania close to the proposed National Pasture Development Institute in Dar es Salaam. Staff of the National Pasture Development Institute should not be involved in Diploma Training but close proximity of the College and Institute should facilitate an appropriate curriculum with adequate practical examples of pasture research and development.

5.34 Certificate Courses

5.341 At present there is provision for a two year preservice certificate course at the MARTI Institutes at Morogoro for Veterinary Science, and at Tengeru for Dairy Science. Consideration should be given to providing training for a certificate course in Pasture Agronomy and Rangeland Management at Tengeru or some other location to ensure an adequate number of technicians and future candidates for ad-

vance training to Diploma or Degree level in Pasture Sciences. In the proposed new certificate course, greater emphasis would be placed on the recognition of nature and introduced pasture species, the importance of legumes and effective nodulation, plant nutrition requirements and the soil-plant-animal ecosystem in both sown pasture and rangeland situations.

5.4 Extension

5.41 There is a need to create an adequate extension service within the Livestock Development Division of the Ministry of Agriculture to encourage better pasture and rangeland utilization. In general, sown pasture development is more likely in the higher rainfall regions of Tanzania suited to dairy production and rangeland developments will be initially associated with beef, sheep and goats production in the humid to semi-arid regions.

5.42 The organization of extension services for pasture improvement and range utilisation should be undertaken by the National Pasture Development Institute which will train two local graduate officers separately specialising in sown pasture extension and Range Utilisation Extension.

5.43 In the course it will be necessary to establish a regional net work of extension officers with Diploma qualifications in each of the major Regions and Districts where livestock production is important.

Some priority should be given to locate pasture and rangeland extension workers at the following towns as centres for regional supervision: Mwanza (Manyara, West Lake, Mara and Singida districts) Moshi (Kilimanjaro and parts of Arusha) Tanga (Tanga) Mbeya (Iringo) Dar es Salaam (Coast, Mtwara and Ruvuma) Arusha (Masailand) Shinyanga (Sukumaland) and Dodoma (Gogoland). A minimum of eight regional extension workers (at diploma level) are required to initiate the regional extension service for pasture and range land improvement. Eventually a pasture and rangeland extension Officer will be required for each separate Region.

5.44 Sufficient knowledge exists from the results of research in Tanzania and other tropical countries to allow experienced extension officers to make considerable progress in establishing large areas of sown pastures and improved rangeland so that preliminary economic assessments can be made of the cost/benefit value of different types of improvement in the different regions. This type of development cannot proceed until there is a sufficient number of trained personnel for a regional net work.

5.45 At present, there is no senior pasture or range officer located at the Ministry of Agriculture in Dar es Salaam and there is only one Range Management Specialist attached to LIDA. There is an immediate need for an increased effort in pasture and rangeland extension and the provisions within the proposed National Pasture Development Institute for Development and Extension activities should effectively mobilize manpower resources into this nationally important service.

6. Summary of Conclusions and Recommendations

6.1 The mission has made recommendations in accordance with its terms of reference and the briefing instructions given in Rome and in Dar es Salaam. It has taken account of the proposals put forward in the draft third five year development plan 1975-80 that provides an additional research in livestock diseases, livestock production, pasture and fodder production and utilisation through the Livestock Development Division at the Ministry of Agriculture-Kilimo (2.7).

6.2 Serious constraints and problems could arise in the implementation of the Five-year (1975-80) Livestock Development Plan if there is insufficient recognition of the need to increase the quality of the pastures available to livestock in addition to the need for disease control and the genetic improvement of local breeds.

6.3 Pasture and Rangeland development in Tanzania is limited by insufficient finance, a lack of trained personnel, the absence of effective pasture extension activities and a pasture research programme that is inadequate for the Republic's need.

6.4 The mission was asked to make an order of priorities in its recommendations and it has classified its proposals in:

6.41 Immediate objectives (5)

- to apply existing research knowledge on tropical pasture development and range management in the major Ecological-climate regions of Tanzania.
- to survey range resources in each major region as an aid to national ranch development
- to investigate the effect of soil type fertilizer and existing natural pastures on the establishment and productivity of improved pasture legumes.
- to train local agricultural Science-graduates in pasture research and extension activities
- to establish a pasture seed industry in Tanzania
- to establish a regional pasture extension service.

6.42 Long range objectives

- to develop standards of expertise in pasture and range sciences
- to complete a National Range Resources Map.
- To develop improved cultivars and management practices for sown pastures.

6.5 National Pasture Development Institute

6.51 The mission recommends as an immediate and obvious need the establishment of a national institute for pasture and rangeland research and extension activities:

6.52 The "National Pasture Development Institute" (NPDI) is needed to coordinate research and extension activities on pastures, forage crops and rangeland utilisation in Tanzania. The NPDI should be attached to the Livestock Development Division of the Ministry of Agriculture. (5.2)

6.53 The NPDI should complement the research activities of the Animal Production and Management Institute at Mpwapa and the Central Veterinary Laboratory at Temeke.

6.54 The organisation of pasture development and research (5.22) is best done from a central headquarter research centre located near Dar es Salaam with two associated regional Research Centres (one near Tabora and the existing Kongwa pasture research centre) and 4 Substations (the existing Lyamungu, Tanga, Ukiriguru pasture research activities and a new substation near Sao Hill)

6.55 Four experts responsible for Pasture Agronomy, Range Management and Survey, Seed Production and Tropical Pasture Extension Activities should be recruited. Each expert will be responsible for training, advising and leading 2 local young postgraduate research officers.

6.56 The international experts are required for 5 to 6 years to set up the project in two phases (5.24)

- a) Phase I: Establishment of the Project (3 years)
- b) Phase II: Expansion of the Project (5 years)

The four expatriate experts will stay for 2 to 3 years after Phase I for advising their counterparts and making easier the recruitment and absorption of the new local staff.

6.6 Objectives of the NPDI

6.61 a) Range surveys (5.25)

- identification of main range types by ecological and phytosociological methods
- potential productivity of the main range types
- range management (stocking rate assessments, selective bush control, adequate seasonal exploitation and periodical rest in order to preserve the potential productivity)
- range improvement (incorporation of valuable grasses and particularly legumes or other plants into ranges)

6.62 b) Sown pasture agronomy (5.252)

- study of the adaptation of sown pasture species to a range of climatic and edaphic environment
- the fertility building and erosion preventing properties of some pastures particularly in crop rotations and in reclaiming overgrazed range needs to be emphasized.
- to determine the economics of milk production and beef fattening on complete sown pastures receiving fertilizer and reduce dependence on concentrate feeding.

6.7 Training (5.253)

6.71 There is a need for an expert in postgraduate training in pasture and range management and animal production to assist the Morogoro Faculty in surveying the demand and facilities required for appropriate training in pasture sciences in Tanzania. Initially the National Pasture Development Institute should train its own local scientists in Pasture Agronomy and Range Management. Afterwards, it could assist in the training of postgraduates in offering research facilities and projects.

6.72 There is a need to strengthen and broaden the undergraduate course work in pasture sciences at the Morogoro University.

6.73 It is recommended that consideration be given to establishing an inservice one year diploma course in a Pasture Agronomy and Rangeland Diploma College located close to the proposed NPDI.

Consideration should be given to providing training for a certificate course in Pasture Agronomy and Rangeland Management at Tengeru Training Institute.

6.8 Extension (5.254)

A minimum of eight Regional Extension Workers (at diploma level) are required to initiate the regional extension service for pasture and range management improvement. (Arusha, Dar es Salaam, Dodoma, Mbeya, Moshi, Mwanza, Shinyanga, Tanga).

The organisation of this extension service should be undertaken by the NPDI.

ANNEX I

ITINERARY INTERVIEWS AND DOCUMENTS CONSULTED

I. ITINERARY

- 23-24/8/75: To Rome
25-26/8/75: Briefing at FAO Headquarters, Rome
27/8/75 : Arrived Dar es Salaam
27-31/8/75: At Dar es Salaam, FAO/UNDP Office, Livestock Division, Ministry of Agriculture, Temeko Veterinary Laboratory, MARCO Ruvu Ranch.
1/9/75 : Dar es Salaam to Arusha by road.
2/9/75 : Tengeru MATI, Ministry of Agriculture Training Centre
3/9/75 : Lyamungu Coffee Research Station
4/9/75 : Masailand US.Aid Range Development Project
5/9/75 : Arusha to Dar es Salaam by road.
8-10/9/75 : Morogoro, Faculty of Agriculture and Forestry, NARCO Mkata Ranch, Mkata Ranch Training Institute.
11-13/9/75: Mpwapwa livestock research centre, Kongwa Pasture research centre, NARCO Kongwa ranch.
14-16/9/75: At Dar es Salaam.
17-18/9/75: Tanga by air; Livestock Research Centre, Azimio Ranch, Kange dairy farm, Milangano National soil science Institute, Tse-tse laboratory.
19-23/9/75: At Dar es Salaam, Livestock division director interview, LIDA general manager interview, trip to Kibaha dairy farm.
24-27/9/75: Mbeya by road; Kitulo sheep and dairy project; Uyole experimental station Nordic project; NARCO Usangu ranch.
28/9/75 : At Dar es Salaam.

II. INTERVIEWS

- Dar es Salaam

UNDP/FAO Office: Grisogono G., UNDP Resident Representative
Podcworthy H., FAO Country Representative

- Ministry of Agriculture-Kilimo

Dr. Maeda, Director of Livestock Division.
Dr. Ilmolelilian, Director of Livestock research department
Dr. Senkondo, Senior Agricultural Officer
Mr. Mac Lean, UNDP Dairy Project Manager.

- LIDA-Livestock Development Authority

Dr. Madallali S.A., General Manager
Mr. Stone , General Technical Manager
Dr. Akilimali. Kibaha Dairy Farm Manager
Managers of NARCO & Kongwa, Ruvu ranches

- Temeko Veterinary Laboratory

Dr. Mwai Wasa, Dr. Laboratory nutrition-chemistry
Dr. Uilenberg, UNDP Ticks Project Manager

- Morogoro-Faculty of Agriculture and Forestry

Mr. Kyomo M.L., Dean
Mr. Lane I.R., Animal Science Department
Mr. Kayumbo H.Y., Crop Science Department

- Mkata Ranch Institute

Dr. Rewanbangira, Director
Mr. Strange, Range Management Instructor
Mr. Zimmerman, Farm Management Instructor

- Mpwapwa, Livestock Research Centre

Dr. Macha, Director
Mr. Mehta R.K., Pasture Research Officer
Mr. Gamanywa C.R., Range Management Assistant Field Officer

- Kongwa Pasture Research Centre

Mr. Ilole I.P., Pasture Field Officer

- Tanga

- Livestock Research Centre

Mr. Busungu Research Officer
Ms. Carrodius G., Pasture Field Officer
Mr. Itu, Range Management Assistant Field Officer

- Azimio Ranch Sisal Corporation: Mr. Stevens

- Kange, Dairy Farm, Tanga Sisal Corporation Manager

- National Soil Science Institute, Milangano

Mr. Burn, Director, Project Manager
Mr. Sempe, Director
Mr. Visconti, Research Officer

- Tse-tse Laboratory: Williamson Director

Arusha

- MATC Tengere: Mr. Alliy S.J.S., Range Management Field Officer
Mr. Dixon H.N., Crop Manager
- Lyamungu, coffee research station
Mr. Senga C., pasture Assistant Field Officer
- Miwakeni-Kahe NAFCO, Kenafe Farm, Manager
- Masailand US Aid Range Development Project
Mr. Morris, Project Manager
Mr. Daniel, Range Management

Mbeya

- Regional Development Director
- Mr. Marinchev, Livestock District Officer
- Mr. Mhina, Tse-tse Officer
- Kitulo Project: Mr. Ahuku, Dairy Manager
Mr. Barwell A., pasture Officer
- Uyole Experimental Station, Nordic Project
Mr. Garnes A.G., coordinator

III. DOCUMENTS CONSULTED-BIBLIOGRAPHY

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ANNEX 2

United Nations Development Programme
Project of the Government
of the United Republic of Tanzania

Title: : National Pasture Development
 Institute

Number :

Duration : 60 months

Sector : Agriculture, Forestry and Fisheries

Sub-sector : Plant Production and Fodder crops
 (AGPC)

Government co-operating Agency : Livestock Division, Ministry of
 Agriculture

Executing agency : Food and Agriculture Organisation
 of the United Nations

Date of submission :

Starting Date :

Government contribution :

UNDP contribution :

Approved :

 on behalf of the Government
 (signature)

Date:

 on behalf of Executing
 Agency
 (signature)

Date:

 on behalf of UNDP
 (signature)

Date:

I. Background and supporting information

-Justification for the Project

1.1 Until recently the development of the livestock industry has been neglected by comparison with the research and development that has gone into cash crops. In recent years, greater emphasis has been placed on the need to increase livestock products. While much effort and progress has initially gone into disease control and genetic improvement, it is now being realized that increased production can only be guaranteed by improving the quality of feed available to the animal.

Natural pastures provide the cheapest mean of producing livestock products. Tanzania is richly endowed with natural pasture grass, legumes and browse plants and the Republic has provided a number of pasture species that are now cultivated throughout the tropics. Tanzania has barely begun to develop its grass land potential. Now is an appropriate time to revise the organisation of pasture research, training and extension activities so as to encourage and expedite the development of this natural resource.

1.2 A great deal is already known about pastures in Tanzania and improved pasture technology for a range of tropical pasture environments. Emphasis should now be placed on adapting this knowledge to suit edaphic and socio-economic conditions in Tanzania. In Tanzania there is a shortage of trained staff in pasture and range management and a central pasture Institute could assist in training Research Officers and post graduates in pasture sciences. There is a little or no extension of improved management techniques for natural grasslands and for the use of improved pasture species and a regional pasture extension service should be established.

2. Description of the project

2.1 Institutional framework

A "National Pasture Development Institute" (NPDI) is needed to coordinate research and extension activities on pastures, forage crops and rangeland utilisation in Tanzania. The NPDI should be attached to the Livestock Development Division of the Ministry of Agriculture.

2.2. Provision for Government follow-up

The NPDI should complement the research activities of the Animal Production and Management Institute at Mpwapwa and the Central Veterinary Laboratory at Temcke.

All of the envisaged activities of the NPDI is inherently long-term and continuing by nature. The NPDI must therefore have adequate permanent Tanzanian staff with the professional qualifications and experience required to conduct the necessary follow-up.

The organisation of pasture development and research is best done from a central headquarter research centre located near Dar es Salaam with two associated Regional Research Centres (one near Tabora and the existing Kongwa pasture research centre) and 4 Sub-stations (the existing Lyamungu, Tanga, Ukiriguru pasture research activities and a new substation near Sao Hill).

2.3 Other related activities

The UNDP "Pasture agronomist and Rangeland" project No.: URT/72/027/C/01/12 has been in progress for nearly two years and should be renewed for an interim period until the starting date of this proposed project to develop a National Pasture Development Institute. The NPDI staff should collaborate with the faculty of Agriculture at Morogoro, the Tengeru Research and Training Institute, the Kitulo New Zealand project, the Uyole-Mbeya Nordic project and the Arusha-Masailand USAID Range Development project.

2.4 Future UNDP Assistance

Pasture and rangeland research is a long term undertaking and as the activities outlined herein progress, it is expected that further fields that require assistance, extension and continuation will become apparent.

2.5 Objectives of the project

2.5.1 Immediate objectives

- To apply existing research knowledge on tropical pasture development and range management in the major ecological climate regions of Tanzania

- To survey range resources in each major region as an aid to national ranch development
- To investigate the effect of soil type fertilizer and existing natural pastures on the establishment and productivity of improved pasture legumes
- To train local agricultural science graduates in pasture research and extension activities
- To establish a pasture seed industry in Tanzania
- to establish a regional pasture extension service.

2.52 Long range objectives

- to develop standards of expertise in pasture and range sciences
- to complete a National Range Resources Map
- to develop improved cultivars and management practices for sown pastures

2.6 Work Plan

To carry out the activities envisaged in this project, it will be necessary for the government to provide 4 houses at Dar es Salaam for the accomodation of the 4 international experts proposed. The international experts staff are required for 5 to 6 years to set up the project in 2 phases.

2.61 Phase I = Establishment of the project (duration 3 years)

Four experts responsible for Pasture Agronomy, Range Management and Survey, Seed Production and Tropical Pasture Extension Activities. Each expert will be responsible for training, advising and leading 2 local young postgraduate research officers. During this period, consultancies are needed for advising and reviewing the process of the project.

2.62 Phase II = Expansion of the project (duration 5 years)

The four expatriate experts will stay for a further 2 or 3 years for advising their counterparts and making easier the recruitment absorption of the new local staff, including two soil scientists, a plant nutrition scientist, a Pasture Evaluation ^{scientist, a} microbiologist, a statistician, etc. Other consultancies are also needed at this time for advising the new staff trained at the University of Dar es Salaam.

3. Description of UNDP Inputs

3.1 Assignment of International Staff

All International Staff will be based at the Institute headquarters in Dar es Salaam and each will be responsible for the training of two local junior research officers (graduates).

All International Staff will be recruited during the first year of the project and the Project Leader should be the first appointed.

Pasture Agronomist (Project Leader) 6 years

The expert will be the most senior and/or experienced expert. His task will be: (i) to co-ordinate the activities of the headquarters group so that the disposition of effort and the training of operations are in accord with the resources available.

- (ii) lead the sown pasture investigations
- (iii) establish and integrate the regional Research Centres and Sub-stations with the overall objectives of the Institute
- (iv) maintain professional contact with Government Ministries and Parastatal organisations associated with land resources and pasture development.

The expert should be knowledgeable in the establishment, fertilizing, management and utilisation of tropical pasture species and forage crops.

Range Management and Surveys Specialist 5 years

A senior research officer, a graduate in agronomy and with special training and interest in plant ecology. Preferably with postgraduate field experience in range surveys in tropical Africa and an established record of research achievement. The expert will be responsible for research activities in range management and survey at all Research centres and substations. He will be responsible for the collection and recording of all climatological data and maintaining ecological records on potential productivity and vegetational succession. The expert will conduct grazing, stocking rate management and improvement trials on natural pasture. He will also be responsible for studies on bush control and will be expected to establish a herbarium and supervise cartographic activities.

Seed Agronomist

5 years

The expert should be knowledgeable in the growing, harvesting, cleaning, packaging and storage of tropical pasture species and forage crops. He will be responsible for establishing a pasture seed industry in Tanzania by introducing the necessary species and technology for mechanized seed production. The expert will be required to define one or more sites in Tanzania where mechanized pasture seed production is feasible. The sites should be capable of producing seed of all the improved grass and legume cultivars that are likely to be used for sown pastures in the different ecological-climatic Regions of Tanzania.

Agricultural Extension

5 years

The expert should have a degree in Tropical Agricultural Science with post graduate experience in teaching, organising, directing and administering an extension service and in advising and implementing modern means for the dissemination of knowledge to small holder (farmers and traditional pastoralists) The expert will be required to collect, study and review the current knowledge on improved pastures and range management techniques that can be applied in Tanzania and prepare the information for regional dissemination and demonstration. He will be responsible for organising a regional pasture and range management extension service in the main livestock regions and for training the necessary extension officers.

3.2 Consultants3.21 Phase I

Duration 3 months

During the first two years, three 4 week consultancies will be required as follows:

- (i) Pasture Agronomy: to review progress in field experimentation and seed production of sown pasture species and to advise on future research and development proposals.
- (ii) Range Management survey: to review progress in range management and survey and to advise on future activities.
- (iii) Seed Agronomist: to review progress in seed production and processing and to review proposals to involve a Parastatal Company in pasture seed production.

3.22 Review Mission 3 months

Provision is made (three consultants x 4 weeks) for the funding in the third year for a joint UNDP/FAO evaluation mission to review the project before proceeding to the Phase II development. The mission should revise the project and determine the need for further assistance and the nature and scope of such assistance. The Mission will also act as consultants in the on-going projects.

3.23 Phase II 3 months

If Phase II is proceeded with, it is likely that there will be a need for three 4 weekly consultancies in the fourth year as follows: (i) Plant Nutrition: to advise in the establishment of a

pasture plant nutrition unit within the Institute and the requirements for staff, equipment and facilities. Suggest appropriate research objectives.

(ii) Rhizobium Microbiology: to advise on the establishment of a Rhizobium microbiology unit for the selection typing and production of more efficient Rhizobium strains for pasture and forage crop legumes. To specify the necessary requirements for staff, equipment and facilities and to suggest appropriate research and development objectives.

(iii) Pasture Evaluation (nutritive value): to advise on the establishment of a pasture evaluation unit for determining the nutritive value and mineral content of natural and sown pastures and forage crops. To specify the necessary requirements for staff equipment and facilities. To suggest appropriate research activities including the use of feed supplements for grazing animals.

3.3 Support Personnel (Local recruitment) 6 years

Administrative Secretary to assist the Project Leader in general administration.

Typists (2) one 6 years
one 5 years

Labour for field trials as and when needed.

3.4 Training Provisions

3.41 The internationally recruited English speaking experts, will each be provided with two young first degree Tanzanian counterparts. One of them will be selected for fellowship training. The following fellowship will be provided during the first three years. The selected candidate for a fellowship will be immediately replaced by another first degree recruit.

- i) one international fellowship in tropical pasture agronomy 1 year
- ii) one international fellowship in tropical agronomy and extension services 1 year
- iii) one international fellowship in Range Management and survey 1 year
- iv) one international fellowship in pasture plant nutrition 1 year

3.42 Fellowships

It may be desirable for each selected Tanzanian counterpart to study in the country of origin of his international expert and that non-English speaking embassies provide foreign language courses in Dar es Salaam followed by a two month course at an applied language centre in the country where they will undertake their fellowship. There are also foreign language courses in the Adult Education Institute at the University of Dar es Salaam.

It should be noted that the International Livestock Centre for Africa (ILCA) has made provision in its budget for training fellowships and they may be able to offer some assistance in training. Selection of the most suitable candidates and the country in which they undertake their fellowship should be left to the Tanzanian Government to decide.

3.5 UNDP Provided Supplies and Equipment.

The funds required for Phase I development for the first six years only.

	<u>Cost US\$</u>
3.523 <u>Office Equipment</u>	
3 Typewriters	1,000
1 mimeograph machine	750
1 photocopier	2,000
2 Desk calculators	2,500
3 Pocket calculators	400
Shelving for Library and Herbarium	1,500
	<u>8,150</u>
3.524 <u>Laboratory Equipment</u>	
Drying ovens	2,000
Laboratory balances	2,000
Seed storage equipment	2,000
Demineralizing units 2	1,500
Binocular microscopes	1,500
Drafting equipment	2,000
Audio-visual equipment	3,500
Extension equipment	4,000
Airconditioned 3 (balance room herbarium, laboratory)	3,000
	<u>21,500</u>
3.53 <u>Capital Developments</u>	
Fencing 60 km at each research Centre	17,000
Clearing bush (headquarters, +other research centres)	25,000
	<u>42,000</u>
3.54 <u>Maintenance</u>	
Operation and maintenance of equipment	180,000
Sundry	25,000
	<u>205,000</u>
3.55 <u>Travel</u>	
3.551 oversea flights	
experts homeleave	14 flights
consultants	6 flights
Fellowships	4 flights

3.552 Local expenditures

Experts per diem	55,800
Consultants per diem	5,400
Fares (domestic flights)	21,600

3.56 Grand Total

Expendable equipment	20,000
Non-expendable equipment	213,150
Capital Developments	42,000
Maintenance	205,000
Travel (24 oversea flights in more)	82,800
Project Personnel	862,200
Training	28,800

1,453,950

The estimation for the five year project is rounded to:

US\$ 1,500,000

3.5 Project Budget covering UNDP contribution (in US\$)

Country: United Republic of Tanzania

Project No.:

Title: National Pasture Development Institute (Phase I)

10. Project Personnel	Total m/m	\$	1976 m/m	\$	1977 m/m	\$	1978 m/m	\$	1979 m/m	\$	1980 m/m	\$	1981 m/m	\$
11. Experts:														
11.01 Pasture Agronomist	72		12		12		12		12		12		12	
11.02 Range Management and Survey	60		12		12		12		12		12		-	
11.03 Seed agronomist	60		12		12		12		12		12		-	
11.04 Agriculture Extension	60		12		12		12		12		12		-	
11.05 Consultants	6		3		-		3		12		12		-	
Sub-Total	258	774,000	51	153,000	48	144,000	51	153,000	-	-	-	-	-	-
11.07 Locally recruited staff	180	12,600	36	2,520	36	2,520	36	2,520	48	144,000	48	144,000	12	36,000
11.08 Labours	2,520	75,600	480	14,400	480	14,400	480	14,400	36	2,520	24	1,680	12	840
		862,200							480	14,400	480	14,400	120	3,600
30. Training														
31 Individual fellowship	48	28,800	-		24	14,400	24	14,400	-		-		-	
49. Equipment														
49.01 Expendable Equipment		20,000		7,500		5,800		2,900		1,500		1,500		800
49.02 Non-Expendable		255,150		180,150		45,000		15,000		8,000		7,000		-
59. Maintenance														
Travels (+24 oversea flights)		205,000		40,000		40,000		40,000		40,000		40,000		5,000
		82,800		18,700		14,400		18,700		14,400		14,400		2,200
99. Grand Total		1,453,950		416,270		280,520		260,920		224,820		222,980		48,440

3.6 Description of Government Inputs

The Government of Tanzania will provide inputs as follows:

3.6.1 Local staff (with salaries, wages and per diem)

- 14 young recently postgraduate from the Morogoro Faculty of

Agriculture:

	i)	pasture agronomist	3
	ii)	range management and survey	3
	iii)	plant introduction and seed production	1
	iv)	pasture extension	3
	v)	pasture plant nutrition	1
	vi)	seed agronomist	1
	vii)	research officers	2
		-diplomates	13
		-certificates	13
15		laboratory staff:	
		laboratory technicians	4
		laboratory assistants	10
		librarian	1
100		other manpower supplies:	
		clerical officers	3
		car drivers	7
		tractor drivers	5
		motor mechanics	2
		carpenters	3
		herdsmen	10
		labours	70
10		postgraduates training for: phase II at the University of Dar es Salaam	
		pasture agronomist	1
		range management and survey	1
		soil pedologist	1
		soil chemistry and soil fertility	1
		plant nutrition	1
		pasture evaluation	1
		Rhizobium microbiologist	1
		Taxonomist	1
		Statistician	1
		Cartographer Geographer	1

3.62 Buildings, farms, equipment and supplies

- 4 living quarters for the international staff at the usual rental charges
- offices and laboratories for the project staff
- 3 research centres with housing, laboratories, stores, workshop facilities and watering supplies:
 - 1000 ha with fenced boundary near Dar es Salaam
 - 500 ha at Kongwa research station
 - 500 ha with fenced boundary near Tabora
- 4 substations with approximately 25 fenced hectares and office and laboratory facilities at:
 - Tanga
 - Lyamungu
 - Ukiriguru
 - near Sao Hill
- All facilities and permits for using and purchasing all background informations in good time, and particularly:
 - meteorological data at "meteorological department "
 - maps, base-maps copies, aerial photographs, mosaics and printlaydowns at "surveys and mapping division".