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MANUSCRIPT REPORTS

**Agricultural Research in Uganda:
A Program for Rehabilitation**

April 1982



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AGRICULTURAL RESEARCH IN UGANDA
- A Program for Rehabilitation -

The Report of an IDRC Mission
of Evaluation, 1981

April 1982

CONTENTS

	<u>Page</u>
SUMMARY OF RECOMMENDATIONS	i
ACKNOWLEDGEMENTS	ix
ABBREVIATIONS	xi
1. INTRODUCTION	1
1.1 Members of the Mission	1
1.2 Terms of Reference	1
2. AGRICULTURE IN UGANDA	4
2.1 Agro-climatic Zones	4
2.2 Crop Production	10
2.3 Agricultural Systems	10
2.4 Population Pressure and Land Deterioration	13
3. AGRICULTURAL RESEARCH AND DEVELOPMENT	15
3.1 Historical Review of Agricultural Research	15
3.2 Contribution of Research and Extension	22
3.3 Methods of Integrating Research, Extension and Production	24
3.4 Present Organization of Agricultural Research	28
4. REHABILITATION OF AGRICULTURAL RESEARCH	35
4.1 Criteria for the Selection of Priorities	35
4.2 Research Strategy	36
4.3 Research Structure and Administration	39
4.4 Coordination with International Agricultural Research	46
4.5 Research Planning and Monitoring	48
4.6 Research Funding	49
4.7 Resource Management	50

	<u>Page</u>
5. AGRICULTURAL RESEARCH PRIORITIES	52
5.1 Priority 'A' Program	52
5.2 Priority 'B' Program	63
5.3 Priority 'C' Program	69
6. BIBLIOGRAPHY	73
Figure 1. Uganda: Agro-climatic Zones, Agricultural Research and Training Facilities	7
Figure 2. Structure of Ministry of Agriculture and Forestry (April 1981)	29
Figure 3. Proposed Structure of Ministry of Agriculture and Forestry	40
Figure 4. Proposed Interrelationship of Agricultural Research Organizations	45
Table 1. Agro-climatic Zones of Uganda	6
Table 2. Production of the Principal Crops of Uganda	8
Table 3. Uganda-Agricultural Research and Training Facilities (April 1981)	32
Table 4. Post-Graduate Training of Agricultural Research Scientists	56

SUMMARY OF RECOMMENDATIONS

The Mission identified several areas that were considered to be of particular concern for a successful implementation of any proposed program of rehabilitation. Thus, it is recommended that:

- a comprehensive review of the entire agricultural sector be carried out as soon as possible;
- a Resource Use Planning and Management Unit be established to co-ordinate all aspects of resource use;
- urgent attention be given to the preparation of a clearly defined overall agricultural research strategy;
- this strategy be based on research by commodity, rather than discipline, closely linked to a farming systems research approach, to ensure that research objectives are appropriate to the requirements and potential of the producer;
- liaison between all research institutions be promoted through the establishment of an Agricultural Research Policy Advisory Committee;
- special emphasis be placed upon encouraging close working links between the Research Division of the Ministry of Agriculture and Forestry, and the Faculty of Agriculture at Makerere University;
- while avoiding radical changes in organizational structure, serious attempts be made to improve liaison between Divisions in the Ministry, especially between research, extension and training;
- consideration be given to establishing a position of Chief Agricultural Research Officer, with appropriate funds and staffing;

- caution be exercised to avoid a dilution of the quality of the research effort, due to overstretching of available resources, and that strict adherence be given to accepted priority ratings;
- a careful evaluation be carried out of the existing research facilities, especially in the Kampala area, and future emphasis be given to upgrading research capabilities on a regional basis;
- detailed consideration be given to all aspects of research staff training and motivation.

The specific proposals of the Mission have been summarized under the following general classifications: a) Research Structure and Administration, and b) Research Priority Programs. More detailed discussion of each recommendation can be found in the text as indicated.

a) <u>Research Structure and Administration</u>	<u>Page</u>
The Mission recommends that:	
- the Leader of each Commodity Research Unit (CRU) be allowed to exercise both technical and financial supervision;	37
- care be taken to ensure that CRUs are not established in excess of available manpower and technical resources;	38
- the initial Farming Systems Research (FSR) team be the responsibility of Makerere, and serve as a training model for future teams;	38
- further FSR teams be established eventually in all agro-climatic zones under the responsibility of the Department of Agriculture;	38
- the staffing and funding of the latter FSR teams be divided between the Research and Extension Division;	38

	<u>Page</u>
- attention be given to methods of streamlining the processes and channels of communication;	39
- the Research Division remain under the responsibility of the Commissioner for Agriculture;	41
- the proposed position of Chief Agricultural Research Officer (CARO) have equal standing with the Deputy Commissioners for Agriculture (Development, Production and Administration);	41
- the CARO hold responsibility for all funding and budget allocations within the Research Division;	41, 49
- consideration be given to methods of increasing communication within the Department of Agriculture, including staff secondments, reciprocal transfers and short courses;	42
- positions for research/extension liaison officers be established at all Research Stations and in the Office of the CARO;	42
- student participation in FSR projects be encouraged through practical credit courses in college curricula;	42
- plans for the construction of more full-scale research stations in the near future be resisted;	43
- the Ministry of Agriculture consider awarding contracts for specific research proposals to suitable agencies, e.g. Makerere;	43
- equitable fringe benefits be available to research staff;	43
- three posts of Senior Principal Research Officer be established;	43

	<u>Page</u>
- the CARO hold the position of Executive Secretary on the proposed Agricultural Research Policy Advisory Committee;	44
- the proposed Advisory Committee comprise representatives from all sectors of research, and also from the farming and business communities;	44
- National Crop Coordinators be appointed as soon as possible;	44
- tea, tobacco and sugar research be funded by industry, with technical coordination by the Advisory Committee;	46
- the former EAC Sugar Diseases Unit at Kawanda be transferred to the responsibility of the industry;	46
- the Sorghum and Millet Research Unit at Serere be transferred from the Ministry of Regional Cooperation to the Ministry of Agriculture with immediate effect;	46
- integration between the Ministry of Agriculture and the Ministry of Animal Resources be promoted to the maximum possible level;	46
- there be increased exchange of information and material on an international level;	47
- close coordination be maintained with the International Agricultural Research Centers, through the designation of a senior researcher as Liaison Officer;	47
- contacts also be established with a wide range of other international institutions;	47
- twinning projects be established between Makerere and other universities;	47
- the formulation and presentation of research proposals be upgraded;	47

- methods be devised to provide for careful monitoring of the progress of research projects, including the appointment of a research systems analyst to the office of the CARO; 48
- professional administrators be appointed to all Research Stations to relieve Directors of most of the administrative burden, thus allowing them to devote more time to their professional responsibilities; 48
- technical assistance be sought for project planning; 49
- funding processes be updated. 49

b) Research Priority Programs

Priority 'A' Program

This program has emergency status and requires immediate implementation. Considerable technical assistance for project planning and preparation will be necessary. The Mission recommends that:

- collation and analysis of previous research data be carried out and interpreted in the light of current conditions; 53
- a program of postgraduate education be initiated for selected candidates; 54
- consideration be given to the transfer of unsuitable staff out of the Research Division; 54
- experienced professionals be contracted to act as replacements during the period of training of local scientists; 55
- a detailed study of the requirements for the rehabilitation of all research facilities be carried out; 57

	<u>Page</u>
- library materials and services be upgraded;	57
- a detailed feasibility study be conducted regarding the requirements for a Plant Introduction and Quarantine Station;	58
- emphasis be given to providing for effective seed multiplication and distribution;	58
- crop improvement efforts be directed initially at all necessary aspects of the following economically important crops;	
- cotton	59
- bananas	60
- maize	61
- finger millet	61
- sorghum	62
- farming systems research be closely coordinated with the work of the commodity research units in order to ensure integration of research at the farmer level.	62

Priority 'B' Program

The timing of the implementation of this program will depend entirely upon the availability of qualified manpower and technical resources in the medium-term future. The Mission recommends that:

- crop improvement studies be concentrated on screening for yield and disease resistance, and improved agronomic practices for the following crops;	
- rice	63
- arabica coffee	64
- groundnuts	64
- beans	65
- horticultural crops	65
- cassava	65
- sweet potatoes	66
- robusta coffee	66

	<u>Page</u>
- a study be conducted of input/output price relationships, concentrating at the farm-gate level;	66
- an examination be made of the economics of comparative mechanization systems;	66
- the economics of livestock systems and services be evaluated;	66
- studies of pasture and animal husbandry improvement for the small-scale farmer be carried out in conjunction with farming systems research;	67
- all aspects of post-production systems be examined;	67
- a survey of the forest estate be carried out;	67
- proposals for a Karamoja Development Program be acted upon.	68

Priority 'C' Program

This program has a very low priority, but may provide useful direction for research in the long-term. The following topics are presented by the Mission for consideration:

- crops and crop groups that may have future significance;	70
- Food Science and Technology Department, Makerere;	71
- crop protection;	72
- animal nutrition;	72
- silviculture.	72

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The Mission relied heavily on the Commonwealth Mission Report (Commonwealth Secretariat, 1979), and on the IADS (1980) and IFAD (1980) reports for recent background information.

Considerable assistance in typing numerous drafts of the Mission's report was provided by the secretarial staff at Kawanda Research Station.

The preliminary arrangements for the Mission were undertaken by Mr. R. Bruce Scott, IDRC Regional Director for Eastern Africa, and his staff based in Nairobi.

Last but not least, the final rewriting of the report was undertaken by Mr. G. Channer and typing was done by Mrs. M. Kovesi of IDRC, Ottawa.

ABBREVIATIONS

The following acronyms are used in the report:

AEC	- Agricultural Experiment Centre
AVRDC	- Asian Vegetable Research and Development Center
CARO	- Chief Agricultural Research Officer
CIAT	- International Center for Tropical Agriculture
CIMMYT	- International Maize and Wheat Improvement Center
CIP	- International Potato Center
CRU	- Commodity Research Unit
CSR	- Cropping Systems Research
DFI	- District Farm Institute
EAAFRD	- East African Agriculture and Forestry Research Organization
EAC	- East African Community
FAO	- Food and Agriculture Organization of the United Nations
FSR	- Farming Systems Research
ICRISAT	- International Crops Research Institute for the Semi-Arid Tropics
IDRC	- International Development Research Centre
IITA	- International Institute of Tropical Agriculture
ILCA	- International Livestock Centre for Africa
IRRI	- International Rice Research Institute
NRC	- National Research Council
USDA	- United States Department of Agriculture

1. INTRODUCTION

Towards the end of 1979, the Ministry of Agriculture of Uganda invited the International Development Research Centre (IDRC) to participate in a mission designed to examine the country's agricultural research needs and priorities, and the rehabilitation of the national agricultural research services.

1.1 Members of the Mission

The Mission took place from February 22 to March 13, 1981, and the team comprised:

Dr. Z. Nyiira, Chief Research Officer, Ministry of Agriculture

Mr. Y.W. Mwaule, Acting Director, Kawanda Research Station

Dr. J. Mukiibi, Head, Department of Crop Science, Makerere University

Dr. R.C. McGinnis, Dean, Faculty of Agriculture, University of Manitoba, Canada, and previously Director of International Cooperation, ICRISAT

Dr. P. McLoughlin, Consultant in Development Economics, Canada

Mr. A.D.R. Ker, Senior Program Officer, IDRC, Canada

1.2 Terms of Reference

The terms of reference of the Mission were defined by the Ministry of Agriculture as follows:

To assist the Uganda Government in the revitalization of the National Agricultural Research Services with particular reference to issues related to research planning, organization and management; manpower training for research; plant quarantine and protection services; and linkages between research and extension.

Within the framework of the above activities, the Mission addressed the following points:

- i) Identification and study of current agricultural research needs in the light of accepted development priorities of the government.
- ii) Assessment of existing and proposed future research programs and activities in relation to those needs; identification of the weaknesses of current research programs; and recommendations for relevant modifications to such programs.
- iii) Identification of current major problems in agricultural research planning, organization and coordination at national level and presentation of recommendations on possible approaches to overcome such constraints.
- iv) Determination of present and future requirements of scientific and technical agricultural research manpower and the most suitable training programs and institutions to meet these needs.
- v) Suggestions for appropriate and workable institutional and operational links between the research system and the agricultural education and extension services to ensure that research results are effectively transmitted to trainees and extensionists, and subsequently implemented by the farming community.
- vi) Identification of the major plant protection and quarantine problems in Uganda and formulation of recommendations on institutional mechanisms for improved plant protection and quarantine services.
- vii) Preparation, in consultation with the government and the agricultural scientific community, of proposals for an overall agricultural research strategy for Uganda taking into account the national development goals and priorities.

viii) Formulation of project proposals in the light of the above study and presentation of these with a priority rating.

Since the above terms of reference were confined to the National Agricultural Research Services of the Ministry of Agriculture, the Mission did not address the broader problems of the rehabilitation and future development of the whole agricultural sector of Uganda. Nor was it involved, more than marginally, with the Research Services of the Ministry of Animal Resources. However, the research program of the Faculty of Agriculture, Makerere University, was considered in some detail, in view of its importance for national agricultural research.

The Mission considers that there is a need for a review of the entire agricultural sector in the context of the overall rehabilitation process. There is a danger in separating an evaluation of agricultural research from other aspects such as extension and education, infrastructure, marketing and pricing policies. The Government therefore may wish to invite one of the larger agencies, such as the World Bank, to undertake a detailed and integrated analysis of the whole agricultural sector in the near future.

The Mission recognizes that the recommendations, particularly those with immediate priority rating, may prove difficult to implement during the rehabilitation period.

External factors, including marketing structure, communications and transportation, world markets and prices for export crops, will also greatly influence the progress of the revitalization of the research services within the agricultural sector.

2. AGRICULTURE IN UGANDA

Uganda has been described as the pearl of Africa. Its tropical climate with temperatures moderated by altitude and well distributed rainfall over the hills and lakes which cover much of the land make it one of the most beautiful and well favoured countries in the world.

It is overwhelmingly an agricultural country, with 93 percent of the population of 13 million living in the rural area¹ and an even higher percentage relying on the agricultural sector for a living. The population growth rate of three percent a year will lead to a doubling of the population from 13 to 26 million in the next 23 years, and a further doubling to over 50 million by 2040.

Uganda is fortunate at present in having sufficient fertile land for the needs of the growing population. However, further increases in agricultural production will have to come from more intensive use of the existing land base and from a movement into more marginally productive areas. Population pressures will inevitably lead to a growing disparity in prosperity between different regions.

Even if rapid urbanization takes place, the 93 percent now on the land might drop to 80 percent by 2040, with towns and cities increasing in proportion. That still means 40 million people living in rural areas compared to 13 million now, and probably at least a doubling or tripling of the national livestock herd. This growth in turn will call for an equivalent expansion of food and fibre production for domestic use, and a major diversification and growth of production for export.

2.1 Agro-climatic Zones

The map of the agro-climatic zones of Uganda in Figure 1, and Table 1 which describes those zones, give a general overview of the

¹ Communities with populations of less than 1,000 inhabitants.

geographical distribution of crop and animal production in Uganda. Further detailed information is available in the Atlas of Uganda (1962).

The distribution of the crops is mainly determined by the amount of rainfall and its distribution. Since the equator passes through southern Uganda, the distribution there is bimodal with two rainy seasons, from March to June and August to November. Around the shores of Lake Victoria, in Zone X, the annual rainfall averages 1200-1500 mm, and is well distributed throughout the year. This is sometimes called the fertile crescent, and is the main banana and robusta coffee growing area. Farther north the two rainy seasons merge into one, and the end of the year dry season becomes longer and more severe. This limits the growth of crops such as bananas, and in Zone III (Teso) and Zone V (Lango and Acholi), although the rainfall is still between 900-1300 mm, the main food crop grown is finger millet with considerable areas of cotton. Zone IV (Karamoja) in the northeast receives a lower rainfall of about 750 mm or less per year, and this is largely an area of semi-nomadic cattle herding, with some sorghum production.

Altitude is another factor which has a major influence on cropping patterns. This reduces temperatures by about 1°C for each 150 m increase, and is usually characterized by higher rainfall at increasing altitude. Zone II (Bugisu/Sebei) in the east and Zone VII (Bunyoro/Toro) in the west have complex cropping systems depending on altitude and rainfall, with arabica coffee and bananas at the higher altitudes of 1500 to 2300 m, and considerable areas of tea in the medium altitude regions of Toro. Zone IX (Kigezi) in the extreme southwest is also at a comparatively high altitude but with a poorer rainfall distribution than the equatorial zones. Here sorghum is the major staple, followed by sweet potatoes, finger millet and beans, together with small amounts of arabica coffee and several other minor crops.

The wide variations in geography and climate, particularly with

Table 1. Agro-climatic Zones of Uganda

<u>ZONE</u>	<u>DISTRICTS</u>	<u>AGRICULTURAL SYSTEM</u>
Zone I:	Busoga/Bukedi	Banana, millet and cotton system, with outliers of the main coffee-banana system.
Zone II:	Bugisu/Sebei	Montane systems: Arabica coffee, bananas (wheat and maize in Sebei).
Zone III:	Teso	Teso systems: finger millet, cotton and cattle keeping (mixed agriculture).
Zone IV:	Karamoja	Pastoral system - cattle keeping.
Zone V:	Lango/Acholi	Northern systems: finger millet, cotton, tobacco (some mixed agriculture also).
Zone VI:	West Nile/Madi	West Nile systems: basic agriculture like Zone V but with predominance of cassava as staple food.
Zone VII:	Bunyoro/Toro	Arabica and Robusta coffee and banana system, Montane systems: heterogeneous agriculture but basically bananas, coffee, tea.
Zone VIII:	Ankole	Montane systems in the west: Pastoral to the east: Arabica and Robusta coffee, tea, bananas, cattle.
Zone IX:	Kigezi	Montane systems but with larger annual crop acreage than other montane systems. Sorghum is major staple. Arabica coffee, tea.
Zone X:	Lake Victoria Crescent	Main Robusta coffee and banana system: Robusta coffee, bananas, tea, cocoa, sugar.
Zone XI:	Northern Buganda	Western extension of the banana-millet-cotton system, but now largely taken up by big ranching projects.

Source: Planning Cell, Ministry of Agriculture.

Figure 1. Uganda: Agro-climatic Zones, Agricultural Research and Training Facilities

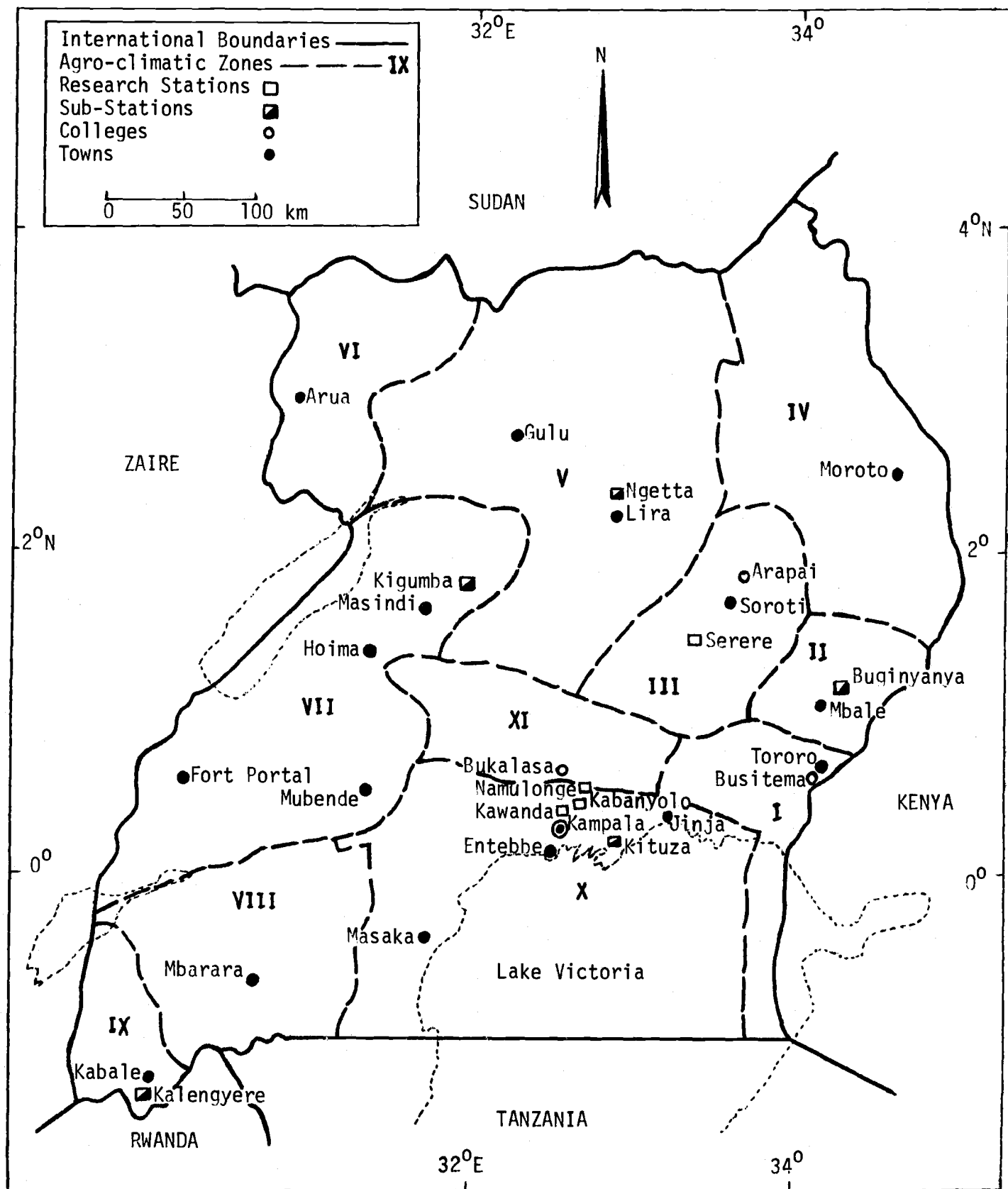


Table 2. Production of the Principal Crops of Uganda

Crop	<u>Area Harvested ('000 ha)</u>		<u>Yield (kg/ha)</u>		<u>Production ('000 MT)</u>	
	1969-71	1980	1969-71	1980	1969-71	1980
<u>Cereals, Total</u>	<u>1401</u>	<u>1478F</u>	<u>1080</u>	<u>964</u>	<u>1512</u>	<u>1425F</u>
Maize	343	550F	1225	909	420	500F
Millet	739	550F	997	818	737	450F
Sorghum	299	350F	1127	1286	337	450F
Rice	16	18F	723	556	11	10F
<u>Roots & Tubers, Total</u>	<u>427</u>	<u>564F</u>	<u>4449</u>	<u>4078</u>	<u>1898</u>	<u>2300F</u>
Potatoes	17	45F	8800	7333	147	330F
Sweet Potatoes	133	139F	5200	4820	693	670F
Cassava	277	380F	3825	3421	1058	1300F
<u>Pulses, Total</u>	<u>443</u>	<u>575F</u>	<u>602</u>	<u>491</u>	<u>267</u>	<u>282F</u>
Beans	263	360F	589	500	155	180F
<u>Oilseeds</u>						
Groundnuts (in shell)	263	230F	786	870	207	200F
Sesame Seed	84	128F	252	344	21	44F
Cottonseed	-	-	-	-	173	16

<u>Other Crops</u>						
Coffee	261	180F	821	685	215	123*
Seed Cotton	923	243*	279	101	258	25*
Tea	12	3F	1524	449	18	1*
Bananas & Plantains	-	-	-	-	2964	3520F
Sugar cane	31	29F	54055	18966	1667	560F
Tobacco	7	3*	721	1000	5	3F

Note: F - FAO estimate

* - Unofficial figure

Source: FAO Production Yearbook 1980

regard to altitude and rainfall distribution, have resulted in the development of a number of different farming systems adapted to the various agro-climatic zones. These systems are typical of those found under similar ecological conditions in other parts of Africa.

2.2 Crop Production

The approximate areas, yields and production of some of the more important crops grown in Uganda are shown in Table 2. The annual crop areas vary considerably from year to year, and it is not known how much reliance can be placed on the figures, particularly for 1980.

It appears that both maize and sorghum may have increased in importance over the period from 1970 to 1980, whereas finger millet has decreased. The area under cassava has increased considerably and has probably partly replaced the millet crop where soils have become exhausted from continuous cropping. Other food crops such as bananas, beans, potatoes and sesame have increased in importance. Conversely, the importance of all the major cash crops has declined, some of them dramatically, over the same 10-year period. Production of seed cotton has gone down from over 250,000 tonnes in 1970 to about 25,000 tonnes in 1980, and coffee from well over 200,000 tonnes to just over 120,000 tonnes. Similarly, tea production is down from 18,000 to about 1,000 tonnes; sugar cane from over 1,500,000 to about 500,000 tonnes; and tobacco from 5,000 to about 3,000 tonnes. In most cases the decline is attributable to reductions in both area and yield.

2.3 Agricultural Systems

The cropping pattern in the higher rainfall areas around Lake Victoria consists basically of bananas as a perennial food crop, with several annual or biennial food crops such as sweet potatoes, cassava, maize, beans and groundnuts. Cotton, which was previously widely grown in this area, was almost entirely replaced by coffee during the 1950s and 60s, except in some limited areas in the west which have a longer dry season. The coffee gained an important position as a

perennial export crop, and was often inter-planted with the bananas and other food crops.

There are approximately two million small holders in this area with a typical farm size of 2 to 2.5 hectares under crops. The only commonly used cultivation implement is the hand hoe, although a few farmers might obtain the occasional use of a tractor from the government hire service or from a large, privately owned farm. Nearly all the food requirements of the household are met from the small holding, and the equivalent of US\$300-600 per year is usually obtained in cash from the sale of coffee. This money would be used to buy tools and essential household items, and to pay school fees. Small numbers of goats and cattle might be kept on the farm and grazed on waste land, and a few poultry are often raised in the house compound.

In Buganda there is considerable variation in farm size as about half of the land was allocated to chiefs and other individuals under a certificate of title in 1900. Since that time the land has been sold and subdivided either on a freehold or tenancy basis, and the typical land holding is now around 2 to 4 hectares. There are a small number of larger holdings, which previously grew substantial areas of coffee and bananas, and employed migrant workers from Rwanda. Since the incomes on these farms have dropped considerably in the last ten years, most of the Rwanda labourers have returned home. Also a number of agronomic problems have affected the growing of bananas, the staple food crop. Although the causes of the decrease in production of many banana plantations are not fully understood, they appear to be related to a combination of several factors, including a decline in soil fertility, nematode attack, and possibly banana weevil and disease depredations.

Sugar cane and tea were mainly grown on a small number of large expatriate owned and managed estates in the lake shore area and in the west around Fort Portal. In the 1960s the government established a number of additional estates, and encouraged small holders in the

vicinity of these estates to produce sugar cane and tea for processing in the estate factories. In recent years problems of marketing, difficulties in maintaining the factories and estates, and shortage of transport to collect the crops have meant that the sugar and tea production has fallen to low levels, and much of the small-holder tea-growing area has been abandoned.

In the northern and eastern parts of the country, with the exception of the Mount Elgon area, the staple food is generally finger millet, with various combinations and amounts of bananas, coffee, maize, sorghum, cassava, sweet potatoes, and groundnuts. Cotton is also widely grown throughout this region as a cash crop for export. A typical farm consists of about one hectare of cotton, one hectare of finger millet, and small areas of the other food crops, often intercropped. Many farmers also keep small numbers of cattle, goats and sheep, and a few poultry.

Since the soils in this area are generally less fertile than those around the lake and in the west, farmers have traditionally practised shifting cultivation. In the Teso district, most of the initial cultivation is carried out with ox ploughs, and this practice is also spreading into the neighbouring areas. The hand hoe is virtually the only implement used for all subsequent operations.

Cotton was the major source of cash income for the farmers throughout this area. Although production required a higher labour input than for coffee, and income levels were generally lower, at about the equivalent of US\$200 to \$250 per farm per year, it was important in providing the means to buy the usual household requirements under normal conditions. However, during seasons when the rains failed, or there was a scarcity for other reasons, the cash income became critical as a form of insurance, allowing the purchase of supplementary food. The low and unreliable prices paid in the last 10 years, and the almost complete breakdown of the transport and marketing systems, have led many farmers to abandon their cotton growing, and this appears to have

been one of the contributory causes of the recent famine conditions in parts of Teso district.

2.4 Population Pressure and Land Deterioration

As in many other tropical countries, Uganda is becoming increasingly affected by the severe problems of soil exhaustion and erosion which accompany the breakdown of the traditional shifting cultivation systems of agriculture. The delicate balance between the number of people living off the land, and the land area available and its natural fertility are being increasingly disturbed in the more heavily populated parts of the country. For example, in Kigezi (Zone IX), the population density is the highest in Uganda, with up to 400 people per square kilometer. In this area the land inheritance system has led to severe fragmentation of holdings, and soil erosion and exhaustion are becoming widespread. Also the farmers have few opportunities to grow export crops, so that farmers' standards of living are low and variable. Much of Bugisu and Sebei (Zone II) is affected in a similar way, although it does have the advantage of the profitable arabica coffee crop.

Several areas, including much of Busoga/Bukedi (Zone I), Teso (Zone III) and West Nile/Madi (Zone VI) are severely affected by population pressure on the land, and relatively infertile soils. There are high rates of migration of people from all these areas to other parts of the country where fertile land is still available. The continuous and progressive soil exhaustion and erosion which is taking place can only result in the deterioration of the land base, and a reduction in the number of people who can live on the land, using existing cropping systems.

In the Lake Victoria Crescent (Zone X), Bunyoro/Toro (Zone VII) and Ankole (Zone VIII) in Western Uganda, the predominantly perennial cropping system of bananas and coffee with some annual crops, have permitted quite intense cultivation. However, even though the soils are relatively fertile, there are now signs of land deterioration in these

areas also. Karamoja (Zone IV), in the northeast, has the fragile ecology and severe problems of over-grazing and consequent soil erosion so characteristic of similar semi-arid areas throughout Africa. The tragic losses of human life following the recent drought and the endemic cattle raiding and disturbed conditions are partly a consequence of the deterioration of the natural environment.

In general, Uganda farmers have not started to use farm yard manure, compost or fertilizers, or adopted long-term soil conservation measures to any great extent, which could enable them to maintain or improve the structure and fertility of their soils. Consequently, the situation is becoming critical in many parts of the country.

It is apparent that there is an urgent need for integrated government action to assist the farmers to stabilize and improve their land management and farming systems, and to increase production of both food and export crops. This program will require extensive applied research, closely adapted to the specific needs of the farmers in the various agro-ecological zones, in order to formulate relevant and economically sound packages for the various components of the farming systems. The extension and education services will also need to be closely involved with the preparation of these recommendations, so that they are in a position to establish an effective two-way communication system with significant numbers of small-scale farmers.

3. AGRICULTURAL RESEARCH AND DEVELOPMENT

Uganda's farmers have traditionally adopted many new crops and incorporated them into their farming systems. For example, the banana was probably brought to Uganda more than 300 years ago, and in the course of time was adopted as a staple food by a large section of Uganda's population. Similarly, crops such as cassava, sweet potatoes, and groundnuts, which originated in the Americas, were brought to Uganda at various times, and are now widely grown by large numbers of farmers. During the process a rudimentary form of experimentation was carried out by the farmers who selected the better adapted strains, and adopted production methods best suited to local conditions.

3.1 Historical Review of Agricultural Research

Formal scientific agricultural research could be said to have started in 1898, when the Botanic Gardens at Entebbe were founded for "better examination and development of agricultural resources". Germ plasm of a large number of tropical crops was introduced and first tested in the Botanic Gardens, including cacao, rubber, tea and oil palm. By 1908 the Department of Agriculture was formed, with headquarters in Kampala, but it was not until 1920 that any experiment stations were established. A cotton-seed selection station was first opened at Bukalasa, about 40 km north of Kampala, to represent the long-grass areas, which can be roughly defined as the more fertile part of the country south and west of the River Nile. In 1937 the headquarters of the Research Division of the Department of Agriculture was transferred to Kawanda, about 13 km north of Kampala, and Bukalasa continued as a research and training centre and later became an Agricultural College. For the drier and generally less fertile short-grass area north and east of the River Nile, Serere Experiment Station in Teso District was operational by 1922, and assumed the full responsibilities of a Research Station in 1962. The Government also established a number of sub-stations and experimental centres representing most of the agro-climatic zones of the country. A certain amount of research

and multi-locational variety screening was carried out by the Agricultural Colleges at Bukalasa, Arapai and Busitema, and at the District Farm Institutes throughout the country.

In 1949 the Empire Cotton Growing Corporation decided to establish its main cotton research station at Namulonge, about 25 km northeast of Kampala. This body later became the Cotton Research Corporation, and in 1972 the Namulonge Station was handed over to the Uganda Government. Since then, in addition to research on cotton, experimentation on annual food crops and pastures has also been carried on.

In the late 1950s, the East African Agriculture and Forestry Research Organization (EAAFRO), which formed part of the East African Community (EAC), established a research unit at the Serere Experiment Station for work on sorghum and millets. EAAFRO also supported a small sugar cane disease research unit at Kawanda Research Station. With the break-up of the EAC in 1977, these two units were absorbed by the Uganda Government.

Makerere University has played a key role in research and education in Uganda since its establishment as a technical college in 1921. During the 1950s and 60s the Faculty of Agriculture developed an outstanding reputation for its program of applied research and education. By 1970, there were more than 40 professional staff, with over 200 undergraduate students and about 60 graduate students. At the same time, the university farm at Kabanyolo, some 20 km northeast of Kampala, was developed into an excellent facility for research and training. The research programs undertaken by the Faculty were wide ranging and generally well adapted to the needs of the agricultural sector of Uganda.

There has long been a strong emphasis on cotton research in Uganda, as in the early decades of the century this crop was the mainstay of the economy (Wrigley, 1959). In the early years the work

consisted mainly of the introduction and screening of varieties from various parts of the world, particularly from the United States, Egypt, Sudan and India. The occasional crop failures were mainly due to diseases, particularly bacterial blight, and selection for resistance was soon started, in addition to the use of chemical seed dressings. Most of the early breeding and screening work was carried out at Bukalasa, where the variety 'BP-52' was selected and became very important for the long-grass areas of the south and west. At Serere, the variety 'S-47' was bred, and was later widely grown in the north and east. Later, in the 1960s, the Cotton Research Corporation introduced new sources of resistance to bacterial blight, and these were combined with the American upland variety 'Allan' to produce the 'Albar' lines with considerably increased yields (Arnold, 1976). Cotton production, grown entirely by small holders, increased to a maximum in 1970, when 85,000 tonnes of lint (467,000 bales) were produced.

The 1920s and 1930s were years of considerable expansion of production of other crops in Uganda, including coffee, tea, sugar cane, rubber, maize and groundnuts. Although the main research effort was concentrated on cotton, the very few qualified scientists available did pay a limited amount of attention to these other crops (Tothill, 1940). At this time the district agricultural officers also carried out research on the improvement of crops for their districts as part of their duties.

In the 1950s and 60s, a considerable increase in coffee production took place, mainly due to the stimulus of high prices during the Korean War. Uganda was fortunate in that a very limited amount of research on coffee to select high yielding types enabled the country to expand production very rapidly. However, much of the credit must go to the Baganda farmers who quickly recognized the incentives of high returns and good access to markets and took the opportunity of raising production substantially. By 1969, coffee production had risen to over 200,000 tonnes, which made Uganda coffee production about the sixth

largest in the world at that time.

At the same time, tea which had been almost solely produced on large estates was extended to large numbers of small growers by a series of small holder production schemes, and total production rose to almost 20,000 tonnes of made tea in 1972. Research on tea was organized by the Tea Board of East Africa and was based at the Kericho Tea Research Institute in Kenya, with sub-stations at Rwebitaba near Fort Portal and at Salama near Kampala.

Sugar cane production also expanded rapidly in the 1950s and 60s, to a maximum of 152,000 tonnes of sugar in 1968. The main research on this crop was carried out by the large estates at Kakira, near Jinja, and at Lugazi, between Jinja and Kampala. This research was coordinated by the Research Division of the Ministry of Agriculture, and was mostly concerned with screening new varieties for disease resistance, and evaluation of improved cultural practices and methods of irrigation.

Although parts of Uganda did suffer from periodic food shortages, usually due to the occasional failure of the rains, in general the country as a whole was never deficient in food, as production kept pace with the increase in population. There was therefore little incentive to devote much research effort to food crops, as large increases in production often proved very difficult to market. Nevertheless, although the main research emphasis was placed on the export crops such as cotton, coffee, and tea, there was a significant program of crop diversification, especially towards food crops which had some export potential.

A considerable amount of breeding and agronomic work was carried out with beans and groundnuts in the 1960s. Maize was also a focus of attention, and rust resistance was incorporated into the improved composites and varieties. Work at the EAAFR0 Sorghum and Millet Unit at Serere resulted in the release of 'Serena' sorghum, which proved popular throughout East Africa. Several other varieties

and hybrids were developed, but problems of production of hybrid seed proved difficult to surmount. Progress was also slow on the improvement of the important finger millet crop. Useful breeding work on cassava was accomplished by EAAFR0 to incorporate resistance to the mosaic virus disease. Some of this resistant material was widely grown in Uganda, and it made a useful contribution as a famine reserve crop particularly in the drier areas.

Food crops research was also carried out by the Makerere Faculty of Agriculture at Kabanyolo, and considerable attention was given to grain legumes including cowpeas, soybeans, phaseolus beans and pigeon peas. On cereals, a start was made in breeding rice resistant to local diseases, and some selection was carried out with maize and sorghum. Intercropping studies were conducted with some of the cereals and legumes.

Livestock research also had high priority and useful programs have been carried out under the direction of the Research Division of the Ministry of Animal Resources. The headquarters and main research station are located in Entebbe, with a sub-station at Nakyesasa adjoining Namulonge, and ranches at Ruhengeri in Ankole and Aswa in Acholi. During the 1960s there was considerable expansion in small holder dairy herds, using exotic breeds, mainly Friesians. Research showed that with careful disease control and good feeding, high levels of milk production could be obtained. The Dairy Industry Corporation organized a successful refrigerated bulk milk delivery system to Kampala. Although this marketing system broke down during the mid-1970s, the production of many of the small-holder dairy farms increased and fresh milk was supplied to local markets. Extensive ranches were also developed for beef production in several parts of the country, but they have not fared so well in recent years. Many of them appear to have been severely looted during the liberation war.

The Faculty of Agriculture at Makerere has conducted some

research in the area of animal husbandry, with particular emphasis on pasture management, forage improvement, poultry parasitology and egg production. The recently established Faculty of Veterinary Science is initiating programs with regard to livestock health. Scientists at both Serere and Kawanda Research Stations also undertook valuable research on animal nutrition, mainly by pasture improvement for milk and beef production, and a limited amount of animal breeding research.

The Forestry Department of the Ministry of Agriculture had a small research section with its headquarters at Nakawa, in the industrial area of Kampala. A considerable amount of useful research was conducted on the management of natural and planted forests during the 1950s and 60s, and Uganda gained an enviable reputation for forest management, silviculture, forest products utilization, and particularly charcoal making.

The Planning Division of the Ministry of Agriculture carried out many farm management surveys of farming practices in various agro-climatic zones, and other related economic research activities. Valuable surveys of soils, vegetation and land-use systems were prepared by the Research Division. Several farm management and agricultural economic studies were also carried out at Makerere, and the results were widely used by the government for policy decisions.

This period of research during the 1950s and 60s at Kawanda, Serere, Namulonge, Kabanyolo and several other research centres generated a significant amount of extremely valuable information. It is worth noting that this data would be applicable in general to current conditions, particularly with regard to food crops, and also to longer term aspects of crop production strategy. Jameson (1970) gives a detailed review of agricultural research undertaken during this period.

During this same period the Ministry of Agriculture became involved in a number of schemes to introduce mechanization to the Uganda farmer. The largest and most expensive scheme involved the purchase of

large numbers of tractors, and the setting up of tractor hire services in almost all parts of the country. The tractors were operated and serviced by the Special Development Division, with its headquarters at Namalere, near Kawanda. Small farmers in the areas served by the tractors were able to hire them to undertake ploughing and disc-harrowing. In the 1960s a number of large government-sponsored group farms were established in an attempt to increase cotton production. Groups of local farmers were encouraged to form cooperatives to operate these farms. Government equipment was used, including bulldozers for bush clearing and tractors for primary cultivation and planting. Other operations such as thinning, weeding and harvesting were carried out by hand by the individual members of the cooperative. A few of these group farms in the more fertile areas did achieve quite high levels of production of cotton, and in some cases of other crops such as maize. Also, in areas where ox-cultivation was not possible due to tsetse infestation, the tractor hire schemes provided a useful service to a limited number of fortunate farmers. However, such economic studies as were carried out indicated that the real costs of both the tractor hire services and the cooperatives were considerably higher than the farm-gate value of the main crops grown (with the exception of flue cured tobacco). In general these programs were considered of very doubtful value, and became a severe burden on the economy due to the heavy subsidies that were eventually necessary.

In contrast, a very useful program of research and development in ox cultivation was undertaken at the Serere Research Station. Particular attention was given to the development of improved low cost implements for ploughing, harrowing, planting, weeding and spraying. It was followed up with a large program to encourage small farmers to buy their own implements according to their needs, and to train oxen and handlers. With the aid of various credit schemes, large numbers of small farmers throughout the east and north of Uganda did adopt ox cultivation and were able to plant larger areas and carry out more timely operations. In general these programs were considered to have been highly successful.

3.2 Contribution of Research and Extension

Uganda had a healthy agricultural sector during the 1950s, 60s and early 70s, and outstanding work was undoubtedly done by many individuals in both research and extension. However, the contribution of government policy and of both the Research and Extension Divisions to the improvement of the lot of the majority of small farmers seems questionable.

While the reasons for this are many and complex, it is generally agreed that the Research Services were to some extent isolated from the problems of the farmers. With the exception of farmers' fertilizer trials and arabica coffee trials, there was little direct contact with farmers, or even with extension workers.

A system of experimental committees, which included both research and extension workers, was established to consider past research results and to plan future programs. Although these committees were quite effective, the identification of problems that required re-searching was often left mainly to the research workers themselves. The result was that some urgent local farming problems did not receive much research attention, whereas other less urgent research areas were over-emphasized.

The Extension Services, on the other hand, were expected to combine law enforcement duties with their extension activities. They were required to assist in the enforcement of local agricultural by-laws, and to carry out inspection and regulatory functions such as the inspection of export crops for quality control, regulation of marketing and approval of farmers' loan schemes. This often made it extremely difficult for extension agents to be effective in their advisory capacity. Even when they had good contacts with farmers, and could gain their confidence, their main activities were concerned with export crops, and little research information was available for improving farmers' production of traditional food crops. Research results for

the export crops were mainly obtained at a small number of research stations, and then promulgated in the form of extension recommendations which were supposed to be adopted by all the farmers growing the particular crop. This inevitably led to problems when little account was taken of local variations in climate or socio-economic conditions. Although this approach might have been useful in increasing production of highly profitable export crops, it generally met with little success with regard to food crops.

It appears that the disappointing results of many extension programs can be attributed to a basic misconception regarding the extension process. The generally accepted implication is that government research workers have all the answers and it is merely necessary for the extensionists to deliver them to the farmers. Unfortunately, it is often very apparent that the research and extension services are singularly lacking the answers to the questions that the farmers are asking. Indeed, research efforts may not even be directed towards solving problems that concern the farmer. It has been repeatedly demonstrated in many countries that farmers will improve their farming methods and adopt new technologies provided that such factors as climate, prices and marketing are favourable, and that the necessary inputs are readily available. The role of the Research and Extension Services is usually to convince the farmer that the changes are going to be beneficial in comparison to the traditional system, and relatively risk free. This requires clear communication and a two-way flow of information from the farmers explaining their circumstances and outlining their problems to the research and extension workers, and subsequently of relevant information from Research and Extension Services to the farmer to be tested under the farmers' conditions. This is not an extension process: it is an education process in its fullest sense, both of the research and extension workers and of the farmers themselves. The success of this education process will depend to a great extent upon the strength of the links that have been developed in communications between the researchers, extensionists and farmers.

3.3 Methods of Integrating Research, Extension and Production

Although the need for efficient communication and an unimpeded flow of information and feedback between the researchers, extensionists and farmers is usually understood and accepted, it is nevertheless often difficult to achieve effective implementation. In order to provide further clarification of the various possibilities, three methods that have proven successful under field conditions will be briefly outlined below.

3.3.1 Farming Systems Research

The Systems Research approach has developed independently in several areas where research workers have become dissatisfied with the benefits that farmers appeared to get from research results. It is particularly appropriate where considerable information regarding various aspects of an innovative technology has become available through the efforts of traditional research methods but has not been incorporated by the farmer into his overall production system.

Using this approach, a Cropping Systems Research program must develop methods of working with farmers to analyze their production systems and to test innovations directly on the farmers' fields. The methods usually involve a progression of interrelated phases: description, design, testing, pre-production and production. The description phase involves the identification and survey of reasonably homogeneous agro-ecological areas and subsequent detailed farm management studies with a small number of selected representative farmers.

This information is used by a multi-disciplinary research team in the design and testing phases to set up simple superimposed trials to test the limitations and potentials of the traditional cropping system. Investigation of possible new cropping patterns using the newly available technology, and specific studies of locally important socio-economic factors are also conducted. Maximum input from the farmer is encouraged and evaluation of all the research is carried out

jointly by the farmer and the research team.

Results from the testing phase are used as feedback to improve the design of subsequent work until an acceptable cropping pattern and the necessary component technology is identified. At this stage multi-locational trials are carried out to test the stability of the new technology and the requirements for infrastructure support. Extension staff are particularly involved in this preproduction phase to ensure that the new methods are understood and presented in an acceptable way. Finally, the extensionists take full responsibility for the production program and the researchers are only consulted if new problems arise.

Although this type of research may appear expensive and somewhat site-specific, the methodology is still evolving with the objective of reducing the amount of unnecessary data collection and making the results as widely applicable as possible. The strength of the method lies in the close contact that is established between the researcher and the farmer, but the role of the extensionist may prove to be a weak link. Nevertheless, excellent results have been obtained in many parts of the world, and the method has shown great promise in several areas of Africa.

3.3.2 Agricultural Development Service

Another possible form of organization could be the establishment of a combined government research and extension division - an Agricultural Development Service. In this case, communication between the research and extension aspects is enhanced by virtue of the fact that both functions are the responsibility of production agronomists or agricultural economists with broadly based agricultural training. The proportion of research and extension varies according to the needs of the local situation and the capabilities of the agronomists. Much of the research is conducted at the farmer level, with technical support from research stations and sub-stations as required. This support is provided by specialists in the various disciplines such as plant

breeding, entomology, pathology, soil science and economics, but they are also required to fulfil at least a minimal extension function. The work of the specialists and the production agronomists is complemented by technical assistants, trained to various levels in relatively narrow fields. An essential feature of this type of organization is that law enforcement and regulatory functions must be completely separated from the Agricultural Development Service and carried out by a different division of the Ministry of Agriculture.

This approach can be integrated well with Farming Systems Research as the production agronomists can be involved in all phases, especially in pilot production testing and production programs. For the introduction of innovative technology in perennial crops a relatively specialized and long-term involvement in one crop is possible, but annual crops must be dealt with in relation to the overall cropping system. Similarly, some involvement by production agronomists and agricultural economists should be possible in animal production systems, as some of the most important constraints involve improved feeding which is essentially an agronomic problem. Specialized support might be required on nutrition, breeding and health and disease considerations.

Critical aspects which might particularly determine the success or failure of an Agricultural Development Service are the management and direction, and the training of the agronomists and technicians. Managers would normally be selected from among the production agronomists or research workers, but management training would be required. Special attention would also be necessary in relation to the technical training program, to ensure that high professional standards were maintained.

3.3.3 Agricultural Education Institutions

In contrast to the directly government-funded research and extension services discussed above, some countries have relied heavily on their agricultural education institutions for research and extension in addition to training. There are many examples where this system has met with outstanding success. In the U.S.A. the creation of land

grant colleges paved the way for the integration of education, research and extension in American agriculture. As a result, the agricultural universities now have strongly developed links with the farmers through their own research and extension workers, which enable farming problems to be rapidly recognized by the research workers, and research achievements to be translated quickly into farming practice. Similarly, in Canada, several provincial universities have major responsibilities for agricultural research and some extension work in cooperation with provincial government services. Other notable examples are the University of the Philippines at Los Baños; the Punjab Agricultural University in India; the Institute for Agricultural Research of the Sir Ahmadu Bello University in Northern Nigeria; and the Alemaya Agricultural College of the University of Addis Ababa in Ethiopia.

This approach is based on the premise that development is primarily an educational process, and therefore should be at least partly the responsibility of the leading educational institutions of the country. It follows that the primary responsibility for agricultural research and extension in the surrounding area would be undertaken by the Faculty of Agriculture of the University or the Agricultural Colleges. Generally, national responsibility for research and development, particularly regarding aspects such as control and regulatory functions, is retained by the Ministry of Agriculture. Coordination committees comprising both government and university scientists and administrators are necessary to determine priorities, prepare and evaluate research programs, and approve and audit budgets.

The methods briefly discussed above for ensuring the maximum communication and interaction between the various components involved in the development process have their particular strengths and weaknesses. There are many other alternative or complementary possibilities. Rarely is only one method completely suitable in any given situation. The objective is to identify a system, or combination of systems, that serves the needs of a country well and maximizes the use of the available

resources. This will be discussed in more detail with specific reference to Uganda in Section 4.2.

3.4 Present Organization of Agricultural Research

Agricultural research in Uganda is primarily the responsibility of the Research Division of the Department of Agriculture, and the Faculty of Agriculture at Makerere University. A limited amount of research relating to specific export crops is conducted by the parastatal organizations. The National Research Council was established in 1970 to coordinate all research in the country.

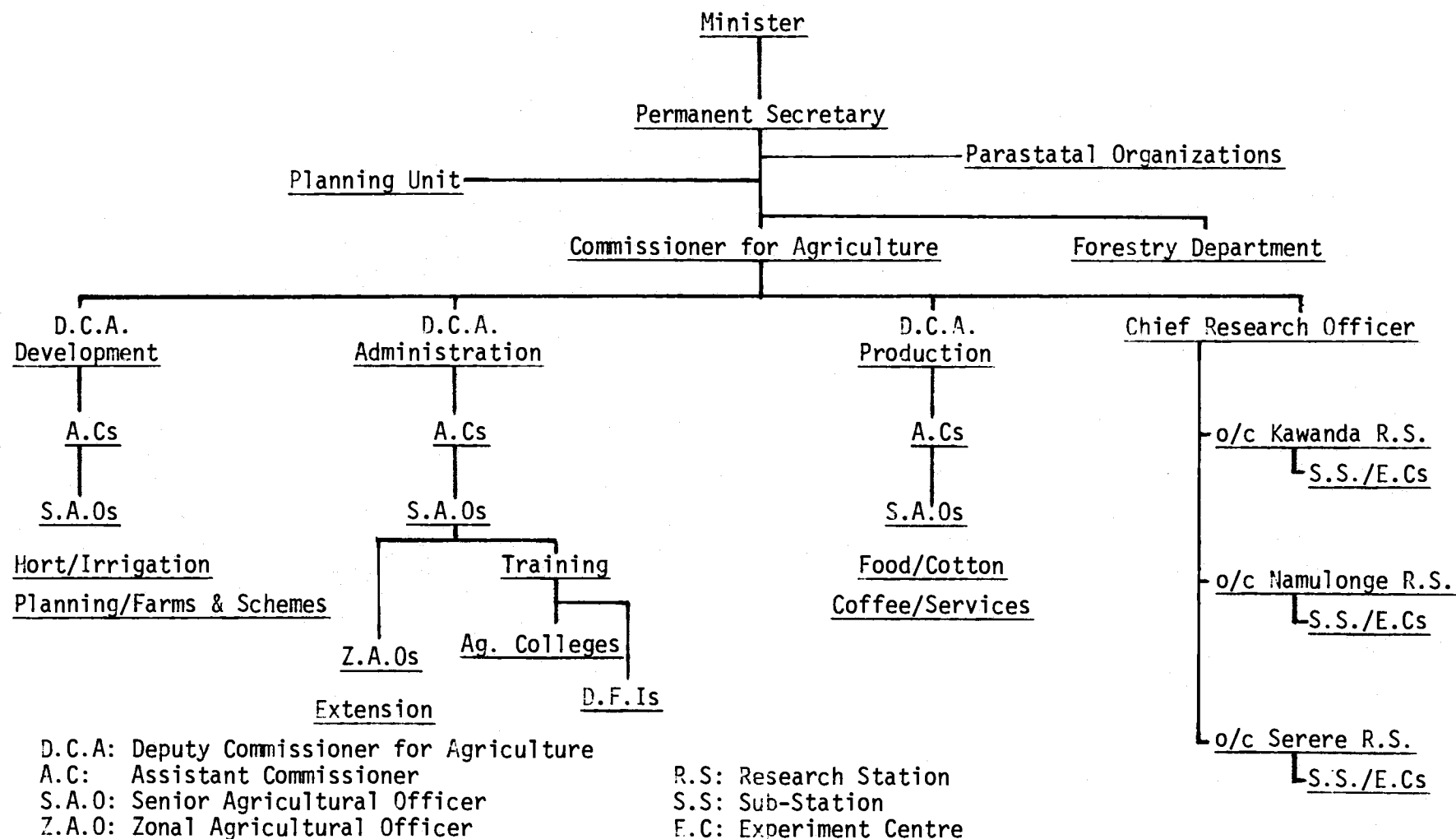
The Minister of Agriculture and a small staff, including a Permanent Secretary, have their offices in Kampala. There is also a Planning Unit which reports to the Minister but is located with the Department of Agriculture in Entebbe. The Department is headed by a Commissioner for Agriculture assisted by Deputy Commissioners for Administration, Development and Production. Under the Deputy Commissioner for Administration are Zonal and District Agricultural Officers, and a large extension service which comprises approximately 4,300 extension workers at various levels. There is also a training section which consists of the Agricultural Colleges and the District Farm Institutes.

The Research Division is headed by the Chief Research Officer, who reports directly to the Commissioner for Agriculture, and advises on all matters relevant to agricultural research and production problems. He holds responsibility for the Research Stations at Kawanda, Namulonge and Serere, and the various sub-stations and experimental centres, and is also responsible for liaising with other related domestic and international organizations.

Although it is much smaller, the Department of Forestry has a similar structure to that of Agriculture. The organogram of the Ministry of Agriculture and Forestry is outlined in Figure 2.

The Office of the Minister of Agriculture was previously

Fig.2 Structure of Ministry of Agriculture and Forestry (April 1981)



located with the Department of Agriculture in Entebbe, but was moved to Kampala to be closer to Parliament and the other Ministries. When accommodation becomes available the Department of Agriculture is likely to be relocated to Kampala. This would allow closer contact with the various Ministries, and with the Research Division based at Kawanda Research Station. It would also allow closer liaison with the Faculty of Agriculture at Makerere and with the University Farm, Kabanyolo.

In general, individual research workers are responsible for the initiation of research project proposals in the Research Division. They are examined for approval first by the Experiment Committee of each Research Station, and then by the Agricultural Research Advisory Committee. These committees include representatives of the research and extension staff, the Chief Research Officer and the Commissioner for Agriculture. Members of the parastatal organizations and marketing boards may also be present. Research proposals from the Faculty of Agriculture are processed by a Research Committee comprising staff members and including the Chief Research Officer. This allows co-ordination of the research effort to some extent.

Since the mid-1970s, the organization of research within the Department of Agriculture has moved away from the grouping of research workers by discipline, towards the organization of research by commodity or crop type. It was considered that this would provide a more effective joint effort towards improved crop production. The establishment of separate commodity research institutions was not feasible due to the expense involved, but related crops were grouped into distinct crop improvement programs. These Commodity Research Units (CRUs) included the following:

- Cotton and Fibre Crops
- Coffee, Cocoa and Oil Palm
- Cereal Crops
- Grain Legume Crops
- Horticultural Crops
- Sugar Cane, Banana and Root Crops
- Oil Crops, Tobacco and Medicinal Crops
- Pasture and Animal Husbandry
- Soil Science and Agricultural Chemistry
- Plant Protection and Crops Storage
- Basic Research and Research Services

The Head of each Unit was responsible for coordinating the various aspects of research relevant to the particular group of crops. Problems were experienced with inadequate funds and funding procedures. Also, rapid turnover of staff, and a lack of qualified and experienced researchers, has led to problems in the administration, and consequently the effectiveness of the CRUs.

The Research Division has a total establishment of 145 research officers, of which 119 posts are filled. However, in early 1981 it was considered that only 21 of these 119 research officers were properly qualified for research (at the Ph.D. or M.Sc. level). Although little postgraduate education has been possible in recent years, there are now five officers undertaking M.Sc. programs.

The research program operated by the Research Division has steadily declined over the past ten years due to the failure of the Government to provide adequate levels of support, and to the uncertainties associated with the previous regime. That there is any significant research still underway is largely attributable to the dedication and resourcefulness of individual research officers working to maintain professional standards under almost impossible conditions. Nonetheless, the lack of a national research plan, and the deterioration of

Table 3. Uganda - Agricultural Research & Training Facilities (April 1981)

<u>Station</u>	<u>Location</u>	<u>Zone</u>	<u>Professional Staff</u>	<u>Research Mandate</u>
1. <u>Ministry of Agriculture</u>				
a) <u>Major Stations</u>				
Kawanda	13 km N Kampala	X	46	Research H.Q. Coffee; maize; and other crops.
Namulonge	25 km NE Kampala	X	19	Cotton; food crops; pastures; livestock.
Serere	30 km SW Soroti	III	27	Cotton; sorghum; millet; pastures; livestock.
b) <u>Sub-Stations</u>				
Buginyanya	Mbale District	II	4	Arabica coffee.
Kituza	40 km E Kampala	X	2	Robusta coffee; cocoa; oil palm; sugar.
Ngetta	5 km N Lira	V	1	Cereals; livestock.
Kigumba	40 km NE Masindi	VII	1	Annual crops; livestock.
Kalengyere	Kabale District	IX	2	Irish potatoes; wheat; barley.
c) <u>Experimental Centres</u>				
46 Centres	All Districts		6	Multi-locational trials.
d) <u>Colleges</u>				
Bukalasa	40 km N Kampala	X	17	Bananas, robusta coffee.
Arapai	10 km NE Soroti	III	12	Annual crops, citrus.
Busitema	Tororo	I	NA	Mechanization.

e) District Farm Institutes

15 Institutes	All Districts	-	NA	All crops.
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f) Department of Forestry

Nakawa	Kampala	X	NA	Research H.Q. Forestry, timber utilization.
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2. Ministry of Animal Resources

Research Headquarters	Entebbe	X	NA	Livestock health and husbandry.
Nakyesasa	25 km Kampala	X	NA	Pastures, livestock husbandry.
Ruhengeri	Ankole	VII	NA	Pastures, livestock husbandry.
Aswa	Acholi	V	NA	Pastures, livestock husbandry.

3. Makerere University

Faculty of Agriculture	Kabanyolo	X	53	All crops, livestock and forestry.
Faculty of Veterinary Science	Kampala	X	NA	Starting livestock health,

4. Tea Board

Rwebitaba	Fort Portal	VII	2	Tea.
Salama	10 km Kampala	X	NA	Tea.

5. Sugar Estates (privately owned)

Kakira	10 km N Jinja	X	NA	Sugar cane.
Lugazi	60 km E Kampala	X	NA	Sugar cane.

NA - Not available

facilities, equipment, vehicles and machinery will necessitate a concentrated effort over a period of years to regain a semblance of a viable research structure.

The Ministry of Animal Resources has a similar structure to that of the Ministry of Agriculture, and the Research Division based at Entebbe is maintaining its animal disease surveillance program. However, its research activities per se have been severely limited by shortages of staff, drugs and equipment. Since this Ministry was not covered by the terms of reference of the Mission, its programs were not considered in detail.

The Faculty of Agriculture at Makerere has also been severely affected by the difficulties of the last 10 years, but still has about 22 experienced staff members. At the Kabanyolo Research Station, research programs are probably functioning at less than 25 percent of capacity. Student programs have been relatively unaffected, at least in regard to quantity, and there are approximately 220 undergraduates in agriculture and 80 in forestry, and graduate students number about 20. Since the faculty represents a major portion of the highly trained agricultural scientists in Uganda at the present time, it is important to consider how it can be effectively integrated into the national agricultural research program.

A summary of the current situation regarding agricultural research and training facilities is given in Table 3.

4. REHABILITATION OF AGRICULTURAL RESEARCH

It is clear that only a minimal program of agricultural research has survived the difficult conditions of the last decade. The Research Division of the Ministry of Agriculture has very few qualified and experienced staff for either research or administrative duties. At Makerere University, the Faculty of Agriculture is also seriously understaffed and the rehabilitation of teaching programs may be given priority over the implementation of research activities. In the parastatal organizations, and the private sector, research has declined together with production levels. Although many individuals throughout Uganda are to be highly commended for attempting to keep programs operating, their efforts have been seriously hampered by a lack of funds, materials, transport and functional facilities, and the extremely unstable environment of the past decade. The Mission recognizes the urgent need for a reorientation of the overall agricultural research strategy. Also necessary is a reorganization of the research structure and administration in order to utilize more fully currently available resources in the various sectors and to establish a solid base for the expansion of future research activities. This will be essential if significant contributions are to be made towards achieving the national objectives for agricultural production.

4.1 Criteria for the Selection of Priorities

The Mission's proposals and recommendations regarding agricultural research are based upon the following key criteria:

- i) the need to ensure that the research strategy is consistent with the longer-term development priorities for the agricultural sector as a whole, and complementary to the overall integrated strategy for land, water and forest use;

- ii) the need to urge upon Government the absolute necessity of a fundamental re-examination of the working links between the training, extension and research services in order to ensure that research is relevant to the needs of the producer, and that results are rapidly incorporated into production practices;
- iii) the need for maximum integration of available resources to achieve efficient operation and avoid duplication of research effort;
- iv) the need to establish a more effective structure for research administration;
- v) the need to improve the morale and spirits of the research staff;
- vi) the need to recognize the constraining shortage of qualified personnel;
- vii) the need to restrict short-term research activities to emergency-type projects with rapid returns to the economy, and a good possibility of attracting external support (Priority A program);
- viii) the need to emphasize adaptive research and use existing research data to augment the short-term program; and
- ix) the need to devise priority research activities for the medium and long-term which can be implemented as resources permit (Priority B and C programs).

4.2 Research Strategy

It is important that a clearly defined research strategy is prepared as soon as possible during the rehabilitation period. This strategy must demonstrate that agricultural research will not be carried out merely for its own sake, with the unthinking momentum of

of the 'status quo', but will provide a vital and indispensable contribution to future agricultural production within the framework of national development goals. Several of the criteria already outlined above for the selection of agricultural research priorities, can also serve as a basis for the detailed formulation of strategy objectives. It is essential that these are reviewed periodically to ensure that flexibility is maintained and that necessary responses can be made to changing circumstances. In essence, agricultural research must provide technically accurate information appropriate to the needs and potential of the producers, while promoting maximum integration and efficient utilization of the resources available at any particular time.

4.2.1 Commodity Research Units

The Mission strongly supports recent moves by the Ugandan research community towards research by commodity rather than by scientific discipline. The Commodity Research Units (CRUs) are designed to provide an environment for an integrated approach to solving problems associated with all the various aspects of production of a particular commodity or group of crops. The CRUs need not necessarily be physically intact entities, but rather a flexible and coordinated group of researchers with the wide range of necessary expertise. It is possible that individual scientists may be based on research stations in different agro-climatic zones, in order to be able to carry out controlled experimentation under the necessary range of conditions. To maintain the integrity of each Unit, it will be essential that the Unit Leader, while exercising technical supervision of the Unit's work, is also administratively responsible for authorizing budgeted expenditures. Administrative and technical support would be provided to each CRU by the service units at each of the major research stations. These services would include agrometeorology, biometrics, economic and statistical information, and publication and library facilities. Overall technical and administrative coordination would be provided by the Unit Leaders reporting to the Station Directors, by means of research

liaison committees. The Mission cautions against the establishment of CRUs in excess of available manpower and technical resources with a consequent decline in the quality of research conducted. It is also most important that while the necessary continuity of CRUs be maintained, staff and other resources allocated to CRUs should be determined in accordance with the overall program of research priorities. As priorities change, the CRUs must remain flexible enough to respond to these changes.

4.2.2 Farming Systems Research

The resultant component technology generated from the CRUs will provide the basic scientific and technical information necessary for the implementation of farming systems research (FSR). It is this program that will provide the essential link between the researcher and the farmer, and ensure that research carried out at the CRUs is relevant and appropriate to conditions at the farmer level. Besides providing an orientation for the CRU programs, FSR will also allow an evaluation of innovative materials and techniques developed by the CRU researchers. The FSR teams will thus become involved in a continuous cycle of testing and feed-back in collaboration with the appropriate CRUs. It is proposed that the formation of the initial FSR group would be the responsibility of the Faculty of Agriculture at Makerere University, and this would serve as a training ground and model for further groups to be developed by the Ministry of Agriculture. These FSR teams would eventually be located throughout the country in all agro-climatic zones, in association with the nearest research or training facility. Ideally they would be staffed from both the research and extension divisions of the Department of Agriculture, thus leading towards the possible eventual formation of an agricultural development service. Initially, it is recommended that an appropriately qualified extension agronomist be seconded to the research unit responsible for implementing the FSR program.

An agricultural research strategy based on the concept of CRUs and FSR teams, should allow for a very close linking of the farmers,

extensionists and researchers, and also for integration between the various research institutions involved. It should also provide a valuable foundation for the preparation of an organized and logical system of resource allocation.

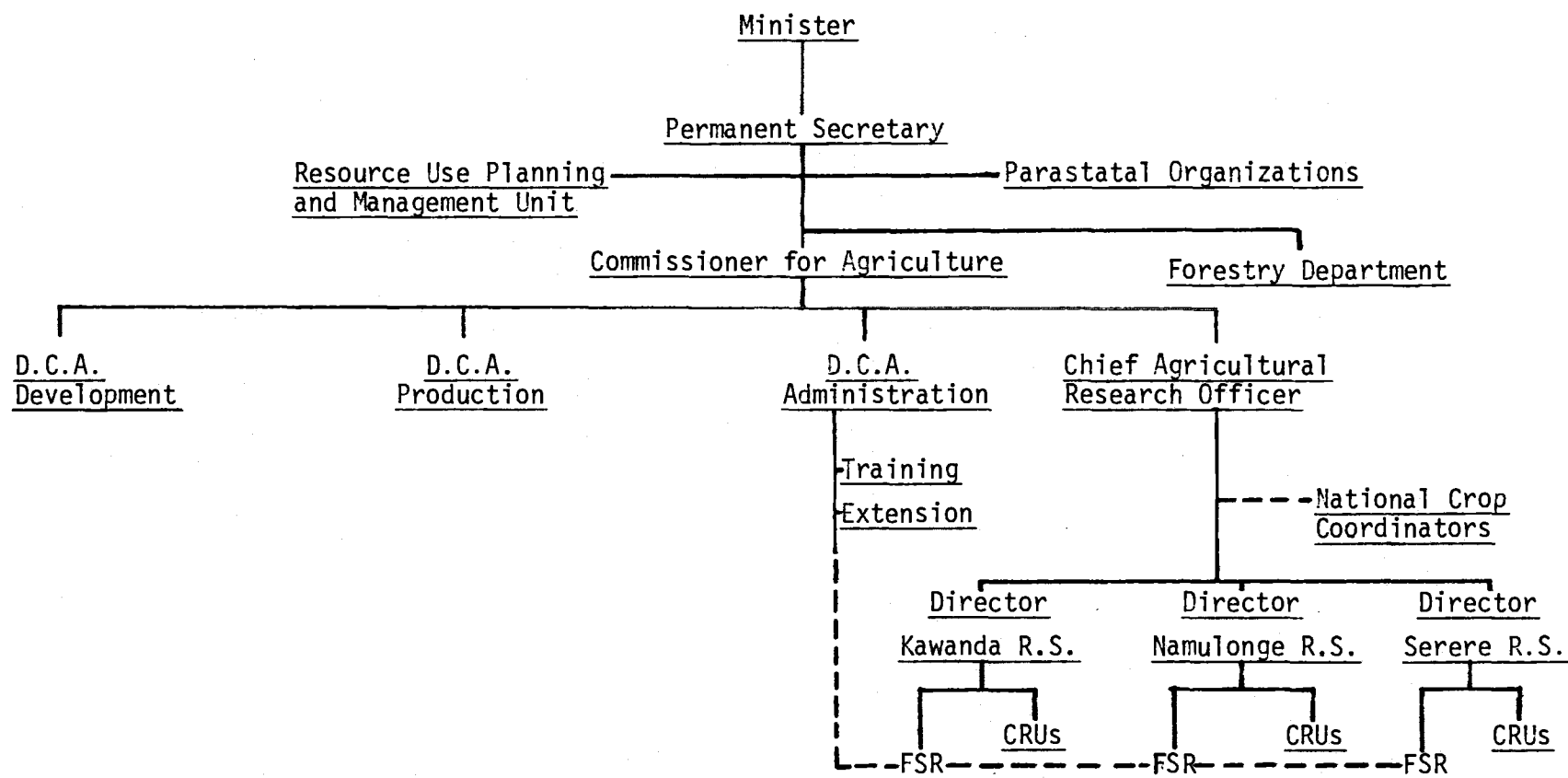
4.3 Research Structure and Administration

The following discussion and suggestions for the reorganization of the research administrative structure are designed to increase the effectiveness of the agricultural research establishment as rapidly as possible. Streamlining of the processes and channels of communication within and between institutions is urgently required but the Mission cautions against any attempt to alter radically the current structure during the initial rehabilitation period. Instead, emphasis must be placed on improving liaison between the various components of the research community, especially between the Ministry of Agriculture and Forestry and the Faculty of Agriculture of Makerere University, and within the Department of Agriculture and the Research Division itself.

For an extended period there has been a constant problem in the Ministry and Department of Agriculture concerning the most appropriate and effective organizational structure with regard to research. The current structure was discussed in Section 3.4 and outlined in Figure 2. Although all other major aspects of this report have a consensus between the Mission and Ugandan Government officials, no final agreement was reached with respect to any revision of the organizational structure. Proposals for a slightly modified structure are presented for consideration in Figure 3.

The Mission considered that several key elements must be accommodated:

Fig.3 Proposed Structure of Ministry of Agriculture and Forestry



D.C.A: Deputy Commissioner for Agriculture
 R.S: Research Station
 C.R.U: Commodity Research Unit
 F.S.R: Farming Systems Research Team

- i) the need to maintain and strengthen operational links between research and extension; and
- ii) the need to incorporate priority research on an equal administrative basis with extension; and
- iii) the need felt by some researchers to provide the Research Division with somewhat greater policy and operating autonomy.

It is recommended that no attempt be made to place the Research Division under the direct responsibility of the Permanent Secretary rather than the Commissioner of Agriculture. Despite suggestions that this would result in more favourable funding and policy priority for the Research Division, the Mission is of the opinion that it would be detrimental to efforts to promote liaison between research and extension. However, in order to strengthen the position of the Research Division within the Department, the formation of the post of Chief Agricultural Research Officer (CARO) is proposed. The CARO would report directly to the Commissioner for Agriculture and have equal standing with the Deputy Commissioners for Agriculture (Development, Production and Administration). The CARO would require a competent administrative staff, including an accountant and a research systems analyst, with adequate funding, but the final influence of the Office, and thus of the Research Division, would depend to a large extent upon the calibre of the CARO himself. All funding and budget allocations within the Research Division would be the direct responsibility of the CARO. It is envisaged that an equivalent position would be established within the Department of Forestry, at an appropriate level.

Within the Research Division the responsibility for the coordination of the agricultural research program would be carried principally by the Directors of the Research Stations and the Leaders of the CRUs, reporting directly to the CARO. The fact that research members of a particular CRU might be located in various stations should tend to

enhance integration of research at the operational level. The establishment of the initial FSR teams will necessarily be in close association with a research station in order that support services will be available. This will also allow for close technical collaboration between an FSR team and the various CRUs located in a particular agro-climatic zone.

It is also proposed that the FSR teams should provide the major link between the Research Division and the Training and Extension Services. Serious consideration should be given to the possibility of dividing the responsibility for staffing FSR teams equally between Research and Extension.

The adoption of various other devices, proven effective elsewhere, might also be useful in enhancing operational links between research and extension staff, regardless of how the higher administrative levels of the Ministry are organized. It is recommended that selected extension and research officers could be transferred to each others activities for shorter or longer periods; short courses could be prepared on a reciprocal basis; and students and junior staff could spend time working in all aspects of both activities.

The establishment of research-extension liaison positions at the research stations and in the Office of the CARO, should also be considered.

In due course, as the network of FSR teams expands, there will be the possibility of basing operations at agricultural colleges, farm institutes, sub-stations and experimental centres. This will provide further opportunities for collaboration, secondment of staff and short-course training. It is strongly recommended that student participation in FSR and extension projects in nearby villages be included as practical credit courses in college curricula.

As previously discussed, the gradual development of CRUs within the existing infrastructure is fully endorsed, especially where this will

provide a strengthening of research capability on a regional basis. The centralization of research facilities is not encouraged, and any moves to provide for the construction of more full-scale research stations should be resisted at the present time. Moreover, the Mission urges that immediate attention should be given to a careful assessment of the necessity of having several major research stations in the Kampala area, located within close proximity and in the same agro-climatic zone. In the event that sufficient Ministry staff and facilities are not available to carry out required research, then consideration should be given to the possibility of awarding specific research contracts to other appropriate institutions. This could particularly apply, for example, in the case of the FSR project proposed by Makerere University. This could serve as a model unit for the development of other similar programs by the Department of Agriculture throughout the country, and be used for training purposes for Ministry personnel. The Mission recommends that the Ministry and the University collaborate to evaluate and clarify the necessary details for a research contract based on these proposals.

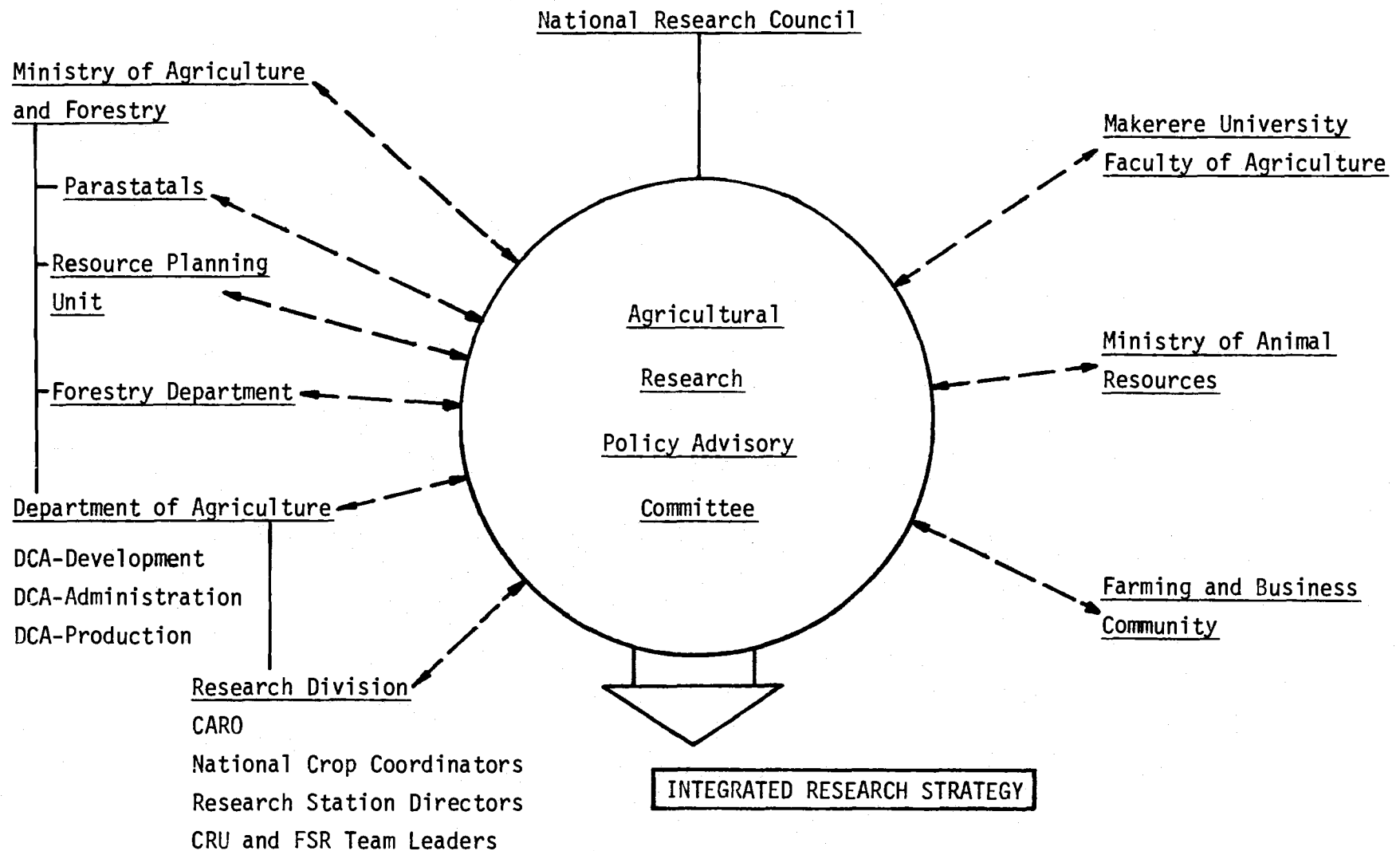
In order to benefit from any long-term reorientation of strategy and structural reorganization, staff motivation must be of prime concern. The Mission considers that the priority research activities will in themselves provide a professional stimulus, but other motivational measures should also be considered. Of great importance would be ensuring that the normal perquisites of the Ministry are applied equally to the research staff. These include educational and training opportunities, and the possibility of attending international meetings and conferences. Fringe benefits, such as domestic travel opportunities, children's school transport and the like, should also be of an order which provide adequate conditions of service and professional satisfaction. A careful assessment should be made of the opportunities for promotion with the research establishment. The Mission recommends that a minimum of three posts of Senior Principal Research Officer should be created within the Research Division, although shortage of qualified staff might not allow the immediate filling of these positions. The requirements for further

education for research workers are discussed in Section 5.1.2.

It is essential that a very high priority be placed on improving liaison between the various institutions involved in agricultural research. The Mission considers that the concept of an Agricultural Research Policy Advisory Committee, as one of several specialised committees formed under the auspices of a strengthened National Research Council, could allow for close coordination within the agricultural research sector, and lead to a well integrated overall research strategy. The Advisory Committee would be chaired by a member of the NRC, and would comprise scientists from the Ministry of Agriculture and Forestry, Department of Agriculture and Research Division, Ministry of Animal Resources, Faculty of Agriculture at Makerere University, and prominent representatives from the farming and business community. The proposed interrelationship with the agricultural research sector is outlined in Figure 4. It is envisaged that the operation of the Advisory Committee would be the responsibility of a permanent executive committee, with the CARO as Secretary. It would be funded through the NRC, with the power to financially support selected research projects. However, its major function would be the coordination of the research efforts of the individual member institutions, each operating principally on its individual core funding.

The Advisory Committee would also have the responsibility of selecting National Crop Coordinators, who could form an important element in the linkage process between domestic research organizations and activities. These Crop Coordinators could be selected from among the research personnel of any of the appropriate institutions, and would be responsible for the research liaison for a particular crop or crop family. Informal, annual meetings might be held to update research results, anticipated research programs, international information and literature. The Crop Coordinators would be responsible to the Advisory Committee, and liaise directly with the Executive Secretary.

Fig.4 Proposed Interrelationship of Agricultural Research Organizations



It is proposed that in the case of tea, tobacco and sugar research should continue to be funded by the respective industries. However, Government must recognize that pricing and marketing policies will affect the profitability of production, and this will inevitably also affect the level and quality of research possible. It is suggested that the overall coordination of research for each of these crops should also be handled through the Advisory Committee, possibly by the formation of Technical Sub-Committees, chaired by Crop Coordinators. Where necessary, secondment of specialized staff could be arranged by the Ministry and the University to ensure that the necessary quality of research is maintained.

It is recommended that former EAC Research Units should be incorporated as appropriate in any reorganization of the research structure. Thus, the Sugar Diseases Research Unit at Kawanda would be transferred to the responsibility of the sugar industry. Similarly, the Sorghum and Millet Research Unit at Serere should be transferred to the Ministry of Agriculture from the Ministry of Regional Cooperation, as soon as possible.

The Mission supports the growing cooperation between the Ministry of Agriculture and the Ministry of Animal Resources with respect to their mutual and complementary research interests. The Mission understands that a complete integration of the two Ministries may not be feasible at this time, but strongly encourages the movement in this direction, and suggests that the formation of an inter-ministerial co-ordinating and monitoring committee should be considered.

4.4 Coordination with International Agricultural Research

There are important links between the Uganda research community and numerous external agencies. The Mission recommends that all possible emphasis be given to strengthening coordination in the following areas:

- i) Uganda's problems in agricultural research and development are by no means unique. They are often very similar to those of other regions in Africa with comparable agro-climatic, economic and social conditions. The possible benefits to be gained from expanding all possible channels of communication should not be underestimated. Reciprocal scientific visits and attendance at regional scientific conferences must be encouraged. The resulting exchange of ideas, research results and germ plasm should prove to be a valuable stimulus to adaptive research.
- ii) There are many International Agricultural Research Centers whose work is very relevant to Uganda's needs. These include ICRISAT, IITA, IRRI, ILCA, CIAT, CIP and CIMMYT. Close and continuing links with the appropriate centers will enable Uganda to make use of their germ plasm, technical expertise, research information and training facilities. The Mission strongly recommends that a senior researcher should be designated as Liaison Officer to ensure close collaboration between the International Centers, the National Crop Coordinators and other research personnel.
- iii) There are numerous other sources of research information and expertise available to Uganda. These include, for example, French institutes such as the Institute de Recherche d'Agronomie Tropicale (IRAT), the Tropical Products Institute (U.K.), and the National Academy of Sciences (U.S.A.). Linkages need to be strengthened and formalized with the maximum number of institutions in as many countries as possible.
- iv) Useful liaison might be formed between the Faculty of Agriculture at Makerere University and other Universities in the developed and developing countries. While many contacts will be informal and personal between individual scientists, it is recommended that consideration be given to continuing or initiating

specific twinning projects to provide for specialized interaction relevant to selected aspects of research and development.

4.5 Research Planning and Monitoring

The Mission considers that the preparation and presentation of research proposals requires upgrading. There appears to be only a minor degree of consistency in the preparation of individual projects, resulting in difficulties in the formulation of a systematic program at the research station level, and subsequently at the national level. This may be one reason why the Mission was unable to locate any documentation showing an approved and funded annual research program. Once the CRUs are operating and the research activities expanding, such systemization will become of critical relevance.

It is therefore recommended that more attention be given to defining detailed and specific research objectives for each proposal. This will assist in directing attention to the research priorities, and allow regular monitoring of progress. During the course of research the objectives may need occasional modification in the light of the results being obtained. However, researchers must hold clear responsibility for satisfactory progress towards the achievement of the stated overall objectives.

The Research Division and the Faculty of Agriculture may wish to collaborate in developing some regular mechanisms for reviewing progress, and for ensuring the satisfactory writing up of intermediate and final results. One possibility would be the appointment of Administrators at each Research Station in order to relieve the Station Director of most of the administrative load and allow more time for professional leadership and guidance. Another would be the appointment of a research systems analyst in the Office of the CARO who could monitor closely the progress of all research projects. These proposals have been discussed in Section 4.3.

The proper documentation of research projects that are to be presented to external agencies for funding consideration will be of critical importance. It is recommended that once a rehabilitation period research program has been agreed upon, the Ministry prepare the proposals as soon as possible. Each specific project should state the problem to be addressed, the research objectives and programs, the methodologies and time period required, and an initial estimate of foreign exchange and domestic currency costs. The possibility of immediate technical assistance for project planning is discussed further in Section 5.

4.6 Research Funding

The Mission is of the opinion that a major obstacle to the return to efficient administration of the agricultural research services is that of the funding process itself. Government financial systems continue to be inefficient, cumbersome, and, at times, unpredictable. Senior research personnel spend an inordinate share of their time coping with a system which precludes proper research planning and affects the continuity of the research program itself. The Mission recommends most strongly that the Research Division and the Ministry work with all possible speed to ameliorate these antiquated processes which, however suitable for other areas of Government, are clearly inconsistent with the requirements of agricultural research. Besides the need to streamline and regularize routine financial transactions and procedures, there is a need to establish a process by which reasonable minimum levels of research funds for each approved project are guaranteed for at least 3 years in advance. It is also recommended that the Chief Agricultural Research Officer should be given full financial responsibility for the research funds allocated, including any foreign funds. The mis-matching of development, recurrent and foreign exchange budgets must clearly cease. The future funding of discrete CRUs and FSR teams, if along present lines, will undoubtedly detract markedly from their effectiveness. The Government might wish to request technical

assistance in a reorganization of the entire funding process.

4.7 Resource Management

The problems facing Uganda due to overcultivation, overgrazing and clearing of forests on watersheds with consequent acceleration of both soil erosion and destruction, have already been outlined in Section 2.4. It is evident that there is an urgent need to develop optimum land use practices and farming systems for all the varied agro-climatic zones of the country, starting with the most seriously affected areas.

As far as the Mission can ascertain, there is no long-term integrated resource use strategy for Uganda. Neither is there a strategy for the agricultural sector, or for agricultural and forestry research.

The Mission therefore places very high priority on the establishment of a Resource Use Planning and Management Unit, with appropriate funding and staffing. While this Unit would be multi-disciplinary in nature, comprising specialists in crops, livestock, forestry, fisheries, water, wildlife, geography and economics, it is proposed that it should have a considerable degree of autonomy and be directly responsible to the Minister of Agriculture. An approach should be made to an external donor for substantial support for the establishment of this unit, including the provision of adequate technical assistance. An initial feasibility study would be needed to determine the most suitable location and organizational structure for this unit. Its terms of reference should include, among others, the following:

- i) soil and water management, utilization and conservation;
- ii) multiple land use planning;
- iii) management of natural forests;
- iv) agro-forestry; and
- v) desertification.

The unit should deal not only with collating and updating of currently available resource inventories, but also with identifying the qualitative and quantitative dynamics of resource utilization, changing settlement patterns and the need for land use intensification. This information will allow research to be directed to new crops and to devising more intensive cropping systems which simultaneously maintain and improve soil structure and fertility. It will thus be possible to develop farming systems appropriate to increasingly inferior cropping and grazing conditions, as a progressively larger proportion of the land brought into use will be of poorer quality. It will also be necessary to monitor the shift of pest and disease populations consequent upon these changes. The continuous improvement and updating of post-production systems will also be essential.

These are major undertakings. They also highlight the priority which must be placed immediately on farming systems research. Uganda must concentrate as well on adaptive research, using the experience of neighbouring countries and the international research system to the maximum. On balance, the Mission feels that the following research programs are consistent in principle with these longer term strategies.

5. AGRICULTURAL RESEARCH PRIORITIES

The Mission has divided the proposals for agricultural research into three levels of priority on the basis of the criteria and requirements discussed in Section 4. The Priority A program has emergency status, and is considered to require immediate implementation. It will form the foundation for the requirements of proposals for the longer term research, but has been restricted to the minimum possible number of projects because of current limitations of qualified staff and resources. Nevertheless, considerable external assistance will be required. The Priority B program is also critically important but will generally require major increases in qualified staff. Priority C is of relatively low importance and proposals are for the long term when adequate resources are available and conditions are stable. The division between the programs is not rigid, and flexibility must be maintained to allow adjustments according to future circumstances.

Each priority class includes a number of projects which could be presented for external funding. The preparation of these proposals will in itself be a formidable task, and thus the Mission strongly recommends that technical assistance be requested for planning and project preparation. Immediate assistance appears to be available under a November 1980 World Bank technical assistance credit. A sub-committee, comprising representatives of the Ministry of Finance and four other Ministries, with coordination by the Ministry of Planning and Economic Development, is designed to screen projects for funding. Acceptable projects are: training; short-term management and technical assistance for existing projects; technical assistance for strengthening planning and preparation of future projects; rehabilitation and capacity utilization studies, and pre-feasibility studies.

5.1 Priority A Program

This program is designed to increase the effectiveness of available resources and personnel as rapidly as possible. Evaluation of existing information and research results will provide invaluable

reference material for the formulation of future projects. The immediate implementation of a comprehensive training program and the rehabilitation of research facilities is not only essential in order to raise morale within the Research Division, but will prove critical to the success of future programs. Meanwhile, attention must be directed towards only the most urgent activities and economically important crops which have the maximum potential for increasing production at the farmer level. It is essential that adaptive research conducted on the five most important crops at the Commodity Research Units is combined with a Farming Systems Research approach in order to ensure that the research results are appropriate to the needs of the farmer and are incorporated into farming practices in the shortest possible time.

5.1.1 Collation and Analysis of Research Results

The Mission understands that the Research Division has a large backlog of unanalyzed data from research previously carried out. The extensive program of farmers' fertilizer trials which were carried out in the 1960s are of particular importance. The results of these trials should be collated and analyzed, and preferably correlated where possible with soil survey results. They could then be linked with an economic analysis of present input and output price relationships, and immediate recommendations on fertilizer use be made available to farmers in all the varied agro-ecological zones of the country. The Mission recommends that an approach be made to an external donor for technical assistance and computer facilities to carry out these analyses in conjunction with Ugandan scientists and economists.

It appears that many other unanalyzed research results are also available. It is recommended that during the immediate period before it is possible to initiate new research programs, all researchers are instructed to collate, analyze and interpret the results of previous experimental work appropriate to their field of study. This should be combined with reviews of the relevant literature and might also be prepared for publication in the form of research monographs.

5.1.2 Further Education for Research Workers

As discussed in Section 3.4, the staffing position of the Research Division is considered to be critically weak, particularly with regard to qualified researchers. Out of an establishment of 145 research positions, 119 are currently filled but of these only 21 have staff with adequate training and experience for research requirements. Many officers were assigned to the Research Division merely because the Government, during the previous regime, guaranteed all graduates a job. Since about one-third of the qualified and more experienced staff are occupied part-time and in some cases almost full-time, with administrative duties, this leaves the equivalent of only 15 qualified staff free for actual research, and many of these need direct and close supervision. The areas of technician training, and the administration and management of research also require immediate attention.

Manpower training policies in the immediate rehabilitation period should be designed to correct the present imbalances and deficiencies so that eventually staff are better prepared to conduct highly professional and effective work over the required spectrum of activities. Post-graduate training is recommended for those who, upon examination and review, show potential for research of a high calibre. Consideration should also be given to the replacement of staff presently in the Research Division who do not exhibit a high potential for research work, but who may be more suited to the requirements of administration, training or extension. The subsequent employment and training of replacement staff must be conditioned by the priority research requirements for the rehabilitation period and of the longer term programs.

The Mission recommends that external funds be urgently sought for the immediate implementation of training of selected candidates who have demonstrated research capabilities, in programs consistent with the priority research proposals. This phase of the training program should include the following:

- 3 Plant Breeders
- 3 Agronomists
- 2 Entomologists
- 2 Agricultural-Economists
- 1 Plant Pathologist
- 1 Horticulturalist
- 1 Seed Technologist
- 1 Virologist
- 1 Biometrician
- 1 Research/Extension specialist
- 1 Research Administrator

Training should be to the M.Sc. level, at institutions appropriate to the particular specialization. These might include international agricultural research centres in collaboration with neighboring universities, or other appropriate universities in developing or developed countries. In addition, as the Faculty of Agriculture staffing returns to normal at Makerere, it is hoped that the previous arrangements for post-graduate training of Ministry research workers, both full-time and part-time, can be resumed. During training, the participants will gain valuable experience while contributing to the research effort, particularly with regard to the CRUs and FSR groups.

A summary of short- and medium-term training requirements is given in Table 4, but it is strongly recommended that more detailed proposals be prepared as soon as possible. These should include identification of personnel involved, institutions offering suitable courses, and the amount and sources of required funding. At the same time, consideration should be given to the requirements for technical assistance with regard to short term contracts (2-5 years) for experienced professionals to act as replacements during the period of training of local scientists.

Table 4. Post-Graduate Training of Agricultural Research Scientists

<u>Speciality</u>	<u>1982-84</u>	<u>1983-85</u>	<u>1984-86</u>	<u>Position on Return</u>
1. <u>Breeding</u>	1 2 - -	1 - 1 -	- - - 1	Cotton CRU Cereals CRU Coffee CRU Legumes CRU
2. <u>Agronomy</u>	1 1 1 - - - -	- - 1 2 - - -	- - - - 1 1 1	Cotton CRU Bananas CRU Cereals CRU FSR Coffee CRU Legumes CRU Pasture CRU
3. <u>Agricultural-Economics</u>	1 1 - -	1 - 1 -	- - - 1	FSR Cotton CRU Cereals CRU Central Services
4. <u>Entomology</u>	1 1 - -	- - 1 -	- - - 1	Cotton CRU Plant Quarantine Coffee CRU Central Services
5. <u>Pathology</u>	1 - -	- 1 -	- - 1	Cotton CRU Root Crops CRU Legumes CRU
6. <u>Horticulture</u>	1	1	-	Horticulture CRU
7. <u>Seed Technology</u>	1	-	-	Seed Production
8. <u>Virology</u>	1	-	-	Plant Quarantine
9. <u>Nematology</u>	-	1	-	Bananas CRU
10. <u>Plant Physiology</u>	-	1	-	Central Services
11. <u>Agro-Meteorology</u>	-	-	1	Central Services
12. <u>Soil Science</u>	-	-	1	Central Services
13. <u>Biometrics</u>	1	1	1	Central Services
14. <u>Research/Extension</u>	1	1	1	FSR/Central Services
15. <u>Research Administration</u>	1 <u>17</u>	2 <u>16</u>	2 <u>13</u>	R.S. Administration

5.1.3 Rehabilitation of Research Facilities

The drastic deterioration of agricultural research facilities over the past decade has had a very adverse effect on the calibre of research work conducted. It is essential that the situation be rectified immediately if proposals for future research are to be effectively carried out. This not only applies to the main research stations but also to the sub-stations and agricultural experiment centres (formerly variety trial centres). The major constraints involve a lack of equipment, machinery and vehicles, together with appropriate maintenance and repair facilities, and a scarcity of basic inputs for field and laboratory experiments. Library services and materials are totally inadequate. There is also serious concern over problems of office and residential accommodation, and the lack of a constant water and power supply.

The Mission recommends that the Ministry apply for urgent technical assistance to carry out an in-depth assessment, in conjunction with Ugandan officials, of the overall requirements for rehabilitation and future maintenance of research facilities. Interim provision should be made to provide for immediate and specific needs such as essential small equipment, water pumps and office supplies.

Advantage should be taken of the opportunity to assess the future role of each research and experiment centre within the proposals for the restructuring of agricultural research on the basis of the CRUs and FSR. Particular attention should be given to a rationalization of the function of each of the major Ministry and University research stations in the Kampala area. Consideration should also be given to the upgrading of selected sub-stations and experiment centres to provide for decentralization of research and subsequent orientation towards regional needs.

5.1.4 Plant Introduction and Quarantine Station

In the past Uganda relied on the East African Community Plant Quarantine Station at Muguga, Kenya, to inspect, and if necessary quarantine all imported seeds and planting materials. Since the break up of the Community in 1977 no plant quarantine or phytosanitary service has been available in Uganda. A dangerous situation has arisen, with virtually unrestricted importation of plant materials. During the last 9 years plant pests and diseases introduced to Uganda include the cassava green spider mite and cassava bacterial blight. It is possible there may be others as yet unidentified. With the increasing movement of plant material and international contact that will inevitably result from the renewed impetus in agricultural research, there will be a greatly increased danger of further introduction of new plant pests and diseases. At the same time it is essential that research workers are not unduly restricted in obtaining a wide range of genetic material from international sources for breeding and evaluation programs.

The Mission therefore strongly recommends that a detailed feasibility study is prepared for the establishment of a small plant quarantine station for Uganda, probably at Kawanda Research Station. This would only require limited facilities in the first instance, and the appointment of a qualified quarantine officer while Ugandan scientists undergo training. The station should also be equipped to carry out phytosanitary inspection for export purposes, and future work should include research into tissue culture techniques for the exchange of plant material.

5.1.5 Seed Production

Although seed production is not strictly a research topic, it is considered to be a vital component for the rehabilitation of agriculture in Uganda. If the results of germ plasm screening and breeding programs are to be made quickly available to farmers, it is essential that there is an effective and efficient method of seed multiplication, processing and distribution. The identification of previously successful varieties

of all crops that are in danger of being lost could provide immediate impact. This would require the assistance of research and extension workers who were familiar with varieties held in high regard by farmers, and that were well adapted to the various agro-climatic zones. For many crops these selected varieties could be purified and bulked up more rapidly than new lines could be bred and evaluated. Later stages would involve the production of breeders and basic seed at appropriate research stations with subsequent large scale production and processing at the Masindi Seed Scheme. It is recommended that consideration be given to production by a system of contract growing rather than from Government seed farms. The Kenya Seed Company in Kitale, which has been very successful in promoting the use of improved seed by small scale farmers, may be willing to provide assistance in setting up a system of contract growers and advice on subsequent processing and marketing.

5.1.6 Crop Improvement

The proposals of the Research Division for crop improvement based on a series of CRUs have been discussed in Section 4.2. It is clear that at the present time qualified and experienced staff are only available for a limited number of these units. The Priority A research program therefore must focus attention on only a few of the most economically important crops. Particular care must be taken to ensure that research efforts are directed towards producing results that are immediately applicable to farmers' conditions. Activities that should be stressed are the collection, evaluation and multiplication of the best available varieties, improvement of agronomic practices and pest and disease control. The crops that are considered to require the most urgent attention are the following:

i) Cotton

Top priority is given to this crop in view of its critical importance for earning foreign exchange and providing cash incomes for large numbers of small farmers. It is also a valuable source of

vegetable oil for the local market.

Cotton breeders normally aim to produce at least one improved strain of cotton seed each year, incorporating enhanced disease resistance, lint quality and yield potential. Each new strain has to be exhaustively tested at a wide range of trial sites in order to ensure that it is superior to its predecessors. Seed multiplication then takes a number of years, and thus there is a considerable lead time before it becomes generally available to the majority of farmers. It therefore appears essential to strengthen the breeding program as soon as possible so that a new series of improved strains can be issued in due course. Meanwhile, purification and multiplication of the best strains of cotton currently available locally would provide seed for immediate distribution.

At the same time, the potential of advanced technologies such as controlled droplet application of new and existing insecticides against bollworms and other pests needs to be assessed both on research stations and under farmers' conditions. The combined packages of practices, including fertilizer use and intercropping or relay cropping required to include cotton in various farming systems, need further research and economic analysis.

This research would be the responsibility of the Cotton and Fibre Research Unit. The team should comprise a plant breeder, entomologist, pathologist and agronomist, based at Serere but with a minor program at Namulonge. Technical assistance should be requested from an external donor. (Britain and the European Economic Community are considering support for the production aspects of this crop.)

ii) Bananas

With over 1.2 million hectares under the crop, bananas provide the staple food for a large proportion of Uganda's population. In recent years there appears to have been a serious increase in nematode damage to the crop, which together with declining soil fertility,

weevil attack and general neglect have led to a decrease in production in some of the main banana-producing areas, particularly around Kampala.

There is an urgent need for research to test nematode control methods, to select resistant varieties and to conduct fertilizer and weevil control trials. Investigations should also be carried out to improve agronomic practices, and in some areas replanting may be necessary if production is to be significantly increased. The Banana Research Unit, with programs at Kawanda, Kizuza and Bukalasa, could initially be staffed with an agronomist and a nematologist, but would also require specialist services to carry out the proposed research. It is recommended that an approach be made to an external donor for assistance with this program.

iii) Maize

This crop is rapidly increasing in importance, with production of almost 0.5 million tonnes in 1980. Recently a widespread outbreak of streak virus has resulted in substantial yield losses, and there is an urgent need to strengthen the breeding and agronomy research programs. Streak-resistant germ plasm is available from IITA and this needs to be crossed with locally adapted material to develop high-yielding, disease-resistant composites suited to Uganda conditions. Other material from Tanzania and Kenya, including both composites and hybrids, are well adapted to certain agro-climatic zones.

The Mission recommends that IITA be requested to send representatives to Uganda to formulate an intensified maize research program for submission to an appropriate donor. The research would be the responsibility of the Cereals Research Unit with programs at Kawanda and Kigumba.

iv) Finger Millet

Although the importance of this crop has declined somewhat in

recent years, it is still a very widely grown staple cereal. It is grown mainly in the drier areas in the north and east of the country, with an area of approximately 450,000 hectares.

The millet research program at Serere Research Station has made some progress over recent years. There is now the possibility of making a major breakthrough in yield levels by the introduction and testing of the successful crosses between Indian and African material developed in India. This program should continue at Serere as part of the Cereals Research Unit.

v) Sorghum

This is the third most important cereal grown in Uganda, after maize and millet, with an estimated area of 350,000 hectares and production of 450,000 tonnes. It is widely grown in the dry short grass area in the north and east, and is particularly important in the drought-prone Karamoja region. Varieties for this area need to be selected on the basis of maturity and drought tolerance. Sorghum is also a staple cereal in the Kigezi district in the extreme southwest, where the high altitude necessitates a different plant type adapted to cool conditions.

The results of previous research at Serere will provide a sound basis for further breeding and agronomic research by the Cereals Research Unit. Material from ICRISAT might also be useful for this area. For the Kigezi district, adaptive research will need to be conducted, probably at Kalengyere, and germ plasm from the IDRC-supported project in Ethiopia might prove suitable.

5.1.7 Farming Systems Research

It is apparent that many aspects of the declining agricultural productivity in Uganda require urgent research attention. However, information and new varieties resulting from the crop improvement research conducted by the CRUs will be of little relevance unless they are immediately applicable and acceptable to the farmer. It is proposed

that the integration of farming systems research into the overall research strategy will provide the essential communication between the various levels of research, extension and production. The principles of FSR and their applicability to the Ugandan situation have been discussed in Section 3.3.1 and 4.2.

In view of the major contribution that FSR can be expected to make to the productivity of Uganda's farming systems, it is recommended that the ultimate objective should be a FSR team in each of the major agro-climatic zones. These teams could be based at research stations, sub-stations, AECs or DFIs as appropriate. Initially, the FSR project already proposed by the Agriculture Faculty at Makerere University for the robusta coffee/banana zone could be used as a pilot scheme and model for future projects. This should provide an ideal opportunity for close collaboration between the University and the Ministry of Agriculture, with the Makerere project providing training of Ministry researchers for future teams. It is suggested that the first Ministry FSR project should be in Teso district, based at Serere.

An approach should be made to an external agency for a farm management economist and an agronomist, experienced in African FSR, with the necessary operating funds, to assist in implementing this program.

5.2 Priority B Program

The Priority A items discussed above are considered the most urgent, and resources should be allocated accordingly. However, it must be emphasized that the dividing line between the Priority A and Priority B programs is not rigid, and research on the following activities should proceed as quickly as circumstances allow.

5.2.1 Crop Improvement

i) Rice

Although rice production is very limited at present, it is considered that there is an excellent potential for expansion in view of

the abundant water resources available in some areas. There is an urgent need to screen for high yielding varieties well adapted to Ugandan conditions, with resistance to blast disease, stem borers and other pests and diseases.

It is recommended that an external donor be invited to assist with a comprehensive survey of the potential for rice production in Uganda. Particular consideration should be given to hydrological and soil aspects, cropping patterns and economic factors.

ii) Arabica Coffee

Although about 90 percent of Uganda's coffee production comes from robusta and only 10 percent from arabica, there are a number of urgent problems with arabica which require research attention. Arabica coffee is severely attacked by Elgon dieback, coffee berry disease and leaf rust. Antestia and other insect pests can also cause severe damage. Control measures have been worked out for some of these problems, but they require constant monitoring and updating, and new methods need to be tested on farmers' coffee together with the appropriate improved agronomic practices. Relevant research results from neighbouring countries should be tested for their applicability under conditions in Uganda.

The Mission recommends that an external donor be approached for support and technical assistance to rehabilitate and upgrade the arabica coffee research sub-station at Buginyanya, near Mbale. Staffing requirements will include a coffee breeder, agronomist and a second plant pathologist, in order to allow a full research program to be undertaken. Additional laboratories, equipment and housing may also be required.

iii) Groundnuts

The area under this important crop is reported to have declined significantly in the last decade, and appears to be decreasing further.

There is an urgent need for intensified research to evaluate improved germ plasm for resistance to rosette, rust, leaf spot and other diseases, and to develop recommendations for improved cultural practices. Germ plasm and technical assistance should be available from ICRISAT, which appears to be making major advances in the improvement of this crop.

iv) Phaseolus Beans

Beans are grown on over 350,000 hectares, and are an important source of protein, particularly in the banana-growing areas where protein malnutrition is widespread. Research is urgently required to evaluate improved germ plasm for high yield and resistance to diseases such as anthracnose, angular leaf spot and rust. CIAT, which holds world responsibility for improvement of this crop, has developed a program for East Africa and should be able to provide useful support.

v) Horticultural Crops

Uganda has a large potential for the production of a wide range of fruits and vegetables in various parts of the country, both for local consumption and export. There is a need for adaptive research to evaluate new varieties and investigate disease and pest problems. In particular, virus and other diseases have resulted in a serious decline in the citrus industry. An Irish potato seed-production project at Kalyengere in Kigezi will need monitoring to ensure freedom from virus. CIP could be expected to have a useful input.

vi) Cassava

Almost 400,000 hectares of cassava are currently grown in Uganda. The crop appears to be increasing in importance as soil fertility declines, and is probably mainly replacing cotton and finger millet. In 1976, cassava bacterial blight was first reported in Uganda and has since spread widely, particularly in the drier areas in the north. Cassava mosaic disease has long been widespread, and causes severe crop losses. Green mites have also spread throughout Uganda,

and indeed most parts of Africa, since their inadvertent introduction in the early 1970s. IITA has developed high yielding cassava varieties with good resistance to bacterial blight and mosaic, which should be introduced, probably by tissue culture techniques, and evaluated under Ugandan conditions. Similarly, green mite resistance has been identified in an IDRC-supported project in Zanzibar, and this material should be introduced and tested. Further research is also needed on aspects of agronomy and intercropping.

vii) Sweet Potatoes

Uganda is one of the largest producers of sweet potatoes in Africa, with almost 150,000 hectares, but research is required regarding some aspects of pest and disease problems. Useful breeding work has recently been carried out by AVRDC and IITA for high yield and resistance to the widespread virus diseases and to sweet potato weevil. An adaptive breeding program is needed to test this material under Ugandan conditions. Ugandan researchers should undertake short courses at IITA to learn the tissue culture techniques which are most appropriate for the introduction of the improved material.

viii) Robusta Coffee

Over 90 percent of Uganda's foreign exchange earnings come from coffee, principally robusta. Although there are few major pest and disease problems with the crop at present, it is essential that breeding for high yield and disease resistance should continue. The crosses between robusta and arabica which have been made give promise of considerably increased yields and improved quality if the breeding program is pursued vigorously. Previous work on fertilizer responses needs to be reviewed in the light of current price relationships, and recommendations adjusted accordingly.

5.2.2 Other Research Activities

i) Input/Output Price Relationships

Makerere Faculty are currently proposing a research project to

analyze the economics and price structure of input supply. The Mission feels that greater value could be achieved by examining output prices as well, concentrating initially at the farm-gate level. While this will prove extremely difficult during the continuing unstable conditions, it is nonetheless a major policy area that must be addressed by Government.

ii) Economics of Comparative Mechanization Systems

A rigorous economic analysis and comparison of tractor- and animal-powered systems is critical since publicly owned and operated tractor systems have been a major economic drain. The fleet of government machinery and equipment is now only a fraction of its former size, but continued maintenance and repair has been costly. Conversely, animal-powered systems already have a long history of satisfactory development. The economics of privately owned tractors could also be investigated as these may offer feasible alternatives to government-run tractor-hire services. Technical assistance should be requested for the implementation of these studies, which need to be initiated during the rehabilitation period. The information gained would be useful in the resource use planning effort.

iii) Economics of Livestock Systems and Services

While some studies have been conducted in the past on the economics of large-scale ranching schemes, the changing cost/price relationships in Uganda now call for a more thorough examination of such schemes, which are once again becoming popular. Total national costs and benefits in realistic terms could then be compared to an equivalent analysis for livestock maintained on small mixed farms, which comprise 90 percent of the national herd. A second supplementary phase to the small farm analysis could prove useful in resource planning and in FSR.

iv) Pasture and Animal Husbandry Research for Small Mixed Farms

One component of the supporting work required for the proposed FSR, discussed in Section 4.2, is pasture and animal husbandry improvement for the small-scale farmer. Once the most serious animal diseases are under control, inadequate nutrition is usually the most serious limiting factor to animal production. Therefore further research is required to develop more productive pastures, improved methods of pasture management, and the use of crop residues and by-products for animal feeding. The pasture research should not only considerably improve animal production but also improve soil fertility. Close collaboration between the Ministry of Animal Resources, the Pastures and Animal Husbandry Research Unit based at Serere and the associated FSR team should result in relevant information becoming very quickly available to the farmer.

v) Post-Production Systems

These systems include harvesting, on-farm crop drying and storage, processing, marketing, transport, quality control and consumer acceptance. While all these aspects need attention, particularly for the urban consumer, on-farm drying and storage require particularly urgent research studies to examine ways of minimizing crop losses. Several research agencies now have considerable experience with this type of research, and could be invited to assist in defining constraints and research approaches. Support for this work in the Research Division could be combined with the proposed program for a new Food Science and Technology Unit at Makerere University (see 5.3.2).

vi) Survey of Uganda's Forest Estate

Uganda's forests are one of its major resources. Although reasonably well controlled in the past, the forests have experienced major destruction over the last 15 to 20 years. Such factors as farming encroachment in areas contiguous to zones of high population density, uncontrolled fires and largely unregulated charcoal burning have led to

a cumulative loss of forests and of watershed protection, and to the acceleration of other associated negative ecological effects. There is therefore an urgent need for a thorough assessment of the nature and condition of the forest estate and its dynamics. On the basis of this survey, more effective management policies and procedures could be developed.

vii) Karamoja Development Program

The Uganda Government's Sectoral Working Team on Agriculture has formulated an integrated Food Production and Rural Development Program for the Karamoja district. In view of the extremely severe problems of famine and loss of life which have affected this semi-arid area in recent years, the Mission strongly endorses this proposal for international support.

5.3 Priority C Program

It is difficult to anticipate accurately the nature of research program requirements some years away. The speed with which Uganda's agricultural research activities can expand is partly a function of the enhancement of operational capacity, in terms of staff, funds and facilities, over the rehabilitation period. It is presumed that research agencies will add to the programs as resources and conditions allow. However, if external support is not forthcoming for Priority B projects, they too may become part of the longer-term Priority C research program.

Several factors may detract from the speed with which effective research programs may be expanded. One is the pressure to dilute activity by spreading resources too thinly. The temptation to support too many projects too quickly, and establish yet more research stations, must be resisted at all costs. It cannot be overemphasized that the initial research should be supportive of the re-development of resources and re-evaluation of past programs and results. This will allow the formation of a solid foundation for the research structure, which will be capable of supporting the future expansion of effective programs.

Another factor is the temptation to use scarce domestic manpower and financial resources to accommodate projects by external donors to acquire foreign exchange, even though these projects may not conform to the Government's priorities. Due caution therefore will need to be exercised regarding these matters or they may seriously hinder the pursuit of national production objectives.

The nature of the research programs' diversification will also depend to a large extent on how well research under way is monitored and controlled. The evolution to CRUs and FSR teams should facilitate the monitoring process and ensure that coordinated research schedules are adhered to if the team leaders provide effective supervision. Under such circumstances each team or unit will know well in advance of an annual review what it can expect to accomplish each year and what its program will be for the subsequent year. Within 3 to 5 years, depending on the resources available and the progress in rehabilitating the research of each unit, capacity will gradually increase for a given number of units and thus the overall research program will become more diversified.

It must also be recognized that many, if not all, of the Priority A and B research projects will need to be continued over the medium and long term. Given the importance of the various crops and research studies, it is difficult to envisage a decline in their relevance. However, crop research requirements, and the relative importance of any given crop, are highly dynamic, and thus any predictions of future priorities may not be very reliable. Future flexibility in resource allocation is therefore critical - including the possibility of termination of any given project if necessary.

5.3.1 Crop Improvement

The following list contains the balance of crops that are considered to have possible present or future significance for Uganda's domestic consumption or export market. The order of presentation

indicates the approximate priority ranking but does not imply that research programs should be initiated in the near future, other than possibly regional trials for germ plasm evaluation.

- 1) Sugar Cane
- 2) Tea
- 3) Cacao
- 4) Tobacco
- 5) Pulses - Cowpeas; Pigeon Peas; Grams; Peas; Soybeans;
Bambara Groundnuts; Chickpeas
- 6) Roots - Cocoyams; Yams
- 7) Cereals - Wheat; Triticale; Barley; Bulrush Millet
- 8) Fibres - Sisal; Kenaf
- 9) Oilseeds - Sim Sim (Sesame); Oil Palm; Castor;
Sunflower; Safflower
- 10) Miscellaneous - Oyster Nut; Pyrethrum; Cashew;
Macadamia; Rubber

5.3.2 Other Research Activities

i) Food Science and Technology Department, Makerere University

The Faculty of Agriculture at Makerere formulated plans for a new Department of Food Science and Technology in the late 1960s. The situation in Uganda during the 1970s prevented any action being taken on this proposal. The rehabilitation of the existing departments should take priority over starting a new department, but once this has been done the Mission strongly recommends the establishment of the proposed Food Science Department. There is an urgent need to educate Ugandan undergraduates and graduates in food and nutrition science and technology, and there are serious problems of malnutrition, crop storage and food processing which require research attention. It is recommended that the Faculty of Agriculture should approach external donors for support, including funding and staff.

ii) Crop Protection

There is a need for research studies directed towards the various aspects of crop protection, including chemical and biological control of weeds, pests and diseases, together with detailed economic analysis. The screening of agricultural chemicals should be carried out in close collaboration with the Ministry of Health.

iii) Animal Nutrition

The Faculty of Agriculture at Makerere has developed a research proposal regarding animal nutrition, including the use of by-products, for dairy farms and larger beef ranches. The Mission recommends that the Ministry Research Division conduct parallel research directed towards the smaller farms, since animal types and resources differ significantly.

iv) Silviculture

The Mission recommends that a Silvicultural Research Unit be established to carry out the selection and evaluation of both indigenous and new tree species.

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