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A Project Proposal
for a
Regional Sorghum and Pearl Millet Improvement Program for Southern Africa (SADCC Countries)

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Contribution to the Agricultural Research and Development Programs of the Southern African Development Coordination Conference

ICRISAT

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A PROJECT PROPOSAL FOR A REGIONAL SORGHUM AND PEARL MILLET IMPROVEMENT PROGRAM FOR SOUTHERN AFRICA (SADCC COUNTRIES)

1. INTRODUCTION, BRIEF PROJECT DESCRIPTION, BACKGROUND

1.1. Introduction

There is growing concern in southern Africa over the need to both increase and stabilize food production and to improve the conditions of the poorer farmers through research in the drier areas prone to drought. ICRISAT has a mandate for research on several of the important food crops in the semi-arid and drier portions of the region as well as farming systems associated with them. The Southern African Heads of Government at their Lusaka Summit in April, 1980, urged ICRISAT to set up a Regional Center in Botswana to serve the nine Southern African Development Coordination Conference (SADCC) member countries -- Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe. ICRISAT responded by sending, in November, 1980, a fact-finding mission to examine the existing production, production constraints, and status of research and development on the ICRISAT mandate crops. (Part 1 of Mission Report is attached as Annex I).

The ICRISAT Mission concluded that ICRISAT could have an immediate role in catalyzing research with respect to constraints to production, by providing germplasm, information and research technology. It was felt that this could best be done by posting highly qualified staff in the SADCC countries. The report stressed that a major element in strategy should be the identification and training of national scientists to ensure long-term continuity and follow through on the crops and systems associated with production.

The ICRISAT Mission report suggested that a regional station for sorghum and millets be located in Zimbabwe. This suggestion was approved at a meeting of SADCC countries on April 27, 1982. The reasons for the choice of Zimbabwe are:

a. both sorghum and pearl millet are important in the in the country.

b. a range of important problems of the two crops are expressed in the country.

c. good communications with other SADCC countries.

d. a good research infrastructure enabling a more rapid take-off for the project.

e. a wide range of agroecological zones within easy travel distance in the country.

The ICRISAT Mission recommended that rather than channeling research through one regional center, agricultural research assistance from ICRISAT in the SADCC countries should be in the form of small multidisciplinary teams functioning on existing national research stations. This was supported by Directors of agricultural research for SADCC countries at their April 27, 1982 meeting in Gaborone. SADCC is still in an organizational stage and it was recognized that the project proposed here is for two crops of priority concern for the region and that funding and development of this project could occur as SADCC develops and eventually operate within the SADCC framework.

INTSORMIL became involved at a later stage in planning when it was determined that its capabilities for providing degree-level training, technical backstopping and speciality staffing would favorably complement ICRISAT's experience and capabilities in conducting regional research.

1.2 Brief Description

The project proposed is to cover the sorghum and millet improvement problems of the SADCC countries on a regional basis. The project is mainly to concentrate on problems and constraints having regional significance. A regional team of scientists composed of relevant disciplines in sorghum and millet improvement and located in Zimbabwe will serve the whole of the SADCC region. The appropriate facilities and support services will be provided to make the team effective. The regional team should establish all the necessary linkages with national, regional and international institutes to serve the entire region effectively.

The ultimate objective of the project is to increase the production of sorghum and pearl millet contributing to stabilization of food supplies in the region and leading to improved nutrition and income for poorer people farming in the drier areas of the region.

The short-term, 5-year, objective is to establish and staff a research base; to initiate a research program sensitive to national needs; to identify varietal materials and good evaluation procedures of value; and to establish a program to train local personnel in sorghum and pearl millet improvement. This will set the stage for production increases.

A long-term objective is the establishment of viable national programs for sorghum and pearl millet improvement and support of a regional service.

1.3 Background

1.3.1 Regional and National Perspectives and Current Status

1.3.1.1 Location, Area and Development Indicators

The region covered by SADCC is very large and diverse. It lies between the Atlantic (11 E) and Indian Oceans (41 E) and stretches from near the Equator to about 30 S; it has a total area of 4.9 million square kilometers. The elevation ranges from sea level to highlands of over 3500 meters. Most of the region is an elevated plateau lying between 900 and 3000 meters; sorghum and pearl millet, with few exceptions, are cultivated below 1500 meters. It is therefore expected that besides research technologies the varietal material from ICRISAT Center, ICRISAT cooperative programs elsewhere in the region and INTSORMIL programs should be transferable. Although 95% of the region is in the tropics, the whole of Lesotho and Swaziland, one third of Botswana, and a small portion of Mozambique lie outside the tropics. These differences in location and physiography are reflected in the wide range of climates, soils, and crop requirements found within the region. Well over 75% of the region is semi-arid, where average rainfall ranges from 400 to 800 mm. The rainfall is seasonal, falls in 3.5 to 5 months, and is highly variable.

Some indicators of the present level of agricultural development of the SADCC countries are given in Table 1.

Table 1. Some Indicators of Agricultural Development of the SADCC Countries.

	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Total/
Least developed countries[a/]		x	x	x			x			
Most seriously affected countries[b/]			x		x		x			
Food priority countries[c/]			x	x	x					
Priority food deficit countries[d/]							x			
Area (000 km^2)	1,251	600	31	119	783	17	940	757	390	4,888
Population: 1980 total (millions)	6.7	0.8	1.3	6.1	10	0.6	19	5.8	7.4	66
Density/km^2	5.5	1.2	42	49.6	12.8	29.4	18.1	7.4	18.5	21
Growth rate (% per year)	2.4	3.4	2.4	3.2	2.6	2.8	3.1	3.2	3.4	2.9
In agriculture (1979 %)	58	81	84	84	65	74	82	67	59	74
Cereal output (million tons) Avg 1977-79	0.4	0.1	0.2	1.4	0.6	0.1	1.6	0.9	1.6	7.4 (0.8)
Annual change cereal output (%) Avg 1969-71 to 1977-79	-3.8	3.0	2.5	2.6	-1.4	-0.2	2.6	-0.1	2.5	2.3
Cereal consumption per person (kg/year) Avg 1977-1979	91	151	247	268	61	203	103	187	218	190
Import content of cereal consumption (%) Avg 1977-79	26	36	21	1	23	16	3	12	Net Exporter	16
Major cereal crops	M,S	M,S	M,S,W	M,S	M,S,R	M	M,S,R	M,S	M,S	

Source: Agricultural Development Indicators. A Statistical Handbook. 1981. International Agricultural Development Service, New York.

a/ Designation by the UN Economic and Social Council
b/ Designation by the UN General Assembly
c/ Designation by the UN World Food Council
d/ Designation by the Consultative Group on Food Production and Investment

M= Maize, S = Sorghum and millet, R = Rice, W = Wheat

The following points are noteworthy:

1. Over 70% of the population is engaged in agriculture and lives in the rural areas.

2. The population growth rate is high, about 3% a year, while the annual increase in cereal production is 2.3%.

3. The region imports an average of 16% of its total cereal consumption. This figure is probably much higher currently as a result of persistent droughts since 1977.

4. Five countries of the region -- Botswana, Lesotho, Malawi, Mozambique, and Tanzania -- are among 52 "crisis" countries in the world that have been designated for special attention by international agencies.

In general the low rate of growth in agricultural production combined with high population growth has led to inadequate or poor nutrition for the population, an increasing reliance on food imports, mainly from South Africa, and low financial contributions to development.

1.3.1.2 Important Food Crops

Table 2 gives the 1980 FAO production data for the main food crops in the SADCC countries. The dominant cereal crop in the region is clearly maize, the production of which far outstrips all other food crops, except cassava. In none of the countries except Botswana does production of the next most important cereal, sorghum, exceed that of maize. Nevertheless, sorghum is a significant cereal crop in most of the SADCC countries. Although pearl millet production data are not given in the FAO report, the crop is important in Zimbabwe, Tanzania, and Angola. These two crops are most important to the drier farming tracts of the region where yields are subject to most variation. Although this project addresses improvement of sorghum and pearl millet, at some future date finger millet (Eleucine coracana), with importance in Zambia and Zimbabwe, could be added.

Table 2. Production (in 100 tonnes) in 1980 of ICRISAT Mandate Crops and Other Important Food Crops in the SADCC Countries.

Country	ICRISAT Crops						Other Important Food Crops				
	Sorghum	Millet[a]		Groundnut (in shell)	Chick-pea	Pigeon-pea	Maize	Rice	Wheat	Dry beans	Cassava
Angole	GNR	GNR	50	20	NG	GNR	320	20	10	42	1,850
Botswana	29	GNR	2	7	NG	GNR	12	NG	1	GNR	GNR
Lesotho	65	NG		NG	NG	NG	112	NG	32	15	NG
Malawi	120	GNR		170	18	GNR	1,100	50	1	62	90
Mozambique	150		5	90	GNR	GNR	250	70	3	GNR	2,800
Swaziland	1	NG		GNR	NG	NG	95	5	1	2	NG
Tanzania	220		160	75	8	GNR	800	180	68	150	4,600
Zambia	35		60	80	GNR	GNR	800	4	7	GNR	177
Zimbabwe	74		180	84	NG	GNR	1,600	5	155	23	60
Total	694		457	456	26	-	5,089	334	278	294	9,577

a/ Includes Pearl Millet and Finger Millet

NG :Not grown

GNR :Grown but not reported

Source:FAO Production Yearbook. 1978. Volume 32.

1.3.1.3 Current Sorghum And Pearl Millet Situation in Countries of the Region.

1.3.1.3.1 Sorghum Production

Most of the sorghum produced is used on the homestead for food and home brewing of beer, and very little is traded. Sorghum beer is regarded as an important "food" item in the rural areas. Average yields obtained by small farmers are low and range from 300 to 700 kg/ha, compared with yields of about 2500 kg/ha for commercial farmers in Zimbabwe. These figures illustrate the potential for increased yields in the region. The potential for the expansion of the area under sorghum exists because most semi-arid areas with low unreliable rainfall, which currently produce poor crops of maize, are better suited to sorghum.

In all countries except Swaziland there is interest in sorghum and plans for research in the semi-arid and traditional sorghum areas in order to provide increased food supplies. No information is available for Angola.

1.3.1.3.2 Sorghum Production Constraints

Several different studies have been made to determine priority constraints to production. Priorities for ICRISAT's 10-year projection (for the 1980's) were based on several sources of information. The ICRISAT Mission also undertook to determine factors limiting production and utilization of the crop and to identify those of high priority. Table 3 gives the range of problems mentioned and their priority and reflects in part the experience of ICRISAT staff and INTSORMIL who have worked and visited in the area.

a. There are some excellent local varieties in the area, such as Segoalane in Botswana, and the local used near Lupane in Zimbabwe. There are areas, as in Zambia, where introduced varieties appear to be superior to local landraces. The value of hybrids, particularly in harsh growing conditions, has already been demonstrated by hybrids from South Africa. ICRISAT is concentrating on the development of hybrids with good yield and food quality. A few of these have already been observed in Zambia where they looked good. With the seed production capability in the region, the commercial use of hybrids holds promise for both small and large farmers.

Table 3. Sorghum Production Problems

Trait	ICRISAT 10 yr. projection	Problems identified by ICRISAT Mission							
		Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe
Breeding									
*Varietal and hybrid improvement	1+		✓		2	✓	3	3	4
°Crop maturity			3++						✓
°Plant height								✓	
Agronomy									
*Soil fertility		✓	2	✓			✓	✓	3
*Intercropping	3		✓	✓		✓	✓	✓	
*Drought Power		3	1	3	✓	✓	4		
°Cynadon control	7	✓							✓
Acid soils								✓	
Water logging								✓	
Physiology									
*Drought	1	1	✓	1	✓		1	2	2
Stand establishment		4							
Lodging			✓						
Cold tolerance	5		✓						
Entomology									
Stemborers	2					2			
*Busseola		*	✓	4	*		✓	4	✓
*Chilo		*		4	✓		✓		
*Sesamia					*		✓		
*Midge	3	*			✓		✓		✓
°Cutworms			✓					✓	✓
°Bollworms				✓					✓
°Shootfly					✓		✓	✓	
°Armyworms	5						✓		
°Sucking bugs							✓		
Seed corn maggots								✓	
Harvester termites				✓					
Grasshoppers								✓	
Aphids					✓				
°Storage insects							✓	✓	
*Birds - Quelea	1	2		2	1	1	2	1	1
Pathology									
*Grain mold	5						✓		✓
°Downy mildew	5	✓							*
°Charcoal rot							✓	✓	*
Leaf diseases		✓		✓					
*Leaf blight	6						✓		*
°Rust	9					✓	✓		*
Grey leaf spot							✓		
Anthracnose	7						✓		✓
°Sooty Stripe	6								*
Zonate leaf spot							✓		✓
Bacterial stripe									✓
Leaf stripe									✓
Ergot									
Ear blight									✓
Smut	8	✓							
Head smut			✓				✓		✓
Long smut							✓		
Covered smut							✓		
Loose smut									
Nematodes					✓				✓
*Striga	3	✓		✓			✓	✓	
Grain Quality									
*Food	2	✓	✓				✓		✓
*Brewing		✓	✓	✓		✓	✓	✓	✓

\+ Priotity 1 high, 10 low
++ Highest ranking problems as indicated by respective countries 1=highest priority
* Indicated as a serious problem
° Indicates problems of concern

Local landrace varieties are generally tall and have been selected to mature after rains to avoid grain weathering problems. These varieties fail to produce grain if rains stop early. Thus there is a need to develop varieties that can produce grain in short seasons (dry years) and yet not be so early in maturity as to weather badly in wet years. Yield increases have generally been associated with reduced plant height resulting in higher grain yield (as a percentage of total dry matter production). It is likely that fairly substantial phenotypic changes will occur with the development of high-yielding varieties and hybrids.

b. Problems of draft include availability of animals and suitable equipment, and animal strength (following the long dry season) to prepare fields for sowing. This problem is likely to be more severe in drier areas where feed production is low, soils harder, and animal resources and equipment low.

Many of the soils in the region are light, sandy, and of low fertility. Increase in production on such soils, even with improved varieties is probably not possible without some improvement in management. Intercropping and sole cropping of sorghum are both common in various parts of the region. Intercropping places some restriction on genotype and can result in altered pest problems.

c. Problems of moisture, temperature, and nutrient stress are interrelated and complex. Heritable difference for these traits and components of these traits are identifiable and can be measured and selected for. These are among the most severe problems of crop production in the region. Problems of stand establishment can be severe and have been mentioned in Botswana where the main cause appears to be soil crusting.

d. Crop damage by stem borers is a serious problem throghout the region and the situation is complicated by the presence of three genera: Chilo, Busseola, and Sesamia. Breeding for resistance is relatively difficult and it is not known whether cross resistance to the genera is available. This project would provide an excellent opportunity to work on this problem.

Midge is a problem on late-maturing types. Seed set and yield can be greatly reduced. It is also a problem that increases in severity when earlier-maturing types are introduced. The midge population builds up on the early varieties and inflicts severe damage on the later-maturing locals. Control of midge will be necessary to use earlier-maturing varieties most effectively.

Cutworms and shoot fly which damage seedlings, armyworms which damage the growing plant, and bollworms and sucking bugs damaging the developing seed are all pests of potential concern. One or more of them could increase in severity following widespread use of new varieties or hybrids and/or with changed management practices. The need to develop a capability to respond to such problems is important. Storage insects can be a problem particularly if the grain of new varieties or hybrids is soft. Grain hardness is important both for food processing and storage purposes.

e. Birds (Quelea) do damage the crop, but there are extensive areas in the region where sweet, pearly white-grained varieties are grown with almost no damage. The actual extent of damage by birds needs more critical evaluation.

f. Grain mold resistance assumes greater importance as earlier-maturing varieties are used. Useful increases in resistance to grain mold have been realized in food quality sorghums. Downy mildew and charcoal rot are in the area, and care would be required to avoid releasing susceptible varieties and hybrids.

A number of leaf diseases are found in the region, particularly in Tanzania and Zimbabwe. Some, such as leaf blight, can be severe. "Hot spot" locations for leaf disease resistance screening are available. Generally, resistance to leaf diseases is fairly heritable; so, with a good screening opportunity, useful progress can be made.

Both ergot and smut are potentially damaging. The former may be controlled by adjustment of sowing date. It is important to monitor both diseases in released varieties and hybrids to ensure that high levels of resistance are maintained.

<u>Striga</u>, an important cause of yield loss in the region, is receiving increased research attention in West Africa and India. Strategies for incorporating resistance through breeding and use of crop management can contribute to <u>Striga</u> control.

g. People are particular about what they eat and drink. Experience has shown that by relatively simple tests, varieties and hybrids can be selected with good food quality. This is important to rapid acceptance of new cultivars, and sooner or later to market price.

h. Official marketing organizations usually do not provide price incentives for sorghum production and, in general, prices paid to farmers are well below those offered for maize. This is a disincentive for sorghum production and encourages farmers to grow maize in areas better suited to sorghum.

1.3.1.3.3 Pearl Millet Production

Pearl millet is grown in all SADCC countries except Lesotho and Swaziland. The major producers are Zimbabwe (the largest producer in Africa south of the Equator), Tanzania, and Angola.

Pearl millet is grown by small farmers for food and home brewing. Yields range from 400 to 500 kg/ha, but yields of up to 5,000 kg/ha have been obtained in experiments in Zimbabwe and Malawi. This wide yield gap between small farmer and experimental yields illustrates the potential for increased production.

The ICRISAT Mission was informed that the present pearl millet area could be substantially expanded and production increased, particularly in Tanzania, Zambia, and Zimbabwe, where large tracts of uncultivated, low rainfall areas are suitable for the crop. However, some of these areas are currently utilized for cattle production and the relative economic benefits of the two systems of land use need close examination.

1.3.1.3.4 Pearl Millet Production Constraints

Production constraints related to varietal and hybrid development, moisture stress, draft power, soil fertility, and birds are similar to those for sorghum, but there are important differences with respect to disease and insect pests. An attempt has been made, using information gathered by the ICRISAT Mission, to summarize production constraints in Table 4. As for sorghum, greater on location experience would make it possible to better resolve priorities.

a. The landraces of pearl millet grown are tall, late-maturing, bristled, and low yielding. Improved cultivars have been introduced and tested in Botswana and Malawi, but these have not shown promise, possibly showing environmental specifity for adaptive traits indicating higher priority for on location varietal development.

Table 4. Pearl Millet Production Problems

Trait	Botswana	Malawi	Mozambique	Tanzania	Zambia	Zimbabwe
Breeding						
*Varietal and hybrid improvement	4+	4	2	3	3	4
°Seed Set						✓
°Crop maturity						✓
°Plant height						✓
Agronomy						
°Soil fertility						3
°Intercropping		✓		✓		
*Drought power	3	3	✓	✓		
Physiology						
*Drought	2	1		1	2	2
Stand establishment	✓					
Entomology						
Armyworm					✓	✓
Cutworms						✓
Seed corn maggot						✓
Rapoka bugs						✓
*Birds - Quelea	1	2	1	2	1	1
Pathology						
°Downy mildew				✓		✓
°Ergot				✓	✓	✓
°Smut					✓	✓
°Rust				✓	✓	✓
Leaf blight					✓	
Leaf spot					✓	✓
Grain Quality						
°Food	✓					✓
Brewing	✓					✓

\+ Highest ranking problems as indicated by respective countries
1 - highest priority

* Priority problems

° Problems of concern

b. Draft power is given high priority with problems similar to those for sorghum. Soil fertility is a constraint, and fertilizer and other agronomic inputs will be necessary to improve production significantly. Intercropping and sole cropping are both practiced, and further work is required on the relationships of interplanted crops.

c. The situation is similar to that for sorghum. Relevant research would involve both crops. Workers in Botswana indicated soil crusting as a factor effecting stand establishment.

d. Several of the insect pests found on sorghum also attack pearl millet, but it appears that the crop suffers little damage. There is need to carry out a survey of the insect pests of pearl millet in the region.

e. The problem of bird damage to pearl millet is the same as described earlier for sorghum.

f. Ergot is the most widespread disease in the region and sometimes causes heavy damage to the crop. Downy mildew, rust, and smut also occur commonly in the region. These diseases do not appear to do much damage to the local landraces, but the situation could change with the introduction of improved cultivars and the adoption of improved production practices.

g. As with sorghum, good food and brewing quality would contribute to faster acceptance of new pearl millet varieties and possibly, in time, to better market prices.

h. Most countries have no official markets or pricing policies for pearl millet. Consequently the crop does not enter into "official" trading. This is a disincentive to growers, and in general marketing policies do not encourage production.

1.3.1.4 Present Research Programs

1.3.1.4.1 Sorghum

There has been minimal research input on sorghum in most countries except in Botswana, Zimbabwe, and Tanzania, all of which have had some intermitent research over the years. Interest in sorghum research has increased in the

past 2 or 3 years. Table 5 gives the list of current sorghum research projects.

Table 5. Sorghum research projects in SADCC countries

Country	Research Project
Botswana	Variety trials, Physiology, Agronomy
Lesotho	Variety trials
Malawi	Breeding, Variety trials
Mozambique	None
Swaziland	None
Tanzania	Breeding, Variety trials
Zambia	Variety trials
Zimbabwe	Breeding, Variety and Agronomy trials

All the existing research programs could be strengthened; usually the only scientist (breeder or agronomist) working on the crop has responsibility for several crops. Thus only a proportion of research time and effort is spent on sorghum.

The Tanzanian sorghum research program is now located at Ilonga, where the environment is not representative of the sorghum-growing areas of the country. ICRISAT had a sorghum breeder in Tanzania for a 3-year period that terminated in 1980 at the end of a contract support period. The ICRISAT Mission was informed that the Ministry of Agriculture is convinced of the need to site the sorghum research program at a suitable location and that appropriate action is being considered. Plans are far advanced to move the major sorghum research site to Ukiriguru, and for INTSORMIL to post a specialist staff member there to serve as Sorghum/Millet Coordinator for Tanzania.

Mozambique and Zambia have made requests to several donors, including FAO and USAID, for financial and technical assistance to initiate their own research programs. After the Lusaka Declaration, Mozambique also made a request for direct ICRISAT assistance in sorghum improvement. A Zambian Sorghum and Millets Improvement Program began in 1983 with SIDA funding.

In collaboration with a USAID-funded Farming Systems Project, INTSORMIL is posting two sorghum agronomists - one principal scientist and one junior agronomist - to Botswana for at least two years' service. These agronomists will conduct sorghum research in collaboration with the Agricultural Research Department, Ministry of Agriculture.

1.3.1.4.2 Pearl Millet

No research on pearl millet has been conducted in countries where the crop is grown, but interest is now increasing. A list of current research projects in the region on pearl millet is given in Table 6.

Table 6. Pearl millet research projects in SADCC countries

Country	Research Projects
Botswana	Variety Trials
Lesotho	Crop not grown
Malawi	Breeding, Variety trials
Mozambique	None
Swaziland	Crop not grown
Tanzania	None
Zambia	Variety trials
Zimbabwe	Breeding, Variety trials

The programs in Botswana, Malawi, Zambia and Zimbabwe are 3 to 4 years old and suffer from insufficient staff and funds. Tanzania expressed strong interest in the crop and plans to initiate an improvement program with assistance from USAID. INTSORMIL will provide initial leadership for this program. Mozambique has no research plans and appears to have no interest in the crop.

1.3.1.5 Research Organization - Experiment Stations and Staff

All countries of the region have a structure for the conduct of agricultural research and a system of experiment stations and test locations for crop development and evaluation. They vary in staff strength and physical facilities; in Mozambique and Swaziland there has been recent losses of expatriate staff with no national trained staff to replace them.

It is useful, however, to highlight that a structure does exist on which to base regional research, but the staff input into sorghum and pearl millet research is not adequate. This may, in part, reflect past interests in growing crops with higher monetary value in the more agriculturally productive agroecological zones. Now, with increasing interest in the productivity of the drier areas, an all-out effort is required to identify, train, and concentrate scientific staff on these crops. USAID, FAO, ODA, IDRC, SIDA, NORAD, and others, are providing increased financial support for improving these crops, sometimes directly (e.g., IDRC and FAO in Mozambique) but frequently as part of a farming systems program. As indicated earlier, INTSORMIL is providing staffing and technical backstopping for sorghum/millet research, collaborating with the USAID projects in Tanzania and Botswana. It is important to recognize that if these crops are to fully contribute to farming systems they must be high yielding and stable in the environment. This proposal has a major component on in-service training and in support of other forms of education and training.

2. PROJECT DESCRIPTION

2.1 The Basic Concept of the Regional Program

Sorghum and millets are grown by some of the poorest farmers in the region living and working where growing conditions are harsh. Stability of yield leading to higher and more constant production is very important to these people. Stability is a variable trait and can be selected for from multilocation testing. Stability is also realized by control of disease, insect, and weed pests. The thrust of the regional team will be to identify and strengthen resistances in the sorghum and millets crops to the extent possible and to evolve management practices directed toward the capability of the poor farmer. It is recognized that chemical control measures are expensive and frequently unavailable so reliability on them will be minimized. Cooperative studies in the area of food technology are anticipated to provide grains acceptable as food, to improve nutrition, and to reduce the drudgery in traditional food processing procedures.

The basic concept, to ensure close working relationships with national programs, is to place a multidisciplinary team of sorghum and millet scientists in the region as soon as possible, operating from a national program station, and only through other national program stations. Emphasis is placed on a multidisciplinary team

centered at one location for the following reasons:

a. To rapidly bring to the region a capability to respond to changes in insect, disease, and weed pressures that follow new varieties, hybrids, and management practices. It should be noted that new varietal materials are already in the region and a sorghum variety has recently been released in Zambia from introductions.

b. To develop high-yielding and stable varieties and hybrids with emphasis on adaptation for the poorer farmers in the region. This is a joint team effort as new varieties and hybrids should have resistance and good food quality traits.

c. To undertake training and educational activities across disciplines as rapidly as possible to strength national program capability.

d. To encourage and work with national programs to develop and stabilize a suitable research program for sorghum and millets.

e. To provide and encourage service activities, such as an off-season nursery, in support of effective research and production in the region.

2.2 Multidisciplinary Sorghum and Pearl Millet Improvement Team

It is proposed that a multidisciplinary scientific team consisting initially of a project leader, sorghum breeder, pearl millet breeder, production agronomist, plant pathologist, and entomologist be placed in Zimbabwe. This combination is viewed as necessary to provide a "critical mass" of scientific talent to undertake the program outlined. In addition to initiating many aspects of crop improvement, the team could contribute to training of staff to strengthen national program research capability. Varietal improvement is a relatively simple though time-consuming aspect of crop improvement. Changes in variety and management result in shifts in pest problems. A vital aspect of the multidisciplinary team would be to develop the capability to cope with changing pest problems to better ensure stable produciton levels primarily for the poor who rely on sorghum and millets for food. Job descriptions for the positions contemplated in the first 5 years are given in Annex II.

2.3 Interactions with National Programs and Other Institutions

An appreciation of many aspects of interactions with national programs of the region can be seen in the following important functions of a team with regional responsibilities.

a. Continually introduce and evaluate breeding stocks and germplasm accessions. The best of these will be provided to national programs.

b. Conduct regional trials and nurseries for yield, resistance traits, and food quality .These activities will be on national stations and there will be a training component. The various screening nurseries will include entries from national, regional, and international programs.

c. Join with national scientists in the evaluation of their material and that from the regional project and jointly plan future programs including crossing blocks.

d. Assist with crossing and screening activities on a regional basis, including training, until national program capability can undertake such functions.

e. Organize an annual reporting and planning workshop so that all sorghum and millets workers in the region participate in regional plans.

f. Assist with training functions including participation by local universities; also in-service activities such as in-service fellows.

g. Assist national programs in structuring their sorghum and millet improvement activities. This can include such topics as main and sub-station identification; staff needs, program priorities, equipment and other facilities required, policy considerations such as varietal release, responsibility for seed production, etc. In the early stage of its operation, senior staff from the project shall review the desire and needs of Zambia for sorghum and millet research and plan for satisfactory coverage of these needs. Focus will be primarily to increase and stabilize production of the poorer farmers in the region.

h. Cooperate as an expert group for SADCC. In terms of the coordinating center this could include inputs into germplasm collection and evaluation, quarantine, standards for seed quality, etc.

i. Adapt useful techniques for sorghum and millet improvement, stabilizing them in national programs.

j. Contribute to or cooperate with the improvement of field research capability of national program stations.

k. Cooperate with agencies within and outside the region as desirable for improvement of the crops.

l. Respond to requests from national programs on issues of concern to them. An effort would be made to keep a focus on the welfare of the poorer farmers in the region.

m. When necessary, publicly describe varieties and hybrids of the regional program which may reach the release stage so that the problem of Plant Breeders Rights does not arise. Such varieties and hybrids could be used by anybody who wants them without facing the Plant Breeders Rights issue.

n. Assist in limited multiplication of promising materials for potential use by farmers of the national programs.

2.4 ICRISAT's Experience of Regional Programs in West Africa

ICRISAT was established in India in July 1972. Its mandate has four major objectives:

a. To serve as a world center for the improvement of grain yield and quality of sorghum, millet, chickpea, pigeonpea, and groundnut and to act as a world repository for the genetic resources of these crops.

b. To develop improved farming systems that will help to increase and stablize agricultural production through more effective use of natural and human resources in the seasonally dry semi-arid tropics.

c. To identify constraints to agricultural development in the semi-arid tropics and evaluate means of alleviating them through technological and institutional

changes.

d. To assist in the development and transfer of technology to the farmer through cooperation with national and regional research programs, and by sponsoring workshops and conferences, operating taining programs, and assisting extension activities.

In view of ICRISAT's global responsibility for sorghum and millet in the semi-arid regions of the world, ICRISAT signed an agreement with the UNDP in January 1975 to set up a regional sorghum and millet improvement program in West Africa. The choice of West Africa as the first target of ICRISAT's international programs was prompted by the droughts in the Sahel in the early 70's. These persistent droughts brought in their wake untold human misery, malnutrition, starvation, and death, and they disrupted human society in this part of the world. The selection of West Africa as the first priority region outside India in the semi-arid regions of the world has been supported by a recent study by Ryan and von Oppen who computed a multi-factor index to prioritize the SAT by regions for ICRISAT's international activities.

The 3-year contract between ICRISAT and UNDP had as its prime objective cooperation with and strengthening of existing West African agricultural research programs and the development of higher yielding varieties of sorghum and millet with the characteristics of consistent and reliable yield, as well as the development of improved technology to go with them. The drought-stricken Sahel area below the Sahara was the focus of concern, as this is where sorghum and millet are staple foods of the majority of the people and where the food-population balance remains seriously constrained.

Initially, the project covered 12 countries from Senegal to Chad. Early in 1977, following discussions between the Government of Sudan, UNDP, and ICRISAT, the contract was expanded to include Sudan. The ICRISAT/UNDP West African Cooperative Program now concerns 13 countries--Senegal, Gambia, Mali, Mauritania, Upper Volta, Ghana, Togo, Nigeria, Niger, Benin, Cameroon, Chad, and Sudan.

A strategy was outlined for implementing an effective program of assistance that would have an early and measurable impact. Basically, the concept was to post ICRISAT scientists to existing research institutions at Bambey, Senegal; Samaru, Nigeria; Kamboinse, Upper Volta; Maradi, Niger; and Wad Medani, Sudan. These scientists

would be linked to and would work in conjunction with ICRISAT Center at Hyderabad, with other ICRISAT scientists internationally, and with other national programs in the region as well as those of the host countries. Implementation of the program has continued to gain momentum and became fully operational for the 1977 crop year. By May 1977, the 12 research positions foreseen in the ICRISAT/UNDP cooperative program were filled.

In addition to the important UNDP contribution, ICRISAT's West African Program receives complementary support from other agencies. The Republic of France, through IRAT, the Government of the Netherlands, USAID, IDRC, IFAD, SAFGRAD, and the Leverhulme Trust continue to provide funds for different program segments.

Presently, 22 scientists are working in ICRISAT's West African Cooperative Program. They are posted in five countries in the region. The UNDP-funded project continues in its third phase.

Agreements between ICRISAT and the host countries vary to some degree, according to the country. As a general rule, however, the program of each ICRISAT scientist posted in a cooperating country can be regarded as including three components:

a) A direct contribution to the national program.

b) A contribution to the regional program, mainly in the organization and supervision of regional trials and consultancy visits to other countries.

c) A contribution to the international program by carrying out trials or nurseries that provide ICRISAT Center with information on behavior and performances of different types of vegetative materials in various ecologies, and by providing unique germplasm from cooperating countries for incorporation into breeding programs at ICRISAT Center.

As can be expected, the distinction between these three components is not always clearly defined and may sometimes appear somewhat arbitrary. However, in order to make as clear as possible the relationship ICRISAT scientists can be expected to develop with their colleagues in the national programs, an attempt has been made in each case to establish this tripartite role.

Reviewing ICRISAT's experience in West Africa, several points are worth noting:

Regions, as ICRISAT has defined them, are geographic in nature (or more correctly geo-political). They turn out to be convenient units of organization for ICRISATS's research programs throughout the semi-arid tropics.

ICRISAT, in setting up the Regional Program in West Africa placed scientists in National Programs as a matter of strategy and convenience. They, however, were assigned triple responsibilites. During the 8 years the program has been in operation, these triple functions have been admirably carried out. A large number of international trials and nurseries have been successfully completed. As regionally-generated products were available, regional trials, such as the African Pearl Millet Regional Trial, were organized. National testing resulted in several cultivars being found suitable for in-country release, such as Ugandi in Sudan, and E35-1 in Upper Volta. ICRISAT's annual work plans are presented at each country's annual research conference and have had the active support of these countries.

The Governments of countries in which ICRISAT scientists are placed have acted in the most enlightened manner in allowing ICRISAT scientists to discharge their tripartite role. On the whole, ICRISAT's West African experience has been satisfactory. The External Review Panel that reviewed the UNDP-funded project and The Joint UNDP Project Advisory Committee concluded that the project objectives were being successfully fulfilled.

The CILSS (Interstate Permanent Committee for Drought Control in the Sahel):

"..... expressed satisfaction with ICRISAT's cooperation proposals in the fields of research and training in millet and sorghum improvement."*

Having a large contingent of scientists dispersed in several countries and at several locations through the region (in West Africa) has caused some difficulties for ICRISAT in management of research objectives and program-administration. The dispersion of scientists throughout the region has led to increased costs of program administration. When staff are responsible on a country by country basis there is no regular mechanism by which regional activities can be conducted, such as regional yield trials. Some regional activities can be accomplished on a voluntary basis

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*as reported in one of the SAFGRAD/OAU Meetings.

by one or the other scientist in the region but this still leaves organizational weakness and limits the extent of regional input. Also, there is a tendency to have all breeders and agronomists with inadequate input into other disciplines. This has been a problem for ICRISAT in West Africa. Organization of ICRISAT's regional research on the basis of research teams sited at a single location is expected to alleviate these difficulties.

2.5 Strengthening the Crop Component of National Programs

The regional effort would be strongly oriented toward strengthening national research capability. Although it is suggested that the multidsciplinary research team would be located at one experiment station in one country, research activities would be undertaken on stations of national sorghum and pearl millet programs in various SADCC countries. Any progress made would thus occur as part of national program development; and all developments, such as new varieties, would belong to the national programs.

a. Developing useful basic breeding stock. Varietal material from sorghum and pearl millet programs worldwide would be introduced and evaluated first by the regional program. The most useful lines would be provided to national programs, thereby reducing the burden of preliminary screening of large numbers where the discard rate is high. the regional program would require several different environmental situations in the region for evaluation of introductions.

b. Conducting regional crossing blocks. Entries chosen would be based on joint evaluation by regional and in country staff in the various countries of the region. There would be an in-service training component so that in time this service activity would be part of national programs.

c. Operating regional off-season nurseries. This has value in providing a second season each year resulting in an increased rate of crop improvement. Some countries of the region cannot have a second cropping season because of cold winter temperatures. Ultimately, an off-season nursery program could be stabilized for these and other crops, as a contribution of SADCC.

d. Screening for resistance traits. Nurseries for screening breeding stocks for traits of priority concern would be part of the regional program. This would require developing techniques and adaptating to local conditions

techniques developed elsewhere. Priority problems are regional in nature and at times screening procedures are detailed and expensive. In such cases, regional evaluation could be stabilized as a SADCC contribution. The techniques required to screen for some traits are relatively simple and inexpensive and could be undertaken as part of a country program. Screening is most effectively undertaken in locations where the problem has uniform expression and occurs annually. Screening activities of the regional program would be developed in the most appropriate locations in the region. An in-service component including research fellows of the regional program would be essential to the operation of these screening nurseries.

e. Food Quality. Food quality evaluation involves a range of tests. Some are simple to use and can be employed to eliminate undesirable types. As the crop improvement process moves forward more detailed tests are required to support selection. The regional program would endeavor to work cooperatively with institutions in the region for food quality evaluation.

2.6 Project Activities

2.6.1 Development of Varieties and Hybrids with Emphasis on Poor Farmer Use

The ICRISAT Center has adequate staff and facilties to develop an array of new varietal materials and many, but not all techniques, relevant to the solution of problems limiting the production of sorghum and millets. For some times nurseries and trials from the ICRISAT Center have been evaluated in many of the SADCC countries. Interaction between the Center and the region will be greatly enhanced by more rapid and effective use of the backstopping that the Center provides. Useful backstopping is also provided by INTSORMIL, in a wide range of technical specialities. These are important considerations to the scope and speed of research activities in the region.

This aspect of the program would begin with the introduction of elite breeding stocks from all over the world followed by evaluation at select locations in the region. Introduction and evaluation would continue to be an important aspect of the program. Those introductions doing well across several locations (a measure of adaptability) would be incorporated into the breeding program, generally by being crossed to the better local varieties or to other promising introductions. New varieties would be selected in advanced generations at the regional program center and on

national stations based on adaptation of the material. As described earlier, scientists of the regional program would participate in evaluation at national experiment stations and assist with screening of the more promising material for food quality and resistance to environmental stresses, pests, and diseases. These activities should result in the development of new stable varieties for the various agroecological zones in the region.

The scientists of the regional program would also help with the identification of varieties that are nonrestoring on cytoplasmic male sterile seed parents of hybrids. Selected nonrestorers would be backcrossed to develop new seed parents. During this process, selection pressure would be applied for food quality and resistance traits.

Better selections--for agronomic eliteness, resistance, and food quality traits--can be used to form the base for recurrent selection (population breeding) programs directed at the various zones of adaptation in the region. This is a valuable breeding procedure for the simultaneous incorporation of several traits into agronomically elite material. Close collaboration with ICRISAT Center's population breeding activities would be valuable.

The improvement of varieties, hybrids, and populations would be a team effort. New techniques for evaluation of food and feed quality and of resistance traits are being developed at ICRISAT Center and in the various INTSORMIL programs. It is likely that these techniques will require some modification to be most effective in different environmental situations in the region. It may be that some new techniques will be required to properly screen for some traits. Generally, a knowledge of the ecology and host-plant relationships are necessary to most effectively work with pest problems. In some instances, pest management aspects may be more important than breeding for resistance.

The potential of new varieties and hybrids can only be realized if they are properly managed. The management procedures will depend upon moisture levels. The presence of some yield-limiting organisms will influence management--for example, clean cultivation to reduce stem borer populations, uniform early crop maturity to avoid midge, sowing date to avoid shoot fly, lower plant population to reduce incidence of charcoal rot, and high fertility level to reduce incidence of *Striga*. Practices such as increased use of compost and use of green manure crops as intercrops can be useful in stabilizing production. Soil management to reduce runoff and erosion and increase water penetration will be undertaken by small farmers if the methods and their

benefits are demonstrated to them. Crop management will be studied across a range of farmer capabilities to develop management procedures useful to different conditions in the region.

An important function of the team would be to adapt and develop useful techniques for screening promising breeding stocks.

2.6.2 Germplasm Collection, Evaluation and Utilization

Early in the life of the project adequate screening will be carried out of sorghum and millet varieties already in use or in advanced stage of testing in the SADCC countries.

Germplasm has been collected, particularly in Bostwana, Malawi, Tanzania, and more recently in Zimbabwe. In cooperation with the Genetic Resources Unit at ICRISAT an effort will be made to complete the collection in the southern African region. Efforts would be made to evaluate the germplasm collected in the region and utilize them in the breeding effort. The long-term storage of the germplasm collected will be at ICRISAT Center in India. However, it is essential to have at hand a seed store which could house a working collection of accessions useful to the region. Many national collections made in the past have been poorly documented and over time have been lost. ICRISAT and INTSORMIL can assist in avoiding these problems and, in time, SADCC might assume responsibility for a seed repository and working germplasm activity for Southern Africa.

2.6.3 Regional Crossing Blocks, Off-season Nurseries, and Screening Nurseries

As described earlier, these would be service functions of the regional program to rapidly initiate and carry forward crop improvement. There would be an in-service training component as part of the effort to introduce these activities to national programs.

2.6.4 Regional trials and nurseries organized for the different agroecological zones of the region are an essential part of the project. Entries for these trials and nurseries will be from various sources including national programs, the regional program, ICRISAT Center, INTSORMIL and elsewhere. Some nurseries would be a screen for resistance to yield limiting traits, diseases, insects, drought, and Striga. Staff of the national program and the

regional team would cooperate closely in conducting and evaluating these trials to make them successful.

2.6.5 Training

ICRISAT and the Collaborative Research Support Program in Sorghum and Millet (INTSORMIL) with Headquarters at the University of Nebraska, USA, will share the responsibilities of this important function.

2.6.5.1 ICRISAT will furnish or facilitate the following types of training (see Annex III for descriptions):

a. In-service training. Training at ICRISAT Center of up to 14 persons per year for a total of 84 person-months per year. For English-speaking trainees, the training period is 6 months. An additional 2 months is required if training in English language is necessary. One round-trip air fare, housing, local transportation, and an adequate allowance for food and expenses for each trainee are budgeted.

b. In-Service Fellows. Up to 8 persons in this training category each year can be provided part-year practical field training based in Zimbabwe and additional training opportunities at ICRISAT Center. This category offers a fellowship for up to 20 months duration and includes one return air fare to ICRISAT.

c. Research Fellow. Up to 7 persons are trained in this category each year for an average fellowhip period of 12 months each. Stipend and air fare will be provided.

2.6.5.2 INTSORMIL will coordinate provision of all undergraduate and postgraduate formal degree training, whether in Africa or elsewhere, under this proposal. A minimum of 87.5 person-years involving 26 persons with approximate distribution of 70% MSc, 20% PhD, and 10% BSc, is planned (Table 7). Degree candidates would be chosen from all SADCC countries (Table 8). Training arrangements will be closely coorindated with ongoing INTSORMIL and ICRISAT research activities.

Table 7. Phasing of degree programs, all countries combined.

Degrees	(persons)	00	Year 1	Year 2	Year 3	Year 4	Year 5	[Year 6]
PhD	(4)		4	4	4	4		
PhD	(1)			1	1	1	1	
MSc	(3)		3	3	3			
MSc	(6)			6	6	6		
MSc	(5)				5	5	5	
MSc	(4)					4	4	4
BSc	( )		2	2	2	2	1	
BSc	(1)			1	1	1	1	0.5
Total	(26)	PY =	9	17	22	23	12	4.5

Grant Total 87.5 PY

Table 8. Time table for degree training, Sorghum and Millet. SADCC/ICRISAT/ INTSORMIL Project; Degree/Beginning year of training.*

Field of Degree Program	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe
Sorghum Breeding	MS/4	MS/2	MS/2	PhD/1	BS/1			PhD/1	PhD/2
P.millet Breeding							MS/1	MS/2	MS/3
Finger millet Breeding							MS/3	MS/1	MS/4
Agronomy	MS/4			MS/2	MS/1			MS/2	MS/2
Entomology							PhD/1	MS/4	BS/2
Pathology		MS/3		MS/3	MS/3		PhD/1		BS/1

Provisionally : Year 1 = 1983-1984. PhD will require 4 years; M.Sc. will require 3 years; B.Sc. will require 4½ years.

2.6.5.3 Workshops

Coordination of the regional research activities will be facilitated by an annual workshop attended by the project scientists and all sorghum and pearl millet workers in the SADCC countries. The workshops will essentially be an in-house review at which progress reports will be presented and discussed and plans made for future work. Thus many activities in the region will be planned by group action.

2.6.6 Project Siting

The ICRISAT Mission Report suggested that a regional station for sorghum and millets be located in Zimbabwe - this has now been approved by SADCC (April 27, 1982 meeting in Gaborone). The reasons for the choice of Zimbabwe are:

a) Both sorghum and pearl millet are important in the country.

b) A range of important problems on the two crops are expressed in the country.

c) There is a good research infrastructure enabling a more rapid take-off of the project.

d) There is a wide range of agroecological zones within easy travel distance in the country.

It was proposed in the Mission Report to establish the project at the Matopos Research Station near Bulawayo. There has recently been some concern related to security and the Kadoma Station has been suggested as an alternative possibility. The siting of the project is not resolved at this writing recognizing the need for consultation with the Government of Zimbabwe and USAID. ICRISAT now has available detailed information about both locations - the choice of one or the other would entail minor budget alterations.

The Matopos Station was originally identified for the following reasons:

a) It is in a sorghum and millet tract of the country.

b) It is the proposed site for the Zimbabwe National Sorghum and Millet Improvement Program. The Regional Center would be advantageous to be close to the National Program Center so that facilities established for the regional program will contribute to the national program.

c) Bulawayo has an international airport facilitating communication with the rest of the region.

d) Bulawayo has good facilities such as schools and medical services.

e) Bulawayo offers many service and support activities important to the function of the regional project.

f) Availability of trained manpower for the various needs of the regional project is good.

The Matopos Research Station of 28,000 ha was established in 1903. The station is 1340 meters in elevation. The mean annual rainfall is 609 mm but varies considerably from 257 to 1376 mm. Temperatures vary from a mean maximum of 29.4 degrees C to a mean minimum 20.9 degrees C in October. Mean minimum temperatures are below 10 degrees C during May, June, July and August with the absolute minimum at -9.5 degrees C. This area is one of the most frost prone sites in the country. As a consequence of these low temperatures it would be necessary to do off-season work elsewhere, likely Chisumbanje. These low temperatures add to the importance of the greenhouses included in the proposal to permit the most intensive work in the winter to remain on site where it can best be done.

The Matopos Station includes a vast area of range and game reserve. Red and black (self mulching) soils from a basement schist and sandy and sodie soils from gneissie granite are found and it would be possible for the project to have fields of red, black, and sandy soils - all three important to the sorghum and millets growing areas of the region. There is an adequate quantity of good quality water coming from two reasonable large lakes - pumping would be necessary. At Matopos, it will be necessary for the project to obtain water rights on the Matopos Lake that was previously granted to the channel Estate. (It should be noted that the main research fields would likely be on this former Estate). Buildings, houses, farming equipment, land development and fencing would all be required to support the added burden of the regional project if centered on the Matopos Station.

In March of 1983 a visit was made to the Cotton Research Station at Kadoma to explore the possibility of this being an alternate station following concern about security in Bulawayo. The Kadoma Station is situated at 18 degrees 19 seconds south at an elevation of 1150 meters with average rainfall of 760 mm. Rainfall is highly variable. Druing the period 1937 to 1961 it varied from 290 to 320 mm. Maximum temperatures over the years average from 18 degrees C to 32 degrees C with the maximum being 36 degrees C.

Minimum temperatures average over the years from 6 to 17 degrees C with the coldest record being 0 degree C. Althought the area is a bit warmer than Bulawayo, it is still too cold for off-season activity which will likely need to be undertaken on the Chisumbanje Station, some soils are derived from a greenstore schist and consist manily of moderately shallow to moderately deep reddish brown clays. Both sorghum and millets crop do well at this station; however, there are no sandy soils - the soils at Motopos are thought to be more representative of the sorghum and millets tracts of the region. Some of the soils on the station are gravelly and some water logged so land selection would be important.

There are no dam sites or rivers in the area so irrigation entirely dependent on underground water and on supply from the Municipality of Kadoma. The quality of ground water is very poor and the station uses if for irrigation only once every 3 years. Water for irrigation is an important problem.

The town of Kadoma is good for staff living - it is about 135 km from Harare with a good road between the two.

As at Matopos, the project would need to construct buildings, and housing, bring in farm machinery, develop and fence land. Project costs would be more or less the same at both locations.

Other crop screening locations in Zimbabwe should be examined. Three have been suggested because of different environmental conditions for testing and to facilitate evaluation of material to different environmental stresses, diseases and pests. These stations are Gwebi, about 1200 meters in elevation with rainfall averaging around 800 mm. This location would be useful to screen for resistance to leaf diseases and grain mold. The station is situated near Harare. The Chiredzi or Chisumbanje station, in the southeast is low elevation (450 meters), hot and dry, and sorghum is a common crop. Stem borers are a severe problem and this is an area visited by the Quelea bird. The station at Makoholi is also hot and dry, on light soils and in a pearl millet area. This complex of four stations in Zimbabwe might provide the array of growing conditions frequently found in the region.

The main locations in other countries to facilitate regional activities are the Sebele station in Botswana, Maseru in Lesotho, Ngabu in Malawi, Nampula in Mozambique, Big Bend in Swaziland, Ilonga (or preferably a new site) in Tanzania, and Mount Makulu or Chipata in Zambia.

Good experiment station development and management are prerequisites for successful and productive field research. The proposal includes a farm manager/development officer (see Table 14) on the staff for three years because of the land and infrastructure development required. The farm development officer could also assist in land development at one or two other locations. A serious effort would be made to train people in the region in this activity.

2.6.7 Construction and Center Development

The importance and requirements of experiment station development and operation is frequently not appreciated hence poorly done. One objective of this project will be a contribution to the field research facilities of national programs in the SADCC region. The research facility for this project has been designed to be adequated both to prperly support the project's research, and also to serve as a model in the region; i.e., to be of demonstrative and educational value. The facilities outlined are required because of added burden that the project places on the host station. Integration and cooperative use of facilities will be undertaken as possible.

Housing is provided to professional and support staff as well as general hands. This must include the purchase of 8 houses for principal staff, plus the construction of 34 mid-level (F-12) houses, and 55 lower-level (F-13) houses. (see Appendix IV). Furnishing is included for principal staff.

The office and laboratory complex includes adequate office, laboratory, work room, conference, library, and maintenance facilities. It is estimated that architectural input would require 6 to 10 months and construction time some 12-15 additional months. While construction is in process it would be necessary to rent a facility that could provide temporary offices and laboratories.

The seed storage and processing building includes storage facilities for seed, fertilizer, chemicals, and small specialized items of equipment. These items, of necessity, require separate storage rooms. Seeds would actually be stored in prefabricated units with rolling shelves, one for sorghum and one for millet. These units are well designed to keep seed in dry cool conditions and free of storage pests.

Harvested material from the field is to be brought to the crop work area for threshing and preparation for storage. This is a relatively dirty operation so it cannot be readily coupled with other facilities. It also provides the opportunity of keeping harvest material from damage in the event of unexpected rains. Field shelters are useful to keep frequently used items close to the field and as a place to get out of rainy weather.

The glass houses are important to the support of specialized research, particularly in pathology, entomology, and agronomy. Additionally, they will also be valuable in the cold winter providing the opportunity of undertaking manpower intensive activities such as hand emasculated crossing.

The shops, spare parts stores, and maintenance areas would be developed taking into account now existing facilities. At both Matopos or Kadoma these facilities need to be greatly strengthened. The facility proposed permits a complete maintenance opportunity. Shop facilities will be strong enough to permit some fabrication of special equipment. The shop facility is designed so that it could be easily added to if expansion is ever required. Shop equipment for service and repair is identified and felt to be complete for most routine service and maintenance requirements. Some of these items of equipment could come from USAID Excess Property.

Station development involves land shaping, to better ensure uniform growing conditions, and proper irrigation of a portion of the area for the project, establishment of an irrigation-drainage system, field roads and fencing. Becuase of the adjacent game reserve at Matopos, adequate fencing is required to keep wild game from grazing the experimental crops. At Kadoma, the city is spreading to the station boundry so trespassing into the experimental fields could be a problem. Station development also involves telephones, water connections to office, laboratories and greenhouses, landscaping, etc.

Vehicles are identified to serve an array of activities: transport of principal staff for family and for business activities; bussing staff from city to station, servicing field functions on the main location and transport to outlying locations; the transport of tractor and farming equipment as needed to support field development and research in the country and region; motor cycles for field support staff use at the main center and at outlying stations are indicated.

Farm equipment is designed for both development and routine farming activities. Field shaping, road, development, irrigation and drainage systems will be required. Some of the equipment will be valuable in digging foundations for housing and buildings. Some of the heaviest equipment can be obtained from USAID Excess Property and can be used, ultimately, for the development of other stations. The farming equipment identified will provide excellent support for quality field research.

3. ANALYSIS AND ORGANIZATION

3.1 Technical Analysis

The present research programs and organizations in each of the national programs of the region have been described elsewhere in this proposal. In the area of sorghum and millet improvement no one coutry of the region has all the necessary manpower and financial resources to cope with all aspects of these crops. The major problems of these crops in the region, varietal and hybrid improvement, plant pathology, entomology, and agronomy have been described. These problems have regional significance and need regional effort to cope with them. To handle the sorghum and millet improvement problems of the region a team of scientists in different disciplines has been proposed, and the justifications for such a team at one location have been given.

The basic concept in the regional approach is to form a corps of sorghum and millet scientists that can respond to regional needs and at the same time contribute towards strengthening the national programs. Some of the functions the team has planned to undertake: develop useful basic breeding stock, conduct regional crossing blocks, operate regional off-season nurseries, screen for resistance traits, conduct food quality and utilization work, and train scientists from national programs of the region.

In the development of basic breeding stocks, emphasis will be given to germplasm both from the region and outside. A special effort will be made to build up the working germplasm for the region. Useful breeding stocks will be utilized directly in the regional station and will also be moved to appropriate national programs for their utilization. Emphasis will be given to both hybrid and varietal development.

The regional crossing block will handle all the crossing work for those national programs that need such service, and hybrids from the crossing block will be transferred to appropriate national programs for evaluation and selection. The parents to go into the regional crossing block will be selected and identified by the regional and/or national programs concerned. The regional crossing block will also serve as a training area where research fellows and technicians could come to assist in its operations and get trained on-the-job.

For varying reasons, most of the national programs could not operate off-season nurseries in their breeding work. This slows down their rate of progress by at least 50%. The off-season nursery to be handled by the regional program ought to handle some aspect of generation advance and seed increase. This could be a critical support service for some of the national programs and the location and operation of this should receive prime consideration.

Screening for resistance traits in diseases, insects, Striga, drought, etc. often requires special facilities, effective and repeatable techniques, and competent personnel which are not adequately available in the national programs. The regional program could handle such nurseries and identify sources of resistances combined with reasonably good regional adaptation. Such resistant materials could be channeled into the regional as well as the individual national programs.

Different aspects of food quality and utilization of sorghums and millets must be worked on in the region. The varieties and hybrids developed must be acceptable for consumption in the region. A modest laboratory and associated support service will be useful in strengthening the breeding program and improving market acceptability of varieties and hybrids developed.

Training research fellows and technicians from the country programs of the region is an important way of strengthening the national capability of each country program. Training will be done as appropriate in the region, at ICRISAT Center, and in collaboration with INTSORMIL.

3.2 Economic and Social Analysis

Socioeconomic Evaluation

The importance of sorghum and millet in SADCC has been measured in terms of their area in the total arable land and in terms of their contribution to total calorie consumption.

The two crops together contribute the following percentage area to total arable land in the following countries: Zimbabwe 19%, Lesotho 16%, Tanzania 14%, Mozambique 10%, Botswana 8%, Angola 6%, Zambia 4%, Malawi 5%, and Swaziland 1% (Table 9).

Table 9. Area under Sorghum and Millet crops and their percent contribution to Arable Land in selected countries of southern Africa

Country	Area '000' ha				Sorghum and Millet area as % to Arable Land
	Sorghum* (1)	Millet (2)	Total (1+2) (3)	Arable Land** (4)	Col. (3÷4)
Zimbabwe	70	390	460	2465	18.7
Lesotho	49.5	-	49.5	310	16.0
Tanzania	340	220	560	4080	13.7
Mozambique	250	20	270	2850	9.5
Botswana	100	10	110	1360	8.1
Angola	-	80	80	1280	6.2
Zambia	80	135	215	5000	4.3
Malawi	120	-	120	2260	5.3
Swaziland	2	-	2	150	1.3
Total	1011.5	855	1866.5	22188	8.4

* 1977-78 Average
**1977 Data only

Source - FAO Production year book 1979, 1980, FAO, Rome.

This area contribution of sorghum and millets is broadly reflected in the percentage contribution of these two crops to total calorie consumption: Zimbabwe 16%, Lesotho 16%, Mozambique 10%, Zambia 6%, Angola 5%, Botswana 35%, Tanzania 4%, Malawi 3%, and Swaziland 1% (Table 10).

Table 10. Per capita consumption of calories per day and percent contribution of calories from Sorghum and Millet to total calorie intake in selected countries of southern Africa

Country	Per capita Consumption Calories per day (1)	% Calories from Sorghum to total Calories consumed (2)	% Calories from Millet to total Calories consumed (3)	% Calories from Sorghum and Millet to total Calories consumed (4)
Zimbabwe	2478	2.0	13.8	15.8
Lesotho	2205	15.8	-	15.8
Tanzania	1956	2.5	1.5	4.0
Mozambique	1987	9.4	0.4	9.8
Botswana	2025	34.0	1.1	35.1
Angola	1993	-	4.5	4.5
Zambia	2014	3.2	2.8	6.0
Malawi	2413	2.7	-	2.7
Swaziland	2117	1.2	-	1.2

Source - FAO - Provisional Food Balance Sheets 1972-74 Average, FAO Rome 1977

In view of the importance of sorghum and millet in many of these countries it is disturbing to notice that the production growth rates in many instances are significantly negative, i.e., the production over time of these crops has been declining (Table 11). In Zimbabwe, the country in which millet and sorghum rank highest in importance, both crops have registered a declining trend primarily due to decreases in area under these crops. In Tanzania and in Mozambique millet production has been declining, while sorghum shows an increasing trend.

Table 11. Percent Annual Compound growth rates of Area production and yield for Sorghum and Millets in selected countries of southern Africa

Country	% Annual Compound growth rate~					
	Sorghum			Millet		
	Area	Production	Yield	Area	Production	Yield
Zimbabwe	-2.2	-1.5**	0.8*	-0.5**	-0.7	-0.3
Lesotho	N.A	N.A.	N.A.	-	-	-
Tanzania	0.9	2.4	1.5*	0.6*	-0.2	-0.8
Mozambique	0.7	1.5**	0.8	0.3**	-1.1**	-1.4
Botswana	0.9	3.1	2.1	26.1**	20.2**	-4.6
Angola	-	-	-	0.4	0.3	-0.03
Zambia	1.2*	1.8**	0.6**	0.9**	2.0**	1.1
Malawi	2.5*	6.1**	3.6*	-	-	-
Swaziland	N.A	N.A.	N.A.	-	-	-

~ Annual compound growth rates for the period from 1961-65 (Average) to 1978 based on regression equation.

Source-IFPRI Computer print outs.
* Significant at 5%.
** Significant at 1%.

In Zambia, and Botswana, production of both crops is increasing, even though this is primarily due to area expansion with stagnation in yields. Only sorghum in Malawi shows a significantly increasing trend.

As population growth in all countries continues at levels of above 3% per year, (see Table 13), it is obvious that stagnating or negative production trends in the production of two important staple crops will lead to increasing food storages in the region, unless other sources for food are being made available at increasing rates to overcome this trend. Since there is evidence that alternative food sources, such as maize, cassava, etc., are also available in limited supply, efforts to increase the productivity of sorghum and millet will be of great importance to feed the growing population of these countries.

There is virtually no research infrastructure for sorghum and millet in southern Africa. Research on high-yielding varieties of rainfed crops such as that done at ICRISAT faces peculiar difficulties; the unreliability of rainfall is limiting the returns from investments into rainfed agriculture; plant breeding has to emphasize the development of varieties with stable yields and with

resistance to diseases and pests. Such multiple objective breeding is more time-consuming than simple selection for high yields of varieties grown in a controlled environment.

However, ICRISAT's first 10 years of efforts are now showing first results in terms of promising varieties. As the mechanisms in which some of the pests and diseases attack and damage the crops are being understood, also screening devices for resistance have been developed which have led to varieties of economically and agronomically good characteristics. For instance, a pearl millet variety resistant to downy mildew and high-yielding, WC-C75, has been released in India. In fact ICRISAT researchers, who have been requested to state their expectations regarding crop yields in India and West Africa, have indicated that on average they expect yields in farmers fields for sorghum and millets to increase by 40% to 50% in India and west Africa from 1980 to 1990 (Table 12).

Table 12. Sorghum and Millet yields in farmers' fields

Year	E/C	Sorghum		Millet	
		Average Yield	% increase Over existing	Average Yield	% increase Over existing
INDIA		Yield/in Kgs/ha			
1980	E	820	-	490	-
1990	C	1240	51	770	57
AFRICA					
1980	E	640	-	470	-
1990	C	950	48	610	30

E. Existing yield levels
C. Yield levels with current research resources

Source - Delphi study - preliminary results.

These expectations are based on progress in variety development, which is not just aiming at maximum yields but emphasizes the selection for stability and pest resistance.

The SADCC countries produce about 1.2 million tons of sorghum and millet on a total of about 2 million ha, i.e., yield levels of about 600 kg/ha. If the effect of a concentrated effort to apply ICRISAT and INTSORMIL screening techniques to increase yields would achieve an increase of 40% after the next 10 years -- an additional 240 Kg/ha -- this would imply an increase in production of 480,000 tons per year assuming the area under the crop remained the same. At a price of say $ 100 per ton this would mean an annual return of $ 48 million after 1990.

The amount of food per person would, after this yield increase, remain at about the same level as before, because rapid population growth requires dividing the additional food among more persons (Table 13).

Table 13. Population, population growth rates, and Production for Sorghum and Millets in selected countries of southern Africa

Country	Population in '000' 1978*	Projected Population 1990+	Population growth rate (Compound) 1978-90	Production in '000' tons (1977-78 Av) Sor*	Mil*	Production Sor+Mil	Production Sor+Mil 1990~
Zimbabwe	6911	10310	3.4	50	220	270	
Lesotho	1279	1700	2.4	61	-	61	
Tanzania	16854	24757	3.3	245	155	400	
Mozambique	9935	13811	2.8	215	7	222	
Botswana	776	1101	2.9	39	5	44	
Angola	6732	9233	2.7	-	50	50	
Zambia	5291	7764	3.3	45	73	118	
Malawi	5773	8628	3.4	30	-	30	
Swaziland	525	737	2.9	2	-	2	
Total	62365	89578	3.1	687	510	1197	1678

* Source FAO Production year book.
\+ Projected population obtained from IFPRI computer print outs based on trend equation.
~ Based on the 40% yield increase from current levels.

Hopefully, an important change will be to bring marginal maize areas into sorghum production. It may not be possible to make a very effective estimate of the importance of this crop change to total increased cereal production; but, it can be substantial as a number of major marginal areas sown to maize are known.

3.3 Administration Analysis and Organization

3.3.1 ICRISAT Management Experience

Since the major project implementing agency is ICRISAT, regular administrative linkage and reporting procedures of ICRISAT will be followed. Elsewhere in Africa, ICRISAT has operated and continues to operate regional projects of this sort. In general, ICRISAT administrative guidelines will be followed and the regional team will have a project manager who will also serve as team leader. All project staff will be responsible to the team leader who in turn will be directly under the Director for International Cooperation of ICRISAT at Patancheru, India. The ICRISAT Center sorghum and millet staff will interact on technical issues and the Program Leaders for sorghum and millets are responsible for overall coordination of technical matters. An administrator will be appointed through the project for handling the business and administrative affairs of the project. The administrator will report to the project manager. The leadership and coordination of activities in each of the discipline areas of the project -- breeding, pathology, entomology, and production agronomy -- will be assumed by the respective principal scientists of the project in each area.

The project will work closely and maintain linkages with appropriate institutions of the host government, Zimbabwe. At Matopos or Kadoma, in particular, the project will cooperate and share services and facilities with the Zimbabwe national program. The project manager will consult closely with the Director of the host station on appropriate management issues.

Close coordination and interaction will all be maintained with the SADCC headquarters in Bostwana. When the SADCC Agricultural Research Coordination Unit gets established in Botswana, this project will work closely with it.

Although the regional program is to be based in Zimbabwe, the project will maintain close working contacts with the national sorghum and millet programs of each of the nine SADCC countries. The project will establish its

contact with the national program leader as well as with national directors of research of each SADCC country.

Advanced degree training matters for trainees from the SADCC countries will be coordinated by the Management Entity of INTSORMIL at Lincoln, Nebraska. Arrangements will be made with INTSORMIL for providing funds through this project and handling advanced degree training in sorghums and millets for the SADCC countries in INTSORMIL universities and other appropriate educational institutions.

3.3.2 Rationale for a Regional Team to be Stationed at One Location

a. Cross discipline interaction is important to the development of the crop. Effective cross discipline cooperation requires constant input to be most effective; the close working proximity of the team will encourage this.

b. The first job of the regional team will be to create material and techniques that national programs in the region find useful and want. This can be done most rapidly if the group is working closely together. Once there is accomplishment the team will have greater credibility to be accepted by national programs.

c. Staff of the regional program will work only through national program structure. This should provide a way for regional staff to contribute to priorities, organization and management of national programs. The regional team, by being multidisciplinary, will encourage an effective balance of these disciplines in national program systems.

d. The regional team, being multidisciplinary, will have a broad base to effecitvely contract for research in specific areas identified from time to time. Already, it is anticipated that close collaboration will be developed in the region for training, socioeconomics, food technololgy; and outside the region with the Denver Wildlife Research Center for bird control; with INTSORMIL and ICRISAT for research on Striga; and with INTSORMIL for degree education and ICRISAT, Center for short-term practical training.

e. The problems of the region are reasonably well known. We are less well informed on the extent and location where problems are severe. It will be useful to keep the team together, to identify locations ("hot spots") where research activities might best be undertaken.

f. There is the possibility of "hot spots" being scattered in the region. An entomologist situated in a good area to screen for stem borer may have to travel to work on shoot fly. It will be just as easy to work in the region

from a team headquarters.

g. It will take time for members of the team to orient their thinking and activities to the same goals, and to a substantial degree, on the same material. This can be much more effectively achieved if the team is together.

h. The proposed project will have insufficient personnel to achieve a presence in each country. In fact, a more scientific and uniform balance of input into countries of the region can be made if the team remains together.

i. It will be possible to more quickly build up a good research base together rather than a team dispersed. This would influence the rate of accomplishment.

j. Administration will be vastly simplified and more efficient.

k. It will be more economical to have the team together in terms of shared use of equipment, including spare parts and satisfactory office and laboratory facilities. One well-managed center would provide a useful example for others.

l. There will be a critical mass of talent together that will serve as an expert pool for interaction with national programs. This concept would be more difficult to generate and make visible if the team were dispersed.

3.3.3 Linkages with National and International Agencies

3.3.3.1 Training

There is considerable concern about training locally at the technician level. ICRISAT is interested in support of such training in association with local universities. ICRISAT staff on the regional team could work with individuals in universities to organize and conduct such training programs. Also, staff from ICRISAT Center, particularly from the Training Program, could contribute to such relatively short-term training activities. This concept of training not only has support from ICRISAT but from others who are concerned as a useful way for the regional team to work with local universities.

It is also possible for universities within and outside of the region to recognize one or the other of the staff of the regional team to guide thesis research. Necessarily, only a limited number of individuals could do this as the regional staff have other responsibilities.

3.3.3.2 Economics

It is recognized that an input into economics will be required, particularly when the project begins to move high-yielding varieties and hybrids with increased use of inputs into the farming community. Input into the area of economics will be undertaken in collaboration with universities, and possibly other agencies in the region. Interaction with some of the farming systems programs in the region much involved in socioeconomic considerations might also be developed. INTSORMIL has special capabilities and experience in this field which could be brought into the project at a later date.

3.3.3.3 Food Technology

There are existing activities in food technology in the region that would need to be visited to determine local need and useful interaction. The objective of the sorghum and millets team will be to develop varieties and hybrids with food traits acceptable to the local population. This evaluation depends on taste panels of individuals who are familiar with local food uses and can detect differences between samples. Only limited numbers of samples can be evaluated as a final food preparation. It is therefore valuable to develop quick tests enabling elimination of a large number of samples so that more detailed measures can be made of selected samples. In terms of the crop improvement project this evaluation can become routine and may best be undertaken by technicians as part of the sorghum and millets research team. There will be other studies such as modification in traditional methods to improve digestability, and the development of a processing technology to put sorghum and millet flour on the urban grocery shelf. Such studies will likely involve a useful interaction with the team on a continuing basis. The team can usefully cooperate on studies related to food and beverage uses of the crops.

In the general area of Post Production Systems (PPS), particularly in appropriate technolgies for dehulling sorghum grains, IDRC already has a number of years of experience in the SADCC region. It has on-going projects in sorghum PPS in Botswana, Zimbabwe, and Tanzania. It would appear best for this SADCC project to collaborate closely with the IDRC supported projects. IDRC's involvement either through direct IDRC-funding for PPS or its participation in coordination of the food quality and utilization work would strengthen the total effort.

3.3.3.4 Birds

Birds, particularly the weaver bird, Quelea quelea can be very distructive and, in parts of the region, the primary limiter of production. It is a difficult problem to manage and goes beyond the scope of a crop improvement program. The crop improvement program can look at bitter seeds that are not attractive to birds and can be used to make beer; and also, to modify sowing dates and crop maturity, where possible, to avoid these migratory birds.

There are community efforts to control these birds, including destruction of nesting sites and the use of sprays to make the crop unactractive to feeding. The Denver Wildlife Research Center has been involved in the eastern and southern African region for some time in research and training activities. The Center is well equipped for chemical studies on seed in relation to bird feeding as well as the development and evaluation of repellants. The regional team can supply seeds with suspected useful traits for their evaluation and use. We have made some very preliminary contacts that should be much strengthened as the regional team is able to do so.

3.3.3.5 Striga

Research on Striga is of important. It is of primary concern in limiting yields of sorghum and millets in West Africa, and ICRISAT has a specialist in Upper Volta. There is also a recommendation to include a Striga specialist in a regional program for eastern Africa. Striga is spreading with new high-yielding hybrids in India, and there is a research program at ICRISAT Center. The IDRC and INTSORMIL are supporting research on Striga in the Sudan. Research on Striga control exists in the USA, and INTSORMIL is now mounting an expanded research program on Striga control. Striga is not considered to be a primary crop production pest in southern Africa though it could become so. It is proposed, at least initially, to utilize techniques developed elsewhere to respond to the Striga problem in the region. This can involve consultation from other ICRISAT programs and INTSORMIL in adapting developed techniques to the region. Should the problem become severe, it may be necessary to increase the depth of research in the region.

3.3.3.6 Farming Systems

In most of the countries of the SADCC region, there are teams of farming research projects under contract with various US universitites and ODA. Each of these teams works on the totality of farming systems problems in the country of their assignment. Sorghum and millets form only a part of the farming systems of the SADCC countries. The ICRISAT team will work closely with these teams in testing technologies or carrying out investigations in farming systems where sorghum and millets are components of the system. As the SADCC sorghum and millet project gets underway and new varieties and hybrids along with their appropriate production technologies are forthcoming, the interaction of the team with the farming systems teams in the region are expected to increase gradually. Although the agronomist of the team will concentrate on specific sorghum and millet related investigations on station, he will also consult and work closely with the farming systems teams for on-farm-testing of new varieties and hybrids and their management. The team agronomist will also work cooperatively with the farming systems teams in intercropping and multiple cropping systems where sorghum and millets are involved.

3.3.3.7 Draft power

The problem of adequate draft power for agricultural operations has been given high priority by existing organizations developing animal drawn equipment in the region. The sorghum and millet improvement project can usefully interact with them by providing findings from agronomic experiments and by evaluating their equipment. An important problem in use of draft power relates to animal strength at the end of the dry season, which often results in delays in sowing. This program could be undertaken on a cooperative research basis to improve the feed situation.

4. IMPLEMENTATION ARRANGEMENTS

4.1 Relationships with Zimbabwe and Other SADCC Countries.

ICRISAT and INTSORMIL will have the responsibility of developing effective and harmonious relationships with SADCC countries as an initial step in the development of a useful research program.

The team management will request from the Government of

Zimbabwe the following general privileges:

a. The right to contract; to aquire and dispose of immovable and movable property; and to institute legal proceedings.

b. Immunity from requisition, confiscation, expropriation or other forms of interference.

c. Immunity from every form of legal process except insofar as in any particular case ICRISAT has expressly waived its immunity. It is, however, understood that no waiver of immunity shall extend to any measure of execution.

d. Have freedom to transfer its funds to or from one country to another or within the country and to convert its funds into any other currency in discharge of its research and training activities.

e. Exemption from all direct taxes. It is understood, however, that ICRISAT will not claim exemption from taxes which are, in fact, no more than charges for public utility services.

f. Exemption from customs duties and prohibition and restrictions on imports in respect to articles imported or exported by ICRISAT for its official use. It is understood, however, that articles imported under such exemption will not be sold in the country except under conditions agreed to by the Government.

g. Freedom from restrictions on the exchange and transport of seeds and other genetic materials within and outside the country, with the provision that appropriate quarantine processes may be respected to prevent import and export of diseases and pests.

h. Authorization for all necessary movement of ICRISAT staff and consultants in and out of Zimbabwe as often as may be necessary.

i. Assuring and safeguarding the interests and security of the internationally-recruited officials of ICRISAT staff to the extent envisaged in Article V, Sections 17, 18(a), (b), (c), (d), (e) and (f); 19, 20 and 21 of the United Nations Convention on Privileges and Immunities.

j. With the exception of foodstuffs and beverages, allow currently used and new personal effects of internationally recruited staff and their families to be imported free of duties and taxes on each assignment to Zimbabwe.

k. Allow the importation, free of duties and taxes of one new vehicle per family for each expatriate ICRISAT staff

member on each assignment to Zimbabwe.

1. Authorize the housing of ICRISAT internationally recruited staff members and their families and ensure the rapid issue of permits for the required residence and free movement within and outside Zimbabwe.

4.2 Schedule for Implementation of Project

Time Period	Activities
0-1 Year	1. Recruitment of Project Manager, Sorghum Breeder, Administrative Officer, Farm Development Officer, and selected administrative and technical support. 2. Agreements with Government of Zimbabwe and its agencies. 3. Plans and specifications and tendering construction contracts; housing arrangements, construction begins. 4. Initial vehicle and farm machinery orders. 5. Sorghum/millet regional research planning workshops, Zimbabwe. 6. Initial sorghum trials in Zimbabwe. 7. First group of degree trainees. 8. Recruit three in-service fellows. 9. First group of in-service trainees.
1-2 Years	1. Recruitment of Millet Breeder, Agronomist, Pathologist, and Entomologist and additional technical and support staff. 2. Second equipment purchase, for farm development. 3. Completion of construction. 4. First Regional trial and regional nurseries established. Intensive disease and pest surveys in region. 5. Complete initial phase development of field facilities. 6. Second sorghum/millet research planning workshop, Zimbabwe. 7. Conclude agreements with other countries of region as necessary. 8. Second group of degree trainees. 9. Second group of in-service trainees. 10. Recruit 5 in-service fellows. 11. 18-month evaluation of project
2-3 Years	1. Continue introduction, evaluation regional yield trial and nursery program. Initiate regional crossing program in support of national programs. Initiate first off-season

nursery.

2. Evaluate locations in the region most appropriate for the various screening functions for insect, disease, weed, and environmental stress factors. Learn more about the severity of these factors in the region.
3. Initiate the first short-term training course in cooperation with a University in Zimbabwe. Staff from the ICRISAT Center and INTSORMIL should participate.
4. Seek cooperation with local organization for input on food technology.
5. Conduct the third annual workshop, beginning to rotate among countries in the region.
6. Third group of degree trainees.
7. Third group of in-service trainees.
8. Recruit replacement in-service fellows.

3-4 Years

1. The breeding, regional trial, introduction-evaluation crossing, off-season nursery should be stabilized. This will be an interaction with all interested countries of the region.
2. Screening nurseries for priority limiting traits will be established and advanced breeding stocks and source materials evaluated. Input on Striga will begin in some countries.
3. Cooperation to strengthen input into areas of socioeconomics, farming systems research, and bird control continues. Working seminars on these subjects.
4. Any remaining work to complete the equipment and structural facilities for the regional team should be finished.
5. Fourth group of degree trainees.
6. Fourth group of in-service trainees.
7. Recruit replacement in-service fellows.
8. Regular workshops and conferences are routine.

4-5 Years

1. The breeding, introduction - evaluation, regional yield trial, nursery, crossing block programs continue. Interaction with national programs routine.
2. A crop improvement pattern is set. screening for pest, environmental factors, and food quality is established as part the crop improvement program.
3. Regional screening nurseries for yield-limiting factors and food quality, including entries from national

programs, are stabilized.
4. Input into training at all levels functional.
5. Begin cooperation with seed production activities in those countries that are ready.
6. The annual workshop, consultant meetings, and working seminars become a regular aspect of the program.
7. Assistance with national experiment station development should be underway.
8. Final evaluation of project.
9. Fifth group of in-service trainees.

4.3 Onward from Year 5 to 10

The more routine aspects of the regional project should be stabilized. There will be changes in objectives and thrust that will occur over time. Countries in the region will strengthen research at different rates and some programs in the region, for example, Zimbabwe and Zambia, can be expected to contribute varietal material into the regional system from their own research.

The regional project may be more involved over the 10-year span with aspects of seed production, training of extension officers, and a gradual shift to more basic work related to the crop improvement activity. Team members may spend a reasonable amount of time with the organization and scope of national programs and the improvement in conditions of research.

The nature of the SADCC Coordinating Center should be known and the regional project could begin to stabilize some service functions, such as off-season nurseries and screening nurseries with them. Possibly the coordinating center will assist with annual workshops, working seminars, experimental design and statistical service, and an input into the production of reports.

The regional team should plan to phase out in a 25-year period with stable national and regional research activities in place. To do this there will be a slow change in emphasis over this time period.

4.4 Project Management

a. The project will be under the immediate direction of a Project Manager (a senior scientist) who will have responsibility for the research program, training efforts, and construction and development. He will be aided principally by an Administrative Officer who will direct the

efforts of nationally recruited staff in matters of finance, procurement, and personnel. A Farm Development Officer (FDO) will serve the proposed project for 3 years under the direction of the Project Manager. The FDO will direct all aspects of development of all field sites and will have secondary duties of overseeing construction contracts. The FDO will also be available to advise and help national research organizations of the region that request his expertise. The ICRISAT research staff will be under the direction of the Project Manager. They will in turn have direct supervision of all technical staff assigned to them.

b. ICRISAT prefers to handle terms of employment and actual recruitment and salary payments of nationally recruited persons through a cooperating national progam at the same location, assuming that the policies of the national program are acceptable. As a second choice, ICRISAT may adopt the acceptable features of local employment terms and conditions as modified by its own policies and perform its own personnel functions.

c. Overall management of ICRISAT's programs is vested in the Director General. The Director for International Cooperation has supervisory responsibilities for programs outside India. Ultimate fiscal procedures are handled through a well-staffed Fiscal Division at ICRISAT Center. Technical support of all programs comes from Program Leaders, and staff in India and Africa.

d. Overall management of INTSORMIL activities is vested in a CRSP Program Directorate at the University of Nebraska, Lincoln, and central resonsibility is exercised through a Program Director. Fiscal matters flow through the Director to the Grants and Contracts Office of the University, who handles receipt, disbursement and accounting of funds. Technical support is provided through discipline coordinators and principal investigators. A Training Coordinator will be appointed to handle and coordinate degree training activities.

e. ICRISAT will propose the establishment of a Technical Advisory Panel to review regional work and suggest improvements and new research to be undertaken. The panel will be composed of representatives of participating National Research Organizations and will meet annually. A training advisory sub-panel will be formed also.

f. Other aspects of the management of the proposed project cannot be anticipated accurately at this time. Project management will coordinate all activities closely with appropriate representatives of the Government of Zimbabwe, with the SADCC organization, and with SADCC countries.

4.5 Project Evaluation

Major Evaluations of progress, direction, and accomplishments are proposed for 1.5 years and 4.5 years after the starting date. ICRISAT and INTSORMIL would expect that an evaluation team be composed of scientists and administrators representing SADCC, the constituent countries, donors, INTSORMIL and ICRISAT. Funds for major evaluations are not included in ICRISAT's proposed budget.

Annual reports of progress, work plans, and fiscal reports will be made.

4.6 Project Relationship with the SADCC Coordinating Center

Within the SADCC countries, Botswana has been assigned the responsibility for agriculture. The Coordinating Cell of the SADCC, which is to be set up, will work in close association with Botswana. It is expected to provide the vital function of coordination between agricultural projects in the region and the member countries and outside implementing agencies. As soon as the modes of Coordinating Cell's operation are known, the sorghum and millet improvement project will seek to establish a link with it through the project manager. The project will request the assistance of the Coordinating Cell in its dealings with member countries and obtain its guidance regarding project implementation. The future creation of a regional coordinating office will facilitate dealings with member countries.

5. BUDGET

The budget in Table 14 is for the first five years of operation.

Table 14. Budget in US Dollars

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
A. PROFESSIONAL STAFF:						
Sorghum Breeder (1)	85,000	93,500	102,850	113,140	124,450	518,940
Pearl Millet Br. (1)	-	93,500	102,850	113,140	124,450	433,940
Entomologist (1)	-	93,500	102,850	113,140	124,450	433,940*
Plant Pathologist (1)	-	93,500	102,850	113,140	124,450	433,940
Agronomist (1)	-	93,500	102,850	113,140	124,450	433,940
Admin. Officer (1)	85,000	93,500	102,850	113,140	124,450	518,940
Farm Manager/ Dev. Officer (1)	85,000	93,500	102,850	-	-	281,350
Project Manager (1)	85,000	93,500	102,850	113,140	124,450	518,940
	340,000	748,000	822,800	791,980	871,150	3,573,930
B. SUPPORT STAFF:						
Technical	82,000	182,200	191,300	200,900	213,300	869,700
Farm Operations	68,000	141,100	148,200	155,600	163,300	676,200
Admin. Staff (Project HQ)	53,000	141,700	148,800	156,200	164,000	663,700
Adm. Staff (ICRISAT STAFF)	15,000	16,500	18,200	20,000	22,000	91,700
	218,000	481,500	506,500	532,700	562,600	2,301,300
Sub-total: Personnel	558,000	1,229,500	1,329,300	1,324,680	1,433,750	5,875,230
C. OPERATIONAL:						
Research Operations and Supplies	90,000	180,000	198,000	217,800	239,580	925,380
Travel (Int'l & Domestic)	102,000	112,200	123,420	135,760	149,340	622,720
Vehicles Operations & Maintenance	76,000	92,000	101,200	111,320	122,450	502,970
Lab. and Comp. ser.	5,000	5,500	6,050	6,660	7,320	30,530
Consultancies & Collaborative Res.	15,000	50,000	55,000	65,000	66,550	251,550
Field Days & Workshops	25,000	45,000	49,500	54,450	59,900	233,850
Communications, Library & Publication	25,000	25,500	30,050	36,660	40,320	157,530
Rental temporary offices & housing	33,600	-	-	-	-	33,600
Sub-total: Operations	371,600	510,200	563,220	627,650	685,460	2,758,130

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
D. TRAINING:						
In-service Trainees	98,000	102,900	108,050	113,450	119,120	541,520
In-service Fellows	30,600	90,600	95,130	99,890	104,880	421,100
Research Fellows	46,200	48,510	50,940	53,480	56,160	255,290
Under Graduate & Graduate (Degree)	194,450	317,820	369,730	380,390	347,060	1,609,450*
Sub-total: Training	369,250	559,830	623,850	647,210	627,220	2,827,360
E. ASSISTANCE TO NATIONAL RESEARCH SYSTEMS FOR TECHNOLOGY TRANSFER:						
Trials & Nurseries	45,000	49,500	54,450	59,900	65,900	274,750
Seed Multiplication	18,000	19,800	21,780	23,960	26,350	109,890
Travel for Scientists from National Prog.	20,000	22,000	24,200	26,600	29,280	122,080
Capital:						
Machinery & Eqpt.	15,000	25,000	15,000	15,000	15,000	85,000
Seed Storage	25,000	25,000	25,000	20,000	-	95,000
Vehicles	30,000	5,000	-	30,000	-	65,000
Sub-total:	153,000	146,300	140,430	175,460	136,530	751,720
F. CAPITAL: (See Annex IV for Construction, Purchase, Development, and some Equipment)						
1. Bldg. construction & Purchase :						
Housing	800,000	1,032,800	-	-	-	1,832,800
Office & Lab.	200,000	138,450	-	-	-	338,450
Seed Storage & Processing	100,000	34,090	-	-	-	134,090
Field shelters	16,200	-	-	-	-	16,200
General Stores	16,000	-	-	-	-	16,000
Glass Houses (3)	-	288,400	-	-	-	288,400
Utility Bldgs.	69,930	50,000	-	-	-	119,930

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
2. Farm & Station Development	150,000	47,650	-	-	-	197,650
3. Equipment :						
Farm	150,000	150,000	148,660	-	-	448,660
Shop	28,850	-	-	-	-	28,850
Maintenance	-	8,140	-	-	-	8,140
Office	15,000	35,000	-	-	-	50,000
Laboratories	50,000	80,000	50,000	-	-	180,000
Crop processing & Storage	20,000	20,000	-	-	-	40,000
Furniture, Office & Labs.	50,000	60,000	-	-	-	110,000
Microcomputers	15,000	5,000	-	5,000	-	25,000
Vehicles (Proj.)	100,000	124,260	-	-	-	224,260
Sub-Total	1,780,980	2,073,790	198,660	5,000	-	4,058,430
G. ICRISAT Overhead (15% of Salaries)	83,700	184,430	199,400	198,700	215,060	881,290
GRAND TOTAL	3,316,530	4,704,050	3,054,860	2,978,700	3,098,020	17,152,160

* To be provided by INTSORMIL

INTSORMIL RECAP:

Staffing	-	93,500	102,850	113,140	124,450	433,940
Training	194,450	317,820	369,730	380,390	347,060	1,609,450
					TOTAL	2,043,390

Overhead is included in above estimates.
No cost-sharing requirement on these amounts allocated to INTSORMIL.

BUDGET NOTES

A. The Principal Staff costs are based on ICRISAT's experience in Africa. They include salary, post allowance, medical insurance, retirement benefits, household equipment, relocation travel, home leave travel and children's education expenses and personal car allowance.

B. Support staff consists of :

1. Technical :

Laboratory Assistants	3
Research Technicians	9
Field Assistants	9
Computer Operator	1

2. Farm Operators :

Farm Superintendant	1
Registered Mechanic	1
Store keeper	1
Tractor drivers	2
Driver-cum-General Assistant	8
Mechanic Helper	1
General Hands	39

3. Adminstrative Staff (Project HQ):

Executive Officer	1
Secretories/Steno	8
Accounts clerk	2
Messenger	1
Electrical and A/c Technician	1
Chief handy men	2
Handy man Helper	1
Janitorial Helpers	3

4. Administrative Staff (ICRISAT HQ):

Administrative Assistant	1
Clerk/Typist	1

C. Operational costs based on current costs in southern Africa. Rental of temporary office and housing based on $ 1000 and $ 600 per month respectively for 12 months, office/houses.

D. Training costs.

ICRISAT costs are current operating costs. INTSORMIL costs are estimates for under graduate and graduate training based on PhD-4years, MSc-3 years, BS-4.5 years, and for staff members, they are estimated in conformity with normal, average practices in member universities.

E. A significant item for the Project is assistance to National Research System to build up their capability and infrastructure. The line items are self-explanatory as to the activities the Project will support.

GENERAL COMMENTS :

1. Inflation calculated at 10% annually, training 5%.
2. Overheads are 15% of salary and wages.

Annex I

REPORT OF THE ICRISAT MISSION TO SOUTHERN AFRICA

(8 Nov - 3 Dec 1980)

PART I - MAIN REPORT

ICRISAT

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ICRISAT Patancheru P.O.
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I. SUMMARY

1. The Southern African Heads of Governments at their Lusaka Summit in April 1980 urged ICRISAT to set up a Regional Center in Botswana to serve the nine Southern African Coordination Conference (SADCC) member countries -- Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. ICRISAT responded by sending, in November 1980, a fact-finding mission to examine the existing production, production constraints, and status of research and development on the ICRISAT mandate crops -- sorghum, pearl millet, groundnut, pigeonpea and chickpea -- and the potential for ICRISAT's input for their improvement. The Mission visited all the SADCC countries except Angola, and gathered detailed information on the ICRISAT crops in each country.

2. The main findings of the Mission were as follows:

a) Of the five ICRISAT mandate crops, groundnut, sorghum and pearl millet are important food crops in Southern Africa. They are grown mostly by small farmers for home consumption and only small surpluses are sold for cash. Groundnut is an important export crop in Malawi and Zimbabwe. Most countries in the region are interested in increasing, and where possible, expanding the production of these three crops.

b) Pigeonpea and chickpea, although grown in a number of these countries, are relatively minor food crops. There appears to be little market demand for these crops since they are not commonly preferred for food, and there is little interest on the part of governments to encourage their production.

c) Small farmer yields of about 500 kg/ha for groundnut, sorghum and pearl millet are very low when compared with the potential yields of over 4,000 kg/ha obtained at experiment stations in the region.

This wide yield gap is due to a number of factors, and those which were given as major constraints to increased production are listed below:

Groundnut :	Cultural practices Drought Diseases	Soil fertility and "pops" Varieties
Sorghum :	Bird pests Drought Varieties	Draught power Insect pests Soil fertility
Pearl millet:	Bird pests Drought Varieties	Draught power Soil fertility

d) Individual country research efforts on sorghum and pearl millet have been non-existent or minimal. However, interest has increased over the past two or three years and five countries now have research programs concentrating on variety trials. These programs are poorly staffed and funded. Groundnut research has been non-continuous in most countries except Malawi and Zimbabwe where the programs have successfully contributed to the improvement of the crop.

3. Based on the above findings the Mission's main conclusion is that there is great potential in Southern Africa for the improvement of groundnut, sorghum and pearl millet, and that ICRISAT could play an important role in this.

4. The Mission examined various ways by which ICRISAT's input could be provided. The proposal to set up a Regional Center in Botswana, or anywhere else in the region, is not recommended as no single site would be suitable for all the ICRISAT crops and programs. The Mission is convinced that ICRISAT can play a major constructive role in agricultural research for the SADCC countries by siting Regional Research Team/Units,

each specialising on one or more of the ICRISAT mandate crops or programs at carefully chosen locations. To this end, the Mission endorses ICRISAT's plans to establish a Groundnut Research Unit in Malawi, and recommends the establishment of Sorghum and Pearl Millet Research Units in Zimbabwe, and a Land and Water Management Research Unit in Botswana. Each Unit should have a basic team or research staff that can effectively deal with the main problems in the region. The main functions of such units would be to develop breeding materials and management practices and help strengthen national research capabilities in the ICRISAT crops and programs.

5. There would be a need for an administrative base -- Regional Coordinating Unit -- in the region to coordinate ICRISAT's activities. Botswana has been given the responsibility for coordination of agricultural activities in the SADCC countries and appears to be a logical place for siting such a Unit. This Unit would be able to liaise with Botswana in the development of ICRISAT activities in the SADCC countries.

6. Maize, rice, wheat, cassava and *Phaseolus* beans are other important food crops in the SADCC countries. The Mission was informed that assistance is also needed for the improvement of these crops, and that ICRISAT is expected to encourage the participation of other CGIAR Institutes in research on crops within their mandate.

II. INTRODUCTION

The declaration on Development Cooperation adopted by the Southern African Heads of Governments at their Economic Summit held in Lusaka in April 1980 urged that the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) set up a Regional Center in Botswana to serve the member countries of the Southern African Development Coordination Conference (SADCC). The SADCC countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe.

The reason for urging ICRISAT's involvement in agricultural research in Southern Africa was the high priority which the Lusaka Summit gave to agricultural research and development as a means of solving the problems of inadequate food supply and poor nutrition in the region, and the increasing reliance on food imports from South Africa. In recent years the fragile food supply and security situation has been aggravated by recurrent drought cycles.

In response to a formal request made by Botswana, on behalf of the SADCC countries, in August 1980, ICRISAT sent a fact-finding Mission to Southern Africa in November 1980. The Mission's terms of reference were to examine the existing status regarding ICRISAT mandate crops (sorghum, pearl millet, groundnut, pigeonpea and chickpea), production constraints, status of research and development on ICRISAT crops, and the potential for ICRISAT involvement in the improvement of these crops in the SADCC countries. The Mission, consisting of Dr. L.K. Mughogho, Dr. M.B. Boling, Dr. J.H. Williams, Dr. S.Z. Mukuru, Dr. W. Reed, and Dr. G. Gunasekera, divided into two groups in order to give adequate coverage to all countries within the limited time available. The first three members of the team visited Malawi (10-15 November), Zimbabwe (15-20 November), Swaziland (20-23 November), and Lesotho (24-26 November). The other three members visited Tanzania (8-15 November), Mozambique (15-22 November) and Zambia (22-27 November).

Both groups met in Botswana (27 November-3 December) and held discussions with the Botswana authorities who have overall responsibility for coordination of SADCC activities in agricultural research. It was not possible for the Mission to visit Angola owing to communication difficulties in obtaining the necessary clearances.

The first group of the Mission was joined in Zimbabwe by Dr. R.B. Contant, a representative of the International Service for National Agricultural Research (ISNAR). ISNAR has recently been established by the Consultative Group on International Agricultural Research (CGIAR) with the mandate to help strengthen national agricultural research capabilities in developing countries. In view of the relevance of this mandate to ICRISAT's activities, ISNAR was invited to participate in the Mission.

The collection of information by the Mission was based on a list of items (see Annex IX in Part II of this report) which was sent to all countries in advance to enable them to obtain the required data for the visit. Unfortunately this list did not reach the concerned departments in some countries in time for them to gather the required data.

The Mission's report is presented in two parts: Part I is the Main Report containing the findings and recommendations and Part II contains the detailed individual Country Reports.

The Mission was well received in all the countries visited and everyone the teams met and had discussions with was very cooperative and helpful. We are greatly indebted to all those who found time to give us the information contained in the reports.

III. BACKGROUND INFORMATION ON THE REGION

Location, Area and Development Indicators

The region served by SADCC is enormous in both size and extent. As shown on Map 1 the region lies between the Atlantic (11°E) and Indian Oceans (41°E) and stretches from near the equator to about 30°S, and has a total area of 4.9 million km^2. In elevation it ranges from sea level to mountains of over 3,500 metres. The major part of the region is a plateau with an elevation of between 900 and 3,000 metres. Although 95% of the region is in the tropics, the whole of Lesotho and Swaziland, one third of Botswana and a small portion of Mozambique lie outside the tropics. These differences in location and physiography are reflected in the wide range of climates, soils and photoperiods found within the region. Well over 75% of the region is semi-arid as defined under ICRISAT's mandate.

In Table 1 are given some indicators of the present level of agricultural development of the SADCC countries. The following points are noteworthy:

(a) Over 70% of the population is engaged in agriculture and live in the rural areas.

(b) The population growth rate is high at about 3% a year, while the annual increase in cereal production is 2.3%.

(c) The region imports an average of 16% of its total cereal consumption. This figure is most probably much higher now because of persistent droughts since 1977. In fact Zimbabwe, which was previously an exporter of grain, imported a substantial amount of grain in 1980.

(d) Five countries in the region, namely Botswana, Lesotho, Malawi, Mozambique and Tanzania, are among 52 "crisis" countries in the world which have been designated for special attention by international agencies.

Map 1: Member Countries of the Southern African Coordination Conference (SDCC)

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Table 1. Some Indicators of Agricultural Development of the Southern African Development Coordination Countries

	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Total/Mean
Least developed countries[a/]		✓	✓	✓			✓			
Most seriously affected countries[b/]			✓		✓					
Food priority countries[c/]			✓	✓	✓		✓			
Priority food deficit countries[d/]							✓			
Area (000 km^2)	1,251	600	31	119	783	17	940	757	390	4,888
Population: 1979 total (millions)	6.9	0.7	1.3	5.9	10	0.5	17	5.6	7.2	66
Density/km^2	5.5	1.2	42	49.6	12.8	29.4	18.1	7.4	18.5	21
Growth rate (% per year)	2.4	3.4	2.4	3.2	2.8	2.8	3.0	3.0	3.4	2.9
In agriculture (1977 %)	60	82	86	86	67	75	83	69	60	74
Cereal output (million tons) Avg 1975-77	0.6	0.1	0.2	1.3	0.6	0.1	1.5	1.2	1.8	7.4 (0.8)
Annual change cereal output (% Avg 1969-71 VS 1975-77	-0.5	9.4	-1.0	1.3	-0.4	3.2	1.2	3.0	5.1	2.3
Cereal consumption per caput (kg/year) Avg 1975-77	102	186	222	253	90	233	113	252	266	190
Import content in cereal consumption (%) Avg 1975-77	14	32	23	2	23	11	13	10	Exporter	16

Source: Agricultural Development Indicators. A Statistical Handbook. 1980. International Agricultural Development Service, New York.

a/ Designation by the UN Economic and Social Council

b/ Designation by the UN General Assembly

c/ Designation by the UN World Food Council

d/ Designation by the Consultative Group on Food Production and Investment.

In general the low rate of growth in agricultural production combined with high population growth rate has led to inadequate and poor nutrition for the population, an increasing reliance on food imports, mainly from South Africa, and low financial contributions to development.

Important Food Crops

Table 2 gives the 1978 FAO production data for the main food crops in the SADCC countries. Of the five ICRISAT crops, the data given for sorghum and groundnut show that these are important in the region. Although pearl millet production data are not given in the FAO report, the crop is important in Zimbabwe, Tanzania and Angola. Both chickpea and pigeonpea are either not grown or produced in relatively small amounts so they generally constitute a negligible proportion of the food requirements of the population.

In addition to the three ICRISAT crops, other important food crops in the region are maize, rice, wheat, *Phaseolus* beans, and Cassava.

Table 2. Production (in 1000 tonnes) in 1978 of ICRISAT Mandate Crops and Other Important Food Crops in Southern Africa

Country	ICRISAT Crops					Other Important Food Crops				
	Sorghum	Pearl Millet	Groundnut (in shell)	Chick-pea	Pigeon-pea	Maize	Rice	Wheat	Beans	Cassava
Angola	GNR	GNR	20	NG	GNR	400	20	10	65	1,700
Botswana	55	GNR	7	NG	GNR	45	NG	1	GNR	GNR
Lesotho	50	NG	NG	NG	NG	100	NG	60	10	NG
Malawi	110	GNR	100	GNR	GNR	1400	43	1	5	40
Mozambique	200	GNR	80	GNR	GNR	400	35	3	GNR	2,450
Swaziland	2	NG	GNR	NG	NG	90	5	1	1	NG
Tanzania	250	GNR	74	8	GNR	1000	260	65	160	4,076
Zambia	50	GNR	31	GNR	GNR	850	3	6	GNR	173
Zimbabwe	50	GNR	120	NG	GNR	1400	5	90	GNR	GNR
Total	767	-	432	8	-	5685	371	237	241	8,439

NG: Not grown

GNR: Grown but not reported

Source: FAO Production Yearbook. 1978. Volume 32.

IV. GROUNDNUT

Production

All SADCC countries, except Lesotho, grow groundnuts. The most important producing countries with substantial surpluses for export are Malawi and Zimbabwe. Small farmers grow most of the crop and their yields at about 500 kg/ha are very low when compared with experimental yields of over 4,000 kg/ha obtained in Malawi and Zimbabwe. There is thus great potential for increases in yield and hence total production in the region.

In most groundnut-producing countries there was the desire to encourage production of both confectionary varieties for export and oil varieties to supply local vegetable oils which are currently imported at considerable foreign currency cost. Zimbabwe is interested mainly in the confectionary varieties as it already exports edible oils from other sources.

Production Constraints

The major constraints to groundnut production are listed in Table 3 in the order of priority as given by the countries visited. These and other constraints are briefly described below.

Cultural practices. Poor cultural practices, particularly late planting, low plant populations and poor weed control, are the major constraints to yield and contribute to the low production levels of groundnuts in most countries of the region.

Table 4. Groundnut research projects in SADCC countries

Country	Research projects
Botswana	Variety trials
Lesotho	Crop not grown
Malawi	Breeding, Pathology, Agronomy, Physiology
Mozambique	Variety trials
Swaziland	None
Tanzania	Variety trials, Agronomy
Zambia	Variety trials
Zimbabwe	Breeding, Pathology, Agronomy, Microbiology

The long standing programs have a breeding component, and pathology and agronomy inputs. Improved varieties and better agronomic practices are being produced and tested. Active breeding for improved drought resistance/tolerance is not being conducted in the region although the breeders are aware of the problem and use random droughts to gather information on the reactions of the material under test. Some promising material is currently being tested in Zimbabwe. Since groundnut sales are most remunerative in the confectionary grades, the breeding programs place considerable emphasis on quality characteristics.

In those countries restarting research, testing of varieties available both locally and from external sources (ICRISAT and neighbouring states) has begun, and some agronomic trials are being conducted to establish techniques and yield potentials for different levels of inputs likely to be applied by the farmers. The germplasm collections made in these countries have, with the exception of Malawi and Zimbabwe, been neglected or lost.

Potential for Improvement

There is considerable room for improvement of groundnut production at the farmers' level based on existing technology in the region. This could be achieved by improved extension services and the provision of seed and other inputs.

If the adoption of existing tested technologies can be achieved, there are possibilities of further improvement in production by the development of a) varieties tolerant to low pH for areas with the "pops" problem, and drought,

b) varieties resistant to leaf diseases and rosette virus disease,

c) dormant short season varieties for areas where the seasons are short, and

d) labour efficient technologies for timeliness of land preparation, planting, weed control and harvesting.

The scope for improvement can be expanded if the countries make concerted efforts to improve the profitability of groundnut production through marketing and price incentives.

V. SORGHUM

Production

Sorghum is grown in all countries; Tanzania, Mozambique and Malawi are the largest producers. However, as a percentage of total cereal production in each country (Table 2) sorghum becomes the most important cereal crop in Botswana at 52% followed by Mozambique, Lesotho and Tanzania at 31, 24 and 14%, respectively.

Most of the sorghum produced is used locally for food and home brewing of beer, and only small amounts occasionally enter the cash market. Traditionally sorghum beer is regarded as an important "food" item in the rural areas. Average yields obtained by traditional farmers are low and range from 300 to 700 kg/ha. This compares unfavourably with yields of about 2,500 kg/ha obtained by commercial farmers in Zimbabwe, and illustrates the potential for yield increases that exists in the region. The potential for the expansion of the area for sorghum production also exists as most semi-arid areas with low unreliable rainfall currently producing poor crops of maize are better suited to sorghum.

In all countries visited, except Swaziland, there was interest and in some cases actual plans to encourage sorghum production in the semi-arid and traditional sorghum areas in order to provide adequate local food supplies.

Production Constraints

The major constraints to increased sorghum production are listed in Table 5 in the priority order as given by the countries visited. These and other constraints are briefly described below.

Table 5. Major constraints to sorghum production in the SADCC countries

Country	Constraints
Botswana	1. Drought 2. Bird pests 3. Draught power 4. Soil crusting
Lesotho	1. Draught power 2. Soil fertility 3. Short season
Malawi	1. Drought 2. Bird pests 3. Draught power 4. Stemborer
Mozambique	1. Bird pests 2. Varieties
Swaziland	1. Bird pests 2. Stemborer
Tanzania	1. Drought 2. Bird pests 3. Varieties 4. Draught power.
Zambia	1. Bird pests 2. Drought 3. Varieties 4. Stemborer
Zimbabwe	1. Drought 2. Bird pests 3. Varieties 4. Soil fertility

Drought and bird pests. In all countries, drought or bird pests are considered to be the biggest constraints to sorghum production. In most years total rainfall is adequate for good production but distribution is erratic, often resulting in drought periods of two to four weeks during the growing season. Bird pests, primarily *Quelea quelea*, have been an important factor causing maize to be planted in areas traditionally sown to sorghum. Much of this area has very low rainfall for dependable maize production which fails more often than not.

Soil fertility. Soil fertility was listed as a production constraint in Zimbabwe and Lesotho. Soils in all the sorghum-growing areas were found to be generally lacking in one or more primary nutrients required, but this is corrected in some countries by the addition of moderate quantities of farmyard manure or commercial fertilizers. Soil crusting, resulting in poor seedling emergence is a major problem in the hardveld soils of Botswana.

Insect pests. Of a large number of insect pests recorded on sorghum, the most widespread and important pest are the stemborers (*Chilo* and *Busseola*). Other pests of importance are shootfly (*Atherigona* spp.), midge (*Contarinia sorghicola*), bollworm (*Heliothis armigera*) and armyworm (*Spodoptera* spp.). Shootfly and midge cause considerable damage on late-planted sorghum. As a rule, insecticide application for pest control is uneconomic and is therefore not practiced by farmers.

Draught power. A lack of adequate draught power was given as a serious production constraint in four of the countries. Many farmers do not have enough draught animals and those that do, often have to delay ploughing and planting at the beginning of the dry season in order to allow oxen to graze on new pasture growth to regain strength lost during the dry season.

Varieties. Lack of suitable varieties was also given as a major production constraint in four countries. A wide range of local cultivars currently grown are tall, late-maturing, and have small hard grains. Improved varieties with high yield potential have not been attractive to the traditional sorghum growers and consumers because they have proved to be less palatable and more susceptible to insect damage in storage than local cultivars.

Diseases. Several potentially serious diseases of sorghum have been recorded in most countries but seldom do much damage, except in localized areas and seasons, to local cultivars under the existing management practices. The most widespread diseases are grain molds, smuts, grey leaf spot, leaf blight, rust, anthracnose and sooty stripe.

Witchweed. The parasitic weed *Striga asiatica* causes heavy losses of sorghum in some areas of Botswana, Malawi, Tanzania and Zimbabwe. *S. hermonthica* is a serious problem in parts of Tanzania. In some countries land that was heavily *Striga* infested was reported to have been abondoned.

Marketing and prices. Sorghum is in most countries regarded as a non-cash crop and therefore no incentives in the way of markets and economic prices are provided by official marketing organizations. Official prices for sorghum paid to farmers are in most cases far below those offered for maize. This is a disincentive for sorghum production and forces farmers to grow maize in areas better suited to sorghum. The case of Tanzania where the consumer price of maize is heavily subsidized while that of sorghum is not, discourages not only the production but also its use as a staple cereal.

Present Research Programs

Individual country research efforts on sorghum have been non-existent or minimal except in Botswana, Zimbabwe and Tanzania, which have had research projects for some time. However, interest in sorghum research has increased over the past two or three years. Table 6 gives a list of current sorghum research projects.

Table 6. Sorghum research projects in SADCC countries

Country	Research project
Botswana	Variety trials, Physiology
Lesotho	Variety trials
Malawi	Breeding, Variety trials
Mozambique	None
Swaziland	None
Tanzania	Breeding, Variety Trials
Zambia	None
Zimbabwe	Variety trials

All the existing research programs are poorly staffed and funded; in most cases the only scientist (breeder or agronomist) working on the crop has responsibility for other crops as well. This means that only a small proportion of research time and effort is spent on sorghum.

The Tanzanian sorghum research program is located at Ilonga where the environment is not representative of the sorghum-growing areas of the country. The Mission was informed that the Ministry of Agriculture is convinced of the need to site the sorghum research program at a suitable location and that appropriate action is under consideration.

Mozambique and Zambia have made requests to FAO and USAID, respectively, for financial and technical assistance to initiate their own research programs. Before this Mission, but after the Lusaka Declaration, Mozambique also made a request for direct ICRISAT assistance in sorghum improvement.

Potential for Improvement

There is great potential for sorghum improvement in the SADCC countries. Any improvement program based in the region would have the tremendous task of developing sorghums for a number of adaptation zones ranging from equatorial in the north to temperate in the south.

The main areas where improvement would be beneficial are:

a) Yield stability under drought and low soil fertility conditions
b) Resistance to stemborers and leaf diseases
c) Cultivars with desirable food qualities
d) Cultivars suitable for different season lengths and photoperiods, and
e) Cold tolerance particularly in Lesotho.

There is probably little that a crop improvement program can do about the bird pest problem. Previous work in the region has emphasized the need for coordinated and cooperative action by all countries, including those immediately outside the SADCC countries, if the *Quelea* bird problem is to be solved.

VI. PEARL MILLET

Production

Pearl millet is grown in all SADCC countries except Lesotho and Swaziland. The major producers are Zimbabwe, Tanzania, and Angola. Zimbabwe is the largest producer of pearl millet in Africa south of the equator.

All pearl millet is grown by small farmers largely for food and home brewing. Average yields range from 400 to 500 kg/ha. Yields of upto 5,000 kg/ha have been obtained in experiments in Zimbabwe and Malawi. This wide yield gap between small farm and experiment yields is evidence of the great potential that exists for improving yields and production of pearl millet in the region.

The Mission was informed that the present pearl millet area could be substantially expanded, particularly in Tanzania, Zambia and Zimbabwe, where large tracts of uncultivated, very low rainfall areas are suitable for pearl millet production.

Production Constraints

Production constraints for pearl millet are essentially of the same order and magnitude as for sorghum. Table 7 gives the major constraints listed in the order of priority as given by the countries visited.

Table 7. Major constraints to pearl millet production in SADCC countries

Country	Constraints
Botswana	1. Drought 2. Bird pests 3. Draught power 4. Varieties
Lesotho	Crop not grown
Malawi	1. Drought 2. Bird pests 3. Human power 4. Varieties
Mozambique	1. Bird pests 2. Varieties
Swaziland	Crop not grown
Tanzania	1. Drought 2. Bird pests 3. Varieties
Zambia	1. Bird pests 2. Drought 3. Varieties
Zimbabwe	1. Drought 2. Bird pests 3. Soil fertility 4. Varieti

Drought and bird pests. What has been written about these two problems on sorghum also apply to pearl millet.

Varieties. Lack of suitable varieties was mentioned more often as a constraint to increased pearl millet production than for sorghum production. The cultivars of pearl millet grown are tall, late maturing, bristled and low yielding landraces. Improved cultivars have been introduced and tested in Botswana and Malawi but these have not shown great promise.

Diseases. Several potentially serious diseases of pearl millet have been observed but seldom appear to do much damage to the local cultivars. The situation could change with the introduction of improved cultivars and the adoption of improved production practices. Ergot (*Claviceps fusiformis*) is the most widespread disease in the region and sometimes causes heavy damage to the crop. Downy mildew, rust and smut also commonly occur in the region.

Insect pests. Little is known about insect pests of pearl millet. It appears that the crop suffers little damage by insects.

Markets and prices. Most countries have no official markets or pricing policies for pearl millet. Consequently the crop does not enter into "official" trading. This is a disincentive to growers. Some countries have marketing policies which are not sufficiently attractive to encourage increased production.

Present Research Programs

As with sorghum, pearl millet research in countries where the crop is grown has been non-existent in the past but interest is now increasing. Table 8 gives a list of current research projects on pearl millet in the region.

Table 8. Pearl millet research projects in SADCC countries

Country	Research projects
Botswana	Variety trials
Lesotho	Crop not grown
Malawi	Breeding, Variety trials
Mozambique	None
Swaziland	Crop not grown
Tanzania	None
Zambia	None
Zimbabwe	Breeding, Variety trials

The programs in Botswana, Malawi and Zimbabwe are 2 to 3 years old, and, like sorghum programs, suffer from insufficient staff and funds. Tanzania expressed strong interest in the crop and plans to initiate an improvement program in 1981 with assistance from USAID and ICRISAT. Mozambique and Zambia have no research plans and appeared to have no interest in the crop.

Potential for Improvement

Pearl millet has received little research attention in the past and a great deal of varietal improvement work will be required for the different agroecological areas of the region. Improvement in yield potential, food quality, resistance to ergot and downy mildew, and drought tolerance are the main areas where improvements would be beneficial. There is also need for the development of short stature and short season cultivars.

The problem of bird pests, particularly the migratory *Quelea quelea* is a tricky one. It would require, as pointed out under sorghum, action by all countries in the region, perhaps under the umbrella of the SADCC.

VII. PIGEONPEA

Production

Pigeonpea is grown as a minor crop in most SADCC countries. Data on yields and total production were not available in any of the countries visited. However, the existence of a small export trade in Malawi and of stockpiles of the produce by the marketing board in Tanzania indicates that only in these countries is the crop of any significance. Malawi was the only country which showed positive interest in encouraging increased production of pigeonpea. In several of the countries, however, pigeonpea is a common backyard or hedge crop and it contributes to farmers' diets particularly during the long dry seasons.

Production Constraints

The major production constraint in most of the countries visited appeared to be a lack of demand for this crop. In Tanzania there had been over production as a result of a generous price paid to farmers over the previous two years. Tanzania is actively seeking an export market for its considerable surplus. In Malawi there is a thriving market for pigeonpea both for local consumption and export. In the other countries there appeared to be no organised marketing of this crop.

As there was little government interest in pigeonpeas, the agricultural staff in most countries had paid little attention to this crop and few people knew anything of the factors limiting productivity. Insect pod borers, presumably *Heliothis armigera* and other lepidopteran larvae, were said to be common. *Fusarium* wilt disease and root knot nematodes were known to be important in Malawi. There was said to be a demand for high yielding, early maturing cultivars that could replace the late maturity landraces grown in Malawi.

Present Research Programs

There are no major active research programs on this crop in any of the countries visited. In Malawi and in Zambia this crop is included in research programs on "grain legumes", but with little or no particular emphasis up to now. It is possible that there will be an increased interest in the research on this crop in Malawi. When the research stations in northern Mozambique are fully staffed there may be some research attention paid to pigeonpea for it is widely grown as an intercrop in that region.

Potential for Improvement

There is little doubt that very good crops of pigeonpea could be grown, particularly in Tanzania, Malawi, Zimbabwe, Mozambique and Botswana. The drought resistance of this crop makes it particularly suited to the semi-arid areas of these countries. Malawi reports yields of "about 900 kg/ha" without the use of any purchased inputs. Farmers in Tanzania produced good crops in response to a good price in the market. In most urban areas this crop is not a commonly preferred food; over much of the area *Phaseolus vulgaris* beans and cowpeas are much more commonly grown and marketed and there is increasing interest in soya beans. Pigeonpea tends to be a backyard crop or a minor component of intercrops, with most of the green peas and dried seeds consumed by the farmer and his family. Unless major export markets are opened up or the dried seeds are popularised among the urban populations, there would appear to be a very limited potential for the expansion of this crop in the countries visited.

Potential for ICRISAT Input

There appears to be no demand for a major research effort on this crop in any of the countries at this time. However, ICRISAT pulse scientists should continue to keep in touch and cooperate with the interested research workers in national programs, particularly in Tanzania, Malawi and Mozambique and supply materials and information on request.

VIII. CHICKPEA

Production

Chickpeas are grown in Malawi, Mozambique, Tanzania and Zambia; but in very minor quantities. In Tanzania there has been limited production of desi types from the black soils in Sukumaland where the crop is commonly sown at the end of the rains. The major production has been commonly near the cotton ginneries where the Asian workers who supervised the machinery, were enthusiastic consumers of this crop.

Production Constraints

Here again, except in Tanzania, the major constraint appeared to be a lack of familiarity or taste for this crop among the bulk of the population resulting in its almost total absence in the markets. In Malawi there is a small demand, both for local consumption and export. In Mozambique there is an apparent demand for this and other pulses, but there is little production.

There was no readily available information on the agronomic or disease and pest limitations of this crop in any of the countries visited except in Malawi where rust, bacterial leaf spot and wilt were said to be damaging.

Present Research Programs

There are no major active research programs on this crop in any of the countries visited. Some research has been conducted in Tanzania and Zimbabwe where ICRISAT variety trials have been grown in recent years.

Potential for Improvement

Good crops of chickpea could undoubtedly be grown over large areas of most of the countries visited if there were a demand for the produce. There is a wide range of germplasm and breeding material in the

ICRISAT and ICARDA (International Center for Agricultural Research in Dry Areas) collections from which cultivars suited to the specific climates within this wide ranging region could be rapidly selected. There are unlikely to be any major constraints to yield that would be peculiar to this region, so the materials and experience already available elsewhere could probably be readily adopted.

Potential for ICRISAT Input

There appears to be no major market or demand, specifically for this crop at this time. ICRISAT should encourage national legume research workers to at least test a range of the available cultivars as a post-rainy season crop, either on heavy soils which cannot be cropped during the rains or, as a second crop after early maturing rainy season crops. Unless and until this crop finds a consumer demand in the region there would appear to be little scope for it to be allocated any major research effort, manpower or funding.

X. COOPERATION IN AGRICULTURAL RESEARCH BETWEEN THE SADCC COUNTRIES

There have been close technical links in agricultural research between all SADCC countries (except Tanzania) through their common membership of the Southern African Regional Commission for the Conservation of the Soil (SARCUSS) which has its headquarters in Pretoria, South Africa. Since its inception in 1950 SARCUSS has promoted and facilitated (a) a continuous interchange of technical and scientific information expertise and know-how between its members; (b) regional conferences of a specialist or general nature; (c) exchange of visits by research staff to member-countries; (d) studies of problems common to several or all member-countries and the initiation of a coordinated, cooperative resolution of such problems. In crop production SARCUSS was particularly active in (a) the exchange of information from research work in progress in the member states, through regular meetings and conferences of research workers (b) exchange of plant material, including breeding material between member states, and (c) the establishment of a cooperative network of regional crop evaluation trials.

Zambia ceased to be a member of SARCUSS sometime in the 1960's while Angola and Mozambique stopped participating in 1975. With the recent withdrawal of Zimbabwe, active participation in SARCUSS by the remaining members is in doubt.

Tanzania had strong agricultural research cooperation with Kenya and Uganda through the East African Agricultural and Forestry Research Organization of the East African Community. The break-up of this in 1977 ended all links and cooperation between these three countries.

The Mission was informed that the SADCC countries had agreed in September 1980 to convene a meeting of officials to assess the need for, and feasibility of, an organisation concerned with technical cooperation in agricultural research and development. The Mission believes that such an organisation promoted by the independent countries themselves would improve communication and transfer of technology between ICRISAT and the countries of the region.

XI. RECOMMENDATIONS FOR ICRISAT INPUT IN SOUTHERN AFRICA

Regional Center

The proposal that ICRISAT should set up a Southern Africa Regional Center to serve the SADCC member countries needs to be critically examined to determine whether this would provide the most useful and cost-effective development when compared with possible alternatives. Firstly, would Botswana be the most productive location; and secondly, would a "Center" be the most efficient means for ICRISAT to help in this region?

A "Center" that could adequately cover the ICRISAT objectives and crops for this region would require a site with land, climate and facilities that would enable a wide range of the available germplasm of all or most of the mandate crops to be grown, preferably with the capability of producing more than one generation each year, so as to accelerate the progress of the breeding programs. Much of Botswana lies outside the tropics and so has a relatively short growing season, during much of which the days are relatively long. Under such conditions only a relatively restricted range of germplasm can be grown with only one generation in each year. A site in northeast Botswana would partially ameliorate some of these problems, but in that area communications would be difficult and there is no well established infrastructure or development. Further, Botswana appears to have little potential or current interest in the ICRISAT mandate crops with the exception of sorghum.

The SADCC countries range from near the equator (Tanzania) to about 30°S (Lesotho) covering a very wide range of climates, photoperiods and soils. A single "Center", particularly if sited in Botswana, would appear to be of limited utility in serving such an area, particularly since the countries with large semi-arid tracts and potential for more than one of the ICRISAT mandate crops (Malawi, Mozambique, Tanzania, Zimbabwe and Zambia) are all situated to the north of Botswana.

The expense of setting up a "Center" with its attendant services and infrastructure has to be weighed against the likely benefits that might accrue, against the existing research center availability and against alternative proposals for research and development. ICRISAT already has a well equipped center in India at which the germplasm of the mandate crops are maintained and utilised in breeding programs that aim to produce selections with resistance to the specific biotic and abiotic production constraints, new genetic combinations and segregating material with wide ranging variability. The materials generated from this center are distributed, to scientists in regional and national programs, for local selection and adaptation. ICRISAT is also building a Center in West Africa at Niamey in Niger which will be relatively small but will supplement the efforts of the main ICRISAT Center with particular emphasis on the problems of the Sahel. These Centers are situated at 17° and 13°N and so can produce genetic materials particularly suited to the photoperiods, and partially for the climates, of much of the central areas of the SADCC countries. If ICRISAT were to set up another center in Africa or elsewhere it would probably be of most benefit if it were established close to the Equator, for at present ICRISAT has no site where materials adapted or restricted to nearly constant 12 hour photoperiods can be generated and evaluated.

Given all of these obvious limitations that an ICRISAT Center in Botswana would face, the Mission advises that such a center would not appear to be the best vehicle for ICRISAT input in the SADCC countries. In discussions in Botswana with the concerned agriculturalists and administrators the Mission was pleased to learn that they had also fully considered most of these points and had independently come to the conclusion that an ICRISAT "Center" in Botswana would not be the most logical contribution to filling the agricultural research needs of the SADCC countries. They were however, anxious that Botswana and ICRISAT should play a leading role in coordinating advances in agricultural research and development, particularly for the semi-arid areas of the region, as requested by the Heads of Governments in the Lusaka declaration (refer to Regional Coordinating Unit on page....).

Regional Research Teams/Units

The Mission is convinced that ICRISAT (and other CGIAR Institutes) can play a major constructive role in agricultural research and development for the SADCC countries by siting Regional Research Teams or Units, each specialising on one or more of the ICRISAT mandate crops or programs at carefully chosen locations. To be most cost-effective such Units should be sited at national research stations where there is already a relevant and productive national program and where communications to the rest of the SADCC countries and to the ICRISAT Centers are good. In such circumstances these Units would benefit from the established infrastructure, materials and knowledge of the national programs. The role of such Units would be to develop and transfer cultivars and knowledge to the other national programs of the region, to assist in strengthening national research capabilities through training, and to promote and facilitate regional cooperation in the ICRISAT crops and programs. To fulfil these roles, it would be essential to develop an effective mechanism of ensuring that the regional teams work closely with every concerned country research program.

Groundnut Research Unit

ICRISAT has already recognised the specialised needs of this region with regards to groundnuts. Negotiations for establishing a Groundnut Research Unit to serve the regional needs for this crop were already well advanced before the Lusaka Declaration. It has been decided that this effort could be most usefully sited in Malawi, where it would benefit from the well established and productive national program. The Unit is intended to act as a channel for exchange of materials and knowledge not only across all the groundnut-growing countries of this region but also to and from the other regional and international groundnut research and development projects.

As already planned before this Mission, the Groundnut Unit will initially have a breeder and a pathologist, and will be funded, hopefully, by the IDRC. The Mission recommends that funds from other sources be sought so that the Unit can be developed to include an entomologist and a physiologist. This Unit is of obvious importance for it could be taken as a model for the development of other ICRISAT Units in the SADCC countries.

Sorghum and Pearl Millet Research Units

There is a clear need and opportunity for ICRISAT to establish regional inputs for Sorghum and Pearl Millet. Most SADCC countries have a major interest in expanding sorghum production in the semi-arid areas. There is a more limited, but locally important, need to improve pearl millet production, particularly from the drier areas of some of the countries. It would probably be most effective and economical if a combined sorghum and millet regional unit could be initiated. Several locations would appear to be suitable, and advantageous from different aspects, for the siting of such a Unit but the Mission favours a location in Zimbabwe, either at Gatooma or near Gokwe.

In making this recommendation the Mission gave due consideration to the request that any new regional inputs should be sited in countries other than Zimbabwe, for that country already has a very well developed research capability and structure and there is an obvious need to spread the research capabilities through the region. While appreciating this viewpoint, the Mission considered that the overwhelming criterion for siting should be the likely productivity and effectiveness. The infrastructure, communications and central location of Zimbabwe, combined with the already well developed national program on these crops would give the Unit, if located in this country, the greatest potential for regional impact. The Mission recommends that the Sorghum and Pearl Millet Teams should each consist of a breeder, physiologist, entomologist and

pathologist. The idea is to have a team that would effectively develop research programs to deal with the various problems of each crop in the region. If funds are limiting the team could initially consist of a breeder for each crop and a physiologist, entomologist and pathologist to deal with both crops.

It is expected that ICRISAT will continue to develop its sorghum program that has already been established in Tanzania, and that the Zimbabwe and Tanzanian Units will maintain close links and complement each other's work.

Pigeonpea and Chickpea Research

There would appear to be no demand for Research Teams to work on either pigeonpea or chickpea at this time. However, ICRISAT should continue to actively encourage an expansion of interest in these crops in the SADCC countries where they can be productively grown, by supply of materials and information, training of national research workers, and by occasional visits.

Farming Systems Research

In Farming Systems Research, there are already extensive plans by one or more aid organisations to set up "farming systems" research and development teams in some of the countries of the region. These teams will generally be centered around socio-economics and extension agronomy and will act as two way links between on-farm developments and research. The Mission identified a need and opportunity for ICRISAT to usefully contribute in farming systems research, primarily in soil and water management. A Soil and Water Management Unit might usefully be established in Botswana where man, animal and tractor cultivation systems are already well established and there is an active interest in the provision and utilization of small-scale water catchments.

ICRISAT could also play an important support role to the fledging national "farming systems" research programs by training staff at ICRISAT Center, research advice and exchange of information.

Regional Coordinating Unit

The development of research units and the effective operation of regional research programs in the SADCC countries will need to be coordinated, preferably from an administrative base located in the region. The Mission recommends the establishment of a Regional Coordinating Unit which would probably be no more than an office housing an administrative coordinator (experienced scientist) supported by administrative and secretarial staff. Botswana has been given the responsibility for coordination of agricultural research activities in SADCC countries and appears to be a logical place for establishing the Coordinating Unit. The Unit would thus be able to liaise with Botswana in the development of ICRISAT activities in the SADCC countries.

If other CGIAR Institutes (see next item) set up regional research teams for improvement of the other important food crops -- maize, wheat, rice, cassava and beans -- the ICRISAT Coordinating Unit could be expanded into a CGIAR commitment that would facilitate regional work of the CGIAR Institutes.

Role of Other CGIAR Institutes in Southern Africa

The Lusaka Declaration of the Heads of Governments of the SADCC countries gave high priority to dealing with the problems of the fragile food supply and food security situation in the region. ICRISAT's mandate does not cover the other important food crops in the region, namely, maize, wheat, rice, beans and cassava. In all the countries visited by the Mission the view was expressed that concerted action by the International Agricultural Centers responsible for improvement of these crops could greatly improve the food situation in the region. To this end, it was expected that ICRISAT would encourage the participation of other CGIAR Institutes in the region.

It is noteworthy that, in response to the recommendations of a regional bean workshop held in Malawi in March 1980, CIAT is seeking funds to establish a 5 to 7 man bean improvement team in the region.

ANNEX II

JOB DISCRIPTIONS

PROJECT MANAGER

1. To represent the regional team to SADCC, SADCC countries, the ICRISAT Center, and the INTSORMIL Management Entity.

2. To be a member of the management entity of the SADCC coordinating center.

3. To be responsible for the day-to-day administration of the regional team. To organize a staff to assist with this activity.

4. To participate in the development of arrangements with the Government of Zimbabwe to host the regional team. This would include recognition of the project, privileges for the project and project staff, movement of people to and from the project (including individuals from within and outside of the SADCC region); etc.

5. To organize an annual workshop and take leadership in the organization of an annual progress report for the regional program.

6. To be himself a scientist and as the program matures and time permits undertake some research contributing to the functions of the team.

7. To be responsible for the purchase of equipment and spare parts. To be responsible for the final identification of land, the interactions with the host station, and the development of facilities (including working with contractors) to offset the added burden of the regional team on the host station.

8. To facilitate interactions with universities and other agencies in and outside the region that might contribute to such activities as socioeconomics, farming systems, food technology, bird control, etc. He would call on the staff of the regional program and others in the region to assist in making effective these interacting activities.

9. To assist in the identification and arrangements for consultants and for the organization of special seminars relevant to the objectives of the project. He would be assisted in these activites by the staff of the regional

project and other interested individuals in the region.

10. To have an important responsibility in interacting with the donors, including budgets and reports.

11. To interact with ICRISAT Center in relation to the various training opportunities offered at the Center, and also to call upon Center staff, particularly from the Training Program, to contribute to short-term training activities in the region. Also to interact with INTSORMIL on matters related to degree training.

12. To interact with ICRISAT Center and INTSORMIL with respect to staff amenities and their periodic modification, staff travel, accounting and auditing, etc. as deemed relevant.

The project manager would be the team leader and have primary responsibility to make possible the effective and harmonious working of the team and its interactions in the region. He should be a member of the team technically and encourage a situation where each scientist is self-expressing and creative. It is a position requiring demonstrated experience as a scientist and in the management of scientific activities.

SORGHUM AND MILLETS BREEDERS

1. To introduce and evaluate, on a continuing basis, breeding stocks and germplasm accessions from all over the world. Useful introductions would be provided to national programs for their use.

2. To develop high-yielding and stable varieties and hybrids for the areas in the region where these crops are found to be competitive. This would involve multilocation evaluation to identify those entries with the most stable performance.

3. To develop regional trials and nurseries for evaluation by national programs in the region.

4. To jointly evaluate, with scientists in country programs, their nursery and yield trial material as well as that provided by the regional program. To develop together plans for the future processing of these materials including the identification of parents for crossing for the selection of new lines, and in relation to the development of hybrids.

5. To conduct as a service regional crossing blocks and off-season nurseries to advance materials jointly selected in national programs and in the regional program.

6. To work closely with the entomologist and pathologist to ensure that breeding stocks are properly evaluated for resistance traits. To cooperate with the ICRISAT Center, INTSORMIL and other regional programs on Striga resistance; and also work in cooperation with local food technological research agencies for evaluation of more advanced breeding stock.

7. To assist seed production agencies, particularly as they begin to produce seeds of new varieties and hybrids. To contribute by assisting with the maintenance of pure type breeders seed. Also to contribute as required from time to time to issues related to seed certification and the seed law; particularly to encourage SADCC to have uniform standards across the region.

8. To maintain, evaluate, and use germplasm accessions. Breeders should also collect and contribute useful landrace material that they find while working in the region.

9. To work with local universities for the establishment and conduct of short-duration training programs. Also to serve as a guide for local students at universities within and outside of the region.

10. To help with the identification of locations in the region important for the most effective evaluation of varietal material in the crop improvement program.

11. To consult on a regular basis with national programs to help them establish the most effective crop improvement program. This would include program organization and facilities required for a national program.

12. To work closely with ICRISAT Center and INTSORMIL assisting with the evaluation of nurseries and trials and participating in the evaluation of new techniques and procedures. Also to work effectively with other agencies contributing to research in the region.

13. To cooperate with the production agronomist in terms of materials evaluated in both sole and intercrop situations and in the array of environments important to sorghum and millets in the region.

14. To cooperate with experiment station management and in efforts to improve conditions of field research at important sorghum and millet stations in the region.

15. To attempt to identify and encourage local sources of supply of expendable products, such as field tags, pollinating bags, and seed envelopes. Also to assist with supply of items such as field books, equipment for hand emasculation, etc.

16. To provide an effective regional coordination in terms of pedigree organization, selection criteria and note taking, testing procedures, release requirements, etc, as relevant and when contributing.

17. To provide effective discipline leadership for the region at the annual workshop.

The sorghum and millet breeders would be members of ICRISAT regional multidisciplinary team with a primary objective to develop superior varieties and hybrids for yield and yield stability and to contribute to the development of effective stable national program capability.

PRODUCTION AGRONOMIST

1. To determine the management best suited to new varieties and hybrids over the range of rainfall and soil conditions in the region. This can include sowing dates, seed rates, plant spacing in the field, fertilizer rates and application methods, etc. It can involve the use of irrigation.

2. To determine crop-limiting soil factors such as major and minor element deficiencies, acidity and aluminium toxicity problems, etc., and steps that might be taken to rectify the problem(s).

3. To work with the entomologist and pathologist to create the most effective screening procedures (for example, fertility and water control as related to the expression of charcoal rot); and to assist with the development of cultural practices in relation to control of disease, insect, and weed pests.

4. To assist national programs in developing the stature required to undertake appropriate agronomic work on sorghum and millets in their countries.

5. To work with universities in the region to conduct short-course training programs for sorghum and millets workers in the region. Also to serve as a guide for thesis research of local students at universities within and outside the region.

6. To cooperate in the improvement of experiment station field research capability at locations important for sorghum and millets.

7. To work closely with physiology and farming systems research at ICRISAT Center and adapt to local environmental conditions new techniques and procedures developed there and elsewhere.

8. To provide effective leaership for the discipline at the annual workshop.

The production agronomist would be a member of the ICRISAT team with responsibility to develop and manage high yielding stable varieties and hybrids in the region. He would also be responsible for developing national capability in his discipline.

PATHOLOGIST AND ENTOMOLOGIST

1. To determine the importance of the various insect and disease pests on sorghum and millets and to identify locations where breeding stocks and germplasm can be evaluated for resistance.

2. To learn of pest-plant-environment interactions to be able to most effectively evaluate breeding stocks and germplasm for resistance. Such studies would also be important to the development of pest control by cultural practices and possibly chemicals. These studies would include such things as population dynamics or disease severity at different times of the year (leading to the most effective planting date for screening); they would contribute to a study of mechanisms of resistance, look at alternate hosts, and predators and parasites. They could adapt useful techniques from ICRISAT Center and elsewhere to local environmental conditions. Studies, as mentioned above would be relevant.

3. To keep a constant vigilance for shifts in disease and insect pest problems, particularly susceptibilities of promising new breeding stock. This would be part of an effort to avoid release of any varieties or hybrids that would increase the incidence of pest problems in the farming community.

4. To work with national programs to develop their own effective capability to deal with insect and disease problems. The current capability is very poor and it can be expected that this would be a continuous effort over time.

5. To assist universities in the region to conduct training programs and serve as advisors for thesis research of local students at universities within and outside the

region.

6. To work with the coordinating unit of SADCC on such issues as plant quarantine, with climatology on the prediction of epidemics and epiphytotics, and assist with the stablizastion of certain screening nurseries to be regional in scope on a continuing basis.

7. To conduct, as a service, various field screening nurseries made up of entries from national programs of SADCC countries, entries from the regional programs, and entries introduced from outside of the region which are suspected to be valuable as a source of resistance for important traits (this would include nurseries from ICRISAT Center, INTSORMIL, and possibly others).

8. To provide effective leadership for the disciplines at the Annual Workshop.

The pathologist and entomologist would be part of the regional team for southern Africa. They would participate as members of a multidisciplinary team working toward a common goal of providing high-yielding and stable varieties and hybrids. They would also be responsible for work directly related to their specializations to make their research contribution most effective and to strengthen their disciplines in the region.

ADMINISTRATIVE OFFICER

This official would have responsibility for:

1. maintenance of accounts,
2. preparation of budgets,
3. disbursement of funds,
4. purchasing,
5. personnel activities,
6. vehicle allocation and maintenance, and
7. supervision of administrative staff.

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TRAINING AT ICRISAT

Annex III

ICRISAT
Patancheru P.O.
502 324 A.P., India

ICRISAT was established in July 1972 at Hyderabad, India. It is located 28 Km west of Hyderabad on the Hyderabad-Bombay highway. The Research Institute contains 1394 hectares provided by the Indian Government. The Institute has the two major soil types of the semi-arid tropic countries, the vertisols and alfisols.

The mandate of ICRISAT is to :

1. Serve as a world center for the improvement of grain yield and quality of sorghum, pearl millet, chickpea, pigeonpea and groundnut and to act as a world repository for the genetic resources of these crops.
2. Develop improved farming systems that will help to increase and stabilize agricultural production through more effective use of natural and human resources in the seasonally dry semi-arid tropics.
3. Identify constraints to agricultural development in the semi-arid tropics and evaluate means of alleviating them through technological and institutional changes.
4. Assist in the development and transfer of technology to the farmer through cooperation with national and regional research programs and by sponsoring workshops and conferences, operating training programs and assisting extension activities.

ICRISAT has established training programs (since 1974) to improve background and qualifications of agriculturists in cooperating programs concerned with the mandate. Scientists in plant breeding, physiology, entomology, pathology, microbiology, socio economics, land and water management, crop production and management and extension methods collaborate in ICRISAT's research and training programs.

TYPES OF TRAINING AND OBJECTIVES

ICRISAT has tailored its training programs to meet the diverse needs of cooperative programs in the semi-arid tropics by establishing broad categories of training.

IN-SERVICE FELLOWS

This program was established for scientists (with a BSc, MSc or PhD) who have been employed as leaders in a country program. Objectives are :

- To provide mid-career scientists an opportunity of working with senior research scientists in on-going research and development programs.
- To acquaint these scientists with the recent developments, approaches and techniques in their area of expertise and employment.

RESEARCH FELLOWS

This program was established for scientists who have recently completed their academic training to a MSc or PhD degree. Objectives are :

- To provide an opportunity of working with senior research scientists.
- To acquaint these professionals with the most recent research developments, approaches and techniques.
- To provide interested professionals an opportunity to do research on a specific problem related to ICRISAT's overall research program.

RESEARCH SCHOLARS

This program is designed for MSc or PhD degree candidates from or interested in working in the semi-arid tropics. Candidates complete course work at selected universities and conduct research for their MSc dissertation or PhD thesis at ICRISAT. They are supervised by senior scientists who are approved as their research guides. Objectives are :

- To give promising students an opportunity to develop competence in technical and managerial skills and techniques in crop breeding, physiology, pathology, entomology, microbiology, socio economics, farming systems and other sciences related to increased and stabilized food production in the semi-arid tropics.
- To provide formal training opportunities leading to an advanced degree for students planning for careers in scientific agriculture in the semi-arid tropics and interested in conducting research on a specific problem within ICRISAT's mandate.

IN-SERVICE TRAINEES

To meet the very specialized needs of particular individuals and cooperating institutions, short-term (up to 6 months) training programs are designed in collaboration with cooperating agencies in the semi-arid tropics.

While the areas studied must fall within ICRISAT's research and support activities, approach and depth of treatment are tailored for managers, scientists, agriculturists, administrators, or others engaged in specialized activities. While there are no specific academic degree requirements, candidates must be engaged in jobs directly related to increasing and stabilizing food production in the semi-arid tropics.

CROP IMPROVEMENT : The program is designed to provide opportunities to :

- Learn breeding techniques for improving and stabilizing yields.
- Assess and learn to utilize the potential of the germplasm available for use in the semi-arid tropics.
- Practice and learn breeding techniques and requirements for efficient and effective identification and utilization of resistances to factors which reduce production in the semi-arid tropics.
- Develop skills in organizing and managing a successful breeding program.
- Work and study with crop improvement scientists.

..2../

CROP PRODUCTION : The program gives trainees an opportunity to :

- Gain practical skills for increasing crop production in the semi-arid tropics through an integrated approach to natural and human resources.
- Assess improved cropping and management procedures and learn how to adapt them to local conditions in ever changing environments.
- Learn to identify and reduce adverse influences that limit crop production in rainfed semi-arid tropics.
- Develop an appreciation of the role and the importance of utilizing social, cultural and economic factors in improving agricultural production.
- Develop the ability to use extension techniques for communicating new and improved technology for increased and stabilized food production.

FARMING SYSTEMS : The program is to provide opportunities to :

- Develop research skills in natural resource utilization related to catchment area development for improved land and water management.
- Become proficient in production factors, research methods and techniques related to agronomic practices, cropping systems, soil fertility, soil physics, plant protection, farm power, machinery, socio economics and management skills to ensure increased and stabilized food production for the rainfed simi-arid tropics.

SHORT-TERM TRAINING : Short-term special training is offered in entomology, pathology, physiology, farming systems, agricultural economics, seed production and agricultural engineering as required and negotiated with cooperating institutions. Limited opportunities for short-term apprenticeships in selected disciplines are available where applicants have their full personal support.

COURSE SCHEDULE

In-Service Fellows	-	1 to 6 Months		
Research Fellows	-	1 to 2 Years		
Research Scholars	-	1 to 2 Years (depends on arrangements made with Universities and the thesis research proposal.)		
In-Service Trainees :				
. Crop Improvement - Sorghum, pearl millet, groundnut, pigeonpea	-	15 May to 15 Nov	-	6 Months
Sorghum, pearl millet, groundnut, pigeonpea, chickpea	-	15 Sept to 15 March	-	6 Months
. Crop Production - Sorghum, pearl millet, groundnut, pigeonpea	-	15 May to 15 Nov	-	6 Months
Chickpea, pigeonpea	-	15 Sept to 15 March	-	6 Months
. Farming Systems	-	15 May to 15 Nov	-	6 Months

ADMISSION REQUIREMENTS

To qualify for the ICRISAT Training Program, candidates must :

- Be nominated and sponsored by an agency or institution working in the semi-arid tropics.
- Have requisite academic training, experience and performance records. Recommendations of sponsoring agencies are evaluated against training opportunities and facilities.
- Be willing to study or conduct research or field production trials in subject areas compatible with ICRISAT's mission and the cooperating and sponsoring agencies' programs.

Trainees are expected to have an adequate command of English, the primary medium of instruction. An intensive English course for candidates from non-English speaking countries may be undertaken for two months in Hyderabad prior to beginning an ICRISAT training program.

NOMINATION AND SPONSORING AGENCY

Candidates are ordinarily nominated by the agency or organization which employs them or guarantees to employ them. These agencies or organizations may also be the sponsor or may seek sponsorship from a funding institution. Normally, the sponsor will provide funds to cover :

- Travel of the trainees to and from ICRISAT.
- An incidental allowance for the trainee's personal expenses.
- Room, food, medical insurance, training and other expenses while in residence in Hyderabad.

ICRISAT has a limited number of partial or complete scholarships. Agencies may apply for these on behalf of their candidates.

ACCOMMODATIONS

Single dormitory rooms to accommodate 140 persons and 16 two-room furnished flatlets are located on the research center. A cafeteria and two canteens are provided on campus for the purchase of food. An ICRISAT shuttle bus system is operating from the research center to the city on a limited schedule. Recreation facilities (swimming, basket ball, foot ball, cricket, lawn tennis, table tennis and other games), reading room and a reference library are available.

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CONSTRUCTION AND CENTER DEVELOPMENT

A. BUILDINGS

		$	$
1. Housing			
a. Professional staff	8 Nos. x $ 50,000	400,000	
Furnishings	8 Nos. x $ 15,000	120,000	520,000
b. * Middle level housing equivalent to Ministry of construction F-12			
	34 Nos. x $ 18,000	612,000	
Electricity, water, sewage			
	34 Nos. x $ 1,200	40,800	652,800
c. **Lower level housing equivalent to Ministry of Construction F-13			
	55 Nos. x $ 11,000	605,000	
Electricity, water, sewage			
	55 Nos. x $ 1,000	55,000	660,000
		Total	1,832,800

* Middle level staff housing for

3 Lab. Assistants
9 Research Technicians
9 Field Assistants
1 Computer Operator
1 Farm Superintendent
1 Registered Mechanic
1 Store Keeper
1 Executive Officer
3 Secretaries/Steno
2 Accounts Clerks
1 Electrical and A/c Technican
2 Chief Handy Men

34

Lower staff housing

2 Tractor Drivers
8 Driver-cum-General Assistants
1 Mechanic Helper
39 General Hands
1 Messenger
1 Handy-man Helper
3 Janitorial Helpers

55

(5 lady secretaries are expected to stay with their husbands, so no housing provision has been made for them)

2. Office and Laboratory buildings

1.	Office staff & reception	10 Nos. x 12 x 12 = 1440
2.	Office, Secretary	7 Nos. x 10 x 12 = 840
3.	General storage	1 Nos. x 12 x 12 = 144
4.	Computer/Photocopier	1 No. x 12 x 12 = 144
5.	Dark room	1 No. x 10 x 12 = 120
6.	3 Toilets 1 No. x 10 x 12;	2 Nos. x 10 x 6 = 120
7.	Kitchen	1 No. x 12 x 12 = 144
8.	Dining room	1 No. x 20 x 12 = 240
9.	Library/Conference Room	1 No. x30.5 x 30 = 915
10.	3 Laboratories	3 Nos. x 25 x 12 = 900
11.	Glass ware/Chemical storage	1 No. x 12 x 12 = 144
12.	Research Assistant Office	5 Nos. x 12 x 12 = 720
13.	Research Technician	2 Nos. x 12 x 12 = 288
14.	General workroom	2 Nos. x 12 x 12 = 288
15.	Electrical room	1 No. x 7 x 6 = 42
16.	Janitor storage	1 No. x 7 x 6 = 42
17.	Plant room (cool heat)	1 No. x 10 x 12 = 120
18.	Corridors	1 No. x290 x 6.5= 1885
		8536 Sq.Ft.

	$
8536 Sq.Ft. = 793 Sq.Mt x $388 =	307,684
= 10% contingencies	30,768
	338,452
or say	338,450

3. Seed storage and processing building

	Feet	Sq.ft.		
Crop work area	40 x 40	1600		
Fertilizer store	24 x 17	408		
Farm Chemical store	10 x 17	170		
General storage	24 x 17	408		
Corridor	6 x 34	204		
Cold storage room	46 x 40	1840		
Office & storage	10 x 17	170		
		4800		
4800 Sq.ft. = 446 Sq.Mt. x $121 =			$ 53,966	$
+ 5% contingencies			2,698	
				56,664
Seed drier	10 x 12	120		
120 sq.ft. = 11 sqMt. x $75 =				825
Cold stores 29' x 6" x 16'9" (seed), prefabricated with refrigation units and dehumidifiers: (similar to Watford Refrigation U.K.)				
FIC = Installation			30,500	
Mobile seed storage shelves (similar to Brown built Ltd., Australia)				
FIC + Installation			7,800	
			38,300	
Total $ 38,300 x 2			76,600	76,600
Total for seed storage and processing building				134,089
			or say	134,090

			$
4.	Field shelters and crop work area		
	3 Nos. x 6 Mts. x 12 Mts. x $75 =		16,200
5.	General stores 130 sq. mts. x 80 =	10,400	
	Shelving	5,600	16,000
6.	Glass houses (2nd year)		
	3 Nos. glass houses	120,000	
	Evaporative coolers 10 per house 3 x 10 x $1,000	30,000	
	Water sources and circulative pumps	10,000	
	Supplementary heating	12,000	
	Metal benches	10,000	
	Pots and miscellaneous tools	7,500	
	Soil sterilization equipment	10,000	
	Water De-ionization unit	8,000	
		207,500	
	+ 30% freight	62,250	
		269,750	
	Head house 8x20 = sq.mt. 160 x $111	17,760	
	+ 5% contingencies	888	
		18,648	
	Total glass houses & equipment		288,398
7.	Shops, spare parts and farm machinery storage buildings		or say 288,400

	Sq.Ft.
Farm machinery storage 40 x 100' (including 10 mtr.toilet and change room)	4,000
Parts storage 28 x 40'	1,120
Vehicle & machinery maintenance shop (including 8 x 10' battery room) 40x40	1,600
Fabrication and machine shop 20 x 30	600
Electrical & A/C & Instrument shop 20x30	600
Carpentry & paint shop 20x30	600
Civil maintenance shop 20 x 30	600
Office, Farm supervisor 10x12	120

Office, stores officer 8 x 12	96	
Office, Machinery maintenance 10 X 12	120	
Receiving bay 12 x 12	144	
	9600 Sq. Ft. =	
	892 Sq. mt. x $ 121/mtr.=	
9600 Sq. ft. = 892 Sq. mtr. x $ 121		107,932
Shelving etc.		12,000
		119,932
	or say	119,930

TOTAL COST FOR BUILDINGS:

1.	Housing	1,832,800
2.	Office and laboratory buildings	338,450
3.	Seed storage and processing building	134,090
4.	Field shelters and crop work areas	16,200
5.	General stores and shelving	16,000
6.	Glass houses and equipment	288,400
7.	Shops, spare parts and farm machinery storage buildings	119,930
		2,745,870
	Incidentals 5%	137,290
		2,883,160

After December 1983 and 2½% per month.

B. STATION DEVELOPMENT

Electric lines and transformers	$11,000.00	
Electric motors and pumps	5,500.00	
Security fencing	40,000.00	
Survey and mapping	2,000.00	
Land shaping	20,000.00	
Underground A.C. irrigation pipe and valves	48,800.00	
Irrigation water storage tank (200,000 gal.)	11,000.00	
Miscellaneous and general tools	10,000.00	
2 Telephone lines	850.00	
Internal telephones and switchgear	30,000.00	
Roads	10,000.00	
Water lines to office, glass houses and other buildings	6,500.00	
Landscaping	2,000.00	
Total for Station Development		$197,650

C. FARM EQUIPMENT

(1)	70 HP Tractor with following accessories - Dual rear wheels front end weights, dual hydraulic valve for operation of 2 remote cylinders, lights	$ 25,000
(1)	60 HP Tractor high clearance with lights Dual hydraulic for operator 2 remote cylinders, wheel weights and front weights	$ 18,000
(2)	4 Row Ridger	$ 4,500
(1)	Cultipack with transport wheels	$ 2,500
(1)	Disc harrow 10 ft. offset with wheels, hydraulic cylinder with pipes	$ 8,000
(1)	Disc harrow 8 ft. offset with wheels hydraulic cylinder and pipes	$ 6,500
(1)	JD 4 row 7100 planter with Oyjord cones and special adaptations	$ 11,000
(2)	Rolling cultivator (4 rows)	$ 7,000
(1)	Applicator, fertilizer/side dressing	$ 3,500
(1)	Back fill blade, heavy duty with hydraulic tilting jacks	$ 3,000
(1)	Rotary Chopper 8 ft.	$ 4,300
(1)	Rotary Chopper 6 ft.	$ 3,500
(1)	Heavy duty land plane for 70hp tractor	$ 7,800
(1)	Bucket scraper for 70hp tractor with independent hydraulic operated front apron - eject unloading and bowl height adjustment	$ 6,000
(1)	Sprayer (tractor mounted)	$ 3,000
(1)	Seed Dryer (heat source)	$ 8,000
(1)	4 wheel farm wagon with metal bed & sides	$ 3,500
(1)	4 wheel wagon for irrigation pipe transport	$ 2,000
(1)	Reversible moldboard plough (4 bottom)	$ 7,200

EQUIPMENT - (contd)

		$
(1)	Reversible moldboard plough (3 bottom)	5,800
(2)	Trailors, 5 ton (hydraulic tipping)	6,500
(2)	Weighing scales	3,500
	Irrigation equipment -	
	Gated pipe & transmission line for 10 ha	75,000
	Sprinkler pipe & dptinklrtd got 2 ha	10,000
(1)	Irrigation pump (diesel)	6,000
(1)	Back hoe, for 70 hp tractor	10,900
(1)	Industrial type front loader with 4 in 1 bucket, for 70 hp tractor	7,600
(1)	Model D7E Cat Buldozer (USAID) Excess Property (Stock No. 2410-782-1130)	25,000
(1)	Scraper for D7E (USAID Excess Property)	9,000
(2)	Plot threshers	14,000
(1)	300 Gallon water tanker and trailer	3,700
	Radios 1 base station & 8 mobile units	12,000
	Miscellaneous hand tools etc.	3,000
		326,300
	Spares 10%	32,630
		358,930
	Freight 25%	89,730
		448,660

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D. SHOP EQUIPMENT : SERVICE AND REPAIR

Item	Qty.	Unit Price	$ Total $
Jack stands	4	15	60
Sted Ramps	1 Set	50	50
Jack (12 ton)	1	75	75
Jack (20 ton)	1	110	110
Grease Gun	2	15	30
Floor Jack (Service) 1 ½ ton	1	175	175
Bucket type grease gun (6000 lb (6,000 lb./sq.in)	1	233	233
Jumper cables	1	25	25
Engine test equipment	1	100	100
Battery charger 230 V, 30 amp	1	170	170
Hand trucks	3	45	135
Trouble light	1	15	15
Shelf truck	1	60	60
Radical saw	1	500	500
Wood lath	1	300	300
Jointer-Planer	1	480	480
Band saw	1	350	350
Belt sander	1	300	300
Drill press	1	350	350
Bits	2 Sets	60	120
Gas welding	1	190	190
Arc welding	1	190	190
Work bench	2	175	350
Vise	2	65	130
Claw Hammer	2	12	24
Hammer, Blacksmith (5 lbs)	2	52	104
Hammer, Blacksmith (10 lbs.)	2	76	152
Hand plane (Jack)	1	30	30
Hand saws	2	16	32
Soldering	1	25	25
Wood Chisels	1 set	35	35

Shop Equipment: Service and Repair

Item	Qty.	Unit Price	$Total$
Metal Chisels	1	65	65
Clamps	4	10	40
Pipe wrench	2	23	46
Anvil (50 lb.)	1	80	80
Hand drills	2	60	120
Pipe cutter (½" to 2")	1	66	66
Skill saw	1	75	75
Pipe threading set (⅛" to 2")	1	360	360
Belt sander (hand)	1	110	110
Calipers (Set of three)	1 set	7	21
Tool set (211 pieces) + chest	1 set	750	750
Tool set (96 pieces)	1 set	100	100
Hack saw (hand)	1	10	10
Wrecking bar (30")	1	60	60
Pinch bar (60")	2	152	304
4 plier set	2	25	50
Screw driver sets (21)	2	35	70
Manual gear hoist	1	120	120
Portable power pull	1	30	30
Transit	1	400	400
Rod for transit	1	85	85
Tripod for transit	1	110	110
Vernier (calipers)	1	30	30
Combination square	1	55	55
Micrometer	1	50	50
Arbor press	1	220	220
Air compressor	1	1100	1100
Paint sprayer	1	70	70
Mechanics tool chest	2	30	60
Extension ladder	1	80	80
Step ladder	1	50	50
Wheel puller	1	60	60
Body grinder/sander	1	125	125

Shop Equipment: Service and Repair

Item	Qty.	Unit Price	$Total$	
Miscellaneous tools: reamers, plumbing tools, carpenter hand tools, chains, chain binders, tire tools, etc.			3500	
Drafting equipment			350	
Machine Shop:				
Lath 8" with tools	X			
Small Shaper	X			
Pull max Metal worker	X	(USAID Excess Property)	12000	
Milling machine	X			
Metal Hack saw (power)	X			
	X			
Electric, AC and Electronic test equipment			2850	
Miscellaneous stock of nuts & bolts			275	
				28,847
			or say	28,850

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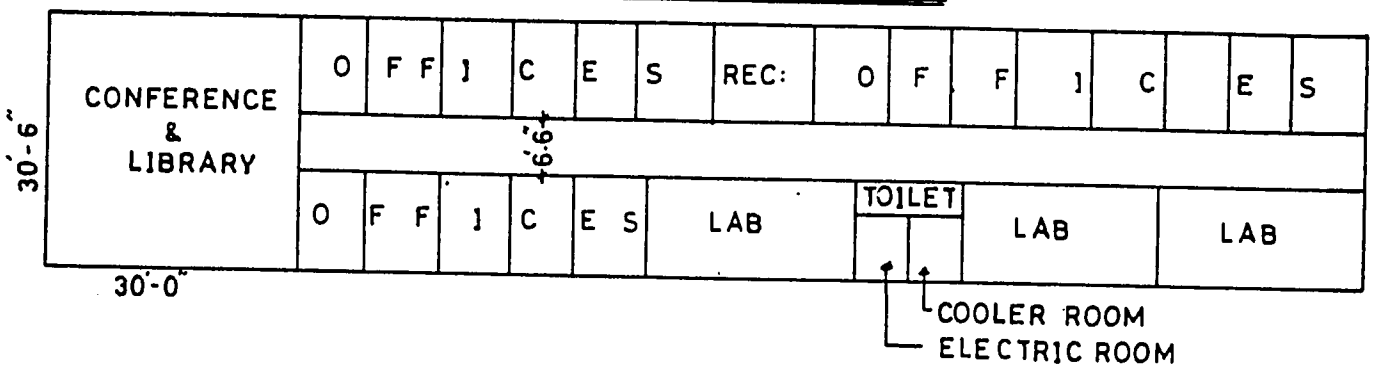
E. BUILDING & LAWN MAINTENANCE EQUIPMENT

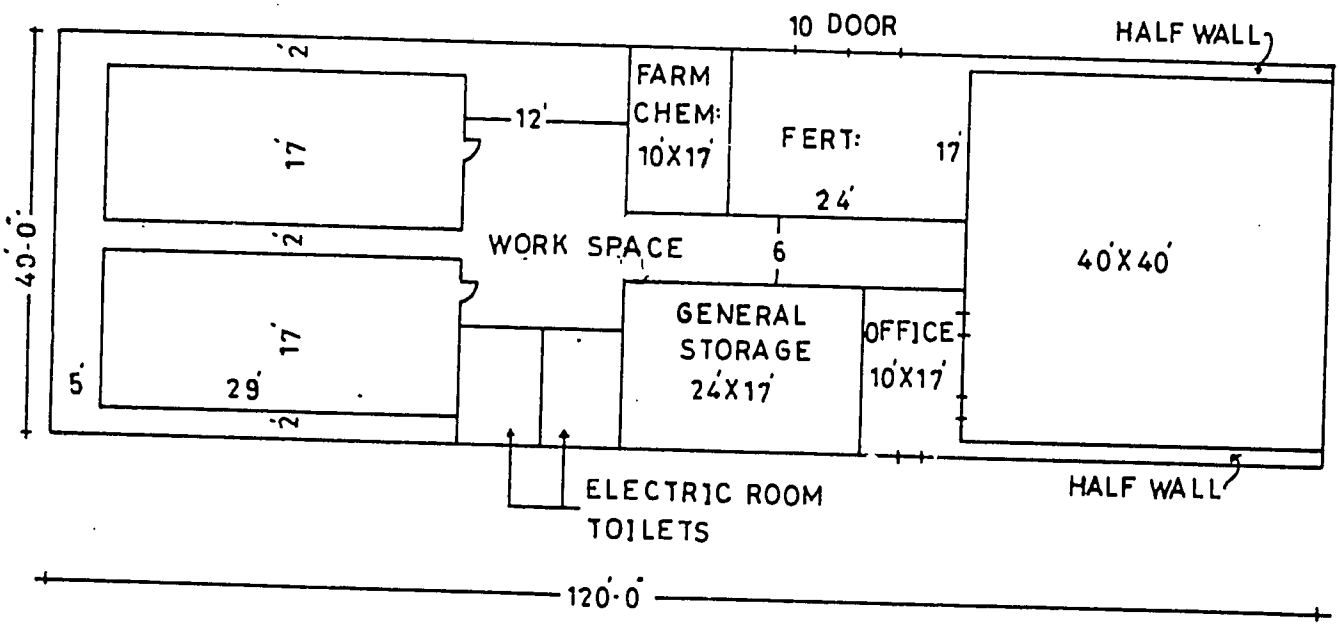
2 Nos. Cleaner vacuum portable (Advance Papoose vacuum machine), Model No.HA 500X-5, 230 V, with 1 HP motor vacuum system filter/ collector bag blower switch cable and belt clip	=	430.00	
1 No. Cleaner Carpetwin vacuum, 20" Swaths, complete with standard attachments 230 Volts	=	421.00	
1 No. Cleaner (floor scrubber) (advance foamatic shampoo machine),with brush drive motor, air supply system, solution tank, brush from delivery hose and other attachments.	=	566.00	
1 No.Cleaner, hydro vac wet & dry (advance hydro vac.wet & dry, 230 volts, single phase, 12 gallon capacity complete with square tank automatic shut-off, 30' cable and other attachments		498.00	
1 No. Industrial vacuum cleaner, engine powered(advance roamer 36" gas vacuum sweeper,complete with intake housing wheels and castors. impellor blower housing with safety deflector collector bag handle twine guard	=	902.00	
2 Nos. Heavy duty lawn mowers push type mower plus leaf and grass catcher		526.00	
Miscellaneous hand tools, lawn sprinklers etc.		4,800.00	
			8,143
		or say	8,140

F. VEHICLES -		$
4 Wheel drive (land rover type)	9500 x 1 No.	9,500
Pickup, long wheel base	4500 x 7 Nos.	31,500
Station Wagon	8500 x 8 Nos.	68,000
Mini Bus, 25 seater	12,800 x 2 Nos.	25,600
Motor cycles 8 main station, 7 sub-station)	500 x 15 Nos.	7,500
Truck heavy duty, cab over engine Long wheel base	15,000 x 1 No.	15,000
Heavy duty tilt bed trailor for transportation of tractors and farm equipment	6000 x 1 No.	6,000
		163,100
10% Initial spare parts	..	16,310
		179,410
Freight 25%	..	44,850
		224,260

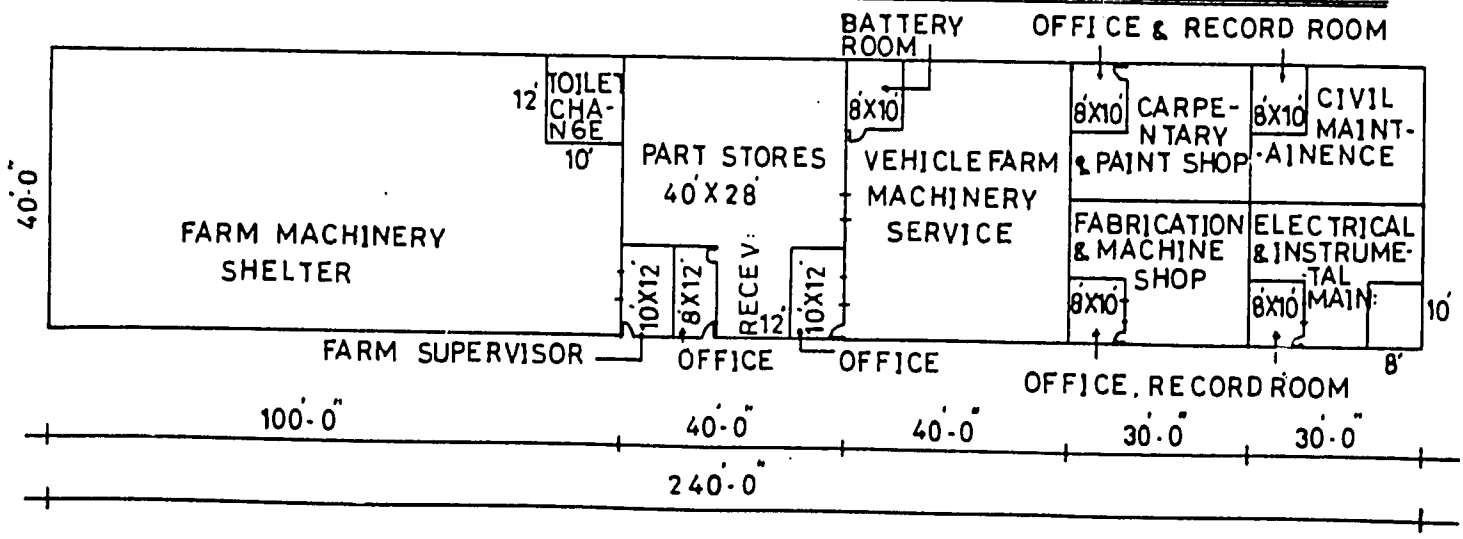
OFFICE & LAB BUILDING



SEED STORAGE AND PROCESSING



SHOP, SPARE PARTS AND FARM MACHINERY STORAGE BUILDING



MEMORANDUM OF AGREEMENT BETWEEN

THE INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS (ICRISAT)

AND

INTSORMIL - THE MANAGEMENT ENTITY OF THE SORGHUM/MILLET COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)

This agreement was made and entered into on June 23, 1983 between the International Crops Research Institute for the Semi-Arid Tropics (hereinafter referred to as ICRISAT) and the Management Entity for the Sorghum/Millet Collaborative Research Support Program (CRSP), located at the University of Nebraska/Lincoln (hereinafter referred to as INTSORMIL).

ICRISAT has a mandate from the Consultative Group on International Agricultural Research (CGIAR) to develop improved crops and cropping systems in the semi-arid tropics, for five crops - Sorghum, Millet, Pigeonpeas, Groundnut, and Chickpeas. To carry out this mandate, it conducts research and related activities at a Center located near Hyderabad, India, and at a number of other sites in the semi-arid tropics.

INTSORMIL conducts research on sorghum and millets with major support from a CRSP grant from the U.S. Agency for International Development. INTSORMIL operates as an associated group of U.S. Land Grant Universities, in collaboration with host country research institutions in developing countries, and with international agricultural research centers. Its principal objective is to improve human nutrition through research and technology development with its subject crops.

Since the research objectives of ICRISAT and INTSORMIL cover the same two crops (Sorghum and Millet) and are closely similar in many respects, this Memorandum is considered appropriate to record the intentions of the two organizations to collaborate closely in an appropriate manner, to maximize the effect and efficiency of each.

In principle, ICRISAT and INTSORMIL agree to cooperate wherever possible in the planning, execution and reporting of research related to sorghum and millet. Each organization will retain its own integrity, funding and operational procedures, but joint or cooperative activities will be conducted

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where feasible and appropriate. These activities will take three general forms:

a. In ongoing research activities based at ICRISAT Center and INTSORMIL institutions, collaboration between scientists of the two organizations will be mutually encouraged, on a continuing basis. If such collaboration is in the framework of approved budgets, no special further agreement between directorates of the two organizations will be required.

b. In host countries where the two organizations are operating under separate host country agreements and with separate funding-ICRISAT and INTSORMIL scientists operating in such countries will be expected to cooperate to the maximum possible extent. Here also, no further special agreements normally will be required.

c. In cases where it appears appropriate to the directorates of the two organizations, ICRISAT and INTSORMIL may enter into formalized joint operation, either with shared funding or with funding from individually available sources, according to appropriate specific subagreements and work plans. This class joint activity will in each case require approval by the Director General of ICRISAT and the Program Director of INTSORMIL.

Unless specifically provided for in separate subagreements, ICRISAT and INTSORMIL each will normally provide salary, support, research expenses, and travel costs for its own staff personnel. However, nothing in this agreement is intended to restrict reciprocal staff visits, staff study leaves, professional exchange on a short-term basis, or participation in collaborative activities, in cases where one organization is willing to fund activities of an individual staff member of the other.

Each organization hereby agrees to share information with the other concerning future plans likely to have an effect on collaborative activities. To this end, appropriate representatives of ICRISAT will be invited to attend

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major planning and review sessions of INTSORMIL, and vice versa. Costs of travel to such sessions will be borne by either or both organizations, as mutually agreed in advance.

This agreement may be amended by mutual agreement at any time or terminated by either party on provision of ninety (90) days written notice to the other party.

Signed at Patancheru (near Hyderabad), India, this 23rd Day of June 1983.

L. D. SWINDALE

DIRECTOR GENERAL - ICRISAT

Earl R. Leng

EARL R. LENG

PROGRAM DIRECTOR - INTSORMIL

1ST SUB-AGREEMENT TO GENERAL MEMORANDUM OF AGREEMENT BETWEEN ICRISAT AND INTSORMIL, TO PROVIDE FOR OPERATIONAL COLLABORATION ON A REGIONAL RESEARCH PROGRAM FOR SOUTHERN AFRICA

1. This Sub-Agreement is executed under the provisions of a Memorandum of Agreement between the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Sorghum/Millet Collaborative Research Support Program (INTSORMIL). Said Memorandum was signed between the two organizations on 23 June 1983.

2. ICRISAT, with the collaboration of INTSORMIL, will submit to the United States Agency for International Development a project proposal "Regional Sorghum and Pearl Millet Improvement Program for Southern Africa (SADCC Countries)". A portion of the research component and the training functions of this proposed regional program will be the responsibility of INTSORMIL, as specified in the above proposal. This regional program is conceived by ICRISAT and INTSORMIL to be a 25-year effort. Specific activities and costs for the first five years only are detailed in the proposal.

3. Funding and other support for the regional program is expected to be provided by the United States Agency for International Development (USAID) and the Government of Zimbabwe. The cooperation and advice of the SADCC organization will be a vital component to the success of this program. Funding may be by a single shared grant, or by two separate grants from USAID to ICRISAT and INTSORMIL. In either event, the provisions of this subagreement shall apply.

4. It is specifically agreed by ICRISAT and INTSORMIL that:

A. as a fundamental principle, the program of research and training at the research locations in Zimbabwe and as extended to SADCC countries in various locations will operate as <u>one</u> unified activity, under the general direction of <u>one</u> Project Manager who will be the officer in charge of all administrative and technical matters and will be an employee of ICRISAT;

B. research and training elements of this regional program that are conducted outside SADCC countries will be agreed upon jointly in principle, but subject to the operational control of the responsible party; and

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C. both parties will collaborate fully to ensure that the objectives of the regional program as stated in the grant and work plan documents, as approved by USAID, are met.

5. In carrying out the work of the regional program, the two organizations agree to accept the following specific responsibilities:

A. ICRISAT

1. Provide for the administration, management, farm and site development, governmental agreements and relationships, purchasing and fiscal accounting, monetary exchange, and all other research operations support, and all other matters arising from the operation of the regional program in SADCC countries as provided for in the grant agreement, excepting the provisions of all of section 5.B. which details INTSORMIL's responsibilities, and recognizing all other mutual agreements in this SUB-AGREEMENT.

2. Specifically in relation to the staff member to be supplied by INTSORMIL, to provide operational support and ICRISAT status. ICRISAT will expect, that salary and benefits to be paid to this investigator will be approximately equal to those for ICRISAT-paid principal staff.

3. Provide for in-service training, in-service fellow training and research fellow training, and workshops.

B. INTSORMIL

1. To provide from funds made available to it for this regional program, at least one Investigator (principal staff), in an appropriate scientific speciality, as agreed with ICRISAT.

2. To handle all matters relating to the selection, travel, and training activities of students and scientists from the Region designated for degree-level (B.S., M.S., Ph.D.) training under the regional program.

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3. To provide scientific support and backstopping, an appropriate and as funds are available, for any activities of the regional program.

Unless otherwise specified above, ICRISAT will have administrative responsibility for the regional research center operations and for the staff.

6. Publications and reports reflecting joint activities under the regional program will jointly credit ICRISAT and INTSORMIL, and will be distributed in such a manner as to indicate the joint nature of the activity.

7. This agreement may be amended by mutual consent at any time or terminated by either party on provision of ninety (90) days written notice to the other party.

Signed at Patancheru, India, this 23rd Day of June 1983.

L. D. SWINDALE

DIRECTOR GENERAL - ICRISAT

Earl R. Leng

EARL R. LENG

PROGRAM DIRECTOR - INTSORMIL

Table 3. Major constraints to groundnut production in SADCC countries

Country	Constraint
Angola	Not visited
Botswana	1. Soil texture 2. Drought 3. Varieties
Lesotho	Crop not grown
Malawi	1. Cultural practices 2. Diseases 3. Pops 4. Labour
Mozambique	1. Varieties 2. Diseases 3. Drought
Swaziland	1. Pricing structure 2. Cultural practices 3. Diseases
Tanzania	1. Varieties 2. Cultural practices 3. Drought 4. Diseases
Zambia	1. Cultural practices 2. Pops 3. Diseases
Zimbabwe	1. Cultural practices 2. Soil fertility 3. Drought 4. Diseases

Groundnuts are usually planted late, about 2 to 3 weeks after planting rains. This results in substantial reduction in yield. The reasons for late planting vary through the region, but generally farmers do so because groundnut is not the most important crop in their range; staple grain crops take first priority. The use of low plant populations is a common feature of groundnut cultivation. The reasons for this were given as insufficient seed retention and/or failure to use seed treatments to prevent fungal attack. The consequences of this are increased incidences of rosette virus disease and increased weed control problems. Under low plant populations and late plantings leaf diseases are apparently not a serious problem since responses to disease control by chemical application are small (50 kg/ha in Malawi) and uneconomic.

Where good cultural practices are followed, a different set of constraints applies, and drought and leaf diseases usually become of much greater significance. Under these conditions weed control can still be a constraint particularly in the case of small farmers who rely on hand cultivation for weed control.

Soil fertility. Soil fertility problems which affect groundnut production are low pH and general nutrient exhaustion in continuously cropped soils. Where rainfall is reliable and sufficient, soils are often leached and have low pH's which may induce seed abortion (pops) and poor seed growth. This problem can be solved by applications of lime and gypsum. However, this is beyond the means of small farmers. The problem of pops becomes less serious in the drier areas of the region where water availability replaces it as the major constraint.

Poor nodulation is generally not a problem of groundnuts in the region but general soil exhaustion under prolonged cropping is, and will continue to increase as a problem for the future, particularly as human populations increase.

Varieties. Lack of suitable varieties for different agro-ecological areas is a constraint to groundnut production in all countries except Malawi and Zimbabwe where good varieties have been released. In Botswana and Swaziland the varieties grown are of South African origin and have high yield potential when well managed. In Zambia there is doubt about the purity of the released varieties which are also very susceptible to pops. The situation in Tanzania is that the previously released varieties have largely become mixed and the research program is currently trying to re-establish those varieties with some semblance of purity. In Mozambique no recognized improved varieties exist.

Throughout the region the lack of short season, dormant varieties which will not sprout under erratic rainfall conditions limits groundnut production.

Drought. The importance of drought as a factor limiting groundnut production varies within the region. In Malawi and Zambia it is of less importance than in the four countries which listed it as a major constraint. The problem in these countries is not the total rainfall received, which is generally sufficient to sustain increased production, but its variability. Mid-season droughts of 2 to 3 weeks are not uncommon in the region. Drought in soils of low pH is thought to increase the problem of "pops".

Diseases. All countries except Botswana listed diseases as a major constraint to groundnut production. The most important and widespread diseases are the two leaf spots caused by *Cercospora arachidicola* and *Cercosporidium personatum* and the aphid transmitted rosette virus disease. Pod rots caused by various species of *Aspergillus* and *Fusarium*, and *Phoma* leaf spot are becoming important, as is bacterial wilt (*Pseudomonas salanacearum*) in Malawi. Rust (*Puccinia arachidis*) occurs in the region but is not yet a serious problem.

Labour and power. Labour and draught power act as constraints to production in several ways. Where hand tillage is practiced, land preparation and planting are done after the first rains. The dry hard soil precludes earlier operations. This situation is even worse where animal draught power is used since the animals have to recover condition lost during the long dry season before they are able to plough. Weeding and harvesting are other labour intensive operations in groundnut production which, if not done on time, lead to decreased yields.

As small farmers usually consume a large proportion of their groundnut production, they generate little cash income to be able to hire labour. This situation is aggravated by the minimum wages established in most countries of the region. Therefore to produce groundnuts farmers rely on family labour which usually attends to the staple grain crop first before other crops.

Economics and marketing. In the major groundnut producing countries, groundnut prices at official markets are very much less than those prevailing in the local unofficial village markets. This situation is most pronounced in those countries where marketing policies are aimed at satisfying the edible oil requirements of the country, and least where the marketing is geared to the confectionary trade. The Mission was informed that the low prices offered make groundnuts an unattractive crop in terms of the labour input, and farmers generally respond by selling their surplus through unofficial markets. It is estimated that official marketing organizations attract no more than 10% of the total crop.

Present Research Programs

In the countries where production estimates are in the region of 75,000 t/annum, or more, there are research programs concentrating on groundnut improvement. The largest program is in Malawi where the crop is of greater significance to the economy than in any other country. This program, and that of Zimbabwe, have been maintained for a long time and have successfully contributed to the improvement of the crop. Although Zambia and Tanzania have a history of research programs these have been allowed to lapse and only recently have they been restarted with assistance from FAO and ODA, respectively. A new program has also just started in Mozambique with IDRC funding. Table 4 gives a list of current groundnut research projects in the SADCC countries.