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SADCC - SOUTHERN AFRICAN DEVELOPMENT

COORDINATION CONFERENCE

GRAIN LEGUME IMPROVEMENT PROGRAMME

FEASIBILITY STUDY

AUGUST, 1984

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ACRONYMS

ACIAR	Australian Center for International Agricultural Research
AOSCA	Association for Official Seed Certifying Agencies
AVRDC	Asian Vegetable Research and Development Center
CDA	Cooperation for Development in Africa
CGIAR	Consultative Group for International Agricultural Research Centers
CIAT	Centro Internacional de Agricultura Tropical (International Center of Tropical Agriculture)
CRSP	Collaborative Research Support Programme
CTC	Consultative Technical Committee of SADCC
GLIP	Grain Legume Improvement Programme
IARC	International Agricultural Research Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development and Research Corporation
IITA	International Institute of Tropical Agriculture
INTSOY	International Soybean Programme
IRHO	Institut de Recherches Pur les Huiles et Oleagineux
SACCAR	Southern Africa Center for Coordination of Agricultural Research
SADCC	Southern Africa Development Coordination Conference
WARDA	West African Rice Development Association

SUMMARY

1. Request for Feasibility Study

The study was requested by the SADCC Consultative Technical Committee (CTC) for Agricultural Research in April, 1983, and was carried out with the financial assistance of CDA (Cooperation for Development in Africa) by an international group of consultants during the period November 1983 to July 1984.

2. Importance of Grain Legumes

Grain Legumes are an important component of the diet of the peoples of the SADCC countries, and the main vegetable source of protein. Total area of production is estimated at over 3 million hectares in six of the nine countries. However, grain legumes are typically components of complex cropping systems and, therefore, production statistics are undoubtedly greatly underestimated. Estimates on area of production in six SADCC countries indicate that beans and groundnuts, with over 1 million hectares each, are most important and cowpeas are third with about half that number of hectares.

3. Constraints on Production

Yields of grain legumes for the SADCC region are generally lower than the average for all of Africa, which in turn are low compared with the world-wide average. Principal constraints include low yielding varieties, damage by diseases and pests, unreliable rainfall, soil infertility, seed production problems, and pricing and marketing policies. Field trials with improved germplasm in the SADCC region have indicated a potential for overcoming many of the limits on production. Thus, it is anticipated that the prospects for greatly increased production are favorable, as well as the possibility of widening the area of production through better adapted varieties for marginal ecological zones.

4. Current Status of Research

All countries have research programmes on grain legume improvement, but most operate under mild to severe restrictions in scientists, facilities and operating funds. A survey of seven of the nine national grain legume research programmes reveals a total of 65.5 professional scientists. Of those 19 are expatriates leaving a total of 46.5 national researchers. Of these, 34.3 scientists are actively participating in research and 12.2 are in training. Furthermore, 13.7 of the scientists are at B.Sc. level, 15.6 at M.Sc. level, with only 5 at the Ph.D. level. An assessment of additional staff needed to provide an adequate programme reveals that national

programmes need to be upgraded in both numbers and educational level. On the whole the research is carried out in relative isolation and without desirable interdisciplinary links. Thus, both the level of the research programme and the staff in national programmes could benefit from a vigorous regional network of research and training.

5. Selection of Crops for Research

Some 12 crops were considered for inclusion in the Grain Legume Improvement Programme (GLIP). However, given the likelihood of budget limitations and the history of other international research institutions which have attempted to cover too many crops, it is recommended that three crops be included initially in the GLIP; namely, beans, cowpeas and groundnuts. Criteria used in the selection of these crops were: current importance in terms of production and area; importance for food production for the smallholder; traditional crops or those readily acceptable by the consumers; adaptability to traditional mixed cropping systems of smallholders; and a good potential for improvement of production.

6. Objectives

The goal of the Grain Legume Improvement Programme is two-fold: (1) increase production and reduce periodic shortages caused by low yielding varieties, diseases, insects and drought, and (2) the strengthening of the national research programmes through collaborative research, the training of national scientists and support personnel and the providing of financial support where necessary.

7. Organizational Alternatives

Three alternative organizations are presented for consideration. Each would establish a research network extending ultimately to all SADCC countries. They are illustrated by organograms (Fig. 1-3). Staffing, advantages and disadvantages, location alternatives and indicative operating budgets are listed for each. The administrative staff is the same for all alternatives and consists of a Director and Administrative Officer and supporting staff to be located in Malawi. All alternatives also have an economist and training officer. The number of research scientists varies according to the requirements of each alternative.

Alternative I

Two research teams, one at high elevation in Malawi and the other at low elevation in Mozambique. All three crops - beans, cowpeas and groundnuts - receive attention at both locations. Eighteen senior scientists are required. The indicative operating budget for five years is approximately 16 million U.S. dollars.

Alternative II

Similar to Alternative I with two research teams, one located at high elevation in Malawi conducting research on beans and groundnuts and one at low elevation in Mozambique giving attention to cowpeas and groundnuts. Fourteen senior scientists are required. The indicative operating budget for five years is approximately 14 million U.S. dollars.

Alternative III

Three research teams in each of three SADCC countries, each team being responsible for one crop. Sixteen senior scientists are required. The indicative operating budget for five years is approximately 16 million U.S. dollars. Recommended locations are: groundnuts - Malawi; cowpeas - Mozambique; and beans - unspecified high elevation location.

8. Research Programme Emphasis

The research on grain legumes should concentrate on the genetic improvement of the crops and the improvement of cropping systems, particularly for the smallholder. A large applied research programme is visualized, requiring plant breeders, plant pathologists, entomologists, agronomists, physiologists and economists, working as interdisciplinary teams and interacting with their counterparts in national research programmes. The transfer of research results to the smallholder will constitute a major thrust of the research. Although this concerted research effort can yield some agriculturally important results almost immediately, a long term effort (25 years minimum) will be required for major contributions, as is characteristic of genetic improvement programmes.

9. Training

Of importance equal to that of research, is the training of national research scientists. Only through training can the national programmes rightfully assume the responsibility for grain legume improvement. Thus, a strong educational component is recommended, involving both long-term training at universities within and outside of the SADCC region and short-term training in specific skills at regional and international research institutes. The inventory of grain legume scientists in the various SADCC countries (mentioned earlier) revealed the need for additional scientists and provided a basis for estimating the training requirements for each country according to discipline and level of education needed (Chapter VI). It is proposed that, in the first five years, a total of 31 scientists be trained, 26 at the M.Sc.

and 5 at the Ph.D. level, with appropriate short-term specialized training for both professional and subprofessional staff.

10. Financial Support to National Programmes

As part of the strengthening of national research programmes, it is recommended that financial or in-kind support be provided where needed to allow full participation in activities relative to the regional research effort on grain legumes.

11. Linkages

The GLIP will establish a research network of national, regional and international organizations to collaborate on improvement of grain legumes. The indicative budget may project a substantial programme, but without the backing of a strong cooperative relationship between research organizations and individuals, it will fall short of contributing substantially and effectively to accelerated agricultural development. It is particularly important to establish appropriate links with and to enlist the full support of the three international centres concerned with beans (CIAT), cowpeas (IITA) and groundnuts (ICRISAT). Linkages with the CRSP research projects in SADCC and elsewhere, the various bilateral programmes, and especially the SADCC national research programmes are mandatory.

12. Management

It is recommended that the GLIP be under the immediate direction of a Project Director who shall be a senior scientist and responsible for developing and operating the research and training programmes. He will be responsible to a Management Entity yet to be designated. Proposals for the management and operation of GLIP should be requested from organizations with the potential for managing the GLIP.

13. Benefits

An attempt at an economic analysis has yielded encouraging results. The internal rate of return is approximately 50 percent. The net present worth, at 30 percent discount rate, is approximately U.S. $23 million. These values make the investment very attractive.

RESUMO

1. Solicitacao do Estudo de Exeqüibilidade

O estudo foi solicitado pelo Comitê Técnico Consultivo para Pesquisa Agrícola da SADCC, em abril de 1983, e levado a efito, com a assistência financeira da CDA (Cooperation for Development in Africa), por um grupo internacional de consultores, durante o período de novembro de 1983 a julho de 1984.

2. Importância das Leguminosas de Grão

As leguminosas de grão constituem importante componente da dieta das populações dos países filiados à SADCC, e a sua principal fonte de proteína vegetal. Estima-se que, em seis dos nove países, a area total de produção dessas culturas alcance mais de três milhões de hectares. As leguminosas de grão, entretanto, são componentes típicos de complexos sistemas culturais e, por isso, as estimativas de produção estão indubitavelmente subestimadas. As estimativas de área de produção em seis países filiados à SADCC indicam que o feijão e o amendoim, cada um deles com mais de um milhão de hectares, são os mais importantes, seguidos pelo caupi, com aproximadamente a metade dessa area.

3. Problemas de Producão

A productividade das leguminosas de grão na área da SADCC é, em geral, mais baixa que a média de toda a África, que, por sua vez, é inferior a média mundial. Os principais motivos dessa situacão incluem: variedades de baixa capacidade produtiva, doencas, insetos, escassez de chuvas, infertilidade do solo, problemas de producão de sementes e políticas de preco e mercado. Ensaios experimentais com germoplasma melhorado, na região da SADCC, têm indicado uma potencialidade para superar muitas das limitacões a producão. Assim, pode-se antecipar que são favoráveis as perspectivas para grandes aumentos de producão e, também, a possibilidade de ampliar a área de cultivo, por meio de variedades adaptadas a regiões ecológicas marginais.

4. Presente Situacõa da Pesquisa

Todos os paises têm programa de pesquisa com leguminosas de grão, mas a maioria funciona com limitacões, que variam de suaves a severas, quanto a cientistas, facilidades a fundos operacionais. Reconhecimento realizado em sete dos nove programas nacionais de pesquisas com essas plantas revelou o total de 65,5 cientistas. Destes, 19 são estrangeiros, deixando o total de 46,5 pesquisadores nacionais, dos quais

34,3 estão participando ativamente de pesquisas e 12,2 estão em treinamento. Ademais, 13,7 cientistas têm treinamento ao nivel de B.Sc., 15,6 ao de M.Sc. e somente 5 ao nivel de Ph.D. Uma avaliação das necessidades adicionais das equipes de pesquisadores, para que possam atingir um grau de eficiência adequado, revelou que os programas nacionais precisam ser melhorados, tanto em numero como em nivel educacional dos pesquisadores. Em geral, a pesquisa é conduzida em relativo isolamento e sem as necessarias ligações interdisciplinares. Dessa forma, um vigoroso programa regional de pesquisa e treinamento poderá beneficiar tanto o nivel das pesquisas como as equipes de cientistas dos programas nacionais.

5. Selecão das Culturas para a Pesquisa

Cerca de 12 culturas foram consideradas, para inclusão no Programa de Melhoramento das Leguminosas de Grão (PM LG). Porém, levando em conta a probabilidade de limitações orcamentárias e a história de outras instituições de pesquisa internacionais que tentaram trabalhar com muitas culturas, recomenda-se que três cultivos sejam inicialmente incluidos no PMLG: feijão, caupi e amendoim. A selecão desses três produtos baseou-se no seguinte: importância em termos de producão e área; importância como alimento para o pequeno agricultor; tradicionalidade da cultura ou sua pronta aceitacão pelo consumidor; adaptabilidade ao sistema de culturas consorciadas do pequeno agricultor; e boa potencialidade para a melhoria da producão.

6. Objetivos

O Programa de Melhoramento de Leguminosas de Grão tem duplo objectivo: (1) aumentar a producão e reduzir a carência periódica causada por variedades pouco prodctivas, moléstias, insetos e seca; e (2) reforcar os programas nacionais de pesquisa por meio de trabalho colaborativo, treinamento de seus cientistas e técnicos e fornecimento de suporte financeiro, quando necessário.

7. Alternativas de Organizacão

Três alternativas são apresentadas, todas visando ao estabelecimento de uma rede de pesquisa que se estenderia a todos os paises ligados á SADCC. As alternativas estão ilustradas nos organogramas das figuras 1, 2 e 3. Para cada alternativa, apresentam-se o quadro de pesquisadores, as vantagens e desvantagens, possiveis localizações e orcamentos de funcionamento indicativos. O corpo administrativo é o mesmo para qualquer alternativa e compreende um diretor, um tecnico em administracão e uma equipe auxiliar, localizados em Malavi.

Todas as alternativas compreendem também um economista agricola e um técnico responsável pelo treinamento. O número de pesquisadores varia de acordo com as necessidades de cada alternativa.

Alternativa I

Dois grupos de pesquisadores, um localizado em Malavi (alta altitude) e outro em Mocambique (baixa altitude), ambos os grupos trabalhando com as três culturas. São necessários 18 cientistas. O orcamento de funcionamento indicativo é de aproximadamente U.S.$ 16 milhões por cinco anos.

Alternativa II

Três grupos de pesquisadores, cada grupo num pais e trabalhando com uma das culturas. São necessários 14 cientistas. Orcamentos indicativos aproximadamente: U.S.$ 14 milhoes por cinco anos. São recomendados os seguintes paises: Malavi, para amendoim; Mocambique, para caupi; e, para feijao, uma localidade não especificada em alta altitude.

Alternativa III

Semelhante a Alternativa I, com dois grupos de pesquisadores, um em Malavi (alta altitude), trabalhando com feijão e amendoim, e outro em Mocambique (baixa altitude), dando atencão ao caupi e ao amendoim. São necessários 14 cientistas. Orcamentos indicativos aproximadamente: U.S.$ 16 milhões por cinco anos.

8. Enfase do Programa de Pesquisa

As pesquisas com leguminosas de grão deverão concentrar-se no melhoramento genético das culturas e no melhoramento dos sistemas culturais, particularmente do pequeno produtor. Visualiza-se um programa de pesquisa amplamente aplicado, o qual requererá melhoristas, fitopatologistas, entomologistas, fitotecnistas, fisiologistas e economistas, operando como equipes interdisciplinares e interagindo com seus colegas dos programas nacionais. A transferência dos resultados da pesquisa para o pequeno agricultor receberá grande atencão do programa. Embora esse esforco combinado de pesquisa possa render, quase imediatamente, alguns resultados importantes, para grandes contribuicões será preciso um esforco mais demorado (25 anos no minimo), como é próprio dos programas de melhoramento genético.

9. Treinamento

Tao importante quanto a pesquisa em si é o treinamento dos cientistas dos programas nacionais. Somente com esse treinamento podem tais programas assumir, verdadeiramente, a responsabilidade pela melhoria da producão de leguminosas de grão. Por isso, recomenda-se um forte componente educacional, compreendendo tanto o treinamento a longo prazo, em universidades dentro e fora da área da SADCC, como o treinamento a curto prazo em habilidades especificas, em instituicões de pesquisa regionais ou internacionais. O inventário dos cientistas que trabalham com leguminosas de grão, nos vários paises ligados á SADCC, revelou a necessidade de maior numero deles e forneceu a base para as estimativas de necessidades de treinamento em cada pais, por disciplina e por nivel de educacão (capitulo VI). Propõe-se que, nos primeiros cinco anos, sejam treinados 31 cientistas, 26 em cursos de mestrado e cinco em cursos de doutorado, além do apropriado treinamento especializado, a curto prazo, tanto dos cientistas como dos técnicos auxiliares.

10. Suporte Financeiro para os Programas Nacionais

Como parte do fortalecimento dos programas nacionais de pesquisa, recomenda-se que suporte financeiro ou de outra espécie seja fornecido, quando necessário, para possibilitar plena participacão de tais programas nas atividades relacionadas com o esforco regional de pesquisa com as leguminosas de grão.

11. Ligacões inter-institucionais

O PMLG estabelecerá uma rede de pesquisa envolvendo as organizacões nacionais, regionais e internacionais. O orcamento indicativo pode projetar um programa ultoso, mas, sem o apoio de uma forte relacão cooperativa entre organizacões de pesquisa e individuos esse programa não conseguirá contribuir substancial e eficientemente para o aceleramento do progresso agricola. É particularmente importante o estabelecimento de ligacões apropriadas e a obtencão de total suporte dos três centros internacionais que trabalham com feijão (CIAT), caupi (IITA) e amendoim (ICRISAT). São obrigatorias as ligacões com os projetos de pesquisa do CRSP, tanto nos paises da SADCC como alhures, com os diversos programas bilaterais e, especialmente, com os programas nacionais de pesquisa na área da SADCC.

12. Administracao

Recomenda-se que o PMLG fique sob a imediata direcão de um Diretor de Projeto, ele próprio um cientista experimentado, que sera responsavel pelo desenvolvimento e operacão dos programas de pesquisa e treinamento. Ele será responsável perante uma Entidade de Administracão, a ser designada. Propostas visando a administracão e operacão do PMLG deveriam ser solicitadas das organizacões com capacidade para tanto.

13. Beneficios

Um ensaio de análise ecônomica forneceu resultados encorajadores. A taxa interna de retorno é de 50%, aproximadamente. O valor liquido atual, com 30% de taxa de desconto, alcanca perto de U.S.$ 23 milhões. Esses valores tornam o investimento muito atraents.

GRAIN LEGUME IMPROVEMENT PROGRAMME FEASIBILITY STUDY (GLIP)

I. INTRODUCTION

The Agricultural Sector of African countries is very important; over 70 percent of the population derive their livelihood from farming. At the present time, Africans are not producing enough food to feed themselves and the rest of the population. FAO's Africa Regional Food Plan and the Lagos Plan of Action set forth strategies for achieving food self-sufficiency. They emphasize the need for research and training, strengthening national programmes, and sub-regional cooperation.

Southern African Development Coordination Conference (SADCC) is an organization for economic and technical cooperation among independent countries in Southern Africa. SADCC was formed in April 1980 at the Lusaka Summit by the Heads of State and Government of nine countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe. SADCC aims to pool resources and coordinate mutual development in agriculture, communications, industry, transport and other fields and to reduce the dependency of member states, particularly their dependency on South Africa. Self-sufficiency in food supplies is of paramount importance to the development of the SADCC region. Individual member countries have been given special responsibilities in developing projects and programmes.

The organizational structure of SADCC consists of the Heads of State and Government which form the 'Summit', followed by the Council of Ministers and thereafter a Standing Committee of Senior Officials. Various other committees provide advice.

Cooperation for Development in Africa (CDA) is an informal association of seven donor nations who support major development activities in Africa. CDA aims to work with African governments and regional organizations to coordinate action in African development, assist in the development of long-term plans and facilitate the coordination of donor support. CDA members are Belgium, Canada, France, Italy, United Kingdom, United States and West Germany.

In March 1983, representatives of CDA made a reconnaissance visit to all SADCC countries. In their report, CDA members recommended the expansion of the Regional Groundnut Programme to include other important grain legume

crops. The Consultative Technical Committee (CTC) of SADCC agreed with this recommendation and proposed that a six-person team be selected to prepare a comprehensive feasibility study for a Grain Legume Improvement Programme (GLIP) for Southern Africa. This study would expand the existing Regional Groundnut Programme located in Malawi, a Programme that is financed by IDRC and implemented by ICRISAT.

The CTC also recommended that support for this Programme be requested from France. SADCC countries could benefit from French expertise and experience in groundnuts in West Africa, particularly in the areas of short season, drought resistant varieties, and seed multiplication and exchange schemes for small farmers.

On May 5, 1983 the SADCC Council of Ministers met in Dar es Salaam, Tanzania. To reflect the Programme's broader scope, they changed the title from Regional Groundnut Programme to Grain Legume Improvement Programme. The Council suggested that Programme headquarters remain in Malawi, but that substations be established in Mozambique, Lesotho and Tanzania.

To prepare a Grain Legume Improvement Programme Feasibility Study, the CTC recommended that a team of experts be assembled with the following composition:

2 members from SADCC countries

1 nominee by Technical Advisory Committee of the Consultative Group for International Agricultural Research (CGIAR) to represent the IARCs.

1 member from France/West Africa (IRHO) and

1 member from the Agency which supplies the team

Nine consultants prepared this report during two missions to Southern Africa (Nov.-Dec., 1983 and May-June, 1984). The consultants are as follows:

Dr. R.I. Jackson - Senior Agronomist (S&T/AGR/AP) A.I.D., Washington, Team Leader

Dr. J.D. Franckowiak - Associate Professor of Agronomy, North Dakota State University, Fargo, ND, USA

Mr. D.R.B. Manda - Deputy Chief Agricultural Research Officer, Malawi

Dr. J.P. Meiners	- Plant Pathologist, Consultant Silver Spring, Maryland/USA
Dr. L. Mosele	- Consultant, 45 010 Riva, (Rovigo) Italy
Dr. B.J. Ndunguru	- Professor and Head, Department of Crop Science, University of Dar es Salaam, Tanzania
Dr. J.F.M. Onim	- Agronomist, CRSP for Small Ruminants, Winrock International, Kenya
Dr. R. Schilling	- Assistant Director (Annual Oil Crops Department) IRHO, Paris, France
Dr. C. Vieira	- Professor of Agronomy Federal University of Vicosa Vicosa, M.G., Brazil

A resume of each member of each team is indicated in Annex A and terms of reference are given in Annex B.

II. STATUS OF GRAIN LEGUMES IN THE SADCC REGION

A. Geographical Setting

The nine countries in the SADCC region cover a relatively large area of the southern portion of Africa. Their climate and ecology vary considerably. The elevation ranges from sea level to highlands which are over 4000 metres above sea level. A major portion of the region is an elevated plateau extending between 900 and 3000 metres above sea level. The region lies between the Atlantic and Pacific Oceans and between the equator and 30° south longitude. The region covers nearly 4.9 million square kilometres. The Indicators of Development for the SADCC countries are presented in Annex C, Table 1.

Grain legumes are grown from sea level to at least 4000 metres. Only 5 percent of the region (Lesotho, Swaziland, one-third of Botswana and a small portion of Mozambique) lie outside the tropics. A wide range of crops, soils and climates are found within the region. Over 75 percent of the area receives an average rainfall of 400 to 800 mm and is therefore classed as semi-arid. The rainfall is seasonal. Only in Tanzania is it bi-modal. The duration of the rainy season is from 3.5 to 5 months and is extremely variable.

The economy of the region is largely agricultural. Over 70 percent of the population is engaged in agricultural activities and lives in rural areas. Annual population growth is estimated to be 3 percent, but the annual increase in grain legume production is about 1 percent. Grain legumes contribute only a minor portion of the total daily caloric intake and a relatively small percentage of the protein intake of diets. However, based upon the observations of the Team and others, it is apparent that statistics do not accurately describe the importance of grain legumes in the region. Most smallholder subsistence farmers produce grain legumes for their own household or for rural markets. This production may not be included in FAO's statistics.

B. Agricultural Setting

1. Crop Situation

The estimates of production of legume crops cited in Annex C, Table 2 should not be considered an accurate representation of the importance of the crops in the SADCC region. First, statistics are not available for many of the crops. Secondly, as much as 99 percent of any given crop may be interplanted with non legumes, and may not be included in the FAO statistics on area devoted to grain legumes.

Thirdly, as much as 90% or more may be marketed locally and not be included in official production statistics.

With this in mind, attempts were made to obtain estimates of area of production that would be more realistic. These are presented in Table 1, and constitute the best estimates of individuals and organizations in each country visited. The estimates indicate that the total area devoted to grain legumes in six of the countries SADCC amounts to over 3 million hectares.

African yields for grain legumes are relatively low on a world-wide basis. Yields for the SADCC region are even lower than the African mean. Dry bean yields are about 20 percent lower than the African mean; yields for peas are 40 percent lower; yields for groundnuts are 12 percent lower. Only soybean yields are higher. Most soybeans are cultivated on highly productive commercial farms in Zimbabwe.

At the regional level in the period 1969-81, bean production has expanded at a rate close to 6 percent per annum; soybeans have doubled in production; pulses have expanded at a rate of only 1 percent; groundnut production has remained static. For beans, soybeans and pulses, production growth is mostly due to farmland expansion. Improved yields are important only for soybeans. Beans and groundnuts show an annual yield growth rate of about 1 percent. Pulse yields have diminished by 0.5 percent per annum. (See Annex C, Table 3.)

As far as yields are concerned in the different SADCC countries, the Study Team concluded the following:

- Beans	Yields range from 409 kg/ha in Angola to 833 in Lesotho.
- Dry Peas	Range is even wider: 278 kg/ha in Tanzania, 1017 kg/ha in Lesotho.
- Soybeans	Variations from 250 kg/ha in Tanzania to 1829 in Zimbabwe.
- Groundnuts (in shell)	From 395 kg/ha in Botswana to 995 in Zimbabwe.

Yield variability from country to country is probably caused by differences in the importance placed on the highly productive commercial sector. Yields from traditional farming methods are more or less the same throughout the region.

Angola. In 1981, Angola is estimated to have produced about 20,000 tonnes of groundnuts and 45,000 tonnes of beans.

Table 1. Area of Grain Legume Crops in Six SADCC Countries

Crop	Botswana	Malawi	Mozambique	Tanzania	Zambia	Zimbabwe	Total
			1,000 Hectares				
Bean		850	50	300	20	16	1236
Cowpea	18	400	150	G 1/	10	6	584
Ground-nut	3	500	250	94	50	150	1047
Soybean				35	5	56	96
Bambara Groundnut	3	20	80	G	10	G	113
Pigeon Pea		110	30	G	G	G	140
Chick pea		25		27			52
Pea				27			27
Dolichos Bean			20				20
Total	24	1905	580	483	95	285	3315

1/ Grown, but no estimates of area of production are available.

No records are available on soybeans or other pulses. Grain legumes are cultivated primarily in the central and northern highlands. Yields have been decreasing at rates of 0.5 percent per annum for groundnuts and 3.5 percent for pulses.

Botswana. The Botswana agricultural sector is constrained by a harsh physical environment and by limited suitable arable land. Livestock is the most important agricultural activity.

Grain legume production in 1981 was about 2000 tonnes of groundnuts, covering about 4000 hectares. The production of beans, cowpeas, and others is about 18,000 tonnes grown on 30,000 hectares. In the period from 1969/72 to 1981, groundnut production has slightly increased in productivity, about 1 percent per year. But the production of pulses has decreased to 4.5 percent per year, both because of the reduced area cropped and productivity. According to the 1981 Botswana Agricultural Statistics, bean and pulses are cultivated mostly in the southern and Gaborone regions and groundnuts mostly in the southern region. Beans and pulses are cultivated by more than 90 percent of the farmers. Groundnuts are cultivated primarily on commercial farms, between 60 and 70 percent.

Lesotho. In Lesotho, agriculture is almost entirely in the hands of small-scale, subsistence producers. As few as 5 to 10 percent of the farmers produce a regular surplus. Livestock contributes about 50 percent of the value of the agricultural production. Maize, wheat and pulses are the main crops grown.

The agriculture of Lesotho is conditioned by its geographical situation, its physical resources, and its climate. Much of the country consists of a rugged range of mountains with a small amount of arable land. Erosion is a serious problem. Climate is unpredictable: drought, hail, frost and excessive rains during the harvest season are common causes of crop losses. Because of the migration of workers to South Africa, labour shortages occur during the agricultural peak periods.

Grain legume production is about 10,000 tonnes of beans and 7,000 tonnes of peas. Groundnuts, soybeans and minor pulses are not cultivated in Lesotho. From 1969/71 to 1981, bean production increased at an annual rate of about 10 percent, due to the expansion of farmlands. During the same time, yields actually decreased by about 2 percent per year. In contrast, pulse production has grown because of an increase in productivity associated with commercial production.

Malawi. This country is generally self-sufficient in its food commodities: maize, cowpeas, pulses, millet and sorghum. Tobacco and groundnuts are the most important agricultural exports. Cotton and rice are also exported.

Malawi's population is exerting pressure on land resources and future increases in production will have to come from improved yields rather than expansion of cultivated areas. Periodic droughts also affect the country.

Traditional farmers in Malawi cultivate grain legumes extensively. Beans, groundnuts and chick peas are the most common; minor pulses are also widely grown. Groundnuts and pulses are cultivated primarily in the Central and Southern Regions. In the Northern Region, they are grown on a smaller scale.

In 1981, Malawi produced 62,000 tonnes of beans, 18,000 tonnes of chick peas, and 1,800,000 tonnes of groundnuts in the shell. The area devoted to groundnuts, beans and other pulses was around 550,000 hectares.

From 1969/71 to 1981, bean production grew at the rate of 2 percent per year because of a slight increase in cultivated areas and increased yields. During the same period groundnut production remained constant; area under cultivation increased but productivity decreased slightly. Pulse production increased at a 2.5 percent yearly rate. Cultivated area expanded 1.5 percent per year; yields increased by 1 percent per year.

Mozambique. Peasant farmers cultivate grain legumes for home consumption. Principally groundnuts have received attention. In 1981 Mozambique produced about 80,000 tonnes of groundnuts and 50,000 tonnes of pulses on about 300,000 hectares. Between 1969/71 and 1981, groundnut production in Mozambique decreased at an average rate of 6.0 percent per annum; both cultivated areas and yields decreased. Pulse production decreased by 2.5 percent per annum; this change was mainly due to reduced productivity.

Swaziland. The agricultural economy at Swaziland is highly dualistic. Commercial farms, ranches and small farms produce cash crops. Traditional farmers practice subsistence agriculture. Approximately 80 percent of farmers can be classified as "commercial." About 20 percent are "traditional."

Grain legume production consists of approximately 1,000 tonnes of groundnuts in the shell and about 4,000 tonnes of pulses. The total area cultivated is around 10,000 hectares. Groundnut is cultivated primarily in the Middleveld and in the Lowveld. Bean and cowpea are found in the Highveld and in the Middleveld, respectively.

From 1969/71 to 1981, groundnut production in Swaziland has decreased at an annual rate of about 11 percent because of

decreases in both cultivated areas and yields. Pulse production increased at a low annual rate of 3 percent as a result of increases in both cultivated areas and yields.

Tanzania. In Tanzania the agricultural system consists of a few large state farms and many small farms. The small farms produce food for subsistence and generate a small surplus for sale.

Consumer preferences have shifted toward maize in the rural areas and rice and wheat in the urban centers. As a consequence, farmers prefer to grow maize rather than the more drought resistant sorghums and millets. Imports of rice and wheat to urban areas have increased dependence on external sources of food.

In 1981, groundnut production (in the shell) totalled 560,000 tonnes. Production of other grain legumes was about 220,000 tonnes.

From 1969/71 to 1981, groundnut production increased by 5.5 percent per year, because of the expansion of cultivated areas, but yields decreased at a rate of 1 percent per year. Pulse production increased at a rate of 2 percent per year as cultivated areas were expanded. Yields improved only slightly.

Zambia. This country has a large and fast-growing urban population (more than 40 percent of the total). The agricultural output from a few commercial farms and a large number of smallholder farms is unable to keep up with demand.

Cultivated areas are difficult to expand because undeveloped land is relatively low in fertility and rainfall is erratic. Also the rate of technology transfer to the traditional farming community is low. Thus, it is becoming more difficult to meet the demands on agricultural production. In 1981, Zambia produced about 6,000 tonnes of soybeans grown primarily on commercial farms, about 30,000 tonnes of groundnuts in the shell produced primarily by the traditional farmers, and about 14,000 tonnes of pulses.

The total area devoted to grain legumes in 1981 was around 70,000 hectares. From 1969/71 to 1981, groundnut production fell at a rate of 8 percent per year. The change was caused by a reduction in cultivated areas and a decrease in yield. During the same period, soybean production expanded rapidly. Most of this increase occurred since 1979. Pulse production has increased at a rate of 5 percent per year as a result of the expansion of cultivated areas.

Zimbabwe. Zimbabwe has been able to not only feed its population but also to generate a surplus of maize, beef, wheat, groundnuts and soybeans for export under normal rainfall conditions.

A few commercial farms produce most of the marketed surplus, while traditional agriculture remains low-yielding. The main legumes cultivated in Zimbabwe are pulses, groundnuts and soybeans. In 1981 Zimbabwe produced about 25,000 tonnes of pulses, 239,000 tonnes of groundnuts and 64,000 tonnes of soybeans. The total area devoted to grain legumes in 1981 was estimated to be 100,000 hectares. The production of groundnuts and soybeans in Zimbabwe has been expanding at a fast rate. Pulses and groundnuts are cultivated primarily by smallholders. Soybeans are cultivated primarily on commercial farms. From 1969/71 to 1981, pulse production remained practically unchanged, but groundnut production increased by 8 percent per year. Soybean production almost doubled; yields obtained are now comparable to yields in North and Latin America.

2. Legume Exports and Imports

The principal export in the SADCC region is groundnuts. In 1981, Malawi exported 11,100 tonnes of groundnuts and Zimbabwe exported 27,000 tonnes. Pulses are imported by Angola, Tanzania, Zambia and Zimbabwe; and exported by Lesotho, Malawi and Tanzania. Information on export and import among the different SADCC countries is not available. However, the Team believes that intra-regional trade in grain legumes is unimportant.

C. Relative Importance of Grain Legumes in the Region

The importance of individual grain legumes varies greatly from country to country in Southern Africa. Table 2 presents the estimated ranked importance of each grain legume by country.

Of some thirteen grain legume crops grown in Southern Africa, three crops are clearly the most important; namely Phaseolus beans, groundnuts and cowpeas. Beans rank either first or second in seven countries; groundnuts in the top three in eight countries and cowpeas third or higher in seven countries. Next in importance is the Bambara groundnut, ranking third, fourth or fifth in seven countries. Pigeon pea, mung bean and chick pea are widely grown in SADCC countries but generally are of less importance. Soybeans, are widely grown, but largely by commercial farmers rather than by small holders. Common pea, lentil and tepary bean are peculiar to one or two countries only.

III. CONSTRAINTS ON LEGUME PRODUCTION

A. Crop Production

In the assessment of constraints on grain legume production, the Team made estimates based on limited data or information from neighboring countries. The production constraints are considered by crops for grain legumes that are important in several SADCC countries. The order in which individual crops are presented in this paper reflects the Team's estimate of the relative importance of each: common bean, groundnut, cowpea, bambara groundnut, soybean, pigeon pea, mung bean, and chicken pea (Table 2).

Seed quality and supply, significant problems for grain legumes in most SADCC countries, are considered in greater detail in section III. B. Several major constraints to production are caused by the variable seasonal rainfall pattern. Most countries have regions where high temperature and low rainfall restrict the production of certain grain legumes. For example, common bean is the most widely grown and popular grain legume in the SADCC countries, but it can be grown successfully on less than half of the arable land area.

1. Common bean, *Phaseolus vulgaris*

Beans are considered the most important or second most important crop in all SADCC countries except Botswana and Mozambique. The two major uses of beans, as a leaf vegetable and dried beans, are each associated with a different group of land races. The quality of introduced cultivars is generally not acceptable to consumers. The sugar bean, kidney shaped with tan-mottled testa, is preferred in many countries because of its taste and rapid cooking qualities. In Zambia and Tanzania, the Lusaka bean, a small, light olive-green coloured bean with a wrinkled testa, commands the highest price in the marketplace.

Limited seed supply and poor seed quality are the major production constraints in most countries (Annex D). The Team rated the seed quality as poor because seed-borne pathogens, such as common bacterial blight, anthracnose and halo blight, were present. The lack of varieties, pure land races or improved cultivars, was generally considered a major problem. Production of beans is limited to high rainfall regions and to areas above 1,200 metres because beans yield poorly under moisture stress or high temperatures. Yet, beans grown for dried seed are often planted one to four months after the rains start. This is done to avoid pod diseases which are severe if the crop matures before the end of the rainy season.

Table 2. Relative Importance of Grain Legume Production in SADCC Countries

Grain legume	Rank within country*/								
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe
Common bean	2	6	2	2	4	1	1	1	2
Groundnut	1	2		1	1	3	2	2	1
Cowpea	3	1	x	3	2	4	3	3	3
Bambara groundnut	4	3		6	3	2	4	4	5
Soybean	x		x		x	x		5	4
Pigeon pea	x			4	5		5	x	x
Mung bean		4		x	6	x	x	x	x
Chick pea				x	x	x	x	x	x
Common Pea			1	5			5		
Dolichos bean						x	x		
Tepary bean		5							
Lentil			3			x	x		
Black gram					x				

*/ Relative rank within country is based on team's estimates;
x indicates the crop was grown in the country but relative importance was not estimated.

Beans are generally intercropped with maize. Because planting is commonly delayed to the first weeding, competition with maize and weeds results in lower yields. Seeding rates are often very low and poor seed germination further reduces plant population. When a second crop of beans is planted in February, the lower leaves of maize are often stripped off to reduce competition with the beans.

The bean crop can be partially or completely destroyed by a host of pathogens and pests. Anthracnose, bean rust, common bacterial blight, bean common mosaic virus (BCMV) and angular leaf spot are the most important bean pathogens. Bean fly and bean bruchid are important insect problems. Excellent resistance to all these, except bean fly, has been identified in bean germplasm and is being transferred into elite material at CIAT. Unfortunately, in most SADCC countries resistances have not been transferred to beans with acceptable testa colouration, cooking time and taste.

Necrotic strains of bean common mosaic virus (BCMV) were reported to occur in several countries. Root knot nematode is a serious problem in beans and has been found throughout Southern Africa. In Swaziland, root knot has restricted the area suitable for bean production. Effective nodulation of beans was reported to be rare in the SADCC countries.

2. Groundnut, Arachis hypogaea

The relative importance of groundnuts in the SADCC countries was difficult to assess. Large seeded types are grown for home consumption and for export in the confectionary groundnut market. Only a very limited portion of the crop is grown for oil extraction and oil meal. Broken nuts from the commercial confectionary market are also used for crushing. In general, the percentage of the groundnut crop exported as confectionary nuts has decreased because aflatoxin control in some countries has been poor. Expansion of the oil market is expected to be slower for groundnuts than for sunflowers, cotton seed and soybeans.

The Team learned that limited seed supply and poor seed quality are the most important factors limiting groundnut production (Annex D). Seeding rates are low in part because groundnuts are often intercropped with maize. Consumer preference for the land race 'Chalimbana' in several countries further restricts seed supply because the seed weight approaches 100g/100 seeds. The partitioning of photosynthates is poor in Chalimbana and yields are only 50 to 70 percent of the best introductions. In addition, Chalimbana must be shelled by hand for the confectionary market as the pods vary in shape and cannot be mechanically shelled without substantial breaks.

Other factors limiting groundnut production include high labour requirements, poor marketing systems and poor control prices. Delayed planting in areas where the rainy season is short or highly variable and the lack of dormancy in early maturing cultivars where the rainy season is relatively long contribute to lower yields. Important biotic factors include poor nodulation, root knot nematodes, groundnut rosette virus (GRV), early leaf spot, rust, seed and seedling rots, and the groundnut aphid. Although root knot nematodes were considered a major constraint only in Swaziland, they have a high potential to limit production. Rosette virus, early leaf spot and rust are considered major groundnut diseases in nearly every country. They probably cause more post-emergence yield loss than all other biotic factors combined. These diseases are the focus of much of the groundnut breeding research in the SADCC countries. Resistances to rosette virus, rust and late leaf spot have been identified in ICRISAT groundnut germplasm. A rosette resistant cultivar, RG1, has been released in Malawi, but its nut quality is considered much inferior to Chalimbana.

Microorganisms which invade groundnut seeds and pods after seed maturation and before dry-down can reduce germination in plant stands. One of these, Aspergillus flavus, produces the highly carcinogenic organic compound, aflatoxin. The symbiotic association between the root-feeding plant hopper, Hilda patruelis, ants and a wilt-inducing fungus, Fusarium solani, may become a major problem in lighter soils or in off-season plantings. Since the same pest complex causes significant losses in Bambara groundnut, effective regional control will require development of resistant cultivars. Control of groundnut wilt has been demonstrated in Malawi using systemic insecticides. The groundnut aphid was reported as a major pest. It is the vector of GRV.

3. Cowpea, Vigna unguiculata

In all SADCC countries except Lesotho, cowpea ranks among the top four grain legumes grown in terms of relative importance to traditional farmers. In Malawi, Mozambique, Tanzania and Zambia, cowpea is preferred as a leaf vegetable. Production of cowpea for dried beans is largely limited to environments and cropping systems where common beans cannot be grown successfully. Cowpea is generally intercropped with maize or sorghum.

The Teams consider the lack of high yielding cultivars to be a major constraint to increased production of cowpeas (Annex D). Early, erect, uniform maturing cultivars could greatly increase the production of cowpeas in SADCC countries. However, the acceptability of new improved lines may be low if they lack adequate leaf quality. Only in Botswana is the seed

quality of cowpea land races equivalent to that found in West Africa. Introduction of cultivars with greatly improved seed quality and reduced cooking time may be necessary to greatly increase production. The preference in the SADCC countries for cowpeas with tender leaves is quite strong. Seed supply limits cowpea production in most countries. Weed competition, low plant population and periodic moisture stress contribute to low average yields. In many countries, the introduction of early maturing cultivars could reduce yield losses caused by drought.

Insects have a greater influence than pathogens on cowpea yields. Bruchids are the major problem during seed storage. Maruca pod and stem borers and bollworm are primary chewing insects which reduce cowpea yields. Groundnut aphid, flower thrips, blister beetles, bean leaf beetle and jassid leaf hopper can delay pod set or reduce vegetative growth. Diseases do reduce yields significantly, but the pathogen reported as the major problem varies from country to country. For example, cowpea yield trials are difficult to grow in Malawi without fungicide application to control Ascochyta blight. Root knot nematode is or can be a major problem on cowpeas in all SADCC countries. The parasitic weed, Alectra vogelti, was reported as a problem in Botswana and is present in Malawi, Mozambique, Zambia and Zimbabwe.

Genetic resistance to nearly all pathogens (except Ascochyta phaseolorum, several insect pests and root knot nematode) is present in materials included in IITA cowpea yield trials and screening nurseries. Thrips are not considered an important cowpea pest in most SADCC countries. But, the thrip resistant entry in one Zambian trial yielded 30 percent more than the next highest yielding entry. Development of cultivars which combine thrip, leaf hopper, Maruca, bruchid and root knot resistance would significantly reduce production losses.

4. Bambara groundnut, Vigna subterranea

Bambara groundnuts have a longer history of cultivation in Southern Africa than any other major grain legume crop. They are used as traditional food and are associated with several tribal ceremonies. Bambara groundnuts have several common names, even in English, including jugo-bean and groundbean.

In many countries Bambara groundnut is considered a famine crop. Under conditions of high temperature and low rainfall, when most other crops fail, yields of Bambara groundnut remain fairly high. In addition, it can be grown successfully at high elevations, on savanna soils, and on acid soils. Experimental yields of up to 4.0 tonnes per hectare have been obtained, but screening trials of Bambara groundnut germplasm indicate that entries are quite environment-specific in their adaptation.

Bambara groundnut is consumed as green seed and in a variety of ways as dried seeds. The variability in testa colour and colour patterns found in land races suggests that seed colour does not greatly influence consumer acceptance. However, large-seeded types appear to be preferred. Bambara groundnut requires a longer cooking time than other grain legumes consumed as cooked beans. Also, the pods are extremely hard, difficult to shell, and generally contain only one seed. Storage in the pod greatly reduce losses caused by bruchids.

Besides hard threshing and long cooking, the major production constraints are weeds, seed supply, and the labour requirement (Annex D). Bambara groundnut produces a small, creeping plant with short internodes; it competes poorly with weeds. If grain legumes are in short supply, farmers may consume part of their seed supply and later increase spacing in their intercropping system. However, agronomic studies show that Bambara groundnut responds well to narrow row spacing and high plant population, when moisture and soil fertility are adequate.

Few pests and pathogens which attack Bambara groundnut have been identified. Even Alectra vogelii and root knot nematode do not cause large losses. The most important biotic problem is probably Hilda patruelis-ant-Fusarium solani, a wilt-inducing complex. In Swaziland, recommendations are that Bambara groundnut should be planted only in virgin soils to avoid this wilt-inducing complex. Since little research on germplasm evaluation or plant breeding has been undertaken for the Bambara groundnut, its potential as a crop in the SADCC countries is difficult to assess.

5. Soybean, Glycine max

The relatively recent introduction of soybean into Southern Africa is associated with the construction of an oil-extracting plant. Production of soybean is concentrated on commercial farms because of the ready market for large quantities. Oil meal and other by-products may be more valuable to consumers than the oil extracted. Oil meal is widely used in Zimbabwe and Zambia as a protein source in poultry feeding. Since local uses are few, traditional farmers are reluctant to grow soybean because of the poor marketing possibilities for small quantities.

Except in Zimbabwe and Zambia, production of soybean is low in SADCC countries. The Team views soybean as an important grain legume for SADCC countries because of its high yields and its potential as a commercial crop. As new techniques for processing and cooking are introduced, human consumption is likely to increase.

Soybean production constraints are summarized in Annex D. Seed quality and rapid loss of seed viability during storage are the major production problems. The short supply of good quality seed may limit production. Soybeans are sensitive to moisture stress and can shatter easily when they mature in hot, dry environments. Labor requirements at harvest can limit production by small farmers. Soybean cultivars tend to be quite limited in environmental adaptation. Cultivars developed in Brazil and Australia do best in Zambia. Those from the central U.S.A. do best in Swaziland. Two cultivars, 'Hernon 147' and 'Magoye', both of which nodulate well with indigenous strains of Rhizobium sp., have been recommended in Zambia for small farmers who do not use commercial seed inoculants.

Few pathogens and pests affect soybean. Bacterial blight reduces yields; beetles reduce pod set; bollworm destroys a portion of the pods. Root knot nematode may become the most important biotic problem of soybean in the SADCC countries. Termites have caused severe losses in isolated cases.

6. Pigeon pea, Cajanus cajan

Pigeon pea is a perennial grain legume adapted to hot, dry environments with seasonal rainfall. Like cowpea, it is suitable for regions in which common beans cannot be grown. Pigeon peas offer more flexibility than cowpeas in cropping systems and time of planting. Only Malawi, Mozambique and Tanzania produce significant amounts of pigeon pea. Pigeon peas are used primarily as green shelled seeds because pods can be harvested during most of the dry season.

Cool temperatures at higher elevations in Malawi and Tanzania limit the production areas of pigeon pea. The development of semi-dwarf, early-maturing cultivars in Kenya has led several scientists to consider testing pigeon pea at higher elevations. Intercropping is the most commonly used cropping system, as pigeon pea must be protected during the first two months when growth is very slow and competition with weeds is poor.

Pigeon pea has few production constraints (Annex D). Seed supply and seed quality can limit production. The need for a long growing season is an important factor. The low yield potential and tall growth habit of pigeon peas are also problems. Utilization of pigeon pea as a ratoon crop and as fuel may partially compensate for these negative factors. The failure of pigeon pea to nodulate well in Southern Africa affects their production and usefulness. Fusarium wilt is the most important disease problem; bruchids and termites are insect pests of importance in nearly all parts of Southern Africa. The American bollworm and blister beetles are important pests on flowers and immature pods. (See Annex D).

Breeding programs in the SADCC countries will rely greatly on local germplasm, because the photoperiod response of pigeon pea appears quite strong. Pigeon pea introduced into Malawi from ICRISAT failed to flower. Primary utilization of pigeon pea as a vegetable crop may further restrict the contribution of introduced germplasm.

7. Mung bean, Vigna radiata

Although mung bean (green gram) is a minor grain legume in SADCC countries, it is an important food crop for a portion of the population in all countries except Lesotho. Large seeded types are preferred in several countries. Mung bean is drought tolerant. It has a relatively short season and adapts well in drier areas. Mung beans can be used as rapid-cooking dried beans, germinated to produce bean sprouts, or harvested for their immature pods.

Diseases which may reduce yields include Ascochyta blight, Ascochyta phaseolorum; anthracnose, Colletotrichum lindemuthianum; and powdery mildew, Erysiphe polygoni. Root knot nematodes can cause yield losses. Bean fly, Ophiomya phaseoli and cowpea bruchids, Callosobruchus chinensis, are important pests on mung bean. Aphids were reported as a problem in one trial in Zimbabwe. A determinate growth habit and resistance to shattering will be economically important characteristics as mung bean production increases.

8. Chick pea, Cicer arietinum

Chick pea is a valuable crop to a small portion of the population in most SADCC countries. However, the Teams considered chick pea to be less important than many other grain legumes. Chick pea yields have been very low, in trials conducted in Malawi, because the crop was damaged by wilt leaf blight, stem rot, rust and pod borers. Poor pod set was reported in one trial, due to insect damage. Obtaining disease and insect resistant cultivars will require a concerted effort.

9. Common pea, Pisum sativum

In Lesotho where peas are grown primarily as an export crop, they are an important grain legume. Peas may also become important in Swaziland if a processing plant is built. In several countries, peas have been evaluated at high elevation or as a cool season, irrigated crop. Since peas are poorly adapted to most SADCC countries, their production will increase only where the climate is cool and an export market exists.

10. Other grain legumes

Hyacinth bean or dolichos bean, Lablab purpureus, is grown and utilized in Malawi and Mozambique. Trials conducted in Malawi in the early 1960s suggest that blister beetle, Myabris spp., can prevent pod set. The pathogens and pests of the hyacinth bean, reported from other parts of the world, include many that are important on beans and cowpeas.

Tepary bean, Phaseolus acutifolius, is an important crop in Botswana. It has been found in common bean collections in Malawi. The tepary bean is the most drought tolerant of the Phaseolus beans, has a short growing season and rapidly produces a food supply in poor rainfall areas.

Lentil, Lens culinaris, is an important crop in Lesotho and is grown in Swaziland. Lentil is considered to be the most nutritious grain legume but it probably can be grown only during the cool dry season in most SADCC countries. As double cropping increases at higher elevations, lentil may become an important irrigated crop.

Black gram, Vigna mungo, is reported to be grown in several SADCC countries.

B. Seed Production

Seed shortage is a major quantitative constraint to crop increase; poor seed quality is a cause of low plant population and high disease incidence. Droughts in dryer regions can result in complete disappearance of a crop when proper plant material cannot be provided rapidly.

Special breeding emphasis has been given to cereals, but legume crops have been somewhat neglected. Only soybean and groundnut seed are distributed on a large scale to commercial farmers, principally in Zimbabwe. The capacity of the various national seed services is generally low and the minor crops rely solely on farm seed production. It can be assumed that, with the exception of the soybean crop in Zimbabwe, the official seed distribution network supplies less than 5 percent of the total requirements of the other legume crops.

Subsistence farmers will not willingly spend money on a crop that gives no monetary return. Seed demand is therefore low, except in cases of scarcity. When certified seed is available, it could be subsidized or preferably be given on credit, the seed distributed at the beginning of the season and returned in kind with a small interest after harvest. Such a system does not exist in SADCC countries. Seed is sold for cash to the farmers at a price that they generally cannot afford.

Inadequate price policies, poor seed distribution networks and the absence of a crop marketing organization are major constraints to the large-scale utilization of inputs (principally certified seed), in SADCC countries. Seed production and availability are major constraints to the development of legume crops in SADCC countries. Seeding rates, seed storage and viability are physical constraints to increased legume production. Large seeded legumes have very low multiplication rates under the prevailing yield conditions.

Seed-borne diseases and the limited adaptability of cultivars to a broad range of environments will have a major impact on the returns realized from GLIP. Any package of production practices recommended to small holders needs to include high quality seed which will respond to the other inputs suggested. The productivity of field agronomists will be related to the quality of seed used in trials and demonstration plots. The plant breeders, entomologists, and plant pathologists will need several environments to select the broad adaptation and to screen for resistance to the array of insects and diseases which attack grain legumes. Arrangements for off-season nurseries can be least double the productivity of the plant improvement program.

The seed-related constraints have, in part, restricted progress made by grain legume improvement programs developed to serve an international clientele. Several of the biological restrictions can be minimized in development of the organizational structure which facilitates the activities of its scientists. For example, an agronomist responsible for cropping systems research or on-farm demonstrations cannot function unless he is provided an adequate supply of clean seed.

If materials generated by a grain legumes breeding program are to be adapted to a relatively wide range of environments, early generation testing will need to be conducted in 3 to 4 different environments, nursery sites. Effective utilization of genetic resources will require three generations per year for beans and cowpeas, and two per year for groundnut. In some cases the delay time between harvest and planting the next nursery could be as short as two weeks. Location of major nurseries of the same crop in two countries would require two directional movement of early generation breeding materials rapidly through plant quarantine services. This seed will likely be contaminated with seed-borne pathogens. Distribution of elite lines and pure seed stocks will likely be uni-directional.

IV. STATUS OF GRAIN LEGUME RESEARCH

A. Ongoing Research Programmes

In their desire to increase agricultural productivity, SADCC countries place high priority on improving agricultural research as a means of achieving improved food security. To perform their functions effectively, national agricultural research systems must operate within a set of policy guidelines that reflect the goals of the society and the realities of the national budget. Within SADCC countries, agricultural research systems differ greatly in organizational structure and in their capacity to conduct research effectively. The structure of agricultural research in all the SADCC countries is well documented in the Southern Africa Centre for Cooperation in Agricultural Research (SACCAR) Report.

The Team examined ongoing research in each SADCC country visited. Findings are presented below by crop for each country (in alphabetical order).

Researchers in Botswana are working primarily on cowpeas under the Bean/Cowpea CRSP. A total of 320 cowpea cultivars, including local and exotic lines are being screened to determine yield potential, drought resistance and disease and insect problems. The Botswana germplasm collection is being increased. More than 400 lines have been catalogued and 180 are being evaluated in field trials.

Cultural practices involving intercropping, plant population, time of planting, micronutrient application and efficiency of rhizobial strains are being tested. A proposal to expand the research program on cowpeas has been developed by IITA. Little research work is being done in other grain legume crops in Botswana.

In Lesotho researchers are using a farming systems approach to study grain legumes. Generally grain legumes are studied in comparison with the staple cereal crops, wheat and maize. Selection work consists of varietal trials made up of local and exotic plant material of groundnuts, soybeans, beans, fresh peas and lentil. Crop management trials include land management, seedbed preparation (plowing and disking), weed control and planting time trials, primarily on beans.

Crop rotation trials to compare different crop sequences (beginning with cowpeas, chickpeas, beans, pigeon peas) are being carried out. Increased nitrogen in the soil is being measured. Crop introduction trials compare traditional cereal crops with soybeans, cowpeas, groundnuts and beans. None of the new crops is particularly outstanding but soybeans warrant

further study on farmers' fields to determine performance under a wide range of growing conditions. At present this crop is not used locally. Frost is often a constraint to proper maturation of groundnuts and cowpeas.

Research in Malawi focuses on groundnuts, beans and other grain legumes.

Groundnuts. Both confectionery nuts and nuts for oil extraction are grown. Groundnuts are particularly important in smallholder agriculture: they contribute significantly to diets; they provide 25-33 percent of smallholder cash incomes; and they improve soil fertility and structure. Groundnuts are Malawi's fourth most important export crop after tobacco, sugar and tea. They supply about half the country's edible oil. Groundnut production has declined since the late 1960's because of the relatively low prices paid to farmers and the incidence of diseases, especially early leafspot and groundnut rosette virus.

Malawi's groundnut research programme aims to determine ways of increasing yield and improving the quality of groundnuts. Trials are underway to find suitable substitutes for the oil variety Malimba and the confectionery variety Chalimbana which are susceptible to the diseases noted above. Closer planting of groundnuts has been shown to reduce the incidence of rosette. The Department of Agricultural Research (DAR) is studying leafspot, with assistance from ICRISAT and Reading University. Agronomic trials include time-of-planting, spacing, fertilizer response, weeding, and harvesting methods. Plant pathology research includes screening cultivars for disease resistance and evaluation of the control of groundnut wilt complex using systemic insecticides.

Beans. Beans are an important part of the Malawian diet. They are beneficial in smallholder farming systems because they have the ability to fix nitrogen. Beans are grown in combination with several other crops, especially maize.

Recent research has focused on mixed cropping of beans with maize. Considerable variability has been recorded in the extent to which different types of beans compete with maize and the extent to which they are synergistic. Although maize yield always drops some, compared with sole-stand maize, the combined yields of maize and beans have been as high as 70 percent above sole-stand maize. Researchers are also intercropping beans with other crops, including groundnuts, tobacco and cassava.

For the past two years, the DAR in Malawi has been one of the cooperators in the Collaborative Research Support Program (CRSP) in beans. Michigan State University is the lead

institution in this CRSP. This program has supported continuation of a strong research component at Bunda College. Cooperative research is mainly on: 1) studies of the genetic diversity of beans (Malawi has one of the most diverse sets of types in the world); 2) studies of the utilization of beans by housewives. (Some women students went to villages for three months, collecting beans and studying utilization in a village for one week at a time.)

Other Grain Legumes. Guar is one of the successes of DAR research. From work of guar beginning in the early 1970s, the first commercial crop of 25 metric tonnes was harvested in 1976. Production is about 5,000 tonnes annually. Current research includes screening and characterizing a wide range of germplasm for yield potential, disease and pest tolerance, and agronomic work. Research on cowpea and pigeon pea is limited to yield trials and evaluation of germplasm introduction.

In Mozambique, ongoing research programmes cover the major legume crops. Only groundnut and soybean trials have attained an advanced level.

Bean/Cowpea/Bambara groundnut. Research being conducted by the Ministry of Agriculture has no funding for extension work. The actual trials do not go beyond germplasm collection, cultivar screening, some crop management work and production of basic seed. Germplasm collection includes 92 lines of cowpeas, 47 lines of Bambara groundnuts, 42 lines of pigeon peas, 27 lines of Phaseolus and various minor crops. Senior staff consists of two researchers (expatriates).

Groundnuts. The research program is in the Faculty of Agriculture and has support from IDRC (2nd phase) until 1985. Two research workers (expatriates) and two Mozambican undergraduates conduct the research programme which consists of: 1) germplasm collection in the north (long season varieties) and south (short season) and introduction from ICRISAT, Senegal and USA; 2) mass selection and single-plant selection, leading to yield trials and screening for disease and drought resistance; 3) crop management work on fertilization, time of planting, plant populations, and inoculation; 4) training at undergraduate, field assistant and farmer levels; 5) a seed-multiplication scheme to be initiated in 1984.

Soybeans. An FAO team is collaborating with a state farm production programme in soybean research. In 1983, the programme involved 2,200 hectares. The programme includes germplasm collection of 150 lines and varietal comparisons. Two varieties have been released. Fertilization and inoculation work (Rhizobium from USA and Australia) has been

undertaken. Staff members include 3 research workers on the FAO team and 5 senior officers at Lioma state farm.

In Swaziland, grain legumes are considered to be smallholder crops. Research has been largely limited to adaptation and cultivar testing. The USAID-financed farming systems research and extension training project, which focuses on cropping systems as part of a range of smallholder needs, is now cooperating with the Ministry of Agriculture. Swaziland also participates in the international seed testing programmes, such as INTSOY, and conducts other varietal evaluations in cooperation with IITA and CIAT. The basic seed production and multiplication project supported by FAO has conducted cooking quality and visual acceptance tests on bean lines from CIAT. The University of Swaziland has several excellent scientists who have conducted research on production trials, surveys of disease and insect problems, germplasm yield trials and mixed cropping evaluation of grain legumes including beans, groundnut, cowpea and Bambara groundnut. However, current support is primarily for the teaching program and field research facilities are largely unavailable.

In Tanzania research focuses on groundnuts, soybeans, cowpeas, beans and other legumes.

Groundnut. Two major programmes are under way. The Department of Crop Science at Morogoro (Dar es Salaam University) is conducting a pulse and groundnut improvement project, funded by IDRC. Breeding targets are: high oil and protein content; increased yields; adaptation to agro-ecological zones in the country; resistance to drought; insects and diseases (with a particular attention to rosette). Progenies are presently at F_3 level; improved varieties may be available for release by 1987 (F_8).

Uyole Agricultural Center (UAC) is conducting an important research programme on annual oilcrops. This programme has a very complete groundnut germplasm collection: rust; rosette; leafspot; drought resistant material from ICRISAT; all released varieties in Senegal; short season varieties from the USA. The programme in agronomy includes: 1) fertilization trials (rates of phosphorus and sulphur, organic fertilizers, micro-nutrients, Rhizobium inoculation); 2) crop management trial (planting time, spacings and intercropping); and 3) plant protection (fungicide and insecticide trials).

Soybeans. Both the IDRC and IITA/USAID/Tanzania projects have a soybean breeding programme, including an international germplasm collection and trial network (INTSOY). Selection for yield, seed viability and nodulation with local rhizobium strains is at an advanced stage. Evaluations of multi-locational trials are underway.

Cowpeas. The major cowpea research programme is conducted by the IITA/USAID crop research project located at the Ilonga Research Institute. Breeding targets are: 1) very early maturing and high-yielding varieties (two varieties released and two lines ready for release); and 2) disease resistance. Multilocational trials are being conducted in long and short rainy season areas. Crop management trials have led to crop management recommendations for "minimum" and "optimum" levels of production. Intercropping, plant protection and storage problems have been studied.

Beans. In beans, Tanzania has three major programmes. The USAID/University bean project includes: 1) germplasm collections for screening and identification of promising lines; 2) mass selection of progenies from crossings made in USA; 3) multilocational trials in collaboration with Ministry of Agriculture; 4) fertilization, inoculation and intercropping trials.

Ilonga Research Institute conducts an international bean rust nursery in collaboration with CIAT. Other work includes trials on plant population, time of planting, varieties and insecticides.

The common bean improvement programme in the southern highlands is a very complete breeding and agronomic program, including fertilization and weed management studies. This project has Nordic financing.

Other legumes. A germplasm collection of green grams has been gathered in collaboration with AVRDC and is maintained in Morogoro. Improved varieties have been released. At present Tanzania has no research projects in Bambara groundnuts and pigeon peas.

In Zambia, research focuses on groundnuts and soybeans.

Groundnuts. Current research on groundnuts is supported by an FAO/USAID cooperative oil seed project and is conducted at the Msekera Research Station near Chiptata. Researchers are collecting local germplasm, introducing new lines and screening these for higher yields. The promising lines are selected for advanced yield trials. There are 900 entries in the groundnut germplasm bank in Zambia of wich about 450 are local collections. All breeding material is in the field for disease reaction.

The main confectionary groundnut grown in Zambia is Chalimbana. Selection within the land race Chalimbana has resulted in several morphologically different lines. After many years in both Zambia and Malawi, Chalimbana has become

mixed. Breeders think that lines can be selected out of the present mixture. Nearly 20 years of yield testing have resulted in only minor changes in yield potential.

Other research in groundnuts involves improving the variety Makulu Red to make it more tolerant to acid soils and thereby reduce the high frequency of "pops."

Soybeans. Soybean research is supported by an FAO/USAID oil seed project and research is conducted primarily at the Magoye Station. Agronomic trials on soybeans in Zambia include fertilizer, spacing, date and depth of planting, herbicides and machine harvesting. Breeding work includes introducing and screening new types for grain yield and general adaptability, and screening varieties for their competitiveness against weeds. Although the programme does not have a microbiologist, the agronomist has screened several lines against rhizobial inocula introduced from various parts of the world. Screening for promiscuous soybean lines which can nodulate without inoculation is one of the priorities. Good lines were selected and two have been released to the smallholders.

Beans/Cowpeas/Bambara groundnut. Research on these three crops is presently centered at Msekera Station. The expatriate staff includes a breeder, a pathologist and an entomologist, supported by a World Bank project. The germplasm collection at Msekera Station contains 1,500 bean entries of which about half were collected in Zambia, 550 cowpea entries of which 300 were collected in Zambia and a relatively large collection of bambara groundnuts, 450 entries about half of which were collected locally by FAO supported missions.

The pathologist-entomologist team has recently completed an extensive evaluation of plant pathogen and insect pests of beans and cowpeas. Introduced cowpea and bean nurseries, from IITA and CIAT, respectively, have been compared with indigenous cultivars. Most introduced beans have better yields, but seed quality and testa colour are probably not acceptable locally. Heat stress is the main climatic problem. Bean fly and bruchids are by far the worst insect problem encountered. Important diseases include anthracnose, bean common mosaic virus, common blight and angular leaf spot. The introduced cowpeas were much more vigorous than local cultivars. Insects appeared to be the major factor limiting cowpea production, but the yield potential of some lines was excellent.

The research effort on bambara groundnut represents only ten percent of the total grain legume program. The large

germplasm collection was tested in unreplicated trials. Little above ground variability was noted; yields of a few lines were excellent, and no major disease or insect problem was observed. Adaptation of lines to specific environments was reported. Some research on pigeon peas was started about five years ago. Remnants of that work continue at Mt. Makulu Research Station. Most work has been discontinued because other grain legumes are considered more important.

Both pigeon peas and chick peas show a good potential for warmer parts of Zambia. The ICARDA chick pea lines have been grown at the Msekera Station. A few trials on guar and lima beans have been completed. Lima bean yields in the long rainfall areas were good.

The Team believes that acute financial constraints do not permit scientists in the national programme to operate effectively. There is a shortage of trained manpower in breeding, agronomy, plant pathology and entomology. However, staff can receive and test improved lines from external sources. The Swedish-supported seed marketing and production project at Mt. Makulu has produced seed of groundnut, soybean, beans and other major crops in Zambia and has trained a local staff for continuation of the program.

In Zimbabwe public commodity research is conducted by the Department of Research and Specialist Services. Special emphasis in legume crops is given to breeding, plant protection, agronomy and crop management.

Beans and cowpeas. The breeding programme includes germplasm collections, bulk population breeding and evaluation work, multilocational variety trials and international bean and cowpea variety trials. The plant protection programme includes general screening of pesticides for various pests. The Department participates in the international cowpeas disease survey. The agronomy programme, combined with breeding, is composed mainly of yield and adaptation trials on beans and includes a yield and adaptation nursery.

Soybeans. The breeding programme covers a very large scope of genetic improvement work: 1) crosses for genetic variability; 2) single seed descent and pedigree breeding techniques; 3) evaluation of introductions and international collection (INTSOY); 4) preliminary, intermediate and advanced multilocational trials. Breeding targets are high yields, determinate growth habit and other favourable agronomic and commercial characteristics. Plant protection programmes include general screening of pesticides (with special emphasis on nematocide trials), foliar diseases, seedling rots and evaluation of post-harvest losses. Herbicide application is being studied.

Particular attention is given to rhizobial nodulation and inoculation. A collection of 500 rhizobium strains, covering most legume crops, is kept in Marondera Grassland Research Station; inoculants for soybeans and groundnuts are delivered ready for use to the farmers on a large scale (86,000 packs of soybean inoculant sold in 1982). Fertilization trials are carried out in combination with inoculation studies.

Groundnuts. Breeding work consists of a large genetic improvement programme: 1) crosses for genetic variability; 2) pedigree breeding; 3) preliminary, intermediate and advanced multilocation trials on short season and long season varietal types. Breeding targets are short season, high yielding dormant types; long season high yielding types; and disease resistance (ICRISAT international foliar disease nursery).

Plant protection work includes seed protection at planting time, foliar disease control trials, and control of Hilda patruelis, an important groundnut pest. Agronomy work includes studies on planting and lifting time. Mineral nutrition studies are carried out in relation with inoculation trials.

B. Scientific Personnel Resources

Adequately trained and experienced personnel are of paramount importance for effectively implementing any agricultural research programme. In a number of countries the teams found few established positions, and some of these had not been filled. In some instances posts were filled by expatriates on short-term contracts.

In Botswana there are 25 established research positions, of which 13 are filled by expatriates. Of the remaining twelve positions filled by nationals, six are vacant because staff are in training overseas. In the Agricultural Research Division in Lesotho, 12 of the 88 research and support staff are expatriates. In Mozambique, all 27 research positions are filled by expatriates; six of the 27 work on grain legumes. In Swaziland there are 13 positions in the Ministry of Agriculture; ten are vacant while staff receives training abroad. In Tanzania, there are 183 positions, of which 63 have not been filled and 32 are temporarily vacant while staff are overseas undergoing training. Of 64 posts in Zambia, half are filled by nationals. In Zimbabwe there are 68 posts. In most cases, scientists in these countries are doing research on more than one crop.

The Team made a survey of the number of scientists currently engaged in research on grain legumes in 7 of the SADCC countries (Angola and Swaziland were not contacted).

Information also was obtained on the level of education, and whether they were nationals or expatriates. Similarly, the number currently assigned to grain legume research, but on leave for graduate study, was documented. The numbers of national scientists, by country, academic degree, discipline, and whether active or in training are listed in Table 3. Similar information on expatriate scientists is presented in Table 4. The particular grain legume crop or crops each scientist was assigned to also was obtained, but is not listed in the tables.

National scientists currently working on grain legumes in the seven countries amounted to 35.4 active and 12.2 in training for a total of 47.5 (Table 3). Of the active scientists, 14.8 have B.Sc., 15.6 M.Sc., and 5.0 Ph.D. degrees. Number of active scientists per country varied from 1 for Mozambique to 12 for Tanzania. The number of expatriate scientists in the 7 countries currently amounts to 19, of which 3.0 have B.Sc., 4.7 M.Sc., and 11.3 Ph.D. degrees (Table 4). Thus, counting national and expatriate scientists, a total of 66.5 are engaged in grain legume research in 7 of the SADCC countries.

While obtaining the inventory of current scientists, country research representatives were asked to give, by educational level, discipline and crop, the number of scientists required for a fully adequate grain legume research programme. Results are presented in Table 5, for each of six countries, by discipline and educational level (information by crop is not included). Those projections call for a total of 85.3 scientists on all grain legume crops, with 1.7 at the B.Sc., 31.4 at M.Sc., and 52.2 at Ph.D. level, respectively. It should be pointed out that considerable variation among countries was encountered in the number and educational level of scientists projected, depending upon what each perceived to be an adequate research programme. Although educational levels projected are considerably higher than those of the current staff, only 19 additional scientists were perceived as needed; an apparently realistic figure.

It should be pointed out that the information in Tables 3, 4, and 5 includes all grain legume crops of interest to the SADCC countries. Most of the current and projected effort is on 4 crops, principally groundnuts and soybeans, followed by beans and cowpeas.

Table 3. Inventory of National Scientists Working on Grain Legumes in Six Countries of SADCC 1/

Discipline		Botswana Act	Botswana Train 3/	Malawi Act	Malawi Train	Mozambique Act	Mozambique Train	Tanzania 2/ Act	Tanzania 2/ Train	Zambia Act	Zambia Train	Zimbabwe Act	Zimbabwe Train	Total Act	Total Train
Agronomist	B 4/			1		.1		2		1		1		6.0	
	M		2		2			2	1	1		1		4	5
	D							1						1	
Breeder	B							1		1		3		5	
	M				2.8			3				2		5	2.8
	D			1							1			1	1
Pathologist	B			1										1	
	M		0.2		1			2				1.7		3.7	1.2
	D			0.5						0.4		0.2		1.1	
Entomologists	B											0.4		0.4	
	M							1		1			.1	2	0.1
	D		0.2									.2		0.2	0.2
Physiologist	B														
	M	0.5												0.5	
	D				1										1
Micro-biologist	B				0.6							1		1	0.6
	M														
	D			0.7										0.7	
Weed Scientist	B											0.4		0.4	
	M											0.4		0.4	
	D														
Nematolo-gist	B			1										1	
	M												0.3		0.3
	D			1										1	
Sub Totals	B			3	0.6	.1		3		2		5.8		14.8	0.6
	M	0.5	2.2		5.8			8	1	2		5.1	0.4	15.6	9.4
	D		0.2	3.2	1			1		0.4	1	0.4		5.0	2.2
Totals		0.5	2.4	6.2	6.4	1		12	1	4.4	1	11.3	0.4	35.4	12.2

1/ Lesotho has 5 agronomists at BS&MS level working on all crops. Approximately 20% of their time is on grain legumes. Numbers of scientists in Angola and Swaziland was not determined.

2/ Staff at the University of Dar es Salaam (Morogoro) is not included. Twenty three conduct part-time research on grain legumes, mostly beans, including agronomists, breeders, entomologists, pathologists, economists, and microbiologists. Advanced degree training is ongoing or planned for six.

3/ Act=Active; Train=In training

4/ B=B.Sc.; M=M.Sc.; D=Ph.D.

Table 4. Inventory of Expatriate Scientists Working with Grain Legumes in Seven Countries of SADCC[1/]

Discipline	Edu	Botswana	Malawi	Mozambique	Tanzania	Zambia	Lesotho and Zimbabwe	Total
Agronomist	BS	1		1				2
	MS			0.6		1		1.6
	Phd	1	0.5	2				3.5
Breeder	BS			1				1
	MS	1						1
	PhD		1	1	1	3		6
Pathologist	BS							0
	MS					1.6		1.6
	PhD				0.2			.2
Entomologist	BS							0
	MS							0
	PhD				0.6	1		1.6
Weed Scientist	BS							0
	MS	0.5						0.5
	PhD							0
Sub Totals	BS	1		2	3.0			
	M	1.5		0.6		2.6		4.7
	P	1	1.5	3	1.8	4.0		11.3
Totals		3.5	1.5	5.6	1.8	6.6	0	19.0

1/ Number of expatriates in Angola and Swaziland were not obtained.

Table 5. Estimates by National Grain Legume Research Programme Representatives of Professional Scientific Staff Needs for an Effective Grain Legume Research Programme.

Discipline		Botswana	Malawi	Mozambique	Tanzania	Zambia	Zimbabwe	Total
Agrono-	BS	1	1					1
mists	MS	1		2	1		5	8
	PhD	2	4		4	3		13
	BS							
Breeders	MS		1	3	2		5	10
	PhD		5		4	4		13
Patholo-	BS							
gists	MS			1	1		2.4	4.4
	PhD	2	3		3	2.5		10.5
Entomol-	BS							
ogists	BS			1	1		2	4
	PhD	1	4		2	1.5		8.5
Physiolo-	BS							
gists	MS							
	PhD	1	1			2		4
Micro-	BS		0.7					0.7
biologists	MS							
	PhD		0.7					0.7
Weed	BS							
Scient.	MS						1	1
	PhD	.5						0.5
Nematol-	BS							
ogists	MS		1				1	2
	PhD		1			1		2
Sub-	BS		1.7					1.7
Totals	MS	1	2	7	5		16.4	31.4
	PhD	6.5	18.7		13	14		52.2
Totals		6.6	22.4	7	18	14	16.4	85.3

C. Research and Training Gaps

The current research effort on grain legumes in the SADCC countries is not adequate to solve the production problems detailed in the section on constraints. No country has the minimum critical mass of scientists, facilities and financial support needed to provide the in-depth research needed to solve the critical and long-term problems.

Most of the scientists listed in Table 3 have responsibility for many crops including non-legumes as well as legumes. Those assigned full-time to grain legumes frequently must attempt to give attention to several or all of the crops. In many research locations, supporting or cooperating disciplines necessary for problem-solving are inadequate or wanting.

A comparison of Tables 3 and 4 reveals that present numbers and educational levels of scientists needed for adequate national research programmes on grain legume improvement are insufficient. Researchers charged with major responsibility for a highly technical segment of the research effort may have only a diploma or BSc degree. While a major effort to provide undergraduate and graduate training is underway in most SADCC countries, it is inadequate to keep up with the requirements. In some countries, candidates are unavailable for established positions.

In many institutions in SADCC countries, scientists must attempt to conduct research without adequate basic laboratory facilities or equipment, although land for experimentation is likely to be available. Transportation and funding for research are major constraints in many instances. For example, major problems include inadequate numbers of vehicles inoperative vehicles, unavailability of fuel and/or insufficient funds to purchase fuel.

Thus, major gaps in both research and training are clearly evident.

V. ESTABLISHMENT OF THE GRAIN LEGUME IMPROVEMENT PROGRAMME

A. Justification and Objectives

Economic and social indicators show that the food situation in SADCC countries is critical. Population is growing at an average rate of about three percent per year. Growth in agricultural production is unable to meet the increasing needs. It is estimated that the region imports at least 16 percent of food consumed. The already critical food situation in the SADCC countries may be worsening.

What applies to the general food supply situation in the region also is true of grain legumes. As indicated in Chapter II, yields of grain legumes in the SADCC countries are extremely low and production is not expanding commensurate with population growth. Yet beans, cowpeas, groundnuts and other grain legumes constitute the principal source of protein for the bulk of the populations of southern African countries. They are cheaper than animal protein and, thus, are of greater significance in the diet of the subsistence farmers and the poor urban dwellers.

To date researchers and planners have given scarce attention to grain legumes. Only groundnuts and soybeans have become important crops to research because they are utilized as export/cash crops. Beans, cowpeas, pigeon peas and Bambara groundnuts have received minor attention. As a consequence, cultivation of most grain legumes has been limited to subsistence and home garden cultivation. Their potential worth as important farming enterprises is not completely established and their role in production and in diets is unexplored.

The current national research efforts, with their meager staffs and facilities and their relatively isolated and independent efforts, cannot hope to produce the in-depth research necessary to increase grain legume production to the desired level in a minimum of time. This can best be done by a regional multidisciplined research team with ample resources to conduct research on the many and complex problems inhibiting production. Furthermore, only a regional team can provide the network necessary for drawing the national programs into a coordinated effort to improve crops and level of research in all of the SADCC countries.

The goal of the Grain Legume Improvement Programme is to increase grain legume production within the region and reduce the incidence of periodic shortages caused by diseases, insects, droughts, and low-yielding varieties. The purpose

of the Programme is to assist in the development of a regional research programme for grain legumes, including the development and introduction of new varieties and improved cultural techniques. Adoption of new technology by farmers will increase production.

B. Selection of Crops for Research Attention by GLIP

1. Criteria

a. Current importance in terms of production and area,

b. Importance in diets of rural and urban consumers,

c. Ability to meet food preferences of consumers,

d. Adaptability to smallholder mixed cropping systems,

e. Yield improvement potential.

2. Crops selected

On the basis of the above criteria, the team recommends giving initial attention to three crops; namely, groundnuts, beans and cowpeas. The relative importance of the crops as determined by the Team and listed in Table 2 indicates them to be first, second or third in nearly all of the nine countries. The area occupied by the three crops in the SADCC region (Table 1) was conspicuously greater than any of the remaining crops. All three are presently well accepted by the people and are nearly universally grown by small holders, particularly in mixed cropping. Comparative yield trials of IARCs have indicated a potential for yield increase in all three crops.

As more funds become available we recommend including bambara groundnut. It is next in importance after the three crops chosen (Table 2) and performs well under adverse conditions.

C. Management

The Team recommends that the GLIP be managed by a Management Entity (ME). The Management Entity would be the sole receiver of funds and would disperse these on a contract basis to the participating institutions. At the same time, it

would use discretion and assist national programmes where funds and services were required. Such assistance could include funds for the carrying out of the proposed screening programmes and other requirements needed to effectively accomplish the objectives of the Programme.

The Team recommends that the Programme be under the immediate direction of a Project Director (a Senior Scientist) who will have responsibility for the research programme, training, construction and development. The Project Director should be responsible to the Management Entity.

D. Organization Alternatives

Three alternative models are proposed for consideration by the CTC for Agricultural Research, SADCC:

Alternative I

Two research teams; one at high elevation in Malawi and the other at low elevation in Mozambique. Each of the three crops (beans, cowpeas and groundnuts) will receive attention at both locations. Eighteen senior staff positions are suggested. The total indicative operating budget for years 1-5 is estimated to be 16.3 million U.S. dollars.

Alternative II

Similar to Alternative I with two research teams, one at high elevation in Malawi conducting research on beans and groundnuts and one at low elevation in Mozambique giving attention to cowpeas and groundnuts. Fourteen senior staff positions are suggested. The total indicative operating budget for years 1-5 is estimated to be 14 million U.S. dollars.

Alternative III

Three research teams in each of three SADCC countries, each team having responsibility for one crop. Recommended locations are: groundnuts - Malawi; Cowpeas - Mozambique; and beans - unspecified high elevation location. Sixteen senior staff positions are suggested. The total indicative operating budget for years 1-5 is estimated to be 16.3 million U.S. dollars.

For GLIP, the design of an effective organization is complicated by the need to conduct research on the improvement of at least three crops, whereas many other regional research teams have had to deal with only one crop. Moreover, the three crops have different adaptabilities, which require different environments for carrying out effective research.

Also complicating the selection of an appropriate organization is the question of whether the team should be at one central location or in different sites. In the latter case should such dispersion be based on (1) one crop per site chosen on the basis of adaptability, or (2) two or more sites based on ecological differences of areas of production, or (3) several sites distributed in countries of the SADCC region.

Organization alternatives are presented below together with staffing and budget, advantages and disadvantages, and possible locations. The relationship of the GLIP to the National Programmes of each SADCC country is shown in a figure for each alternative (Figs. 1-3), followed by the staffing at the end of five years (phase 1), a discussion of advantages and disadvantages of each alternative, and a staffing schedule and indicative operating budget for years 1-5.

The latter is not to be considered as an accurate or detailed operating budget, but only indicative and to be used for comparing the costs of one alternative with others. More accurate budgets can be prepared only when decisions have been made as to location and type of organization.

A budget for building construction, modification, and/or purchase; farm and station development, and purchase of equipment is not included. This could amount to from five to twenty million U.S. dollars depending on alternative and/or locations selected.

Alternative I

Headquarters in Malawi with research teams at two locations, one at high elevation (Malawi) and the other at low elevation (Mozambique) (Fig. 1).

Senior Staff:
High Elevation:
- 1 Project Director
- 1 Administrative Officer
- 1 Training Officer
- 1 Bean Breeder
- 1 Cowpea Breeder
- 1 Groundnut Breeder
- 1 Pathologist (virus diseases)
- 1 Pathologist (other diseases)
- 1 Agronomist (cropping systems)
- 1 Agronomist (production-farm manager)
- 1 Entomologist
- 1 Microeconomist

Low Elevation:
- 1 Bean Breeder
- 1 Cowpea Breeder
- 1 Groundnut Breeder
- 1 Pathologist or Physiologist
- 1 Agronomist
- 1 Entomologist
- 18 Total

This alternative would emphasize improvement of grain legume production largely through breeding. Currently grown cultivars are inherently low yielding and yield trials in the SADCC countries with exotic germplasm have indicated a potential for improvement. Research and surveys by scientists in national programmes have revealed the prominent role of diseases and insects in producing low yields, hence the need for a team made up of a breeder, pathologist and entomologist. In fact diseases and pests limit production of grain legumes substantially more than those of cereals, especially maize, sorghum or millet.

At both locations field research can proceed while construction of facilities (if required) is underway, using a minimum research staff of 1 or 2 breeders, an agronomist, pathologist and entomologist.

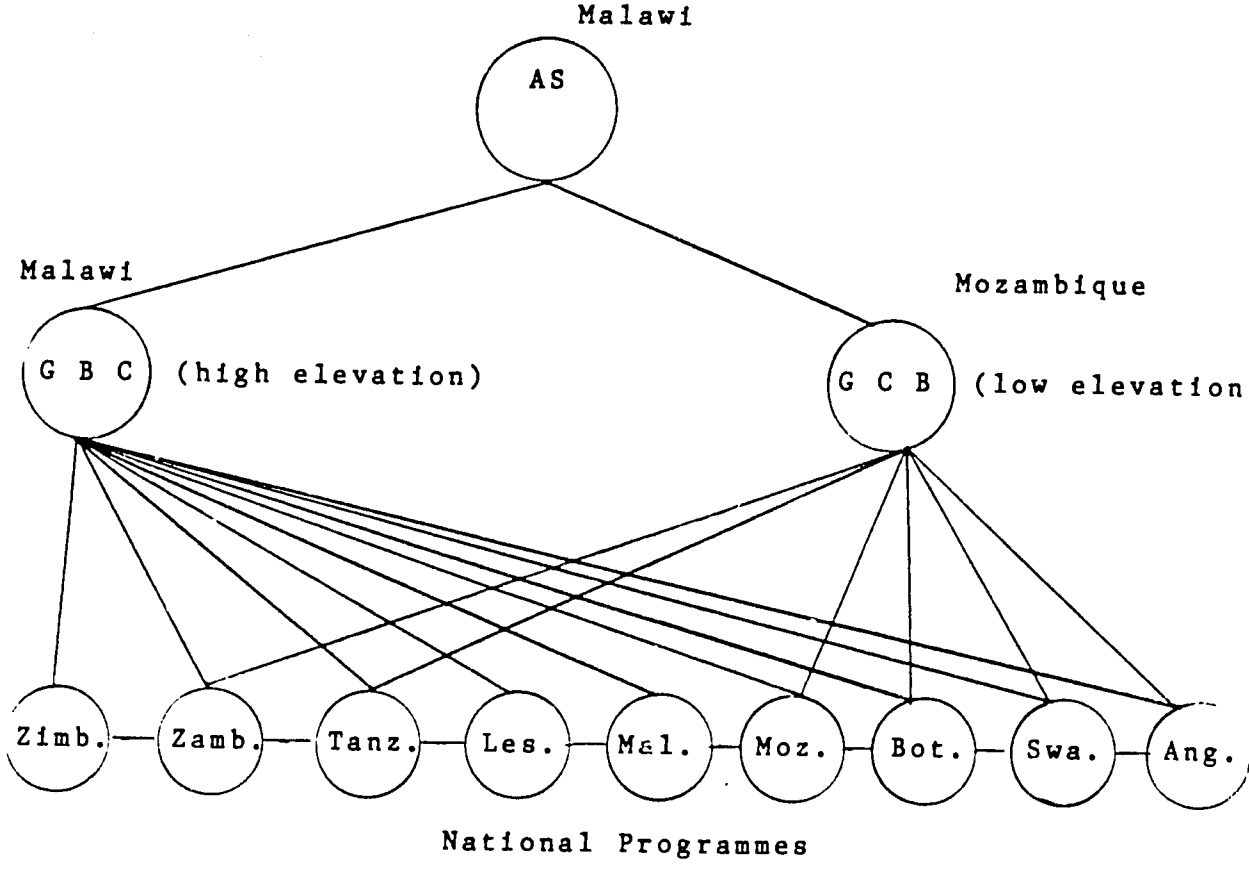

FIG. 1 - Alternative I

Advantages:

(1) Location of the team in the environment similar to that where the crop is grown will result in research results more applicable to that environment and expedite the transfer of technology to the small landholders.

(2) It would permit more in-depth research applicable to the ecological zone than would be possible from a central location in a different zone.

(3) The critical mass of scientists at each location would permit interdisciplinary research leading to a quality research product, produced earlier in the programme.

(4) Of the three crops to be included in the programme, beans are more widely adapted to higher elevations and cowpeas to lower elevations. Thus, this organization permits research on a specific crop to be conducted under more favorable conditions than would accrue from a single center.

Disadvantages:

(1) Alternative I would require a large number of scientists for the critical mass necessary for in-depth research.

(2) Location of one of the Teams away from headquarters would complicate administration of the programme and be more costly in terms of additional travel required.

(3) Some national programmes would have to interact with two research teams, which could complicate relationships.

Location:

Most countries of SADCC have within their boundaries both high and low elevations where grain legumes are produced. Thus, a number of sites would be available for either team.

For the high elevation location possibilities exist in Malawi, Tanzania, Zambia and Lesotho. Within Malawi two locations have been suggested. One is near the Chitedze Research Station and the other is near Zomba at the Makoka Research Station. At Chitedze, land probably can be made available by the Government of Malawi for the programme. If not, an alternative site near Bunda College would be satisfactory, providing land can be obtained there. The sites near Lilongwe have the advantage of being near the international airport, providing readily available transportation and communications with other countries. They

are situated near the Malawi national grain legume research programmes in the Ministry and at Bunda College. These sites also are in a major grain legume producing area of the country.

The Makoka Research Station is being phased out by the Government of Malawi in connection with its Agricultural Research Strategy Plan, and thus the entire station including land and facilities is available if this site is chosen for GLIP. The team (Meiners and Vieira) visited this site. Field space, laboratory facilities and staff housing would be sufficient for the GLIP programme. Some additional facilities in the way of guest house, dormitories for trainees, irrigation system and domestic water supply would be required. Disadvantages include poor telephone communications, distance from international air terminal and isolation from the national programme on grain legumes. Moreover, the site is outside the major grain legume growing area of the country, except pigeon peas. The station is suitable for beans and cowpeas, but not suitable for groundnuts because of acid soils.

Although use of the Makoka site would save considerable investment in construction, it is secondary to Chitedze as the most desirable location for GLIP in Malawi. Thus, if GLIP is to be a long range programme, the advantages of Chitedze would be worth the additional investment.

In Tanzania, the Mbeya area is ecologically characteristic of the high elevation grain legume area, but is too isolated for serious consideration. The same is true for the Msekera Station near Chipata, Zambia. Although at high elevation, Lesotho is not typical ecologically of the major high elevation grain legume growing areas of the region.

For the low elevation location, possible sites include Mozambique and Tanzania. In Mozambique several sites could be selected such as the Guijo Experiment Station. This is an important area for both summer and winter grown edible legumes. The international airport at Maputo would be fairly convenient. The Ilonga station in Tanzania also would be in the proper ecological zone, and is in a grain legume growing area. However, transportation problems make it too isolated for an effective international research programme. As an alternative, a site adjacent to Morogoro University would be readily accessible.

Recommendation:

For the high elevation team and headquarters of GLIP - a site near Lilongwe, Malawi; for the low elevation team - a site near Maputo, Mozambique.

Staffing and Budget

The staffing pattern and indicative operating budget for years 1-5 for Alternative I are presented in Table 6. Cost of operations for the first five years are estimated to be about sixteen million U.S. dollars.

Table 6. Alternative I. Staffing and Budget (in U.S. dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
A. SENIOR STAFF						
1. High Elevation Team						
Project Director	90,000	95,000	100,000	105,000	110,000	500,000
Administrative Officer	85,000	90,000	95,000	100,000	105,000	475,000
Training Officer	-	-	95,000	100,000	105,000	300,000
Bean Breeder	-	90,000	95,000	100,000	105,000	390,000
Groundnut Breeder	85,000	90,000	95,000	100,000	105,000	475,000
Cowpea Breeder	-	90,000	95,000	100,000	105,000	390,000
Pathologist (Virus)	85,000	90,000	95,000	100,000	105,000	475,000
Pathologist (Other)	-	-	-	100,000	105,000	205,000
Agronomist (crops sys.)	-	-	-	100,000	105,000	205,000
Agronomist (production)	-	90,000	95,000	100,000	105,000	390,000
Entomologist	-	90,000	95,000	100,000	105,000	390,000
Microeconomist	-	-	95,000	100,000	105,000	300,000
2. Low Elevation Team						
Bean Breeder	-	-	-	-	105,000	105,000
Cowpea Breeder	-	-	95,000	100,000	105,000	300,000
Groundnut Breeder	-	-	-	100,000	105,000	205,000
Pathologist (Physiologist)	-	-	-	100,000	105,000	205,000
Agronomist	-	-	-	-	105,000	105,000
Entomologist	-	-	-	100,000	105,000	205,000
	345,000	725,000	1,050,000	1,605,000	1,895,000	5,620,000
B. SUPPORT STAFF						
Technical (3 x 10,000/ scientist)	60,000	180,000	270,000	420,000	480,000	1,410,000
Farm Operations	70,000	100,000	150,000	155,000	160,000	635,000
Administrative Staff	50,000	100,000	150,000	155,000	160,000	615,000
	180,000	380,000	570,000	730,000	800,000	2,660,000
Sub-Total: Personnel	525,000	1,105,000	1,620,000	2,335,000	2,695,000	8,280,000

Table 6. Continued

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
C. OPERATIONS						
Research Support (60,000/scientist)	120,000	360,000	540,000	840,000	960,000	2,820,000
Travel	100,000	120,000	140,000	160,000	170,000	690,000
Vehicles	40,000	80,000	100,000	110,000	120,000	450,000
Consultancies	60,000	70,000	80,000	85,000	90,000	385,000
Field Days and Workshops	20,000	50,000	60,000	65,000	70,000	265,000
Communications	20,000	30,000	35,000	40,000	45,000	170,000
Sub-Total: Operations	360,000	710,000	955,000	1,300,000	1,453,000	4,780,000
D. TRAINING						
Degree	100,000	200,000	280,000	380,000	480,000	1,440,000
Short Term	-	100,000	160,000	160,000	180,000	600,000
Sub-Total: Training	100,000	300,000	440,000	540,000	660,000	2,040,000
E. PROJECT EVALUATION	80,000	90,000	95,000	100,000	120,000	485,000
F. ASSISTANCE TO NATIONAL PROGRAMMES	150,000	150,000	150,000	150,000	150,000	750,000
GRAND TOTAL	1,215,000	2,355,000	3,260,000	4,425,000	5,080,000	16,335,000

Alternative II

Headquarters in Malawi with two research teams, one located at high elevation (Malawi) conducting research on beans and groundnuts and one at low elevation (Mozambique) giving attention to cowpeas and groundnuts (Fig. 2).

Senior Staff:
High Elevation:
- 1 Project Director
- 1 Administrative Officer
- 1 Training Officer
- 1 Breeder - Beans
- 1 Breeder - Groundnuts
- 1 Pathologist
- 1 Agronomist - Farm Manager
- 1 Entomologist
- 1 Microeconomist

Low Elevation:
- 1 Breeder - cowpeas
- 1 Breeder - groundnuts
- 1 Pathologist or Physiologist
- 1 Entomologist
- 1 Agronomist - Farm Manager

14 Total

Locations and staffing are similar to Alternative I. However, only two crops are to be considered at each location rather than three as in Alternative I. This results in four fewer staff members with resultant savings and at minimum sacrifice to the quality of the research programme. Moreover, it retains research on groundnuts at the two locations because the latter crop differs genetically at lower and higher elevations.

Advantages:

(1) Similar to those discussed for Alternative I.

(2) The reduced number of staff results in a saving without lowering the efficiency of the research programme significantly.

(3) As compared to Alternative III, it provides for groundnut research the needed diversity of locations essential to a successful improvement programme.

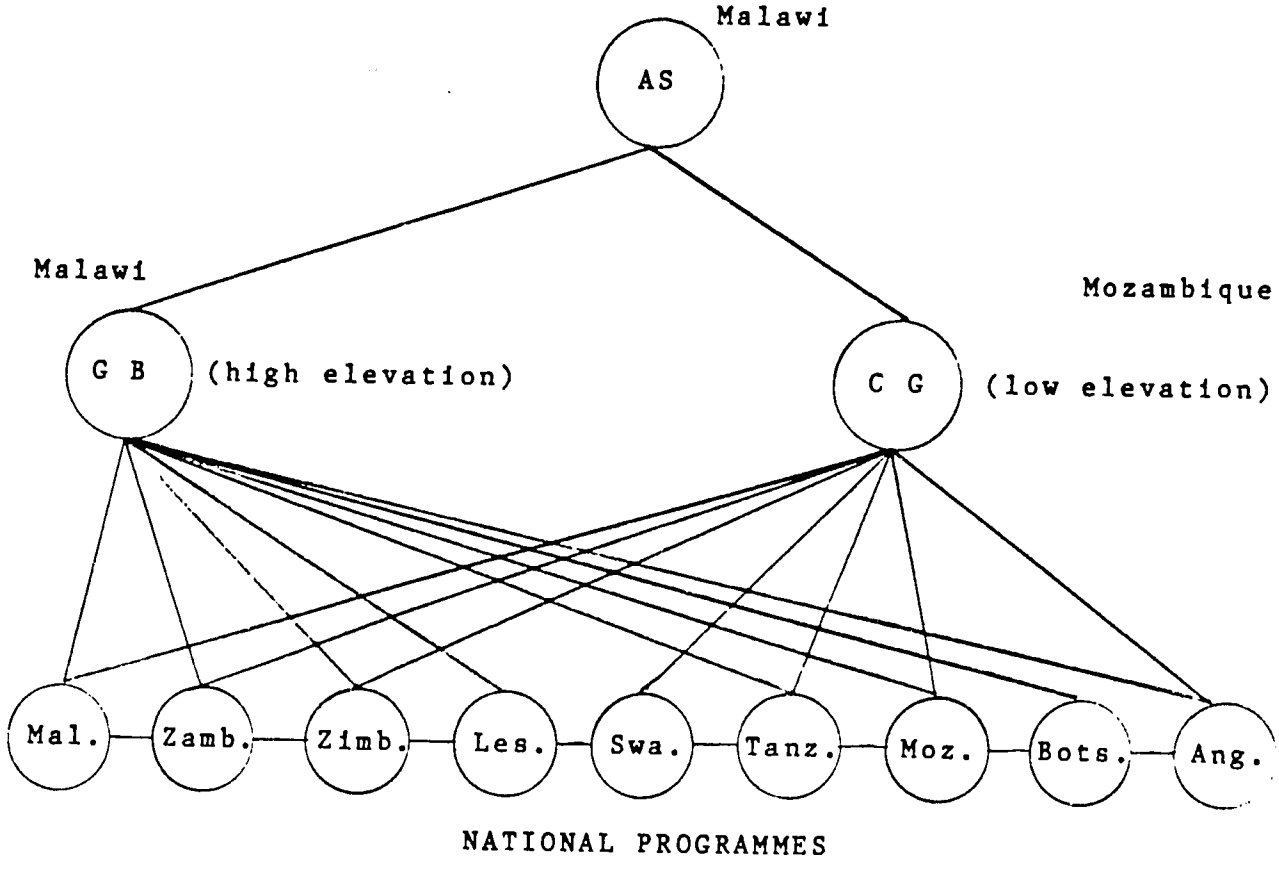

FIG. 2 - Alternative II

Disadvantages:

(1) Except for the requirement of a larger staff, the disadvantages listed to Alternative I apply.

(2) Compared with Alternative I, research on beans only at the higher elevation and cowpeas only at the lower elevation will reduce somewhat the overall efficiency of the programme. However, research at both elevations is not as essential for beans and cowpeas as it is for groundnuts.

Location:

Locations recommended for Alternative II are the same as those for Alternative I.

Staffing and Budget

The staffing pattern and indicative operating budget for years 1-5 for Alternative II are presented in Table 7. Cost of operations for the first five years are estimated to be about fourteen million U.S. dollars.

Table 7. Alternative II. Staffing and Budget (in U.S. dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
A. SENIOR STAFF						
1. High Elevation Team						
Project Director	90,000	95,000	100,000	105,000	110,000	500,000
Administrative Officer	85,000	90,000	95,000	100,000	105,000	475,000
Training Officer	-	-	95,000	100,000	105,000	300,000
Bean Breeder	-	90,000	95,000	100,000	105,000	390,000
Groundnut Breeder	85,000	90,000	95,000	100,000	105,000	475,000
Pathologist	85,000	90,000	95,000	100,000	105,000	475,000
Agronomist	-	90,000	95,000	100,000	105,000	390,000
Entomologist	-	90,000	95,000	100,000	105,000	390,000
Microeconomist	-	-	95,000	100,000	105,000	300,000
2. Low Elevation Team						
Cowpea Breeder	-	-	95,000	100,000	105,000	300,000
Groundnut Breeder	-	-	-	-	105,000	105,000
Pathologist (Physiologist)	-	-	-	100,000	105,000	205,000
Agnonomist	-	-	-	-	105,000	105,000
Entomologist	-	-	-	100,000	105,000	205,000
	345,000	635,000	955,000	1,265,000	1,475,000	4,615,000
B. SUPPORT STAFF						
Technical (3 x 10,000/ scientist)	60,000	150,000	240,000	300,000	390,000	1,140,000
Farm Operations	70,000	80,000	120,000	125,000	130,000	525,000
Administrative Staff	50,000	80,000	120,000	125,000	130,000	505,000
	180,000	310,000	480,000	550,000	650,000	2,170,000
Sub-Total: Personnel	525,000	945,000	1,435,000	1,755,000	2,125,000	6,785,000

Table 7. Continued

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
C. OPERATIONS						
Research Support (60,000/scientist)	120,000	300,000	480,000	600,000	720,000	2,220,000
Travel	100,000	110,000	125,000	130,000	135,000	600,000
Vehicles	40,000	80,000	90,000	95,000	100,000	405,000
Consultancies	60,000	65,000	70,000	75,000	80,000	350,000
Field Days and Workshops	20,000	50,000	60,000	65,000	70,000	265,000
Communications	20,000	25,000	30,000	35,000	40,000	150,000
Sub-Total: Operations	360,000	630,000	855,000	1,000,000	1,145,000	3,990,000
D. TRAINING						
Degree	100,000	200,000	280,000	380,000	480,000	1,440,000
Short Term	-	100,000	160,000	160,000	180,000	600,000
Sub-Total: Training	100,000	300,000	440,000	540,000	660,000	2,040,000
E. PROJECT EVALUATION	80,000	90,000	95,000	100,000	120,000	485,000
F. ASSISTANCE TO NATIONAL PROGRAMMES	150,000	150,000	150,000	150,000	150,000	750,000
GRAND TOTAL	1,215,000	2,115,000	2,975,000	3,545,000	4,200,000	14,050,000

Alternative III

Headquarters in Malawi with a research team in each of three SADCC countries, each team being responsible for one crop (Figure 3).

Senior Staff:

Headquarters:

- 1 Project Director
- 1 Administrative Officer
- 1 Training Officer
- 1 Microeconomist

Bean Team:

- 1 Breeder
- 1 Pathologist
- 1 Entomologist
- 1 Agronomist

Cowpea Team:

- 1 Breeder
- 1 Pathologist
- 1 Entomologist
- 1 Physiologist

Groundnut Team:

- 1 Breeder
- 1 Pathologist
- 1 Entomologist
- 1 Agronomist

16 Total

The staffing for the team at each location and for each crop is considered the minimum for an effective research programme. Thus each major discipline must be represented by at least one scientist, and thus each must not be specialized within a discipline. If construction were required, field research could be initiated by one or two of the staff until facilities were completed.

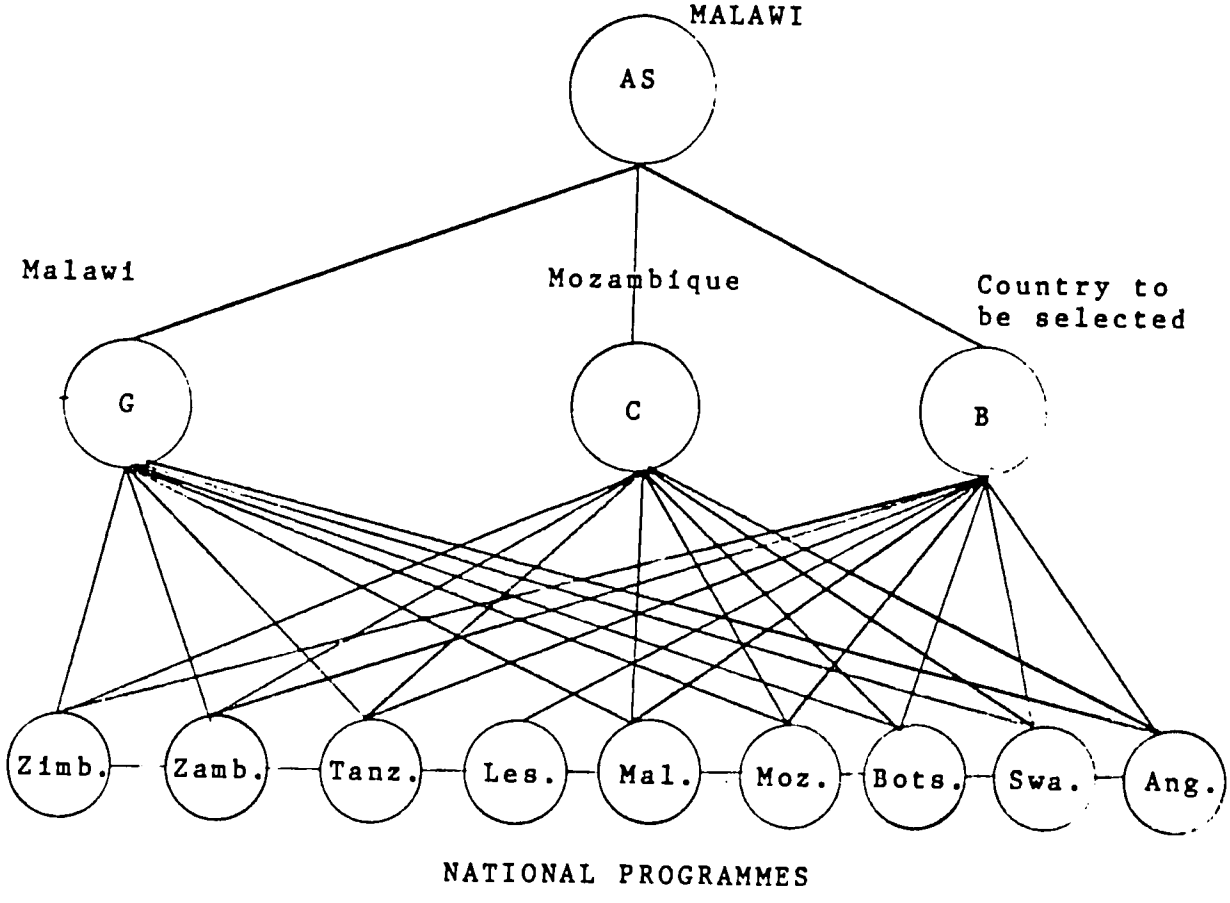

FIG. 3 - Alternative III

Advantages:

1) The research team for each crop could be located in the area of largest production of that crop.

2) At least three of the countries would be more directly involved in the programme by virtue of location.

3) Team scientists in all disciplines would be responsible for only one crop, allowing greater in-depth research and more rapid progress.

4) Scientists of the teams would be in continuous contact with scientists of three national programmes by virtue of their location.

Disadvantages:

1) Establishing and administering a programme in three different countries would be more complicated.

2) Scientists of one team would not have the day-to-day opportunity to interact with those of other teams for more diverse exchange of ideas and procedures.

3) Some national programmes would benefit more than others from this organization.

4) By locating each crop-related team in the area of largest production, other important areas in different ecological zones may not receive proper attention or improved genetic materials; for example, groundnuts at low elevation.

Locations:

The major bean growing areas in the SADDC countries are in the higher rainfall areas of Lesotho, Malawi, Tanzania, Zambia and Zimbabwe, and the Bean Team could be located in any one of those countries. As pointed out in Alternative II, Lesotho is not typical ecologically of the major area, and locations in Tanzania and Zambia are not as accessible as the location in Malawi.

The location for cowpeas should be at low elevation in either Mozambique or Tanzania and the issues between those are discussed under Alternative I.

The major producers of groundnuts in the SADCC region are Malawi, Mozambique and Zimbabwe, but they are important in most countries. A regional groundnut programme presently is in

operation in Malawi and the groundnut team to be established under GLIP probably should be continued at that locaton. Other locations for consideration include Tanzania (Ilonga), Zambia (Msekera) and Mozambique (location undetermined).

Recommendation:

Bean Team: Tanzania if an accessible location in one of the major bean growing areas can be identified. If not, the Msekera Research Station near Chipata, Zambia.

Cowpea Team: Site near Maputo, Mozambique

Groundnut Team and GLIP Headquarters: Site near Lilongwe, Malawi.

Staffing and Budget

The staffing pattern and indicative operating budget for years 1-5 for Alternative III are presented in Table 8. Cost of operations for the first five years are estimated to be about sixteen million U.S. dollars.

Table 8. Alternative III. Staffing and Budget (in U.S. dollars)

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
A. SENIOR STAFF						
1. Headquarters						
Project Director	90,000	95,000	100,000	105,000	110,000	500,000
Administrative Officer	85,000	90,000	95,000	100,000	105,000	475,000
Training Officer	-	-	95,000	100,000	105,000	300,000
Microeconomist	-	-	95,000	100,000	105,000	300,000
2. Bean Team						
Breeder	-	90,000	95,000	100,000	105,000	390,000
Pathologist	-	-	95,000	100,000	105,000	300,000
Entomologist	-	-	95,000	100,000	105,000	300,000
Agronomist	-	90,000	95,000	100,000	105,000	390,000
3. Cowpea Team						
Breeder	-	-	95,000	100,000	105,000	300,000
Pathologist	-	-	-	-	105,000	105,000
Entomologist	-	-	-	100,000	105,000	205,000
Physiologist	-	-	-	100,000	105,000	205,000
4. Groundnut Team						
Breeder	85,000	90,000	95,000	100,000	105,000	475,000
Pathologist	85,000	90,000	95,000	100,000	105,000	475,000
Entomologist	-	90,000	95,000	100,000	105,000	390,000
Agronomist	-	90,000	95,000	100,000	105,000	390,000
	345,000	725,000	1,240,000	1,505,000	1,685,000	5,500,000
B. SUPPORT STAFF						
Technical (3 x 10,000/ scientist)	60,000	180,000	330,000	390,000	420,000	1,380,000
Farm Operations	50,000	100,000	160,000	175,000	190,000	675,000
Administrative Staff	50,000	100,000	150,000	155,000	160,000	615,000
	160,000	380,000	640,000	720,000	770,000	2,670,000
Sub-Total: Personnel	505,000	1,105,000	1,880,000	2,225,000	2,455,000	8,170,000

Table 8. Continued

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Total $
C. OPERATIONS						
Research Support (60,000/scientist)	120,000	360,000	660,000	780,000	840,000	2,760,000
Travel	100,000	140,000	160,000	130,000	200,000	780,000
Vehicles	40,000	80,000	120,000	130,000	140,000	510,000
Consultancies	60,000	70,000	80,000	85,000	90,000	385,000
Field Days and Workshops	20,000	50,000	60,000	70,000	80,000	280,000
Communications	20,000	30,000	40,000	45,000	50,000	185,000
Sub-Total: Operations	360,000	730,000	1,120,000	1,290,000	1,400,000	4,900,000
D. TRAINING						
Degree	100,000	200,000	280,000	380,000	480,000	1,440,000
Short Term	-	100,000	160,000	160,000	180,000	600,000
Sub-Total: Training	100,000	300,000	440,000	540,000	660,000	2,0[illegible]0,000
E. PROJECT EVALUATION	80,000	90,000	95,000	100,000	120,000	485,000
F. ASSISTANCE TO NATIONAL PROGRAMMES	150,000	150,000	150,000	150,000	150,000	750,000
GRAND TOTAL	1,195,000	2,375,000	3,685,000	4,305,000	4,785,000	16,345,000

VI. ACTIVITIES OF THE GRAIN LEGUME IMPROVEMENT PROGRAMME

A. Research Programme Emphasis

1. Genetic Improvement

Central to the regional research programme is the achieving of increased productivity and consumer acceptance through genetic improvement.

Initially germplasm will be accumulated from within the region (by collecting or utilizing national programme collections) as well as from the international center collections or others from outside the region. Priority will be given to evaluating these for resistance to diseases and pests, adaptability, intrinsically high yielding ability, plant types suitable for multiple cropping systems and sole cropping, improved seed quality, short cooking time, improved nodulation and traditional grain characteristics. Where required or desirable, types with early or medium maturity and/or drought and temperature stress resistance will be identified. If sufficiently promising germplasm is identified as superior, it can be made available to national programmes for further evaluation or release as varieties.

The genetic improvement also will emphasize, from the beginning, a crossing programme involving germplasm and cultivars from the SADCC region and genetic sources of traits only obtainable from exotic germplasm. Segregating material will be evaluated by the GLIP staff at several locations and distributed to national programmes for evaluation in cooperation with GLIP.

In addition to providing materials, the GLIP breeding staff will also assist national programmes in the development of breeding priorities and techniques.

2. Cropping Systems Improvement

The programme will give emphasis to improved cropping systems primarily for the small landholder. New and improved varieties may require new or modified systems of culture. For example, under traditional systems, pests and diseases of grain legumes were minimized by low populations, early planting or other means. With disease and pest resistant varieties, higher populations can be sustained and planting time can be flexible. The programme will include development of optimum plant densities, crop associations, fertility level, soil - water-crop relationships, land preparation and management, etc. Plant protection strategies may also change under new

cropping systems and must be investigated. Economic comparisons between the traditional and the new cropping systems should be made as soon as new methods of culture are developed. As new farming systems are shown to be effective on operating farms, a vigorous effort must be made to transfer the new technology to the farmer via national programme participation, particularly in extension training.

Disease free, high quality seed is necessary for cropping systems and production research and is an essential step in distribution of elite line developed or identified by the genetic improvement program. Projected minimum staffing does not include seed production scientists. Clean and disease-free seed production for use in research programmes and for initial distribution to national programs must be the joint responsibility of the breeders, pathologists, entomologists and agronomists. Funds to provide specialized expertise in seed production should receive high priority in any expansion of the GLIP.

Problems encountered by the cropping systems program will provide guidance to the genetic improvement programme.

B. Enhancement of Research Capability in National Programmes

1. Training

Of equal importance to raising the level of grain production through a regional research programme is the need to enhance the research capacity of SADCC national scientists and technicians engaged in grain legume research. Both long-term training leading to M.Sc. or Ph.D. degrees (in some countries to B.Sc. degrees) and short-term training to acquire specialized skills are required.

a. Long-term training

One of the high priority items of the GLIP programme to upgrade the research capacity of national grain legume research programmes is education of scientists at the M.Sc. and Ph.D. levels. A thorough academic training, including the performing of research leading to the preparation of a dissertation, is necessary in order to develop the high degree of competency, skill, knowledge and originality required to identify and define the problems, and to plan a research programme that will result ultimately in a recommendation for optimum grain legume production by smallholders. Thus, a substantial training programme at the graduate level must be strongly supported, beginning with initiation of GLIP.

The inventories and projections presented in Chapter IV Section C (Tables 3, 4 and 5) serve to emphasize the need to add to the national research capability both in number and educational level. GLIP should endeavor to do so by providing financing for the educational advancement of as many scientists as funds will permit, commencing as early in the programme as possible.

Using as guides, the inventory of national scientists and those in training (Table 3), the probable temporary status of the expatriates (Table 4) and the projected staff requirements for the future (Table 5) minimum degree training requirements for the first 5 years were assessed (Table 8). It is proposed that a total of 31 scientists be trained, 26 to the M.Sc. level and 5 to the Ph.D. level. The distribution by country, discipline and degree level is indicated in Table 8. Because research is restricted to three crops, only staff members assigned to research on beans, cowpeas or groundnuts would be trained by GLIP.

In selecting positions for training, attempts were made to fill gaps in the research teams for specific crops, disciplines and locations. Furthermore, the nature of the problems on specific crops was taken into consideration for choice of discipline.

Based on $20,000 per person-year and assuming that the M.Sc. takes two years and the Ph.D. four years, the indicated budget for the first five years during which 26 persons will be trained to the M.Sc. level and 5 to the Ph.D. level, amounts to $1,440,000, a very conservative figure.

The sending of national research staff outside Africa for advanced degree training is very costly. Over time, some local universities in SADCC could be strengthened in their M.Sc. degree programmes. GLIP should make a long-term commitment to strengthen one or two SADCC country universities with the resources needed.

Funds for long-term training could also be conserved by having students conduct research for their dissertation at GLIP, after they have completed course work elsewhere. This may even enhance the value of the degree, since their research may be more applicable to subsequent research responsibilities.

b. Short-term training

The following types of training will be carried out under this category:

1) In-service training

Table 8. Training to be Sponsored by GLIP During the First 5 Years, by Discipline and Country, for National Scientists Working on Beans, Cowpeas and Groundnuts.

		Botswana	Lesotho	Malawi	Mozambique	Tanzania	Zambia	Zimbabwe	Total
Agronomist	BS								
	MS		1	1	1	1	1	1	6
	PhD								
Breeder	BS								
	MS	2			1		3		6
	PhD			1		1			2
Pathologist	BS								
	MS	1		1	1		1		4
	PhD					1		1	2
Entomologist	BS								
	MS	1		1	1	1		1	5
	PhD			1					1
Microbiologist	BS								
	MS								
	PhD								
Weed Scientist	BS								
	MS	1							1
	PhD								
Discipline Unknown	BS								
	MS								4 1/
	PhD								
Totals		5	1	5	4	4	5	3	31

1/ No information on training needs were obtained from Angola and Swaziland. However, it is suggested that three M.Sc. for Angola and one M.Sc. for Swaziland be included, discipline unknown.

This will involve two types of training. One for scientists with degrees which will involve the opportunity to work with senior research scientists in an actual research situation, in order to acquaint them with the most recent research developments and techniques. This will involve 6 months of training at the appropriate IARC or at GLIP. This can serve both mid-career scientists who need to up-date their skills, or recent graduates who need to have more specific skills in the field of grain legume research. GLIP should provide for up to 14 scientists a year in this category.

The secondary type of training is for technicians and serves to sharpen skills in specific areas of research such as breeding, field techniques, producing disease epiphytotics for screening purposes, etc. This training will be for up to 3 months duration at GLIP or one of the IARCs. GLIP will provide for up to 14 trainees per year for this purpose.

2) Seminars and workshops

Research scientists and technicians will be brought together periodically for workshops and seminars on specific topics. These may be held at GLIP or at National Research Programme locations. These will constitute one of the linkages in the GLIP National Programme network.

2. Financial Support to National Programmes

The GLIP is regional in nature and requires interaction with and dependence upon the national research programmes. For these programmes to participate in regional research activities, they must be in a position to conduct nurseries, intercropping trials and other activities. The capacity to do this will differ among the countries and differ from time to time in each country. The regional programme, if it is to be successful, must provide budgetary resources to national programmes, where needed, to fill gaps which are related to their conduct of activities in the regional Grain Legume Improvement Programme. Such assistance could take the form of spare parts for equipment, field and laboratory supplies, and chemicals, or temporary labor, etc.

Early in the GLIP programme, contacts should be made between GLIP scientists and national programmes to determine the capability of each to participate and to permit rapid responses by GLIP where necessary.

C. JOB DESCRIPTIONS

The GLIP is to be staffed by internationally recruited senior scientists representing breeding, pathology, entomology,

agronomy, and agricultural economics. This team composition reflects the realization that the principal constraints to increased bean, cowpea and groundnut production in the region can be overcome primarily through genetic improvement of the grain legume cultivars to impart disease and insect resistance and tolerance to existing adverse climatic and edaphic conditions. It also takes into consideration the critical need for agronomic and economic evaluation of new technology, seed production, and the establishment of an interface with technology-delivery mechanisms in participating countries.

The Project Director, also a senior scientist, with demonstrated experience in the management of scientific activities, will manage GLIP with the aid of an Administrative Officer and a Training Officer. The Project Director or the Training Officer should be fluent in Portuguese, in order to permit an effective interaction with Angola and Mozambique, the two Portuguese speaking members of SADCC.

Project Director. He will be the team leader and be responsible for the effective and harmonious functioning of the team and its interactions with the national programmes. He will represent the regional team to SADCC, SADCC countries, and Management Entity. He will be responsible for the day-to-day administration of the regional team. Among his duties, the following deserve mention: (1) responsibility for the purchase of equipment, spare parts, and other facilities; (2) interaction with universities, IARCs and other agencies in and outside the region that might contribute to GLIP activities; (3) responsibility for the preparation of budgets and reports to be presented to donors and to SADCC; (4) designation of the research coordinator for each crop.

Administrative Officer. This official will have responsibility for: maintenance of accounts; preparation of budgets; disbursement of funds; purchasing; personnel activities; vehicle allocation and maintenance; and supervision of administrative staff.

Training Officer. This official will have responsibility for the organization of workshops, seminars, and short courses, and for the administration of long-term and short-term training programmes. Furthermore, he will be responsible for the preparation of audiovisual facilities for workshops, seminars, conferences, and short courses, such as slides, printed materials, and videotapes.

Research Coordinator. For each commodity one of the senior scientists will be designated research coordinator and will be responsible for the coordination of his team activities.

Plant Breeder. He will be responsible, among other duties, for (1) the introduction and evaluation, on a continuing basis, of breeding stocks and germplasm accessions from all over the world; (2) the development of high-yielding and stable varieties; this means that he will work closely with the pathologist, entomologist, and agronomist to ensure that breeding stocks are properly evaluated; (3) the development of regional trials and nurseries for evaluation by the national programmes; (4) the assistance to seed production agencies, particularly as they begin to produce seeds of new varieties; (5) the assistance to the production agronomists in terms of materials evaluated in both sole and multiple cropping as well as in the array of environments important to grain legumes; (6) the assistance to breeders of national programmes at their request.

Agronomist. Much of his work will concentrate on regional testing of improved germplasm and providing continuous feedback to the breeders regarding the performance of newly developed materials and further characteristics which are in need of genetic improvement. The agronomist is also expected to closely interface with the extension sector and to assist in the selection of superior germplasm to be considered for commercial production. Furthermore, the agronomist is expected to develop improved agronomic practices, and to contribute to improved cropping systems for enhanced grain legume production. Finally, he will also assist the breeders in the increase of seed for newly developed varieties.

Plant Pathologist and Entomologist. They will be responsible for screening local and introduced germplasm for disease and insect resistance and to identify promising sources of resistance. They will also develop integrated disease and insect control strategies, and watch for shifts in disease and insect pest problems, particularly susceptibilities of promising germplasm.

Agricultural Economist. He will closely collaborate with the other GLIP scientists and national programmes scientists in the design and analysis of on-farm trials. He will assume major responsibility for the characterization of the grain legumes production sector and in the development of base line data, and - once new technology is available - in the impact assessment of improved technology. In the technology development process, the economist is to analyze the socioeconomic implications of new varieties and associated agronomic practices. He will also monitor grain legumes consumption and production patterns at the macro and micro level.

Physiologist. He will study the components of structure of yield in environments where stress is caused by high temperatures associated with low soil moisture, and having identified the features which contribute to grain yield and stability, will work with the breeder to produce stress-resistant germplasm.

D. Technology Transfer

The transfer of technology to the national programmes and ultimately to the smallholders is a goal of the regional Grain Legume Improvement Programme. Some of the ways this is to be accomplished is covered in this and other sections.

Research materials and methods need to be made available to the national programmes. Examples include early generation segregating material or later in the programme, elite material with specific adaptabilities or resistances. Regional nurseries can be made available on a request basis. Research on farming systems should be pursued in collaboration with national programmes under specific and varied ecological conditions.

At a different level, GLIP should encourage, support and participate in on-farm research by national programmes as it applies to smallholders. Such trials should also facilitate the training of extension workers, an activity in which GLIP should also participate as part of the transfer of technology.

As a part of technology transfer GLIP should disseminate information at both the research and extension levels. Research results can be made available in the form of scientific papers and annual reports to be exchanged between GLIP and national research organizations. A regional grain legume newsletter reporting on research and extension and other information could become a means of exchanging information between GLIP and national scientists and administrators. GLIP scientists and the training officer should also assist national programmes in preparing extension publications, films, video cassettes, etc. The GLIP library should be accessible to national programme scientists.

Attention should be given to the fact that in two SADCC countries Portuguese is the national language. Thus, certain key publications, such as GLIP annual reports and the newsletter, should be prepared in both English and Portuguese.

E. Programme Evaluation

To provide independent evaluation of the Grain Legume Improvement Programme, a Technical Advisory Comittee should be

established. The committee would be an independent scientific advisory body and would report directly to SACCAR and representatives of the Donors. The Committee would be comprised of 7 outstanding scientists from different fields of grain legume research. Three members would be selected by SACCAR and four by representatives of the Donors.

F. Provisional Economic Analyses

An economic analysis is presented in Annex E. It must be noted that this analysis was based on the premise that the GLIP would conduct research on all grain legume crops rather than on three only. Furthermore, the statistics on area cultivated per year (Table 1, Annex E) have been modified considerably (Table 3). Also, the cost of the research may vary depending upon the organization alternative selected and thus may differ considerably from that used in the analysis.

VII. LINKAGES

A. National Programmes of SADCC Countries

1. Research and Training Committees

It is proposed that a Research and Training Committee be established for each crop. It should be composed of the National Coordinator (leader) of each country with the GLIP Project Leader as chairman.

Its functions include the following: (1) exchange of information concerning the research programmes of each country and GLIP and exchange of materials (germplasm, breeding lines, etc.) developed by national programmes and GLIP; (2) evaluation and recommendation on programme performance, emphasis and problems; (3) discussion and recommendations for workshops, seminars, short courses and consultancy; (4) discussion and recommendations for professional training; (5) other matters needing coordination between GLIP and national research programmes.

2. Scientist to Scientist

Scientists of both GLIP and the national programmes should exchange information and ideas at the research level. This may be accomplished by periodic visits of teams of GLIP scientists or individual scientists from GLIP with counterparts in national programmes and vice versa. Such visits should be with the consent of the national programmes.

B. International

1. IARCs

The SADCC Grain Legume Improvement Programme is being established at a time when several International Agricultural Research Centers (IARCs) have mandates to cover all major grain legumes. GLIP should take maximum advantage of the germplasm and information already available from this network of IARCs. The three grain legume crops to be included in GLIP fall under the mandate of ICRISAT (groundnut), IITA (cowpea) and CIAT (bean).

These IARCs carry out research to develop knowledge and technology to increase production of grain legumes, to contribute to the training of human resources on the national level and to strengthen research systems and technology transfer in developing countries for the benefit of small scale farmers. The national agricultural research institutions in the SADCC region maintain cooperative technical links with many IARCs and these could continue after the establishment of GLIP.

The network of IARCs and the proposed GLIP, endowed with human resources of high scientific caliber and with ample funds, could provide significant assistance to national programmes. IARCs have available a large reserve of genetic material, and both IARCs and GLIP could collaborate in producing breeding material, incorporating desirable genes into populations and varietal nurseries. National institutions with breeding programmes could obtain segregating material from which national plant breeders could select lines suitable for their own needs and ecological adaptation. Difficulties may arise when national programmes are heavily dependent upon genetic material from one centre because materials may contain characteristics that are undesirable to local markets or may be poorly adapted to their environments. Overall, national programmes can benefit greatly from both the regional and IARC programmes.

The relationship of the research and training programme of GLIP with those of the International Centers must be carefully worked out to avoid unnecessary duplication. Each should keep the other fully informed by means of visits to each others location, by exchange of scientific information such as parent materials and sources of resistance and by keeping each other informed of training activities. Sending of the same breeding material to national programmes should be avoided. To facilitate coordination and exchange of information it would be desirable to invite a representative of the appropriate International Center to attend the meetings of the Research and Training Committee described in Section VII.A.1.

To be sure that duplication is avoided and coordination is maximized, it may be desirable to draw up a formal agreement similar to the one now in existance between CIAT and CRSP.

With IITA, GLIP must cooperate closely on the cowpea research. By virtue of its location in West Africa the germplasm should be especially valuable to the GLIP programme, as it has been to SADCC national programmes.

ICRISAT currently has an active Regional Groundnut Programme in Malawi staffed by a breeder and a pathologist. This is the programme to be expanded into GLIP when it is activated. GLIP should continue to have a close relationship with ICRISAT and should coordinate its programme with other ICRISAT programmes in Africa, including the Sorghum and Millet Regional Programme in Zimbabwe. For example, cooperation with the latter programme may be appropriate in farming systems involving both grain legumes and sorghum or millet.

Linkages with CIAT in bean research and training are more critical since it operates bean programmes in Central (Rwanda, Burundi and Zaire) and East (Kenya, Uganda, Somalia and Ethiopia) Africa. These programmes evolved from the Regional Workshop on the Potentials for Field Beans in Eastern Africa, held at Lilongwe, Malawi, March 1980. The African CIAT projects and GLIP should complement one another. For example, breeders and pathologists based in Rwanda and Kenya are likely to face problems similar to those encountered in the SADCC region, so there should be opportunities for exchange of information and materials between projects.

2. CRSP Projects

Under the Collaborative Research Support Programme (CRSP) cooperative research is conducted at universities in the U.S. with research institutions (usually universities) in developing countries. The research is supported largely by grants from U.S.A.I.D. The Bean/Cowpea CRSP is involved in 3 projects in the SADCC countries; namely, one in Botswana on cowpeas (Colorado State University and Botswana Ministry of Agriculture); one on beans in Malawi (Michigan State University, Virginia State University and Bunda College); and one on beans in Tanzania (Washington State University, University of Illinois and Morogoro University).

GLIP must be aware of the research underway in these CRSP programmes and attempt to complement it rather than duplicate it. The reciprocal is also true. This can be done informally by contacts between researchers of both groups during which they should informally agree on research areas to be pursued. Cooperation could be further enhanced by a representative of the CRSP project meeting with the Research and Training Committee of GLIP.

C. Regional (SACCAR)

The Southern Africa Centre for the Coordination of Agricultural Research (SACCAR) is being set up by the SADCC countries in 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.

The Grain Legume Improvement Programme should work closely with SACCAR, particularly in looking to it for assistance in relationships with member countries and in obtaining guidance regarding project implementation. The regional coordinating office of SACCAR will facilitate cooperation with other regional and national research projects and provide a basis for coordination and collaboration, while avoiding duplication.

D. Other Programmes

GLIP should keep itself informed on a number of other bilateral, international and regional programmes dealing with grain legumes in Africa. For example:

(1) The FAO Nitrogen Fixation Programme in East Africa.

(2) The AID-funded bean storage project in Rwanda and Burundi.

(3) The EEC-funded project on seed production for maize and beans in Uganda.

(4) The Nordic-funded grain legume research at the Uyole Agricultural Centre, Tanzania.

ANNEX A

JEROME D. FRANCKOWIAK

Present Position:

Associate Professor and Barley Breeder, Agronomy Department, North Dakota State University, Fargo, ND 58105, U.S.A.

Experience:

1970-1973
Lecturer/Cowpea Breeder
Department of Plant Science, University of Ife, Ile-Ife, Nigeria/USAID contract

1973
Visiting Scientist
Grain Legume Improvement Project, International Institute of Tropical Agriculture (IITA)
Ibadan, Nigeria

1974-1975
D. F. Jones Postdoctorate Fellow
Wheat Cytogenetics,
Agronomy Department,
North Dakota State University,
Fargo, North Dakota

1975-1976
Postdoctorate Fellow
Plant Breeding and Genetics Dept.
International Potato Center (CIP),
Lima, Peru

1976-1978
Co-team Leader for Potato Research, Office of Rural Development,
Suweon, Korea

Education:

B.S., M.S., Ph.D., University of Wisconsin,
Agronomy - Plant Breeding

ROBERT I. JACKSON

Present Position:

Senior Agronomist
S&T/AGR/AP
Agency for International Development
State Department
Washington, DC 20523, U.S.A.

Experience:

1950-1951
Associate Professor
Clemson College
Clemson, South Carolina

1951-1958
Plant Breeder
U.S.A.I.D., Bogor, Indonesia

1959-1966
Agronomist, U.S.A.I.D.
Khartoum, Sudan

1966-1970
Food and Agriculture Officer
U.S.A.I.D., Accra, Ghana

1970-1975
IRRI Representative and Team Leader
Bogor, Indonesia

1976-1977
Agriculture Development Consultant

Education:

B.S., Physics, University of Chicago,
Ph.D., Plant Breeding, Cornell University

D.R.B. MANDA

Present Position:

Deputy Chief Agricultural Research Officer, Department of Agricultural Research, Ministry of Agriculture, P.O. Box 30134, Lilongwe 3, Malawi

Experience:

1968-1972
Research Agronomist and National Research Coordinator for Cotton, Rice, Sugarcane Irrigation, Research Director, Makanga Research Station

1972-1973
Research Director, Mbawa Research Station and National Research Coordinator for Maize, Finger Millet, Essential Oils and Oilseed Crops

1973-1975
Principal Agricultural Research Officer, Research Director, Chitedze Research Station and National Research Coordinator for Maize, Finger Millet and Wheat

1976
Research Director, National Rice Research Station, Lifuwu

1976- Present
Department of Agricultural Research, Ministry of Agriculture, Deputy Chief Research Officer, National Research Coordinator, Scientific Liaison. Reviewing and Evaluating on-going research programme, research project proposals for external donor funding and compiling annual reports as well as extension circulars. Crop recommendation and other miscellaneous matters.

Education:

1964-1968
B.Sc. (Agronomy) Allahabad University

1971
FAO-SIDA post graduate diploma in genetics and plant breeding (I.A.R.I.), India

1982
International Course for Development Oriented Research in Agriculture, including a three and one-half month field study of farming systems in Kenya.

JACK P. MEINERS

Present Position:

Plant Pathologist, Consultant
2012 Forest Dale Drive
Silver Spring, MD 20903, USA

Experience:

1949-1950 - Plant Pathologist, Div. of Vegetable Crops and Diseases, Bu. of Plant Industry, Soils and Agricultural Engineering, U.S. Department of Agriculture, Twin Falls, Ida.

1950-1953 - Associate Professor of Plant Pathology, Washington State University, Pullman, Washington.

1953-1958 - Plant Pathologist, Cereal Crops Research Branch, Crops Research Division, Agr. Res. Service, U.S. Dept. of Agr., Pullman, WA.

1958-1980 - Service with the Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD as follows:

1958-1965 - Assistant Chief, Cereal Crops Research Branch, Crops Research Division

1965-1970 - Assistant Director, Plant Science Res. Div.

1970-1972 - Leader, Bean and Pea Investigations, Vegetable Crops Research Branch, Plant Sci. Res. Div.

1972-1976 - Chairman, Plant Protection Institute, Beltsville Agr. Res. Center.

1976-1980 - Chief Applied Plant Pathology Lab. Beltsville Agr. Res. Center.

1980-1984 - Consultation in International Agricultural Research as follows: ICRISAT-India; World Bank - North Yemen; CRSP - Brazil.

Education:

BS Agronomy, Washington State University; Ph. D. Plant Pathology, Washington State University

LUCIANO MOSELE

Present Position:

Consultant with the Italian "Dipartimento Per La Cooperazione Allo Svilvppo" of the Foreign Ministry

Experience:

1981 - Present
Free Lance Consultant in Agricultural Economics and Rural Development - Mission to Mali and Chad (FAO); Colombia and Ecuador (Agrotec); Nigeria (Consultant); Panama (Cerpi); Angola (Italiconsult)

1977-81
With Snam Progetti, Project Manager in 1973-1977, Southern Yemen and Angola. With Agrotec, Agricultural Economist in projects in Ethiopia, Somalia, Central America, Indonesia, Rwanda, Central Republic

1970-1972
With the ISAGRARIA in Madagascar ISTITUTO Agromic per L'Oltremare (Florence) Research Assistant

Education:

DoHore In Science Agrarie, University of Florence, 1970

Master of Agriculture Degree in Food and Resources Economics, University of Florida, 1972

Specialization in Sub-Tropical and Tropical Agriculture, I.A.O., 1964

BRUNO J. NDUNGURU

Present Position:

Associate Professor and Head, Department of Crop Science, University of Dar es Salaam Faculty of Agriculture Forestry and Veterinary Science, Morogoro, Tanzania

Experience:

1972-1979
Served the University of Dar es Salaam, initially as Tutorial Assistant, thereafter as Assistant Lecturer, Lecturer and Senior Lecture in Crop Science and Production

1979-1983
Senior Lecturer and Head, Department of Crop Science, University of Dar es Salaam

1979-to present
Project Leader - Intercropping Project, University of Dar es Salaam (supported by IDRC until 1980)

Project Leader - Pulses and Groundnut Research Project, University of Dar es Salaam (supported by IDRC)

Project Leader - Farming Systems Research University of Dar es Salaam (supported by IDRC)

Host Country Principal Investigator Bean/Cowpea Collaborative Research Support Programme, University of Dar es Salaam in collaboration with Washington State University and University of Illinois (supported by USAID)

Education:

B.Sc. (Agric.) (Dar es Salaam); M.Sc. (Whole Plant and Crop Physiology) (Reading); Ph.D. (Reading)

J. F. MOSES ONIM

Present Position:

Agronomist, Small Ruminants CRSP, P. O. 252, Maseno, Kenya. Winrock International, Petit Jean Mountain, Morrilton, Arkansas 72110-9537, U.S.A.

Experience:

1972
District Agricultural Officer, Homa-Bay District

1978
A member of international ad-hoc committee on Pigeon Pea Improvement of ICRISAT

1982
A member of a team appointed to advise the Director General of FAO on the Development of Durable Crop resistance to pests and diseases in Africa (IITA)

1974-1983
University Teaching (Genetics and Plant Breeding) Senior Lecturer

Leader of the National Pigeon Pea Improvement in Kenya (IDRC funds)

1978-1983
Chief, Scientific Investigator in Kenya for the use of induced mutations in the improvement of grain legumes (IAEA of the UN)

Education:

B.Sc. Hons Agric. (1st Class), Makerere; M.Sc. (Plant Breeding), Makerere; Ph.D. (Plant Breeding), Nairobi

ROBERT SCHILLING

Present Position:

Assistant Director, Oilcrops Department, Research Institute for Oils and Oilcrops (IRHO). Paris, France

Experience:

1964-1969
Research Officer, Groundnut Breeding and Agronomy, DAROU Research Station (Senegal)

1969-1971
Director, Annual Oilcrops Research Station SARIA (Upper-Volta)

1971-1973
Director, DAROU Research Station, Senegal

1972-1975
IRHO Director in Senegal

1976-1983
Technical advisor to the Minister of Rural Development, Dakar, Senegal

Education:

License es Sciences, Paris and Marseilles c.e.s. Agronomie Tropical, Marseilles.

CLIBAS VIEIRA

Present Position:

Professor of Agronomy
Plant Science Department
Federal University of Vicosa
36570 Vicosa, MG, Brazil

Experience:

1953-1954
Extension Agronomist, American International Association for Economic and Social Development, Brazil

1955-1962
Assistant Professor of Agronomy
Plant Science Department
Federal University of Vicosa (FUV), Brazil

1964-1969
Dean of the Graduate School, FUV

1974
Head, Technical-Scientific Department
Brazilian Organization for Agricultural Research (EMBRAPA), Brasilia

1974-1978
Board of Trustees
International Potato Center (CIP)
Lima, Peru

1974-1978
Technical and Advisory Committee
Bean Program
Centro International de Agricultura Tropical (CIAT), Cali, Colombia

1976-Present
Phaseolus Genetic Resources Committee
International Board for Plant Genetic Resources

Education:

B.Sc., Federal University of Vicosa (FUV); M.Sc., University of California at Davis; Dr. Agr.Sc., FUV.

Terms of Reference for Feasibility Study

GRAIN LEGUME RESEARCH AND TRAINING PROGRAM FOR SOUTHERN AFRICA (SADCC COUNTRIES)

SADCC Agricultural Research Project No. 3

The purpose of this paper is to spell out the terms of reference for a team that will prepare a feasibility study for a Regional Grain Legume Research and Training Programme for SADCC countries. The team will conduct the study in November and December 1983, and submit a report to the CTC for Agricultural Research in January 1984.

I. BACKGROUND

At the second meeting of the SADCC Consultative Technical Committee (CTC) for Research held in Harare, Zimbabwe, April 19-21, 1983, the CTC for Research recommended that the Groundnut Improvement Research project in Malawi be broadened to become a Grain Legume Research and Training Programme for Southern Africa. The CTC for Research recommended that:

1. The project include groundnuts (*Arachis hypogea*), cowpeas (*Vigna unguiculata*), beans (*Phaseolus vulgaris*), and pigeon peas (*Cajanus cajan*). The project should exploit research advances by the International Centers, IITA, CIAT and ICRISAT, respectively.

2. The Grain Legume Project Headquarters is envisioned to remain in Malawi, but substations might be established in Mozambique (low altitude, dry), Lesotho (high altitude) and Tanzania.

3. The team preparing the feasibility study should consist of internationally recognized experts and the following minimal composition:

   a. 2 members from SADCC countries
   b. 1 member from the agency which supplies the team
   c. 1 member from French West Africa (IRHO)
   d. 1 nominee from the Technical Advisory committee of the Consultative Group for International Agricultural Research (CGIAR) to represent the International Centers,

Pursuant to the CTC meeting in April 1983, the Chairman of the CTC for Agricultural Research, on behalf of the Government of Botswana, requested assistance from a group of donors - Cooperation for Development in Africa (CDA)- in preparing the feasibility study for SADCC.

Dr. John Yohe, Bureau of Science and Technology, A.I.D., Washington, DC, visited Botswana, Zimbabwe, Malawi and Zambia activities and discussed problems and priorities with a large number of research scientists, research administrators and donor representatives. The report below spells out the Terms of Reference for the team preparing the feasibility study.

II. INVENTORY AND ASSESSMENT OF NATIONAL AND REGIONAL GRAIN LEGUME RESEARCH PROGRAMS

Botswana will arrange for the team to visit all nine SADCC countries where discussions will be held with representative groups of grain legume scientists and administrators in the national agricultural research services and other bodies concerned with research on the subject of grain legumes. The team will collect the following information for each country:

(a) Production by commodity (all grain legumes and oilseed legumes)
(b) Production constraints by commodity
(c) Present research programmes by commodity.

The team should refer to the August 1983 SACCAR report which contains a brief description of national research programmes in SADCC countries, and to the DEVRES assessment of SADCC countries' research capability (Malawi, Swaziland and Botswana have been completed).

(d) Support available to participate in the regional program.
(e) National programme contraints to exchange of germplasm between and among SADDC countries and external organizations.
(f) Role of agricultural universities and colleges in National Grain Legumes research programmes.
(g) Seed multiplication capability for small holders by national programmes.
(h) Contraints to center or subcenter staff to move freely from one participating country to another.
(i) Programme organizational constraints to coordination and cooperation with the regional grain legume project, i.e., oilseed vs. grain legumes (groundnuts often fall under oilseed programmes rather than grain legume activities).
(j) Research organization, including experiment stations staff, physical plant, and equipment (field and laboratory) available for grain legume research.
(k) Current levels of cooperation with IARC's, CRSP's, and other external organizations.

III. PROPOSED GRAIN LEGUME RESEARCH AND TRAINING PROGRAM FOR SOUTHERN AFRICA

The team will prepare a 15 year general programme plan and a five year detailed programme plan, staffing pattern, budget and phasing of activities for an initial 5 year period. The plan will include the basic concept for a regional programme which will include the description of:

(a) Regional Research Center Organizational Plan

The team will recommend an administrative organizational plan on how to implement a grain legume research and outreach programme involving national programmes, appropriate IARC's, CRSP's and other external research organizations. Possibilities include:

(i) Regional Center conducting multidisciplinary research on all subject grain legumes with coordinating, cooperating likages with the SADCC network. This might include providing necessary operational and recurrent cost funds to assure success in national programmes, or

(ii) A regional administrative center with one or more sub-centers conducting research on the subject grain legumes with a plan for new working with non-sub-center SADCC countries.

The team will also recommend on the structure and organization of a Management Entity to coordinate efforts (technical assistance, germplasm exchange, training workshops, and practical short-term training) of external technical assistance sources, i.e., IARC's or others, and to be responsible for the overall implementation of the program.

The team will recommend appropriate cooperation and coordination of activities with the Regional Center for Cooperation in Agriculture Research (SACCAR).

(b) Multidisciplinary research team organization.
(c) Interactions and networking with national programmes and other institutions.
(d) Strengthening Grain Legume Team Research in National Programs.
(e) Describe Project activities to be conducted at the Center and National Programme sites:

1. Breeding Programmes
2. Agronomy Programmes
3. Integrated Pest Management
4. Regional testing trials
5. Germplasm activities
6. Technology Transfer

(f) Project Location.
(g) Construction and Center Development if required.

(h) Training - The team should prepare a 10-year training plan with an initial 5-year budget. Training should be coordinated with the SADCC Swaziland manpower study. Plans should be presented for involving national institutions in hosting and presentation of workshop, short term training programmes and professional (B.S. and advanced degrees) training as appropriate. Appropriate short-term and long-term training activities should also be identified for the center.

(i) Recommendations of grain legume crops to be considered by team include: Groundnuts (*Arachis* hypogea) Common Bean (*Phaseolus vulgaris*), Cowpea (*Vigna unguiculata*), Pigeon Pea (Cajanus cajan), and others, i.e., Bambara groundnut (*Vigna subterranea*), Soybeans (*Glycine mac*), and other minor legumes such as: Chick pea (*Cicer arietinum*), Mung bean (*Vigna radiatus*, Wilczek) and Guar.

IV. TECHNICAL ANALYSIS

(a) Technical Feasibility.

(b) Economic and Social Analysis.

(c) Administration Analysis and Organization.

V. IMPLEMENTATION ARRANGEMENTS

(a) Relationship with Malawi and other countries.

(b) Schedule of implementation for the project for first five years.

(c) Draft schedules for years five to fifteen.

(d) Programme management schedule.

(e) Programme relationship to SACCAR.

(f) Evaluation plan.

VI. BUDGET

A detailed budget for the first five years of operation.

VII. GENERAL

The team should assess the following constraints and provide an analysis of the general problem and ways the Grain Legume Research programme should organize to approach the problems identified.

(a) Constraints to exchange of germplasm and research information between the participating countries.

(b) Plan for supporting operational costs deficiencies within the participating SADCC national programmes.

(c) Identify constraints to seed multiplication in national programmes.

(d) Constraints to technology transfer should be fed into national research programms, national farming systems research programmes and national extension services.

(e) Identify constraints to SADCC Regional Grain Legume participants and center staff in moving from country to country within the SADCC region. Describe how linkages between center and national programmes will be established including specific persons and/or functional project components required to establish country linkages. Describe mechanism by which technical research officers of participating countries can guide and redirect programme of the center.

Table 1. Some Indicators of Development of the Southern Africa Development Coordination Conference Countries

	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Total (Mean)-- SADCC	Africa Total (Mean)--
1- GENERAL											
. Least developed countries*/			X	X			X				
. Most seriously affected countries**/			X		X		X				
. Food priority countries***/			X		X		X				
. Area (000 km^2)	1,247	600	31	119	799	17	945	753	390	4,901	30,331
. Area distribution %	25.5	12.2	0.6	2.4	16.3	0.3	19.3	15.4	8.0	100	-
. Population 1981 (in thousands)	7,262	832	1,374	6,369	10,757	574	18,510	5,961	7,656	59,295	
. Population distribution %	12.3	1.4	2.3	10.7	18.1	1.0	31.2	10.0	13.0	100	-
. Density (No./Kmg) 1981	5.8	1.4	49.3	53.5	90.4	33.7	17.[illegible]	7.9	17.6	(17.1)	16.0
. Population growth rate per year	2.7	2.2	2.4	3.4	2.8	2.9	3.3	3.3	3.4	(3.1)	2.7
. Population projection to 2000 (in thousands)	12,025	1,427	2,146	12,037	18,177	985	34,100	11,022	14,470	106,389	-
2- ECONOMICS											
. GNP per capita 1980 (US$)	470	NA	420	230	230	NA	280	560	630	-	-
. % Average GNP annual growth 1970-80	2.3	NA	6.1	2.9	-0.1	NA	1.9	0.2	0.7	-	-
. Annual rate of inflation 1970-80	21.0	NA	11.6	9.8	11.2	NA	11.9	8.1	8.8	-	-
. Percent GDP due to agric. 1980	48	NA	31	43	44	NA	54	15	12	-	-
. Percent GDP due to agric. 1960	50	NA	NA	58	55	NA	57	11	18	-	-
3- FINANCE											
. 1980 Current account balance Millions US$	NA	NA	NA	-139	NA	NA	-548	-508	-255	-	-
. 1980 Debt service ratio as percentage of:											
GNP	NA	NA	0.8	4.5	NA	NA	1.0	9.5	0.9	-	-
. Exports of goods and services	NA	NA	NA	18.4	NA	NA	7.3	24.4	2.6	-	-

Table 1. Continued

4- AGRICULTURE											
. Agricultural population 1981 (%)	57.1	79.4	82.9	83.0	63.4	71.5	80.4	65.9	58.1	(70.4)	64.7
. 1982 FAO agric. prod. index	83	92	92	133	95	140	110	90	97	-	117
. 1982 FAO per caput agric. prod. index (1974-76 = 100)	70	75	77	106	79	114	89	72	76	-	93
. 1982 FAO food prod. index	103	92	90	128	96	137	118	90	95	-	117
. Production index (1974-76 = 100)	86	75	76	102	80	112	95	72	75	-	93
. 1982 FAO crop prod. index	78	67	77	134	93	145	106	80	109	-	118
. 1982 FAO crop prod. index for caput (1974-76 = 100)	65	56	65	107	77	118	85	64	82	-	90
. 1982 FAO cereals prod. index	62	24	66	124	71	71	101	64	103	-	119
. 1982 FAO cereals prod. index per capita (1974-76 = 100)	52	19	55	99	59	58	82	51	81	-	88
. 1982 FAO livestock prod. Index per capita (1974-76 = 100)	93	94	92	99	92	99	107	95	66	-	105
. 1980 Arable land (1000 ha)	2,950	1,360	292	2,300	2,850	200	4,110	5,100	2,465	21,627	1,631
. 1980 Distr. per country (%)	13.6	6.3	1.3	10.6	13.2	0.9	19.0	23.6	11.5	100	-
. 1980 Arable land per caput (ha)											
. Total population	0.42	1.7	0.22	0.37	0.27	0.36	0.23	0.88	0.34	(0.38)	0.34
. Agric. population	0.72	2.1	0.26	0.45	0.42	0.50	0.28	1.33	0.57	(0.53)	0.22
. 1975-77 Food Intake per capita per day											
. Calories	2,067	2,070	2,140	2,227	1,930	2,283	2,089	2,056	2,546	-	-
. % from cereals	34.7	56.1	76.9	70.3	37.1	53.6	36.0	67.7	72.5	-	-
. % from legumes	3.6	7.9	2.5	8.8	2.8	0.8	4.7	1.1	1.5	-	-
. Proteins (GR)	42.9	70	63.1	68.1	36.1	58.4	49.2	57.2	73.4	-	-
. % from cereals	24.2	47.1	74.5	61.1	52.3	55.3	37.4	65.7	66.5	-	-
. % from legumes	11.2	14.8	5.5	18.0	9.7	1.9	12.4	2.6	3.4	-	-

* Designation by the UN Economic and Social Council.
** Designation by the UN General Assembly.
*** Designation by the UN World Food Council.

Sources: Consultants' elaboration of data derived from: FAO Production Yearbook, Vol. 35, 1981; FAO monthly bulletin of statistics, Vol. 6, July-Aug. 1983; FAO Hojas de Balance de Alimentos, 1975-77; World Bank: World Development Report, 1982.

Table 2. Production of Legume Crops, 1981 Data

	ANGOLA	BOTS	LESOTHO	MALAWI	MOZ.	SWAZ.	TANZ.	ZAMB.	ZIMB.	SADCC TOTAL	AFRICA
PRODUCTION (1000 MT)											
- Beans (Dry)	45(F)	GNR*/	10(F)	62(F)	GNR	2(F)	150(F)	GNR	24(F)	293	1,353
- Dry peas	GNR	NG	7(F)	NG	NG	GNR	8(F)	NG	NG	15	327
- Chick peas	NG	NG	NG	18(F)	GNR	NG	8(F)	GNR	NG	26	185
- Soybeans	GNR	NG	NG	GNR	GNR	NG	1(F)	6	64	70	319
- Groundnuts in shell	20(F)	2(F)	NG	180(F)	80(F)	1(F)	56(F)	30(F)	239	608	5,201
- Cowpeas	GNR	GNR	NG	GNR	GNR	GNR	GNR	GNR	GNR		
- Pigeon peas	GNR	NG	NG	GNR	GNR	NG	GNR	NG	GNR	390	
- Bambara g/nuts	GNR	GNR	NG	GNR	GNR	GNR	GNR	GNR	GNR		-
- Mung beans	GNR	GNR	NG	GNR	GNR	GNR	GNR	GNR	GNR		
- Guar	NG	NG	NG	GNR	NG	NG	NG	GNR	GNR		
AREA (1000 ha)											
- Beans (Dry)	110(F)	-	12(F)	95(F)	-	2(F)	300(F)	-	40(F)	559	2,122
- Peas	-	-	7(F)	-	-	-	27(F)	-	-	34	425
- Chick peas	-	-	-	25(F)	-	-	27(F)	-	-	52	371
- Soybeans	-	-	-	-	-	-	35(F)	5(F)	5(F)	45	349
- Groundnuts	40(F)	4(F)		250(F)	170(F)	3(F)	94(F)	50	240(F)	851	6,470
- Cowpeas											
- Pigeon peas										504	
- Bambara g/nuts											
- Mung beans											
- Guar											
YIELD (Kg/ha)											
- Dry Beans	409	-	833	653	-	682	500	-	600	520	667
- Dry peas	-	-	1,077	-	-	-	178	-	-	440	769
- Chick peas	-	-	-	720	-	-	278	-	-	500	544
- Soybeans	-	-	-	-	-	-	240	1,087	1,829	1,560	914
- G/nuts in shell	500	395		720	471	481	596	600	995	710	804
- Cowpeas											
- Pigeon Peas										770	438
- Bambara g/nut											
- Mung beans											
- Guar											

Source: FAO Production Yearbook, Vo. 35, 1982 and Team's Findings.

*/NG = Not grown; GNR = Grown, but not reported; (F) = FAO estimates.

Table 3. Grain Legume Production Index; Evaluation in the SADCC Countries in 1981 (1969-71 = 100)

COUNTRY	BEANS						SOYBEANS						GROUNDNUT (IN SHELL)						TOTAL PULSES					
	PROD.*/		AREA		YIELD		PROD.		AREA		YIELD		PROD.		AREA		YIELD		PROD.		AREA		YIELD	
	I	%	I	%	I	%	I	%	I	%	I	%	I	%	I	%	I	%	I	%	I	%	I	%
Angola	92	-1.4	50	-4.5	71	-3.5	-	-	-	-	-	-	100	-	108	1.0	93	-0.5	64	-4.5	92	-1.0	71	-3.5
Botswana	-	-	-	-	-	-	-	-	-	-	-	-	40	-15.0	80	- 2.0	40	-15.0	150	4.5	136	3.0	105	0.5
Lesotho	250	10.0	350	13.5	80	-2.3	-	-	-	-	-	-	-	-	-	-	-	-0.7	189	6.5	73	-3.0	275	10.0
Malawi	124	2.0	106	1.0	117	1.5	-	-	-	-	-	-	99	-	107	0.5	92		123	2.5	113	1.5	109	1.0
Mozambique	-	-	-	-	-	-	-	-	-	-	-	-	57	-6.0	77	-2.5	74	-2.5	77	-2.5	104	0.5	73	-3.0
Swaziland	200	7.0	100	0	163	6.5	-	-	-	-	-	-	35	-11.0	60	6.0	87	1.5	133	3.0	117	1.5	113	1.5
Tanzania	12[illegible]	2.0	123	2.0	98	0.3	100	-	250	9.5	94	-.5	175	5.5	192	6.5	90	-1.0	124	2.0	119	2.0	105	0.5
Zambia	-	-	-	-	-	-	-	-	-	-	-	-	44	-8.0	45	-8.0	97	-1	166	5.0	150	4.0	104	0.5
Zimbabwe	100	-	100	-	100	-	1067		583	19.0	188	6.5	210	8.0	131	3.0	160	5.0	100	-	100	-	100	-
Tot.SADCC	197	6.5	179	6.0	110	1.0	1000		450	16.0	160	5.0	100	-	75	-3.0	114	1.0	111	1.0	117	1.5	94	-0.5
AFRICA	120	2.0	109	1.0	111	1.2	181	6.0	221	7.5	181	6.0	92	0.5	90	-1.0	105	0.5	106	0.5	103	0.2	103	0.2

Source: Team's interpretation of data in FAO Production Year Book, 1982.

*/ Production, Area and Yield are stated as I (Index of 1969 - 71 = 100) nd % (Annual compound growth rate, approximate percent).

ANNEX D

CONSTRAINTS ON LEGUME PRODUCTION - SUPPORTING TABLES

Table 1. Common Bean, Phaseolus vulgaris, Production Constraints in SADCC Countries

Factor or organism	Problems by country*/									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary/**/ Rank
Social - economic factors										
Consumer preference	x*/		3	1	x	3	4	2	2	2
Utilization - leaf vegetable				x	x		x	x	x	20%
Utilization - snap beans			x	x	x		x	x	x	12%
Utilization - green seed			x	x	x		x	x	x	8%
Utilization - dried beans	x		x	x	x	x	x	x	x	60%
Seed supply and price	x		2	2	1	1	1	1	1	1
Labor supply/draught power/ mechanization			x	x		2	2	3	3	3
Fertilizer and pesticides			x	x		4	3	x	4	5
Produce marketing	x		1		2		x	x	x	4
Crop management										
Seed quality	x		1	2	2	x	1	1	1	1
Cropping system and techniques			x	x		x	x	x	x	
Time of planting	x		x	x	1	x	x	x	4	4
Plant population	x		2	3	x	2	3	3	2	3
Weeds	x		3	1	x	1	2	2	3	2
Environmental factors										
Moisture stress/drought	1			2	1	x	1	2	1	1
Temperature stress	x		1	1	2	x	2	1	x	2
Mineral nutrition			2		x	2	x	x	x	
Soil texture and structure			3			3	3	x	2	
Soil acidity			4	x	x	1				

Table 1. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Plant characteristics										
Yield potential/plant vigor	1		1	1	1	1	1	1	1	1
Growth habit			2	2	x	x		2	3	2
Crop duration	x			x	x	2	2	x	2	3
Uniform maturation			3				x		x	
Nodulation, *Rhizobium phaseoli*			1	1	x	x	1	1	x	1
Diseases - viral										
BCMV, bean common mosaic virus	x			x	x	4	4	6	x	4
BYMV, bean yellow mosaic virus				x			x			
Diseases - bacterial										
Common bacterial blight, *Xanthomonas phaseoli*	x		x	2	x	3	x	2	x	3
Halo blight, *Pseudomonas phaseolicola*			x	4			x			
Diseases - fungal										
Anthracnose, *Colletotrichum lindemuthianum*	x			1	x	2	1	1	2	1
Bean rust, *Uromyces appendiculatus*	x			3	x	4	2	3	1	2
Angular leaf spot, *Phaeoisariopsis griseola*				5			3	4	3	5
Ascochyta blight, *Ascochyta phaseolorum*		x					5			
Collar rot, *Sclerotium rolfsii*								x		
Scab, *Elsinoe phaseoli*								x		
Powdery mildew, *Erysiphe* spp.			x				x	x		

Table 1. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Ashy stem blight, *Macrophomina phaseoli*								x		
Fusarium root rot, *Fusarium solani*				x						
Nematodes										
Root knot, *Meloidogyne* spp.	x			x	x	1	x	x	1	1
Insect pests										
Bean fly, *Ophiomya phaseoli*				1	1	x	1	1	x	1
Black bean aphid, *Aphis fabae*				x	x		5	4		
Groundnut aphid, *Aphis craccivora*				x	x		x	x	x	
Jassids, *Empoasca lybica*, *E. kraemeri*				x	x		x	x		
White fly, *Bemisia tabaci*				x	x		x	x	x	
Flower Thrips, *Taeniothrips sjostedti*					x		7	x		
Pod bug, *Mirperus juculus*								x		
Stink bug, *Nezara viridula*					x		x			
Giant coreid bug, *Anoplonemis curvipes*					x			x		
Leaf bettle, *Ootheca mutabilis*				3	2		6	2	x	3
Striped foliage beetle, *Medythia quaterm*						x	x			
Blister beetles, *Mylabris* spp.(4)			1	5		x	5	2		4
Pollen beetle, *Coryna* spp.				x	x		x	x		
Pod borer, *Maruca testulalis*				x	x		2	x	x	
Bollworm, *Heliothis armigera*	x		x	4	x		4	x	x	5
Bean bruchid, *Aconthoscelides obtectus*	x		2	2	x	1	3	3	1	2
Cowpea bruchid, *Callosobruchus chinensis*						x	x			
Harvester termite, *Hodotermes mossambicus*						x	x	x		

*/ Relative rank within country by major faction grouping is based on team estimates; x indicates the problem was reported, but relative importance is unknown.

**/ Team estimates of the relative rank of constraints within a grouping over the SADCC countries.

Table 2. Groundnut, *Arachis hypogaea*, Production Constraints in SADCC countries

Factor or organism	Problems by country*/									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary/**/ Rank
Social - economic factors										
Consumer preference		x		2		x	x	2	x	4
Utilization - confectionary	x	x		x	x	x	x	x	x	80%
Utilization - oil				x	x		x	x	x	5%
Utilization - oil meal				x	x		x	x	x	15%
Seed supply and price	x			1	1	1	1	1	2	1
Labor supply/draught power/mechanization				3		2	3	4	1	3
Fertilizer, and pesticides	x	1		x		x	x	x	3	5
Produce marketing		x			2		2	3	4	2
Crop management										
Seed quality	x	x		1	3	2	3	1	x	1
Cropping system and techniques					5		x	x	x	5
Time of planting		1		3	1		1	2	x	3
Plant population		x		4	2	3	2	4		4
Weeds	2			2	x	1	4	3	x	2
Environmental factors										
Moisture stress	1	1		x	1		1	1		1
Temperature stress	2	2				x	2	3		2
Mineral nutrition				x	x	x	x	x	x	4
Soil texture and structure		x		x		1		2		3
Soil acidity						2	x			5
Plant characteristics										
Yield potential/plant vigor	x	1		1	2	1	1	1	1	1
Growth habit		x		x	x	x	x	x	x	4
Crop duration, dormancy	x				1	2	2		2	3
Uniform maturation										
Threashability		x		2	x	3	x	2	3	2

Table 2. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Nodulation, *Rhizobium* spp.	x	x		x	x	x	x	x	1	
Diseases - viral										
GRV, groundnut rosette virus		1		1	1		1	1	1	1
PMV, peanut mottle virus				x			x			
Diseases - fungal										
Early leafspot, *Cercospora, arachidicola*	1	4		2	4	1	3	2	2	2
Late leafspot, *Cercosporidium personatum*	x	x		x	5		4	4		6
Leaf scorch, *Leptosphaerulina trifolii*		x		6						
Rust, *Puccinia arachidis*	x	2		3	3		2	3		3
Aflatoxin, *Aspergillus flavus*	x	x		x	x	x	x	6	x	
Seed and seedling rots, *Asperigillus Pythium, Rhizoctonia Sclerotina* spp.	2	3		5	2	2	5	5	4	4
Wilt, *Fusarium solani*				4		x	x	x	3	5
Phoma leaf spot, *Phoma arachids*				x	x				5	
Botrytis blight, *Botrytis cinerea*								6		
Nematodes										
Root knot, *Meloidogyne* spp.	x		x	x	1	x	x	1	1	
Root lesion, *Pratylenchus* spp.						x				
Parasitic weeds										
Witchweed, *Alectra vogelii*				x	x			x		

Table 2 Continued.

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Insects										
Plant hopper, Hilda patruelis/ants/ wilt		x		1	x			x	1	2
Groundnut aphid, Aphis craccivora		x		2	x		1	1	x	1
Jassids, Empoasca spp.				x				2		x
Bollworm, Heliothis armigera				x				x		
Bruchids, Caryedon spp.	x	x		x	x	x	x	x	x	3
Termites, Odontotermes spp.	x	x		3	x		x	x	x	4
Elegant grasshoppers, Zonocerus elegans								x		

*/ Relative rank within country by major factor grouping is based on team estimates; x indicates the problem was reported, but relative importance is unknown.

**/ Team estimates of the relative rank of constraints within a grouping over the SADCC countries.

Table 3. Cowpea, Vigna unguiculata, Production Constraints in SADCC Countries

Factor or organism	Problems by country*/									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary**/ Rank
Social - economic factors	*/									
Consumer preference	x	2		1	2	x	x	3	x	2
Utilization - leaf vegetable				x	x		x	x		25%
Utilization - green shelled				x	x		x	x		10%
Utilization - dried bean	x	x		x	x	x	x	x	x	65%
Seed supply and price	1	1		2	1	2	1	1	1	1
Labor supply/draught power/ mechanization		x		x		1	2	2	2	3
Fertilizer and pesticides				x			3		3	4
Produce marketing					3			x		
Crop management										
Seed quality	x	3		x	x		x	x	x	
Cropping system and techniques	x	x		x			x	x	x	
Time of planting	x	1		x	x		3	1	x	3
Plant population	2	2		1	2	2	1	3	1	1
Weeds	2	2		1	2	2	1	3	1	1
Environmental factors										
Moisture stress	1	1		1	2	x	1	1	1	1
Temperature stress	2	2	1	2	1	x	x	x	2	2
Mineral nutrition							x			
Soil texture and structure	x	x				2		x		
Soil acidity			2	x		1				

Table 3. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Plant characteristics										
Yield potential/plant vigor	1	1	x	1	1	1	1	1	1	1
Growth habit	x	x		2	x	x	x	2	x	3
Crop duration	2	2		x	2	x	x	3	2	2
Uniform maturation						x		x	x	
Threshability/shattering		3		x				x	x	
Diseases - viral										
CAMB, cowpea aphidborne mosaic virus		1		3		1		1	1	1
CYMV, cowpea yellow mosaic virus		x		x	x		x		x	4
White fly transmitted virus						1				
Diseases - bacterial										
Bacterial blight, *Xanthomonas vignicola*		x			x			2	x	
Diseases - fungal										
Scab, *Elsinoe phaseoli*				2				3		1
Rust, *Uromyces appendiculatus*					x					
Ascochyta blight, *Ascochyta phaseolorum*				1						
Sepotoria leaf spot, *Septoria* spp.		x			x		x	4		2
Cercospora leaf spot, *Cercospora* spp.					x			x		

Table 3. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Anthracnose, Colletotrichum indemuthianum		x							5	x
Dactuliophora leaf spot, Dactuliophora tarrii								x		
Cowpea wilt, Fusarium spp.					x		x			
Web blight, Rhizoctonia solani					x					
Powdery mildew, Erysiphe polygoni								2		
Nematodes										
Root knot, Meloidogyne spp.	x	1		x	x	1	1	x	x	1
Parasitic weeds										
Witchweed, Alectra vogelii		1		x	x			x	x	1
Insects										
Bean fly, Ophiomya phaseoli					x		x	x		
Groundnut aphid, Aphis craccivora	x	2		5	x	4	4	8	1	3
Black bean aphid, Aphis fabae				x				x		
White fly, Bemisia tabaci					x		x	x		
Jassids, Empoasca lybica, E. Kraemeri			x	3	x	x	x		8	
Giant coreid bug, Anoplocnemis curvipes			x	x		4	x			
Pod bugs,(6 genera)				7	x	x	6	x		
Flower thrips, Taeniothrips sjostedti	1		4	x	5	x	5	x	4	
Foliage thrips, Sericothrips occipetalis					x					
Bean leaf beetle, Ootheca mutabilis				x	2		3	7		6
Blister beetles, Mylabris spp.	x	x		3	4	x		3	2	5
Pollen beetle, Coryna kersteri					x					
Bollworm, Heliothis armigera	x	x		x	x	3		x	x	7
Pod borer, Maruca testulalis	x	x		2	5	2	1	1	3	2
Seed borer, Cydia ptychora					6					
Cowpea bruchid, Callosobruchus chinensis	1	3		1	1	1	2	2	4	1

*/ Relative rank within country by major factor grouping is based on team estimates; x indicates the problem was reported, but relative importance is unknown.

**/ Team estimates of the relative rank of constraints within a grouping over the SADCC countries.

Table 4. Bambara Groundnut, *Vigna subterranea*, Production Constraints in SADCC Countries

Factor or organism	Problems by country*/									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary/**/ Rank
Social - economic factors	*/									
Consumer preference	x	x		x		x		x	x	3
Utilization - green seed	x	x		x	x			x	x	60%
Utilization - dried bean	x	x		x	x	x		x	x	40%
Seed supply and price	x	x		1	x	2	x	1		1
Labor supply/draught power/ mechanization				2		1	x	2	x	2
Crop Management										
Cropping systems and techniques				x				x		
Time of planting									x	
Plant population				x	x			x		2
Weeds	1			1	1	1	x	1	x	1
Environmental factors										
Moisture stress	x	x		x				x		
Temperature stress	x	x		x		x		x		2
Mineral nutrition									x	
Soil texture and structure		x				1		x		1
Soil acidity										
Plant characteristics										
Yield potential/plant vigor	x	x		x	x	2	x	x		2
Growth habit				x					x	
Threshability		1		1	x	1	x	1	1	1

Table 4. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Diseases - fungal										
Ascochyta leaf spot, *Ascochyta phaseolorum*				x				x		3
Cercocpora leaf spot, *Cercospora canescens*										
Brown blotch, *Coletotricham capsici*								x		
Rust									x	
Downy mildew						2				
Powdery mildew, *Erysiphe polygoni*				x			x	x		2
Wilt, *Fusarium solani*				x		1	x	x	x	1
Nematodes										
Root knot, *Meloidogyne* spp.	x	x		x	x	1	x	x	x	
Parasite weeds										
Witchweed, *Alectra vogelii*		x		x	x			x		
Insects										
Plant hopper, *Hilda patruelis*		x		x	x			x	x	2
Jassid, *Empoasca* spp.					x		x	x		
Bruchid, *Callosobrachus* spp.	x	x		1	x	1	1	x		1

*/ Relative rank within country by major factor grouping is based on team estimates; x indicates the problem was reported, but relative importance is unknown.

**/ Team estimates of the relative rank of constraints within a grouping over the SADCC countries.

Table 5. Soybean, *Glycine max*, Production Constraints in SADCC Countries.

Factor or organism	Problems by country*/									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary/** Rank
Social - economic factors	*/									
Consumer preference	x				x					
Utilization - oil	x			x		x	x	x	x	2%
Utilization - soya cake	x			x		x	x	x	x	90%
Utilization - flour							x	x		8%
Seed supply and price	x			2		2	1	1		1
Labor supply/draught power/ mechanization				3		3	2	x	1	2
Fertilizer and pesticides				4		x	x	x	x	4
Produce marketing				1		1	3			3
Crop management										
Seed quality	x			1		x	1	1		1
Cropping system and techniques						x	x	x	1	
Time of planting	x					x	x		2	
Plant population				2			3	2	4	2
Weeds	x			x		x	2	x	3	3
Environmental factors										
Moisture stress	x			2			1	1	1	1
Temperature stress	x			1		2		2	2	2
Mineral nutrition				3			x	3	3	3
Soil texture and structure									x	
Soil acidity						1			x	4

Table 5. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Plant characteristics										
Yield potential/plant vigor	x			1		1	1	1		1
Growth habit				x				x		4
Crop duration							x	x		3
Shattering	x			2		x	x	2	1	2
Nodulation, *Rhizobium* spp.	1			1	x	1	x	1	x	1
Diseases - mycoplasma - like										
Witches broom							x			
Diseases - bacterial										
Bacterial blight, *Pseudomonas glycinea*				x		x		x		1
Bacterial pustule, *Xanthomanas phaseoli*				x		x				
Diseases - fungal										
Leaf spot, *Pyrenochaeta glycine*									x	
Purple stain, *Cercospora* spp.				x						
Anthracnose, *Colletotichum truncatum*									x	
Nemotodes										
Root knot, *Meloidogyne* spp.	x			x	x	1	1	x	x	1

Table 5. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Insects										
Noctuid moth, *Plusia onchalcea*				x						
Stink bug, *Nezara viridula*								1		2
Blister beetle, Mylabris spp.				x						
Cutworm, *Agrotis* spp.				x				x		3
Caterpillar, *Xanthodes graeliis*							x	x		
Termites, *Odontotermes* spp.	x			x			x	x		1
Foilage thrips, *Sericothrips occipetalis*									x	
Bean leaf beetle, *Oothera mutabilis*				x	2		3	7		6
Blister beetles, *Mylabris* spp. (4 species)	x	x		3	4	x		3	2	5
Pollen beetle, *Coryna* spp.										
Bollworm, *Heliothis armigera*	x	x		x	x	3		x	x	7
Pod borer, *Maruca testulalis*	x	x		2	5	2	1	1	3	2
Seed borer, *Cydia ptychora*					6					
Cowpea bruchid, *Callosbruchus chinensis*	1	3		1	1	1	2	2	4	1

*/ Relative rank within country by major factor grouping is based on team estimates; x indicates the problem was reported, but relative importance is unknown.

**/ Team estimates of the relative rank of constraints within a grouping over the SADCC countries.

Table 6. Pigeon pea, Cajanus cajan, Production Constraints in SADCC Countries

Factor or organism	Problems by country*/									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanazania	Zambia	Zimbabwe	Summary/** Rank
Social - economic factors										
Consumer preference									x	
Utilization - green seed	x			x	x		x	x	x	70%
Utilization - dried bean	x			x	x		x	x	x	25%
Utilization - fodder										5%
Seed supply and price				1	x		1		x	1
Labor supply/draught power/ mechanization				2			x		x	2
Fertilizer and pesticides				x					x	
Produce marketing				x			x		x	
Crop Management										
Seed quality				x			x			2
Cropping system and techniques				x	x		x		x	3
Time of planting				3						
Plant population				1	x		2	x		
Weeds				2	1		1	x	x	1
Plant characteristics										
Yield potential/plant vigor	x			3	2		3			2
Growth habit/Photoperiodism				2	x		2		x	3
Crop duration				1	1		1		x	1
Uniform maturation										
Threshability/shattering				x	x		x		x	
Nodulation, Rhizobium spp.	x			x	x		x	x	x	1

Table 6. Continued

Factor or organism	Problems by country									
	Angola	Botswana	Lesotho	Malawi	Mozambique	Swaziland	Tanzania	Zambia	Zimbabwe	Summary Rank
Diseases - fungal										
Wilt, *Fusarium udum*				1	x		1	x	x	1
Root knot, *Meloidogyne* spp.	x			1	x		1	x	x	1
Insects										
Blister bettle, *Mylabris* spp.				4						4
Pod borer, *Maruca testalalis*										x
Boll worm, *Heliothis armigera*				1			x	x	x	3
Thrips, *Taeniothrips nigricernis*				x						x
Bruchids, *Callosobruchus* spp.				2	x		x	x	x	1
Termites, *Odontotermes* spp.				3	x		x	x	x	2

*/ Relative rank within country by major factor grouping is based on team estimates; x indicates the problem was reported, but relative importance is unknown.

**/ Team estimates of the relative rank of constraints within a grouping over the SADCC countries.

ANNEX E

PROVISIONAL ECONOMIC ANALYSES

A. Background

The situation which emerges from the analysis of the economic and social indicators of the nine countries of SADCC is cause for much concern. The main reasons are:

- Population is growing at an average rate of about 3 percent per year;
- Agricultural production growth is absolutely unable to meet the increasing needs;
- The total food production indices in 1982 (1974/76 = 100) show that food production has been increasing only in Malawi, Swaziland and Tanzania;
- The per capita index in 1982 confirms that only Malawi and Swaziland have slightly increased their per capita production, but this may decrease in a few years, as populations continue to grow;
- Imports of food products have been increasing; estimates suggest that the region imports an average of at least 16 percent of its consumption.

This analysis suggests that the already critical food situation in SADCC countries may get worse. SADCC countries may have to rely on imports, thereby increasing balance of payments deficits. Grain legumes should be far more important than they are in the agricultural system and in human diets. Grain legumes have a role to play in the cropping system, through their capacity to fix nitrogen.

To date researchers and planners have given scarce attention to grain legumes. Only groundnuts and soybeans have become important crops to research because they are utilized as export/cash crops. Cowpeas, pigeon peas and Bambara groundnuts have received minor attention. As a consequence, cultivation of most grain legumes has been limited to subsistence and home garden cultivation. Their potential worth as important farming enterprises is not completely established and their role in production and in diets is unexplored.

The worsening of the food situation has made it obligatory to look at other nutritional food crops that fit into the prevalent system of limited resource farming. Grain legumes are a promising source of vegetable protein. Countries in the region must increase their production or resort to increased imports of all food crops.

GLIP is intended to improve research on grain legumes in the SADCC region. Investments in agricultural research often give high rates of return. Many studies confirm that returns on research are two or three times higher than returns on alterrative investments in agriculture and rural development.

However, it must be stressed that research is only the first step of a chain of events to enable higher production. This chain includes:

- The development of an effective extension service;
- The existence oi demand for the products and a marketing system able to pay prices which are an incentive to production;
- The existence of an organization and a policy able to supply farmers with improved production inputs at acceptable prices; credit opportunities have often been an important condition of the acceptance of new technology by smallholders.

B. Methodology

In the region each year about two million hectares are cultivated with grain legumes, mostly groundnut, bean, cowpea and Bambarra groundnut. Smallholders use traditional technology to cultivate grain legumes. Yields are very low. For evaluation purposes estimates were made on: 1) the yield of the crop attainable in 25 years by smallholder farmers using improved technologies generated by the GLIP Programme; and 2) the degree of penetration, i.e., the percentage of the total area which is effectively reached by the Programme results.

The estimates are summarized in Table 1. It is believed that these results will be achieved if there is an organization for effective technology transfer and a system for supply of inputs, and if smallholders are able to obtain the inputs with credit.

Table 1. Estimates*/ of the Yields and Acreage Attainable in Southern Africa as a Consequence of the Grain Legume Improvement Programme

CROPS	PRESENT	1985-89	1990-94	1995-1999	2000-2009
YIELDS, kg/ha					
Groundnuts, unshelled	500	500	600	900	1,400
Index	100	100	120	180	280
Soybeans	1,500	1,500	1,890	2,000	2,500
Index	100	100	120	150	167
Beans	600	600	750	1,000	1,200
Index	100	100	125	167	200
Others	600	600	700	800	1,000
Index	100	100	117	133	167
AREA CULTIVATED PER YEAR 000's of ha					
Groundnuts	850	850	850	850	850
Index	100	100	100	100	100
% of area in improved varieties	-	-	40	50	60
Area of improved varieties			340	425	510
Soybeans	45	55*/	85	165	200
Index	100	122**/	189	367	445
% of area in improved varieties	-	-	60	80	80
Area of improved varieties	-	-	51	132	160
Beans	560	560	640	640	640
Index	100	100	114	114	114
% of area in improved varieties	-	-	40	50	60
Area of improved varieties	-	-	256	320	384
Others	500	500	500	500	500
Index	100	100	100	100	100
% of area in improved varieties	-	-	20	30	40
Area of improved varieties	-	-	100	150	200

*/Estimates assume that not all land will be cultivated with improved technology, and that effects of GLIP will be evident from 1985 onward.
**/Not due to the Programme.

The costs of technology transfer and input supply are extremely difficult to estimate. Conditions of organization effectiveness vary from country to country. In Tables 2 and 3 the cost per hectare of the technology transfer and input supply was estimated. This estimate is very rough. It includes costs that do not directly depend upon research, for example, the additional costs of expanding farmland, and it does not include the training costs of personnel.

A further condition to increasing productivity is the existence of a market and the existence of favorable produce prices. This aspect is not considered in the analysis for a number of reasons. It is assumed that the growing population will increase the demand for grain legumes. Thus, prices will increase, hopefully to prices satisfactory to the farmer. Considering the problems of balance of payments which the countries are facing (and will probably continue to face in the future), it was assumed that SADCC countries will institute price and marketing policies favorable to the producer.

On the basis of existing trends, this analysis assumes that SADCC countries will have to import grain legumes. Production will then have an import substitution function. For this reason, future production has been estimated at "border prices," i.e., the prices SADCC countries will have to pay in the future if measures of increasing domestic production are not put into effect. Border prices represent the amount of foreign currency saved by implementing the Programme. This analysis assumes that groundnut exports from Malawi and Zimbabwe will not be affected since their high quality permits premium prices. The prices estimated here are CIF prices to Europe, prevailing during the period January-June 1983, plus 10 percent for higher transportation costs to SADCC countries.

The adopted base prices, taken from FAO Bulletin of Statistics, August 1983, were the following:

- Groundnuts 500 US$/M.T. (shelled)
- Soybeans 270 US$/M.T.
- Beans 300 US$/M.T.
- Other (reference peas) 260 US$/M.T.

Increases in production will occur if governments make appropriate policies and allocate resources for grain legume production. Tables 4 and 5 present estimates for the increase in costs to governments and to smallholders.

Table 2. Estimates of the Increase of the Cost Per Hectare at Farm and Government Levels

	1985-89	1990-94	1995-1999	2000-2009
FARM LEVEL				
Type of technology*/	A	A+B	A+B+C	A+B+C
Incremental costs US$:				
Seed quality		5	5	5
Crop management and oxen plowing	5	5	5	5
Chemicals		10	15	15
Fertilizer		15	30	30
TOTAL	5	35	55	55
GOVERNMENT LEVEL				
Technology Transfer**/		7	7	7
Credit 2-3% of the increased cost at the farm level		1	1	1
TOTAL		8	8	8

*/A = Improved Seed; B = Improved Management and Chemicals; C = Fertilizer.
**/Cost calculations for technology transfer are given in Table 19.

Table 3. Computation of the Cost of Technology Transfer per Year

Position/Transport	Area Covered ha	Total Cost US$	Cost per ha US$
1 Extension Officer	500	2,000	4.00
1 Bicycle	500	300*/	0.12
1 Div. Officer	5,000	5,000	1.00
1 Motor Bike	5,000	1,500*/	0.06
1 Project Officer	25,000	7,500	0.30
1 Land Rover	25,000	15,000*/	0.12
1 Project Manager	100,000	10,000	0.10
1 Car	100,000	10,000*/	0.02
Housing, 10% of Salaries			0.54
Allowances 10% of Salaries			0.54
Equipment Maintenance, 30% of Cost			0.10
Total			6.90
		Rounded to	7.00

*/Purchase cost, five-year life assumed.

Table 4. Estimated Production Increase and Value per Year

	1990-1994	1995-1999	2000-2009
	Production in 000's Tonnes		
Groundnuts	34.0	170.0	459.0
Soybeans	15.0	66.0	160.0
Beans	38.4	128.0	230.4
Others	10.0	30.0	80.0
	Value in 000's U.S.$		
Groundnuts	17,000	85,000	229,500
Soybeans	4,050	17,820	43,200
Beans	11,520	38,400	68,120
Others	2,600	7,800	20,800
Total	35,170	149,020	361,620

Table 5. Projected Cost Increases to 2009

	1985-89	1990-94	1995-99	2000-2009
ha Improved x 1000	-	747	1,027	1,254
At Farm Level 000's $US	-	26,145	56,485	68,970
At Government Level 000's $US	-	5,976	8,216	10,032
Total Costs	-	32,121	64,701	79,002

In addition to the cost of research, which will be about 15 million dollars in the first five years and 2 million dollars per year in successive years, it will be necessary to allocate about 32 million dollars during the period 1990-94, 64 million during the period 1995-99 and 79 million during the period 2000-2009 (See Table 6).

C. Justification

The Programme is justified by: 1) the need to increase the supply of vegetable protein in the SADCC countries; 2) the expected high returns on investments; 3) the expected saving of foreign currency; 4) the anticipated increase in income for smallholders; and 5) by the multiplier effect.

Table 6 presents estimates for expected increases in per capita supply of legumes grown. The Programme will not only match the growing demand of the population but also will contribute to improved diets.

In Table 7, the estimated increase in per capita legume supply is compared with the 1975-77 FAO "food balance sheets". Consumption levels assume that the increased supply of grain legumes in the different countries is correlated with the population of the same countries. This is highly unlikely. The table, however, permits one to ascertain the importance of the Grain Legume Improvement Programme in the diets of people in different countries.

To assess the investment returns, it was calculated the internal rate of return (IRR) and the net present worth (NPW). (See Table 8.) The IRR is approximately 50 percent. The NPW at 30 percent discount rate is about U.S. $23 million. These values make the investment very attractive.

These results are similar to those quoted in the Executive Summary of 1982 Plant Breeding Research Forum held by Pioneer Hi-Bred, Inc., Des Moines, Iowa, August 11-13, 1982. Insofar as tropical countries are concerned, the internal rate of return for listed research programmes ranged from 24 percent in Malaysia to 70-110 percent in Brazil. The sensitivity analysis considers a reduction of benefits (which are the data with highest probability of error) of 20 and 40 percent giving the IRR of 45 percent in the first case and 28 percent in the second. This further confirms the soundness and attractiveness of this Programme.

As noted before, present trends make it likely that SADCC countries will have to resort to imports to maintain present levels of per capita consumption. The Programme permits a considerable savings in foreign currency.

Table 6. Expected Increase of Per Capita Supply Due to the Programme

	1990-1994	1995-1999	2000-2009
Increased production M.T./year	107,400	394,000	929,400
Population in 000's	84,400	98,480	123,410
Increase in consumption kg per capita per year	1.27	4.00	7.5

Table 7. Projected Per Capita Legume Supply in kg., Compared to the 1975-1977 FAO Estimates

	FAO 1975-1977	Projected 1990-1994	1995-2000	2000 -2009
Angola	8.1	9.4	12.1	15.6
Botswana	17.5	18.8	21.5	25.0
Lesotho	5.7	7.0	9.7	13.2
Malawi	20.7	22.0	24.7	28.2
Mozambique	6.0	7.3	10.0	13.5
Swaziland	2.0	2.6	6.0	9.5
Tanzania	10.7	12.0	14.7	18.2
Zambia	2.3	3.6	6.3	9.8
Zimbabwe	3.2	4.5	7.2	10.7

Table 8. Programme Cash Flow

Project Year	1	2	3	4	5	6-10	11-15	16-24
Calendar Year	1985	1986	1987	1988	1989	1990-94	1995-1999	2000-2009
Incremental Benefits								
Grain Legumes	-	-	-	-	-	35,170	149,020	362,620
Total		-	-	-	-	35,170	149,020	362,620
Incremental Costs								
Research								
Investments	2,265.8	2,251.8	63	36				
Operation	728.3	1,662.7	2,209.4	2,569.4	2,605.4	2,605.4	2,605.4	
Technology Transfer								
Credit Services						32,121	64,701	79,002.0
Total	2,994.1	3,914.5	2,593.4	2,532.4	2,605.4	34,726	67,306.4	81,607.4
Cash Flow Balance	-2,994.1	-3,914.5	-2,593.4	-2,532.4	-2,605.4	+444	81,713.6	281,012.6
Accumulate Cash Flow	-2,994.1	-6,908.6	-9,502.0	-12,034.4	-14,639.8	-12,419.8	396,145.2	3,206,275

IRR = Around 50%

*/ End of the period.

Increasing yields of grain legumes will permit smallholders to generate a surplus that could be sold to provide cash income.

Increased investments, reorganization of the marketing and input supplies, increased production and marketable surpluses will have an effect on the economy. Although this effect cannot be estimated currently, it will certainly be important in the future.

ANNEX F

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ANNEX G

ORGANIZATIONS AND PERSONS CONTACTED

BOTSWANA

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D. Gollifer	-	Chief Arable Research Officer
C. Manthe	-	Entomologist
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