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PRELIMINARY REPORT ON

THE INTERNATIONAL TRAINING WORKSHOP ON

BIOTECHNOLOGY AND GENETIC ENGINEERING

SPONSORED BY UNIDO
BIOTECHNOLOGY UNIT, P O BOX 300
A-1400, VIENNA - AUSTRIA

CONTRACT NO: 93/258

BY

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VENUE DEPARTMENT OF BIOLOGICAL SCIENCES

DATES DECEMBER 6 - 20TH 1993

I. PURPOSE OF THE WORKSHOP

The main purpose of this training workshop was Training the trainers. This was accomplished by brining together 2 African Scientists. practising in Biotechnology to expose them to the latest methods used in Modern Biotechnology and Recombinant Biotechnology. They were trained through the lecture series and more importantly. through the practical course work.

The second aim was to develop a Network of African Biotechnologists and develop linkages in areas of mutual interest. This would lead to the development of collaborative research team work. This comes out of the realization that most of the problems of research that the African Scientists wish to tuckle are the same. This workshop enabled scientists to share ideas and develop new and joint approaches.

This workshop was very successful in the accomplishment of the set goals.

II WORKSHOP PARTICIPANTS

The participants come from the following countries. Ghana. Tanzania, Bukina Faso. Cameroon. Kenya. South Africa and Zimbabwe. A list of the workship participants is provided. The 23 participants were selected from a total of 75 applicants. on the basis of their qualification and practice in biotechnology. The purpose was to have people who have some experience in Biotechnology research. who in turn. could serve to train others in their own countries. when they went back.

III WORKSHOP INSTRUCTORS

After failure to secure the services of several international experts in the field of Biotechnology from Europe or USA. we were able to get the services of four eminent African Scientists. who are experts in the field of Biotechnology:

A. Prof. J. Thomson

Microbiology Department, University of Cape Town come to lecture and taught practical courses. Her lecture courses covered the following areas:

- Genes. Genomes. their structure and organisation,
- Gene expression
- Expression vectors.

Her practical course covered the following:

Practical course I: Plasmid DNA extraction, restriction digestion and gel-electrophoresis

Practical course 2a: Demonstration of suicide vector PECOR251 and

b: Transformation of competent cells with plasmid DNA.

B. Dr David Jewell

Dr Jewell. is the team leader at CIMMYT. Zimbabwe. He agreed to come and gave two lectures;

(i) An introduction to RFLPs and Priority Setting for their utilization in Applied Plant Breeding.

(ii) Utilization of RFLPs at CIMMYT for tagging Quantitative Trait Loci and Marker facilitated selection

C. Dr Molapo Qhobela, Cape Town University

Microbiology Department: Dr Qhobela's lecture and practical courses covered the following areas:

(i) Principles of RFLPs. isolation of DNA and preparation. selection of probes, detection of RFLPs using the DIG and analysis and interpretation of RFLPs.

(ii) Principles of polymerise Chain Reaction. Gene specific PCR, Primer design, amplication conditions. and generation of RFLPs map from amplified products.

(iii) Random Amplified polymorphic DNA PCR. principles and use of RAPD PCR. principles and use of RAPD PCR fingerprints.

(iv) Pulse field Gel-electrophoresis. Principles of PFGE. choice of rare Cutting Restruction Enzymes for PFGE. fingerprints.

Dr M. Qhobela's, practical course covered some of the following: (i) RFLP which involved: DNA purification determination of DNA quantity by UV spectrophotometry. Restriction digestion electrophoresis. Southern transfers. DIG labelling system, hybridization and detection using themoheminescence and colorimetric detection.

(ii) PCR. PCR primer design and reaction oplimisation. random amplification of polymorphic DNA by PCR. RAPC procedure.

V THE BUDGET

Please note that this is a provisional budget. A full detailed statement of account shall be provided at a later date when all statement of payment have been received.

BUDGET SUMMARY

Total income = US$15 700 = Z$105 190

Description of items of expenditure

1.	Hotel accommodation		
	a. Bed and breakfast for 15 participants for 5 nights	=	S51 750
	b. Dinners at $35/person for 12 days	=	6 300
2.	Participants pocket money at $300/person for 15 people	=	4 500
3.	Labour:		
	a. Three technicians overtime pay at $2000.00 each	=	6 000
	b. Secretarial services	=	2 100
	c. Technical and secretarial assistance	=	2 300
	d. Drivers		586
4.	Honorarium for 3 people	=	5 000
5.	Opening Ceremony Expenses	=	300
6.	Lunches:		
	a. Senior Common Room for 2 days	=	1 050
	b. DACS for 10 days	=	12 250
7.	Group Visit to Imire Game Park	=	4 000
8.	Car Hire	=	3 000
9.	Entertainment		
	a. Braai	=	1 000
	b. Reception	=	3 000
	SUB TOTAL		Z$ 103 136

Bills yet to pay

1. Chemicals

Consumables for the course Dr Ohobela. Cape Town University = ZS11 060

2. Other costs

a. Photocopying	=	2 000
b. Tea/Coffee	=	3 000
c. Snacks	=	4 000
TOTAL		ZS20 060

Total expected expenditure = ZS123 195

Total expected income = US$ 19 700

= ZS131 990

VI. EQUIPMENT AND BOOKS

I confirm that the equipment and books which I requested has been provided and that I have received them. I have received the equipment and books listed below:

a. One DNA - Thermal cycler TCI
Complete set N801 - 077
shippers Part number 801 82413

b. Gene Amp PCR Reagent kit with 2 polymerise
(250 units) N801-0055
Shippers part NON 80191765

c. Gene Amp PCR Reaction tubes
(015 ml) PK/2000. N801-0180
Shippers part No: 801 87005

d. Ampli Taq DNA polymerise
N801-0060
Shippers number 8019 1764

e. Polaroid No. 545, 4 x5 Land film holder POLO 545

f. Polaroid film F 5640. Type 59 positive/negative 20 exposure Pol. 5640.00

g. One colour T.V Multi-System, Sony model KV.2965mT one VCR multisystem, VHS Auto Voltage selector. Panasonic NV-SD25

h. One Video Camera, VHS (auto focus), Panasonic, NV-M3000EN, complete with AC adapter/charger and battery pack.

i. One carry case.

BOOKS

a. Comprehensive Biotechnology Pergamon Press
Volume 1-4.

b. Molecular cloning, A Laboratory manual
2nd Edition, Sambrok, Fritsch and Mariatis
Volume 1-3

VII. WORKSHOP CONCLUSIONS AND RECOMMENDATIONS

The majority of the Workshop participants felt that the main goals of this workshop were accomplished. This workshop offered the first opportunity to many of the participants to have an on-hand experience in the art of doing Basic Biotechnology Research Methods. Many of them were able to realize that much of Basic Research Methods are double in Developing Africa. They came to a realisation that Basic Research in Biotechnology can be part of their culture.

The workshop also brought together 35 African scientists to learn together from experienced African Scholars. The fact that the instructors were African, demonstrated to the participant that Basic Research is double in Africa. The Scientists also had the first opportunity to develop Networks in basic biotechnology methods in African Countries. They were able to share ideas on research development and planning. Presentation by Prof C.J Chetsanga on the role of the Scientific and Industrial Research and Development Centre (SIRDC) in the development of Biotechnology Research in Zimbabwe, was very inspiring and challenging to many African Scientists, to see how their own countries can develop and monitor developments in biotechnology.

It was also concluded that some of the problems faced by the African Countries, such as lack of drought resistant/tolerant cultivars can be solved through the practice of basic biotechnology methods. Other problems such as development of vaccines, diagnostic probes, exploitation of medicinal and industrial plants etc, are possible through the practice of basic biotechnology.

RECOMMENDATIONS

The Workshop participants, encouraged by the workshop achievements, challenged by the devotion and intellectual ability of the African Workshop instructors, and their resolve to practice basic biotechnology research methodologies, unaminously recommend:

1. That Dr Gopo be requested to contact UNIDO/SAREC/Rockefeller/Foundation/USAID/EEC, IDRC and other donors, for support to organize a scientific meeting follow-up. The present participants should come to present papers which show how they have made use of the methods which they learned from the present workshop.

2. UNIDO and SAREC be encouraged to support more such training workshops in Africa. The emphasis on such workshops be on "Training." through the practical course work such as was given during this workshop.

3. The workshop participants develop Networks at Country level, subregional and at an African regional level.

4. The workshop participants tasked Dr J M Gopo to find out about the Biotechnology Network headed by Prof Okonkwo of the African Biosciences Network (ABN) and see how this network can be of use to them.

BIOTECHNOLOGY WORKSHOP PROGRAMME
WEEK I

DAY	TIME	ACTIVITIES
MONDAY 06.12.93	0800 - 0900	Registration of participants BZI laboratory
	0900 - 1030	Opening ceremony LT 400
	1030 - 1100	Tea break
	1100 - 1230	Lecture Gene, Genomes and their structure and organisation - Prof J A Thomson
	1230 - 1400	Lunch Senior Common Room
	1400 - 1500	Lecture - Introduction to RFLPs and priority setting for their utilisation in applied plant breeding Dr David Jewell - Team leader - CIMMYT, Zimbabwe
	1500 - 1700	Practical preparation for practical 1
	1800 - 1930	Reception

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Opening Ceremony

Date: 6 December 1993

Time: 0900 hours

Venue: New Lecture Theatre LT400

0900 - 0915 hours:	(a) Welcome Guests - Dr J M Gopo (b) Introduction of Guests
0915 - 0920 hours:	Brief Description of the purpose of the Workshop - Dr J M Gopo
0920 - 0930 hours:	Remarks by the Sponsors (1) SAREC (Mr Hedebro) (2) UNIDO (Mr Carlos Lopes)
0930 - 0935 hours:	Music
0935 - 0950 hours:	Key note address - Prof C J Chetsanga 'Biotechnology in Zimbabwe, present and future perspectives'
0950 - 1000 hours:	Music/Recitation - Prof S Mutsvairo
1000 - 1015 hours:	Welcome by the Vice Chancellor Prof G L Chavunduka
1015 - 1030 hours:	Official opening of Workshop - Hon. Minister Dr S Mudenge
1030 hours:	Tea break

DAY	TIME	ACTIVITIES
TUESDAY 07.12.93		
	0830 - 0930	Lecture - Prof. C J Chetsanga
	0930 - 1030	Utilization RFLPs at CIMMYT for taging Quantitative trait Loci and Marker facilitated selection
	1030 - 1100	Coffee/ Tea Break
	1100 - 1230	Lecture - Genes/Genomes Prof J. Thomson
	12.30 - 14.00	Lunch
	14.00 - 18.00	Practical 1 - Prof J. Thomson

****

DAY	TIME	ACTIVITIES
WEDNESDAY 08.12.93	0930 - 1030	Lecture - Gene Expression Prof J. Thomson
	1030 - 1100	Coffee/ Tea Break
	1100 - 1230	Lecture - Principles of RFLPs Dr P. Tongoona - U.Z., Crop Science
	12.30 - 14.00	Lunch
	14.00 - 17.00	Practical 11 - Prof J. Thomson

****

DAY	TIME	ACTIVITIES
THURSDAY 09.12.93	0930 - 1030	Lecture - Expression Vectors Prof J. Thomson
	1030 - 1100	Coffee/ Tea Break
	1100 - 1230	Lecture - Principles of RFLPs Dr P. Tongoona/Dr Qhobela
	1230 - 1400	Lunch
	1400 - 1800	Practical 111 - Dr Qhobela/Tongoona - RFLPs DNA preparation, purification, restriction, electrophoresis

****

DAY	TIME	ACTIVITIES
FRIDAY 10.12.93	0930 - 1030	Lecture - RFLPs Use of DNA markers in plant and animal improvement
	1030 - 1100	Coffee/ Tea Break
	1100 - 1230	Lecture - RFLPs Dr M. Qhobela - Selection of probes, detection and analysis
	1230 - 1400	Lunch
	1400 - 1800	Practical 111 - RFLPs Dr Qhobela/Tongoona
	1900 - 2100	Braai

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DAY	TIME	ACTIVITIES
Saturday 11/12/93	1000 hours	Visit to Imire Game Park
Sunday 12/12/92		FREE

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BIOTECHNOLOGY WORKSHOP PROGRAMME

WEEK II

DAY	TIME	ACTIVITIES
MONDAY 13.12.93	08.30 - 09.30	Lecture
	09.30 - 10.30	Lecture - Principles of PCR - Dr Qhobela
	10.30 - 11.00	Coffee/ Tea
	11.00 - 12.30	Lecture - RFLP's Dr Tongoona
	12.30 - 14.00	Lunch
	14.00 - 18.00	Practical V - PCR Dr Qhobela

****

DAY	TIME	ACTIVITIES
TUESDAY 14.12.93	08.00 - 09.30	Lecture - DNA Research and Biosafety issues in Developing Countries - Dr S.B. Feresu
	09.30 - 10.30	Lecuture - RAPD Dr Qhobela
	10.30 - 11.00	Coffee/Tea
	11.00 - 12.30	Utilisation RFLPs at CIMMYT for taging Quantitative trait Loci and Marker facilitated selection - Dr D. Jewell
	12.30 - 14.00	Lunch
	14.00 - 18.00	Practical VI - PCR Dr Qhobela

****

DAY	TIME	ACTIVITIES
WEDNESDAY 15.12.93	08.30 - 09.30	Lecture - Biotechnology and Food Safety in Developing Countries - Mr Chigumira
	09.30 - 10.30	Lecture - MQ PCR Dr Qhobela
	10.30 - 11.00	Coffee/Tea
	11.00 - 12.30	Lecture - Cluster Analysis Dr P. Tongoona
	12.30 - 14.00	Lunch
	14.00 - 18.00	Practical - PCR Dr Qhobela

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DAY	TIME	ACTIVITIES
THURSDAY 16.12.93		
	08.30 - 09.30	Lecture - Biotechnology in Zimbabwe: Issues and Policy Options - Dr S. Mlambo
	09.30 - 10.30	MQ PCR Dr Qhobela
	10.30 - 11.00	Coffee/Tea
	11.00 - 12.30	MQ PCR Dr Qhobela
	14.00	Free Afternoon

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DAY	TIME	ACTIVITIES
FRIDAY 17.12.93	10.00 - 12.00	Closing Ceremony

CLOSING CEREMONY

10.00 - 10.15	Introductory remarks - Dr J.M Gopo
10.15 - 11.00	Workshop appraisal - Prof C.J Chetsanga National Consultant
11.00 - 11.30	Certificate presentation, the Vice Chancellor
11.30 - 11.35	Closing of Workshop, The Vice Chancellor

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INTERNATIONAL TRAINING WORKSHOP IN MODERN BIOTECHNOLOGY AND GENETIC ENGINEERING

DECEMBER 6 - 20 1993

LIST OF PARTICIPANTS

NAME & ADDRESS	AREA OF SPECIALIZATION	PHONE (FAX) EMAIL
Abou Bado (Dr) Epidemiology & Biotechnology Unit International Center for Research Development on livestock in Humid & Sub- Humid Area (CIRDES) 01 P O Box 454 Bobo Dioulasso 01 BUKINA FASO	-Immunogenetic, -cytogenetic -phylogenetic	Tel: (226) 97-22-87 Fax: (226) 97-23-20
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Wilson Byarugaba (Dr) Dept. of Pathology Makerere Medical School P O Box 7072 KAMPALA Uganda	Cytophatology	Tel: 256 (41) 540604

Contd/.....

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Mary Halm Food Research Institute P O Box M20, ACCRA Ghana	-Food microbiology -Food fermentation -Grain storage	Tel: 777647 Code: 23321 Fax: 23321/ 777647
Mrs Santhamma James Biology Department University of Bophuthatswana P Bag X2046 MMABATHO 8681 RSA		Tel: (0140) 892-111 Fax: (0140) 25775
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Gerard Majella Mutumba Dept. of Botany Makerere University P O Box 7062 KAMPALA Uganda	-Cell Biology/Plant Physiology. - Coffee micropropagational & improvement with respect to drought etc. -Germplasm characterisation in the cooking plantain-DNA fings printing to be applied	
C.N. Mzira Dept. of Biosciences University of Zimbabwe P O Box MP167 MOUNT PLEASANT Harare	-Molecular virologys	
M. Dieudonne Nwaga Dept. of Plant Biology The Biotechnology Centre University of Yaounde I P O Box 812 YAOUNDE Cameroon	-Plant microcganism interactions -Symbiosis (legumes-Bradyihizobium and VAMycorhizae -Seed storage protein of Legumes	Tel: 237429 Tlx: 8384 KN Fax: (237) 237429 or (237) 23.53.88
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Agatha Masemola Dept. of Biochemistry University of the North Private Bag X1106 SIVENGA 0727 South Africa	-Biochemistry -Leukemia Research	Tel: 68-2340 or 68-2342 Code: 01521 Fax: -
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STATE OF BIOTECHOLOGY IN ZIMBABWE

"INSTITUTIONAL ORGANIZATIONS AND CONSTRAINS"

BY

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1. INTRODUCTION

The Biotechnology Forum of Zimbabwe Commissioned a study on the state of Biotechnology in the country. Mr Muza and Dr Woodend were tasked to determine the Crop Production constraints. Institutional Biotechnology capabilities and priorities. Their fundings form the background basis for this paper.

2. BIOTECHNOLOGY : DEFINITIONS, AND APPLICANTS

Biotechnology has been very broadly defined by the Office of Technology Assessment (US) as "Any technique that uses living organisms, or parts of organisms, to make or modify products, to improve plants or animals, or to develop micro-organisms for specific uses." We propose that biotechnology be defined as the "integrated use of molecular genetics, biochemistry, microbiology, and process technology employing micro-organisms, parts of micro-organisms, or cells and tissues of higher organisms to supply goods and services." As such, this definition embraces "traditional biotechnology" which includes fermentation, rapid plant propagation, biological pest control and conventional animal vaccine production. Modern biotechnology is based on recombinant DNA techniques, cell fusion and novel bioprocessing techniques.

3. BIOTECHNOLOGY INSTITUTIONS AND ORGANISATIONS IN ZIMBABWE: ACTIVITIES, CAPACITY AND CONSTRAINTS

3.1 STATE OF BIOTECHNOLOGY

In order to consider the state of biotechnology in Zimbabwe, it comes necessary to look at various sectors of the Zimbabwean society. There is need to examine the practice of biotechnology at several levels. This paper shall consider the state of biotechnology in Zimbabwe by examining the state and practice of biotechnology in the following sectors:

(a) The public sector
(b) Private sector
(c) Non-Governmental Organisation

4. PUBLIC SECTOR INSTITUTIONS

There are several public sector institutions which are practising biotechnology. I will discuss a few of these in this section.

4.1.2 MINISTRY OF LANDS, AGRICULTURE AND WATER DEVELOPMENT (MLAWD); DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES

The Department f Research and Specialist Services (DR & SS), together with its sister departments, AGRITEX and Veterinary Services, is entrusted with the furtherance of the welfare and technical progress in Zimbabwe's agriculture. It is responsible for conducting research in agricultural science (crop and livestock production), and is also entrusted with regulatory services under various Acts.

The Director's view is that the single most important area where biotechnology will have an impact on agriculture is in crop improvement. The Director has now sanctioned active participation in biotechnology related activities, and one breeder has now assumed responsibilities of biotechnology coordinator for the Department. Various institutes have the capacity to utilize biotechnology.

4.1.1 CROP BREEDING INSTITUTE (CBI)

Specialists at the Institute have developed national programmes of breeding and selection for hybrid maize, wheat, barley, sorghum, millets, soyabeans, groundnuts, sunflowers, potatoes, beans, cowpeas and bambara nuts. Each crop has its own breeder. The institute has a biotechnology coordinator who is tasked to assist breeders.

Four ways that the biotechnology coordinator may be able to assist breeders in the Crop Breeding Institute are as follows:

i) Molecular marker assisted selection using RFLPs, RAPD's and Southern Blotting techniques.
ii) Use of transgenic lines in backcross programs
iii) Genetic engineering of elite lines to introduce useful genes
iv) Disease diagnostics

There are plans to build a diagnostic laboratory within the institute. From the basic materials developed in the institute, suitable varieties for widely differing environments are tested in different ecological zones on research stations and farm plots in commercial and small scale communal area sectors. There is close collaboration with the Agronomy, Plant Protection, Chemistry and Soils, and Seed Services Institutes.

In terms of manpower, the institute is well staffed. Of the 12 breeders, 4 are PhD, 6 MSc and 2 BSc level. The aim is for every breeder to be PhD level. CBI would welcome scholarships for such training through BFZ. In addition, CBI is sourcing funds for one breeder to undertake post-doctoral training in genetic engineering.

Because of devaluation of the dollar and other reasons, funds for travelling to research stations and on-farm testing sites are dwindling. If the BFZ can source funds to support such activities, that would be beneficial. The number of varieties released by CBI since 1932 are listed below.

BFZ = Biotechnology Forum of Zimbabwe

Crop	Number of cultivars released
maize	28
sorghum	4
pearl millet	2
finger millet	2
wheat	31
barley	6
soyabeans	12
groundnuts	9
sunflower	3
potatoes	8

4.1.2 PLANT PROTECTION RESEARCH INSTITUTE (PPRI)

Research on plant pests and diseases of economic importance is at present centred in the PPRI at Harare. The institute also provides identification and advisory services and is expanding facilities for surveys and research on crop protection problems in the communal areas.

The work of the three main sections. Entomology, Pathology and Nematology is concerned with basics biological problems relating to particular pests and diseases as well as with the disease complex of the more important crops close co-operation is maintained with agronomists and plant breeders, and with commercial organisations handling new materials.

When a diagnostic laboratory is established in the Crop Breeding Institute PPRI can benefit in molecular diagnosis of various diseases, especially viruses. In addition, transfer of various genes for resistance to pests and disease can also be done on a joint basis with CBI.

The Institute staff are responsible for phytosanitary control regulations, including regulations for integrated pest control for cotton tobacco etc., and for the registration of agricultural pesticides. As biotechnology research develop in DR & SS, PPRI should be actively involved in developing biosafety protocols.

4.1.3 HORTICULTURE RESEARCH CENTRE (HRC)

The Horticulture Research Centre at Marondera is primarily responsible for research on store fruits, vines and vegetables as well as introducing new crops. The target group is all farming sectors. Two projects are directly for small scale farmers:

i) The Vlei Project: research on vegetables grown on vlei gardens
ii) Supply of improved, disease free, planting materials of fruit trees such as mangoes and guavas.

Examples of work being carried out include improvement of onions for carlines, bolting resistance, longer storability, and higher yields. In tomato, a breeding program has been initiated with focus on pest and disease resistance.

It is noted that some of the constraints limiting vegetable production by small scale farmers include lack of storing expertise, use of traditional cultivars, and poor inputs. Other details will be discussed in the crop specific section under vegetables.

The HRC is building a tissue culture laboratory. The objectives of this lab are:

i. to propagate disease free material
ii possible collaboration on transformation
iii importation of germplasm in tissue culture to prevent introduction of new diseases.

The lab has a partial mandate on potatoes. Cornell University has a partial mandate from CIP to select for heat tolerance (important for Zimbabwe). Seed imported in tissue is almost ready for field testing.

The lab will also be working with blueberries. Some lines have already been imported in tissue culture. The advantages are that in addition to avoiding disease, the tissue culture route is the easiest for bulking up the material.

Between HRC and PPRI, they have 95% of the technology to effectively do tissue culture work. The building is now complete and some equipment has already been purchased.

Close cooperation with UZ's Crop Science Department, and with Brookfields Nursery will be maintained. Internationally, the lab has linkages with Rockefeller Foundation, CIP in Kenya, FAO, and Cornell University on potato selection.

4.1.3.1 CONSTRAINTS LIMITING PROGRESS

Equipping the lab is not yet complete. Additional funds apart from that supplied by the World Bank may be required. In addition, access to chemicals needs to be worked on.

4.1.3.2 GENETIC RESOURCES

Since HRC is responsible for horticultural crops and introduction of new crops. a lot of the germplasm is imported from abroad.

4.1.3.3 MANPOWER AND CAPACITY TO SERVE OTHER INSTITUTES

So far the responsibility for the lab lies with one BSc scientist with some biotechnology background. Further training to PhD level is necessary with probable emphasis on virology, physiology and certain specific kinds of biotechnology. A technician will also be desirable.

The lab will be in a position to assist with regeneration in collaboration with CBI and PPRI. It will also complement Dr Robertson's lab at UZ.

The project should be quite self sustainable, with revolving funds of up to US$10 000 per year. It has the capacity to generate income as well.

4.1.3.4 EQUIPMENT

Building : Completed at a cost of ZW$200 000
Refrigerator
Freezer
Autociave
Microwave Oven
Automatic Collection Bottle
Analytical balance
Magnetic Stirrer
Laminar flow station
Shaker
Growth Room
Low temperature incubator
Microspore filter units
Growth substances/chemicals.

4.1.4 LEGUME INOCULANT FACTORY

The Legume Inoculant Factory with a supportive Microbiology Laboratory was in operation in October, 1962, as a non-profit making service to farmers in Zimbabwe.

From over 360 species of legumes found in Zimbabwe, Rhizobium bacteria were extracted from the root nodules and classified. With a few imported strains added, the collection has over 700 different strains of Rhizobium. Zimbabwe is rated third in the world with the largest collection. It is known internationally as the Grasslands Rhizobium Collection with the prefix MAR/ ...followed by the strain identity number.

Sales of inoculant to commercial farmers began with soyabean, groundnut, lucerne and field beans with a small but steady demand for peas, sunheamp, velvet beans, clovers and lupins.

The unit of inoculant was grown on Agar nutrient in flat glass bottles until 1982 when, due to high costs involving foreign currency, use now made of the waste product from sugar cane called bagacillo. The Lowveld Sugar Estate sends sacks of bagacillo to the Factory where it is sieved to the required fineness.

The preparation of Rhizobium culture in flasks of nutrient broth and injecting it into the bags takes place during June - December. Estimates of inoculant required by farmers are given by the Farmers' Co-ops and associations handling the marketing of legume crops, to the Factory Manager.

Every bag Unit has the Batch Number and Rhizobium Strain Number written onto the label and the boxes have the name of the legume for which the inoculant is to be used, with instruction sheets included.

The batches made ready for sale are stored in Cold Rooms at 4°C which keeps the Rhizobium bacteria dormant. Viability during this period is safe for six months.

The units are sold through approved selling agents for the Ministry of Land, Agriculture and Rural Resettlement for $2.00 a unit. These agents sell to the farmers. Boxes of inoculant ordered are sent overnight by rail or road transport which ensures they are kept cool until received by the selling agents into their approved cold rooms. Recent trials have shown good viability of Rhizobium kept at cold room temperature for two to three months which will greatly assist the communal land farmers in more remote areas.

ANNUAL SALES : This varies from 60-90 000 units of inoculant with:

Soyabean inoculant (treats	100kg seed)	±	88.5%
Groundnut " "	100kg seed	±	3.6%
Pea " "	35kg seed	±	3.5%
Bean " "	42kg seed	±	2.4%
Lurcene and miscellaneous	1kg-7kg	±	2.0%

The variability of quality of seed one unit of inoculant treats depends upon the seed surface area. The percentage of sales also depends upon the availability of seed. Lurcen sales are generally higher when seed is available.

Research is being conducted to assist the communal land farmer to be aware of the beneficial use of Rhizobium inoculant for legume and to understand more fully the wonderful symbiotic relationship these two have to produce the plant own nitrogen requirements at a fraction of the cost of Ammonium Nitrate fertilizer. with added benefit of improving the soil structure for non-legume crops.

4.1.4.1 CONSTRAINTS TO PROGRESS

The lab is operating fairly efficiently. It should be expanded to include work on mycorrhizas.
the NBF can help source of funds to rehabilitate the factory as well as assist in training personnel.

4.1.4.2 GENETIC RESOURCES

From over 360 species of legumes found in Zimbabwe. Rhizobium bacteria were extracted from the root nodules and classified.

4.1.4.3 MANPOWER AND CAPACITY TO SERVE OTHER INSTITUTE

The lab has one Research Officer (MSc) and one technician. It is envisaged that at least one additional officer with a PhD is fermentation with a PhD in fermentation technology is required. In addition. one more technician and two laboratory hands would make the lab very efficient. the officer in charge, currently holding an MSc in fermentation technology, needs to be trained to PhD level.

The factory gives free units to UZ, African University. Mlezu Agric. College, Chibero and Gwebi Colleges, Kushinga Pikelela as well as the Pasture section and Grasslands Research Stations and to Matopos Research Station, Internationally there has been collaboration and sales to Uganda, SA, Zambia and Mozambique

Although the target group of this factory is supposed to be the small scale farmers, over 96% of the 200 000 units produced annually are bought by commerical farmers. It is clear the small scale farmers need to be educated about the yield benefits o inoculation legume crops. collaboration with the Agronomy Institute and AGRITEX in terms of field trials and demonstration plots for the benefit of SSF'a is a major priority.

4.1.4.4. FACTORY EQUIPMENT

Autoclaves
Balances
Bottle cutting machine
Aseptic cabinet
Centrifuge
Cold room
Incubators

4.1.4.5 EQUIPMENT REQUIRED

Distillation apparatus Bibby merit W4000
Weighing scale (Digital)-Mettler PS 3600
Automatic dispenser
Motor cycle - delivery of small quantities of inoculant
Hospital trolley
Adjustable laboratory stools
Telephone answering machine
Apple Macintosh Computer IIsi2/40
Apple Macintosh Personal Laser Writer LS
Plastic Bag Sealer - with double seal

4.1.5 COFFEE RESEARCH STATION (CRS)

The Coffee Research Station located in Chipinge appears to be seriously understaffed and presently has only two research officers specializing in entomology and physiology/agronomy. It undertakes research on variety evaluation, physiology and agronomy, entomology and pathology; no breeding work is carried out.

Of particular relevance to small-scale coffee producers are the minimum input trials which are being carried out at the station. These trials entail investigations on the use of processing byproducts (i.e. effluent and pulp) as organic fertilizers. Unfortunately, the lack of funds has prevented on-farm trials.

The station has a very well equipped pathology laboratory in which some tissue culture and micropropagation work could be undertaken with the provision of finance for chemicals and glassware, and trained personnel. An attempt was made to undertake some micropropagation but, due to lack of inputs (i.e. hormones, etc.) the work was terminated. A request to the World Bank has been made for the establishment of a tissue culture facility at the station.

4.1.6 COTTON RESEARCH INSTITUTE (CRI)

The CRI is responsible for all research on cotton including breeding, entomology, agronomy, physiology and pathology. Of particular relevance to RPFs who are very important cotton producers, is the CRI research programme specialising in variety evaluation and agronomic studies in cotton. Until recently, an essentially one variety policy was adopted despite the dichotomy between the high and low-input LSCF and RPF subsectors, respectively. Starting a few years ago, a deliberate effort has been underway to develop varieties for low-input conditions. The objectives of this programme are to develop indeterminate, drought tolerant, and pest and disease-resistant varieties which are suitable to the C.F. Reduction in the need for expensive chemical inputs is envisaged as a major priority in this programme.

RPF = Resource Poor Farmers
LSCF = Large Scale Commercial Farmers
C.F. = Communal Farmers

Breeding for resistance to jassids. bacterial blight and Verticillium wilt is routinely undertaken using conventional approaches. Considerable progress has been made given that there are several sources of host plant resistance to these constraints. Because there are no sources of host plant resistance to bollworms. no breeding for resistance has been carried out: rigorous scouting and chemical control remain the only options for control.

In view of the considerable progress that has been made in cotton biotechnology particularly as regards Bt-induced resistance to Heliothis and pink bollworms. the CRI has initiated some work in this area. Initially about six genotypes were sent to the US for studies on regeneration ability due to the inability of the station to carry out such studies. Results indicated that the African upland cottons grown in Zimbabwe do not regenerate easily
and are therefore not amenable to transformation. Therefore the best and perhaps only option for the application of cotton biotechnology in Zimbabwe is rapid back-crossing of transgenic traits into local cultivars.

The CRI, with the assistance of the ISAAA. is now actively pursuing the possible of Bt in the control of bollworms. In the initial phase, Bt protein originating from Monsanto and administered as a spray, will be tested for effectiveness against local biotypes of Heliothis under greenhouse conditions. If successful,transgenic Coker lines will then be imported and utilized in a rapid back-crossing programme designed to incorporate Bt into local cultivars. The necessary financial arrangements for this project will presumably be concluded between the CRI, the Cotton Growers Association, ISAAA and Monsanto.

The CRI possesses no facilities or personnel to undertake biotechnology research which might include a more thorough investigation on the regeneration ability of local material. It has however received a scholarship offer for biotechnology training at Monsanto. Subsequent placement of trained personnel is a matter of concern given the lack of facilities at the station.

Monitoring.NBF,safety, acceptability, etc.

As yet the cotton Bt project dose not require adherence to the working guidelines that have been drafted. However, should field testing of transgenic imported Coker lines be proposed after evaluation of the Bt protein,the project will require evaluation and approval by the national biosafety board. Given that cotton is an industrial crop. it would appear that issues such as cultural acceptability and environmental-friendliness will not be problematic. But. it is imperative that all issues relating to Bt use elsewhere be thoroughly examined during the evaluation exercise.

Of concern would be the long-term effectiveness of Bt resistance and its effect on pest biology. Special attention should be given to reports of Bt resistance breakdown and the measures that are being proposed or made to bolster and maintain this novel resistance. The consultancy is adamant the CRI. which presently has little contact with the NBF. should be
co-opted into membership so as to ensure that it is kept fully informed on recent developments. Overreliance on the information and opinions of externally based broking agencies is viewed with some concern.

4.1.7 LOWVELD RESEARCH STATION

The Sub-tropical Horticultural Unit is based at the Lowveld Research Station which is located near Chiredzi. Research undertaken includes studies on sub-tropical fruits and nuts as well as some vegetables. Crops under investigation include bananas, coffee, grapefruits, litchi, mango. oilpalm. peach, guava, pineapple. tomatoes, cabbage, covo, okra. sweetpotato. onions. watermelon and jojoba. Mainly varietal evaluation and agronomic work is carried out at this station.The station has no biotechnological capability or interest but could prove valuable in the evaluation of biotechnology-derived commodities under lowveld conditions

4.1.8 UNIVERSITY OF ZIMBABWE (UZ)

M.Sc. Biotechnology Programme

The M.Sc Biotechnology programme is jointly offered by the Faculties of Agriculture and Science and was initiated in 1991 with assistance from SERAC and the Dutch government. The first 8 students have graduated and 15 have been accepted for the second course. It is anticipated that graduates will proceed to the D.Phil. or Ph.D level to better equip them with knowledge and skills in biotechnology.

The following courses are offered the two-year programme:

Basic Microbiology
Basic plant Biotechnology
Recombinant DNA Technology
Advanced Fermentation
Enzyme Technology
Advance Plant Biotechnology
Immunology and Virology
Cloning Technology

In the second year students have to complete a research project at an approved local or foreign institution.

4.1.8.1 FACILITIES

Facilities for the programme include:

Laminar growth cabinets
Growth chambers
Agrobacterium and *E. coli* vector systems
Electrophoresis equipment for proteins and DNA
DNA and protein photographic equipment
Ultracentrifuges
Amino acid analyser
Chromatography equipment, including glc and hplc
Transmission electron microscope
Incubators and ultra-deep freezers
Fermenters and autoclaves
DNA thermal cycle for PCR

The course represents a very significant and useful development in local biotechnology capacity and capabilities.

4.1.8.2 DEPARTMENT OF BIOLOGICAL SCIENCES

Dr Gopo's Laboratory

Recombinant DNA Technology
Dr Gopo's lab is strong on the current definition of biotechnology, i.e. recombinant DNA technology and related molecular biology aspects. Currently this lab is using molecular markers to characterise the phyllogenetic relatedness amongst the *Tillapia* spp of fish, basically using the Southern Blotting technique. Because of the inadequacy of markers/probes obtained from abroad, this lab has developed its own probes which are giving more definitive results. Further development of diagnostic techniques continues to be important.

Development of plasmid constructs with different genes and promoters is another area of focus. A different lab. maybe in the Crop Science Dept. should be developed to specialize in transformation and regeneration techniques and therefore collaborate on that basis. In this manner, a holistic package on genetic engineering can be realized.

Dr Gopo's lab has constructs with Bt genes from two strains, one that produces protein specific for mosquito control, and the other for tsetse control. Bacterial expression of these genes has been obtained. A fermenter is needed to produce these insecticidal proteins on a large scale basis. These can then be sprayed in the rural areas where these insects cause a lot of suffering, limiting agricultural production.

It has been found that in Zimbabwe, areas where *Mycobacterium avium* is abundant have low apportunestic infections in HIV positive people. A complete DNA library of this bacterium has been made and efforts are underway to isolate M. avium specific gene for diagnostic purposes. Needless to say, this can be a major step in the fight against AIDS.

4.1.8.3 CONSTRAINTS LIMITING PROGRESS

The amount of government money put into research by developing countries is too low. In developed countries, less than 0.1% of GDP goes into research, whereas in developing countries its about 1% This situation must change for the fruits of research to be fully realized.

The lab is not yet fully equipped (see section on inventory).To start with, it was externally funded,basically by USAID funds. Now there is also a running UZ grant of about ZW$50 000 per annum. Organizing biotechnology workshops is one of sourcing funds and equipment.

Availability of reagents and other consumables is a problem. These should be made available through OGIL. A company called ZEMETHICOLL can now buy things like restriction enzymes using local currency. Apart from further negotiating withe government to make reagents easily available from abroad, local industries should be encouraged to develop these locally.

4.1.8.4 GENETIC RESOURCES

Bt genes against mosquitoes and tsetse flies are available in constructs, in addition to various probes, RFLP markers and reporter genes.

4.1.8.5 MANPOWER AND CAPACITY TO SERVE OTHER INSTITUTIONS

The lab is currently run by one phD scientist and two technicians. Another MSC or phD scientist is required, possibly through staff development.

The lab is in a position to help other institutions in the following areas:

a molecular diagnostics and gene cloning
b molecular marker assisted selection for breeders at DR&SS and others Seed Companies.
c hands-on training for breeders. In addition to formal university training, these lab has co-ordinated. A training workshop on "Biotechnology and Genetic Engineering held at the University of Zimbabwe from 6 to 20 December 1993. Scientists from agricultural research institutions attended the workshop.

4.1.8.6 LAB EQUIPMENT

DNA manual sequencer	ZWS	10 000
Electrophoresis equipment		15 000
High speed centrifuge		500 000
Ultracentrifuge	1	000 000
Cooled centrifuge		40 000
Bench centrifuge		25 000
Microfuge		30 000
Ultrafreezer		17 000
Pulsed field gel electrophoresis unit		40 000
Polaroid camera and transilluminator		5 000

PCR
Fraction collectors for column chromatography
Two fridges
TV monitor, VCR and Camera

4.1.8.7 NEEDED EQUIPMENT

UV visible spectrophotometer
Vertical pulsed field gel electrophoresis system
New ultracentrifuge
Special rooms: culture room, dark room
Fermenter
DNA synthesizer

4.1.9 DR S FERESU'S LABORATORY

Dr Feresu is by training a bacterial taxonomist and is presently in the second year of her 3-year Chairmanship of the Department of Biological Sciences. She is the author of the Biosafety Guidelines for Zimbabwe and her laboratory is engaged in research on both traditionally and commercially fermented milk, and studies on cattle aborting bacteria of the *Leptospira* genus.

The fermentation of unpasteurised milk is routinely carried out in the rural areas of Zimbabwe to produce a thick, yoghurt like product which is consumed with the staple sadza or various melons. A similar product called "Lacto" is produced by the Dairy Marketing Board using starter cultures which are regularly imported from Denmark. This product is routinely purchased by both urban and rural dwellers. Dr Feresu's work has entailed comparisons of Lacto with the traditionally fermented product, and isolation of bacteria from both. The ultimate objective of this research would be to locally produce a starter culture which can be used by organisations such as ADA and perhaps CA farmers as well. However, the acceptability of such a product to CA farmers might be difficult given that all of them ferment their milk traditionally and are likely to have a taste preference for their own product.

Some studies on cattle aborting bacteria of the genus *Leptospira* has been undertaken primarily with the objective of characterizing local isolates. It is important to note that most vaccines used in Zimbabwe are based on European or US serotypes and may therefore not be very effective in controlling diseases incited by local isolates. A better understanding of local pathotypes could therefore be very useful in establishing the basis for production of more effective vaccines. However, the importance of this work should be viewed in relation to the other threatening cattle diseases for which there already are vaccines. Unlike the milk fermentation project which has some potential for CA farmers and ADA, this project is more likely to be beneficial to commercial interests engaged in vaccine production.

Constraints to Dr Feresu's laboratory include funding, trained and experienced personnel. At present she has only one research assistant and is a co-supervising a Zimbabwean student who is doing a Ph.D. in Norway. Her manpower requirements are one technician, 3-4 graduate level assistants and at least one Ph.D. level graduate. It should be noted that her laboratory is set up mainly for bacteriological work.

4.1.10 DEPARTMENT OF CROP SCIENCE

Dr I. Robertson's Laboratory

4.1.10.1 TISSUE CULTURE

Located in the Crop Science Department of the Faculty of Agriculture, Dr Robertson's Lab has developed tissue culture expertise, especially clonal propagation in vitro, or micropropagation. The crops they are working with, specifically to propagate disease-free material, include sweet potato, cassava, strawberries and potatoes and coffee. The target group is the small scale farming community, bearing in mind that it is difficult for these farmers to maintain their own stocks.

So far a few diseases have been controlled by meristem culture. For potatoes, this includes the leaf roll virus, the PVY virus and Pseudomonas bacteria. Potential exists for control of : PVX, PVS and PVA. For cassava, the African Cassava Mosaic Virus (ACMV) has been controlled. Some viruses have also been eliminated in sweet potato, and potential is there for viral elimination for strawberries.

Disease-free material released or sold to farmers remains so only for that season. Thereafter, yields gradually decline as seasons advance. Up to 100% increases in yield have been realised through use of disease free planting materials developed by micropropagation.

Each of Dr Robertson's six students are working on specific projects. They have developed a system of rapid clonal propagation using somatic embryogenesis. This involved isolating protoplasts and regenerating them from somatic embryogenic calluses. They are also working on micropropagation in potatoes. A whole system of virus elimination, screening and propagation has been developed.

The sustainability of the project depends on funding. This lab is basically funded by the Netherlands government. However, the project can self-sustain on a commercial basis. The problem is the low income level of the target group: the small scale farmers. Therefore external funds are necessary.

4.1.10.2 CONSTRAINTS LIMITING PROGRESS

Availability of consumable, access to literature(eg. access to AGICOLA).

Genetic Resources

Superior varieties and good traditional cultivars.

4.1.10.3 LAB EQUIPMENT

Constant temperature growth room
-20 degrees c refrigerator
4 degree refrigerator
Incubators
Flow cabinet
Pipette washer
Ovens
Autoclave
Microwaves
Stirrers
Ph meter
Chemicals and other consumables

4.1.10.4 NEEDED EQUIPMENT

Easier access to consumables like chemicals, micropippettes etc.
Cold rooms
Incinerators
-70 degrees C refrigerator
More efficient waste disposal facilities.

4.1.10.5 RECOMBINANT DNA TECHNOLOGY (MOLECULAR BIOLOGY)

A separate molecular biology laboratory has been constructed in the Crop Science Department as extra efforts are now being directed towards developing expertise in recombinant DNA techniques. This lab is now capable of doing RFLP analyses and Southern Blotting, as well as PCR based analytical methods like RAPDs. They are already doing some gene cloning. Transformation with the GUS marker gene has been successful with sorghum and sweet potato using Agrobacterium method. Success with sorghum gives hope for cereals where generally this method has proved difficult. Some success has been realised in transforming tobacco with the GUS gene using the an adaptation of the biolistic particle gun. No useful gene has been transferred yet.

Attempts are being made to transform cassava with the coat protein gene for resistance to the African Cassava Mosaic Virus (ACMV), but the transformation technique for this crop still needs to be refined. They also attempted to clone the gene for resistance to *Cladosporium* disease of tomato.

Again the sustainability of the project depends entirely on donor funding until transgenic lines are produced from which royalties can be claimed. Current donors are the Netherlands Government in addition to a UZ research grant.

4.1.10.6 CONSTRAINTS LIMITING PROGRESS

Further basic training is needed, as well as exposure to established laboratories abroad. The lab is not yet fully equipped (see inventory section), and ways should be developed for easier access to consumables. Access to literature is desirable, eg. subscription to EMBO, CELL, PMB etc.

4.1.10.7 GENETIC RESOURCES

A tobacco transgenic line with the Bt gene is available. A sorghum line and a sweet potato line with the GUS marker gene have been established. A few genes are available in constructs, including the coat protein gene against the leaf roll disease, Bar herbicide resistance gene, Bt gene, HPT, TPSPEC, TMS, NPT, Kanamycin, Cre, and DPTH-2.

4.1.10.8 MANPOWER AND CAPACITY TO SERVE OTHER INSTITUTIONS

Since Dr Robertson's emphasis is in tissue culture, another professor with strong molecular biology background is essential to satisfy the management capacity. There is an MSc Biotechnology Department of the Faculty of Science. A molecular biology lecturer is needed.

All current PhD students are locally trained, but will go for short courses abroad. So far 8 students have graduated with MSc in Biotechnolgy, while 15 are enroled this year. In addition to Dr Robertson's 6 students, there are four lecturers in the Crop Science Department with some expertise in biotechnology.

It is part of the UZ's mandata to provide other institutions with organisational, technical and scientific advice. Dr Robertson's lab can provide the following technical services:

a. micropropagation of plant materials
b. Plant hormone Analysis
c. Molecular marker assisted screening/selection
d. Transformation and regeneration (still being developed).

4.1.10.9 LAB INVENTORY

Plant growth chamber
oven
PCR machine
Centrifuges
Flow cabinet
Bench top darkroom
Electrophoresis equipment
Camera
Electroporator

4.1.10.10 NEEDED INVENTORY

Pulsed field electrophoresis equipment
DNA and Protein Sequencers
DNA Synthesizer

4.1.10.11 DEPARTMENT OF BIOCHEMISTRY

Professor Chetsanga's Laboratory

The research work going on in Professor Chetsanga's laboratory is focused on studying the molecular biology of hepatitis B virus (HBV) and its involvement in the etiology of hepatocellular carcinoma (HCC).

Zimbabwe is in a region that is endemic for HBV. The countrywide screening that has been done has shown that about 8-12% of the Zimbabwe population is infected with HBV and is thus at risk for HCC.

In terms of cancer incidence, HCC in Zimbabwe comes fourth after cervical carcinoma, oesophageal carcinoma and skin cancer. In terms of cancer caused fatalities, HCC is the leading cause of cancer-related deaths in Zimbabwe.

The HBV project is at present involved in characterising the DNA of HBV (HBV DNA). This is being pursued by cloning the DNA in the plasmid PBR 322 and propagating in E. Coli. A number of HBV isolates have been subjected to this treatment for further analysis.

They would like to sequence the DNA of these isolates to determine if there is much nucleotide polymorphism. They are particularly interested in the pre-S and S-gene regions of the HBV genome. This region codes for the surfaced antigen (HBsAg) which has immunogenic properties. The S-antigen has been used as a vaccine. They have been amplifying the pre-S and the S-gene region by the polymerise chain reaction (PCR).

They now want to determine the nucleotide sequence of the S-gene of a number of HBV isolates and compare them with the sequences of the isolates from other parts of the world. This will enable them to determine the degree of variation in this region. They want to generate a database on the S-gene nucleotide motif and try to construct new clones from it. The S-genes from the clones will be propagated in an expression vector. The S-protein recovered from the expression host will be assayed for its immunogenic properties.

These analytical procedures will be used to generate a database on the S-gene system from which investigations on immunogenicity predictions can be done. There is thus great scope to this project. The techniques that they have now acquired will be shared with agricultural bitechnology in Zimbabwe. They hope that such sharing of new technology will expedite the diffusion of biotechnology into more and more Zimbabwe research laboratories.

Nationally the lab collaborates with Dr Tswana of the Medical Microbiology lab. Internationally they collaborate with Nagoya City University Medical School, Japan.

4.1.11.1 CONSTRAINTS LIMITING PROGRESS

With equipment worth over ZW$1 million, the lab is relatively well equipped, but some extra equipment is still needed. Lack of access to literature and some relevant databases e.g. access to gene bank is sometimes limiting. In addition, financial support is needed for students.

4.1.11.2 MANPOWER REQUIREMENTS AND CAPACITY TO SERVE OTHER INSTITUTIONS

Currently the lab is run by one PhD. scientist. Two more PhDs are required, preferably by staff development training abroad. The lab can accommodate five post-graduate students.

The lab is in a position to collaborate with agricultural institutes interested in doing biotechnology projects. Examples are:

a. They can do molecular biology diagnostic in collaboration with the Crop Science Department, Biological Sciences Department and DR & SS,
b. Gene isolation, sequencing and expression in vectors,
c. Participation in training programmes and workshops.

4.1.11.3 EQUIPMENT AVAILABLE

Biorad manual sequencer
IBM PC and digitizer for sequence analysis
Vacuum oven
Gel drier large format
Biorad vertical electrophoresis system
Bench top incubator 25°C - 40°C
Horizontal electrophoresis tanks (4 minigels)
MP4 camera for instant gel photography
Two ultracentrifuges
Two large autoclaves
Microcentrifuge (Eppendorf)
Laminar flow hood for PCR work
Scintillation counter
PCR machine - Eppendorf microcycler

4.1.11.4 EQUIPMENT NEEDED

Shaking waterbath (0-90°C)
Shaker incubator
UV transilluminator
C-D-ROM driver for IBM comparable with gene bank database
ELISA plate shaker
Laser printer for IBM compatible
Refrigerated microcentrifuge (Eppendorf)
IBM PC for word processing
Micropipettes (3 sets of Gilson - all sizes)

4.1.12 DR READ'S LABORATORY

In terms of plant molecular biology, there are a few projects underway in this lab. Dr Sithole is supervising a PhD project on molecular characterization of some Zimbabwean cowpea viruses. In Zimbabwe over 90% of small scale farmers produce cowpeas for both consumption and sale. The ultimate objective of this project is to confer viral resistance to cowpeas using genetic engineering. The procedure is first to sequence the complete genome of one viral strain. They will then focus on the coat protein gene for possible manipulation to engineer viral resistance. The whole process will involve isolation of genomic DNA and generating DNA clones.

Dr Sithole is also working with chloroplast genes. There is an interest in possible transfer of RNA genes. So far they have looked at genes that code for the two proteins involved in the synthesis of the photosynthetic pigment that can fix herbicide resistance, and now these interact with the coat protein gene.

There is also research going on with plant proteins. They have identified and purified a lectin from Mukwa (Pterocarpus angolensis) specific for fetal red blood cells. This has a possible place in blood transfusion. This lectin was isolated using a DNA probe from pea lectin.

This laboratory is also involved in Biochemical Engineering. There is Protein Biotechnology Group composed of Dr Read, Dr Zvauya and Dr Binhura. Dr Zvauya is working thermophillic bacteria, looking at possible exploitation of the enzymes. One post graduate is using sorghum for ethanol fermentation.

Dr Read's work involves insect pheromones and lipids, membrane biotechnology (medical) and research on seed proteins including lectins. There is also work on the importance of lipases in organic solvents for organic transformation e.g. modification of triglycerides.

Dr Binhura has emphasis on enzyme technology. He is using enzymes in analytical procedures to determine polymer structures of various carbohydrates. Apart from using commercially available enzymes they also prepare some in their lab. In addition, they use enzymes to try and modify polymers for commercial application.

There is also research in immunotechnology at a fairly basic level. On the medical side, they are characterizing Schitozome antigens and the related immunoresponse. On the veterinary side, in collaboration with Veterinary Services, they are characterizing tick fever antigens for development of antibodies for Ostrich, Rhinocerus etc. i.e. preparing anti-antibodies. This is an example of interaction between wildlife and the cattle industry.

This lab would like the NBF to be instrumental in sourcing funds to set up a basic lab with standard equipment to analyses vegetable oils etc. e.g. for aromatic plants for export..

There is close collaboration with Biological Sciences and Crop Science Department. Internationally, linkages include cooperation with the University of Lund and University of OPSOL in Sweden.

4.1.12.1 CONSTRAINTS LIMITING PROGRESS

This lab is relatively well equipped with good funding from SAREC and UZ research grants. However, a few important equipment are needed (see inventory section). Availability of chemicals and consumables is still a problem, but most can be obtained through OGIL. Poor access to databases and the gene bank hampers progress.

4.1.12.2 MANPOWER AND CAPACITY TO PROVIDE SERVICE TO OTHER INSTITUTIONS

There are four PhD scientists in this lab, which is somehow adequate, but there is a need for a full-time PhD level lecturer in molecular biology, to complement Dr J. Sithole's efforts.

This lab has the capacity to assist other institutes in the following ways:

a. diagnostic procedures recombinant DNA techniques like RFLPs. RAPD's etc.
b. analysis and modification of complex carbohydrate molecule
c. protein analysis: structure and amino acid sequencing
d. potential to analyses oils
e. DNa sequencing and manipulation

4.1.12.3 LAB EQUIPMENT

2 Computer controlled fermenters
An upright autoclave
bench shaking incubator
2 shaking water baths
HPLC
Column Chromatography
GLC
Amino Acid Analyzer
DNA sequencer (Manual)
Bench top centrifuges
Gel Electrophoresis System
Required Inventory:
DNA synthesizer
Protein Synthesizer
Freezer Drier
Gas chromatography: lipid and Carbohydrate Analysis

4.1.13 DEPARTMENT OF SOIL SCIENCE

Details of the work being carried out on symbiotic N-fixation by Mr Mpepereki. a PhD. student, could not be obtained as he was away in the US. However. in a report prepared by Professor Chetsanga. the following were listed as research areas:

- Determination of Rhizobia populations in a wide range of soils
- Isolate collection and preservation
- Characterization of isolates with regard to growth on different media
- Examination of effectiveness of different host-strain combination
- Field trials using selected strains and crops

4.1.14 HARARE POLYTECHNICAL COLLEGE

The Polytechnic previously offered City and Guilds (UK) level technical training for students aspiring to be technicians. More recently though. City and Guilds has been replaced by National Diploma in Biological Techniques. Chemistry. Horticulture. Chemical Technology and Physics Technology.

The course in Biological Processes provides the students with some training in microbiology and biochemical tests. Practical classes include biochemical testing for proteins (Kjeldah analysis), fats and amino acids, and microbe isolation and culture. Facilities such as autoclaves and incubators are available but the students have no access to laminar flow cabinets. Microbiological work is undertaken by using bunsen burners and thorough desk swabbing. Virtually no biotechnology is taught although basic fermentation is given some attention in the Chemical Processes Course.

For all course, students have to complete a project in their field of interest. It is possible, for example, for a student to undertake a tissue culture project provided he/she can source the required materials and laminar flow cabinet. A student from National Breweries is presently engaged in such a project using facilities available in the Quality Control laboratory.

The main issue is whether students qualifying with a National Diploma are capable of providing good technical assistance in biotechnology laboratories given that several of the interviewed scientists identified lack of trained technicians as a constraint to their research. It would appear the level and scope of training at the Polytechnic does not adequately equip students for assistance in biotechnology laboratories although the outstanding and dedicated students can undergo appropriate in-house training. Therefore, there is likely to always be a need for biotechnology laboratories to implement their own training and, if possible, send their most promising technicians for external courses. Thereafter, the ability to retain qualified and experienced technical staff could be problematic. One of the public sector scientists interviewed commented about the problems associated with the resignation of a technician who had recently been sent on an external course.

4.1.15 SCIENTIFIC AND INDUSTRIAL RESEARCH AND DEVELOPMENT CENTRE (SIRDC)

At a meeting between the Research Council of Zimbabwe (RCZ) and the Permanent Secretaries of the Ministry of Energy, Water Resources and Development (EWRD), Public Construction and National Housing (PCNH) and the then Ministry of Industry and Technology (IT), in February 1989, a proposal to establish a National Scientific and Industrial Research and Development Centre (SIRDCO) was approved. The five research institutes to be established during Phase I are as follows (with an Administrative complex and Allied Services Buildings):

a) Building Engineering Institute
b) Microelectronics Institute
c) Biotechnology Institute
d) Energy Institute
e) Mechanical Engineering Institute

The centre is headed by a Director General (Prof Chetsanga), and each institute has its own director. The research institutes are all intended to provide R & D services to relevant industries in both the private and public sectors. SIRDC will be situated in Ratcliffe, and [illegible] will be provided by government.

4.1.16 BIOTECHNOLOGY INSTITUTE

The Biotechnology Institute will occupy a total area of 10 ha inclusive of building complexes and research plots. It should be operative from 1995/96, having about 12 scientists and 24 technicians.

The institute will undertake R & D activities designed to help improve agricultural production and promote the development of medical and industrial biotechnology. Its main functions will include:

a) Research into applied animal and plant genetics with a view to producing species that are adaptable to the varied Zimbabwe environment.

b) Develop crop varieties suited to growth in marginal areas of Zimbabwe. including those crops that will benefit the small scale farmer.

c) Develop expertise and provide services in food processing (food science and technology to enable rural community enterprise and the food industry to beneficiate Zimbabwe agricultural commodities.

d) Develop new diagnostic tools and vaccines for animal and human health. as well as developing technologies and processes that will promote the growth of biotechnology industries in the country.

e) Provide technical expertise in collecting the germ plasm of endangered species as well as in establishing and maintaining a gene bank.

f) Take initiative and adapting biotech to local needs and applications.

g) Contribute to adequate national and international legal procedures on issues related to biotech (biosafety and intellectual property rights protocols).

The institute, although built by government money, will be equipped by donor money, with the Dutch as the key players. Efforts will be made to be sure of easy availability of chemicals, consumables and other equipment on OGIL. The Institute of Chemical Engineering will take charge of reducing dependence on foreign trade eg ethanol from sugar-other related chemicals will come from that.

4.1.17 MANPOWER

Although to start with the majority of the scientists will be expatriate.. gradually the Institute will have a full compliment of local scientists. Salaries will be competitive to increase retention. Staff development up to post doc level will be part of the programme.

4.1.18 INTERACTION WITH NBF

SIRDC's Biotechnology Institute will work with NBF to encourage establishment of a Biotechnology Network of Zimbabwe, to link up users of biotech in the country and to set up priorities. The network offices can be located at the centre. SIRDC advocates professional societies, and there is a possibility of a journal on biotechnology to evolve. Collaboration with APBNet, IPBNet and African Academy of Sciences is recognized.

On the issue of biosafety, there is need to identify a committee to streamline the current proposal. SIRDC is not too keen to push the legal aspects, but realized the need for scientific guidelines. Zimbabwe will be a signatory to conventions which will promote biotech development in the country. Organisations like UNIDO need to be considered critically.

5. AGRICULTURAL AND TECHNICAL EXTENSION SERVICES (AGRITEX)

The Department of Agricultural and Extension (AGRITEX) in Zimbabwe's Ministry of Lands, Agriculture and Rural Resettlement (MLARR) is the vehicle for extension of research to all the farmers, and is particularly important for extension to the small scale farming (SSF) community. In addition to extension, AGRITEX is well placed to provide a feedback service on the constraints limiting agricultural production in the rural areas.

AGRITEX has three divisions: Field Division, Agricultural Engineering Division and Technical Division, each headed by an Assistant Director responsible to the AGRITEX Director. The Field Division is the one with the primary responsibility for extension of research results to the farmers.

The efficacy of service organizations like DR & SS, AGRITEX, UZ Seed House etc. and the interaction between these critical to the alleviations of constraints limiting production in the rural areas. AGRITEX is faced with understaffing in terms of manpower needed to effectively translate technology to the SSF's. The current extension worker to SSF ratio is 1:400-600; yet the ideal ratio should be about 1:50. The Field Branch, responsible for the provision of technical, professional, and managerial extension service to all farmers, had got 45 (from a possible 49 posts) District Agricultural Extension Officers (DAEOs), 24 with BSc and 25 with MSc degrees. A total of 55 DAEOs are required, and 12 more need to be trained to MSc level by 1995. The same branch has 188 (from a possible 196 posts) Agricultural Extension Officers (AEOs), 65 of which have MSc degrees. A total of 215 are required, and 65 more need to be trained to MSc level. The BFZ can play a crucial role in organizing a scholarship fund for AGRITEX to improve the extension service in the country.

AGRITEX has linkages with DR & SS, District Development Comities from village, ward, District Province, as well as with the private sector. It also organises workshop and field days where relevant parties are invited. Interaction with the University is good, and several joint projects are underway.

On a regional level, AGRITEX interacts with the Early warning Unit, Army worm and locust control, Foot and Mouth Control and seed distribution.

6. PARASTATALS

6.1. Tobacco Research Board (TRB)

Constituted as a statutory body in 1950, the function of the TRB are to control and direct tobacco research in Zimbabwe. Its work encompasses investigations of all aspects of flue-cured barely and oriented tobacco production. In the past, investigations on cigar tobacco and N rustica have also been done. It conducts research in breeding, agronomy, physiology, pathology, nematology, soils and chemistry. LSC farmers who provide considerable funding for the TRB are the main target group although RPFs are also catered for through research in burley and oriented tobacco, and studies on appropriate curing systems. The very high cost and strict management requirements of tobacco trails are major obstacles to on-farm studies.

Although the breeding programme is based mainly on conventional techniques, tissue culture has been used to overcome some interspecific incompatibility barriers and, more importantly, in the development of the doubled haploid cultivar Kutasanga 110. Of recent, cytosplasmic male-sterility has assumed increasing importance in hybrid production.

The TRB is unique in that it has established a biotechnology department which is tasked with developing a variety of new and novel techniques for the genetic improvement of tobacco and transformation of local materials. This department was formed in 1991 and will be officially opened in April. Extensive instructure development costing over Z$2.6 million is nearing completion and approximately Z$1.3 million will be spent on equipment. Greenhouses facilities for controlled testing of transgenic plants are budgeted at Z$200 000 and awaiting final approval. When complete, the department will be very well equipped and staffed to undertake a wide range of biotechnology projects.

The biotechnology department collaborates closely with academic institutions in South Africa, Monsanto, the University of North Carolina and BFZ. There are excellent prospects for further national collaboration provided interested parties adhere to certain conditions.

Research projects currently listed for the department include studies on:

1. The response of plant regeneration from leaf discs to cytokinin concentration.

2. The effect of kanamycin concentration on caulogenesis and callogenesis

3. Establish of protocols for routine transformation of local cultivars.

4. Transfer of a Bt toxin gene for insect resistance from E coli to a plant vector

5. Development of male-sterile lines by asymmetic protoplast-cytoplast fusion

6. In vitro nodal propagation of planting material.

The department does not intend to engage in high-level molecular biology such as gene isolation and identification. Rather, it proposes to acquire useful genes, prepare vector systems if necessary, and transform local material.

6.1.1 CONSTRAINTS

At present the department is well funded and not experiencing any meaningful constraints. However, staffing is still in progress. The need for highly competent technical personnel is of some concern.

6.1.2 GENETIC RESOURCES

The TRB is well endowed with genetic resources which include imported material, mainly from the US, and a very number of lines derived from its breeding programme. A collection of wild species and local landraces is also maintained.

The Biotechnology Department has access to the latest cultivars and any promising varieties and hybrids. It has also acquired the tabtoxin self-protection (Ur) gene cloned from Pseudomonas syringe pv. tabaci and a Bt gene. Various constructs are available or will be developed in the department.

6.1.3 MANPOWER AND CAPACITY TO SERVE OTHER INSTITUTIONS

The department consists of Dr Cole (Head), Dr Kassianoff, Mr Matibiri (on Ph.D study leave at Wye College) and a well-trained technician. Further staffing is envisaged with Zimbabwean students at South African universities being the main target due to the lower costs and relatively easy availability.

The TRB is willing to host experienced local scientists in its Biotechnology Department to work on projects which are consistent with its line of work and activities. However, adequate compensation would have to be paid for this service. With appropriate authorization, scientists from the department may be able to assist other institutions by providing advice on scientific matters and setting up of biotechnology facilities. Mr Matibiri is presently completing his PhD in Dr Sinclair Mantell's laboratory at Wye College and should, after his return, be in a position to give useful advice on tissue culture facilities and techniques.

6.1.4 INVENTORY

A complete inventory of the laboratory could not be carried out as it is still in the process of acquiring most of its equipment. At present it has excellent tissue culture facilities. When complete, it will have PCR and various other facilities for DNA work.

6.1.5 REQUIREMENTS

The department still requires an isolation greenhouse for initial testing of transgenic plants but should acquire one soon. the most pressing requirement is for highly competent technical staff. Funding is still adequate.

6.1.6 TRICHODERMA PROJECT

Another TRB biotechnology project that could be relevant to RPFs centres around its work on Trichoderma harzianum (strain T77). Investigations have shown that certain Trichoderma strains can control Rhizoctonia which is responsible for damping off in several crops. In addition, it has been found to have a growth stimulating effect on tobacco seedlings. This technology has been patented and is now under commercial development by a local agro-chemical company. Apparently there is considerable demand for this myco-fungicide from some tobacco farmers and horticultural concerns. It would appear to have potential for use in seedbeds and intensive high-value crops. As regards RPFs, there may be some prospects for its use by those farmers engaged in high-value intensive cropping or nurseries. However, as in the case of legume inoculants, the development of an appropriate carrier system will be critical to success.

As regards cultural acceptability, environmental-friendliness and sustainability, there are only two tobacco projects that are worth mentioning. With regard to the Bt project which is still in its infancy, the situation is likely very similar to that for cotton as discussed previously in the section on the Cotton Research Institute. The second project on transgenic resistance to wildfire and angular leaf spot is unlikely to raise any significant issues in terms of cultural acceptability and environmental friendliness. Sustainability or durability of the resistance may be a technical issue as it often is, even in instances where conventional host-plant resistance is exploited. Both projects are highly unlikely to have any effect on the sustainable production of tobacco by RPFs.

7. AGRICULTURAL DEVELOPMENT AUTHORITY (ADA)

The Agricultural Development Authority is entrusted with carrying out state farming operations and assisting RPFs in the development and management of agricultural projects. As such, it does not have any biotechnology capacity of capabilities but could assist in the diffusion and management of biotechnology applications for RPFs. Through its work on project establishment and management and active participation in the provision of planting material for crops such as coffee, tea, bananas, paprika and tomatoes, it could assist in biotechnology transfer to RPFs.

8. PRIVATE SECTOR

8.1 SEED CO-OP

Seed Co-op research division is based at Rattray Arnold Station with a few experimental plots also located at the company's new premises at Stapleford, just outside Harare. The company is the leading seed supplier in the country. Its effort are targeted mainly to the LSc subsector although its maize breeding programmes is addressing constraints such as streak which are relevant in the CAs.

The research programmes includes the breeding of improved maize, wheat and soyabean cultivars an hybrids. Present germplasm holdings are 1000, 800 and 1000 for maize, wheat and soyabeans, respectively. The breeding programme is based on essentially the same objectives as the national programme and there is considerable exchange of germplasm between the two institutions.

Perhaps the most notable achievement of Seed co-op's breeding programme is the imminent release of maize hybrids with resistance to the streak virus. The host plant derived resistance emanates from three sources which, in combination, impart very effective resistance against the virus.

Seed Co-op does not have the facilities nor personnel for research and applications in biotechnology and hence would have to reach technical agreements in order to undertake any biotechnological work. It has, over the last three seasons, experienced considerable difficulty with water supply such that its research programme has to be curtailed.

9. SUGAR EXPERIMENTAL STATION

The ZSA Experiment Station was established in 1966 to investigate problems associated with the production of sugarcane under irrigation in the south-eastern lowveld of Zimbabwe. It is independently financed by the sugar industry and possess well equipped chemistry. pathology and physiology laboratories.

Sugarcane improvement work is restricted to the testing of varieties obtained from other countries. Starting in 1976, a collaborative breeding agreement was reached with the South African Sugar Association Experiment Station in Natal whereby the basic breeding is done there and more advanced progenies and material sent here for testing. The material is routinely tested for reaction to smut and leaf scald. the former of which is the most important disease in the country.

The Experiment Station does not have any facilities nor the inclination to undertake biotechnology work on sugarcane. Given the most of the fundamental breeding work is done in South Africa. it is likely that any biotechnological applications would emanate from there with Zimbabwe continuing to be a test location for new germplasm and varieties.

10. AGRICULTURAL RESEARCH TRUST (ART)

The trust was established in 1981 primarily to serve the interests of the LSC farming sector. It consists of a self-supporting commercial section which produces an assortment of crops and livestock and a research section which is heavily subsidized by LSC farmers. It is located in NR Ha near Harare but has the ability and resources to carry out widespread trials, including some in the CAs.

Research undertaken at ART is largely by contract although it does undertake some research on wheat as a service to DR & SS. contract research includes mainly variety evaluation and agronomic studies for crops such as maize, passion fruit, barley, wheat mango tout. etc. It is important to note that starting in 1990/91, ART initiate CA Maize Hybrid trials in Chiweshe. Dotito and Musana all located in NR II and demonstrated and CA yields can be dramatically improved by applying agronomic practices and management.

In 1992 carried out first trial on Bambara nut varieties due to increasing interest in the crop mainly for export to neighbouring countries.

As regards biotechnology. the ART neither has the facilities nor personnel to undertake any research in this areas. However. it could possibly participate in authorized field testing of transgenic [illegible] in several areas given its experience and capability in [illegible] evaluations at several sites.

11. TISSUCULT AND BROOKFIELDS NURSERY

Trissucult is a privately-owned plant micropropagation unit established to produce high-yielding and ostensibly disease-free foundation stock for the horticultural industry. Its main clients are LSC farmers producing mushrooms and various horticultural crops. Recently though, the laboratory received a request from a CA farmer with an interest in cut flower (Alstomeria and carnations) production. The company is managed by Ms J Tiffin who has considerable experience in tissue culture after training at Michigan State University and Fort Collins, Colorado. Two in-house lab assistants provide technical support.

The following plants have been, or are presently propagated commercially: bananas, strawberries, carnations, chrysanthemums, coffee, rasbery, potatoes, hops, asparagus, orchids (germination from seed), leather leaf fern, asters and Johannesburg Gold. Experimental projects which have been undertaken or are in progress include propagation work on grapes, Alstroemaeria, Jatropha curcas, cucumber, blueberry and ornamentals.

Although a major objective of the lab is disease elimination by meristem culture, sometimes including thermotherapy, it cannot guarantee disease elimination to the unavailability to testing facilities. It is envisaged that the new facility being set up at the Horticultural Research Centre in Marondera or the University of Zimbabwe may soon be able to undertake ELISA testing of material to ensure that it is disease free.

11.1 CONSTRAINTS

The major constraints are:

- lack of a suitably qualified person of the calibre and training of Ms Tifffin to assist and co-manage the tissue culture laboratory, particularly during her absence
- A greenhouse for use in the post-hardening phase of seedlings
- An insect-proof greenhouse for housing ostensibly virus-free mother plants
- An insect-proof greenhouse ostenbily virus-free mother plants
- ELISA facilities and adequately trained and experienced to undertake indexing
- A general upgrading of the growth room facilities is also required to overcome problems with mite and other infestations.

11.2 MANPOWER AND CAPACITY TO SERVE OTHER INSTITUTIONS

The tissue culture laboratory managed by Ms J Tiffin who received training in the US. Assistance is provided by two "O" Level graduates who have been trained in the laboratory. Although understaffed, the laboratory is willing to consider contracted projects. There are also prospects for training of tissue culture technicians from other institutions. The TRB has in the past sent a few of its junior staff for orientation and training here.

11.3 INVENTORY

The laboratory was established with equipment obtained from Delta Operations after the demise of its hop propagation operation. As such, it is well equipped to undertake tissue culture work and some thermotherapy treatment of cultures meristem. It is equipped with four laminar flow cabinets, 2 autoclaves, a "hot box" for thermotherapy treatment, balances and has sufficient illuminated growth room space for 200 000 plantlets. It has a very good stock of chemicals and is able to source more from a local company.

11.4 REQUIREMENTS

The following are required:

- Funding for refurbishment of the growth room facilities
- Highly qualified assistant
- Post-hardening phase greenhouse and insect-proof screenhouse
- Easy access to ELISA facilities for virus indexing

12 PIONEER HYBRID INTERNATIONAL

This US-based seed company has been active in Zimbabwe for some time now primarily with interests in hybrid maize. However, company officials declined to complete a questionnaire on their activities.

13 CARGILL

Cargill is a US-based agribusiness company which has only recently (1991) established itself here. Its interest are in mainly hybrid maize, as well as sunflower and sorghum. At present it is in the process of establishing itself here with the acquisition of land for a centre and more widespread breeding and testing.

Its objectives with regard to maize are yield level and stability, resistance to foliar diseases such as maize streak and Helminthosportium, standability, resistance to cob diseases and ear placement, and adaptation to marginal environments characterized by moisture deficit and management limitations.

The company maintains that there may be some prospects for it to in biotechnology transfer given that it does have fairly extensive affiliations with US and European seed companies and research laboratories. However, such transfer via its products would require proprietary protection and be in the business interest of the company.

The company's crop improvement exercise in Zimbabwe is presently based on conventional breeding techniques and hence it cannot as yet participate in the biotechnological research and applications.

14 PANNAR

Pannar is a South Africa-based plant breeding and seed company which has been operational in Zimbabwe since 1982. Its interests include white and yellow maize, hybrid sunflower, hybrid red and white sorghum, soyabeans, drybeans, forage sorghum, triticale, forage millet, lucerne, wheat, groundnuts and barley. Its major thrust in Zimbabwe is on hybrid maize although some inroads into white sorghum primarily for CA consumption. All its breeding work is undertaken in South Africa; only widespread testing of advanced material is carried out in Zimbabwe. The company presently commands about 20% of the hybrid maize market.

As regards biotechnology, the company has recently established a biotechnology laboratory in South Africa to bolster its conventional breeding programme. Details of the activities of the laboratory are scanty at present. However, it is interesting to note that one of the main objectives of the biotechnology laboratory will be the fingerprinting of Pannar material for proprietary protection.

15 AFRICA UNIVERSITY

Prof. Muphuru, Dean of the Faculty of Agriculture at Africa University, Mutare, envisages that in the short term, his faculty will be involved with biotechnology only in as far as it fits in with tissue culture work of horticulture. Liaison with Dr Robertson's lab and HRC in this respect is imperative.

Currently there are no facilities for any biotechnology research. It is intended that biotechnology related courses will be incorporated into the academic curriculum.

16. NON-GOVERNMENTAL ORGANISATIONS

16.1 Environmental and Development Activities (ENDA)

The non-governmental organisation ENDA is engaged in a number of activities relevant to RPFs and is also tasked with housing the National Biotechnology Forum (NBF) Secreteriat. Its objectives are:

1. To conserve and encourage use of locally adapted indigenous germplasm, particularly that of small grains in drought-prone areas.

2. To document indigenous knowledge of farmers

3. To undertake on-farm germplasm characterization and evaluation

4. To undertake basic small grain improvement by mass selection in collected populations

5. To produce and supply seed of open-pollinated varieties. In this regard, it is important to note that it is now producing some small grain seed for Seed Co-op.

ENDA has spearheaded small grain and maize germplasm collection in the CAs and presently holds about 195 samples. Some of these have been made available to the CBI. One of its concerns as regards sorghum and millet breeding is that "local checks" have not been included in on-farm trials. Hence, it is argued that there is need to ensure that improved varieties developed on-station are compared with niche-specific adapted varieties which have been selected and retained by RPFs.

ENDA owns a 17 acre smallholding near Harare and is considering the establishment of a tissue culture facility to primarily service the needs of RPFs. It is envisaged that such a facility could produce disease-free planting material for RPFs and also provide a service to other farmers. Non-RPFs would be expected to pay for all services and thereby generate income for the facility.

16.2 ZIMBABWE FARMERS UNION (ZFU)

The Zimbabwe Farmers' Union (ZFU) was formed specifically to look after the needs of the resource poor farmers. Out of 1 million people affiliated with ZFU only 52 000 are resettled. 12 000 small scale (in former APA), and the rest are communal area farmers.

According to ZFU, their farmers are faced with the following problems:

a. Transport availability and costs
b. Power supply : No electricity
c. Poor financial resources : loans availability and accessibility and viability
d. Unfavourable pricing policies for the more "suitable crops"
e. Low rainfall. Unreliable. 65-70% of farmers are in NR III, IV and V
f. Lack of good drinking water

ZFU is very instrumental in influencing government to act in favour of resource poor farmers, thereby solving the imbalance previously prevailing. The organisation needs money to train and employ experts in fields like irrigation and livestock management. In addition it needs people who can adequately represent the farmer. It is faced with a problem of high staff turnover. Salary packages need to be reviewed to increase staff retention.

16.3 BIOTECHNOLOGY FORUM OF ZIMBABWE (BFZ)

The BFZ was established in 1992 with its main objective being to stimulate, organise and coordinate biotechnology activities which are relevant to RPFs in Zimbabwe. In this regard, it is intended to serve as a forum for interaction between scientists, farmers, policy makers, rural development organisations, NGOs and extension workers. Its Secretariat, whose function is to facilitate coordination of biotechnology activities and disseminate information to relevant parties, is to be housed by ENDA.

The consultancy is of the opinion that the BFZ co-ordinator should immediately undertake the following tasks:

1. Detailed documentation of biotechnology research output in Zimbabwe. In this regard, all thesis and scientific publications relevant to biotechnology should be documented. In addition, an attempt should be made to document the work being undertaken by externally-based Zimbabwean students working in biotechnology. This exercise will provide more useful and sound information on the capability of Zimbabweans to undertake biotechnology projects.

2. Contact organisations and institutions that are in a position to provide information for a national database in biotechnology with the objective of providing up-to-date information to interested parties. Use of CD-ROM facilities at the TRB and UZ should be considered. In addition, the Biotechnology Information Centre in the US and similar organisations should be contacted to determine if they can assist in this operation and provide detailed information on the status and availability of biotechnology expertise and products from the Netherlands.

From interviews with scientists in different labs and institutions, the following areas emerged as possible areas of collaboration with the BFZ:

- Establishing linkages (networking):
  There is a general consensus that a biotechnology network needs to be established in Zimbabwe. The BFZ will not necessarily be the network, but should be part of it and has the potential to act as the major co-ordinator to effect its establishment. It will link up policy makers, researchers and scientists, farmer organisations, NGOs, extension workers and the farmers.

  Linkages with the African Plant Biotechnology Network (APBNet), African Academy of Sciences, the International Plant Biotechnology Network (IPBNet), the Agricultural Biotechnology For Sustainable Productivity (ABSP) project, UNIDO, ISAAA, DGIS and other biotechnology networks should be strengthened.

- organising seminars for scientific interaction, as well as financial assistance for biotechnology training workshops.

- Fusing commercial, government and academic institutions in research efforts. The BFZ can be very instrumental in negotiating with the government to facilitate easy access to consumables, like chemicals and enzymes required in biotechnology work,with minimal customs hustles, preferably through OGIL.

Financial sourcing for buildings, equipment, and training.

The aspect of training should include highly specialized training at phD and post Doctoral level in the fields of tissue culture and genetic engineering, as well as training at the Technical level.Training of extension staff is also important.
Assistance is also required in updating a biotechnology database.

Streamlining of regulatory protocols involving biosafety issues and intellectual property rights.

Further,because Zimbabwe is a small country, it is important to appreciate that the ramifications of biotechnology applications could be widespread and thereby possibly affect the situation in non-target crops. In this regard, the consultancy is adamant that the BFZ should be instrumental informing open and informed discussions on all proposed projects. Thereafter, more critical appraisal of projects can be carried out by the national BSB.

1^ INTERNATIONAL ORGANISATIONS

The international organisations of relevance to the development and application of biotechnology for EPIs are the CGIAR-funded international agricultural research centres (IARC's) CIMMYT, ICRISAT, CIAT, CPI and IITA. In addition, biotechnology transfer initiatives such as CAMBIA and ISAAA may have some relevance.

Zimbabwe generally has very good relations with the IARCs, two of which (i.e. ICRISAT AND CIMMYT) have locality-based research programmes. Because germplasm and scientific information is freely available from the IARCs, their activates in biotechnology should be very closely monitored. Although most biotechnology innovations and applications tend to emanate from the private sector or private sector-funded projects in developed countries, the prospects of acquiring "near-term" biotechnologies and relevant information from IARCs must be constantly examined.

The SADCC/ICRISAT sorghum and Millet Improvement Project (SMIP) located at Matopos near Bulawayo, conducts research on sorghum and pearl millet, in addition to a highly successful extensive higher degree training programme of the relevant scientists in the SADCC region. The team comprises of the Executive Director, Sorghum Breeder, Entomologist, Pathologist, Agronomist, Food Technologist, Training Officer and two Field Development Officers. The constraints they are working on are covered in the corp specific section for sorghum and pearl millet.

Molecular biology work on sorghum and pearl millet is being carried out at ICRISAT Center in Hyderabad, India. An Biotechnology Laboratory has been built. SADCC/ICRISAT SMIP is willing to collaborate with NARS as a bridge for any envisaged biotechnology work in sorghum and pearl millet through ICRISAT Centre. SMIP is in a position to work with transgenic germplasm in backcross programs and field testing.

CIMMYT has a collaborative project with UZ on maize research, located at the University Farm. They are developing several maize hybrids with resistance to some common insects and disease, diagnostic techniques for screening germplasm. There is increasing interest in focusing on the coat protein gene of the streak virus. A project is being developed jointly with PPRI and UZ in terms of possible manipulation of the gene and transformation of maize lines of impart streak resistance.

IITA no longer has a base in Zimbabwe, but collaborative projects are still underway. It collaborates with CIMMYT and UZ on development of streak resistance.

CIAT collaborates with CBI in cowpea breeding and germplasm exchange. These organizations may facilitate acquisition of transgenic lines of interest from their centres.

As regards the activities of CAMBIA, ISAA and other similar initiatives which are already known to most institutions and organisations engaged or interested in biotechnology, the consultancy maintains that the channel of communication between local institutions and the NBF should be utilised to:

- keep all parties fully informed on any developments in their initiatives
- evaluate the relevance and suitably of proposed biotechnology transfer projects
- provide interested or participating institutions [illegible] with sound and up-to-date impartial information [illegible]

11 BIOSAFETY ISSUES IN ZIMBABWE

Realizing that biosafety is an important issue in Zimbabwe the Research Council of Zimbabwe (RCZ) initially requested a three-person task force to draft Biosafety Guidelines for Zimbabwe in 1991. Using guidelines and other forms of regulation from elsewhere e. a draft "Proposal for Recombinant DNA Biosafety Guidelines", by Dr S. Feresu of UZ was prepared and presented at a Biotechnology Workshop in 1991. At a subsequent Workshop on Bitechnology and Biosafety Guidelines in July 1992. the proposed guidelines were discussed and revised in consultation with several participants. The amended document has been prepared and presumably constitutes the Working Guidelines for Zimbabwe. The essential aspects of the guidelines are the following:

1. A national Biotechnology Safety Board (BSB) should be constituted under the auspices of the RCZ to review proposals and ensure that appropriate safeguards are adhered to.
2. Institutional Biosafety Committees (IBCs) should be set up at each relevant institution to oversee compliance with the Guidelines.

It appears that the constitution of the national BSB has been delayed despite the submission of at least one proposal for field testing of a transgenic plant. However. a Chairman has now been appointed and it is likely that appointments to the BSB will soon be announced. As regards IBCs. only the Tobacco Research Board has formed such a committee to oversee its rapid developments.

To date only one informal proposal for the field testing of transgenic tobacco has been submitted to the RCZ for approval will shortly be evaluated in conjunction with a team of experts from the Netherlands. The evaluation of this proposal will provide an opportunity for Zimbabwean to receive some training in biosafety.

It is important to note that the important issue of the need for guidelines or legislated regulations was raised at the 1992 Workshop. Because guidelines constitute only a voluntary code of conduct which is not binding on any scientist engaged in biotechnological research, some workshop participants felt that some form of legislation is required to ensure compliance and effective BSB oversight. However, the RCZ is still reluctant to pursue legislation for fear of instigating a bureaucratic legislative bungle that could adversely affect the progress of biotechnology in Zimbabwe.

19. PRIORITY SETTING FOR BIOTECHNOLOGY SOLUTIONS TO CONSTRAINTS IN THE SMALL SCALE FARMING SECTOR

Priority setting is a complex, demanding and daunting task which should be multidisciplinary, participatory, open, interactive, continuous and iterative. In essence, it requires extensive and intensive discussions among all relevant parties. As such, the consultancy is only able to make broad recommendations and raise a number of issues that should be considered in the priority setting workshop. An appraisal of possible methodologies for priority setting is initially undertaken to serve as a basis for selection of an appropriate methodology.

19.1 METHODOLOGIES

In addition to informal "common sense" approaches based on experience, intuition and cognisance of needs, the following formal methods for priority setting require consideration. Congruence, Checklists, Scoring, Domestic Resource Cost (DRC) ratios.

Benefit/cost analysis, Mathematical Programming, Systems and Simulation analysis.

Congruence is based on allocation of resources to crops in the same proportion as their existing contribution to domestic product. Although it is generally a useful starting point for national priority setting, it is of limited value to priority setting for RPF biotechnology problem-solving.

Checklisting is based on the listing of criteria, such as feasibility, cost, comparative advantage and impact, and their associated vital questions. As such, it has modest data requirements and is therefore widely used as a starting point in priority setting. It is considered to be a very useful procedure for priority setting for RPF biotechnology problem-solving.

Scoring is essentially a more sophisticated version of checklisting in that it entails numerical weighting. This method has been used as the basis of the Assessment Model previously applied to Biotechnology for RPFs in Zimbabwe (Bunders, 1991). It also has modest data requests. It is recommended that it be further utilised in the priority setting exercise.

Benefit/Cost Analysis is perhaps the most informative but difficult to apply in its strict sense. Elements of this approach can possible be adopted in a Biotechnology assessment model (BAM) although the estimation of some costs and potential benefits is fraught with severe problems.

Domestic Resource Cost Ratios, Mathematical Programming, and Systems and Simulation Analysis are more sophisticated, require considerable data and not suitable for biotechnology priority assessment.

The consultancy is aware that BAMs have been applied to preliminary priority setting in Zimbabwe and that others are being developed elsewhere. Therefore, it is strongly recommended that these models be carefully examined in preparation for the priority setting exercise in Zimbabwe.