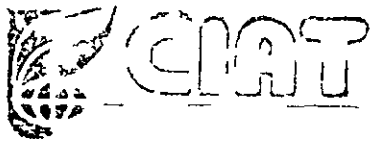
Workshop Proceedings
Actes de Seminaire

rk on Bean Research in Africa
u de Recherche sur le Haricot en Afrique



PROCEEDINGS OF THE SECOND MEETING OF THE BEAN PATHOLOGY WORKING GROUP

Kakamega Kenya
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Edited by D J Allen and R A Buruchara

Workshop Organizers R A Buruchara
R Otsyula KARI

PREFACE

This volume reports the proceedings of the second meeting of the working group on bean pathology that was held in Kakamega in Western Kenya in early June 1995 It is the 37th in a series of workshop proceedings which are designed to serve the bean research networks in Africa, that are supported through funds provided by the Office of Agriculture Bureau for Research and Development, U S Agency for International Development under grant No LAG-4111-G-00 2026 00 and the Canadian International Development Agency (CIDA) Activities of the bean research networks in Africa are further supported by the Swiss Agency for Development and Cooperation (SDC) The opinions expressed herein are those of the authors and do not necessarily reflect the views of these contributing donor organizations nor of CIAT

Further information on regional research activities on bean in Africa that are part of these projects is available from

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OPENING ADDRESS

A B Orodho

The Chairman
Distinguished participants
Ladies and Gentlemen

It gives me great pleasure and indeed great honour to be here with you once again this time to officially open the Specialist Meeting

First let me take this opportunity to welcome participants from outside the country to Kenya and in particular to Kakamega in the western part of the country Hardly two months ago Kakamega hosted the Workshop on Eastern Africa Bean Research Network (EABRN) from 24 28 April 1995 I wish therefore to record my personal and KARI s appreciation for the Steering Committee of the Bean Research Network in Africa to have chosen KARI s Western Regional Centre to host this Specialist Meeting The choice of this region is the most appropriate one particularly when considering bean research on fungal diseases The occurrence of the bean root rots in the region and the on going research activities on these diseases by this Research Centre have no doubt contributed to this appropriate choice

Agriculture is the corner stone of Kenya s economy because it produces nearly all the country s food requirement employs about 75% of the total labour force provides 35% of GDP and 60% of the export earnings

Ladies and Gentlemen the common bean is an important food crop in Kenya and indeed in the whole of tropical Africa It is produced by small scale farmers primarily in association with maize The crop is usually grown in poor soils by small scale farmers who usually have limited inputs Bean production has not kept pace with the rising demand for this product it is limited by the plant s susceptibility to diseases and pests its physiological defects and drought periods We appreciate that CIAT s Bean Program has sought in conjuction with the National Bean Programs to increase the yield of the varieties these improvement efforts have concentrated initially on disease resistance commercial acceptability and adaptability to bean producers cropping systems Hence specialist meetings like this one will go a long way toward finding lasting solutions to farmers bean disease problems

The KARI Regional Research Centre Kakamega focuses on the identification and diagnosis of production problems in its mandate area and adapts technologies for increasing production at farm level The Centre is a major contact point with the extension service and the farmer It has a multi disciplinary team of scientists in relation to the scale of productivity problems to be addressed Because KARI may not have all human resources and specialized disciplines at each Centre it encourages Centres to make important linkages and collaborations with other national and international organizations with reference to technology for solving farmers problems We realise that all these national and international organisations have a common goal to uplift the welfare of farmers particularly small scale farmers

Mr Chairman let me highlight some of the most important linkages that are important in technology development and disssemination

Research/Extension Linkages

These linkages are important as agricultural research is essentially a service to the agricultural industry and must be seen to be so in the planning and implementation of programmes and in the promotion and adoption of research findings and recommendations Research should start with the farmers problems and opportunities and conclude with solutions and technologies that would enhance them to increase their incomes In order for research to achieve these objectives linkage activities/mechanism must be established and maintained between research extension and the farmer

Linkages with other National Research Institutions and the Private Sector

It is of paramount importance that KARI fosters strong linkages with other National Research Institutions (like KEFRI) and the private sector KARI is aware that we have a common client the farmer (particularly the small scale farmer) and there is need for these institutions to interact at various levels to ensure efficient utilisation of the resources available for agricultural research and development

Linkages with Universities and other Tertiary Institutions

Highly qualified human resources in agricultural research and development are based at the Universities and other tertiary institutions in the country National Universities have more Specialist Scientists trained at the Ph D level than the entire KARI It would therefore be necessary to devise ways of involving this pool of human resources in the problem solving research within the framework of nationally determined priorities for agricultural research and development The major objective here is to integrate universities and other tertiary institutions with national agricultural research development One of the most effective ways of achieving this is through joint research activities involving University scientists and KARI scientists based at the Research Centres

Linkages with International Agricultural Research Centres (IARCs)

The network of IARCs of the Consultative Group on International Agricultural Research (CGIAR) System represents a major resource of scientific knowledge and improved technologies to which Kenya s National Agricultural Research System (NARS) should be linked Fortunately for Kenya a number of the IARCs have their Headquarters or Regional Offices based in the country and are already contributing to the strengthening of NARS The linkages between KARI and IARCs need to be developed and strengthened The major objectives of maintaining strong linkages are to strengthen the national capacity in carrying out effectively the planned programme of agricultural research and development to facilitate KARI to contribute to the pool of knowledge in tropical crops and livestock production and

the exchange of information

The NARS is this region have already shown keen interest in the creation of regional partnerships as reflected in the creation of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) CGIAR lays emphasis on international and regional partnership through network and consortia

I note with gratitude that in the spirit of collaboration the regional networks on bean research in Africa (EABRN RESAPAC and SADC) are collaborating in holding this 2nd Specialist Meeting on Bean Pathology focusing on Fungal Diseases The objectives of this Meeting will be

To review research priorities and activities under the regional sub project

To evaluate the achievements made and weaknesses or failures encountered since the last meeting (which was held in Thika Kenya 3 years ago)

To encourage self evaluation of efforts

To determine opportunities and expected obstacles

To develop general research activities in the various regional sub projects and

To recommend areas for future support

I also note that the participants of this meeting comprise senior scientists and specialists in fungal diseases Most of you have a wealth of experience and no doubt our Kenyan scientists will benefit a lot from the exchanges in expertise particularly on the subject of bean root rot problems facing the small scale farmers in the region

I must remind each one of you that you have a big task before you The deliberations of this Specialist Meeting are being eagerly awaited by KARI and other participating institutions I do wish you very fruitful deliberations I also hope that you will find some time from this busy schedule to visit some of the farmers in the country side to appreciate their problems to visit our Regional Research Centre Kakamega and to enjoy our good weather vegetation and culture

May I take this opportunity to thank CIAT that has always championed the participatory approach to technology development and transfer KARI very much appreciate the role CIAT has played in getting us this far in bean technology development NARS no longer look at CIAT as a white elephant! I also wish to thank the Bean Network in Africa for funding the Meeting KARI also recognizes the important and significant contributions made by three donors namely USAID CIDA and Swiss Development Cooperation I do thank all these donors a great deal and I appeal to them to continue funding this important Programme I also recognize the contributions made by NARS Governments in providing some

collaborative funds human resources infrastructure and other facilities used for the success of the Programme

While wishing you the best of luck in all your deliberations this week it is now my great pleasure to declare the Specialist Meeting 2nd Pan Africa Working Group on Bean Pathology focusing on Fungal Diseases officially open

THANK YOU

CONTROL OF ANGULAR LEAF SPOT THROUGH THE USE OF RESISTANT VARIETIES

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ABSTRACT

In Kenya bean is the most important food legume Diseases and insect pests are the major constraints to bean production Angular leaf spot is one of the major diseases which is seed borne and can cause yield losses of up to 80 % This disease is caused by the fungus Phaeoisariopsis griseola which has genetic variation The trial reported here was initiated to determine resistant/tolerant varieties as well as the extent of pathogenic variation in Kenya A total of two hundred and twenty two (222) accessions have been screened to date in a trial of RCB design replicated three times Preliminary trials indicated that several diseases occur together This resulted in the masking of angular leaf spot symptoms Under such conditions accessions T1 GLP 585 027933 and T5 are promising P57 is also promising although it succumbs to root rots Several other varieties showed resistance to the disease However all these varieties need to be further tested under higher disease pressure On the determination of pathogenic variation 10 isolates were collected and the fungus isolated on V8 agar purified and conserved ready to be tested on differential varieties The major constraint has been non availability of laboratory equipment Due to this reason future work is proposed to be carried out collaboratively with the University of Nairobi

INTRODUCTION

In Kenya bean is the most important grain legume second only to maize as a staple food crop (Stoetzer 1981 Darling 1992 Wortmann and Allen 1994) It is grown under a wide range of environmental conditions except where temperatures are too high for pod setting in sites below approximately 600m altitude (Stoetzer 1981) The average yield is 750 kg/ha for a pure stand and 375 kg/ha for a mixed crop (Rheenen et al 1981) Dry beans are grown mostly in association with other crops (Allen 1986) with the main crop being maize (Wortmann and Allen 1994) Farmers practice mixed cropping for various reasons to reduce risk diversification and for cash generation Results of a survey carried out in Kenya revealed a downward trend of yields (Darling 1992) due to a combination of several constraints Among the main farm problems identified pests and diseases ranked high in the list (Darling 1992) Most of the preferred varieties are susceptible to these diseases (Rheenen et al 1981)

The most serious diseases are angular leaf spot (ALS) anthracnose rust and BCMV (Wortmann and Allen 1994) Angular leaf spot of beans is caused by the fungus *Phaeoisariopsis griseola* (Sacc) Ferraris and is a widespread disease in Kenya It causes severe losses under favourable conditions (Stoetzer and Omunyin 1983 Correa Victoria et al 1989) Yield losses ranging from 40 80% have been recorded (Correa Victoria et al 1989 Pyndji 1987) The disease is seed borne (Stoetzer and Omunyin 1983 Correa Victoria et al 1989) It also occurs in association with other pathogens (Pyndji 1987

Makini and Makelo unpublished observation) This fungus has been found to exhibit pathogenic variation (CIAT 1989) which has not been determined in Kenya

The use of resistant or tolerant varieties is the best control method for all diseases wherever possible For these reasons this trial was initiated with the following objectives

To identify different isolates of angular leaf spot in Kenya To identify resistant varieties to ALS which are of favoured grain type and are competitive in an intercropping system To determine the level of control of the disease in an intercroping system using cultural methods and to determine yield loss caused by ALS

MATERIALS AND METHODS

Bean germplasm was collected from the National Horticultural Research Centre at Thika the genebank at the National Agricultural Research Centre Muguga and the Regional Research Centre Kakamega This is a continuous process whereby more varieties are still being collected Initially the seed is bulked before testing

Screening for resistance

A total of 222 accessions were sown in a randomised complete block design replicated three times The plots were 2 rows 2m long in between rows of disease spreaders (a local rose coco type and GLP2) which were established about 3 weeks earlier in two rows 2m long Scattered maize plants were also planted to create a favourable microenvironment for disease infection

Data were collected mostly at flowering (R6) and pod formation (R7) stages The CIAT scale of 1 9 was used where 1 3 was resistant 4 6 moderately resistant and 7 9 susceptible Other diseases were also scored using the same scale

Pathogenic variation

Diseased materials were collected from various places Isolations were made on V 8 agar media After sporulation single spore isolation was done at the University of Nairobi to purify the fungus for conservation

RESULTS AND DISCUSSION

Screening for resistance

The results indicated that most of the initial 156 accessions tested were susceptible to ALS (Table 1) Only 19 indicated resistance to ALS However severe halo blight and BCMV incidences may have masked results A total of 36 accessions could not be scored because of serious masking effects of the ALS symptoms by other diseases There were also severe infections of root rots nematodes and beanfly A few accessions showed some multiple

disease resistance

Of the sixty six accessions 44 showed resistance to ALS (Table 2) Data collection continues and conclusions will be drawn at the end of the trial

Preliminary results indicated that some accessions show tolerance/resistance to ALS but are highly susceptible to other diseases (eg 027982) However some accessions show multiple disease resistance (eg T1 GLP 027933 and T5) P57 is also a promising line except that it succumbs to root rots

Pathogenic variation

The isolates were collected from various places The fungus was isolated from diseased materials purified and conserved awaiting the availability of differential varieties from CIAT to determine the variation if any

The isolates were from Kisii Research Centre (Kisii District) Oyani (Migori District) Nyangusu (Kisii District) Nyamache (Kisii District) Menyinkwa (Kisii District) Thika (Thika District) Limuru (Kiambu District) Uthiru (Kiambu District) Muguga (Kiambu District)
Narok (Narok District) This collection is continuing

CONCLUSIONS

A few accessions are promising such as T1 GLP 585 027933 T5 and P57 especially as regards multiple disease resistance Several other lines also have resistance to ALS

Lack of basic laboratory equipment has been the major constraint leading to the objectives not being attained Due to this artificial inoculations were not carried out as well as the work on pathogenic variation However work on pathogenic variation has now commenced at the University of Nairobi

It is proposed that this project be carried out as a collaborative work with the University of Nairobi The laboratory work will be done at the University (race studies) and the screening work to continue at RRC Kisii This will enable the project to attain its objectives because the laboratory at the University of Nairobi is well equipped

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Table 1 The rating and disease reaction of the accessions to ALS on the scale of 1 9

Rating	**Disease Reaction to ALS**	**No of accessions**
1 3	Resistant	19
4 6	Moderately Resistant	14
7 9	Susceptible	87

Table 2 The rating and disease reaction of the accessions to ALS CBB BCMV anthracnose halo blight and root rots on the scale of 1 9

Rating	ALS	CBB	BCMV	Anth	H/Blight	Root rots
1 3	44	15	36	44	44	33
4 6	1	16	6	9	9	4
7 9	21	35	24	13	13	29

DETERMINATION DE GENEPOOL DU PATHOGEN ET GROUPES DE RACES DE *Phaeoisariopsis griseola* DANS LA REGION DE GRANDS LACS

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ABSTRACT

Previous studies conducted in Zaire show existence of pathogenic variation in Phaeoisariopsis griseola, the causal agent of angular leaf spot (ALS) in beans Recent studies in Latin America show that pathogenic variation of P griseola is not only diverse but like its host can be grouped into Mesoamerican and Andean pathogen genepools which attack Mesoamerican (mainly small seeded) and Andean (mainly large seeded) bean genotypes respectively The objectives of these studies were to determine the occurrence of the two pathogenic groups in the Great Lakes Region of Central Africa and the relationship between genotypes of Andean and Mesoamerican origin and existence of the pathogen groups

Ten isolates obtained from Zaire (7) Burundi (2) and Rwanda (1) were to be characterized on the basis 17 differential cultivars that have been used in CIAT Colombia However 6 Andean differentials were not used due to lack of adequate seed Fourteen day old monosporic cultures were used to inoculate 21 day old plants of 10 differential varieties Final evaluation was made 20 days after inoculation For race characterization a CIAT evaluation scale of 1 to 9 was used where 1 to 3 was considered resistant and 3 1 to 9 was susceptible

Five isolates (2 3 8 9 and 10) from Zaire gave similar reactions on the differential varieties used and could be considered similar or belonging to the same race Isolates 1 and 5 were distinct from each other and from the other Zairian isolates Each of the isolates from Burundi and Rwanda were different from each other and from those from Zaire Most isolates attacked Mesoamerican differentials Most isolates were obtained from small seeded genotypes and explains why they affected most Mesoamerican differentials This also indicates that the isolates could belong to the Mesoamerican pathogen genepool There is however need to confirm these results by using the now revised set of 12 differential varieties that represent both the Andean (6) and Mesoamerican (6) genepools

INTRODUCTION

Les travaux deja effectues sur les taches anguleuses au Zaire ont montre que *Phaeoisariopsis griseola* posséde une variabilité pathogénique Chez son hote le haricot commun il existe une diversité des genotypes qui est groupée en deux suivant l origine du genotype type Andean (grosse graine) et type mesoamerican (petite graine) Les résultats obtenus au Zaire (Pyndji 1992) ont demontré qu l existe tres peu des variétés

résistantes dans type andean (grosses graines)

En Afrique les grosses graines etaient traditionnellement preferees par les fermiers mais les petites graines ont manifeste une résistance aux maladies et un haut rendement

La lutte par la restance semble etre le meilleur moyen pour les petits fermiers il est alors necessaire de verifier si ce pathogene posséde aussi une diversité des races comme son hote le haricot commun afin de developper des sources de resistance conforme a la diversité recherchee

Les objectifs vises par cette etude sont les suivants

> Verifier s il existe la diversite pathogenique de *P griseola* dans la region de grands lacs c est a dire s il y a presence de deux groupes de race (mesoamerican et andean) et comment sont ils repartis dans la region
>
> Voir la relation qui existe entre genotypes d origine Andean au Mesoamerican avec le pathogene dans les endroits ou ils sont cultives dans la region de Grands Lacs

Ceci nous permettra d etablir une carte des races de *P griseola* pour la region des Grands Lacs afin de donner une image aux selectionneurs sur la strategie de developper la source de resistance adaptee a l aire de race et a la diversite trouvee

MATERIALS ET METHODES

Isolement

L isolement de *P griseola* a ete fait a partir des echantillons des feuilles ou des gousses du haricot infectes collectes dans la region des Grands Lacs (Burundi Rwanda Zaire)

L isolement etait fait suivant les techniques d isolement production d inoculum decrits par Pyndji 1990 Le pathogene etait isole a partir des lesions sur feuilles ou gousses infectees du haricot Les spores sont prelevees au sommet du synemata a l aide d une aiguille fine munie d un morceau d agar Le morceau est depose dans une goutte d eau distillee sterile sur le milieu water agar (WA) au potato dextrose agar acidifié (APDA) et est ensuite disperse avec une baguette pliee Les boites de Petri sont alors incubees a 22 25oc pendant 24 48 heures jusqu a la germination des spores 5 a o spores bien germees sont reperees a l aide d un stereomicroscope puis trandferees sur le milieu nutritif V8 agar (200ml de jus V8 3 gr de carbonate de calcium 15 gr d agar et 800 ml d eau distillee) Les boites de Petri sont emballees dans le papier Kraft et incubees a 22 24oc pendant 14 ou 21 jours jusqu a ce que les colonies atteignent 5 a 10 cm de diametre

Production et preparation d'inoculum

Des cellules monosporiques de 21 jours sont prelevees sur le milieu V8 agar ecrasees

dans quelques gouttes d eau distilee sterile ^Une suspension est aspiree à l aide d une pipette puis versée dans des boites sont incubees pendant 14 a 21 jours dans les conditions decrites precedemment L inoculum est prepare en raclant les conidies (spores) avec une brosse La concentration des spores est déterminee a l aide d un hemacytometre et ajustee a 2 0 10^4 conidies par mililitre de suspecion

Inoculation et variétés differentielles

Un lot de 10 varietes differentielles pour taches anguleuses compose des genotypes andean (grosse graine) et mesoamerican (petite graine) en provenance du CIAT a ete utilise Chaque variete differentielle était seme en deux repetition dans deux pots de trois plants chacun Le sol melange avec du samble proportion (5 1 v/v) était prealablement sterilise 19 a 21 jours apres semis les plants de 1 a 3 feuilles trifoliolees sont inoculés avec une suspencion des conidies d une concentration de 2 0 10^4 conidies/ml Un pulverisateur manuel de 11 est employe pour pulvériser les spores sur les feuilles Les plants étaient couvertes avec des sachets plastics pour maintenir une humidite relative puis les pots sont places sous les bancs pendant 72 heures Apres les sachets sont enleves et les plants sont remis sur les bancs

Evaluation de la maladie

11 jours apres inoculation la severite de la maladie est evalee suivant l echelle standard CIAT de 1 a 9 ou 1=absence des symptomes 3=2% de la surface foliaire infectee 5=5% 7=10% et 9=25% au plus de la surface foliaire infectee L évaluation a ete faite au 11 14 17 et 20 jours apres inoculation

RESULTATS ET DISCUSSIONS

Les differentielles utilisées comprenaient particulierement des varietes de type mesoamericain et andean Ce dernier etait utilisé par manque de semences du type mesoamericain Une observation notable etait que les isolats no 2 3 8 9 et 10 provenant du Zaire ont produit des reactions similaires sur les varietes differentielles et peuvent donc etre considerees appartenir au meme pathotype Les isolats no 1 et 5 sont differents entre eux et des autres isolats du Zaire Les isolats de Burundi et du Rwanda diffèrent entre eux et aussi de ceux du Zaire La plupart d isolats ont attaque des variétes differentielles de type mesomericain Comme la plupart d isolats provenaient de genotypes a petite graine ceci explique pourquoi presque toutes differentielles d origine mesoaméricaine etaient attaquees cela indique aussi qu ils appartiendraient probablement au gene de pool mesoamericain du pathogene Cependant il ya un besoin de confirmer ces resultats en utilisant la gamme habituelle de 12 varietes differentielles qui representent tous les deux genes pools andean et mesoamericain

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Tableau 1 Reaction des variétés différentielles aux 10 isolats de *Phaeoisariopsis griseola* du Zaire[u] Burundi et Rwanda[w] 20 jours aprés inoculation

Varietes differentielles		Zaire							BU		RW
Identity	Gene pool	1	2	3	5	8	9	10	4	6	7
Cornell 49242	M[x]	S	S	S	S	S	S	S	S	S	S
Rosinha G 2	M	S	S	S	S	S	S	S	S	S	S
Catu	M	S	S	S	S	S	S	S	S	S	S
PAN 72	M	S	S	S	S	S	S	S	S	S	S
BAT 332	M	S	S	S	S	S		S	R	S	R
G 2858	M	S	S	S	S	S	S	S	S	S	S
G 1805	M	R	S	S	S	S	S	S	R	R	R
Mexico 54	M	R	S	S	S	S	S	S	S	S	R
G 5686	A	S	S	S	S	S	S	S	R	R	R
Pompador Checa	A	S	S		R	S	S	S	S	R	S

= Isolates from Zaire 1 KAGARA 1 2 TSHIRUMBI Nakaja 3 TSHIRUMBI Mélange local 5 TSHIRUMBI 8 TSHIRUMBI Kirundo 9 BIRAVA 10 MOLEHE

= Isolates from Burundi 4 GISOZI 6 MOSO 2

[w] = Isolates from Rwanda Rubona

= Bean genepool M = Mesoamerican A = Andean

[y] = Reaction of differential varieties based on a CIAT scale of 1 to 9 where 1 3 is resistant and 3 1 = 9 is susceptible

= not tested

Bu = Burundi RW = Rwanda

ANGULAR LEAF SPOT RESEARCH UNDER SADC

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INTRODUCTION

The economic importance of angular leaf spot (*Phaeoisariopsis griseola* (Sacc) Ferr) on common beans (*Phaseolus vulgaris* L) is widely reported (Correa Victoria *et al* 1989 Buruchara 1992 Mushi *et al* 1989 Msuku & Bokosi 1990 Mkuchu & Mayona 1989) Yield losses due to the disease in the SADC countries of southern Africa vary between 7 53% depending on cultivar and climatic conditions (Mwalyego 1987 1990 Mukandala & Teri 1987 Swai & Keswani 1984)

Breeding for genetic resistance is generally considered to be the most cost effective and sustainable method of managing the disease especially under the small farmers environment However breeding programmes in the region are overshadowed by speculation that pathogenic variation occurs in *P griseola* Efforts to clarify this were initiated by the CIAT/SADC Steering Committee in November 1992 when it agreed to fund a three year sub project to investigate the genetics of the host/pathogen interaction and pathogenic variation in *P griseola* This paper outlines progress of the project

The sub-project

The aims were to study the genetics of the host/pathogen interaction and pathogenic variation in *P griseola* to assemble a regional ALS nursery from bean lines in Zaire Tanzania and Zambia and from entries in CIAT s Bean Angular Leaf Spot International Trial (BALSIT) and subsequently to initiate a breeding programme for resistance to ALS

Progress and limitations

The sub project was initially based in Swaziland under the coordination of Professor J M Teri Unfortunately the coordinator took up another job before effective take off of the studies In November 1993 the Steering Committee appointed the author to coordinate the sub project and pledged to release some funds to get the work started Funding has not materialized to date Nevertheless seeds of differential cultivars (Table 1) were secured from CIAT in October 1994 and are being multiplied at Selian Agricultural Research Institute (SARI) Arusha Performance of the cultivars is satisfactory except G 11796 and Bolon Bayo which seem not to flower under SARI conditions during the Short Rains season The performance of the two cultivars will be assessed again in the coming Long Rains season Collection of local isolates of the pathogen has also begun

The future

Angular leaf spot is ranked the highest in Africa in terms of total yield loss especially in

southern and central Africa (Buruchara 1992) Pathogenic variation of *P griseola* appears to be common and widespread (Pyndji 1992 Correa Victoria *et al* 1989) This variability of the pathogen has not been verified in eastern and southern Africa constituting a profound weakness in breeding programmes for resistance to ALS

The concern of the Steering Committee in 1992 is as valid today as it was then Concerted efforts in the form of collaborative studies are still vital so as to make the most efficient use of limited expertise and financial resources It is hoped that this working group meeting will come up with valuable views on the logistics of getting this sub project underway

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Table 1 Angular leaf spot differential cultivars under multiplication at Selian Arusha

Mesoamerican Origin	Andean origin
Cornell 49242	G 5686
PAN 72	Amendoin
BAT 332	Montcalm
Mexico 54	Don Timoteo
G 2858	G 11796
Flor de Mayo	Bolon Bayo

ANTHRACNOSE SUB PROJECT UNDER SADC

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INTRODUCTION

The project commenced in mid season 1991 and was scheduled for completion in 1994 Objectives were to assess the importance of anthracnose through surveys and crop loss studies in farmers fields to identify prevailing pathogenic races and map their distribution and to
study disease control measures through plant resistance and cultivar mixtures

The race studies were shelved after the first year through lack of financial support to the sub project If funds were to become available the race studies might possibly be continued and on farm trials on the improvement of traditional mixtures might be initiated

METHODOLOGY

Crop loss studies

On station a factorial design was used with treatment factors being varieties (local susceptibles known susceptible and resistant) and various levels (5 6) of disease severity managed by spraying either with conidia and limiting disease development in some treatments by spraying with fungicides In hot spot areas (farmers fields) a single factor randomized design was envisaged where half of the field with local varieties as planted by farmers would be protected by fungicides while the other half would be kept unsprayed and under field inoculum This however could not be achieved as most farmers planted late to fight anthracnose and not much disease developed Hence the experiment as set on station was repeated in farmers fields where they usually plant beans and to enable an early planting

Surveys

Visits were to be made to the bean growing areas during the season to assess the severity and incidence of anthracnose Disease severity scores would then be correlated with the yield loss results The survey would also assist in showing the distribution and importance of the disease especially where there is missing information and trials cannot be laid out

Race studies

During the surverys samples of anthracnose were collected and a total of 79 isolates were obtained From these 15 isolates were selected on the basis of diversity of origin and colony characteristics before multiplication and inoculation onto a set of race differential bean cultivars obtained from CIAT

[1] Deceased

Disease control

Screening local and introduced germplasm for anthracnose resistance under artificial inoculation with isolates from the race studies Promising genotypes were to be tested in a common nursery at sites in Zambia Tanzania Angola and Malawi

Disease control through cultivar mixtures

Assessment of farmers mixtures Single factor replicated experiment involving 3 8 mixtures and pure stands of components Trial to be surrounded by spreaders artificially inoculated with local isolates Monitoring of disease progress and comparison of yield between mixtures and their components would be done

Effective levels of resistant components in a mixture

Single factor replicated design treatments being various combinations of a resistant and a susceptible variety plus pure stands of components as controls Monitoring of disease severity and spread throughout the season and yield gain were to be determined

RESULTS

Crop loss studies

Preliminary results have been presented previously (Mwalyego 1992[b]) Table 1 shows a comparison of mean yield losses incurred from anthracnose in on farm trials and on the research station

Race studies

Investigations of pathogenic variation in *C lindemuthianum* in Zambia (Haciwa 1991) and in Tanzania (Mwalyego 1991a 1992a) confirm the existence of races Results of tests of pathogenicity of 15 isolates on a standard set of 12 differential bean genotypes are shown in Table 2 Two isolates (J and L) were found non pathogenic Isolates B and F were the most virulent each attacking 8 of the differentials Isolates G and O were among the least virulent The host genotype G 2333 was resistant to all isolates tested
Races identified were race 6 race 28 race 60 race 63 race 98 race 155 race 182 race 287 race 618 race 958 race 1478 race 1515 and race 1678

Disease Control Screening for resistance

A total of 282 bean genotypes were screened over the past three seasons including local bean crosses entries from the IBAT and PADN nurseries
Some entries have been tested at more than two sites Over 50% of the entries tested appeared to be resistant to anthracnose Nevertheless a good number of the resistant ones

were susceptible to angular leaf spot or other diseases Notable among the introduced lines were EMP 87 NAG 51 CAL 85 MCM 1015 AND 879 MCR 57 DRK 47 IBAT 415 IBAT 420 IBAT 363 IBAT 381 IBAT 390 IBAT 365 IBAT 347 IBAT 402 IBAT 395 AFR 392 XAN 78 BAT 1295 G 11544 G 12538 G 12539 G 14508 and G 16140 among others These were found to have high levels of resistance to most diseases as well as potential for yielding well

Assessment of varietal mixtures for disease control

Eight traditional bean mixtures from Rungwe and Mbozi (in the Southern Highlands) and from Moshi Rural (in northern highlands) in Tanzania were evaluated for their disease susceptibility relative to that of their pure components Table 3 presents results from the 1992/93 season

There was considerable variation in disease reaction as well as in seed yield among the mixtures Although mean seed yield from the mixtures was generally equal to or heavier than the mean yields of their corresponding components in pure stand none of the mixtures yielded as much as the heaviest yielding components Overall disease severity of the mixtures was decreased by about 13% relative to that in the components the severity of anthracnose was reduced by 31% The mean yield gain from mixture was 10% with the largest gain in mixture E from Mbozi

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Table 1 Comparison between results on station and on farm in yield losses in common bean from anthracnose over 3 seasons at 4 sites in Tanzania

	Mean loss in seed yield (%)	Range (%)
On farm	36	22 47
On station	47	34 86

Table 2 Pattern of reaction[1] in 12 race differential genotypes of *Phaseolus vulgaris* when inoculated with 15 isolates of *Colletotrichum lindemuthianum* from Tanzania

Cultivar	Binary value[2] when susc	Isolate														
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	0
Michelite	1					+	+		+						+	
MDRK	2	+	+	+	+	+	+	+	+	+		+			+	
Perry Marrow	4	+	+			+		+		+		+		+	+	+
Cornell 49 242	8		+		+	+	+		+	+				+	+	+
Widusa	16		+			+			+			+		+	+	+
Kaboon	32		+	+	+	+	+					+		+		
Mexico 222	64	+		+	+		+									
PI 207262	128	+	+				+		+	+		+				
To	256	+	+				+								+	
Tu	512		+		+					+						
Ab 136	1024	+					+			+						
G 2333	2048															
Race denomination		1478	958	98	618	63	1515	6	155	1678	0	182	0	60	287	28
No cultivars attacked (virulence)		6	8	3	5	6	8	2	5	6	0	5	0	4	6	3

[1] + denotes compatible (susceptible) reaction denotes no test (germination failure) and a blank indicates incompatible (resistant) reaction

[2] Binary values based on Annual Report of the Bean Program for 1988 CIAT Working Document No 53 p 128

Table 3 Mean seed yield (kg/ha) and disease severity scores (mean 1 9) in eight traditional bean mixtures and their components

	Mixtures			Components		
Mixture	Mean yield	Mean anth	Mean other diseases	Mean yield	Mean anth score	Mean other diseases
A Rungwe	1016	4 9	5 5	808	4 1	6
B	1146	5	4 5	742	4 2	6
C	1066	4	6 5	915	4 8	7
D Mbozi	1656	5 3	5 5	479	5 2	6
E	1780	4	5	618	5 1	5 8
F	1720	3 6	4 3	973	4 1	4 6
G Moshi	1320	5 2	5	1017	3 9	3 6
H	1806	4 0	4 1	875	4 2	5
Mean	1364	4 5	5 1	803	4 7	5 5
C V %	18 1	32 2	14 1			

THE EFFECT OF A RESISTANT COMPONENT IN BEAN CULTIVAR MIXTURES ON THE MANAGEMENT OF ANTHRACNOSE

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ABSTRACT

Studies of the effect of incorporating different levels of a resistant component in a bean mixture in the management of anthracnose and grain yield revealed that both the incidence and severity of anthracnose was significantly decreased in mixtures Disease decreased progressively with increases in the proportion of the resistant component in the mixture The mean severity of anthracnose was reduced by 26% in the mixtures compared to the pure stand crop and mean yield of the mixture components was 23% higher than the mean yield of the sole crop

In the mixtures the mean yield of the susceptible component was 33% higher than in pure stand presumably due to reduced intensity of disease in the mixtures Yield of the susceptible component also increased with increases in levels of resistance in the mixture

INTRODUCTION

Intraspecific crop mixture studies mainly with cereal crops have shown that those with genetic variation relevant to specialized pathogens often yield more than their component mean (Burdon and Whitbread 1979 Chin and Husin 1982 Chin and Wolfe 1984 Wolfe 1985 Malik et al 1988 Gunipert 1989) The higher yields have been associated apart from intergenotypic compensation with less disease incidence and severity in mixtures than in pure stands and sometimes to the differential reactions of components to the environment It is often assumed logically that because of the increased plant diversity and differential susceptibility diseases may not spread as rapidly in mixtures when compared to sole crops

It is well known that subsistence farmers in most parts of Africa plant bean mixtures whose components may differ in their levels of resistance to various diseases as well as in agronomic and culinary characters Sometimes disease resistant bean cultivars released by national programmes have been sampled in farmer s mixture components (Mwalyego 1991)

Promising results in some preliminary studies of bean cultivar mixtures in East Africa mainly for the management of angular leaf spot (*Phaeoisariopsis griseola*) and rust (*Uromyces appendiculatus*) have been recorded (Lyimo et al 1985 Msuku and Kapalamula 1989 Panse et al , 1989 Mwalyego 1991) Since no such studies have focused on bean anthracnose (*Colletotrichum lindemuthianum*) this study was undertaken to investigate the significance of a resistant component in bean mixtures on anthracnose severity and grain yield

MATERIALS AND METHODS

Seeds of two bean cultivars CG113 (which is highly susceptible to anthracnose) and Kabanima (which is highly resistant to all pathotypes of the anthracnose pathogen) were mixed together in the following proportions 25 75% 50 50% and 75 25% Both cultivars are determinate bush types of almost equal maturity periods (112 days) but differing in seed size and colour to enable their separation at harvest

The trial was planted in a randomized complete block design with three replicates during the major bean growing season at Uyole The planting was systematic to ensure that the mixture proportions were maintained in each line Plot size measured 3 x 5m^2 with seven rows spaced at 50 x 8cm Fertilizers and beanfly control were applied according to recommendations The trial was surrounded by two border rows planted with anthracnose infected seed to act as disease spreaders Observations made in each plot included disease incidence and severity plant population after emergence and at harvesting mean number of pods per plant 100 seed weight and seed quality on 1 3 scale where 1 = very clean seed and 3 = dirty or grade B seed Disease incidence was measured by the proportion of infected plants at weekly intervals in each plot starting at two weeks after emergence for a period of six weeks

Disease severity was recorded from the entire plot after 4 8 and 12 weeks of growth on 1 9 scale where 1 = No disease and 9= Highly infected Equivalent yields were calculated from the formula

$$y = a/b \times c \quad \text{where}$$

y= equivalent yield of susceptible component in mixture
a= yield of the component in the mixture
b= plant population of the component in the mixture
c= plant population of the component under sole crop (i e 420 plants/plot)

RESULTS AND DISCUSSION

Anthracnose incidence increased at a faster rate in the sole crop of the susceptible component than in mixtures (Table 1) Within two weeks of emergence disease incidence in the sole crop was about 27% higher than in the mixtures After 5 weeks all plants of the sole crop were infected as compared with an average of 82% in the mixed stands Disease incidence also progressively decreased with increases in the proportion of the resistant component in the mixture Except for the mixture in which the resistant component comprised 75% the differences in disease incidence between the sole crop and the other mixtures were significantly different up to 5 weeks after germination Anthracnose severity was also significantly higher in the sole crop than in the mixtures where 50 and 75% resistance was included (Table 2) Where there was only 25% of the resistant component anthracnose severity was not significantly different from that of the pure stand As with disease incidence severity also increased with

increases in the proportion of the susceptible component in the mixture from 25 75% Such differences were significantly marked at the beginning of the season The incidence and severity of other diseases (mainly angular leaf spot and floury leaf spot) in the trial were insignificant

The differences in mean yield between the treatments were statistically significant (P=0 05) The mean yield from the mixtures was 23% higher than that of the component mean (Table 3) The susceptible component yielded significantly better (33% higher) in the mixtures than when grown as a sole crop Highest yields were achieved when the proportion of resistance in the mixture was 25 50% (Table 4) A significantly close association (r= 0 96) was found between yields of the susceptible component and anthracnose severity within 12 weeks after emergence (Tables 2 and 4) Since the coefficient of determination (R^2) showed that up to 31% of the observed differences in yield could be attributed to disease it can be concluded that the higher yields of susceptible components obtained in mixture were attributable to protection from disease afforded by the resistant component With only 25% of resistance in the mixture yields increased by 13 8% over the sole crop As the proportion of resistance was increased to 50% and 75% the yield increased by about 40% (Table 4)

It can be concluded that the presence of resistant components in farmers mixtures help in decreasing anthracnose severity so that higher bean yields can be achieved Farmers should be encouraged to include or retain more seeds of resistant components in their prefered mixtures

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Table 1 Anthracnose incidence in sole and mixed bean stand from two to six weeks after emergence

Proportion (%) of components in mixture		Number and proportion (%) infected plants				
Res	Susc *	2 wks	3 wks	4 wks	5 wks	6 wks
25	75	5 (5)	22 (21)	54 (51)	72 (69)	105 (100)
50	50	26 (12)	63 (30)	116 (55)	188 (89)	210 (100)
75	25	40 (13)	106 (34)	208 (66)	284 (90)	315 (100)
0	100	89 (21)	240 (57)	380 (90)	420 (100)	420 (100)
100	0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean mixture		24 (10)	64 (28)	126 (54)	181 (83)	210 (100)
Sole crop (susceptible)		89 (21)	240 (57)	380 (90)	420 (100)	420 (100)
LSD 5%		10 74	15 52	29 75	62 6	5 77
CV %		41 5	21 8	22 7	36 1	2 8

* Susceptible = CG 113
Resistant = Kabanima

Table 2 Development of anthracnose (mean severity score 1 9 scale) in mixtures of resistant and susceptible components relative to pure stand

Proportion (%) of components in mixture		Weeks after emergence				
Susc	Res	4	8	12	Mean	Mean score other diseases
25	75	2 0	3 3	5 0	3 4	3 0
50	50	3 0	3 7	5 5	4 1	2 0
75	25	4 7	5 8	6 5	5 7	3 0
100	0	4 3	5 7	7 5	5 8	3 0
0	100	1 0	1 0	1 0	1 0	4 0
Mean (mixture)		3 2	4 3	5 7		2 7
Mean (pure stand)		4 3	5 7	7 5		3 0
LSD 5%		1 62	2 5	1 4	4 3	NS
CV %		23 9	27 2	22 1	39 9	23 4

Table 3 Mean yield and yield components of two bean cultivars under sole and mixed stand

Bean cultivars/ mixture	Yield (kg/ha)	Plants/ plot	Pods/ plant	100 seed wt (g)	Seed quality (1 3 scale)
CG 113 (S)	2356 b	419	13 8	27 b	3 0 a
Kabanima (R)	2342 b	418	15 3	40 a	2 0 b
25% S + 75% R	3013 a	418	14 7	30 ab	2 7 a
50% S + 50% R	3182 a	417	18 1	27 b	2 7 a
75% S + 25% R	2956 a	418	11 5	30 ab	3 0 a
Mean (pure stand)	2349	419	15 0	33 3	2 5
Mean (mixture)	3050	418	15	29	2 6
LSD 5%	403 6	NS	NS	11 1	0 59
CV %	7 7	0 31	27 16	19 29	11 86

Means followed by same letter are not significantly different (P =0 05)

Table 4 Yield (kg/ha) of the susceptible component (CG 113) in the mixture and its equivalent yield under pure stand

Proportion of CG 113 in the mixture	Yield of CG 113 in the mixture	Yield equivalent of pure stand	Yield increase over pure stand (%)
25%	964 b	3858 a	39
50%	1971 a	3956 a	40
75%	2049 a	2732 b	14
100%	2356 a	2356 b	
Mean pure stand	2356	2356	
Mean mixtures	1661	3515	
LSD 5%	782 1	1128	
CV %	21 3	17 43	

Means followed by same letters are not significantly different ($P = 0\ 05$)

STUDIES ON THE IMPORTANCE PATHOGENIC VARIATION AND MANAGEMENT OF BEAN ANTHRACNOSE IN ETHIOPIA

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ABSTRACT

A field survey demonstrated that the major diseases of the common bean in various regions of Ethiopia were anthracnose rust common bacterial blight ascochyta blight and angular leaf spot Studies of pathogenic variation among 20 isolates of the anthracnose pathogen led to the identification of at least nine races Only two isolates were identical *Races identified were race 128 race 269 race 511 race 585 race 712 race 883 race 906 race 952 and race 961 The most virulent race (511) which appears to predominate at Meki attacked nine of the differentials and the least virulent race (128) which was repeatedly found at Ziway attacked only one differential cultivar Assessment of yield loss demonstrated that about 75% loss in seed yield can occur in a susceptible cultivar when unprotected Fungicidal seed treatment was shown to provide as much protection as foliar spraying at intervals of 14 or more days Significantly better protection was given by mixed applications of mancozeb and benomyl at weekly intervals Preliminary results from field screening for anthracnose resistance across three seasons and four sites has led to the identification of promising materials some of which have been used in a breeding programme* (ed)

INTRODUCTION

Common bean (*Phaseolus vulgaris* L) is an important food legume crop and provides an essential part of the daily diet of Ethiopia It is grown as a subsistence crop under traditional farming systems usually as an intercrop with cereals coffee or enset (wild banana *Ensete edule*) Improved cultivars have not yet been widely introduced and adopted Seed yields are low averaging only about 600 800 kg/ha These low yields may be attributed to a combination of several yield constraints among which diseases play a major role (Habtu Assefa and Dereje Gorfu 1985) Important bean diseases are anthracnose rust common bacterial blight angular leaf spot floury leaf spot ascochyta blight and bean common mosaic

Of these bean anthracnose (*Colletotrichum lindemuthianum)* is widely distributed in the major bean growing districts of Ethiopia Anthracnose is associated with heavy yield losses wherever susceptible bean cultivars are grown in locations with cool to moderate temperature and high humidity or free moisture (Schwartz and Galvez 1980) The occurrence of the disease has increased significantly in recent years However very little information was available on the epidemiology and management of the disease Thus this paper presents results of survey loss assessment race identification and varietal screening trials undertaken in Ethiopia

since 1992

MATERIALS AND METHODS

Survey and laboratory greenhouse and field experiments of the anthracnose sub project were conducted at the Plant Protection Research Center at Ambo in the period 1992 1994

Bean anthracnose survey

Anthracnose surveys were conducted in the major bean production regions in the Rift Valley and southern Ethiopia Haricot bean fields were assessed at intervals of 15 20 km in farmers fields and on state farms Ten to fifteen sample points were randomly selected along the diagonals and were assessed on a 1 9 scale at growth stages close to R7 and R8 (van Schoonhoven and Pastor-Corrales 1987) Infected samples were also collected for laboratory analysis

Race identification

Samples of bean anthracnose were collected from Ambo Nazareth Meki Ziway Awassa Arsi Negele Areka Bako and Admi Tulu A total of 20 isolates were purified multiplied in the laboratory and inoculated on 12 standard differentials in both field and greenhouse The reaction of the differentials were recorded using 1 - 9 scale and translated into binary numbers to identify the races (van Schoonhoven and Pastor Corrales 1987)

Greenhouse test

Five seeds of each differential were sown in 15 cm diameter pots with 3 replications and were kept for 10-15 days in the greenhouse at about 21 30 C Ten day old seedlings were inoculated with 2 week old cultures of *Colletotrichum lindemuthianum* at a concentration of 1 2 x 10^6 conidia/ml and then kept in a humid chamber Each plant was evaluated 7 days after inoculation

Field test

The trial was designed as a randomised complete block with 4 replications The plot size was 4 x 0 60 m with double rows Susceptible checks (Mexican 142 Jalesco 33 and Cuv 168-14) were sown after every ten entries Artificial inoculation was also applied Disease reactions were assessed on a 1 9 scale before and after flowering and at podding stage

Loss assessment

Field experiments were conducted in a randomised complete block design (RCBD) with 6 replications using a susceptible cultivar Mexican 142 Plot size was 4 x 3 2 m with 8 rows from which 4 central rows were harvested Mancozeb (0 2%) mixed with benomyl (20%) at the

rate of 2 g/l were sprayed at intervals of 7 14 21 and 28 days Seed dressing with benomyl at the rate of 0 5 kg/100 g of dry seed and a blank control were used in the experiment Diseases in each plot were recorded every 2 weeks using 1-9 scale starting from the first spray For intensive disease evaluation purposes 16 plants were randomly selected and tagged in each plot

Data collected included leaf severity at 3 5 9 leaflets infected pods/plant pod severity dead tissue leaf area incidence pods/plant seed/pod seed yield seed weight and other diseases

Resistance screening

A trial which was conducted over three years (1992 - 1994) was composed of 100 entries per year A susceptible cultivar (Mexican 142) was sown between and around the replications in order to increase disease pressure Resistant (Red Wolaita) intermediate (Black Dessie) and susceptible (Mexican 142) were sown as checks after every ten test entries The design was RCBD with 2 replications with a plot size of 2 x 0 60 m The nurseries were exposed to natural infection but in some cases they were also inoculated with mixed anthracnose populations Disease reaction was evaluated before flowering after flowering and during podding on a 1 9 scale (van Schoonhoven and Pastor-Corrales 1987)

RESULTS AND DISCUSSION

Survey

Results revealed that different diseases predominated in different bean growing regions of the country The most common diseases were anthracnose rust common bacterial blight angular leaf spot ascochyta blight floury leaf spot and halo blight

The mean severity of anthracnose was 36% across all surveyed zones of the country The severity of anthracnose was slightly higher in the Western zone and the Rift Valley than in the Southern zone Mean severities of rust and common bacterial blight were 29 and 22% respectively (Table 1)

A total of 58 isolates of *Colletotrichum lindemuthianum* were collected both from experimental fields (where many bean genotypes were concentrated) as well as from farmers fields (planted with a susceptible cultivar Mexican 142) Farmers traditionally use the same seeds as planting material encouraging the build up of anthracnose inoculum from year to year

Race studies

Samples collected in the period 1992-94 across a range of sites in Ethiopia have been used in the analysis of races and results confirm that the anthracnose pathogen is highly variable in the country Table 2 shows the pattern of reaction of nine of the isolates when

inoculated on a set of differentials Races identified include the following 128 269 511 585 712 883 906 952 and 961 The two races 128 and 511 were repeatedly identified from Ziway and Meki respectively and it is significant that these two races represent the least virulent (race 128) and the most virulent (race 511) among those isolates on which data are presented here (Table 2)

Loss assessment

The severity of anthracnose was greatest in the unprotected control treatment and least in the treatment that received fungicidal protection at 7 day intervals (Table 3) Almost 75% loss in seed yield was recorded in the unprotected plots relative to the yield of plots receiving most frequent protection In terms of fungicide efficacy in protecting against yield loss from anthracnose there were no significant differences between the seed treatment and foliar spraying at intervals of 14 or more days The components of yield most affected by anthracnose were the number of pods per plant and seed size the number of seed per pod was unaffected

Resistance screening

Attempts were made to identify new sources of resistance to bean anthracnose among accessions from geographically diverse regions sources combining resistance with other desirable agronomic characters like growth habit grain colour and size Results from evaluation over four sites and three seasons revealed that the majority of entries were resistant (Table 4) Anthracnose developed sufficiently in susceptible materials to provide an effective evaluation except at Awassa (where some escapes may have been selected) Promising materials are presented in Table 5

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Table 1 The severity of anthracnose and other major diseases of beans in farmers fields and on state farms in Ethiopia 1992 94

Survey location (altitude m)	Severity (%) at podding		
	ANTH	RUST	CBB
Rift Valley			
Mojo (1910)	51	33	31
Meki (1690)	45	34	21
Ziway (1600)	25	35	20
Adamitulu (1690)	34	29	24
Alemaya (2020)	30	29	21
Southern Zone			
Awassa (1740)	22	20	15
Wolaita Sodo (2010)	35	35	15
Arsi Negele (1930)	29	23	28
Western Zone			
Bako (1600)	41	34	20
Didesa (1610)	35	21	20
Metu (?)	28	19	15
Jima (2000)	45	35	23
Ambo (2150)	45	30	28
Mean severity	36	29	22

Table 2 Pattern of reaction[1] in 12 race differential genotypes of *Phaseolus vulgaris* when inoculated with 9 isolates of *Colletotrichum lindemuthianum* from Ethiopia

Cultivar	Binary value when susc	Ambo	Awassa	Meki	Bako	Areka	Ziway	Jima	Alem Tena	Adami Tulu
Michelite	1	+	+	+		+		+		
MDRK	2			+	+	+				
Perry Marrow	4			+				+		
Cornell 49 242	8	+		+	+			+	+	+
Widusa	16			+		+			+	
Kaboon	32			+		+			+	
Mexico 222	64	+	+	+		+				+
PI 207262	128		+	+	+		+		+	+
To	256		+	+	+	+		+	+	
Tu	512	+	+		+	+			+	+
AB 136	1024									
G 2333	2048									

Race denomin	585	961	511	906	883	128	269	952	712
No cultivars attacked (virul)	4	5	9	5	7	1	4	6	4

[1] + denotes susceptible reaction

Table 3 Assessment of yield loss and its components from anthracnose 1992 1994

Treatment	Disease severity (%)	Yield (g/plot)	Seed size (g/100 seed)	Seeds/ pod	Pods/ plant	Yield loss (%)
7 days	25 1	1029 5	34 8	4 6	16 0	
14 days	60 3	667 6	33 0	4 2	13 8	35 1
21 days	66 0	677 2	32 8	3 5	15 1	34 3
28 days	78 4	590 5	29 0	4 2	15 2	42 7
Seed trt	79 5	562 6	34 0	4 1	13 4	45 3
Control	84 1	260 7	25 5	3 3	9 1	74 7
P	**	**	**	NS	*	
CV (%)	9 8	25 6	4 9	26 3		

Table 4 Reactions of entries in anthracnose screening nurseries in Ethiopia 1992 94

Location	Mean sev (1 9 scale) on suscept	No entries	Reaction of entries (%)		
			Resist	Int	Suscept
Meko	7 0	100	59	20	21
Ambo	8 7	107	71	15	14
Awassa	6 0	100	80	15	5
Areka	9 0	100	57	16	27

Table 5 Reactions to anthracnose (mean severity 1 9 scale) across locations of promising entries

Entries	SEASON		
	1992	1993	1994
Coco a la creme	2	2	1
Imuna	2	2	2
Kaboon	2	2	2
Prıncor	2	2	2
Wıdusa	3	2	3
PVAD 791	2	2	3
PAD 37	1	2	2
A 4754	2	2	2
K 2	2	2	3
ZAA 5	1	2	3
TU	2	3	3
AB 136	2	2	2
G 2333	2	2	3
BAT 448	2	3	3
Ecuador 299	2	2	3
ACV 17	2	3	2
CEN 60970	2	3	2
PVAD 1184	2	2	2
A 4754	2	2	3
A 613	2	2	1
G 18549	2	3	3
G 19175	3	3	3
Dıacol Calıma	3	2	3
Awash 1	6	5	2
Roba	1	2	2
Negrow 150	3	4	3
Eth 39	2	2	3

Perry Marrow	3	3	3
Local checks			
Mexican 142	7	8	8
Black Dessie	3	5	6
Red Wolaita	2	2	3

STUDIES ON COMPONENTS OF PARTIAL RESISTANCE IN THE HARICOT BEAN RUST PATHOSYSTEM GENOTYPE VARIABILITY AND RELATIONSHIPS AMONG COMPONENTS

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INTRODUCTION

Haricot beans (*Phaseolus vulgaris* L) differ widely in their susceptibility to bean rust (Coyne and Schuster 1975 Ballantyne 1978) Genetic studies in beans have suggested most rust resistance to be monogenic (Stavely 1984 Grafton et al 1985 Webster and Ainsworth 1988) Because of the ability of the bean rust fungus to adapt to new bean cultivars with monogenic resistance (high variability in terms of pathogenicity) the effectiveness of race specific resistance is only temporary (Beebe and Pastor Corrales 1991) For a variable pathogen such as rust of beans selection for higher levels of partial resistance is a better alternative than selection for specific resistance Partial resistance (PR) a resistance that causes a reduced epidemic build up of a pathogen despite a susceptible infection type (Parlevliet 1981) can be expressed at different phases during the life cycle of a pathogen (Zadoks and Schein 1979)

Latent period infection frequency pustule size sporulation capacity and sporulation (infectious) period were used as estimates of partial resistance in several patho systems (Mehta and Zadoks 1970 Shaner and Hess 1978 Statler and Parlevliet 1987) In the bean rust pathosystem (Statler and McVey 1987) no differences in latent period between cultivars were found but the number of pustules per unit area and the number of spores per pustule were associated with levels of partial resistance For a better understanding of the interactions between haricot bean and rust it is essential to evaluate components of PR For application in a breeding program one or two of the components have to be selected In the bean rust pathosystem this paper addresses two aspects

i) identify components which shall be used for rust screening purposes and ii) evaluate and detect differences in the level of resistance in bean cultivars found in the advanced stages of the Ethiopian Bean Improvement Program

MATERIALS AND METHODS

Experimental design

The fifteen bean cultivars used for this experiment originate from the bean improvement program of the Institute of Agricultural Research Nazareth Ethiopia Red Wolaita and Mexican 142 are widely grown cultivars Enrico 23 (Awash 1) and A 176 (Roba) were recently released and Brown Speckled is a standard check in the large kidney bean trials The

experiment was replicated in four blocks and repeated three times Two separate experiments were carried out one for determining latent period infection efficiency and pustule size and the other for determining sporulation capacity and infectious period

Inoculation

All cultivars were inoculated with urediniospores of an Ambo isolate at the primary leaf stage 10 12 days after sowing Inoculation was carried out by spraying suspensions of urediniospores over both sides of the primary bean leaves Microscope slides greased slightly with vaseline were placed horizontally near the plants to check the resulting spore density (spores cm^{-2}) After inoculation all plants were placed in a near saturated atmosphere Twenty four hours after the deposition of spores plants were returned to a bench in the greenhouse where they remained for the duration of the experiment

Experimental data

Numbers of pustules per cultivar were counted daily once white flecks had been observed The change in number of pustules with time was plotted to see variation between cultivars Latent period LP_{50} was calculated as the time in days between inoculation and the moment at which 50 % pustules were open The infection efficiency (IE) the ratio between the number of resulting pustules and the number of spores applied was determined by counting the number of pustules per unit leaf area (sum of the upper and lower surfaces) of the leaves about 15 days after inoculation Pustule size (PS) was assessed when it reached its maximum at about 14 days after inoculation for most of the cultivars according to the scale of Stavely et al (1983)

Sporulation capacity (SC weight of spores produced per unit area) and infectious period (IP period in days from the appearance of the first open pustule until the end of sporulation) were determined per cultivar Spores were collected every 3 days (until no more sporulation occurred) by means of a spore collector beginning the first day of sporulation

All data were collected from areas of 4 cm^2 at either side of the leaf The data were subjected to ANOVA and mean values were separated by LSD at $p \leq 0\ 05$

RESULTS AND DISCUSSION

In some cultivars minute raised white flecks appeared on both sides of the leaves about 7 to 8 days after inoculation A day or two later the epidermis ruptured and reddish brown coloured sporulating pustules appeared Except BAT 338 1c which was found immune to an Ambo isolate cultivars showed sigmoidal curves In most cultivars a maximum was reached 15 days after inoculation but for Awash 1 and Roba sporulation was delayed and did not reach maximum until about 24 days

Variation in components of partial resistance

LP_{50} varied between 9 4 days for ICA 15441 and 18 6 days for Awash 1 Latent periods for most cultivars ranged from 9 4 to 9 9 days In others such as Mexico 6 CSW BAT 1198

and Veracruz 10 LP_{50} ranged between 10 1 and 11 4 days Roba and Awash 1 showed an LP_{50} of 17 or more days

IE varied between 0 1 % for Roba to 5 4 % for KY Wonder 765 IE was below 1 % for Roba BAT 1198 and Awash 1 between 1 and 2 % for Veracruz 10 2 3 % for 4 cultivars and greater than 3 % for the remaining cultivars Differences in IE were mainly due to the small numbers of pustules observed in Roba BAT 1198 and Awash 1 Pustule sizes were small (< 3 μm) for Roba BAT 1198 and Awash 1 small medium (3-4 μm) for ICA 15441 CSW Mexican 142 Mexico 6 US # 3 and Veracruz 10 large (5 μm) for Brown speckled KY 765 and Red Wolaita and very large (> 5 μm) for Jalisco 33

Total amount of spores produced during one infection cycle varied between 0 04 mg cm^2 for Roba to 1 12 mg cm^2 for Jalisco 33 Total amount of spores produced was high for Jalisco 33 and Red Wolaita moderate for Mexican 142 Diacol Calima and Mexico 6 and low for Roba Awash 1 and BAT 1198

Infectious period varied considerably Cultivars with a short infectious period were Roba Brown Speckled CSW Awash 1 Jalisco 33 and Red Wolaita In the intermediate category are BAT 1198 KY Wonder 765 Mexican 142 Mexico 6 and US # 3 ICA 15441 and Diacol Calima had a long infectious period

Latent period infection efficiency pustule size sporulation capacity and infectious period are important components of partial resistance In experiments latent period was found to be an important component in some pathosystems (Neervoort and Parlevliet 1978 Savary et al 1988) but not in others (Statler and McVey 1987 Roumen 1993) However in the 15 cultivars of beans studied here important differences in latent period were found The differences were largely due to two cultivars Roba and Awash 1 with latent periods exceeding 16 days In some cases the difference is one day If the bean season is 90 days and the rust season is 80 days (primary leaf infected) the rust can complete 8 cycles in some cultivars and 7 or less cycles in others Thus the use of a partially resistant cultivar in an area of origin could play an important role in reducing the amount of rust inoculum travelling to other parts of the country Awash 1 and Roba are newly released cultivars tested under a wide range of environmental conditions in Ethiopia Despite their susceptibility to anthrac nose (Habtu unpublished) limiting wider acceptance they showed high levels of partial resistance to bean rust Collaborative activities either in the area of regional rust nurseries or bean yield regional trials currently ongoing in eastern Africa should help to determine the performance of these cultivars under varying climatic conditions

Differences in infection efficiency between cultivars were found in most pathosystems studied (Statler and McVey 1987 Roumen 1993) Our study also supports such findings Small pustule size was associated with slow rusting of wheat (Ohm and Shaner 1976) and high partial resistance in beans (Statler and McVey 1987) Sporulation capacity was highly correlated with partial resistance in the field (Neervoort and Parlevliet 1978 Aust et al , 1984) In our study cultivars Roba and Awash 1 with long latent periods low infection efficiencies and low sporulation capacities had small pustules

This study has indicated wide differences between cultivars in five components of partial resistance Awash 1 and Roba seem to possess ideal characteristics a long latent period low infection efficiency small pustule size low sporulating capacity and a short infectious period A highly susceptible cultivar will have a short latent period high infection efficiency high sporulation capacity long infectious period and large pustule size Of the 15 cultivars tested none showed such characteristics Mexican 142 the widely grown cultivar showed a moderate infection efficiency If all components are considered Mexican 142 is in the higher intermediate category Red Wolaita the most dominant cultivar in southern Ethiopia showed a high infection efficiency

Relationships between the PR components

Linear correlations between latent period and infection efficiency and between pustule size and sporulation capacity were high (> 0.70) Linear correlations between infection efficiency sporulating capacity or pustule size with infectious period were not significant Significant linear correlations exist between latent period and sporulation capacity latent period and infectious period and infection efficiency and infectious period but r values were generally lower (≤ 0.62)

The cultivars appear to differ from one another in all components of PR Clustering of cultivars provides a good picture of associations between cultivars with respect to the components studied Except for Roba and Awash 1 cultivars differ to some degree from one another in the response of their components The expression of partial resistance is complex and so is its measurement (Roumen 1993) depending on environmental factors (Imhoff et al 1982) The differences between cultivars for the various components may point to a race non specific type of resistance (Shaik 1985) which is believed to be durable (Parlevliet 1993)

Any one parameter may not suffice to explain the PR potential of a particular cultivar Our results suggest the inclusion of latent period infection efficiency and pustule size in the selection for partial resistance For the evaluation of large numbers of bean cultivars in the greenhouse infection efficiency and pustule size are preferable to minimize labour As pustule size and sporulation capacity are strongly correlated there is no need to include the latter for screening purposes Infectious period showed poor correlation with other components and thus should be handled with care

Research implications

Because of the different responses of cultivars for the different parameters it is unlikely to find one measure representative for all components The results suggest differences however small in all the components studied For polycyclic diseases such as rust (Parlevliet 1975 Zadoks and Schein 1979) even small differences as found here may benefit integrated bean rust management The existence of such differences in all parameters provides opportunities for identifying PR cultivars at an early stage in the Ethiopian national bean breeding scheme Further studies need to be made (*i*) on the relationship between component response in a monocyclic study on seedling leaves and polycyclic disease progress in the field on adult

plants (*ii*) on correlation between component response at seedling and adult plant stages and (*iii*) in testing a range of PR cultivars with various rust genotypes

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Table 1 Latent period (LP_{50}) infection efficiency (IE) sporulation capacity (SC) infectious period (IP) and pustule size (PS) of primary leaves of 14 cultivars inoculated with a bean rust isolate from Ambo

Cultivars	LP_{50}	IE	SC	IP	PS
ICA 15441	9 4a	2 5d	0 34ef	27 6a	4 0c
Jalisco 33	9 6a	3 1bcd	1 12a	14 6d	6 0a
Red Wolaita	9 6a	3 5bc	0 76cd	15 2d	5 0b
Brown Speckled	9 7a	3 9b	0 38ef	15 2d	5 0b
KY Wonder 765	9 7a	5 4a	0 44de	24 3b	5 0b
Diacol Calima	9 9ab	2 4d	0 58cd	27 3a	4 0c
Mexican 142	9 9ab	2 9cd	0 53de	23 6b	3 5cd
US # 3	9 9ab	3 4bc	0 50de	21 5bc	3 5cd
Mexico 6	10 1ab	2 4d	0 51de	21 5bc	4 0c
CSW	10 2ab	3 6bc	0 47de	15 5d	3 5cd
BAT 1198	10 7ab	0 8ef	0 04g	19 6c	2 5e
Veracruz 10	11 4b	1 2e	0 19fg	22 4b	3 0de
Exrico 23 (Awash)	17 0c	0 2f	0 04g	14 4d	2 5e
A 176 (Roba)	18 6c	0 1f	0 04g	15 0d	2 5e

Cultivar means within each component followed by the same letter are not significantly different at $p \leq 0\ 05$

Table 2 Correlation matrix of latent period (LP_{50}) infection efficiency (IE) sporulation capacity (SC) infectious period (IP) and pustule size (PS) Number of observations (Table 1) = 14 $p \leq 0\ 05$ Entries are linear correlation coefficients

	LP_{50}	IE	SC	IP
IE	0 74			
SC	0 62	0 62		
IP	0 43	ns	ns	
PS	0 62	0 77	0 85	ns

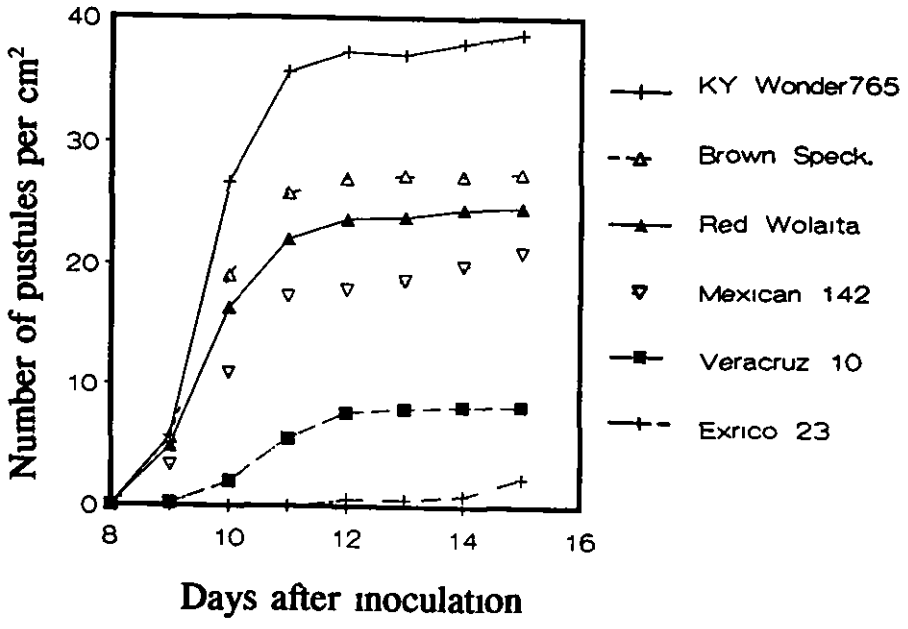

Fig 1 Progress curves of number of pustules cm^2 with time in days for 6 representative cultivars primary leaves

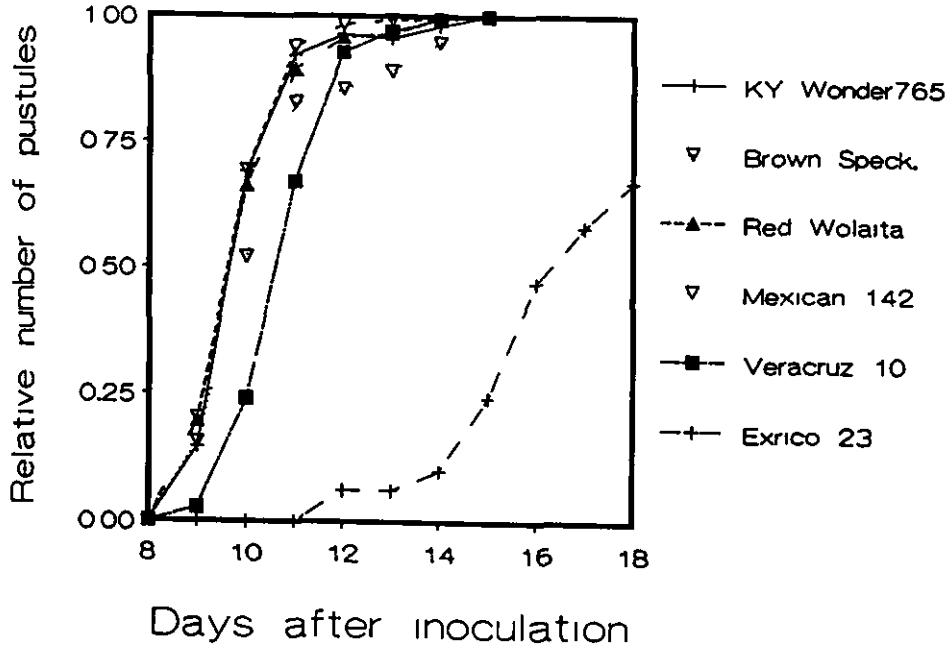

Fig 2 Relative number of pustules per cultivar plotted with time in days for determination of latent period (LP_{50}) graph showing six representative cultivars

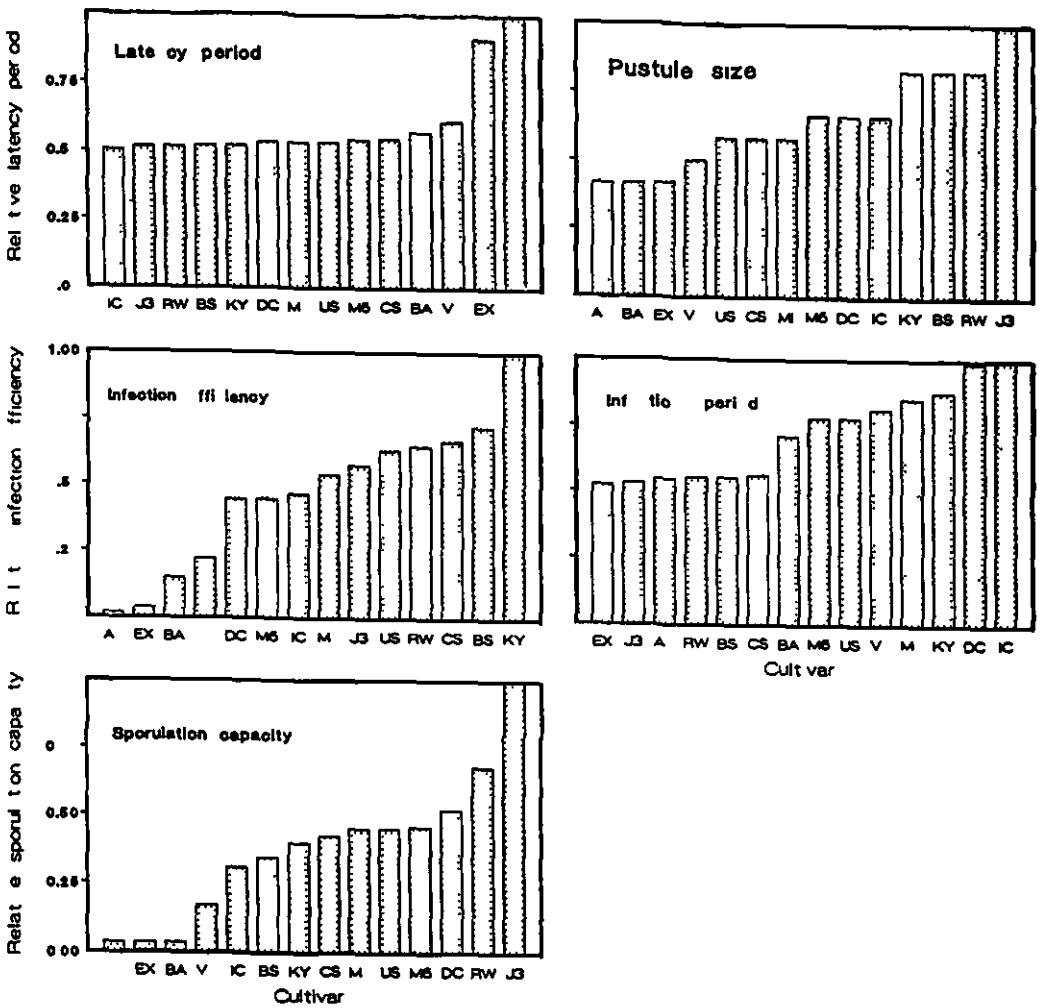

Fig 3 Ranking of cultivars for each of the partial resistance components (relative values) A = latency period B = infection efficiency C = pustule size D = sporulation capacity E = infectious period

SCREENING FOR RUST RESISTANT VARIETIES ADAPTED TO THE HIGHLANDS OF MADAGASCAR

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INTRODUCTION

The highlands of Madagascar including the regions of Antananarivo and Fianarantsoa are the main bean producing regions of the country Bean production is essentially traditional and farmer managed Because of variation of climate throughout the country beans are produced at different times through the year depending on the geographical location There are three main growing seasons of beans in Madagascar during the rainy season (October to February) and the dry season (March to July) in the highlands and after water recedes (April to July) in the lowlands of the south west and north west

In spite of this high potential bean productivity is still low mainly because of various constraints due to both abiotic and biotic factors Among the biotic ones diseases caused by rust anthracnose and angular leaf spot pathogens are the most important yield reducing factors Rust itself causes substantial yield losses varying from 18 to 100% in Latin America (Schwartz and Pastor Corrales 1989) In Madagascar rust was reported to be present throughout the country causing important damage extending to the pods under favourable conditions (Rasolofo and Raliariso 1971) However no effort has been given to control the damage

The present project was designed with the following objectives to assess the importance of the problem throughout its distribution and to develop heavier yielding varieties with tolerance to rust Earlier studies (Rakatomalala and Rabakoarihanta 1993) indicated the existence of varieties which showed various degrees of resistance At this stage it is useful to determine the variability of the local rust pathogen

MATERIALS AND METHODS

To determine the distribution of the rust pathogen surveys including open questions were conducted in several locations when dealing with farmers Formal surveys by questionnaire wwere also carried out The extent of the problem the importance of the crop in the production system and the seriousness of the problem (quantity of loss frequency) were assessed

To search for resistant varieties a screening trial of 25 entries including both local and

introduced materials was conducted for three seasons at several locations After 3 seasons reaction of trial entries was established and rust resistant varieties were identified A multilocational advanced trial resulted in the identification of high performance varieties The combination of the results of both trials enabled the selection of 12 varieties as entries in a final trial which then included highly rust resistant and high yielding varieties The experimental design was a randomized complete block with three replications Each variety in the trial was planted in four row plots measuring five meters long with a spacing of 40 to 50 cm between the rows and 20 cm within rows with two seeds per hill The trial was conducted at three locations representative of distinct agroclimatic regions the characteristics of which are presented in Table 1

In addition a rust nursery consisting of 76 entries was received from Ethiopia and was planted along with 10 entries identified locally as rust resistant Susceptible spreader varieties were planted after every 10 varieties and also around the trial to enhance natural infection Artificial inoculation was also applied three weeks after planting

Reaction to rust was recorded on a 1 9 scale (van Schoohoven and Pastor Corrales 1987) where 1 = no apparent symptoms rated highly resistant and 9 = with more than 25% of leaf area covered with lesions rated highly susceptible The nursery was planted with two replications at two sites Nanisana and Ankazobe (Antananarivo region)

For race identification a set of 20 differential varieties from CIAT (Cali Colombia) was used Race identification was attempted by operating in the following steps (1) Collecting rust spores from three locations Ankazobe Antsirabe Fianarantsoa (2) Planting the highly susceptible variety Gallary and the highly resistant Ikinimba in the field for confirmation of their reaction to the rust pathogen (3) Inoculating the susceptible variety in the greenhouse with spores obtained from a monospore culture and (4) Inoculating the differential varieties with monospore cultures isolated from one infected plant per location and multiplied in the greenhouse for maintenance of inoculum

Evaluation was done a few weeks after inoculation Plants growing in pots were arranged in a complete randomized block design with two replications two pots per variety per replication with 4 plants per pot

RESULTS AND DISCUSSION

Assessment of the importance of rust in different bean producing regions

Investigation started during the cropping season of 1992 1993 in the High Plateaux of Madagascar where the bean crop is most important From the 120 farms surveyed in the regions of Antananarivo Antsirabe and Fianarantsoa it was concluded that rust was present everywhere For the Antananarivo region the middle western part was the most heavily infected this region has a warm and humid climate during the rainy season Rust damage varied from 10 to 25% as compared to the central part of the region For Antsirabe the distribution of rust attack was rather homogeneous for the entire cultivated area The region of Fianarantsoa is humid during the whole year so tends to be less infected than the central or the western part From these observations it can be concluded that rust constitutes one

of the major constraints to bean production in the High Plateaux of Madagascar

Testing the performance of rust resistant varieties

The average seed yield of the different cultivars planted at two representative sites of the regions of the High Plateaux is given in Table 2 The results showed that performance of varieties varied with the region Varieties adapted to one region are not the same as those adapted to the other regions Varieties shown to perform consistently well can be proposed for prerelease

Rust nursery

At Nanisana lack of rainfall for three consecutive months during the pod filling stage led to failure in rust development despite inoculation

At Ankazobe where planting was done in February the bean plants took take advantage of a good rainfall distribution and different reactions to rust were detected Angular leaf spot developed in some cultivars and anthracnose affected the variety PVA 774 (Table 3) The reaction of Gallaroy and Ikinimba in the greenhouse was similar to their reaction in the field (Table 4)

Identification of rust races

Three of the differential varieties failed to germinate Reactions of the remaining varieties are presented in Table 5 Differences between the three isolates in the response of the race differentials are suggested by these data which are regarded as insufficient for separation of races because environmental variation can influence pathogenicity and it is argued further studies are warranted

CONCLUSION AND PERSPECTIVES

The area over which beans are cultivated in Magadascar is wide and different cropping systems exist in different ecological zones After a series of multilocational trials a range of rust resistant varieties has been obtained for the three bean growing regions If different rust races are confirmed to exist a new stage of variety testing against these under controlled environment would become necessary Resistant varieties presently available could be proposed to the extension service for pre release by their inclusion in on farm trials

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Table 1 Agroclimatological characteristics of the locations where rust resistant varieties were tested

Region	Altitude (m)	Annual rainf all (mm)	No of rainy days	Mean annual temp (oC)
Ankazobe	1225	1458	88	19 9
Antsirabe	1506	1432	110	16 9
Fianarantsoa	1106	1224	120	16 6

Table 2 Mean yield (kg/ha) of 12 bean varieties grown at Ankazobe (AKZ) and Antsirabe (ATS) in Madagascar

Variety	AKS	ATS
A 410	1270	1153
Rosinha G2	917	226
Ikinimba	430	1020
Goiano Precoce	1166	1194
Carioca	1041	1071
Pico de Ouro	1104	1184
XAN 78	1083	1260
AND 208	1166	1310
GLPX93	1562	1054
Nain de Kyondo	875	1262
997 CH 173	1354	1115
Menakely	917	1260

Table 3 Reaction to rust angular leaf spot (ALS) and anthracnose (ANT) of some varieties included in the rust nursery at Ankazobe

Varieties	Rust	ALS	ANT
CAN 27	S	R	R
A 445	S	R	R
XAN 97	I	R	R
Mexican 142	R	S	R
TY 3326 6	S	R	R
Ex Rico 23	S	R	R
Cornell 46242	I	R	R
Mexico 35	R	S	R
Compuesto Chimaltenango	I	R	R
A 262	I	R	
Redlands Pioneer	R	S	R
VRA 81035	I	R	R
PAC 19	R	S	R
A 344	S	R	R
A 410	I	R	R
BAT 39	S	R	R
AND 175	S	R	R
MX 1301 1	I	R	R
A 197	R	S	R
PVA 1774	R	R	S
PAN 172	R	S	R
ICAL 24	R	S	R
PAN 134	R	S	R
Ormiston	S	R	R
PAC 29	S	R	R

TY 3396 1	R	I	R
A 139	I	R	R
Black Turtle Soup	R	S	R
Bean Redlands	S	S	R
Diacol Calima	R	S	R

S = Susceptible R = Resistant I = Intermediate

Table 4 Reaction to rust of Gallaroy and Ikinimba in the field and in the greenhouse at three locations in Madagascar

	Field		Greenhouse	
Location	Gallaroy	Ikinimba	Gallaroy	Ikinimba
Ankazobe	S	R	S	R
Antsirabe	S	R	S	R
Fianarantsoa	S	R	S	R

S = Susceptible R = Resistant

Table 5 Reaction (1 9 scale) of differential varieties to inoculation with rust isolates from three locations Ankazobe (AKZ) Antisarabe (ATS) Fianarantsoa (FNR)

	Isolate		
Differential Varieties	AKZ	ATS	FNR
U S No 3	7	7	7
California Small White No 0643			
Pinto No 650	9	9	9
Kentucky Wonder No 780	5	5	1
Kentucky Wonder No 814	9	9	5
Kentucky Wonder No 184			
Golden Gate Wax	7	5	1
Early Gallatin	1	?	?
Mountaineer White Half runner	5	5	1
Redlands Pioneer	5	5	1
Ecuador 299	1	1	5
Mexico 235	1	1	1
Mexico 309			
Brown Beauty	1	5	5
Olathe	5	1	1
AXS 37	1	7	5
NEP 2	1	1	7
Aurora	1	5	1
51051	1	5	5
Compuesto Negro Chimaltenango	1	1	1

Germination failure

PROGRESS IN STUDIES ON FLOURY LEAF SPOT

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INTRODUCTION

Floury leaf spot of beans caused by *Mycovellosiella phaseoli* is amongst those diseases that have previously been ranked as minor in Uganda it has become prevalent in recent years The disease appears at about pod formation in low altitude areas and when severe it results in premature leaf defoliation and pod abortion Severely infected plants tend to have very few or no filled pods

Realizing the potential danger of this disease a project was set up with the following objectives to assess the yield loss associated with floury leaf spot in beans in Uganda to identify suitable inoculation methods for evaluation of bean germplasm for resistance to floury leaf spot to screen a wide range of germplasm from within and outside Uganda in order to identify genotypes resistant to floury leaf spot to compose a floury leaf spot nursery and to develop integrated floury leaf spot control measures The progress with these is described below Results from yield loss assessment have been published elsewhere (Opio 1995)

ASSESSMENT OF YIELD LOSS

Materials and Methods

A study to determine the yield loss associated with floury leaf spot (FLS) was carried out for two seasons (March to June 1993 (1993A) August to November 1993 (1993B) at Kawanda Research Institute and for two seasons at Namulonge Research Institute in 1994 A and 1994 B Both institutes are based in the Lake Victoria crescent zone of Uganda

Three varieties differing in susceptibility to the disease were used in combination with three chemical treatments The varieties were PIE 129 (intermediate) MCM 5001 (K31) (intermediate) and K20 (susceptible) The chemicals included benomyl kocide 101 and water The experimental design was a split plot with varieties in main plots and chemicals in subplots Plot sizes were 10 x 12m with two rows of maize between plots and in guard rows to reduce interplot interference

Spraying with chemicals commenced four weeks after planting and continued weekly until physiological maturity FLS was assessed as severity (percentage leaf area affected) and incidence (percentage number of leaves and number of plants affected) Incidence was counted on ten plants randomly selected in each plot and severity used a 1 9 scale developed at CIAT

The number of plants per plot was assessed using a 1m square quadrat Five quadrats were taken per plot At R8 (pod filling) other diseases present were assessed Insect pests were controlled by two sprays of ambush Regression analysis was used to evaluate the relationship between FLS and yield

Results

There were significant differences in yield between varieties in disease severity and incidence from pod filling stage (R7) to physiological maturity (R9) in all four seasons K 20 was the most susceptible and PIE 129 the most resistant However PIE 129 was not significantly different from MCM 5001 and no difference in efficacy was detected between Benlate and Dithane M45 The two fungicide treatments were significantly different ($P \leq 0.05$) from the control (water)

The effect of FLS on yield was dependent on the susceptibility of the genotype stage of growth and season Regression analysis showed that the highest loss in yield of beans due to FLS occurred if the disease was severe at pod filling (R8) stage

The regressions of yield on severity for K20 were negative and significant ($P \leq 0.05$) at pod filling stage over the four seasons The severity of FLS was 8 19% There was significant and negative correlation between severity and yield for genotypes MCM 5001 in 1994A only No significant correlations were noted for PIE 129 in any season The slope (regression) coefficients for the significant regressions were as follows for K20 the coefficient for 1994A was 25 9 Yield loss estimates using FLS severity values at pod filling stage showed that K20 suffered the highest loss for the four seasons At this stage the losses for this genotype ranged from 10 8 27 8% Significant yield reductions for MCM 5001 in 1994A was 8 3% (Table 2)

EVALUATION OF INOCULATION TECHNIQUES

Materials and Methods

A study was carried out for three seasons (1993 B 1994 A and B) to evaluate three different inoculation methods and to determine which among these methods was most appropriate for evaluating bean germplasm for FLS The three inoculation methods used were dried leaf powder (i e dusting ground leaf powder on leaves) spraying using a spore suspension spreading infected dried leaves within the rows of beans

Three varieties with differing levels of resistance to FLS were used These were K20 (susceptible) CAL 96 (susceptible) and MCM 5001 (intermediate) The experimental design was a split plot with varieties in main plots inoculation was at three weeks after planting flowering (R6) pod formation (R7) and pod filling (R8) FLS was assessed at R6 R7 R8 and R9 (physiological maturity)

Results

No significant difference between the inoculation methods was obtained This means any of the methods could be used in assessing of bean germplasm for susceptibility to FLS There were significant differences between varieties as expected with K20 giving the highest severity of FLS followed by CAL 96 and MCM 5001 respectively

FLOURY LEAF SPOT NURSERY

Two hundred bean lines were evaluated for FLS in 1993A when the disease was very severe Out of the materials screened 33 lines were selected for inclusion in the initial FLS nursery which was planted in 1994A Most of the bean lines were resistant or intermediate A few susceptibles were included In 1994B the 33 lines together with lines received from pathologists in Tanzania (10 lines) Malawi (8 lines) and Ethiopia (7 lines) were evaluated for FLS reaction at Namulonge Research Institute Table 3 shows the reaction of the bean lines evaluated at Namulonge in 1994B Fifteen lines were resistant thirty eight were intermediate and seven susceptible These lines will again be grown in Namulonge in 1995A and then they will be sent to collaborators who are interested in evaluating them in their countries

INTEGRATED CONTROL OF FLS

The study on integrated control of floury leaf spot was started in 1994 It is being carried out with farmer participation initially in one village (Matugga) Planning meetings with farmers were held in Matugga in season 1994 A to discuss what control measure could be used against FLS and how they perceived diseases in general

The methods that farmers suggested were the use of resistant varieties the use of clean seed roguing crop rotation and the use of organic soil amendments like *Crotalaria* in agroforestry and farmyard manure

The initial step was to select resistant varieties We selected four resistant two intermediate and two susceptible One of the susceptibles was the farmers variety Farmers planted the varieties and selected the seed at harvest Selection of seed was from plants marked just before harvest with very little or no FLS infection Pods were handpicked from these plants and threshed separately At planting large clean seeds were selected for planting

In 1995A the seed harvested as described above is the one the farmers have used as seed Thirty farmers are involved They are now carrying out rotation About ten of them are using organic amendments in addition to rotation They are also practicing roguing In doing this other important diseases such as CBB BCMV ALS and rust are also being taken into consideration This work will continue for another three seasons to determine whether FLS will be reduced by the above management

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Table 1 Mean squares from analysis of severity at pod filling (R8) and clean seed yield to determine the effect of floury leaf spot on yield of beans at Kawanda over two seasons (1993A 1993B) and at Namulonge for one season (1994A)

Source	df	Mean squares					
		Severity			Seed yield (kg/ha)		
		1993 A	1993B	1994A[b]	1993A	1993B	1994A
Replicat ion	2	0 48	1 11	0 56	9410 8	37378	1135 92
Varieties (v)	2	3 81**	0 12**	1 82**	264495 2*	4051 1**	355120 6**
Error	4	0 53	0 04	0 06	20339 5	1545 4	50172 6
Chemic als (c)	2	0 26	0 04	0 16	2011 7	26951 2	16813 5
C x V	4	0 98	0 07	0 15	38605 7	8369 2	29942 1
Error	12	0 8	0 34	0 62	33554 8	11835 4	25126 6
CV (%)		17 9	16 5	17 5	27 8	21 7	22 2

* Significant at 5% level

** Significant at 10% level

Table 2 Severity of floury leaf spot and yield loss associated with three genotypes of *Phaseolus vulgaris* at Kawanda (in 1993) and Namulonge (in 1994) in Uganda

Genotype	Growth stage	Season	b	Severity	MAY[b]	Yield loss (kg/ha)	Yield loss (%)
K 20	Pod filling (R8)	1993A	22 9	12	1392	274 8	19 7
		1993B	11 9	8	850	95 2	10 8
		1994A	25 9	19	1536	492 1	27 8
MCM 5001	Pod filling (R8)	1993A	12 7	10	2750	127 0	4 6
		1993B	8 4	4	2250	33 6	1 4
		1994A	16 6	12	2400	199 2	8 3
PIE 129	Pod filling (R8)	1993A	10 5	7	2640	73 5	2 8
		1993B	7 2	3	2100	21 6	1 0
		1994A	14 5	9	2830	130 5	4 6

b is the slope (regression) coefficient indicating the reduction in yield for every unit increase in disease severity

[b] MAY Maximum attainable yield yield loss = $\frac{b \times \text{severity}}{\text{MAY}} \times 100$

Table 3 Reaction (mean scores 1 9 scale) of bean lines to floury leaf spot and other diseases at Namulonge in second season 1994

Entries	ALS			CBB			RUST			FLS			BCMV		
	R7	R8	R9	R7	R8	R9	R7	R8	R9	R7	R8	R9	R7	R8	R9
EMP 233	2	3	5	2	3	4	2	3	3	2	2	2	2	2	3
PIE 129	2	2	4	2	2	3	2	2	2	3	6	7	2	3	3
OBA 1	5	6	7	2	3	3	2	2	2	4	5	6	1	1	2
K 131	3	5	6	3	4	4	1	1	3	3	6	6	2	2	4
UGP 6088	3	5	7	3	4	4	1	1	2	3	6	6	2	2	3
APRS 41	4	5	6	2	2	2	2	2	3	3	4	5	1	1	2
RAB 475	4	5	5	3	4	4	2	2	3	4	6	7	1	1	2
F8 DC86 298	4	5	5	2	3	2	2	2	2	3	4	4	2	2	2
RAB 482	2	3	5	2	3	4	1	1	3	4	5	7	1	1	3
ERA 4	2	3	4	2	3	4	3	3	2	4	5	5	1	1	1
RIZ 103	2	3	4	2	3	4	2	2	3	3	4	6	1	1	4
K 132	4	6	6	2	3	5	2	2	3	3	4	5	2	3	3
AND 905	4	6	7	2	3	2	1	1	2	4	6	6	1	1	1
F9 SDDD 184 35	3	5	5	2	2	2	1	1	2	3	3	4	2	2	2

AND 890	3	5	6	2	3	3	1	1	2	3	3	3	2	2	2
F8 DC95 109	4	4	6	2	2	2	1	1	2	2	2	3	1	1	2
F8 DC96 106	4	5	7	2	3	3	1	1	2	2	3	3	2	2	2
RWR 140	4	5	6	2	3	3	2	2	2	3	5	5	1	1	1
F8 DC95 126	5	6	6	2	2	3	2	2	3	2	3	4	2	2	2
AND 773	5	6	7	2	2	3	2	2	2	2	3	3	2	2	2
K 20	5	6	7	2	3	3	3	4	4	2	2	2	2	3	3
AFR 600	3	4	6	2	3	3	2	3	3	5	7	7	4	5	7
AND 923	5	6	5	2	3	3	2	3	3	3	5	5	2	2	5
MCM 3031	3	4	7	2	3	3	2	2	3	2	3	6	1	1	4
EMP 234	4	6	8	2	2	3	1	1	3	4	5	5	2	2	6
MCM 2203	2	3	4	2	2	3	1	1	3	4	6	7	1	1	6
F8 DC95 125	3	4	7	2	2	2	2	2	2	2	3	4	2	2	2
MCM 2001	3	4	6	2	2	4	1	1	3	3	5	6	2	2	4
MCM 1015	3	4	6	3	4	4	1	1	2	4	6	6	2	2	3
CNF 5506	2	2	3	2	3	3	1	1	2	4	6	6	1	1	1
RWR 136	4	6	7	2	3	3	1	1	2	2	3	5	1	1	3
6 1	5	7	8	2	2	4	1	1	3	2	2	4	2	2	3

G 5167	3	5	8	2	2	2	2	2	3	2	2	3	2	2	2
PVB 1589	3	4	7	2	3	4	1	1	4	4	6	6	2	2	2
COS 9	3	4	7	3	4	5	2	2	3	3	4	5	2	2	2
PVA 692	3	4	6	2	2	4	2	3	3	3	3	4	2	3	3
PC 293 C11	2	2	4	2	2	3	2	3	4	2	6	6	2	2	2
5 2	3	4	7	2	2	3	2	3	2	2	2	2	2	3	3
17N/3	4	5	8	2	2	3	2	3	4	2	2	2	2	2	2
Black Sukanywele	3	4	7	2	2	2	2	3	5	2	2	2	2	2	2
G 5476	4	4	6	1	1	3	1	1	3	1	1	2	2	2	4
Mbozı Bonıfo	4	6	7	2	2	3	3	4	6	2	2	2	2	3	3
Uyolego	3	4	5	3	4	4	2	2	4	3	6	6	1	1	3
Uyole 84	3	4	7	2	2	4	1	1	3	2	2	3	2	2	2
Lyamungu 85	5	6	8	2	2	4	4	5	5	3	4	4	2	2	2
PBABL 146	5	6	7	2	2	4	3	4	4	2	3	3	2	2	2
EAI 2525	4	6	7	2	2	4	2	2	4	2	3	3	1	1	3
Ilomba	3	4	6	2	2	4	1	1	3	3	4	5	1	2	2
OQG 273	3	4	6	2	3	4	1	1	3	4	6	6	2	2	3

G 18211	3	4	5	2	2	4	4	6	6	2	2	4	2	2	4
REPEEP 12 553	3	4	6	3	4	5	2	2	4	3	5	5	2	2	3
Cap Haitien	4	6	6	2	2	4	2	3	5	2	3	5	1	1	3
BAT 496 ANT	2	2	5	2	2	4	2	2	4	2	6	6	2	3	3
A 613	3	5	6	3	4	4	1	1	3	2	5	6	2	2	3
A 585	3	3	6	2	2	4	1	1	3	1	6	7	1	1	3
K 2	5	8	8	2	2	3	1	1	3	1	3	6	1	1	3
A 482	4	8	6	2	2	3	2	2	5	2	2	4	2	2	3
CEN 60970	4	5	6	3	4	5	1	1	4	2	7	7	2	2	3
A 493	3	4	7	2	2	4	1	1	3	2	3	4	2	2	4

CONTROL STRATEGY FOR BEAN ROOT ROT IN WESTERN KENYA

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ABSTRACT

Ten sources of resistance and six sources of tolerance to root rot were identified among lines of common bean evaluated All these promising materials were introductions from Rwanda except GLP x 92 which is of Kenyan origin Local farmers in Vihiga district of western Kenya were found to be willing to adopt GLP x 92 instead of the root rot susceptible GLP2 The application of diammonium phosphate and green manure each improved plant stand and root regeneration and significantly increased seed yield relative to an untreated control Ridging also gave some significant improvement but less so The use of potassium chloride urea certified seed and benomyl treated seed gave no advantage over the control (ed)

INTRODUCTION

Beans *(Phaseolus vulgaris L)* are believed to have been introduced to Kenya in the 16th Century and have been cultivated for over 300 years (Mukunya & Keya 1975) Field beans are the most important leguminous crop and leading source of plant protein for the Kenyan population (Acland 1986 De Groot 1979) Acland (1986) indicated about half a million hectares were grown annually By 1991 about 1 000 000 hectares were grown (Otsyula 1991) attributed to area expansion Beans are grown over a wide range of environments largely by small scale farmers for subsistence At present national average yields are low (700kg/ha) relative to research yields (1500kg/ha) Main constraints in bean production are diseases low soil fertility and insect pests in descending order of importance

Bean root rot is a major bean disease in the region It is caused by a number of soil pathogens including species of *Fusarium Sclerotium* and *Pythium* Root rot is prevalent under conditions of low soil fertility high soil moisture and continuous cropping of beans The root rot pathogens are spread through soil seed and water The symptoms associated with root rots are reddish discoloration of the primary root stunted growth and progressive yellowing of the leaves Buruchara et al (1992) indicated that bean root rots are associated with production systems and environmental conditions such as continuous growing of beans use of high plant densities lack of inorganic fertilizers and continuous use of susceptible varieties Consequently there is build up of inoculum in the soil and less vigorous plants prone to attack so that severity is high (Abawi 1989)

In western Kenya human population densities are very high and land size per family has reduced to 0 75 ha Farmers are therefore growing beans throughout the year in both Short and Long rains This has resulted in low soil fertility with nitrogen and phosphorus as limiting nutrients (Rachier 1990) There is a limited number of varieties for farmers in this region The national bean program has only been able to release five varieties in the last fifteen years Among the released varieties GLP 2 is grown widely by the farmers of

western Kenya where it has become susceptible to bean root rot Possible control measures of bean root rot lie in the manipulation of the environment and screening of bean germplasm lines in an attempt to identify sources of resistance This paper describes recent progress in this direction

MATERIALS AND METHODS

Germplasm evaluation

Work started in the Short Rains (1992) season with identification of hot spots through farmer interview two farmers were chosen in Vihiga district Cultivar GLP 2 which is susceptible to bean root rot was planted at these sites as confirmatory of the hot spots and to increase disease pressure Three hundred and seventy four local and twenty six introduced (from CIAT Rwanda) lines were screened They were planted in 2 rows of 3 m without replication Forty two lines were selected from the two farmers in the Long Rains 1993 During the Short Rains 1993 these lines were planted in 2 replicated trials on the two farms for further screening Root rot was assessed by sampling plants from each row and the extent of root rot lesions was determined Reactions were classified as resistant (less than 10% of the root covered by the lesion) tolerant (10 30% of the root covered by the lesion) and susceptible (more than 30% of the root covered by the lesion) The data taken included plant count two weeks after emergence root rot score at the V2 stage root score at podding plant count at harvest yield per plot and root regeneration ability

Cultural methods

Soil fertility treatments were investigated for the effect on root rot as follows

Potassium chloride was applied as a source of potash at the rate of 100 kg/ha

Diammonium phosphate was applied at the rate of 150 kg/ha

Urea was applied (at 40 kg/ha) as a source of nitrogen

Green manure was applied 10 14 days before planting at the rate of 10 tons

Beans were planted on ridges

Certified seed Benlate was used as a seed treatment at the rate of 28 g/ha of bean seed

Farmers own seed and practice

The trial was laid out on the farmers fields in Vihiga during the Long and Short Rains 1993 using a randomized complete block design with three replications Plot size was six 3 m rows spaced at 50 x 15 cm Four middle rows were harvested (net plot of 3m x 2m) and the two were used for destructive sampling for root rot severity scores Similar data as taken in the germplasm evaluation trial were collected

RESULTS

Germplasm evaluation

From the 42 lines evaluated in the Long Rains 1993 16 entries were selected (Table 1) All the materials found resistant were introductions from Rwanda the only local material found tolerant was GLP x 92

Cultural methods

Combined data over two seasons are presented in Table 2 Diammonium phosphate and green manure each significantly improved root regeneration and increased yield relative to the control (Table 2) Potassium chloride urea seed treatment and certified seed showed no improvement Ridging led to improved stand count slightly improved root regeneration and somewhat increased seed yield relative to the control but the yield response was significantly inferior to that given by diammonium phosphate and green manure

DISCUSSION

There was no association between root rot resistance or tolerance and either seed type or maturity group THe line KK ITR 25 which is considered root rot resistant in Rwanda (Buruchara 1992) was found susceptible in the present study It is possible that this discrepancy is attributable either to environmental variation (or to differences in the species components of the pathogen complex ed) between the two locations

From the results on cultural practices against root rot it is evident that soil infertility influences root rot severity which is decreased by the addition of phosphate or green manure The high cost of inorganic fertilizer may limit its use but there may possibly be opportunities for production of green manure perhaps in systems of agroforestry Prospects for the control of root rot by an integrated approach seem sound

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Table 1 Identity seed colour and maturity group of germplasm found resistant (R) or tolerant (T) to root rot during the 1993 Short Rains Vihiga district Western Kenya

Line	Seed Type	Maturity	Reaction
KK ITR 22	RED HARICOT	LATE	R
KK ITR 15	BLACK	EARLY	R
KK ITR 1R	GREY	MED	R
KK ITR 8	ROSE COCO	EARLY	R
KK ITR 20	CANADIAN WONDER	EARLY	R
KK ITR 14	CHOCOLATE YELLOW	LATE	R
KK ITR 12	ROSE COCO	EARLY	R
KK ITR 21	ROSE COCO	MED	R
KK ITR 10	GRAY SMALL	LATE	R
KK ITR 19	ROSE COCO	MED	R
GLP X 92	PINTO	MED	T
KK ITR 7	ROSE COCO	EARLY	T
KK ITR 9	ROSE COCO	EARLY	T
KK ITR 13	CHOCOLATE YELLOW	MED	T
KK ITR 2	ROSE COCO	MED	T
KK ITR 23	ROSE COCO	MED	T

Table 2 Effects of cultural method on seed yield plant stand root regeneration and severity of root rot

Treatment	Yield (kg/ha)	% Stand Count		% Root lesion	% Root Regene
		2 WAP	Harvest		
DAP	646 2 A	80	78	50	70
Green Manure	496 7 A	70	66	50	50
Ridging	361 3 B	100	70	50	30
Urea	271 2 C	70	8	50	<10
KCL	253 1 C	70	10	50	<10
Seed Certified	262 2 C	70	7	50	<10
Seed treatment	211 3 C	70	7	50	<10
Control	129 9 C	70	5	50	<10
LSD	134 8				
CV (0 05) %	29 6				

WAP weeks after planting
DAP diammonium phosphate KCl potassium chloride

Values followed by the same letter are not statistically different (at 5% level)

BREEDING BEANS FOR MULTIPLE RESISTANCE TO FOLIAR FUNGAL DISEASES STRATEGY AND EXPERIENCE

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INTRODUCTION

Development of cultivars with resistance to disease is probably one of the cheapest and most effective management strategies Use of chemicals is not only expensive for small scale producers but also poses environmental hazards Biological and cultural methods often serve as supplementary strategies Consequently breeding for resistance has been a major objective in most bean improvement programmes in eastern Africa Host resistance does not add to production costs unlike other strategies In recent years bean programmes have tended to focus on specific major diseases such as angular leafspot (Pyndji 1992 Gasana 1992) rust (Habtu Assefa 1992) charcoal rot (Songa 1992) and ascochyta blight (Male Kayiwa 1992) However in production fields the incidence and severity of these major diseases varies with seasons and locations such that two or more diseases cause economic losses in any one region (Wortmann and Allen 1994) In eastern Africa anthracnose angular leafspot rust halo blight bean common mosaic virus and root rots are widespread and cause major losses Cultivars with resistance to only one of these diseases is likely to be of limited value Little effort has been made to develop bean cultivars with multiple resistance to major diseases in eastern Africa A programme was initiated at the Department of Crop Science University of Nairobi in 1989 to develop bean cultivars with improved resistance to two or more diseases combined with other desirable characters This paper reports on the strategies and progress made in this programme with emphasis on foliar fungal diseases

MATERIALS AND METHODS

Figure 1 shows the generalized scheme used in developing lines with improved multiple resistance to disease and grain yield

Choice of parents

Seven bean lines with contrasting resistance to anthracnose angular leafspot halo blight bean common mosaic virus and common bacterial blight grain yield and seed characteristics were selected from available bean germplasm Characteristics of these lines have been described previously (Kimani et al 1990) The lines included four locally popular cultivars (GLP2 GLP24 GLP288 and GLPX 92) one black seeded local land race with resistance to rust anthracnose and angular leafspot (NB 123) a small white seeded line also with resistance to rust anthracnose angular leafspot and root rots (L226 10) and one line derived from Canadian Wonder (GLP 24) through mutation breeding

Hybridisation

The seven lines were crossed in a complete diallel in the glasshouse in 1986 The F1 plants were advanced to F2 and F3 generations

Screening for resistance to anthracnose, angular leafspot and rust

The parents F1 F2 and F3 generations were grown in pots in the glasshouse and in the field at Kabete near Nairobi They were inoculated separately with local isolates of *Colletotrichum lindemuthianum Phaeoisariopsis griseola and Uromyces appendiculatus* as described by Kimani et al (1990) Individual plants were rated for disease reaction on a 1 9 disease severity scale where 1 3 are resistant 3 1 6 0 moderately resistant and 6 1 9 0 susceptible (van Schoonhoven and Pastor Corrales 1987) Test materials were inoculated both in glasshouse and in the field Disease assessment was done about 21 days after inoculation (R6) and also at mid pod filling stage (R8) The higher of the two ratings was taken as the final rating F2 plants rated resistant to each disease were advanced to F3 Those combining resistance to two or more diseases were advanced to F4

Selection for grain yield

Selected F4 lines were evaluated in an early generation replicated yield trial for three seasons (1988 1990) In each line ten plants with high podding ability (> 10 pods/plant) and mean yield were bulked and advanced to the next generation Two hundred F5 and F6 lines were selected for preliminary yield trials at five locations in Kenya These were Kabete (Nairobi district) Thika (Thika District) Marimanti (Meru district) Rongai (Nakuru district) and Tigoni (Kiambu district) in 1991 and 1992 Fifty lines were selected on the basis of grain yield and disease reaction at the five locations Seed characteristics were also considered The 50 lines were evaluated in advanced yield trials at ten locations (Kabete Taita Tigoni Nyeri Embu Kisii Katumani Ol Jorok Kakamega and Rongai) for three seasons (1992B 1993A and 1993B) In each trial the experiment was laid out in a randomized complete block design with four replicates A plot consisted of four 5m rows with a spacing of 50cm between rows and 10cm within rows A basal rate of 100 kg ha^{1} diammonium phosphate (18%N and 45% P_2O_5) was applied at planting Plots were kept weed free by hand cultivation Five locally popular cultivars were included as checks in each trial Data were recorded on severity of anthracnose rust angular leafspot and grain yield

Screening for resistance to floury leafspot

Leaves infected with *Mycovellosiella phaseoli* were collected from farmers fields in Taita Tavetta district where preliminary surveys had shown a high incidence of the disease Spores from sporulating lesions were incubated on potato dextrose agar (PDA) enriched with host material and incubated at 20 24oC Single conidia were isolated from 15 day old cultures and transfered to enriched PDA media incubated at room temperature A conidial suspension was prepared by flooding 15 day old cultures of *M phaseoli* grown in bean leaf decoction agar In the glasshouse experiments 56 F9 lines were inoculated using a modified a 48 hour double inoculation technique The conidial suspension was applied on both sides of the leaf using a Bayton atomizer (Bayer East Africa Ltd) High humidity was maintained by covering

inoculated plants with transparent plastic bags for 4 days and soaking the floor of the glasshouse Field experiments were conducted in Wundanyi division Taita Tavetta district in a farm with a history of high incidence of floury leafspot during 1993B and 1994A seasons Inoculation was done 2 3 and 4 weeks after germination Disease reaction was assessed three times after appearance of symptoms The severity rating was on a 1 9 scale where 1=0% leaf area infected 2=0 1 5% 3=5 1 12% 4=12 1 20% 5=20 1 30% 6=30 1-40% 7=40 1 50% 8=50 1 60% and 9 where more than 60% of the leaf area was infected Grades 1 3 were considered resistant 4 6 moderately resistant and 7 9 susceptible

Data analysis

Data were analysed on an individual site basis to determine if there were any significant genotypic differences for each trait A combined analysis was performed as described by Gomez and Gomez (1984) Least significant differences (LSD) were used to separate mean values

RESULTS AND DISCUSSION

Results from the early generation yield tests and initial screening of the segregating materials have been reported previously (Kimani et al 1990) In the advanced yield trials at ten locations there was considerable variation in disease incidence and severity among locations and seasons Only in seven of the twenty trials were disease levels adequate to facilitate a fair assessment of the reaction of the 50 lines to foliar fungal diseases The data fron these trials are presented in Tables 1 2 and 3

Anthracnose

Anthracnose was not severe at Kabete during 1992B and 1993A seasons Katumani in 1992B nor Taita Tavetta in 1993A and B There were significant differences among the lines in their reaction to anthracnose All the early maturity lines were rated as moderately resistant Disease scores ranged from 3 2 to 4 9 Lines E 3 37 and E10 were rated susceptible at Taita during 1993A The check cultivars GLP 585 had the highest score of 8 3 at the same site Among the medium maturity lines mean anthracnose ratings varied from 1 6 for M21 to 4 2 for M13 Eleven lines were rated resistant and 9 as moderately resistant The highest anthracnose scores were recorded at Taita during 1993A season M13 M26 and M31 were rated susceptible at this site for one season M21 was consistently rated resistant al all sites In the late maturity group anthracnose ratings varied from 2 2 (L39 and L44) to 4 4 (150) L44 was consistently rated resistant at all sites GLPX92 had the lowest disease score among check cultivars GLP24 and GLP585 were relatively more susceptible to anthracnose compared to GLPX92 and GLP2

Angular leafspot

Severe incidence of angular leafspot was recorded at Kabete for three seasons Taita for two seasons and at Katumani for one season There were significant differences among the lines in their reactions to angular leafspot (Tables 1 2 and 3) Severity varied with genotype location and season The highest mean ratings for angular leafspot were recorded at Taita in 1993A The reaction of individual lines differed with location For example M26 was

rated resistant (1 0) at Kabete and moderately resistant (5 5) at Taita Among the early maturity group E1 E8 and E10 were rated resistant All other lines in this group were moderately resistant Among the medium maturity lines angular leafspot ratings varied from 2 6 (M27) to 5 1 (M30) Two lines were rated resistant (M15 and M27) All others were moderately resistant to angular leafspot In the late maturity group angular leafspot ratings varied from 2 7 (L41 and L44) to 4 1 (L37) GLP 585 was the most susceptible check with a score of 8 0 at Taita in 1993A At this site and season lines with high levels of resistance were E10 (1 0) L39 (2 5) L32 (2 5) L41 (2 5) E7 (1 8) M21 (3 0) and L46 (3 0) M30 (8 5) L37 (8 5) L49 (6 5) L33 (6 5) M31 (6 5) M29 (6 5) were rated susceptible All other lines gave an intermediate reaction

Rust

The highest rust scores were recorded at Kabete (1992B and 1993B) Katumani (1992B and 1993B) and Taita (1993A and B) The check cultivar GLPX92 showed consistent susceptible reaction at the three sites (mean score 7) Mean scores showed that the test lines had generally good levels of resistance to rust During the 1993 A season E8 M16 M19 M31 L34 were rated as susceptible GLP X92 had a rust score of 8 5 at this location Three early (E3 E6 and E9) ten medium (M11 M14 M18 M20 M21 M23 M24 M26 M29 M30) and 17 late maturity lines were rated resistant to rust at Taita in 1993A All other lines showed intermediate reactions

Floury leafspot

Glasshouse and field ratings for floury leafspot are shown on Tables 1 2 and 3 Although severity in the glasshouse was higher the glasshouse and field ratings were positively and significantly correlated (r = 0 89 P = 0 01) Among the ten early maturity lines four were rated resistant (E1 E4 E5 and E9) The rest were moderately resistant Among the medium maturity lines 8 were susceptible three resistant Of the five check cultivars two were resistant (GLPX92 and GLP 585) two moderately resistant (GLP 2 and GLP 24) and one susceptible (GLP 1004) Only one late maturity line (L40) was resistant to floury leafspot Nine late maturing lines were rated susceptible both in the glasshouse and in the field All other lines showed an intermediate reaction

Yield

The grain yields of the 50 lines over the seven environments with the highest disease severity are shown in Tables 1 2 and 3 for the early medium and late maturity lines respectively Among the early maturity lines grain yield varied from 1818 to 2425 kg/ha Grain yield among the medium maturity lines varied from 1902 kg/ha (M29) to 3131 kg/ha (M21) The range was 2027 kg/ha (L33) to 3197 kg/ha (L40) among the late maturing lines GLP2 had the highest yield (2343 kg/ha) among the check cultivars Seed yield of GLPX92 was considerably reduced at Taita (905 7 kg/ha) probably due to the high rust incidence One early 19 medium and 12 late maturity lines had higher yields than the best check cultivar

DISCUSSION

Lack of an appropriate methodology is a constraint in breeding for multiple resistance to diseases Backcross breeding has been widely used in breeding for major gene resistance to individual diseases We propose a new methodology for breeding for multiple resistance and grain yield (Fig 1) The key steps in this method are choice of parents hybridisation development of disease screening nurseries and selection early generation yield testing researcher farmer collaborative preliminary yield trials advanced yield trials on farm testing seed increase and release Choice of parental lines with resistance to disease is crucial for subsequent progress Parents may be obtained from available germplasm such as landraces accessions released cultivars or advanced breeding lines Well adapted popular but disease susceptible lines should be included whenever possible For example in the present study GLP2 and GLP 24 were included because they are the most popular varieties in Kenya despite low levels of resistance to some fungal diseases NB 123 is a local landrace with resistance to anthracnose rust and angular leafspot However its seeds are small and black and hence unacceptable to majority of consumers If reliable information on disease reaction and other desirable characteristics of parental lines is not available preliminary evaluation is advisable The number of parents should be limited to less than ten to reduce the number of segregating populations to be handled in subsequent steps A suitable mating design should be applied in the hybridisation programme In this study strict adherence to conditions favourable for successful pollination and fertilization resulted in exceptionally high crossing success rates (Kimani et al 1990) Diallel three way or polycross mating designs may be employed The F1 progeny is advanced to the segregating F2 generation Adequate F2 seed for the individual disease nurseries to be established will depend on diseases being considered Equal amounts of F2 seed should be planted in each disease nursery If artificial inocula of races of a pathogen are available sequential or multiple inoculations are appropriate Suitable susceptible checks for each disease should be included Individual resistant F2 plants from each nursery should be advanced to F3 The F3 progeny lines are grown in disease nurseries and artificially inoculated Families of resistant F3 plants are advanced to F4 Pedigree of F2 and subsequent generations should be maintained F4 lines with resistance to two or more disease are evaluated for yield and other desirable characteristics in two or more disease hot spots Selected F4 lines are evaluated in preliminary yield trials at 3 to 5 sites On station farmer evaluations are desirable as materials are advanced to F6 and F7 generations This provides an opportunity for farmers to introduce their selection criteria which may differ from that being pursued by the breeder F8 to F10 lines are evaluated in multi location yield trials The number of lines in multilocation trials should be limited to provide for a better assessment of individual lines Local checks should be included in preliminary and advanced yield trials Selected lines from advanced trials are grown on farm in conditions representative of growing areas The final selections are based on breeders and farmers criteria Selected superior lines should be grown in large plots for increase of breeders seed and meticulously examined and characterised This selection scheme takes about 12 years to develop a new cultivar if only one generation is produced each year However if two generations are advanced per year progress is greatly accelerated This procedure has the advantage that selection for both monogenic and polygenic characters can be handled

The results of this study illustrate the potential progress and difficulties that can be expected through this selection scheme Results identified lines with improved resistance to all four

foliar diseases For example E1 and E5 are resistant to angular leafspot rust floury leafspot and intermediate for anthracnose M25 was rated resistant to anthracnose rust floury leafspot and intermediate for angular leafspot *L40* combined high levels of resistance to the four diseases and had the highest yields However some lines were susceptible to the four diseases and yet yielded well More lines were susceptible to floury leafspot than to other diseases because selection against this disease was only done at advanced stages There is evidence of pathogenic variation for rust (Mukunya and Keya 1978) anthracnose (Mwangi 1986 Mukunya and Keya 1978) and angular leafspot in Kenya and it is possible that some of the site effects we obtained are attributable to such variation

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Table 1 Seed characteristics yield and disease severity (mean score 1 9 scale) of ten early maturing bean lines grown in seven environments in Kenya 1992 93

Line/Cultivar	Source population	Seed type	100 seed weight (g)	Disease Rating *			Floury leaf spot		Yield (kg/ha)
				ANT	Angular Leaf Spot	Rust	Glass house	Field	
E1	K7/6A	RC	55 8	3 6	2 9	1 9	3 0	3 0	2425 0
E2	K7/9A	RC	52 6	3 6	3 1	2 1	6 0	4 0	2265 0
E3	K7/12A/2	RC	56 5	4 9	3 1	1 5	4 0	4 0	1896 0
E4	K7/13A III	RC	49 6	3 2	3 4	1 9	3 0	3 0	2151 0
E5	K7/26B	RC	56 2	4 0	3 0	1 6	2 0	2 0	2103 0
E6	K7/27A/1	RC	54 5	4 3	3 1	1 3	4 0	3 5	2127 0
E7	K15/1A1	RC	53 3	4 5	3 5	2 7	5 0	5 0	1818 0
E8	K15/2A/1	RC	48 8	3 6	3 0	2 5	5 0	5 5	2387 0
E9	K15/6CI	RC	53 6	4 8	3 3	1 4	2 0	2 0	2036 0
E10	K15/7A	RC	54 0	4 5	2 2	2 3	5 0	4 0	2138 0
Checks									
GL2**		RC	50 4	2 9	3 6	2 4	4 0	3 0	2343 2
GLP 24**		CW	38 8	4 2	3 6	2 7	5 0	4 0	2246 4

GLPX 92**	MW	39 3	2 4	4 0	7 0	2 0	2 0	2310 6
GLP 585	RH	26 9	4 1	5 0	3 5	2 0	2 0	2088 7
Mwezi Moja	MM	42 5	2 3	4 2	3 4	7 0	8 0	1744 7
LSD (0 05)		7 0	1 1	1 2	0 9			1026 5

RC=Rosecoco CW=Canadian Wonder MW=Mwitemania RH=Red Haricot and MM= Mwezi Moja types

* Worst seven seasons

** Commercial Check cultivars

Table 2 Seed characteristics yield and disease severity (mean scores 1 9 scale) of 21 medium maturing bean lines grown in seven environments in Kenya 1992/93

Line/ cultivar	Source population	Seed type	100 seed weight (g)	Disease rating			Floury Leaf Spot		Yield (kg/ha)
				ANT	Angular Leaf Spot	Rust	Glasshouse	Field	
M11	K1/2B/A	CW	40 4	4 3	4 2	1 2	7 0	7 0	2873
M12	K6/6B II	RC	41 6	3 9	3 8	1 8	7 0	7 0	2368
M13	K6/10B	CW	41 0	4 2	4 2	2 0	4 0	4 0	2318
M14	K7/6B1	RC	56 5	3 7	3 8	1 7	5 0	4 0	2537
M15	K7/26B/1	RC	41 0	3 0	3 0	1 9	7 0	5 0	2642
M16	K8/24B	MW	35 1	2 8	3 5	3 2	4 0	5 0	2593
M17	K13/1A II	CW	41 4	3 4	4 2	2 5	8 0	8 0	3039
M18	K13/9B	MM	49 6	1 9	3 3	2 0	8 0	7 0	2856
M19	K15/1A	MW	35 5	2 4	4 2	3 0	2 0	5 0	2625
M20	K19/4A	CW	39 9	2 6	3 6	1 2	8 0	7 0	2424
M21	K19/4C	MM	48 1	1 6	3 9	1 9	6 0	6 0	3131
M22	K19/22A I	RC	48 6	2 1	3 6	3 3	5 50	5 0	2833
M23	K19/38A	RC	46 7	2 6	3 9	1 5	3 0	4 0	2713

M24	K21/46A II	CW	46 0	3 1	3 8	2 1	8 0	6 0	2912
M25	K25/13A	RC	37 4	2 0	3 4	3 0	2 0	2 0	2660
M26	K33/38A	RH	38 9	4 1	3 2	2 3	3 0	3 0	2490
M27	K33/38B	RH	42 4	4 0	2 6	2 3	6 0	7 0	2480
M28	M262/16	CW	33 8	2 3	3 7	3 1	6 0	6 0	2765
M29	M355/1	CW	37 0	3 6	4 2	2 0	6 0	6 0	1903
M30	M355/27	CW	41 3	2 7	5 1	1 6	2 0	7 0	2519
M31	Local landrace	RH	24 4	3 4	4 0	4 1	8 0	2 0	2689
Checks									
GLP 2		RC	50 4	2 9	3 6	2 4	4 0	3 0	2343
GLP 24		CW	38 8	4 2	3 6	2 7	5 0	4 0	2246
GLPX 92		MW	39 3	2 4	4 0	7 0	2 0	2 0	2311
GLP 585		RH	27 0	4 1	5 0	3 5	2 0	2 0	2089
GLP 1004		MM		2 3	4 2	4 1	7 0	8 0	1745
LSD (0 05)			5 8	1 3	1 1	1 2			1112

RC=Rosecoco CW=Canadian Wonder MW=Mwitemania RH=Red Haricot and MM = Mwezi Moja types

Table 3 Seed characteristics yield and disease severity (mean score 1 9 scale) of twenty late maturing bean lines grown in seven environments in Kenya 1988 94

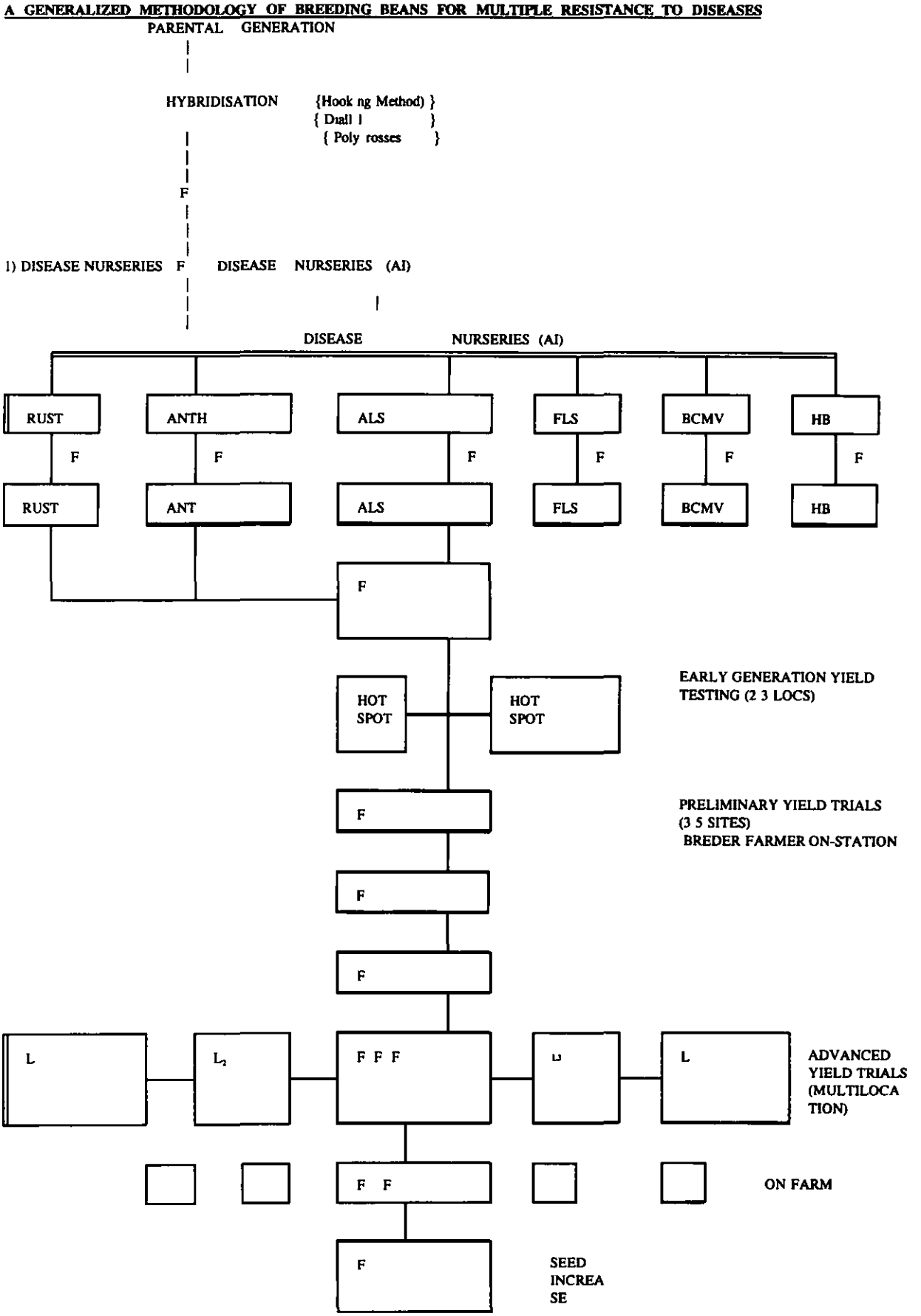
Line/ cultivar	Source population	Seed type*	100 seed weight (g)	Disease Score			Floury Leaf Spot		Yield (kg/ha)
				ANT	Angular Leaf Spot	Rust	Glasshouse	Field	
L 31	K3/2B/2	CW	36 0	2 6	3 1	2 1	4 0	4 0	2094 7
L32	K13/5BI	RC	50 8	3 7	2 9	1 6	6 0	6 0	2306 5
L33	K13/26B	RC	45 3	3 9	3 5	2 1	5 0	6 0	2027 1
L34	K13/26C	RC	47 3	3 8	2 7	2 6	5 0	4 0	2123 1
L35	K13/27A	RC	57 5	3 3	3 0	2 3	7 0	6 0	2603 5
L36	K13/27A1	CW	47 6	3 7	3 9	2 4	5 0	5 0	2470 5
L37	K21/24A	RC	46 3	4 0	4 1	1 6	4 0	4 0	2047 0
L38	K21/46A	CW	44 5	2 6	3 0	2 3	5 0	7 0	2442 9
L39	K23/19C	RC	43 7	2 2	2 8	1 7	7 0	6 0	2424 1
L40	K23/21	CW	40 1	2 3	3 2	2 0	2 0	3 0	3197 0
L41	K23/28C/3	RC	46 9	2 7	2 7	1 7	3 0	5 0	2765 5

L42	K28/29A	CW	38 1	3 1	4 0	2 5	6 0	7 0	2342 1
L43	K28/33BI	CW	36 5	3 8	3 4	2 0	8 0	8 0	2538 7
L44	K29/6CI	MM	38 1	2 2	2 7	2 0	6 0	8 0	2556 4
L45	K29/36DI	CW	44 9	4 1	3 7	1 7	8 0	8 0	2552 9
L46	K33/28CII	RH	34 3	2 4	3 4	1 9	7 0	6 0	2462 7
L47	M262/13	CW	36 1	3 4	3 8	1 9	5 0	6 0	2090 8
L48	M262/35	CW	38 1	3 0	3 7	2 5	6 0	7 0	2360 0
L49	M355/21	CW	40 3	3 1	3 8	1 4	6 0	6 0	2345 8
L50	M355/22	CW	40 2	4 4	4 0	2 2	9 0	7 0	2354 7
Checks									
GLP2		RC	50 4	2 9	3 6	2 4	4 0	3 0	2343 2
GLP24		CW	38 9	4 2	3 6	2 7	5 0	4 0	2246 4
GLPX92		MW	39 3	2 4	4 0	7 0	2 0	2 0	2310 6
GLP585		RH	26 8	4 1	5 0	3 5	2 0	2 0	2088 7
LSD (0 05)			6 3	1 3	1 3	1 0			

* RC=Rosecoco CW=Canadian Wonder MW=Mwitemania MM=Mwezi Moja and RH=Red Haricot

Figure 1

A GENERALIZED METHODOLOGY OF BREEDING BEANS FOR MULTIPLE RESISTANCE TO DISEASES



CONTROLE DES MALADIES PAR INCORPORATION DES VARIETES AVEC RESISTANCE PARTIELLE DANS LA SEMENCES PAYSANNES

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ABSTRACT

Farmers in the Great Lakes Region (GLR) of Central Africa cultivate beans in varietal mixtures as a way of stabilizing production and minimizing risks posed by biotic and abiotic factors Some of the mixture components have low yield potential and are susceptible to a number of major diseases Previous studies conducted at Mulungu in the South Kivu region of Zaire showed that incorporation of a variety resistant to angular leaf spot (ALS) in farmers mixtures could reduce severity of the disease and increase yield Given that growing mixtures in the GLR is the rule rather than the exception a strategy to improve resistance of farmers mixtures against major diseases is important The objective of this study was to determine the effect of incorporating multiple components with disease resistance on disease severity and yield

Two farmer mixtures collected from Walungu and Kabare areas containing 10 and 12 components respectively and five improved cultivars (A 285 MLB 49 89A MLB 4289A MOORE 90026 and RWR 221) resistant to some major diseases were used in the study Trials were installed in farmers fields selected from each of the two areas The five cultivars were incorporated in farmer s mixtures from each area to constitute 50% of the new mixture (the proportion of each cultivar in the new mixtures was 10%) The mixture incorporated with resistant varieties was compared with the two farmers mixtures for disease reaction and yield Nine farmers fields were used at each site and each field constituted a repetition Disease reaction was evaluated at different stages of plant growth but evaluations made at R8 were used in data analysis

Diseases observed were anthracnose angular leaf spot ascochyta blight and rust There was significant reduction in ALS severity by incorporating resistant cultivars in farmers mixtures The reduction was 12% at Kabare and 14% at Walungu in season A In season B the corresponding reductions were 14 and 23% respectively Severity levels of other diseases were relatively low and were not affected by season Incorporation of resistant varieties significantly increased yield in both seasons but yields in season B were overall better than season A

RESUME

Les agriculteurs de la Region de Grands Lacs cultivent le haricot en melange varietal constitue de plusieurs varietes non performantes L incorporation des 5 varietes a resistance partielle aux maladies importantes de la region dont maladies racinaires Antrachnose

Ascochytose Tache angulaire et Rouille dans une proportion de 50% dans le melange local aurait un effet sur la reduction de la severite de la maladie de taches anguleuses et sur L aungementation de rendement en saison B mais les autres maladies ne seraient pas influencees

INTRODUCTION

Les resultats d une etude anterieure realisee par Pyndji (1991) ont montres que l incorporation d une variete resistante aux taches anguleuses dans le melange local etait efficace pour reduire la severite de la maladie et contribuer a l augmentation de rendement Au Sud Kivu comme partout ailleurs dans la region de Grands Lacs les agriculteurs cultivent le haricot en melange varietal d autant plus qu ils limitent les resques dus aux aleas climatiques et phytosanitares Cependant ces melanges du paysan sont constitues de plusieurs varietes non performantes Ce qui serait a la base de la baisse de rendement La pratique du melange etant une regle et non une exception pour les fermiers des Grands Lacs (Buruchara 1991) l incorporation de plus d une variete avec resistance partielle aux maladies importantes de la region pourrait non seulement faire baisser la severite et augmenter la productivite du haricot en milieu paysan mais aussi doter les farmiers de quelques variete protectrices contre les maladies dans les melanges

Le but de l etude en cours est de verifier l effet des variete a resistance partielle sur la severite des maladies importantes de la region et le rendement dans le melange local

MATERIELS ET METHODES

L étude a ete menée en champ d agriculteurs de la zone de Kabare et de Walungu au Sud Kivu Deux lots de semences paysannes constitues des melanges des variétés locales ont ete collectes dans ces deux zones Leurs composants respectivement 12 et 10 ont ete evalues du point de vue phytopathologique en station Cinq variétes avec resistance partielle (VRP) a savoir A285 MLB-49 89B MLB-42 89A MOORE 90026 RWR221 ont ete multipliees Nous avons mene deux essais separes Le matériel de l essai etait constitue pendant les 2 saisons culturales (saison A et B) de la meme annee des melanges composes de 100% des variétes locales (ML) du site et d une combinaison de 50% semence paysanne plus 50% VRP La proportion des varietes a resistance partielle etait de 10% par variete L essai etait installe chez 9 fermiers par site Chaque fermier constituait une repetition

Les maladies ont ete evaluees au stades V3 R6 et R8 Pour l analyse statistique nous avons considere les resultats a R8 L evaluation e faite suivant l echelle Standard CIAT de 1 a 9 ou 1=0% de la surface foliaire infectee 3=2% 7=10% 9 23% de la surface foliare infectee Enfin le rendement parcellaire extrapole en hectare est analyse statistiquement

RESULTAS ET DISCUSSIONS

Les maladies suivantes ont été d une facon dominante observees dans nos parcelles d essais

au stade R8 la tache anguleuse l anthracnose l ascochytose et la rouille L attaque de la mouche bien qu elle a ete observée au stade V3 elle a ete presente chez un nombre réduit des fermiers De ce fait les resultats n ont pas fait l objet d analyse Les resultats figurent dans le Tableaux 1 et 2

A Kabare et Walungu il y a eu difference significative entre le 100% melange local et 50% melange local (ML) + 50% variete a resistance des taches anguleuses aucours de deux saisons (Tableaux 1 et 2) En saison A la reduction de la severite a ete de 12% a Walungu En saison B elle a ete de 14% pour le 1er et 23% pour le second site La severite n a pas ete influencee par les saisons Cette reduction de la severite du traitement 2 est l effet des VRP qui ont constitues une barriere a la propagation de l inoculum primaire

Cependant la difference significative s observe pour la severite de ces 2 saisons La pression est forte en saison A (cfr Tabl 2 range) Ceci est du a la grade quantite des pluies qui entraine l humidite favorable au developpement de cette maladie

Pour l anthracnose et la rouille les VRP n ont pas eu d effet sur les maladies aucours de toutes les 2 saisons dans les 2 sites Quant au rendement il existe une difference significative entre 100% ML et 50% ML au seuil p=0 05 tant a Kabare qu a Walungu en saison B Entre les saisons il y a eu egalement une différence significative Le rendement est tres eleve en saison B

Le rendement eleve de 50% ML est l effet des varieties a resistance partielle qui ont constituees une barriere a la propagation de l inoculum En saison B le rendement est favourise par les pluies moins abandantes la culture de haricot n est pas associee avec d autres cultures qui accasionnent l humidite favorable au developement des maladies

CONCLUSION PARTIELLE

L incorporation des varietés a resistance partille dans les melanges de Kabare et de Walungu aurait un effet sur la reduction de la severite d autres maladies evaluees ascochytose anthracnose rouille ne serait pas affectee par les VRP La saison influence le taux de severite de l ascochytose Cette reduction de la pression des maladies entainerait une augmentation de rendement en saison B

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Tableau 1 Séverite des maladies et rendement obtenus par l incorporation des varietes a resistance partielle a Kabare

Traitement	Severite des maladies pendant les saisons[y] A et B								Rdt (ka/ha)	
	T anguleuses		Ascochytose		Anthracnose		Rouille			
	A	B	A	B	A	B	A	B	A	B
100% ML	5 2 a	5 1 a	3 5 a	2 6 b	2 0 a	2 0 a	2 5 a	2 6 a	295 c	860 2 b
50%ML + 50% VRP	4 4 b	4 4 b	3 3 a	2 4 b	2 0 a	2 0 a	2 8 a	2 8 a	397 c	1177 1 a
CV%	9 2		15 7		0		12 1		15 6	

= Echelle CIAT d evaluation de la severite des maladies

[y] = Saisons A et B

= Les valeures suivies d une même lettre indiquent qu il n y a pas de difference significative au seuil probabilite P=0 05

Tableau 2. Sévérité des maladies et rendement obtenus par l'incorporation des variétés à résistance partielle à Walungu

Traitement	Sévérité des maladies pendant les saisons[y] A et B								Rdt (kg/ha)	
	T. anguleuses		Ascochytose		Anthracnose		Rouille			
	A	B	A	B	A	B	A	B	A	B
100% ML	5.1 a	4.7 a	2.7 a	2.2 b	1.6 a	1.8 a	2.6 a	2.1 a	698 c	1623 b
50%ML + 50% VRP	4.4 b	3.6 b	2.5 a	2.2 b	1.6 a	1.8 a	2.7 a	2.1 a	788 c	2144 a
CV%	8.6		9.0		14		6.9		31.1	

[x] = Echelle CIAT d'évaluation de la sévérité des maladies

[y] = Saisons A et B

= Les valeures suivies d'une même lettre indiquent qu'il n'y a pas de difference significative au seuil probabilité P =0.05

OCCURRENCE AND IMPORTANCE OF BEAN DISEASES IN SOUTHERN AFRICA

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INTRODUCTION

In most of the SADC countries beans are grown mainly in the rainy season that extends from October to April depending upon the country and location Length of the rainy season determines the type of varieties being grown and constraints that limit their production Beans are also grown in some parts as a winter crop under irrigation or on residual moisture since the region receives rainfall in a unimodal pattern

Seed size and seed colour are two of the most important quality factors in the region Large seeded bean types of any colour except black are prefered The important production constraints are diseases poor soils and lack of seed of improved and well adapted varieties As national and international teams continue to develop genetic materials of wider adaptation across eco geographical areas and climate regimes accurate measurements of plant diseases become important in all studies that relate disease severity to yield loss and to subsequent management tactics Diseases are one of the most important factors associated with low bean yields in most bean producing regions in Southern Africa Because resource limitations do not permit use of high cost plant protection technology disease management through breeding resistant varieties is at the forefront in the region

At present there is little or no evidence that races exist within the pathogens that cause white mold ascochyta blight web blight charcoal rot *Rhizoctonia* and *Fusarium* root rots southern blight common bacterial blight and other minor bean pathogens (Beebe and Pastor Corrales 1991) This means that germplasm that is resistant or susceptible to any of the above pathogens in one location has a similar reaction in another location However many other pathogens that cause bean diseases are known to have races or vertical pathotypes for example pathogens that cause rust anthracnose angular leaf spot halo blight bean common mosaic virus (BCMV) and *Fusarium* wilt One of the best possible methods to identify resistant parents is to expose the potential sources of resistance to all the existing pathogenic variation over different production areas and over a period of several years This can be accomplished through international/regional disease nurseries whose main objective should be to identify either race nonspecific or race specific resistance of the broadest possible nature

The SADC region ranges from seven degrees to 33 degrees south of the equator with two major environments the cooler environment (more than 1500 m a s l) and the cool to warm environments (less than 1500 m a s l) Angular leaf spot anthracnose rust common bacterial blight and bean common mosaic virus (BCMV) are the most important and widespread diseases in the region Other diseases capable of causing considerable yield losses are restricted to specific bean growing regions Examples include halo blight web

blight *Fusarium* wilt white mold scab and powdery mildew Halo blight and ascochyta blight are favoured by cool humid environments while powdery mildew flourishes under cool dry environments

For the region resistance screening across production areas is achieved through regional trials The SAZBEN and SAZBYT (Southern African Zonal Bean Evaluation Nursery and Southern African Zonal Bean Yield Trial respectively) are coordinated by the Malawi national bean program and SARBEIN (Southern African Regional Bean Evaluation and Improvement Nursery) until 1993 coordinated by the South African national bean program Recently the SARBEIN has been merged in the other regional trials The main objective of these regional trials has been to facilitate sharing of germplasm and promote collaboration among the national programs in the region These trials also serve as a major tool in monitoring genetic variability and reaction to different diseases Highlights of results obtained and reaction of important genotypes to important diseases are discussed below

REGIONAL NURSERIES

Southern African Zonal Bean Evaluation Nursery (SAZBEN)

The SAZBEN is composed of breeding and germplasm lines developed by participating countries The 1993 94 SAZBEN had 100 such entries contributed only by Malawi and the trial was grown in Zambia Zimbabwe Tanzania Namibia Lesotho Swaziland Boswana Mozambique and South Africa

Results (Chirwa and Aggarwal 1994) showed a wide variation in both yield and disease reacion among entries in different countries indicating a strong genotype by environment interaction and a need for each country to select its own varieties Among the best 20 yielders at each site no single entry was common at all the ten sites where data were received However a few lines appeared in more than one location but their rankings were not the same The most common entries that appeared in the top 20 at three or more locations were CAL 143 (5 locations) A 197 (5) AND 971 (4) TM 27J1J2 and SUG 84 (3) CAL 143 gave the highest average yield and showed good levels of ALS resistance (Table 1) In another related investigation for disease resistance in Malawi (Table 2) CAL 143 was also found to have good resistance to powdery mildew and halo blight This variety is earmarked for release to farmers as a multiple disease resistant variety Also A 197 has been found to be resistant to BCMV in multilocation trials in Malawi (Chirwa and Aggarwal 1994) and is a potential candidate for release to farmers both in Malawi and Zambia

Southern Africa Zonal Bean Yield Trial (SAZBYT)

This was a replicated trial consisting of 15 varieties contributed by Malawi Lesotho Zambia Zimbabwe Mozambique South Africa and CIAT Varieties included were those which had either been released or were in the advanced stage of testing in different countries

Yield in this trial varied significantly (Table 3) across locations due to drought (Chitedze and Msekera) poor soils (Misamfu) and high levels of disease The top six yielding varieties

across sites (Puebla Cafe BAT 477 ICA PIJAO CAL 143 A 197 and ZPV 292) showed considerable amounts of resistance to ALS rust and anthracnose The first three varieties belong to the Mesoamerican gene pool and the other three to the Andean gene pool suggesting particularly that resistance to ALS can be found in the Andean gene pool which is widely grown in Africa

Southern African regional Bean Evaluation and Improvement Nursery (SARBEIN)

Results of 1993 and 1994 seasons showed that rust ALS and scab are major disease problems in South Africa (especially at Cedara) and ALS at Bembeke (Malawi) Brown spot has been found to be present in South Africa

ACHIEVEMENTS OF REGIONAL TRIALS AND PROBLEMS ASSOCIATED WITH RESISTANCE SCREENING

These trials have helped us to record diseases occuring in different parts of Southern Africa Although the majority of the diseases are widespread some are confined to particular countries or particular ecological zones A typical example is brown spot in South Africa (Liebenberg 1994) where it is now one of the more serious diseases These trials have and continue to encourage collaborative research among national programs in the region and allow easy access to new germplasm To date Malawi has identified two promising varieties A 197 and CAL 143 which are being considered for release to farmers Similarly Zambia is planning to release A 197 Other countries have selected many varieties which are currently being evaluated for future release

The major problems associated with screening for disease resistance in the regional nurseries and trials are best summarized as the following three factors poor site selection poor pathogen management and poor staffing Experience has shown that sites sometimes do not sufficiently represent environments that are the most conducive to disease development and screening Limitations of seed quantity or in access to appropriate sites are factors here Poor management of pathogens is attributable to the insufficient use of artificial inoculation to supplement natural infections that often exert insufficient pressure for effective screening Most national programs are poorly staffed with the result that the ability to evaluate disease reactions is very limited

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Chirwa R M and Aggarwal V D (1994) Bean Research Annual Report Chitedze Agricultural Research Station Lilongwe Malawi

Liebenberg A J (1994) SARBEIN Annual Report Oil and Protein Seed Centre Potchefstroom South Africa

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Mkandawire et al (1990) Bean Research Annual Report Bunda College of Agriculture Lilongwe Malawi

Table 1 Comparative performance of the five best adapted entries in the SAZBEN during the 1993 94 season in Southern Africa

Entry	Yield (kg/ha	ALS	CBB	BCMV	ANT
CAL 143	2237	3	4	2	2
A 197	1603	4	4	2	1
AND 971	1021	4	4	4	1
TM27J1J2	1701	4	5	1	2
SUG 84	2228	4	3	4	1
Mean across sites	690	5 3	4 6	3 1	2 0

Table 2 Reaction of five bean lines to halo blight and powdery mildew in the 1994 winter season in Malawi

Line	Halo blight (%)	Powdery mildew (%)
CAL 143	5 0	6 0
H2 Mulathino	12 6	3 5
MCM 5001	20 8	11 5
Nasaka	43 5	71 7
Phalombe	61 8	70 0
Mean	28 7	32 5
S E +	9 45	3 12
Significance	**	***

Table 3 Seed yield (kg/ha) of entries in the Southern African Zonal Bean Yield Trial (SAZBYT) at nine locations 1993/94

Entry	Location*								
	BBK	BVW	CTZ	MRU	MNO	UYL	MSF	MSK	GWB
BAT 477	2406	1047	1203	1028	1587	2552	292	607	675
Masaka	1604	327	1299	521	680	2005	250	759	462
Puebla Cafe	2844	912	978	993	2089	2352	338	472	567
A 197	2833	1307	946	792	1274	2358	575	616	915
NW 590	2024	749	560	563	450	1946	371	569	325
SWH	1545	427	595	514	998	1976	483	617	355
Phalombe	1823	232	1195	556	1575	2507	646	643	498
ZPV 292	2774	1139	990	368	1181	2047	361	602	781
PVA 773	2774	184	897	708	1291	2407	204	554	1020
AFR 599	2149	668	1107	472	1283	2225	475	715	667
ICA Pijao	2587	539	811	917	1464	2044	1079	463	581
CAL 113	2788	435	573	521	1439	2232	350	659	800
CAL 143	2462	893	1006	976	1252	2380	693	494	908
Umvoti	2174	743	1471	611	1212	2429	440	623	534
Local control	1090	242	743	639	1239	2358	471	378	625
Trial Mean	2259	656	958	679	1268	2255	469	585	648
CV%	18	34	27	30	24	17	85	25	16

SE ±	233 9	128 2	151 7	117 1	175 7	215 3	228 6	83 1	73 2

* For identification of locations see Table 4

Table 4 Reactions to Angular Leaf Spot (ALS) and common bacterial blight (CBB) in the Southern African Zonal Bean Yield trial (SAZBYT) across locations[1] 1993/94

Entry	ALS						CBB				
	BBK	BVW	MRU	UYL	MSF	GWB	BBK	BVW	CTZ	MRU	GWB
BAT 477	2	3	3	1	5	1	5	4	5	3	2
Masaka	7	7	7	7	5	1	4	9	9	5	4
Puebla Cafe	2	2	3	1	5	1	7	3	7	3	2
A 197	5	7	7	5	3	2	6	7	4	4	2
NW 590	4	5	4	2	5	1	4	6	8	5	2
SWH	6	7	7	5	5	2	6	9	9	4	3
Phalombe	7	7	8	5	7	1	5	8	8	5	4
ZPv 292	3	5	4	3	9	1	8	7	8	4	1
PVA 773	5	6	8	5	3	1	7	8	5	5	2
AFR 599	7	7	5	6	5	2	6	8	8	4	3
ICA Pijao	3	3	4	2	3	1	3	5	7	5	2
CAL 113	5	6	8	4	5	1	7	7	7	3	2
CAL 143	2	3	4	3	4	1	7	6	7	4	2
Umvoti	6	7	7	6	5	1	6	9	8	3	4
Local control	3	6	6	6	5	2	4	8	8	4	3

Trial Mean	4	5	6	4	5	1	5	7	7	4	3
CV (%)	16	19	32	14	16	46	27	14	11	24	49
SE ±	0 4	0 6	1 0	0 3	0 5	0 3	0 8	0 6	0 5	0 5	0 7

BBK Bembeke C Malawi BVW Bvumbwe S Malawi CTZ Chitedze C Malawi MRU Meru N Malawi MNO Mancongco Swaziland UYL Uyole S Tanzania MSF Misamfu N Zambia MSK Msekera E Zambia GWB Gwebi Harare Zimbabwe

Table 5 Reactions (severity scores 1 9 scale) to Halo Blight (HB) BCMV rust anthracnose (ANTH) and scab among entries in the Southern African Zonal Bean Yield trial (ZAZBYT) across locations[1] 1993/94

Entry	HB	BCMV		RUST			ANTH		SCAB
	GWB	BVW	GWB	CTZ	MRU	UYL	BBK	GWB	MSF
BAT 477	3	2	3	2	2	5	5	2	1
Masaka	2	3	3	6	3	6	2	7	2
Puebla Cafe	1	4	3	5	2	5	3	1	1
A 197	1	2	2	4	4	5	1	1	3
NW 590	1	6	4	9	9	8	5	1	3
SWH	1	4	3	9	7	4	8	2	6
Phalombe	4	5	2	6	3	4	5	1	8
ZPv 292	1	5	2	8	7	7	2	1	9
PVA 773	2	7	4	3	2	3	2	2	3
AFR 599	2	4	2	7	5	6	5	1	7
ICA Pijao	2	2	4	5	2	1	4	1	1
CAL 113	1	6	3	6	2	5	3	1	5
CAL 143	1	7	2	5	5	3	2	1	3

Umvoti	2	4	3	8	3	5	2	1	7
Local control	4	4	2	7	4	5	7	1	6
Trial Mean	2	4	3	6	4	5	4	1	5
CV (%)	36	46	35	23	47	28	29	56	20
SE ±	0 4	1 1	0 5	0 8	1 1	0 8	0 6	0 4	0 5

[1] For identity of locations see Table 4

PART 2

Review and Planning of the Research Activities on Fungal Bean Diseases in Africa

Reports from the Working Group Sessions

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Introduction

In 1992 the Pathology Working Group Meeting was held in Thika Kenya Using the Planning by Objective method (PPO) a range of research and related activities that were considered essential in the management of fungal diseases were identified Details of the procedure used are described in the proceedings (Scheidegger and Buruchara 1992) of the meeting In summary it involved identification of the main disease problems and an analysis of their possible causes Based on this analysis potential solutions and a series of activities were proposed to address the problems These included both research and non research activities The activities were prioritized and agreement reached on the division of responsibilities among potential and participating institutions It was also recommended that a review be made after three years to assess the relevance of the problems progress made failures and obstacles encountered

Methodology of the Review and Planning Procedure

In reviewing the present status and progress made and planning for the future participants were divided into smaller working groups and used a two stage process

I Review of the problems and interventions identified in 1992

A review of the problems associated with 5 bean diseases considered in 1992 was made to assess if they were still valid This involved revisiting diseases considered in the 1992 meeting to determine whether the list needed modification (addition or reduction) Problems specific to each disease and those that are common to all diseases previously identified were reviewed The validity of objectives and potential solutions or interventions previously identified was also reviewed The assumptions were that after three years there might have been need to revise the basis of planning for the future

II Self Evaluation

The second stage of the review was a self-evaluation in carrying out the activities proposed in 1992 To do this the SWPO (success weakness potential and obstacles) method (Anon) was used SWPO (SEPO in French) is a working tool used for self

evaluation and project piloting The method is based on looking back on past experiences (e g 3 yr planning period for the Pathology Working Group) evaluating them and adjusting future approaches or activities accordingly Lessons learnt from the past serve as a guide for the future The tool enables teams or groups to describe learn to accept experiences estimations and hopes and to discuss the conclusions which are drawn from them SWPO can be used for self-evaluation and planning The method is suited to carrying out self-evaluation because it

is adaptable and flexible
portrays varying experiences made by different groups of actors
respects the experiences opinions and estimation of marginal groups
is based on visual aids and facilitates participatory evaluation and assessment of experiences and perceptions
allows use of common language and a step by step problem solving approach
links evaluation (review) with the adjustment of objectives and planning

In planning the method

facilitates the approach to planning since it enables those involved to express their experiences failures hopes fears in view of future changes
allows expression of diverse visions of different actors involved
links the review of the past while looking into the future in order to initiate possible joint action

The SWPO Window

SWPO is based on the ability to repeatedly recall the past experiences (activities) and anticipate the future It locates the experience on a time axis shown on Figure 1 where future plans are based on the past Both the look into the past (review) and the look a head in to the future (anticipation) are complemented by a simple evaluation criteria of positive / negative) creating the four part SWPO window shown in Figure 2

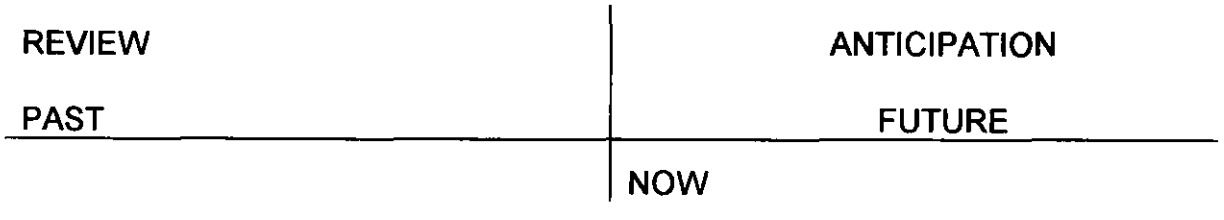


Figure 1 Illustration of time axis (past now and future) which is the basis of self evaluation and planning using the SWPO method

POSITIVE	
Success (window 1)	Potential (window 3)
NEGATIVE	
Weakness (window 2)	Obstacles (window 4)

Figure 2 The SWPO windows showing simple evaluation criteria (success and weakness relating to the past and potential and obstacles relating to the future)

For each of the developed objective planned activity or intervention past experience is reviewed The criteria used are success (qualitative and quantitative aims achieved etc) and weaknesses (failures difficulties encountered and bottlenecks) In planning for the future potentials (wishes trends ideas unused abilities) and obstacles (unfavorable conditions) are considered In the process it is important to preserve the SWPO sequence of windows 1 2 3 4

Self Evaluation and Planning Process in the 2nd PWGM

In the self-evaluation exercise objectives interventions and specific activities proposed in 1992 were considered Participants were divided into smaller working groups to address specific diseases or themes Successes achieved and weaknesses observed in carrying out each activity or fulfilling each objective were discussed These discussions formed the basis for future planning or re-orientation of direction Decision on continuity or modification of activities or approach (potential) and expected obstacles or difficulties were discussed Results from working groups were further discussed in the plenary sessions Below is an example of the logic and steps in self evaluation and planning exercise

Disease Angular leaf spot

One of the solution identified in the 1992 meeting in developing resistant varieties to angular leaf spot were *Determination of pathogen diversity of angular leaf spot pathogen (Phaeoisariopsis griseola) in Africa*

One the activity proposed then was to *Collect and characterize pathogen diversity of P griseola isolates in Zaire Uganda Kenya and Malawi* In assessing the performance of participating institutions (countries) the first aspect considered was to look back on what was done and assess the success The *successes* in carrying this activity were

Isolate collections and isolation were made in Zaire Uganda Kenya and Malawi

Eight isolates were characterized in Zaire

Several isolates were conserved in Zaire Uganda Kenya and Malawi for characterization

Differential varieties were multiplied

The second step was to identify the *weaknesses* or *difficulties* experienced These were

Characterization of isolates only in one country
Unavailability and inadequacy of differential varieties
All collaborators did not know characterization methodologies

On the basis of accomplishments and difficulties experienced aspects that need to be addressed in the future (potentials) are identified These are the activities of the next planing period

Start characterization in Kenya Uganda and Malawi
Conduct more characterization in Zaire
Characterization methodology is known to all collaborators

However some of the *obstacles* that are likely to affect planned activities and which need to be considered and addressed are

Limited availability of differential varieties
Limited availability of laboratory equipment

Results

I Review of the problem trees identified in 1992

Results of the review of the problem trees (some go over two pages) are presented on pages — to – The central problem of all the 5 diseases considered in 1992 remained valid meaning the diseases were still regarded important but there were modifications of some cause-effect relationships which reflected changes resulting from on-going or work done In a few cases new cause-effect relationships were introduced Modified or new causes-effect relationships of reviewed problem trees are shown as shadowed square or rectangular boxes with rounded corners to distinguish them from the others If a cause or effect was no longer valid it was shown as a blank box in its original position Reference to problem trees developed in the 1992 meeting (Scheidegger and Buruchara 1992) enables the reader to appreciate the revisions made

II New problem trees

Floury leaf spot previously not regarded as a serious disease was said to be increasing in importance Powdery mildew was identified as a growing problem in southern Africa countries particularly during winter Lack of use of IPM strategy in disease management was identified as a problem worthy addressing independently Problem environments (trees) potential solutions were developed and specific research activities were recommended to address the three problems The three problem trees developed are presented on pages to

III Self Evaluation

Results of the self-evaluation exercise of activities proposed in 1992 are presented in the charts on pages -- to using a format described hereafter For each disease problem there is an overall objective (see page) To achieve these objectives there are areas of intervention leading to intermediary results Activities are grouped under each result they are meant to achieve For each activity the self-evaluation exercise identified successes failures potentials and obstacles For ease of reference objectives results and activities are numbered using the system used in the proceeding of 1992 (Scheidegger and Buruchara 1992) meeting

IV Planning matrices

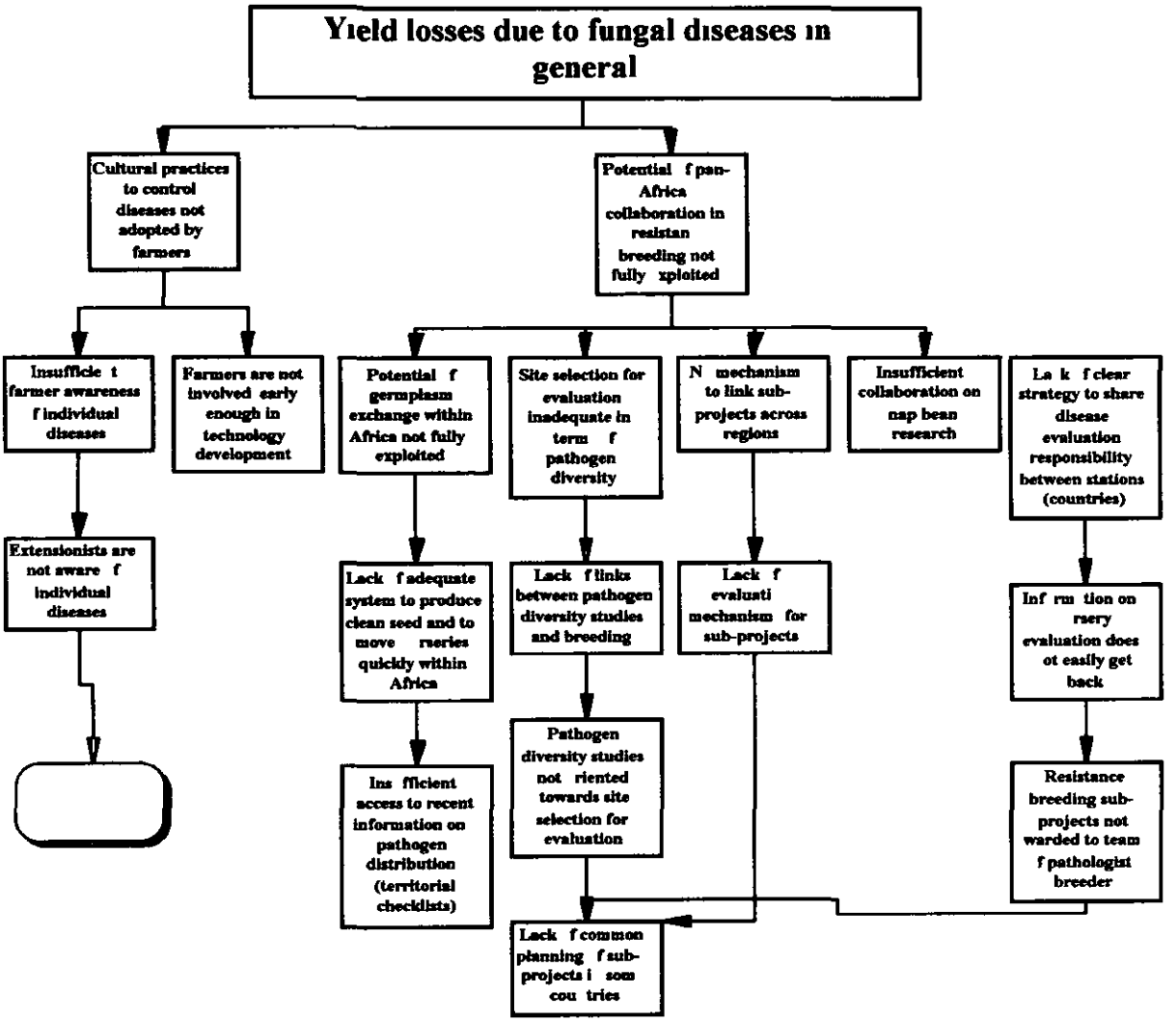
Results of the planning matrices are presented on pages to The heading of each table indicates the overall objective for the next three years Activities are grouped under the intermediary results they are helping to achieve Allocation of responsibilities and priority ranking for activities proposed was done differently by different groups Some indicated collaborating institution(s) while other did not P indicate the priority of the activity where 1 = high and 3 = low The number in bracket in the last column indicates priority ranking

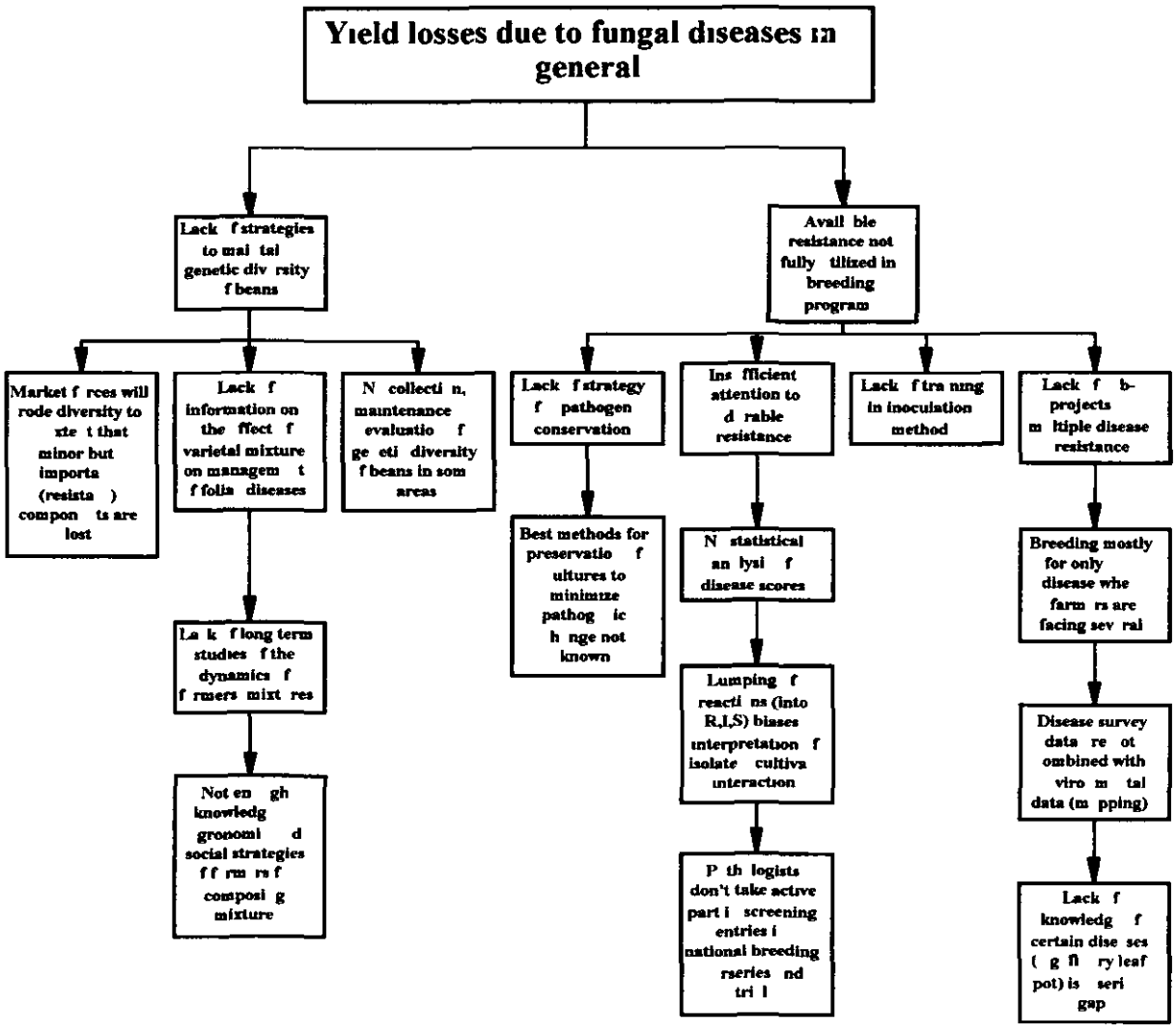
References

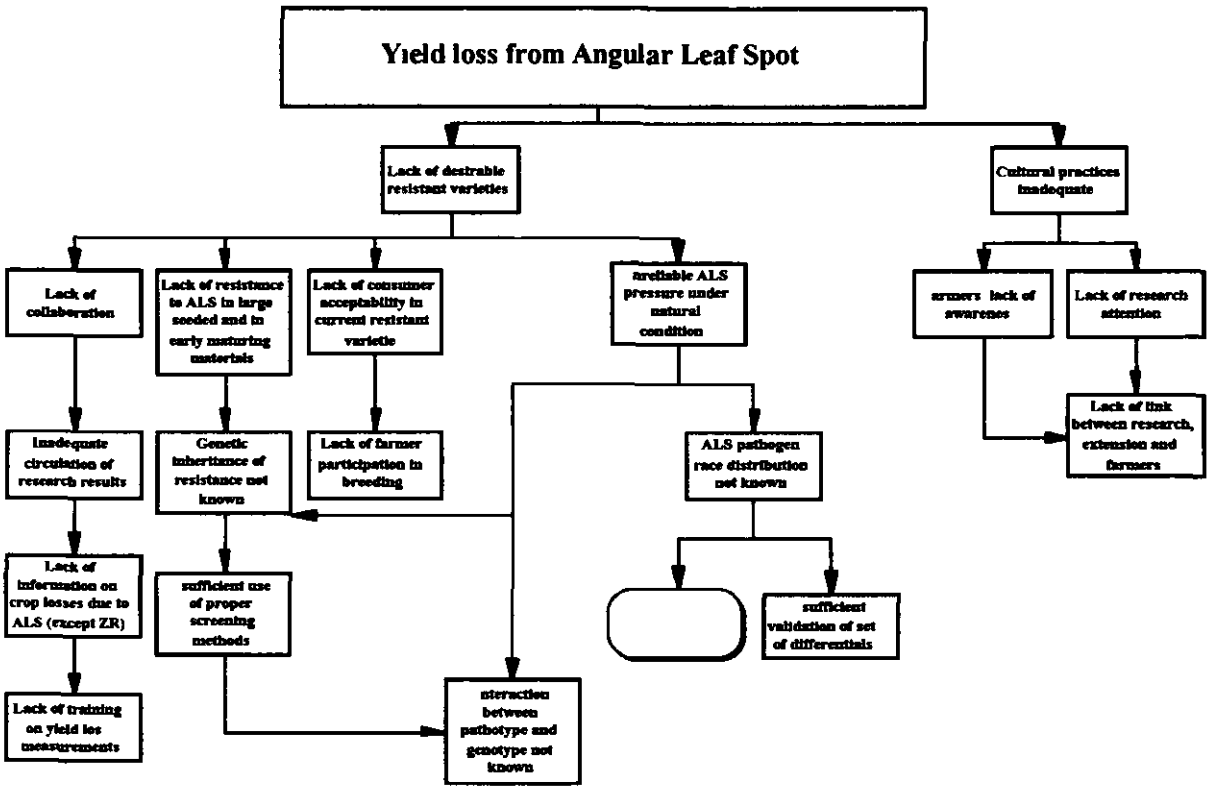
Scheidegger U C and Buruchara, R A 1992 Reports from the working group sessions pp 95 119 In R A Buruchara and U C Scheidegger (eds) Proceedings of the Pan Africa Bean Pathology Working Group Meeting May 26 30 1992 Thika, Kenya 124 p

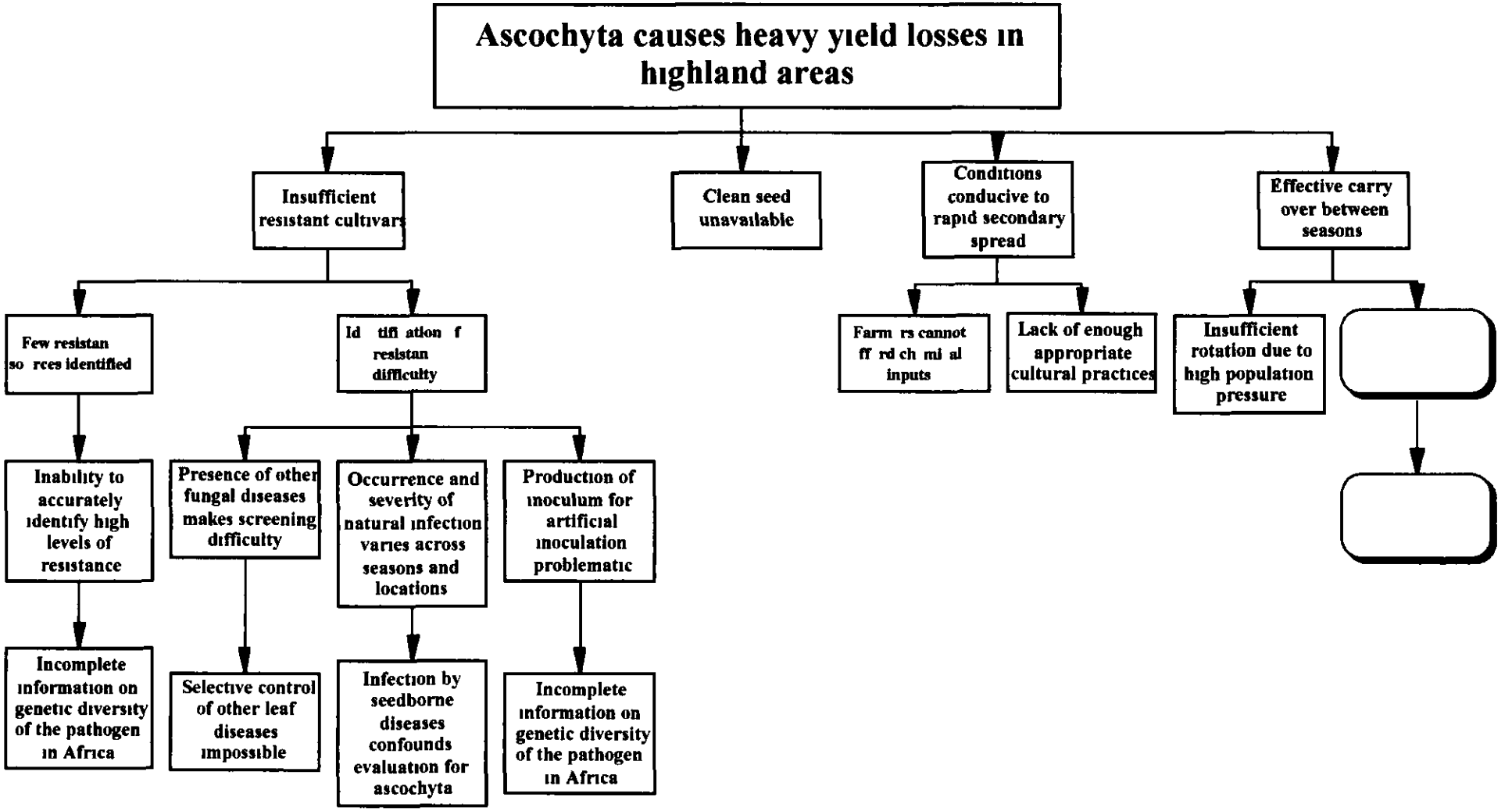
Anonymous SWPO Tool 4p In Working Instruments for Planing Evaluation, Monitoring and Transference into Action (PEMT) CDC Publication Series

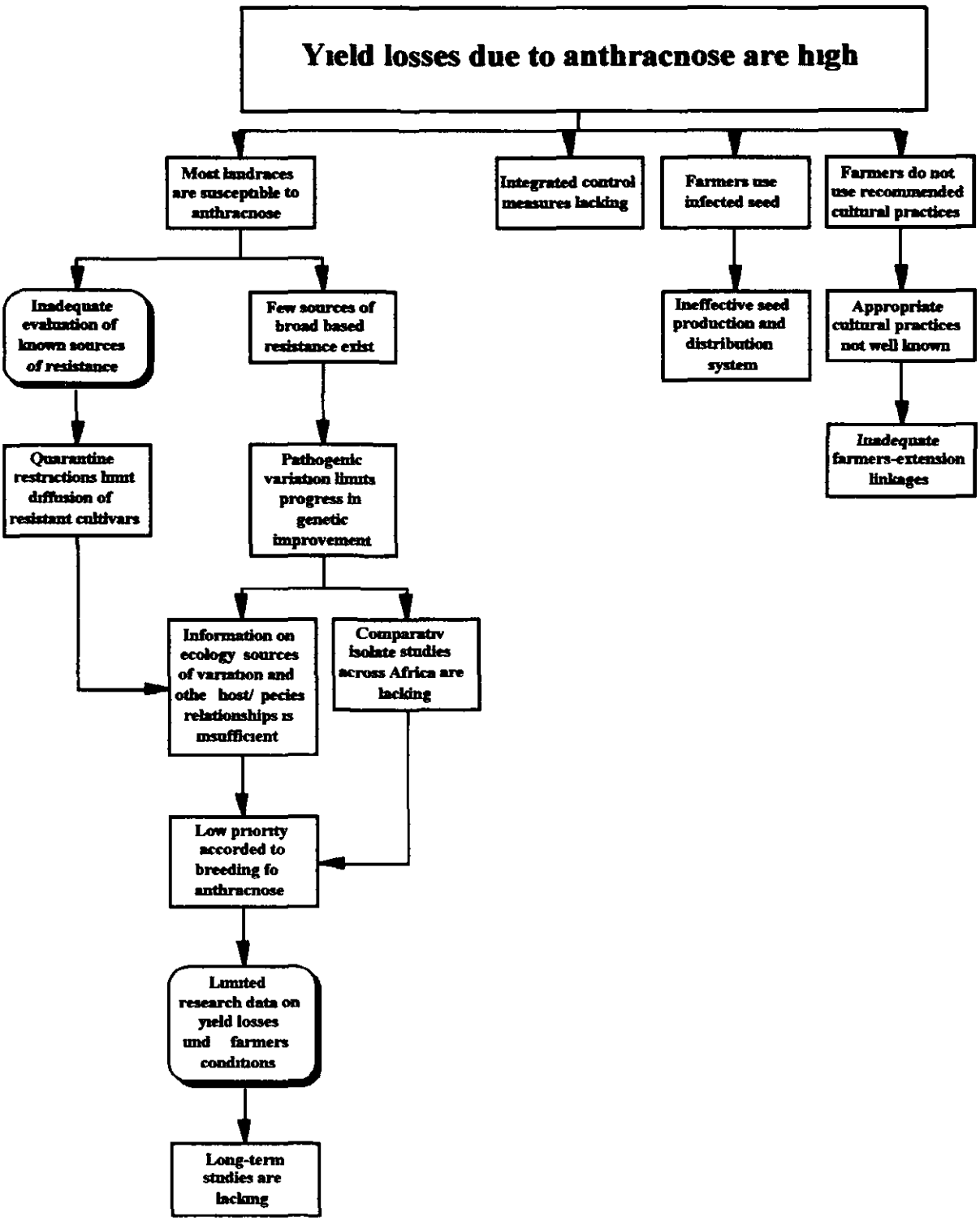
Reviewed Problem Trees

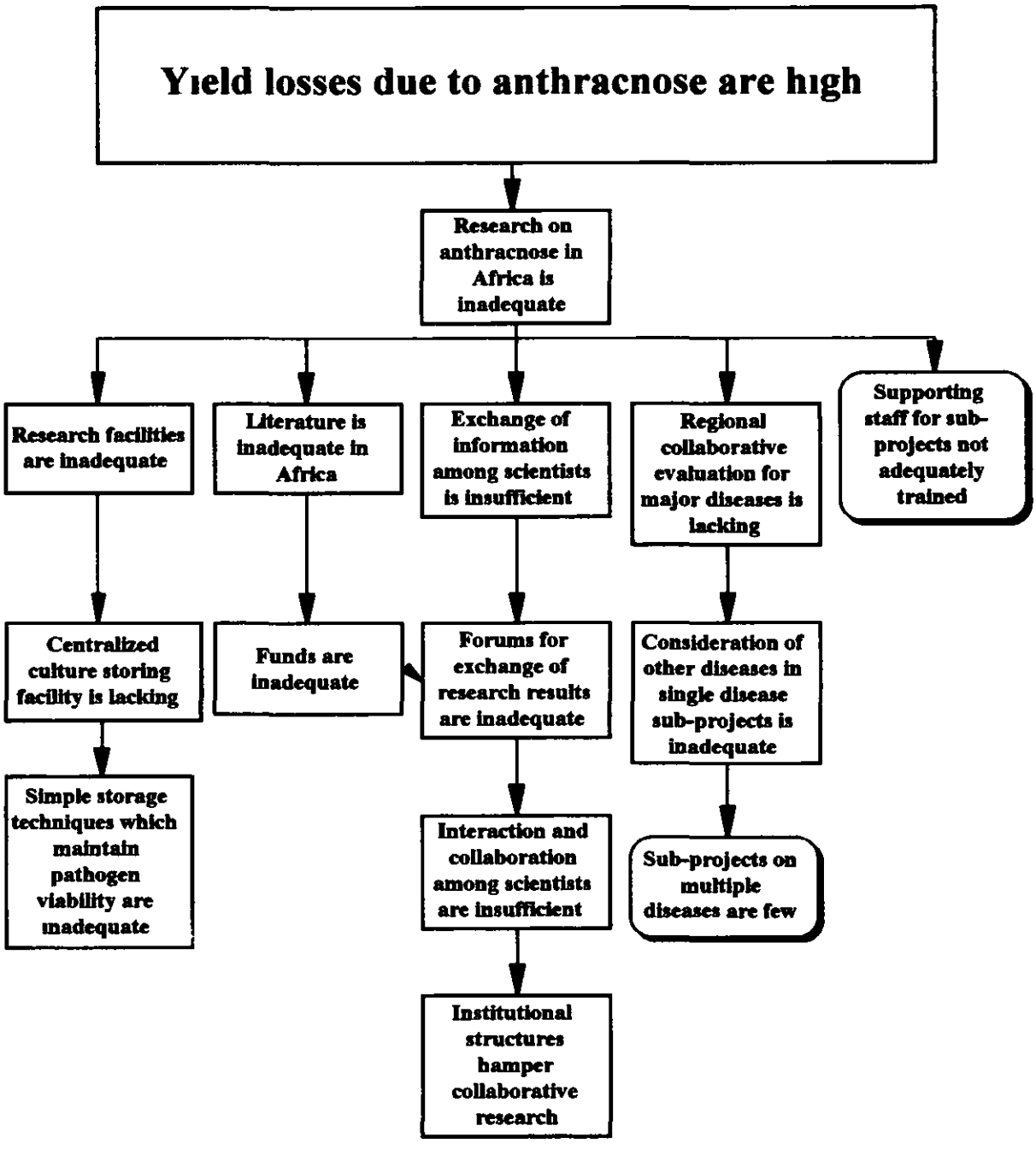

Yield losses due to fungal diseases in general
Cultural practices to control diseases not adopted by farmers
Potential f pan-Africa collaboration in resistan breeding not fully xploited
Insufficie t farmer awareness f individual diseases
Farmers are not involved early enough in technology development
Potential f germplasm exchange within Africa not fully exploited
Site selection for evaluation inadequate in term f pathogen diversity
N mechaniam to link sub-projects across regions
Insufficient collaboration on nap bean research
La k f clear strategy to share disease evaluation responsibility between stations (countries)
Extensionists are not aware f individual diseases
Lack f adequate system to produce clean seed and to move rseries quickly within Africa
Lack f links between pathogen diversity studies and breeding
Lack f evaluati mechanism for sub-projects
Inf rm tion on rsery evaluation does ot easily get back
Ins fficient access to recent information on pathogen distribution (territorial checklists)
Pathogen diversity studies not riented towards site selection for evaluation
Resistance breeding sub-projects not warded to team f pathologist breeder
Lack f common planning f sub-projects i som cou tries

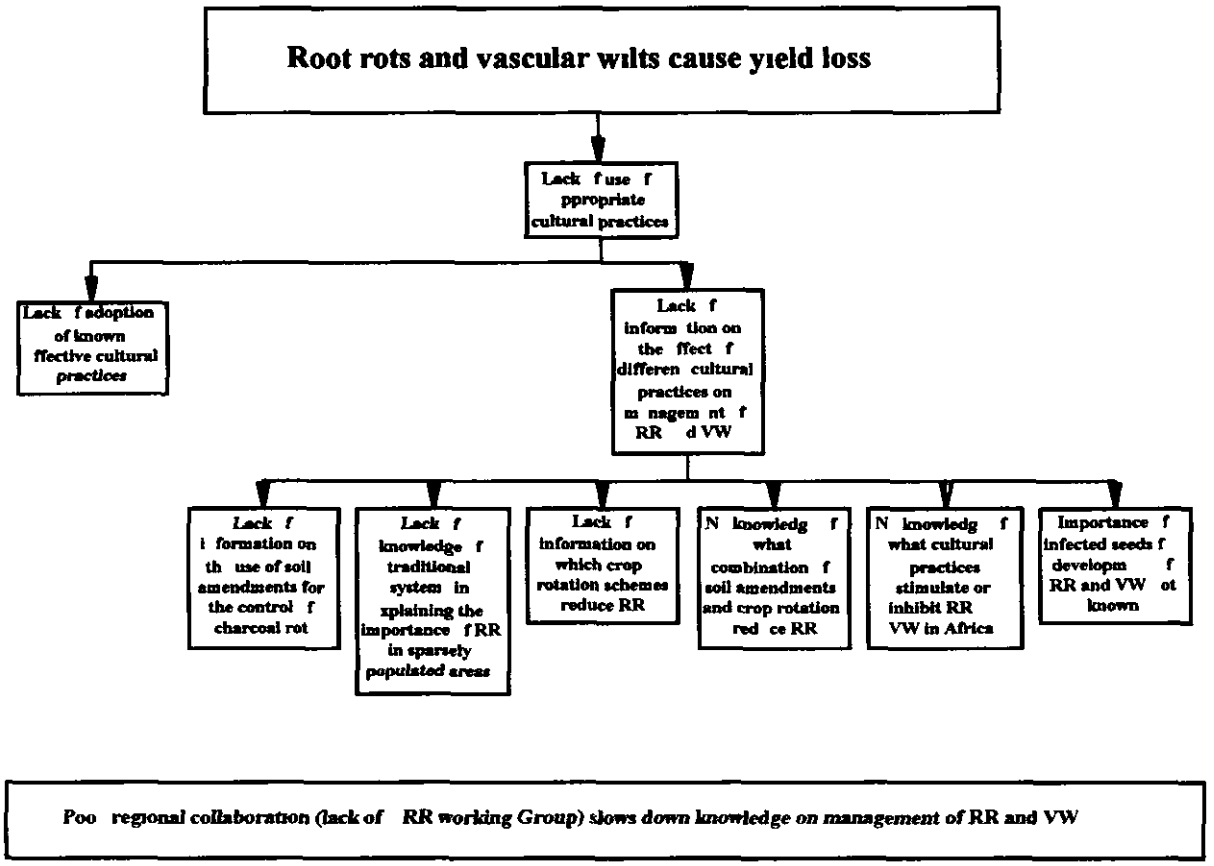

Yield losses due to fungal diseases in general
Lack f strategies to mai tai genetic div rsity f beans
Avail ble resistance not fully tilized in breeding program
Market f rces will rode diversity to xte t that minor but importa (resista) compon ts are lost
Lack f information on the ffect f varietal mixture on managem t f folia diseases
N collecti n, maintenance evaluatio f ge eti diversity f beans in som areas
Lack f strategy f pathogen conservation
Ins fficient attention to d rable resistance
Lack f tra ning in inoculation method
Lack f b- projects m ltiple disease resistance
Best methods for preservatio f ultures to minimize pathog ic h nge not known
N statistical an lysi f disease scores
Breeding mostly for only disease whe farm rs are facing sev ral
La k f long term studies f the dynamics f f rmers mixt res
Lumping f reacti ns (into R,I,S) biases interpretation f isolate cultiva interaction
Disease survey data re ot ombined with viro m tal data (m pping)
Not en gh knowledg gronomi d social strategies f f rm rs f composi g mixture
P th logists don't take active part i screening entries i national breeding rseries nd tri l
Lack f knowledg f certain dise ses (g fl ry leaf pot) is seri gap

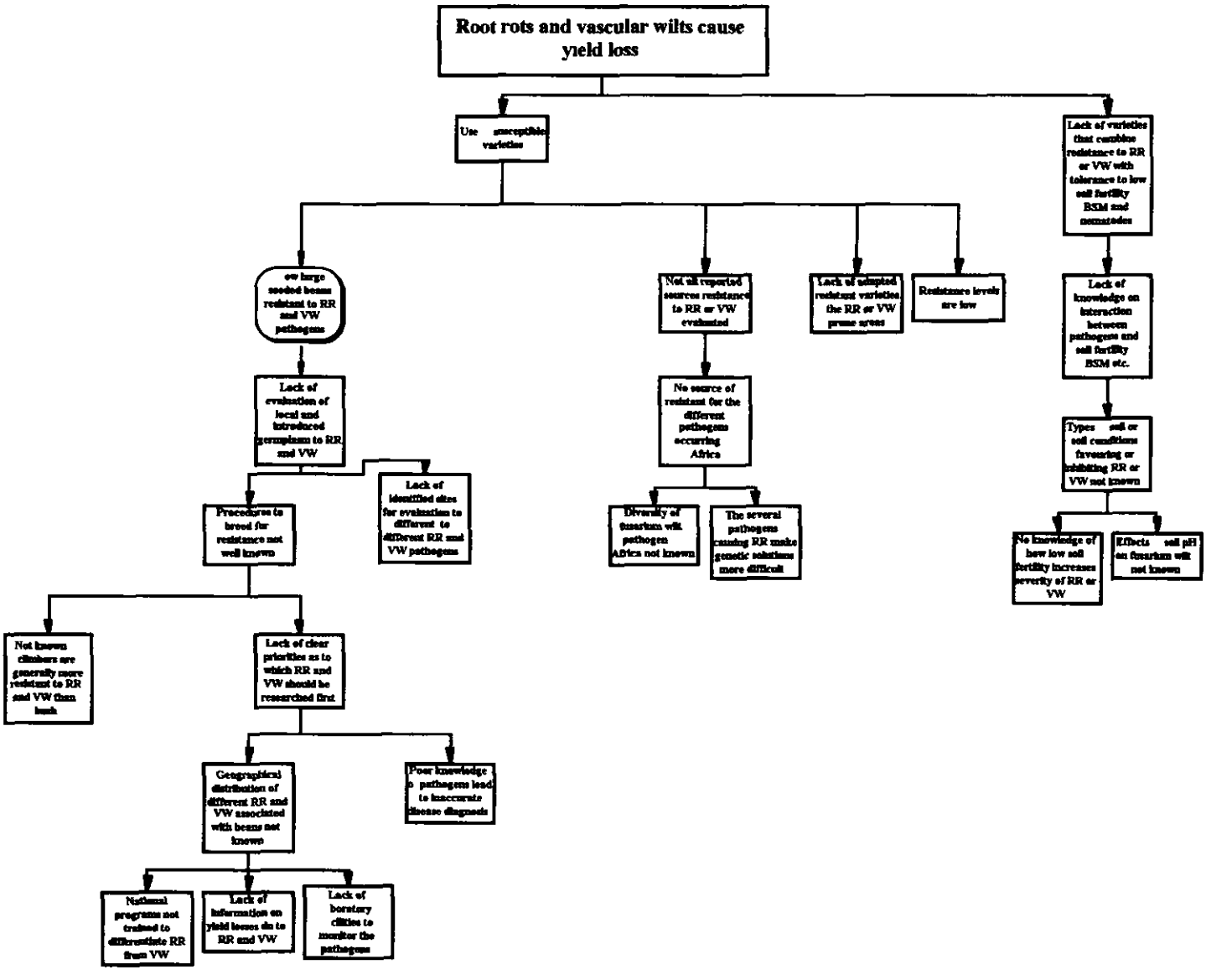

Yield loss from Angular Leaf Spot
Lack of desirable resistant varieties
Cultural practices inadequate
Lack of collaboration
Lack of resistance to ALS in large seeded and to early maturing materials
Lack of consumer acceptability to current resistant varietie
Unreliable ALS pressure under natural condition
farmers lack of awareness
Lack of research attention
Inadequate circulation of research results
Genetic inheritance of resistance not known
Lack of farmer participation in breeding
ALS pathogen race distribution not known
Lack of link between research, extension and farmers
Lack of information on crop losses due to ALS (except ZR)
sufficient use of proper screening methods
sufficient validation of set of differentials
Lack of training on yield los measurements
interaction between pathotype and genotype not known

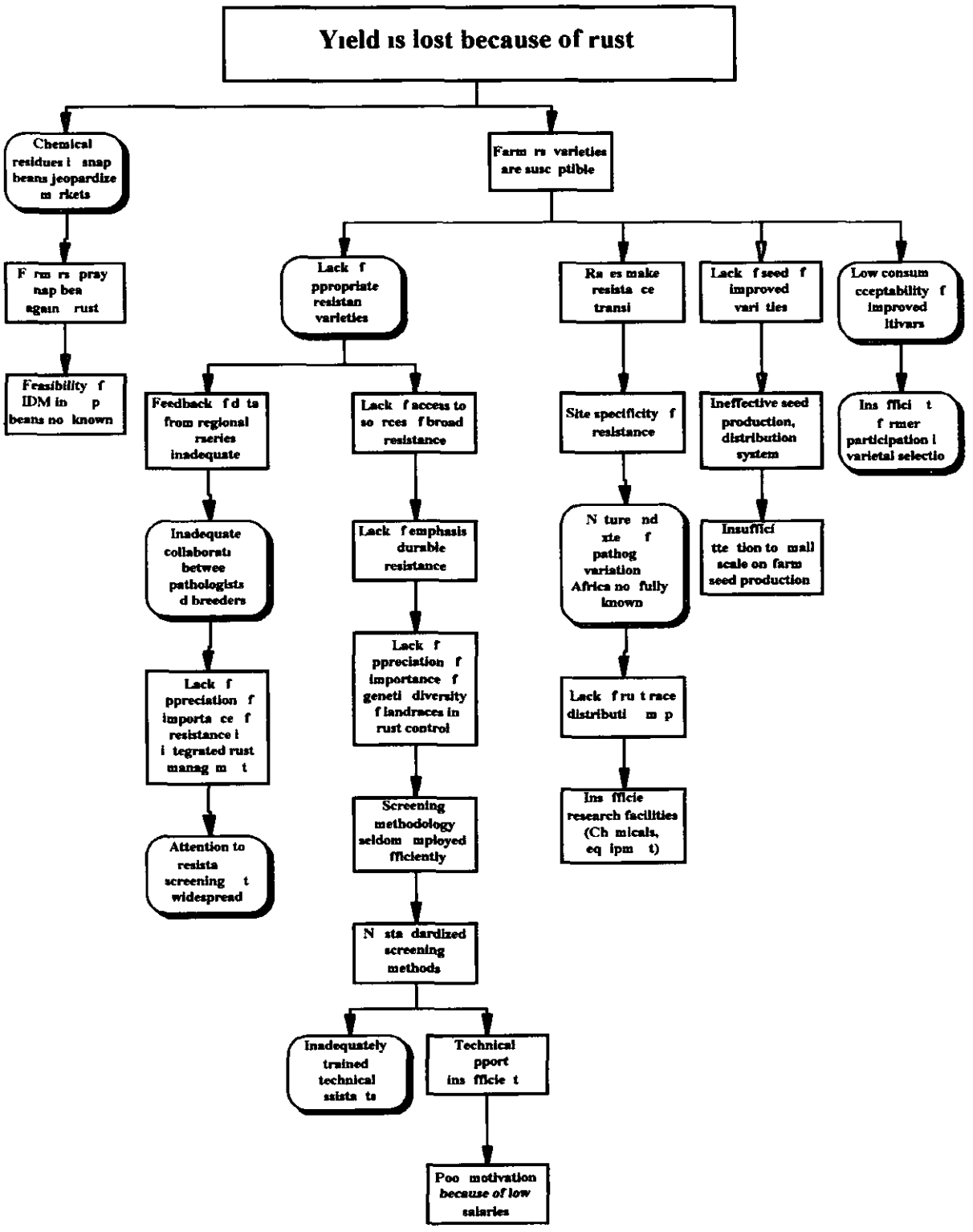

Ascochyta causes heavy yield losses in highland areas
Insufficient resistant cultivars
Clean seed unavailable
Conditions conducive to rapid secondary spread
Effective carry over between seasons
Few resistan so rces identified
Id tifi ation f resistan difficulty
Farm rs cannot ff rd ch mi al inputs
Lack of enough appropriate cultural practices
Insufficient rotation due to high population pressure
Inability to accurately identify high levels of resistance
Presence of other fungal diseases makes screening difficulty
Occurrence and severity of natural infection varies across seasons and locations
Production of inoculum for artificial inoculation problematic
Incomplete information on genetic diversity of the pathogen in Africa
Selective control of other leaf diseases impossible
Infection by seedborne diseases confounds evaluation for ascochyta
Incomplete information on genetic diversity of the pathogen in Africa

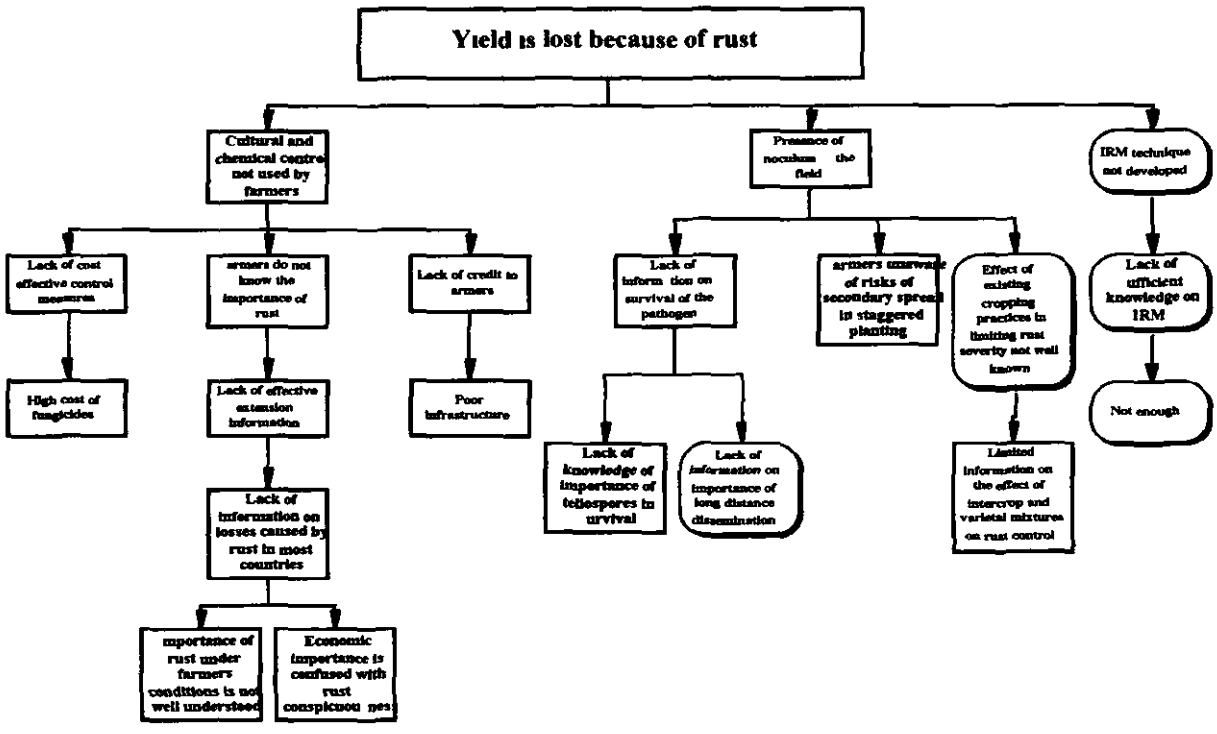

Yield losses due to anthracnose are high
Most landraces are susceptible to anthracnose
Integrated control measures lacking
Farmers use infected seed
Farmers do not use recommended cultural practices
Inadequate evaluation of known sources of resistance
Few sources of broad based resistance exist
Ineffective seed production and distribution system
Appropriate cultural practices not well known
Quarantine restrictions limit diffusion of resistant cultivars
Pathogenic variation limits progress in genetic improvement
Inadequate farmers-extension linkages
Information on ecology sources of variation and othe host/ pecies relationships is insufficient
Comparativ isolate studies across Africa are lacking
Low priority accorded to breeding fo anthracnose
Limited research data on yield losses und farmers conditions
Long-term studies are lacking


Yield losses due to anthracnose are high
Research on anthracnose in Africa is inadequate
Research facilities are inadequate
Literature is inadequate in Africa
Exchange of information among scientists is insufficient
Regional collaborative evaluation for major diseases is lacking
Supporting staff for sub-projects not adequately trained
Centralized culture storing facility is lacking
Funds are inadequate
Forums for exchange of research results are inadequate
Consideration of other diseases in single disease sub-projects is inadequate
Simple storage techniques which maintain pathogen viability are inadequate
Interaction and collaboration among scientists are insufficient
Sub-projects on multiple diseases are few
Institutional structures hamper collaborative research

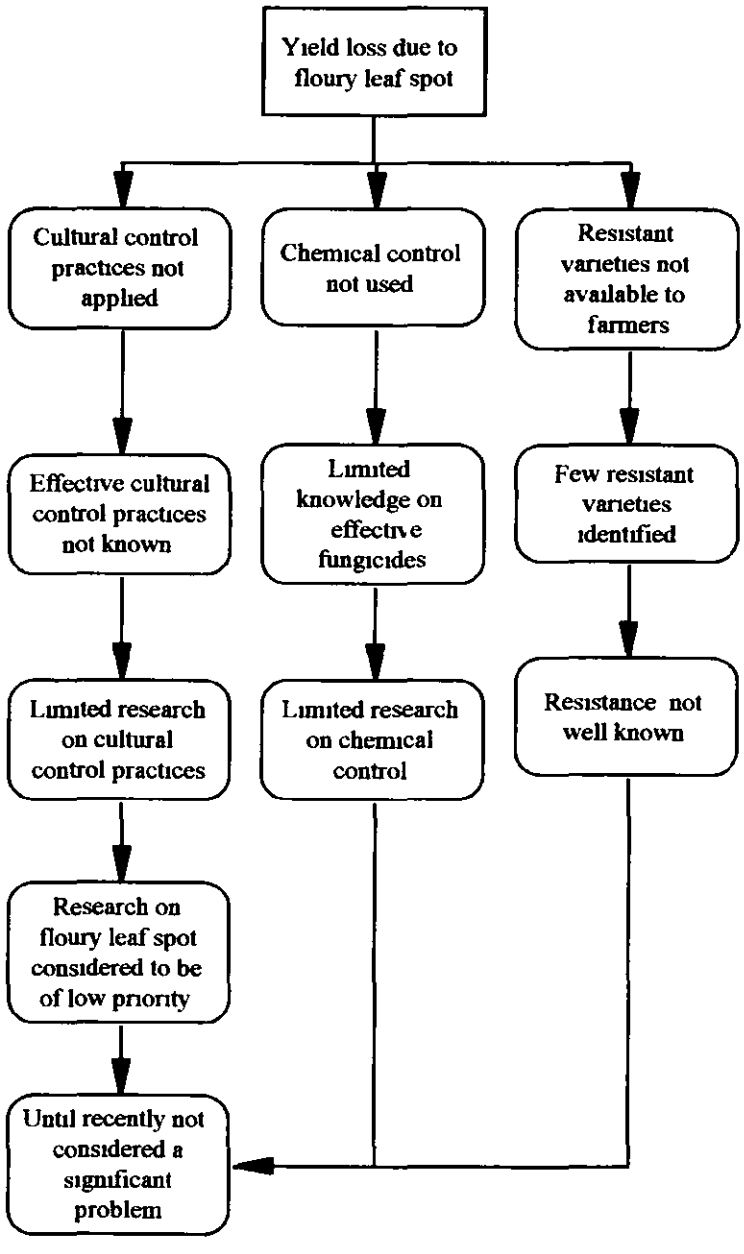

Root rots and vascular wilts cause yield loss
Lack f use f ppropriate cultural practices
Lack f adoption of known ffective cultural practices
Lack f inform tion on the ffect f differen cultural practices on m nagem nt f RR d VW
Lack f i formation on th use of soil amendments for the control f charcoal rot
Lack f knowledge f traditional system in xplaining the importance f RR in sparsely populated areas
Lack f information on which crop rotation schemes reduce RR
N knowledg f what combination f soil amendments and crop rotation red ce RR
N knowledg f what cultural practices stimulate or inhibit RR VW in Africa
Importance f infected seeds f developm f RR and VW ot known
Poo regional collaboration (lack of RR working Group) slows down knowledge on management of RR and VW

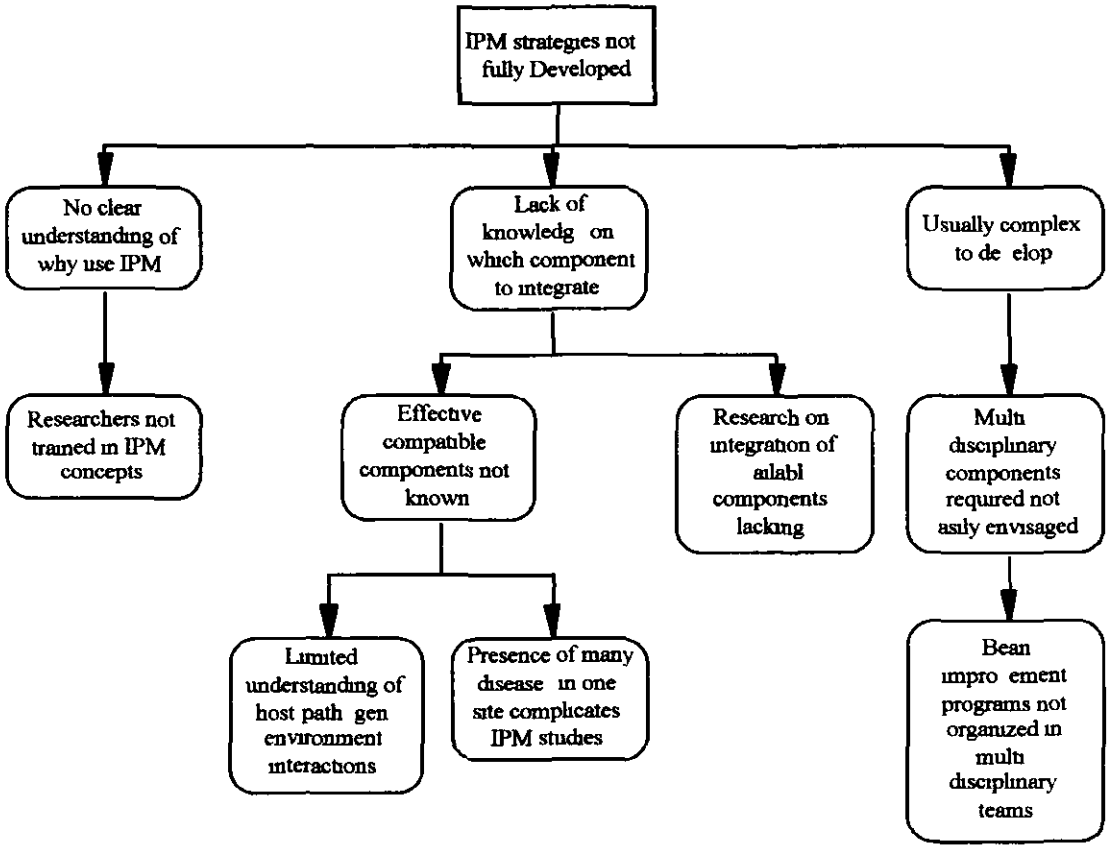

Root rots and vascular wilts cause yield loss
Use susceptible varieties
Lack of varieties that combine resistance to RR or VW with tolerance to low soil fertility BSM and nematodes
ow large seeded beans resistant to RR and VW pathogens
Not all reported sources resistance to RR or VW evaluated
Lack of adapted resistant varieties the RR or VW prone areas
Resistance levels are low
Lack of knowledge on interaction between pathogens and soil fertility BSM etc.
Lack of evaluation of local and introduced germplasm to RR and VW
No source of resistant for the different pathogens occurring Africa
Types soil or soil conditions favouring or inhibiting RR or VW not known
Lack of identified sites for evaluation to different to different RR and VW pathogens
Procedures to breed for resistance not well known
Diversity of fusarium wilt pathogen Africa not known
The several pathogens causing RR make genetic solutions more difficult
No knowledge of how low soil fertility increases severity of RR or VW
Effects soil pH on fusarium wilt not known
Not known climbers are generally more resistant to RR and VW than bush
Lack of clear priorities as to which RR and VW should be researched first
Geographical distribution of different RR and VW associated with beans not known
Poor knowledge o pathogens lead to inaccurate disease diagnosis
National programs not trained to differentiate RR from VW
Lack of information on yield losses du to RR and VW
Lack of boratory cilities to monitor the pathogens


Yield is lost because of rust
Chemical residues in snap beans jeopardize markets
Farmers varieties are susceptible
Farmers spray snap bean again rust
Lack of appropriate resistant varieties
Race make resistance transi
Lack of seed of improved varieties
Low consumer acceptability of improved cultivars
Feasibility of IDM in p beans no known
Feedback of data from regional series inadequate
Lack of access to sources of broad resistance
Site specificity of resistance
Ineffective seed production, distribution system
Inefficient farmer participation in varietal selectio
Inadequate collaboratn betwee pathologists d breeders
Lack of emphasis durable resistance
Nature and extent of pathog variation Africa no fully known
Insufficient attention to small scale on farm seed production
Lack of appreciation of importance of resistance in integrated rust manag m t
Lack of appreciation of importance of genetic diversity of landraces in rust control
Lack of rust race distributi m p
Attention to resista screening t widespread
Screening methodology seldom employed efficiently
Inefficie research facilities (Chemicals, equipment)
Nonstandardized screening methods
Inadequately trained technical assistants
Technical support inefficient
Poor motivation because of low salaries


Yield is lost because of rust
Cultural and chemical control not used by farmers
Presence of inoculum in the field
IRM technique not developed
Lack of cost effective control measures
farmers do not know the importance of rust
Lack of credit to farmers
Lack of information on survival of the pathogen
farmers unaware of risks of secondary spread in staggered planting
Effect of existing cropping practices in limiting rust severity not well known
Lack of sufficient knowledge on IRM
High cost of fungicides
Lack of effective extension information
Poor infrastructure
Not enough
Lack of knowledge of importance of teliospores in survival
Lack of information on importance of long distance dissemination
Limited information on the effect of intercrop and varietal mixtures on rust control
Lack of information on losses caused by rust in most countries
importance of rust under farmers conditions is not well understood
Economic importance is confused with rust conspicuous nes

New Problem Trees

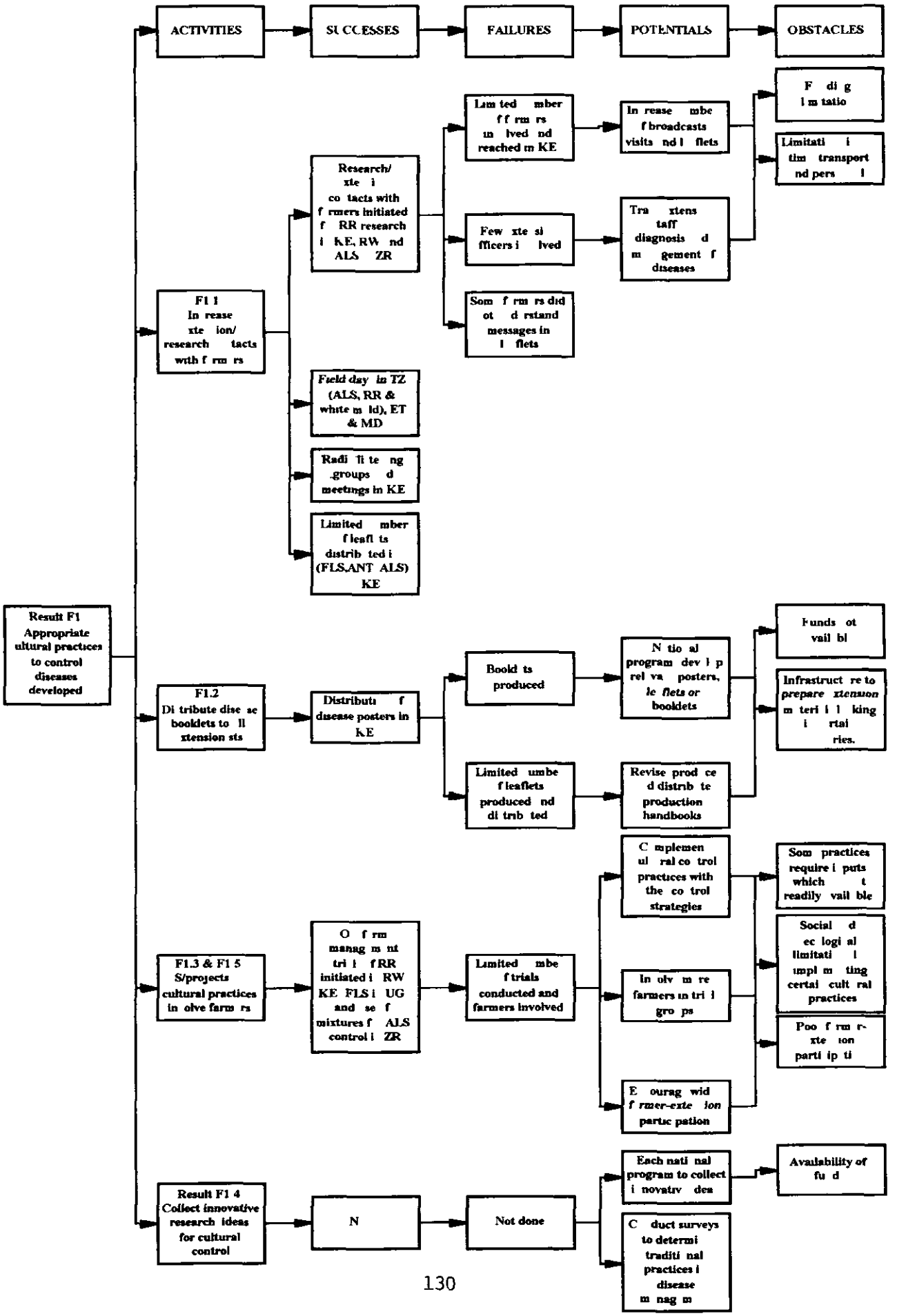

Yield loss due to floury leaf spot
Cultural control practices not applied
Chemical control not used
Resistant varieties not available to farmers
Effective cultural control practices not known
Limited knowledge on effective fungicides
Few resistant varieties identified
Limited research on cultural control practices
Limited research on chemical control
Resistance not well known
Research on floury leaf spot considered to be of low priority
Until recently not considered a significant problem

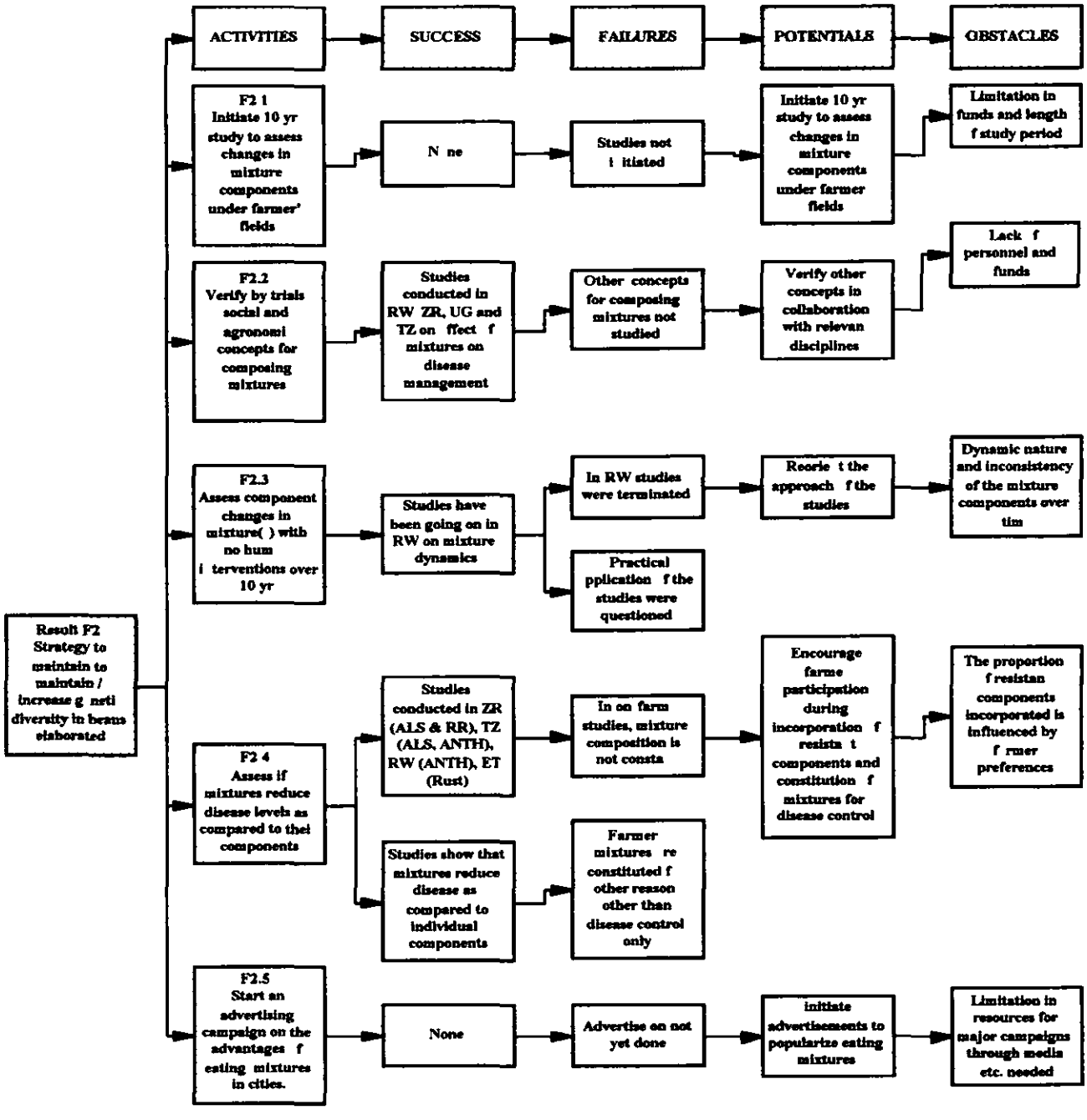

IPM strategies not fully Developed
No clear understanding of why use IPM
Lack of knowledg on which component to integrate
Usually complex to de elop
Researchers not trained in IPM concepts
Effective compatible components not known
Research on integration of ailabl components lacking
Multi disciplinary components required not asily envisaged
Limited understanding of host path gen environment interactions
Presence of many disease in one site complicates IPM studies
Bean impro ement programs not organized in multi disciplinary teams

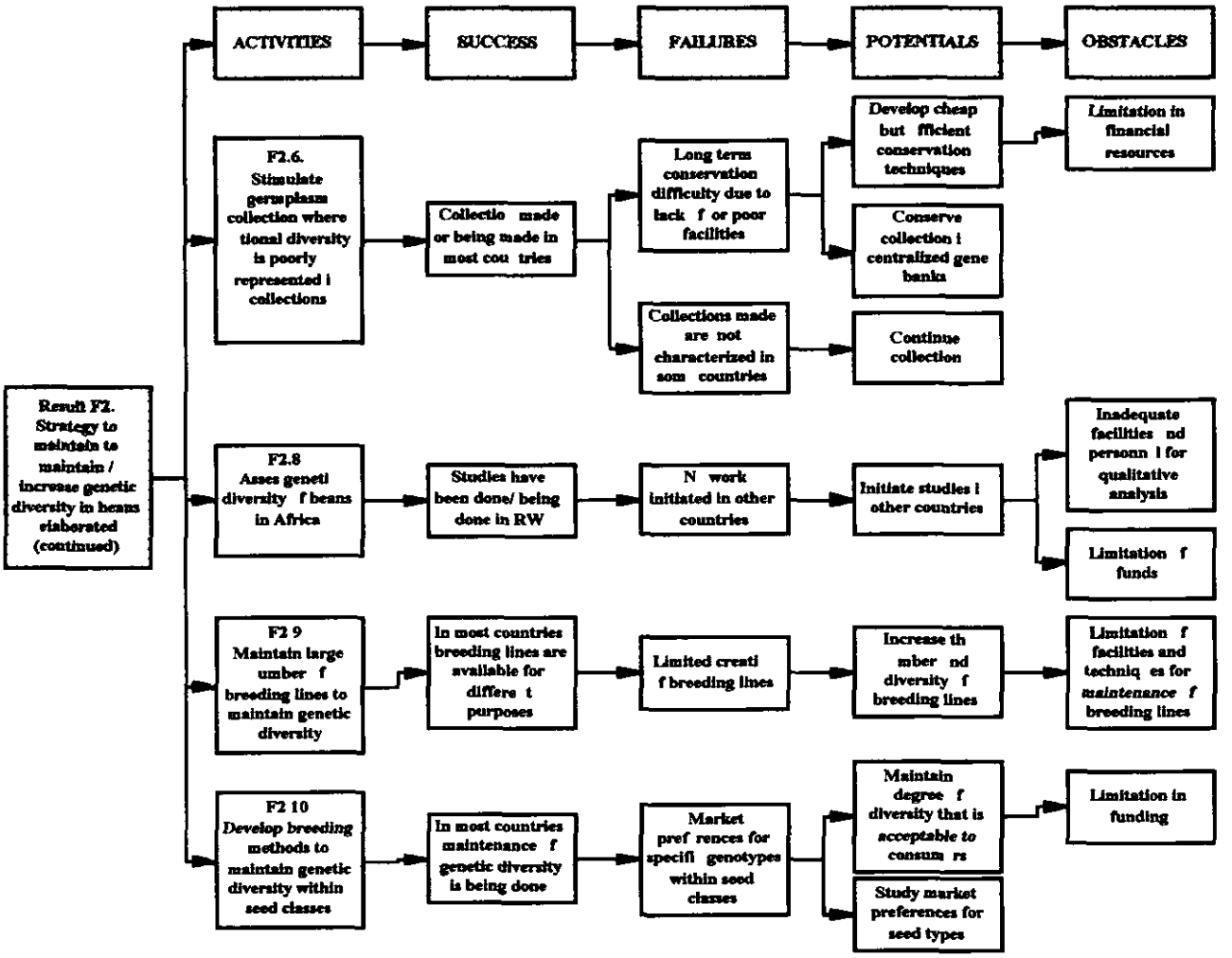
Yield losses due to powdery mildew
Cultural control methods not used by farmers
Resistant varieties not used by farmers
Chemicals control method not used by farmers
Farmers unaware of the PM problem
Cultural control methods not known to farmers
Effective cultural control methods not developed
Resistant varieties not yet identified
Chemical control not cost effective
Effective chemicals not identified
Lack of information on the importance of PM
Extension research linkages weak
Screening for resistance lacking
No screening of chemical done
Lack of information on the importance of PM
Powdery mildew not considered important

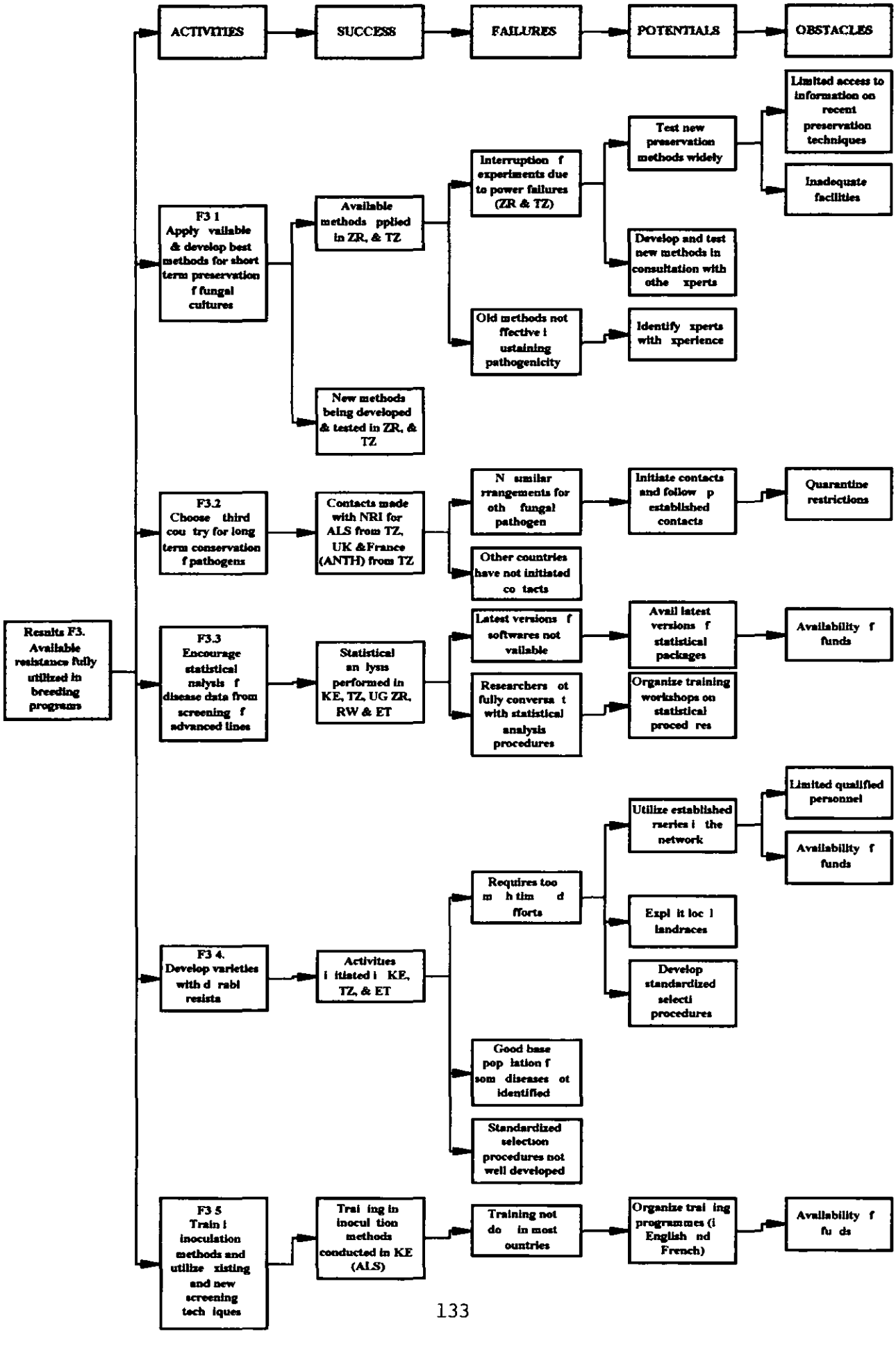
Self-Evaluation charts

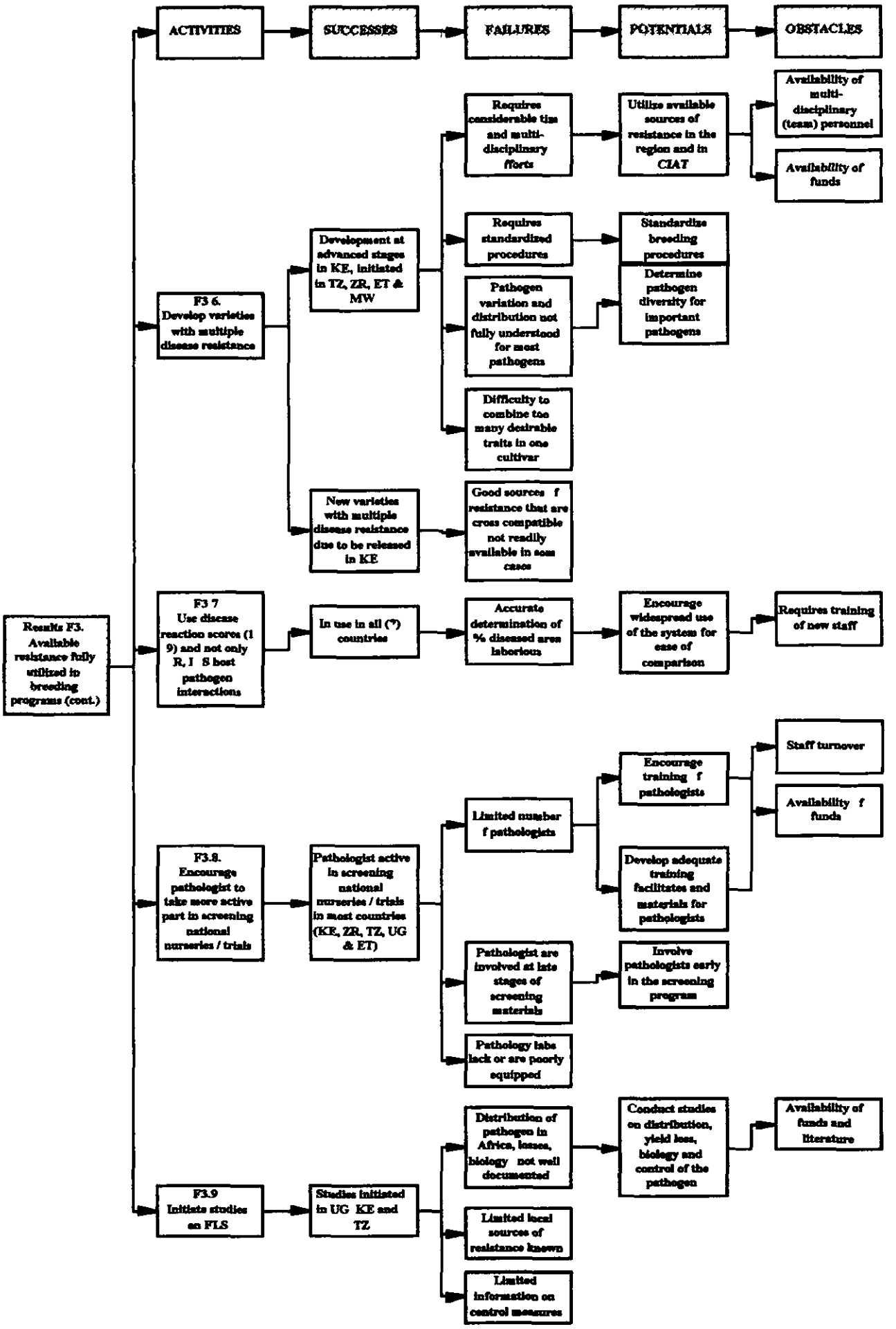
Rust	
Objective U To reduce yield losses due to rust below the level of economic importance	
Result U1 Decreased reliance on pesticides in snap bean production	
Result U2 Use of cost effective control measures	
Result U3 Farmers use resistant varieties	
Result U4 Decrease field inoculum	

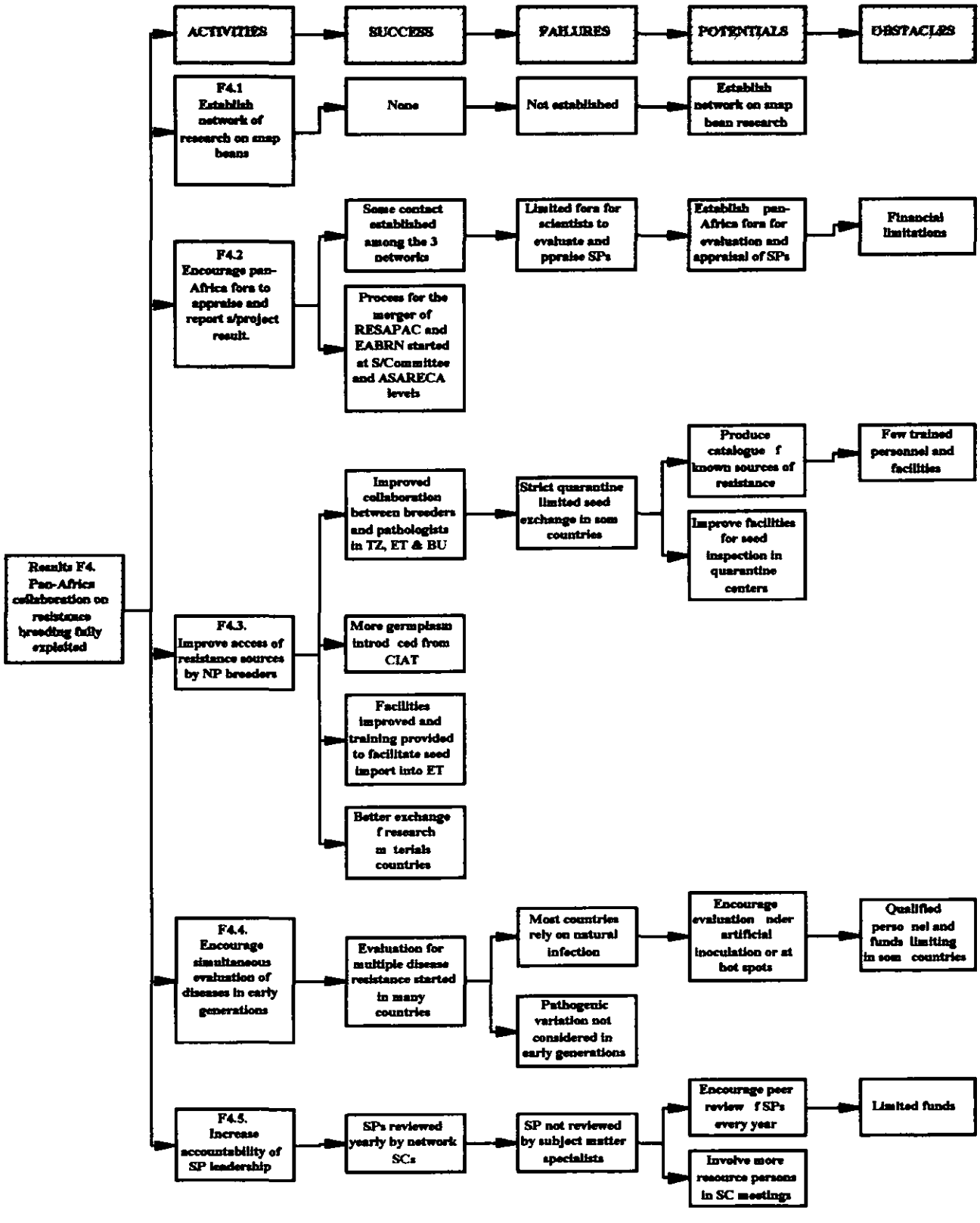

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Result F1
Appropriate ultural practices to control diseases developed
F1 1
In rease xte ion/ research tacts with f rm rs
Research/ xte i co tacts with f rmers initiated f RR research i KE, RW nd ALS ZR
Lm ted mber f f rm rs in lved nd reached m KE
In rease mbe f broadcasts visits nd l flets
F di g l m tatio
Limitati i tim transport nd pers l
Few xte si fficers i lved
Tra xtens taff diagnosis d m gement f diseases
Som f rm rs did ot d rstand messages in l flets
Field day in TZ (ALS, RR & white m ld), ET & MD
Radi ti te ng .groups d meetings in KE
Limited mber f leafl ts distrib ted i (FLSANT ALS) KE
F1.2
Di tribute dise se booklets to ll xtension sts
Distributi f disease posters in KE
Bookl ts produced
N tio al program dev l p rel va posters, le flets or booklets
Funds ot vail bl
Infrastruct re to prepare xtension m teri l l king i rtai ries.
Limited umbe f leaflets produced nd di trib ted
Revise prod ce d distrib te production handbooks
F1.3 & F1 5
S/projects cultural practices in olve farm rs
O f rm manag m nt tri l f RR initiated i RW KE FLS i UG and se f mixtures f ALS control i ZR
Lmited mbe f trials conducted and farmers involved
C mplemen ul ral co trol practices with the co trol strategies
Som practices require i puts which t readily vail ble
Social d ec logi al limitati l impl m ting certai cult ral practices
In olv m re farmers in tri l gro ps
Poo f rm r- xte ion parti ip ti
E ourag wid f rmer-exte ion partic pation
Result F1 4
Collect innovative research ideas for cultural control
N
Not done
Each nati nal program to collect i novativ dea
Availability of fu d
C duct surveys to determi traditi nal practices i disease m nag m

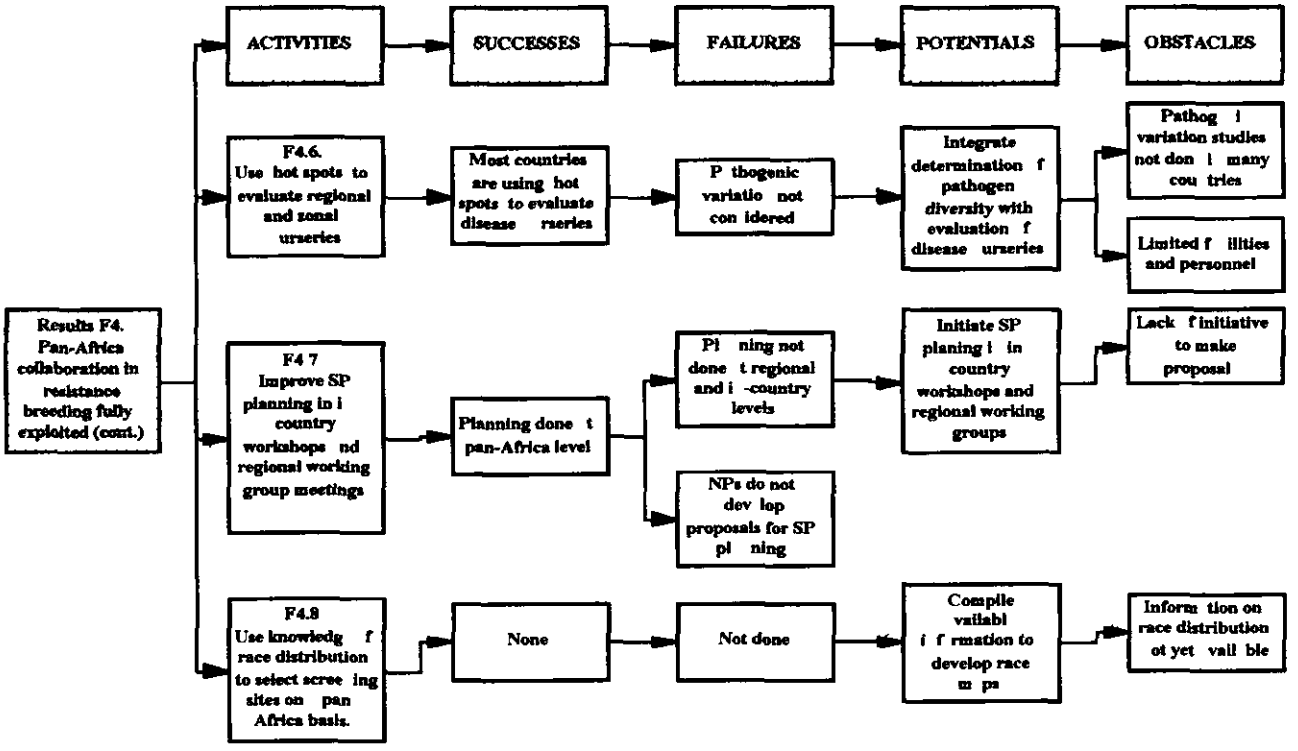

Result F2
Strategy to maintain to maintain / increase g nti diversity in beans elaborated
ACTIVITIES
SUCCESS
FAILURES
POTENTIALS
OBSTACLES
F2 1
Initiate 10 yr study to assess changes in mixture components under farmer' fields
N ne
Studies not i itiated
Initiate 10 yr study to assess changes in mixture components under farmer fields
Limitation in funds and length f study period
F2.2
Verify by trials social and agronomi concepts for composing mixtures
Studies conducted in RW ZR, UG and TZ on ffect f mixtures on disease management
Other concepts for composing mixtures not studied
Verify other concepts in collaboration with relevan disciplines
Lack f personnel and funds
F2.3
Assess component changes in mixture( ) with no hum i terventions over 10 yr
Studies have been going on in RW on mixture dynamics
In RW studies were terminated
Reorie t the approach f the studies
Dynamic nature and inconsistency of the mixture components over tim
Practical pplication f the studies were questioned
F2 4
Assess if mixtures reduce disease levels as compared to thei components
Studies conducted in ZR (ALS & RR), TZ (ALS, ANTH), RW (ANTH), ET (Rust)
In on farm studies, mixture composition is not consta
Encourage farme participation during incorporation f resista t components and constitution f mixtures for disease control
The proportion f resistan components incorporated is influenced by f rmer preferences
Studies show that mixtures reduce disease as compared to individual components
Farmer mixtures re constituted f other reason other than disease control only
F2.5
Start an advertising campaign on the advantages f eating mixtures in cities.
None
Advertise on not yet done
initiate advertisements to popularize eating mixtures
Limitation in resources for major campaigns through media etc. needed

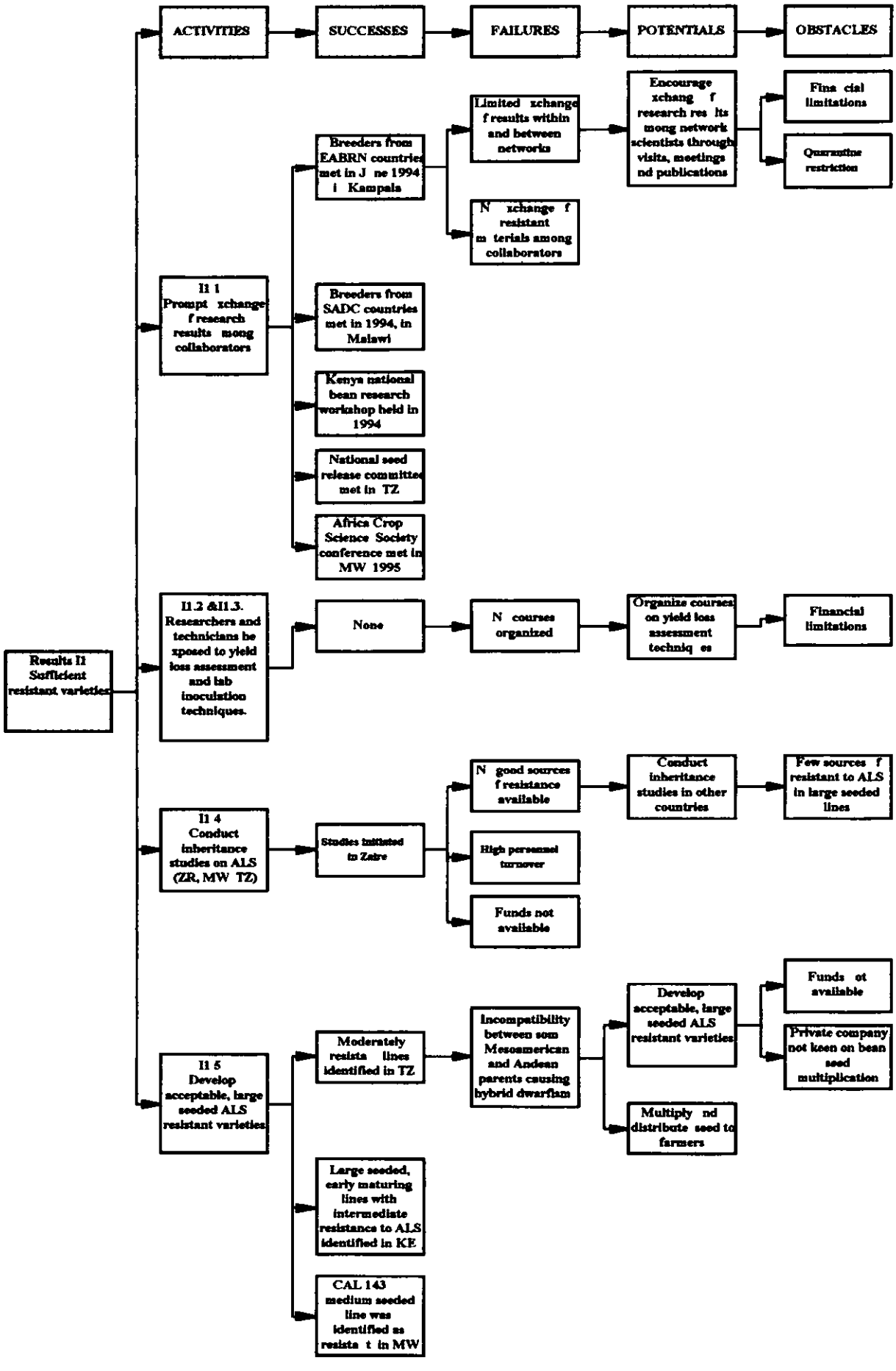

ACTIVITIES
SUCCESS
FAILURES
POTENTIALS
OBSTACLES
Result F2. Strategy to maintain ta maintain / increase genetic diversity in beans elaborated (continued)
F2.6. Stimulate germplasm collection where tional diversity is poorly represented i collections
Collectio made or being made in most cou tries
Long term conservation difficulty due to lack f or poor facilities
Develop cheap but fficient conservation techniques
Limitation in financial resources
Conserve collection i centralized gene banks
Collections made are not characterized in som countries
Continue collection
F2.8 Asses geneti diversity f beans in Africa
Studies have been done/ being done in RW
N work initiated in other countries
Initiate studies i other countries
Inadequate facilities nd personn l for qualitative analysis
Limitation f funds
F2 9 Maintain large umber f breeding lines to maintain genetic diversity
In most countries breeding lines are available for differe t purposes
Limited creati f breeding lines
Increase th mber nd diversity f breeding lines
Limitation f facilities and techniq es for maintenance f breeding lines
F2 10 Develop breeding methods to maintain genetic diversity within seed classes
In most countries maintenance f genetic diversity is being done
Market pref rences for specifi genotypes within seed classes
Maintain degree f diversity that is acceptable to consum rs
Study market preferences for seed types
Limitation in funding

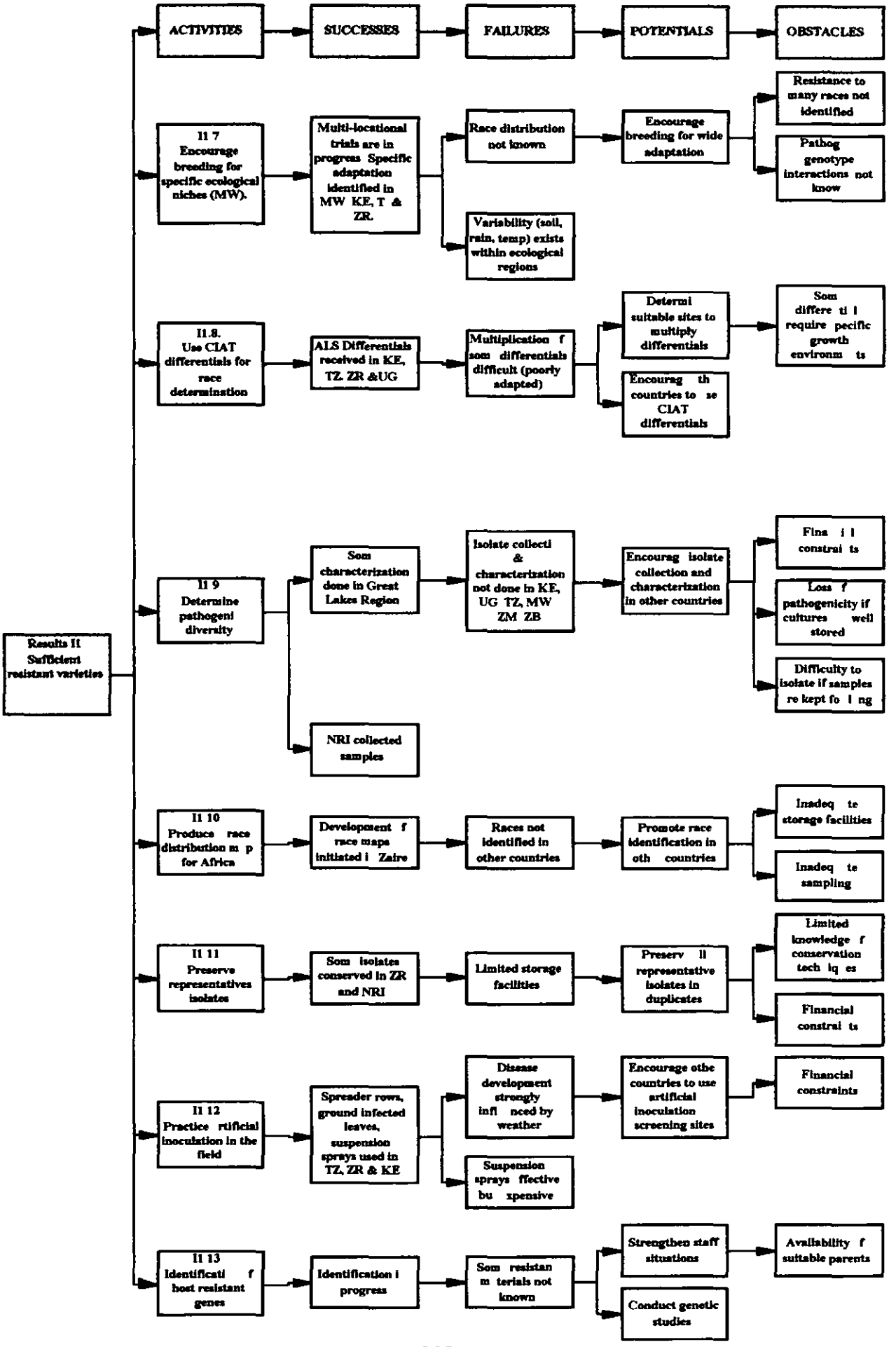

ACTIVITIES
SUCCESS
FAILURES
POTENTIALS
OBSTACLES
Results F3. Available resistance fully utilized in breeding programs
F3 1 Apply vailable & develop best methods for short term preservation f fungal cultures
Available methods pplied in ZR, & TZ
New methods being developed & tested in ZR, & TZ
Interruption f experiments due to power failures (ZR & TZ)
Old methods not ffective i ustaining pathogenicity
Test new preservation methods widely
Develop and test new methods in consultation with othe xperts
Identify xperts with xperience
Limited access to information on recent preservation techniques
Inadequate facilities
F3.2 Choose third cou try for long term conservation f pathogens
Contacts made with NRI for ALS from TZ, UK &France (ANTH) from TZ
N similar rrangements for oth fungal pathogen
Other countries have not initiated co tacts
Initiate contacts and follow p established contacts
Quarantine restrictions
F3.3 Encourage statistical nalysis f disease data from screening f advanced lines
Statistical an lysis performed in KE, TZ, UG ZR, RW & ET
Latest versions f softwares not vailable
Researchers ot fully conversa t with statistical analysis procedures
Avail latest versions f statistical packages
Organize training workshops on statistical proced res
Availability f funds
F3 4. Develop varieties with d rabl resista
Activities i itiated i KE, TZ, & ET
Requires too m h tim d fforts
Good base pop lation f som diseases ot identified
Standardized selection procedures not well developed
Utilize established rseries i the network
Expl it loc l landraces
Develop standardized selecti procedures
Limited qualified personnel
Availability f funds
F3 5 Train i inoculation methods and utilize xisting and new screening tech iques
Trai ing in inocul tion methods conducted in KE (ALS)
Training not do in most ountries
Organize trai ing programmes (i English nd French)
Availability f fu ds

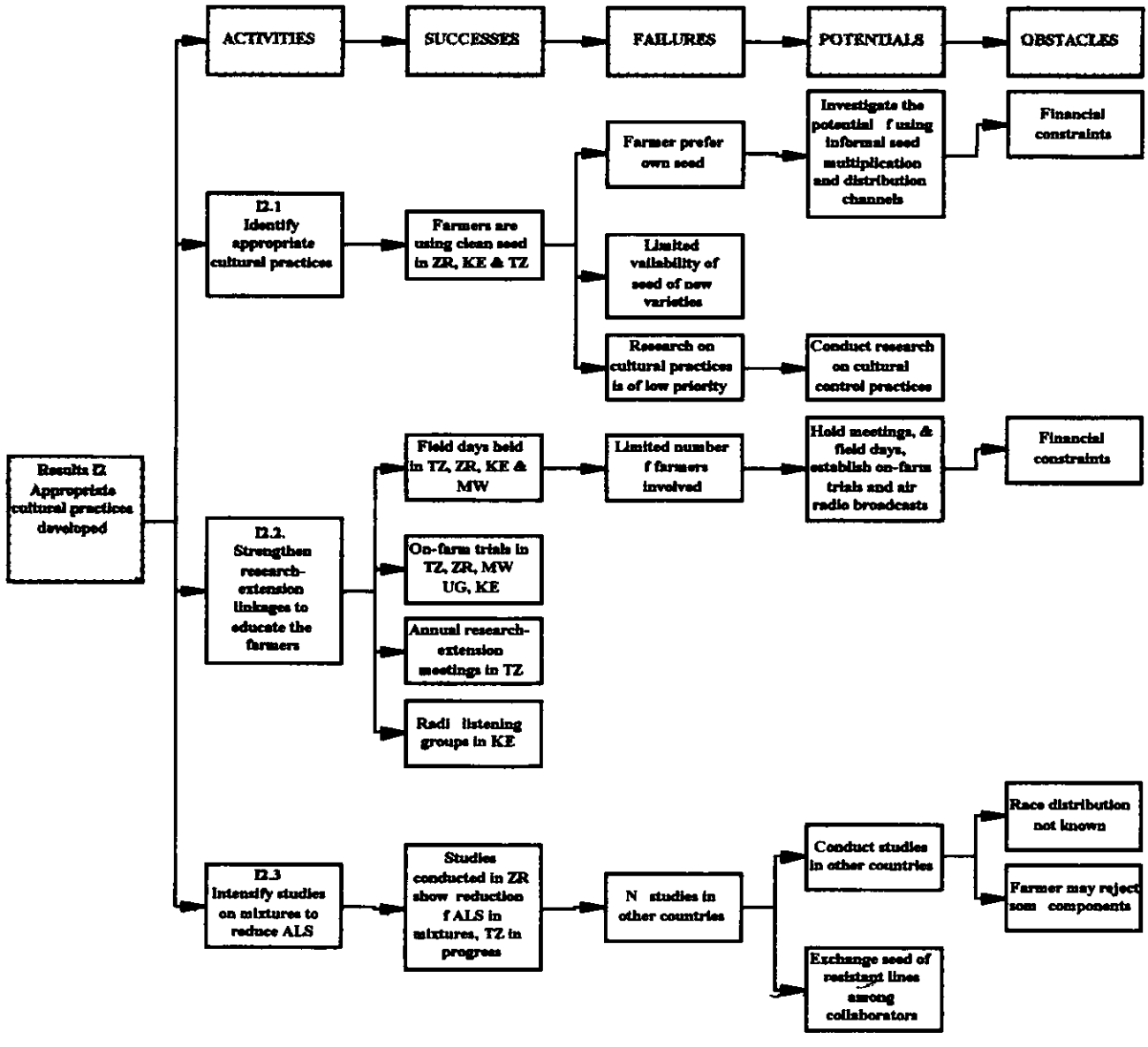

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results F3. Available resistance fully utilized in breeding programs (cont.)
F3 6. Develop varieties with multiple disease resistance
Development at advanced stages in KE, initiated in TZ, ZR, ET & MW
Requires considerable tim and multi-disciplinary fforts
Utilize available sources of resistance in the region and in CIAT
Availability of multi-disciplinary (team) personnel
Availability of funds
Requires standardized procedures
Standardise breeding procedures
Pathogen variation and distribution not fully understood for most pathogens
Determine pathogen diversity for important pathogens
Difficulty to combine too many desirable traits in one cultivar
New varieties with multiple disease resistance due to be released in KE
Good sources f resistance that are cross compatible not readily available in som cases
F3 7 Use disease reaction scores (1 9) and not only R, I S host pathogen interactions
In use in all (*) countries
Accurate determination of % diseased area laborious
Encourage widespread use of the system for ease of comparison
Requires training of new staff
F3.8. Encourage pathologist to take more active part in screening national nurseries / trials
Pathologist active in screening national nurseries / trials in most countries (KE, ZR, TZ, UG & ET)
Limited number f pathologists
Encourage training f pathologists
Staff turnover
Availability f funds
Develop adequate training facilitates and materials for pathologists
Pathologist are involved at late stages of screening materials
Involve pathologists early in the screening program
Pathology labs lack or are poorly equipped
F3.9 Initiate studies on FLS
Studies initiated in UG KE and TZ
Distribution of pathogen in Africa, losses, biology not well documented
Conduct studies on distribution, yield loss, biology and control of the pathogen
Availability of funds and literature
Limited local sources of resistance known
Limited information on control measures

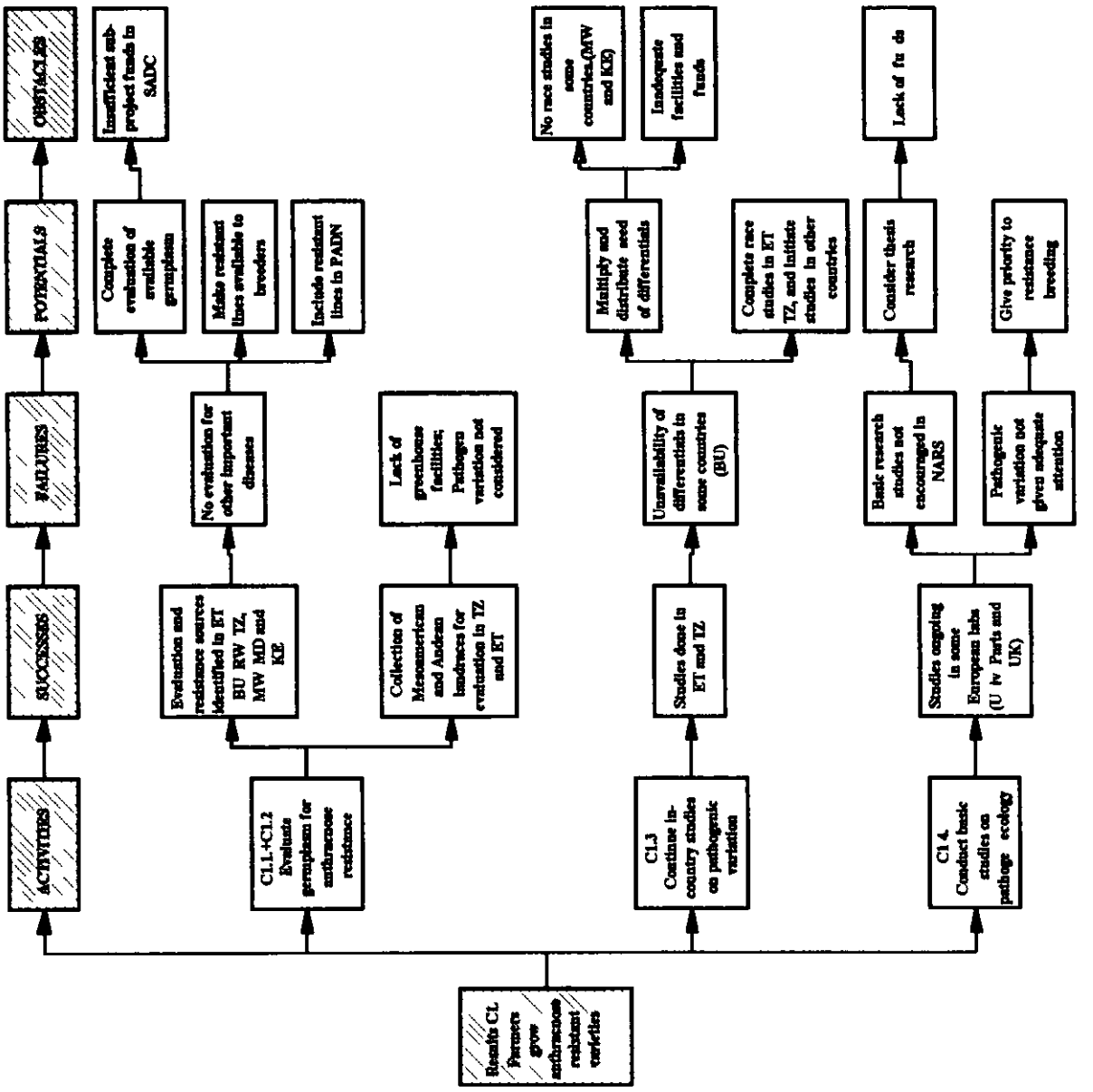

ACTIVITIES
SUCCESS
FAILURES
POTENTIALS
OBSTACLES
Results F4. Pan-Africa collaboration on resistance breeding fully exploited
F4.1 Establish network of research on snap beans
None
Not established
Establish network on snap bean research
F4.2 Encourage pan-Africa fora to appraise and report a/project result.
Some contact established among the 3 networks
Process for the merger of RESAPAC and EABRN started at S/Committee and ASARECA levels
Limited fora for scientists to evaluate and ppraise SPs
Establish pan-Africa fora for evaluation and appraisal of SPs
Financial limitations
F4.3. Improve access of resistance sources by NP breeders
Improved collaboration between breeders and pathologists in TZ, ET & BU
More germplasm introd ced from CIAT
Facilities improved and training provided to facilitate seed import into ET
Better exchange f research m terials countries
Strict quarantine limited seed exchange in som countries
Produce catalogue f known sources of resistance
Improve facilities for seed inspection in quarantine centers
Few trained personnel and facilities
F4.4. Encourage simultaneous evaluation of diseases in early generations
Evaluation for multiple disease resistance started in many countries
Most countries rely on natural infection
Pathogenic variation not considered in early generations
Encourage evaluation nder artificial inoculation or at hot spots
Qualified perso nel and funds limiting in som countries
F4.5. Increase accountability of SP leadership
SPs reviewed yearly by network SCs
SP not reviewed by subject matter specialists
Encourage peer review f SPs every year
Involve more resource persons in SC meetings
Limited funds

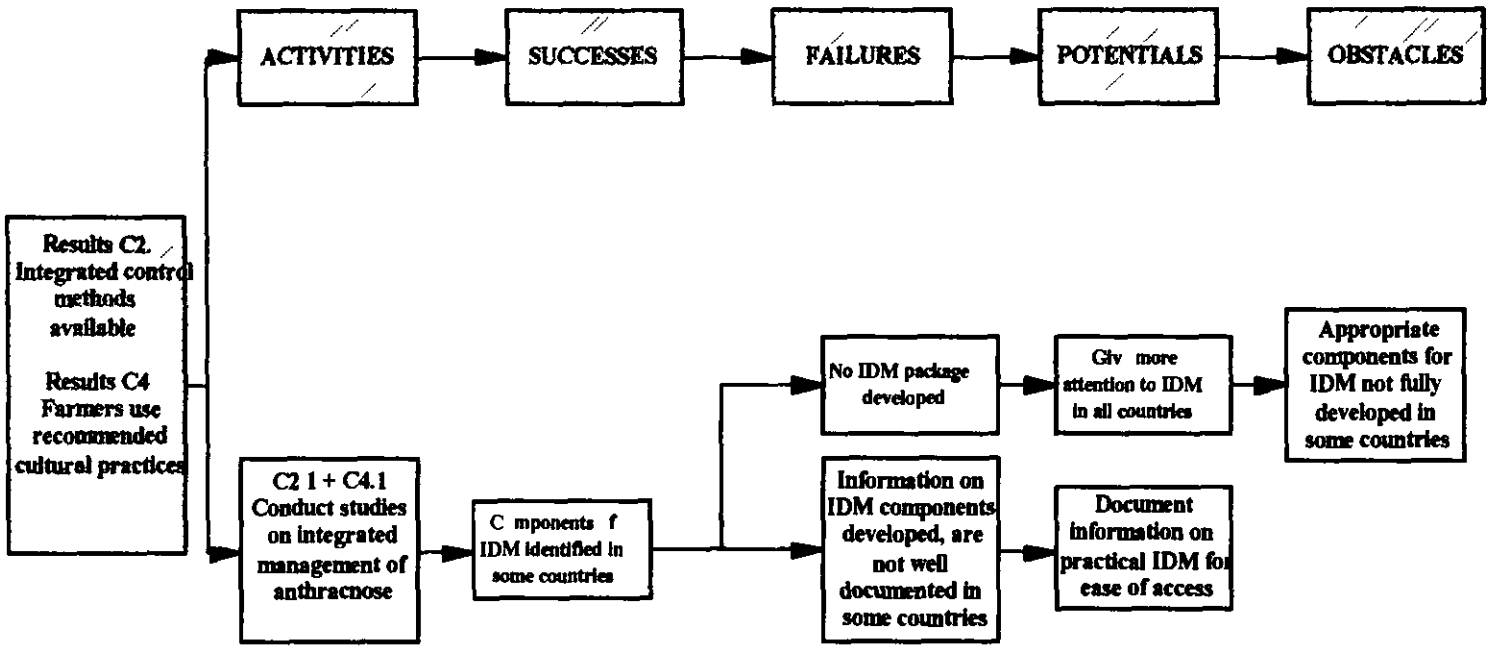

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results F4. Pan-Africa collaboration in resistance breeding fully exploited (cont.)
F4.6. Use hot spots to evaluate regional and zonal urseries
Most countries are using hot spots to evaluate disease rseries
P thogenic variatio not con idered
Integrate determination f pathogen diversity with evaluation f disease urseries
Pathog i variation studies not don i many cou tries
Limited f ilities and personnel
F4 7 Improve SP planning in i country workshops nd regional working group meetings
Planning done t pan-Africa level
Pl ning not done t regional and i -country levels
NPs do not dev lop proposals for SP pl ning
Initiate SP planing i in country workshops and regional working groups
Lack f initiative to make proposal
F4.8 Use knowledg f race distribution to select scree ing sites on pan Africa basis.
None
Not done
Compile vailabl i f rmation to develop race m ps
Inform tion on race distribution ot yet vail ble

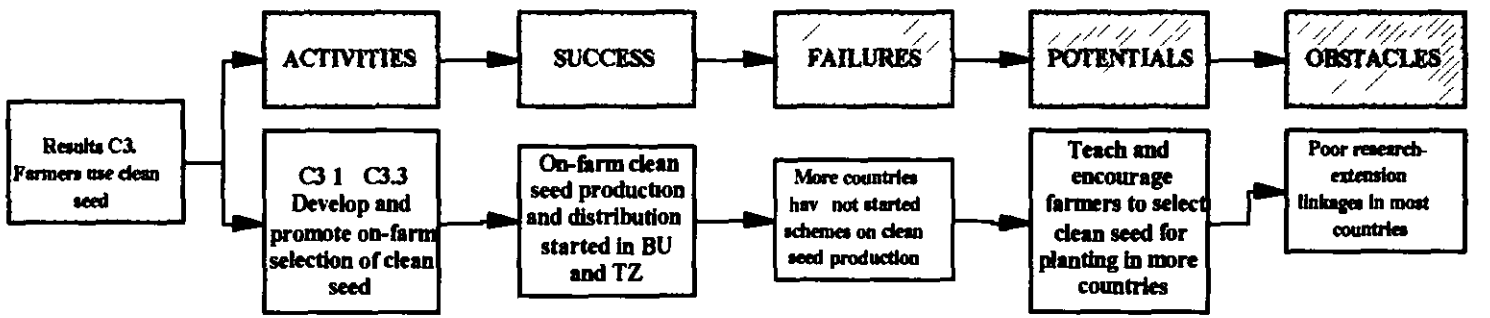

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results I1 Sufficient resistant varieties
I1 1 Prompt xchange f research results mong collaborators
I1.2 &I1.3. Researchers and technicians be xposed to yield loss assessment and lab inoculation techniques.
I1 4 Conduct inheritance studies on ALS (ZR, MW TZ)
I1 5 Develop acceptable, large seeded ALS resistant varieties
Breeders from EABRN countries met in J ne 1994 i Kampala
Breeders from SADC countries met in 1994, in Malawi
Kenya national bean research workshop held in 1994
National seed release committee met in TZ
Africa Crop Science Society conference met in MW 1995
Limited xchange f results within and between networks
N xchange f resistant m terials among collaborators
Encourage xchang f research res lts mong network scientists through visits, meetings nd publications
Fins cial limitations
Quarantine restriction
None
N courses organized
Organize courses on yield loss assessment techniq es
Financial limitations
Studies initiated in Zaire
N good sources f resistance available
High personnel turnover
Funds not available
Conduct inheritance studies in other countries
Few sources f resistant to ALS in large seeded lines
Moderately resista lines identified in TZ
Large seeded, early maturing lines with intermediate resistance to ALS identified in KE
CAL 143 medium seeded line was identified as resista t in MW
Incompatibility between som Mesoamerican and Andean parents causing hybrid dwarfism
Develop acceptable, large seeded ALS resistant varieties
Multiply nd distribute seed to farmers
Funds ot available
Private company not keen on bean seed multiplication

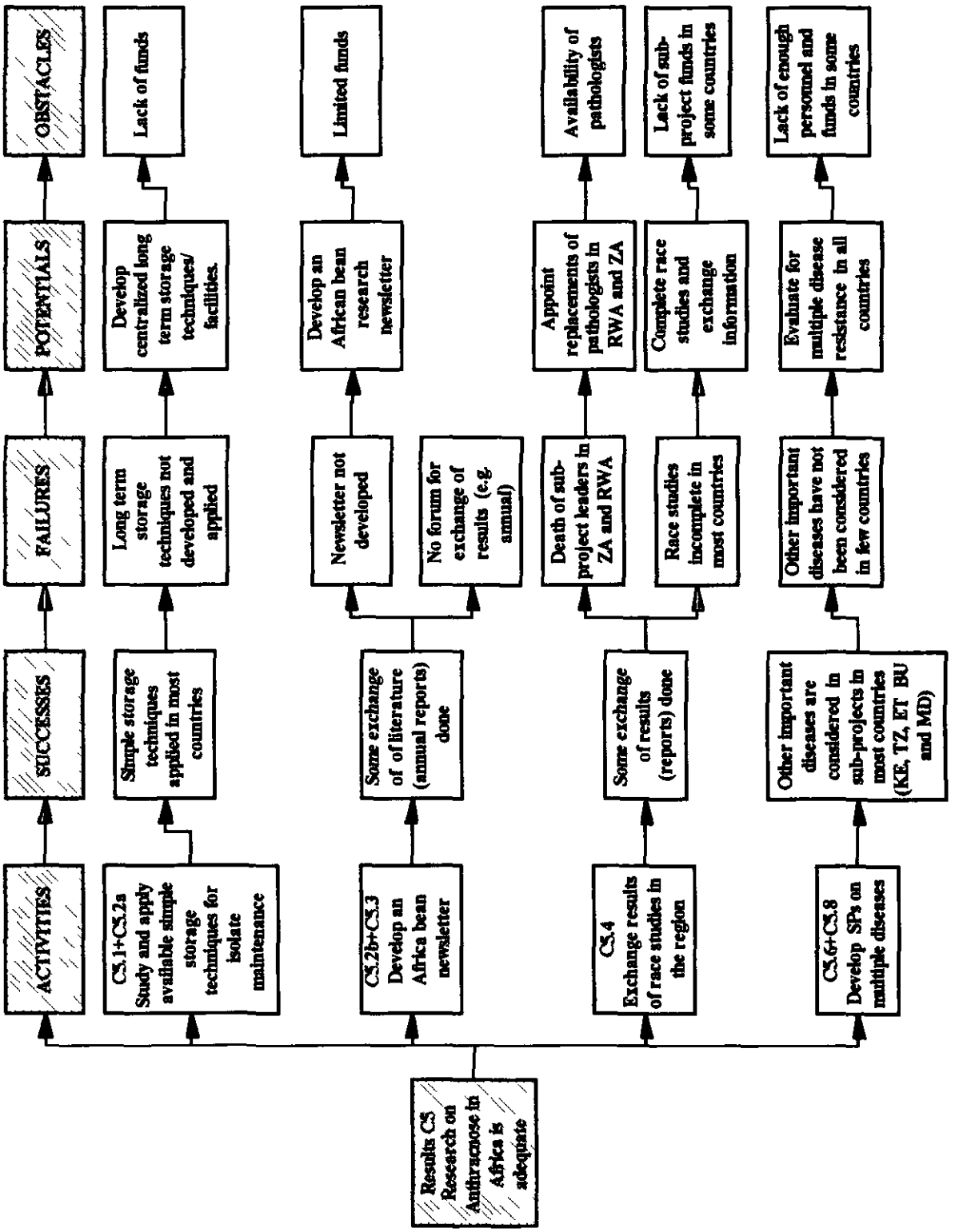

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results II Sufficient resistant varieties
II 7 Encourage breeding for specific ecological niches (MW).
Multi-locational trials are in progress Specific adaptation identified in MW KE, T & ZR.
Race distribution not known
Encourage breeding for wide adaptation
Resistance to many races not identified
Pathog genotype interactions not know
Variability (soil, rain, temp) exists within ecological regions
II.8. Use CIAT differentials for race determination
ALS Differentials received in KE, TZ. ZR &UG
Multiplication f som differentials difficult (poorly adapted)
Determi suitable sites to multiply differentials
Encourag th countries to se CIAT differentials
Som differe tI l require pecific growth environm ts
II 9 Determine pathogeni diversity
Som characterization done in Great Lakes Region
Isolate collecti & characterization not done in KE, UG TZ, MW ZM ZB
Encourag isolate collection and characterization in other countries
Fina i l constrai ts
Loss f pathogenicity if cultures well stored
Difficulty to isolate if samples re kept fo l ng
NRI collected samples
II 10 Produce race distribution m p for Africa
Development f race maps initiated i Zaire
Races not identified in other countries
Promote race identification in oth countries
Inadeq te storage facilities
Inadeq te sampling
II 11 Preserve representatives isolates
Som isolates conserved in ZR and NRI
Limited storage facilities
Preserv ll representative isolates in duplicates
Limited knowledge f conservation tech lq es
Financial constrai ts
II 12 Practice rtificial inoculation in the field
Spreader rows, ground infected leaves, suspension sprays used in TZ, ZR & KE
Disease development strongly infl nced by weather
Suspension sprays ffective bu xpensive
Encourage othe countries to use artificial inoculation screening sites
Financial constraints
II 13 Identificati f host resistant genes
Identification i progress
Som resistan m terials not known
Strengthen staff situations
Conduct genetic studies
Availability f suitable parents

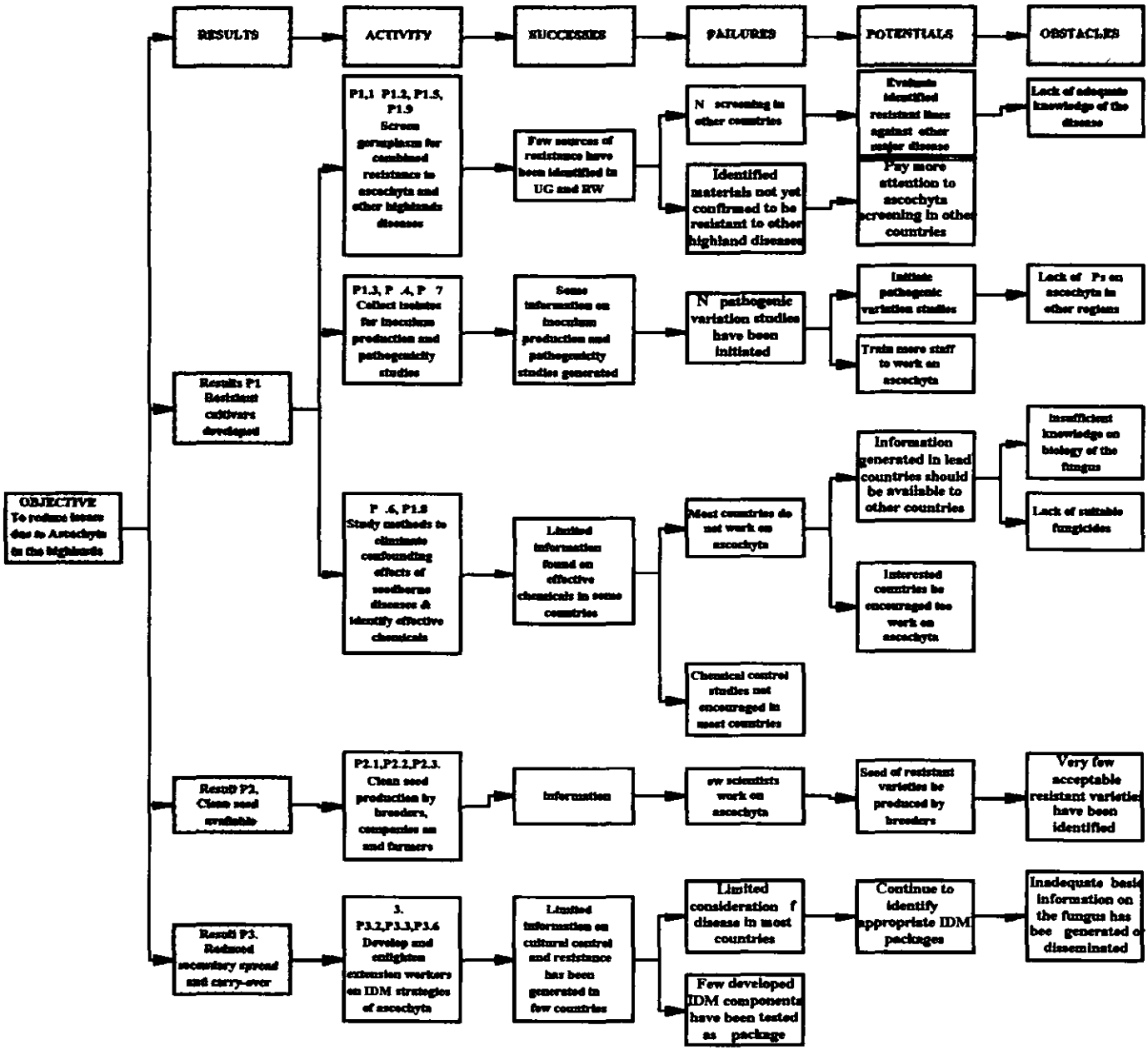

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results I2 Appropriate cultural practices developed
I2.1 Identify appropriate cultural practices
Farmers are using clean seed in ZR, KE & TZ
Farmer prefer own seed
Investigate the potential f using informal seed multiplication and distribution channels
Financial constraints
Limited vailability of seed of new varieties
Research on cultural practices is of low priority
Conduct research on cultural control practices
I2.2. Strengthen research-extension linkages to educate the farmers
Field days held in TZ, ZR, KE & MW
Limited number f farmers involved
Hold meetings, & field days, establish on-farm trials and air radio broadcasts
Financial constraints
On-farm trials in TZ, ZR, MW UG, KE
Annual research-extension meetings in TZ
Radi listening groups in KE
I2.3 Intensify studies on mixtures to reduce ALS
Studies conducted in ZR show reduction f ALS in mixtures, TZ in progress
N studies in other countries
Conduct studies in other countries
Race distribution not known
Farmer may reject som components
Exchange seed of resistant lines among collaborators

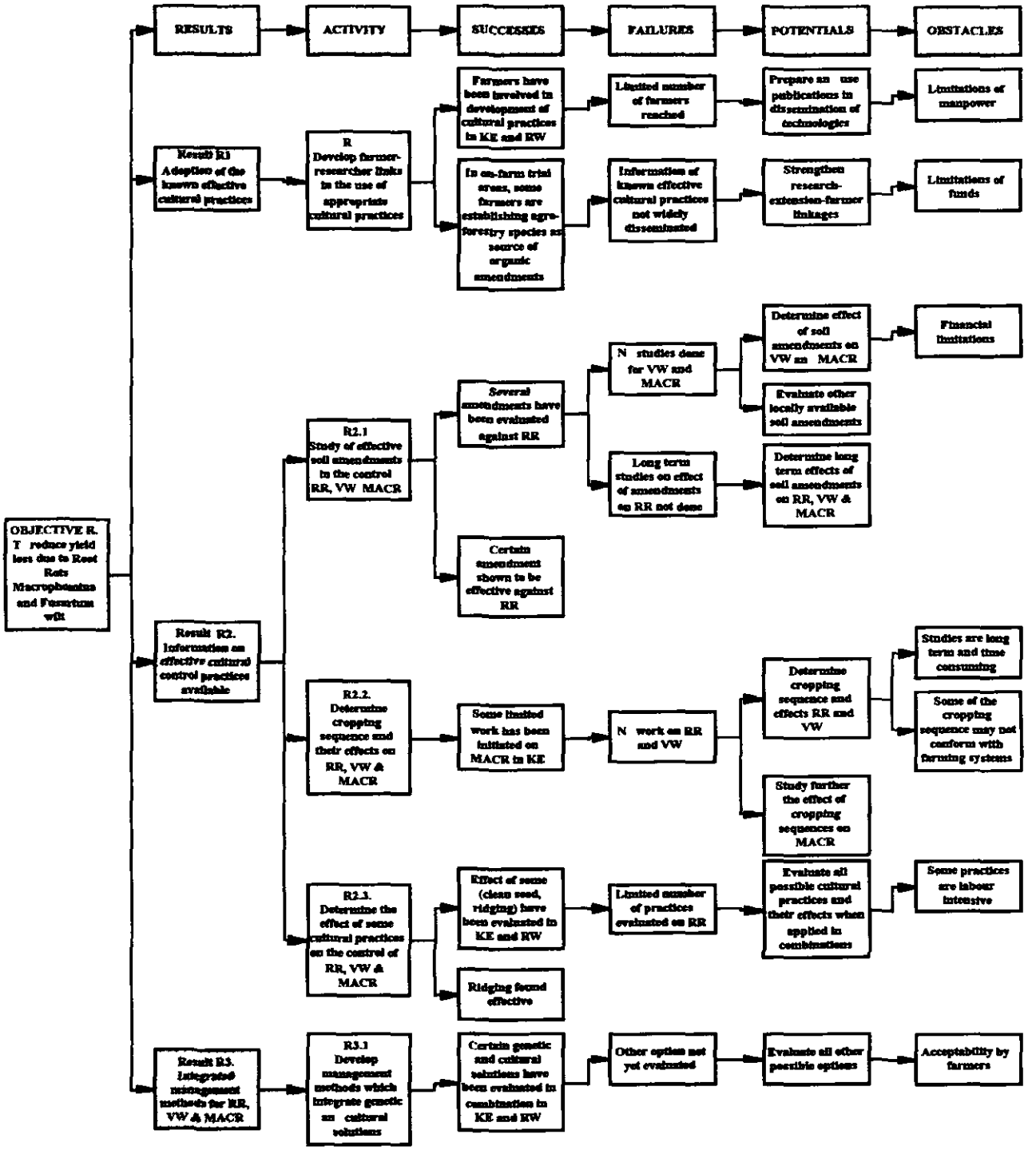

OBSTACLES
Insufficient sub-project funds in SADC
No race studies in some countries(MW and KE)
Inadequate facilities and funds
Lack of fu ds
POTENTIALS
Complete evaluation of available germplasm
Make resistant lines available to breeders
Include resistant lines in PADN
Multiply and distribute seed of differentials
Complete race studies in ET TZ, and initiate studies in other countries
Consider thesis research
Give priority to resistance breeding
INDICATORS
No evaluation for other important diseases
Lack of greenhouse facilities; Pathogen variation not considered
Unavailability of differentials in some countries (BU)
Basic research studies not encouraged in NARS
Pathogenic variation not given adequate attention
SUCCESSES
Evaluation and resistance source identified in ET EU RW TZ, MW MD and KE
Collection of Mesoamerican and Andean landraces for evaluation in TZ and ET
Studies done in ET and TZ
Studies ongoing in some European labs (U lv Paris and UK)
ACTIVITIES
C1.1+C1.2 Evaluate germplasm for anthracnose resistance
C1.3 Continue in-country studies on pathogenic variation
C1.4 Conduct basic studies on pathoge ecology
Results C1 Farmers grow anthracnose resistant varieties

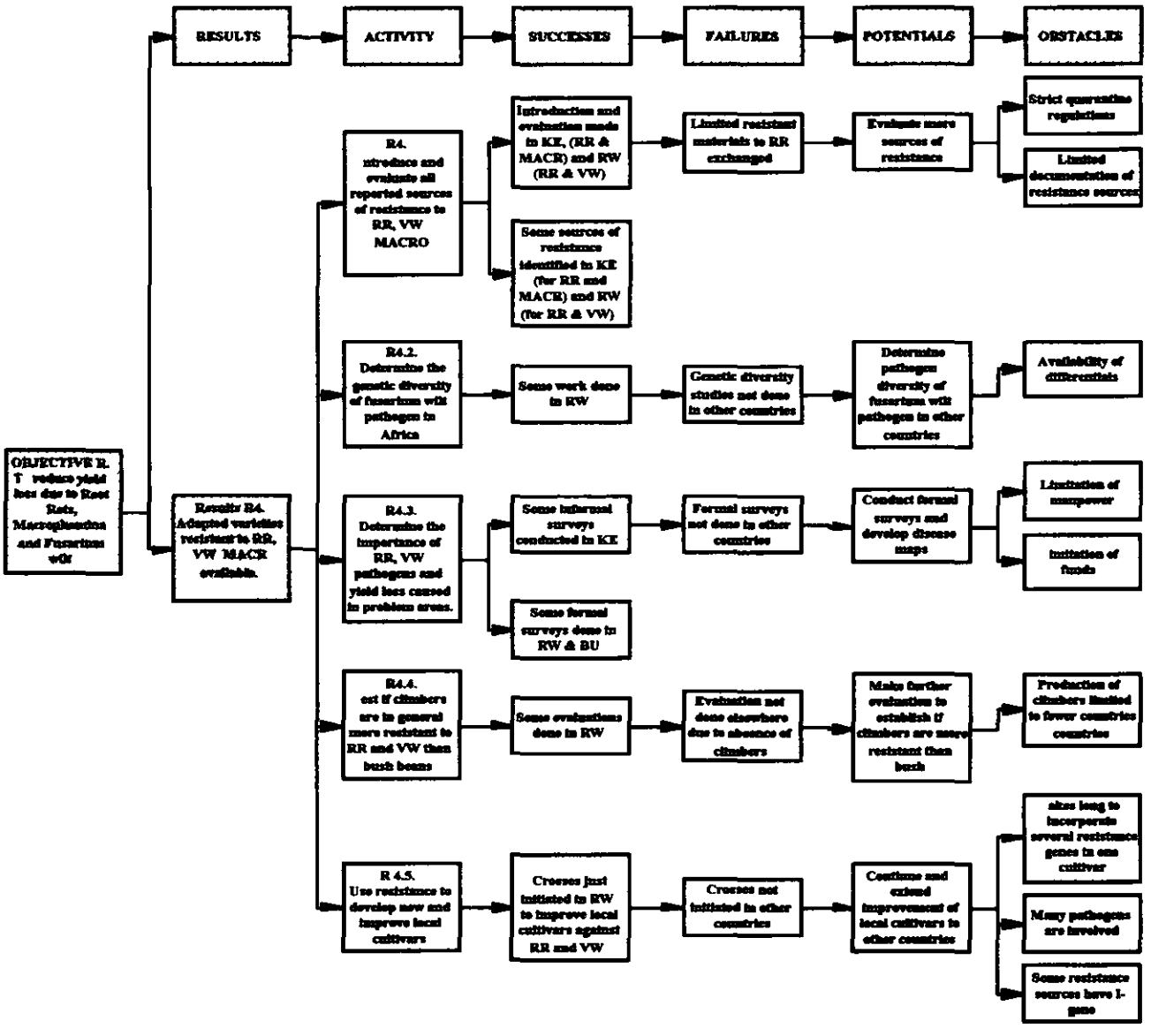

ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results C2. Integrated control methods available
Results C4 Farmers use recommended cultural practices
C2 1 + C4.1 Conduct studies on integrated management of anthracnose
C mponents f IDM identified in some countries
No IDM package developed
Giv more attention to IDM in all countries
Appropriate components for IDM not fully developed in some countries
Information on IDM components developed, are not well documented in some countries
Document information on practical IDM fo ease of access

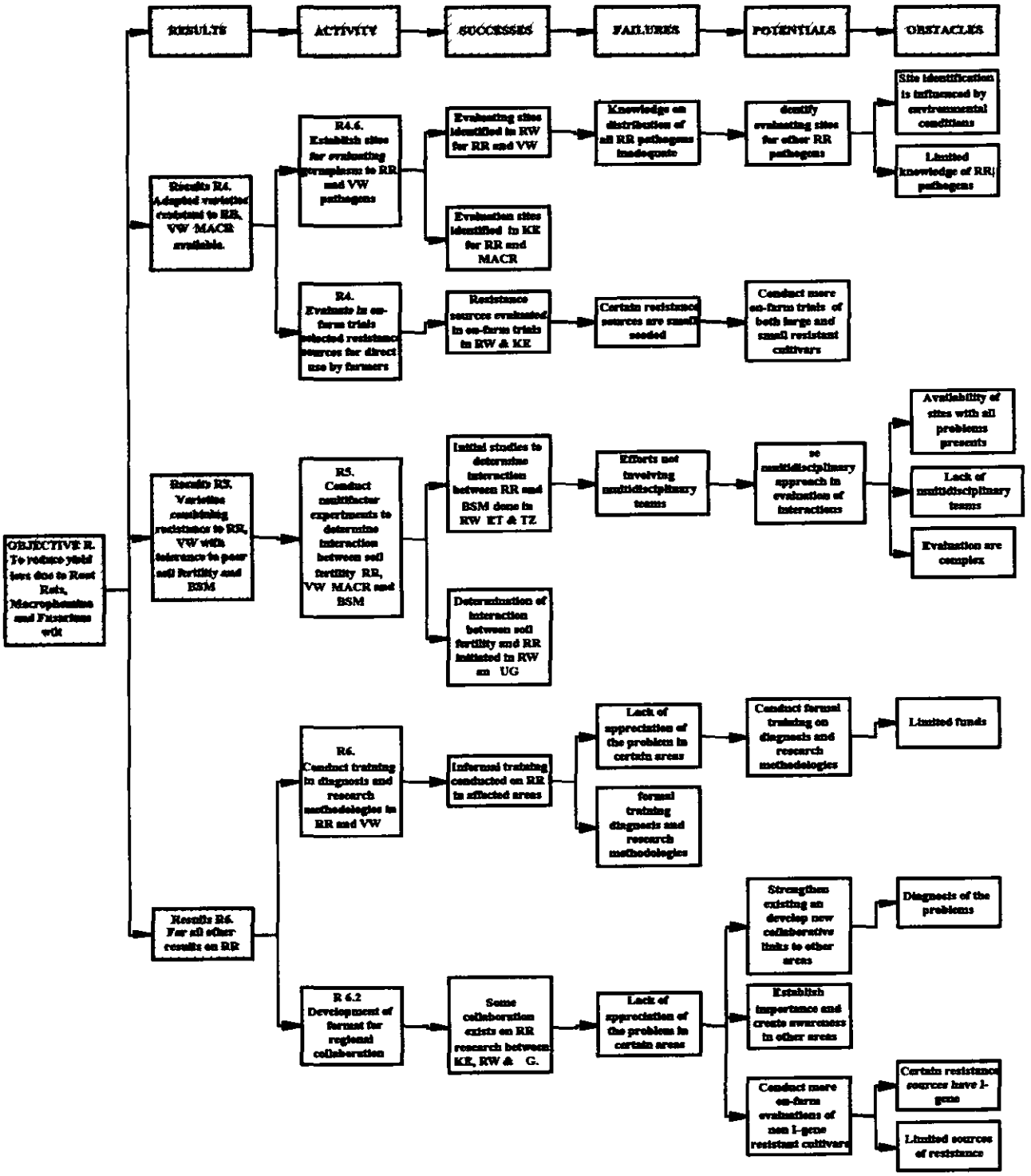

ACTIVITIES
SUCCESS
FAILURES
POTENTIALS
OBSTACLES
Results C3. Farmers use clean seed
C3 1 C3.3 Develop and promote on-farm selection of clean seed
On-farm clean seed production and distribution started in BU and TZ
More countries hav not started schemes on clean seed production
Teach and encourage farmers to select clean seed for planting in more countries
Poor research-extension linkages in most countries

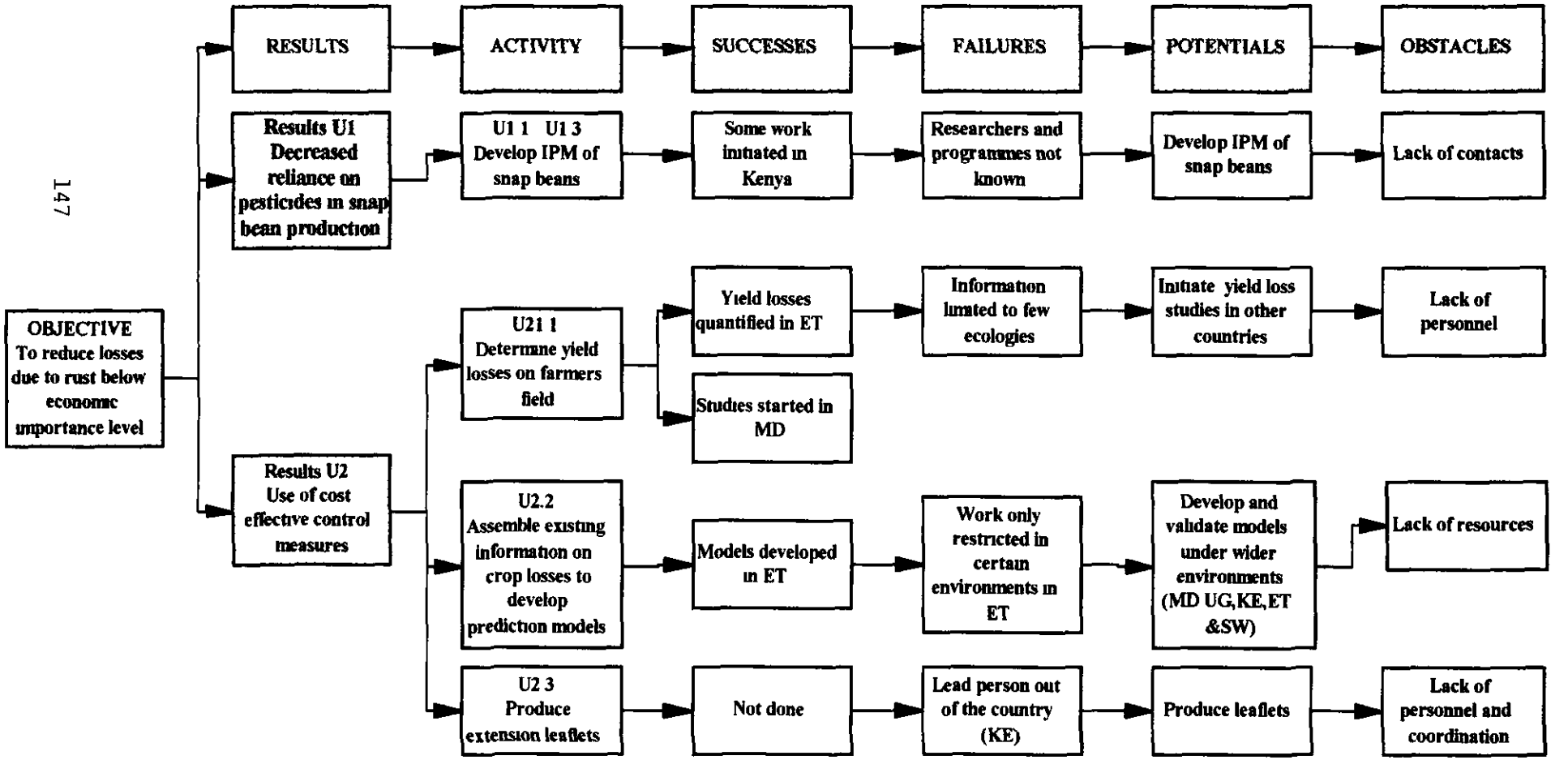

Results C5 Research on Anthrax/zoo in Africa is adequate
ACTIVITIES
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
C5.1+C5.2a Study and apply available simple storage techniques for isolate maintenance
Simple storage techniques applied in most countries
Long term storage techniques not developed and applied
Develop centralized long term storage techniques/ facilities.
Lack of funds
C5.2b+C5.3 Develop an Africa bean newsletter
Some exchange of of literature (annual reports) done
Newsletter not developed
No forum for exchange of results (e.g. annual)
Develop an African bean research newsletter
Limited funds
C5.4 Exchange results of race studies in the region
Some exchange of results (reports) done
Death of sub-project leaders in ZA and RWA
Race studies incomplete in most countries
Appoint replacements of pathologists in RWA and ZA
Complete race studies and exchange information
Availability of pathologists
Lack of sub-project funds in some countries
C5.6+C5.8 Develop SPs on multiple diseases
Other important diseases are considered in sub-projects in most countries (KE, TZ, ET BU and MD)
Other important diseases have not been considered in few countries
Evaluate for multiple disease resistance in all countries
Lack of enough personnel and funds in some countries

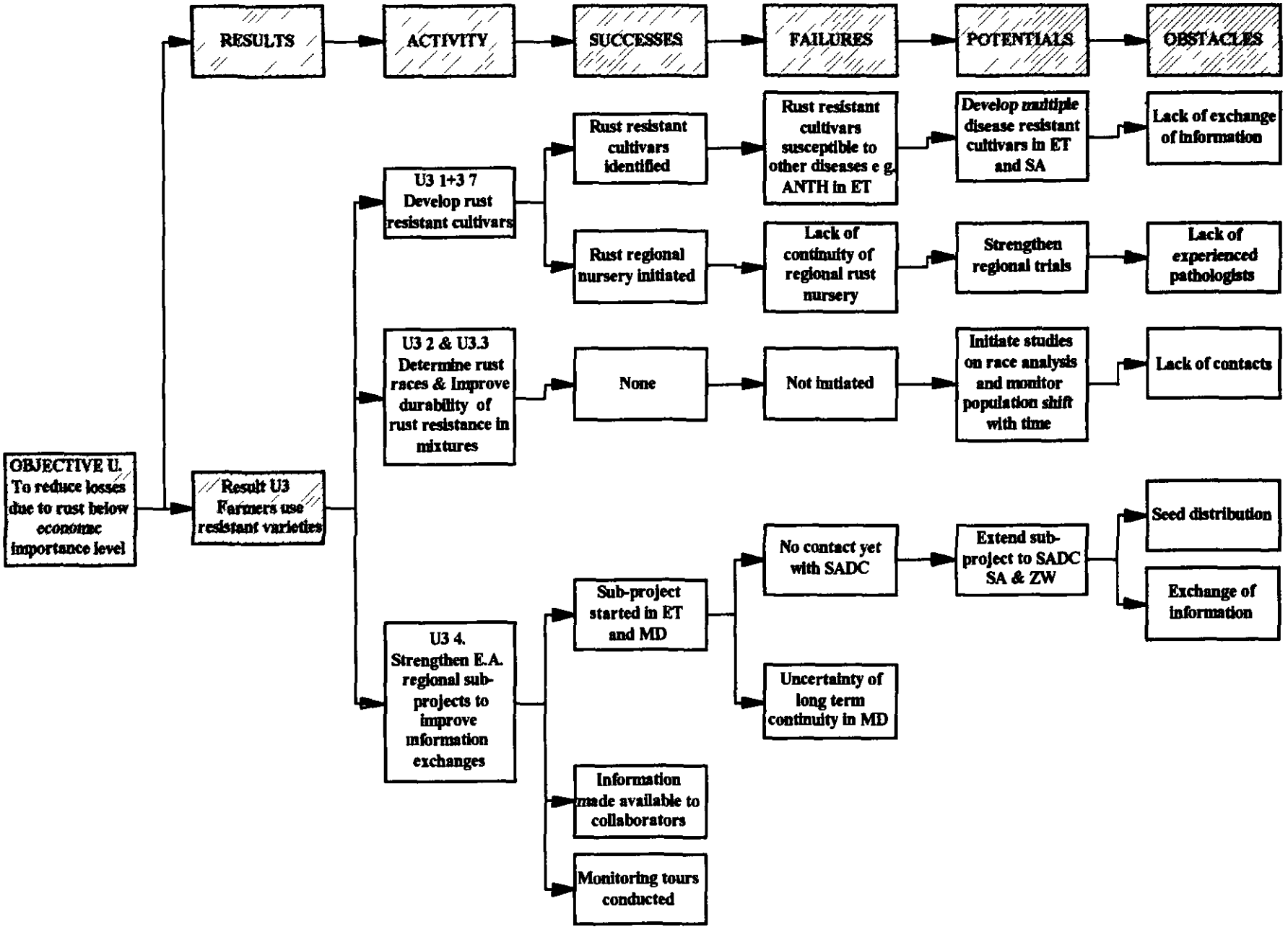

RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
OBJECTIVE
To reduce losses due to Ascochyta in the highlands
Results P1 Resistant cultivars developed
P1,1 P1.2, P1.5, P1.9 Screen germplasm for combined resistance to ascochyta and other highlands diseases
Few sources of resistance have been identified in UG and RW
N screening in other countries
Identified materials not yet confirmed to be resistant to other highland diseases
Evaluate identified resistant lines against other major disease
Pay more attention to ascochyta screening in other countries
Lack of adequate knowledge of the disease
P1.3, P .4, P 7 Collect isolates for inoculum production and pathogenicity studies
Some information on inoculum production and pathogenicity studies generated
N pathogenic variation studies have been initiated
Initiate pathogenic variation studies
Train more staff to work on ascochyta
Lack of Ps on ascochyta in other regions
P .6, P1.8 Study methods to eliminate confounding effects of seedborne diseases & identify effective chemicals
Limited information found on effective chemicals in some countries
Most countries do not work on ascochyta
Chemical control studies not encouraged in most countries
Information generated in lead countries should be available to other countries
Interested countries be encouraged too work on ascochyta
Insufficient knowledge on biology of the fungus
Lack of suitable fungicides
Result P2. Clean seed available
P2.1,P2.2,P2.3. Clean seed production by breeders, companies an and farmers
Information
ew scientists work on ascochyta
Seed of resistant varieties be produced by breeders
Very few acceptable resistant varieties have been identified
Result P3. Reduced secondary spread and carry-over
3. P3.2,P3.3,P3.6 Develop and enlighten extension workers on IDM strategies of ascochyta
Limited information on cultural control and resistance has been generated in few countries
Limited consideration f disease in most countries
Few developed IDM components have been tested as package
Continue to identify appropriate IDM packages
Inadequate basic information on the fungus has bee generated o disseminated

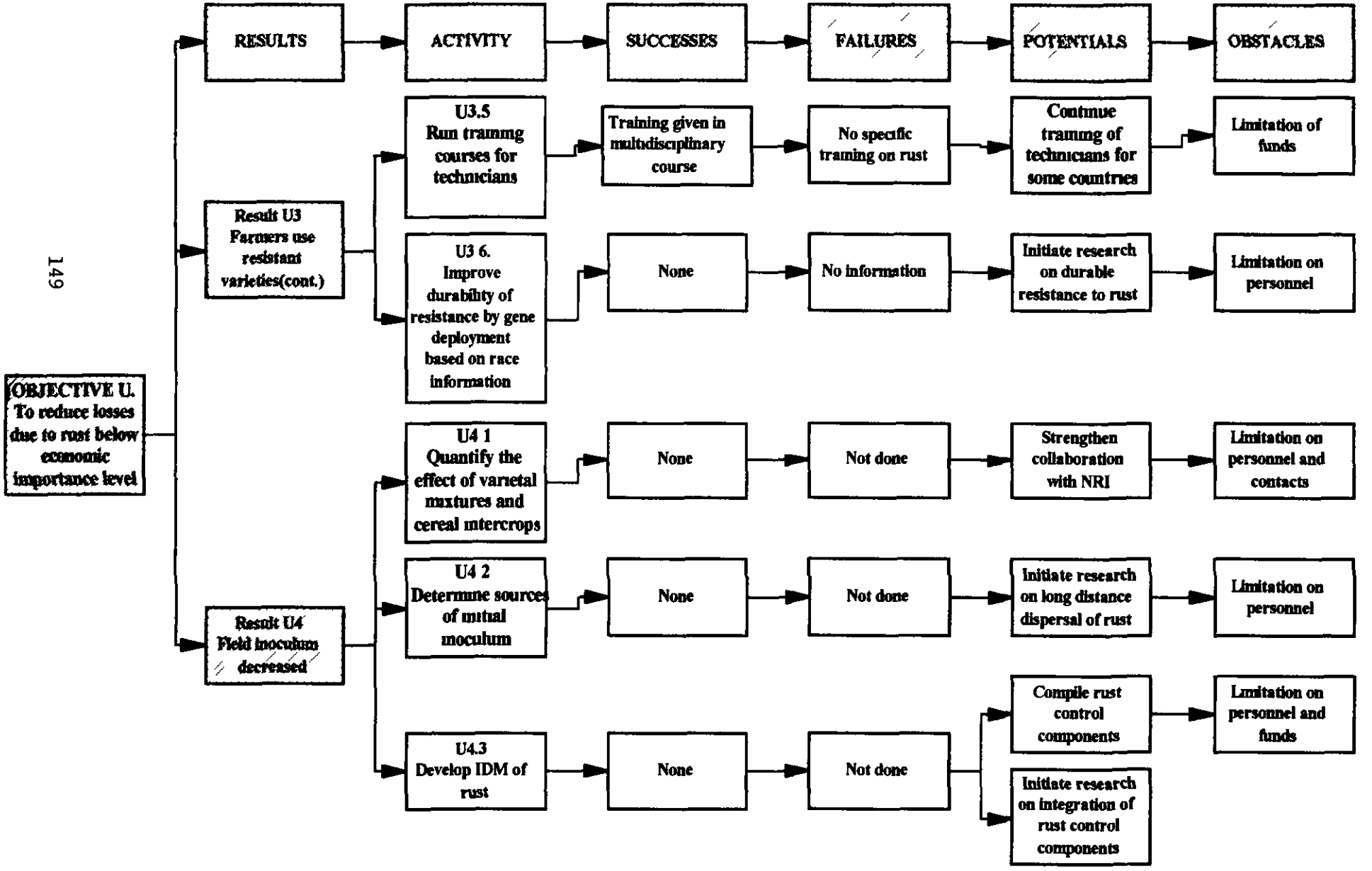

RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
OBJECTIVE R. T reduce yield loss due to Root Rots Macrophomina and Fusarium wilt
Result R1 Adoption of the known effective cultural practices
R Develop farmer-researcher links in the use of appropriate cultural practices
Farmers have been involved in development of cultural practices in KE and RW
Limited number of farmers reached
Prepare an use publications in dissemination of technologies
Limitations of manpower
In on-farm trial areas, some farmers are establishing agro-forestry species as source of organic amendments
Information of known effective cultural practices not widely disseminated
Strengthen research-extension-farmer linkages
Limitations of funds
Result R2. Information on effective cultural control practices available
R2.1 Study of effective soil amendments in the control RR, VW MACR
Several amendments have been evaluated against RR
N studies done for VW and MACR
Determine effect of soil amendments on VW an MACR
Financial limitations
Evaluate other locally available soil amendments
Long term studies on effect of amendments on RR not done
Determine long term effects of soil amendments on RR, VW & MACR
Certain amendment shown to be effective against RR
R2.2. Determine cropping sequence and their effects on RR, VW & MACR
Some limited work has been initiated on MACR in KE
N work on RR and VW
Determine cropping sequence and effects RR and VW
Studies are long term and time consuming
Some of the cropping sequence may not conform with farming systems
Study further the effect of cropping sequences on MACR
R2.3. Determine the effect of some cultural practices on the control of RR, VW & MACR
Effect of some (clean seed, ridging) have been evaluated in KE and RW
Limited number of practices evaluated on RR
Evaluate all possible cultural practices and their effects when applied in combinations
Some practices are labour intensive
Ridging found effective
Result R3. Integrated management methods for RR, VW & MACR
R3.3 Develop management methods which integrate genetic an cultural solutions
Certain genetic and cultural solutions have been evaluated in combination in KE and RW
Other option not yet evaluated
Evaluate all other possible options
Acceptability by farmers


RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
OBJECTIVE R. T reduce yield loss due to Root Rots, Macrophomina and Fusarium wilt
Results R4. Adapted varieties resistant to RR, VW MACR available.
R4. ntroduce and evaluate all reported sources of resistance to RR, VW MACRO
Introduction and evaluation made in KE, (RR & MACR) and RW (RR & VW)
Limited resistant materials to RR exchanged
Evaluate more sources of resistance
Strict quarantine regulations
Limited documentation of resistance sources
Some sources of resistance identified in KE (for RR and MACR) and RW (for RR & VW)
R4.2. Determine the genetic diversity of fusarium wilt pathogen in Africa
Some work done in RW
Genetic diversity studies not done in other countries
Determine pathogen diversity of fusarium wilt pathogen in other countries
Availability of differentials
R4.3. Determine the importance of RR, VW pathogens and yield loss caused in problem areas.
Some informal surveys conducted in KE
Formal surveys not done in other countries
Conduct formal surveys and develop disease maps
Limitation of manpower
Limitation of funds
Some formal surveys done in RW & BU
R4.4. est if climbers are in general more resistant to RR and VW than bush beans
Some evaluations done in RW
Evaluation not done elsewhere due to absence of climbers
Make further evaluation to establish if climbers are more resistant than bush
Production of climbers limited to fewer countries countries
R 4.5. Use resistance to develop new and improve local cultivars
Crosses just initiated in RW to improve local cultivars against RR and VW
Crosses not initiated in other countries
Continue and extend improvement of local cultivars to other countries
akes long to incorporate several resistance genes in one cultivar
Many pathogens are involved
Some resistance sources have 1-gene


RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
OBJECTIVE R. To reduce yield loss due to Root Rots, Macrophomina and Fusarium wilt
Results R4. Adapted varieties resistant to RR, VW MACR available.
R4.6. Establish sites for evaluating germplasm to RR and VW pathogens
Evaluating sites identified in RW for RR and VW
Evaluation sites identified in KE for RR and MACR
Knowledge on distribution of all RR pathogens inadequate
identify evaluating sites for other RR pathogens
Site identification is influenced by environmental conditions
Limited knowledge of RR pathogens
R4. Evaluate in on-farm trials selected resistance sources for direct use by farmers
Resistance sources evaluated in on-farm trials in RW & KE
Certain resistance sources are rarely seeded
Conduct more on-farm trials of both large and small resistant cultivars
Results R5. Varieties combining resistance to RR, VW with tolerance to poor soil fertility and BSM
R5. Conduct multifactor experiments to determine interaction between soil fertility RR, VW MACR and BSM
Initial studies to determine interaction between RR and BSM done in RW ET & TZ
Determination of interaction between soil fertility and RR initiated in RW an UG
Efforts not involving multidisciplinary teams
so multidisciplinary approach in evaluation of interactions
Availability of sites with all problems presents
Lack of multidisciplinary teams
Evaluation are complex
Results R6. For all other results on RR
R6. Conduct training in diagnosis and research methodologies in RR and VW
Informal training conducted on RR in affected areas
Lack of appreciation of the problem in certain areas
formal training diagnosis and research methodologies
Conduct formal training on diagnosis and research methodologies
Limited funds
R 6.2 Development of formats for regional collaboration
Some collaboration exists on RR research between KE, RW & G.
Lack of appreciation of the problem in certain areas
Strengthen existing an develop new collaborative links to other areas
Establish importance and create awareness in other areas
Conduct more on-farm evaluations of non I-gene resistant cultivars
Diagnosis of the problems
Certain resistance sources have I-gene
Limited sources of resistance


RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Results U1 Decreased reliance on pesticides in snap bean production
U1 1 U1 3 Develop IPM of snap beans
Some work initiated in Kenya
Researchers and programmes not known
Develop IPM of snap beans
Lack of contacts
OBJECTIVE To reduce losses due to rust below economic importance level
U21 1 Determine yield losses on farmers field
Yield losses quantified in ET
Studies started in MD
Information limited to few ecologies
Initiate yield loss studies in other countries
Lack of personnel
Results U2 Use of cost effective control measures
U2.2 Assemble existing information on crop losses to develop prediction models
Models developed in ET
Work only restricted in certain environments in ET
Develop and validate models under wider environments (MD UG,KE,ET &SW)
Lack of resources
U2 3 Produce extension leaflets
Not done
Lead person out of the country (KE)
Produce leaflets
Lack of personnel and coordination


RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
OBJECTIVE U.
To reduce losses due to rust below economic importance level
Result U3
Farmers use resistant varieties
U3 1+3 7
Develop rust resistant cultivars
Rust resistant cultivars identified
Rust resistant cultivars susceptible to other diseases e g. ANTH in ET
Develop multiple disease resistant cultivars in ET and SA
Lack of exchange of information
Rust regional nursery initiated
Lack of continuity of regional rust nursery
Strengthen regional trials
Lack of experienced pathologists
U3 2 & U3.3
Determine rust races & Improve durability of rust resistance in mixtures
None
Not initiated
Initiate studies on race analysis and monitor population shift with time
Lack of contacts
U3 4.
Strengthen E.A. regional sub-projects to improve information exchanges
Sub-project started in ET and MD
No contact yet with SADC
Extend sub-project to SADC SA & ZW
Seed distribution
Exchange of information
Uncertainty of long term continuity in MD
Information made available to collaborators
Monitoring tours conducted


OBJECTIVE U.
To reduce losses due to rust below economic importance level
RESULTS
ACTIVITY
SUCCESSES
FAILURES
POTENTIALS
OBSTACLES
Result U3
Farmers use resistant varieties(cont.)
U3.5
Run trainmg courses for technicians
Training given in multidisciplinary course
No specific training on rust
Continue trainmg of technicians for some countries
Limitation of funds
U3 6.
Improve durability of resistance by gene deployment based on race information
None
No information
Initiate research on durable resistance to rust
Limitation on personnel
Result U4
Field inoculum decreased
U4 1
Quantify the effect of varietal mixtures and cereal intercrops
None
Not done
Strengthen collaboration with NRI
Limitation on personnel and contacts
U4 2
Determine sources of mitial inoculum
None
Not done
Initiate research on long distance dispersal of rust
Limitation on personnel
U4.3
Develop IDM of rust
None
Not done
Compile rust control components
Initiate research on integration of rust control components
Limitation on personnel and funds

Planning Matrices

Objective F To reduce yield losses due to fungal diseases in general

Activity	Country / Institution	Priority (1 = high, 3 = low)
Result Appropriate cultural practices to control diseases developed		
F1 1 Increase contact and train farmers and extension staff on diagnosis and management of diseases		
F1 2 Develop and distribute extension materials (posters leaflets or booklets)		
F1 3 Complement cultural control with other control strategies		
F1 4 Encourage wider farmer-extension participation in sub project research		
F1 5 Conduct surveys to determine innovative and/or traditional practices to manage diseases		
Result Strategy to maintain / increase genetic diversity in beans elaborated		
F1 6 Initiate long term studies (10 yr) to assess changes in mixture components under farmer s conditions		
F1 7 In collaboration with other disciplines verify other sociological and agronomic concepts for composing mixtures		
F1 8 Encourage farmer participation in studies to constitute or incorporate components in mixtures for disease control		
F1 9 Continue to collect national germplasm and conserve in centralized gene banks		
F1 10 Increase the number and diversity of breeding lines that are acceptable to consumers		
F1 11 Study market preferences for seed types		
Result Available resistance fully utilized in breeding programs		
F1 2 Develop and test new methods for short and long term conservation of fungal cultures		
F1 13 Avail the latest versions of statistical packages and organize training on statistical analysis of disease screening data		
F1 14 Utilize established nurseries in the network and local landraces in developing durable resistance		
F1 15 Utilize available sources of resistance in the region and at CIAT and standardize breeding procedures to develop multiple disease resistant varieties		
F1 16 Determine pathogenic variation of important disease pathogens		
F1 17 Conduct studies on the distribution yield loss biology and control of floury leaf spot		
Result Pan Africa collaboration on resistance breeding fully exploited		
F1 19 Establish a network on snap bean research		
F1 20 Establish a pan Africa forum for evaluation and appraisal of regional sub projects		

F1 21 Produce a catalogue of known sources of resistance		
F1 22 Encourage germplasm evaluations using artificial inoculation or at hotspots		
F1 23 Encourage peer review of sub projects every year		
F1 24 Involve more resource persons in Steering Committee meetings		
F1 25 Integrate determination of pathogenic diversity with evaluation of disease nurseries		
F1 26 Initiate sub project planning in in-country workshops and regional workshops		
F1 27 Compile available information to develop race maps		

Objective I To reduce yield losses from Angular Leaf Spot

Activity	Country / Institutions	Priority (1 = high 3 = low)
Result Sufficient resistant varieties developed		
I1 1 Encourage exchange of research results among network scientists through visits meetings and publications		
I1 2 Conduct inheritance studies		
I1 3 Develop acceptable large seeded ALS resistant varieties multiply and distribute seed of the varieties to farmers		
I1 4 Encourage breeding for wide adaptation		
I1 5 Multiply distribute and use CIAT differentials to determine pathogen diversity		
I1 6 Complete characterization of pathogen diversity in countries not done		
I1 7 Conserve representative isolates of the ALS pathogen in duplicates		
I1 8 Encourage use of artificial inoculation with characterized isolates representing existing pathogen diversity		
I1 9 Conduct genetic studies to identify host resistance genes		
Results Appropriate cultural practices developed		
I1 10 Investigate use of informal seed multiplication and seed distribution channels in the production and use of clean seed		
I1 11 Conduct research on cultural control practices		
I1 12 Hold meetings field days and establish on farm research to strengthen researcher-extension farmer linkages		
I1 13 Conduct studies in some countries in the use of mixtures in ALS control		
I1 14 Exchange seed of resistant components/lines among collaborators		

Objective C To reduce yield loss due to Anthracnose

Activity	Country / Institution	Priority 1= high 3 = low
Result Farmers grow anthracnose resistant varieties		
C1 1 Complete evaluation of available germplasm in most countries		1
C1 2 Make resistant germplasm available to breeders		1
C1 3 Include resistant germplasm in PADN and evaluate in all collaborating countries		1
C1 4 Develop race maps in each country		1
C1 5 Multiply and distribute seed of differential cultivars		3
C1 6 Complete race studies of anthracnose pathogen in Ethiopia Tanzania and initiate similar studies in other countries		1
C1 7 Facilitate potential candidates to undertake thesis research		2
C1 8 Give more priority to resistance breeding		2
C1 9 Complete ongoing yield loss studies (Ethiopia Tanzania)		1
C1 10 Generate information on yield loss in anthracnose prone countries		2
C1 11 Compare survey data with results from yield loss studies in few farms and make extrapolations		1
C1 12 Complete ongoing anthracnose surveys in all countries		2
Results Integrated control methods available Farmers use recommended cultural practices Farmers use clean seed		
C1 13 Give more attention to Integrated Disease Management (IDM) in all countries		1
C1 14 Document information on practical IDM components so that they are accessible to potential users		1
C1 15 Teach and encourage farmers to select and use clean seed for planting		2
Result Research on anthracnose in Africa is adequate		
C1 16 Develop and use techniques and facilities for short and long term storage of anthracnose pathogen cultures		2
C1 17 Develop an African bean researcher newsletter for exchange of information		1
C1 18 Appoint pathologists in countries having none		1

C1 19 Complete race studies of anthracnose pathogen and exchange results		1
C1 20 Screen for multiple disease resistance in all countries		2

Objective P To reduce yield losses due to ascochyta in the Highlands

Activity	Country / Institution	Priority (1 = high 3 = low)
Results Resistant cultivars developed Clean seed available		
P1 1 Evaluate sources of resistance to ascochyta against other major diseases		2
P1 2 Pay attention to ascochyta screening in countries where it may not be a major disease		2
P1 3 Conduct training on ascochyta research methods		3
P1 4 Share with other countries information generated in lead countries		1
P1 5 Initiate appropriate and complementary studies in collaborating countries where ascochyta is important		2
P1 6 Develop cultivars resistant to ascochyta and make seed of the cultivars available to other researchers and farmers		1
Result Reduced secondary spread and carry over		
P1 7 Continue to identify appropriate IDM components and packages		1

Objective R To reduce yield loss due to Root Rots Ashy Stem blight and Fusarium Wilt

Activity	Country / Institution	Priority (1 = high 3 = low)
Result Known effective cultural practices adopted		
R1 1 Prepare and use publications in dissemination of effective cultural management technologies	CIAT	1
R1 2 Strengthen research extension farmer linkages	KE UG RW	3
R1 3 Train extension workers and farmers on effective cultural management practices	KE UG RW	2
Result Information on the effects of different cultural practices on IDM of RR, VW and MACR available		
R1 4 Study the effects of soil amendments on VW and MACR	AHI KE RW UG	1

R1 5 Conduct studies on the long term effect of soil amendments on VW MACR and RR	KE RW UG AHI	1
R1 6 Evaluate other locally available soil amendments	AHI KE UG RW	1
R1 7 Determine cropping sequences and their effects on RR & VW and MACR	AHI KE UG RW	3
R1 8 Evaluate cultural practices and their effects when applied in combination	do	1
Result Adapted varieties resistant to RR, VW and MACR available		
R1 9 Screen more germplasm originating from different geographical sources	KE RW UG SU BU ZR	1
R1 10 Conduct pathogen diversity studies on the fusarium wilt pathogen	KE UG RW ZR, BU	2
R1 11 Establish further if climbers are more resistant to RR, VW and MACR than bush beans	KE RW UG	2
R1 12 Continue improvement of local varieties in RW KE and UG and extended this to cover other countries	RW KE UG	1
R1 13 Conduct more on farm evaluations of non 1 gene resistant cultivars	UG RW KE	2
R1 14 Conduct more on farm trials of both large and small seeded resistant cultivars	KE UG RW	2
R1 15 Use a multidisciplinary approach to evaluate interactions between soil fertility RR, VW MACR and bean stem maggot	ET TZ KE RW	2
R1 16 Conduct formal surveys to develop disease maps	KE ZR, UG TZ ET	2
R1 17 Identify sites for evaluating resistance of germplasm against RR, VW and MACR		2
Result Researchers trained and collaboration improved		
R1 18 Conduct formal training on diagnosis and research methodology	CIAT	1
R1 19 Strengthen existing regional collaborative links and develop new ones with scientists in other areas	CIAT NPs	2
R1 20 Establish importance of these diseases and create awareness in other areas	CIAT NPs	2

Objective U To reduce losses due to rust below economic importance level

Activity	Country / Institution	Priority (1 = high 3 = low)
Result Farmers use resistant varieties		
U1 1 Develop multiple disease resistant cultivars	MD KE TZ, SA	1
U1 2 Conduct research on durable resistance	ET KE SA	1
U1 3 Evaluate and exchange results of the Rust Regional Nursery	KE MD ET SA	1
U1 4 Characterize pathogen diversity of the rust pathogen in the region	ALL	1
U1 5 Monitor population shifts of prevalent races over time	ET MD	2
U1 6 Monitor long distance dispersal and rust migration		
Result Use of cost effective control measures (food beans)		
U1 7 Establish qualitative and quantitative yield losses	MD KE ZW	2
U1 8 Develop yield loss models and validate them under wider environments	ET MD KE TZ, SA	2
U1 9 Produce extension leaflets on rust management	KE ET MD	1
Result Decrease field inoculum		
U1 10 Conduct research on integrating IDM components	ET MD	1
U1 11 Compile available IDM components	ET MD	2
Result Decrease reliance on pesticides in snap bean production		
U1 12 Develop IDM strategies to control rust on snap beans	KE ZW	3
U1 13 Study epidemiology of rust on snap beans	KE ZW	2
Result General		
U1 14 Train technical personnel on rust research methods	ALL	2
U1 15 Strengthen contacts with NRI and other advanced labs	ALL	3
U1 16 Initiate rust sub projects in SADC	SA, ZW TZ	1

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