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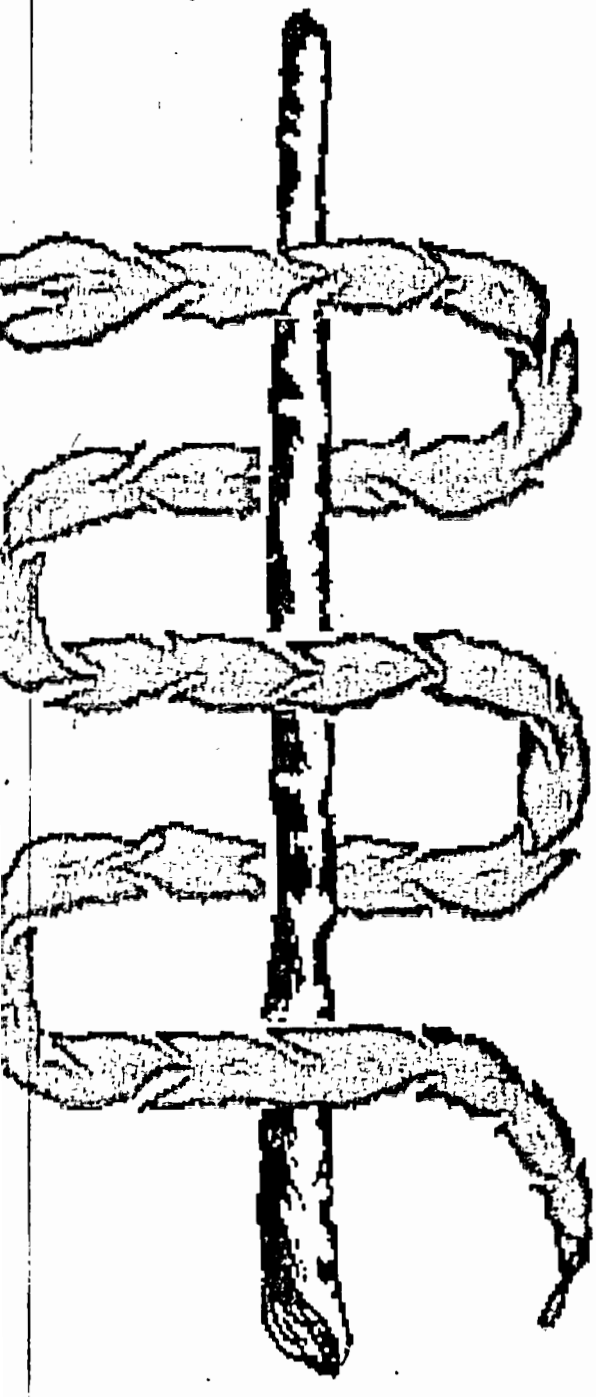

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(OAU/IAPSC)

COFFEE RESEARCH FOUNDATION
(CRF)

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FOREWORD

The Coffee Research Foundation (CRF), Ruiru and the Inter-African Phytosanitary Council (IAPSC) of the Organization of African Unity (OAU) jointly organized a meeting to constitute a network on research on the control of the Coffee Anthracnose, commonly known as Coffee Berry Disease (CBD). The meeting was recommended by a joint Permanent Secretariat set up by resolutions CM/RES 1173 (xlviii) and CM/RES 1238 (1) of the OAU Council of Ministers in their 48th and 58th Ordinary Sessions. Participants in the meeting were expected to come from about ten African countries which grow arabica coffee and which are affected by CBD; namely Kenya, Burundi, Rwanda, Uganda, Zimbabwe, Tanzania, Ethiopia, Malawi and Zambia; as well as representatives of the General Secretariat and the Scientific, Technical and Research Commission of the OAU. The meeting was held at Hotel 680, Nairobi between 26 and 28 May 1993.

We are all aware that Agriculture is the mainstay of the economy of most African countries. It is also a way of life for the majority of the peoples, providing employment to a high percent of the population. For many of the African countries, coffee is one of the principal export commodities. Coffee was contributing, on average, 26% of the total domestic export value of Kenya until 1988/89, when this per cent started to drop as a result of the low world prices experienced after the collapse of the price support mechanism of the International Coffee Agreement (ICA). There has also been a decline in overall production of coffee linked to the now unstable and depressed market situation resulting in low prices already alluded to above. The low prices led to poor husbandry practices and generally low morale on the part of the farmers.

The current cost of producing coffee in Kenya is about K£ 2,700 per metric tonne which is considered high. Control of the diseases alone contributes 30% of this total cost. Coffee berry disease (CBD) caused by a fungus *Colletotrichum kahawae* Waller & Bridge, is the most severe disease of coffee in Kenya and other African countries which grow Arabica coffee. The disease attacks berries in all stages of growth, but the most susceptible stages are the green expanding berries (6-16 weeks after flowering) and ripe berries, and especially when these stages coincide with wet weather conditions.

On green berries, symptoms first appear as small dark, sunken patches (anthracnose) which spread rapidly and may cover the whole berry. Usually the fungus penetrates the interior and destroys the beans. Eventually, the whole berry dries out and takes the appearance of black mummified bodies resembling 'buni'. Infected berries may also be shed off as soon as lesions develop.

Coffee berry disease was first detected in 1922 in Western Kenya, but has since spread to all coffee growing areas in Kenya. It has also been reported in many other African countries, namely, Uganda, Tanzania, Rwanda, Burundi, Zaire, Angola, Ethiopia, Cameroon, Zimbabwe, Zambia and Malawi. The disease has not been reported outside the African continent.

Rainfall is the most important facet of weather which influences CBD, because the causal agent of CBD requires water for dispersal of its spores, subsequent germination and penetration of healthy berries, leading to development of lesions. The fungus is also favoured by cool temperatures in the range of 15 to 25°C. These two weather requirements, coupled with the almost continuous flowering of coffee trees, make the high altitude coffee more vulnerable to CBD than the coffee from medium and low altitude zones.

The Coffee Research Foundation, Kenya, has made a lot of progress in developing efficient chemical control measures to CBD. These include spraying with a number of recommended fungicides to protect the developing crop during the rainy seasons. Copper-based fungicides were used in Kenya until 1969 when captafol and later other organic fungicides, became available. The small-scale farmers in Kenya have continued using copper mainly because of its relatively low cost, and also because copper controls other major coffee diseases, namely coffee leaf rust , and in some areas, bacterial bli h of coff c. In the estates sector, however, tank mixtures at half the normal rates, and co -based ungicides at a reduced rate, are now widely used. The tank mixtures give effective co of CBD and result in good yields. They are less costly than the organic fungicides used by ther es, because of the reduced rates and the inclusion of the much cheaper copper fungicides. In

addition, the tank mixtures control coffee leaf rust and bacterial blight of coffee (two other serious disease of coffee) on the same spray programme.

With the present downward trend in coffee prices and increase in production costs, there is already a drastic decline in the profitability to the producers from coffee. The small-scale farmers lack capital and are not able to carry out in full, or at all, the recommended spray programmes. Coffee berry disease is therefore a constant threat to this major source of income.

The CRF realized as far back as 1967, that developing disease resistant varieties would be the long-term answer to the present problems. A breeding programme has been in progress at the CRF since 1971. Apart from CBD resistance, the programme has incorporated rust resistance improved yield, quality and compact growth in the new variety. The product of the CRF breeding programme is Ruiru 11, which was officially launched in 1985. Ruiru 11 is a hybrid arabica cultivar which flowers within a year of planting and gives yield per tree, bean size and cup quality comparable to those of the established commercial varieties SL 28 and SL 34. The compact growth allows greater planting density thus increasing yield per unit area. To-date some 4,000 hectares of Ruiru 11 have been planted and it is expected to reduce the cost of production by about 30%. The mass adoption of Ruiru 11 has, in the past, been hampered by the low production of hybrid seed and seedlings; but the CRF is now producing more seedlings through vegetative propagation methods, and in the near future, through tissue culture.

In certain circumstances, the use of fungicides on coffee has been associated with increased coffee diseases, particularly CBD, in Kenya. Fungicides have also been reported to have 'tonic' effect on coffee, which increases growth and productivity above that expected from straight disease control. There is now some evidence that these effects might be mediated through changes in the microflora of the coffee surfaces. A recent study carried out at the CRF has established that specific types of microflora occur on coffee surfaces and these are affected quantitatively and qualitatively by changes in seasons, growth stages as well as fungicide regimes. The commonly occurring components of these microflora were shown to antagonize the CBD pathogen. The CRF hopes to pursue the possibility of using these natural surface microflora as a biocontrol method which can be integrated in the chemical control of CBD.

It is well known that research on CBD and other aspects of coffee is going on in respective African countries, perhaps more in some than others. However, since we have a common crop, coffee, with the same or similar problems, it would be to our mutual benefit to join our efforts and share our experiences. The network on CBD which has been constituted in Nairobi is intended to facilitate co-operative research in the effective and economical control of CBD in African countries. It is hoped that the network will solicit and co-ordinate funding for research programmes, bring together scientists to exchange experiences regarding the problem, as well as document and disseminate scientific literature within African. We therefore welcome the OAU's recommendation of constituting the network, thank the Inter-African Phytosanitary Council for sponsoring it, and Kenya for agreeing to host this important meeting.

Wilson R Opilé
Director of Research
Coffee Research Foundation

WELCOME ADDRESS BY HON. SIMEON NYACHAE, EGH, M.P. MINISTER FOR AGRICULTURE, LIVESTOCK DEVELOPMENT AND MARKETING

Mr Chairman Distinguished Delegates, Ladies and Gentlemen,

On behalf of the Government of the Republic of Kenya, the Ministry of Agriculture, Livestock Development and Marketing, the Organizing Committee of the Constitutive Network meeting on the Coffee Anthracnose and myself, I would like to extend our warm welcome to Kenya to those that have come from other countries, and to you all the participants of this meeting. I hope your stay here will be pleasant and worthwhile. It gives me, my Ministry and the Coffee Research Foundation (CRF) great pleasure to host this very special meeting organized on coffee matters in Africa. We have been informed that the meeting was recommended by a joint Permanent Secretary set up by two resolutions (CM/RES 1173 (XL. III) and CM/RES 1238 (E) of the OAU Council of Ministries in their 48th and 58th ordinary sessions.

Mr Chairman, it is common knowledge to us all that agriculture is the backbone of the economy of most African countries. Agriculture is also a way of life for the majority of our peoples, besides providing employment for a big percentage of our working population. For Kenya, this percent is 80%. For many of us, coffee is one of the principal agricultural export commodities. Until 1988/89, coffee was contributing on average 26% of the total domestic export, but its contribution has since dropped to 18% in 1990/91 as a result of the low prices experienced after the collapse of the price support mechanism of the International Coffee Agreement (ICA).

The importance of coffee to the national economy of Kenya convinced the Government, at the very early stage, of the need to have a centralized statutory organization which could implement the production and marketing policies in accordance with an Act of Parliament which was enacted in 1933. The Coffee Board of Kenya (CBK) is responsible for the running of the coffee industry broadly with respect to production, research, marketing, warehousing and advisory services to farmers and overseas promotion. The CBK has in turn delegated the research responsibilities to the CRF which is an official organization financed by the coffee farmers through the CBK.

Although coffee is an important commodity in our countries, we know that it has several problems: lack of proper know-how, especially at the small farmers' level who are the main producers; lack of adequate infrastructures like roads and warehouses; the rising costs of farm inputs like machinery and agricultural chemicals, drought or excess of rains now and then; pests and diseases; and in the recent past, low world market prices. These major constraints systematically require different and scientific approaches for their solutions. For many of these problems, strengthened research programmes and regional cooperation will be of vital importance. Coffee Berry Disease (CBD), the subject of this meeting, is a major problem in the African countries which produce arabica coffee; especially in Kenya, Tanzania and Ethiopia. As you may all know, CBD was first reported in Kenya in 1922 but has since slowly spread to Uganda, Zaire, Angola, Cameroon, Tanzania, Rwanda, Burundi, Ethiopia and more recently, to Malawi, Zambia and Zimbabwe. CBD has not been reported outside Africa and therefore, still remains solely an African problem. The losses due to the disease are enormous and despite successes in establishing and using fungicide control regimes, there are cases where crop losses of 20 - 30% are experienced during excessively wet weather conditions. Chemical control of the disease is expensive and imposes a continuing economic burden to the farmer. In Kenya, it is estimated that disease control contributes about 30% of the total cost of production of coffee.

Mr Chairman, with the present downward trend in coffee prices and increase in production costs, there is already a drastic decline in profitability to the producers from coffee. The majority of our smallscale farmers lack capital and are unable to carry out in full, if at all, the recommended spray programmes. An alternative long-term to the CBD problem is developing disease resistant varieties. Resistance to CBD is known to occur in some coffee varieties and has been used in Rwanda (Jackson Hybrid), Zaire (Bronze-tipped tyres), and Cameroon (Java variety). In Ethiopia, selection and multiplication of CBD resistant varieties from semi-natural coffee populations was made possible because it is the centre of genetic diversity of arabica coffee.

In Kenya, the CRF opted to combine resistance to CBD and coffee rust with high yields and the good quality typical of Kenya coffee in a well-planned long-term breeding programme. The programme, which started in 1971, has produced a hybrid cultivar, Ruiru 11, which has been planted by Kenyan farmers since its official launching in 1985. This has been a milestone in the research on CBD in Kenya. Ruiru 11 is expected to cut down the cost of production by about 30%. The mass adoption of Ruiru 11 has, however, been hampered by the low production of hybrid seed and seedlings, and the high cost of establishment of the variety at close spacing. It is likely that screening of the wide variety of germplasm available in most of the African countries will lead to the eventual release of more CBD resistant cultivars. This is a long-term process requiring regional collaboration in germplasm exchange and selection for local adaptation.

It is well known that research on CBD and other aspects of coffee is going on in our respective countries, perhaps more in some than in others. However, since we have a common crop, coffee, with the same or similar problems, it would be to our mutual benefit to join our efforts at least at a regional level and share our experiences. We are all aware that there are few opportunities available to African scientists to meet and exchange technical findings, and information on our common problems even the circulation and distribution of scientific literature within Africa is so limited that very little is known of what is being done in neighbouring countries on similar problems.

In the area of CBD, however, there was a first regional workshop organized in Addis Ababa, Ethiopia, in July 1982. The workshop was organized by the Association for the Advancement of Agricultural Sciences in Africa (AAASA) in conjunction with the Ministry of Coffee and Tea Development and the Institute of Agricultural Research in Ethiopia and financed by the European Economic Commission (EEC). The workshop brought together delegates from many countries of the Eastern part of Africa and other eminent scientists from international organizations and institutions outside the continent. The proceedings for the workshop were published with the help of EEC and sent to individual participants. Amongst the resolutions and recommendations of this workshop was the need for exchange of information among African countries as well as the initiation of joint research programmes in neighbouring countries or those countries with similar ecological zones. The workshop was thought-of-as the beginning of an on-going regional CBD control development programme. Unfortunately, there has not been any follow-up meetings (over ten years now) and there is no way we can evaluate the progress made by individual countries regarding the technical resolutions and recommendations made. It is my hope that this Nairobi meeting is going to perform this onerous task.

More recently, the Inter-African Coffee Organization (IACO) has felt the need for improved research to increase the productivity and quality of coffee in Africa. The IACO has since formulated and constituted an African Coffee Research Network (ACRN also known as RECA in French), which is currently operative under the IACO Secretariat in Abidjan, Cote D'Ivoire. Kenya has been fortunate enough to have the Director of Research, CRF, elected as the first Chairman of the Network. The Network on CBD, which this meeting will constitute, shall, therefore, act as a specialist branch of the umbrella Network, ACRN. In this meeting, you are going to discuss in depth the current situation of CBD in our countries, the related research programmes, the results obtained, and their application at farm level. I hope at the end of your deliberations, you will come up with a stronger basis for the network and concrete plans for its future programmes.

Finally, may I take this opportunity to thank the General Secretariat, the Scientific, Technical and Research Commission and the Inter-African Phytosanitary Council of the OAU for having taken the initiative of organizing and sponsoring the meeting, and the CRF, in conjunction with my Ministry, for coordinating and hosting it.

Having said this, it is my pleasure and privilege to declare the meeting open and to wish you success in your deliberations.

Thank you!

STATEMENT BY DR. N. NKOUKA, AG. SCIENTIFIC SECRETARY OF THE INTER-AFRICAN PHYTOSANITARY COUNCIL OF THE ORGANIZATION OF AFRICAN UNITY (OAU)

Your Excellency, the Minister for Agriculture, Livestock Development and Marketing, the Director of the Coffee Research Foundation, Honourable Delegates, Ladies and Gentlemen,

The subject matter which is uniting us here today in this beautiful country, Kenya, concerns a severe disease on Coffee (Anthracnose) in Africa. Dr Salim Ahmed Salim, Secretary General of the OAU attaches great importance on questions linked with food and agriculture, and in this context, I am highly honoured to represent him in this meeting. I also take this opportunity to transmit to you, the feeling of great importance which he is reserving to the outcome of this meeting of scientists, particularly, reinforced by various national experiences acquired in the field.

I do not want to hesitate in taking this opportunity, on behalf of His Excellency, the Secretary General of the OAU, to thank the Political Authorities of Kenya who did not spare a single minute to accept to host this important meeting here in Nairobi.

The high standard work already produced by the Coffee Research Foundation naturally weighed on this choice and the Director of Research, CRF, should kindly allow me to express here, on behalf of the OAU, my sincere thanks for their availability and the African warm welcome accorded to the participants.

Research scientists from various countries should transmit in a better way their experiences in order to avoid duplication, save more time and set up a more coherent African Scientific space. This is one of the goals of the Network on Coffee Anthracnose which we have just created in Nairobi. To create is one step but to ensure the care for breeding this baby which is just born will be thrilling and it is at that time that we shall need the experience of one another in order to make it come to our expectation.

Your Excellency, Ladies and Gentlemen,

I know that the task awaiting us is more important than this word of introduction, and while renewing the firm conviction of the OAU to give a helping hand to member countries to express their ambition for advancing research, I wish total success to the First Constitutive Network on Coffee Berry Disease (Anthracnose).

Long live the OAU, Long live the Inter-African Research!

I thank you.

RESOLUTIONS AND RECOMMENDATIONS

The participants of the First Constitutive Network Meeting on Coffee Anthracnose wish to express their sincere appreciation and gratitude to the Organization of African Unity (OAU) in general and to the Inter-African Phytosanitary Council (IAPSC) in particular, for having conceived and sponsored this meeting. The idea of forming an Inter African research Network on the coffee anthracnose is indeed a profound positive step towards ensuring survival of the coffee industry, the back-bone of the economies of many OAU member states. The network shall pool together and utilise its own manpower resources, which have hitherto been working in isolation. To us participants, this meeting has been very educative and has given us the hope that the CBD problem can be overcome at a lower cost.

The participants express their utmost appreciation to the Government of the Republic of Kenya for hosting the meeting in Nairobi, and for the inspiring opening address by his Excellency, the Minister of Agriculture, Livestock Development and Marketing. They further acknowledge with gratitude the brotherly and warm welcome that was accorded to them during their stay in Kenya.

Participants would like to thank the Director of Coffee Research Foundation (CRF) for coordinating the meeting and also for the informative tour of the Coffee Research Station, Ruiru, which was conducted on the 28 May 1993. They learnt some valuable information which will help improve their own coffee programmes back home.

CONSTITUTION OF THE NETWORK

It was agreed that the ability to directly sponsor national programmes on the coffee anthracnose is now limited because of the financial constraints individual countries are experiencing, and especially at a time when coffee as a commodity, is fetching very low returns. Funding organizations are also tending to sponsor joint or regional programmes as opposed to national programmes.

Since the Organization of African Unity (OAU) had offered to play a liaison role between member countries and financing Institutions, it was recommended that the formation of the Network on Coffee Anthracnose was essential. Participants were aware that the same OAU members through their membership to the Inter-African Coffee Organization (IACO) had recently formed the African Coffee Research Network (ACRN) which will deal with all research aspects on coffee. It was further explained that OAU through the Inter-African Phytosanitary Council, would play a liaison role between the proposed Network on Coffee Anthracnose and the ACRN to ensure that the two work in harmony.

NAME OF NETWORK

The participants then resolved to form the network on the coffee anthracnose. The official name of "Coffee Anthracnose Research Network in Africa" (CARNA), was adopted.

OBJECTIVES

The objectives of the Network are:-

1. To initiate and encourage formulation of joint research projects on the coffee anthracnose to member states

2. To document and disseminate information on coffee anthracnose within member states

3. To facilitate the exchange of research experiences between member countries through organizing scientific meetings, attachments, training, etc for researchers working on the Coffee Anthracnose.

MEMBERSHIP OF NETWORK

It was resolved that membership be open to all African states (including Malagasy), where coffee is grown, irrespective of whether or not the coffee anthracnose is a problem.

HOME BASE

It was resolved that Kenya, due to its more advanced research on the coffee anthracnose, become the home base of the Network. It was however, noted that the home base for CARNA could be moved to another member country in case of unforseen problems.

COORDINATOR

The participants of the 1st Constitutive Network meeting on Coffee Anthracnose in Africa, unanimously elected Dr (Mrs) Dinah M Masaba (Kenya), as Coordinator, and Dr Joseph Bakala (Cameroon) as Deputy Coordinator of CARNA.

FUNDING FOR NETWORK

The Scientific Secretary (OAU) assured participants that the initial funding of CARNA will be undertaken by the Inter-Phytosanitary Council of OAU. It was hoped that later programmes could be maintained through external donor funding.

RECOMMENDATIONS

After deliberating on the contents of the country reports and the discussions made during the different sessions of the meeting, the following recommendations were resolved.

CO-OPERATIVE RESEARCH PROGRAMMES

The participants noted that individual countries were at different levels of research on the coffee anthracnose, and as such research priorities differ. It was, however, agreed that each country prepare sub-project proposals on areas of priority. The sub-projects were to be sent to the Coordinator who will draw out joint proposals representing the global needs on the coffee anthracnose. The joint proposals will be sent to the potential donors who will be identified by the Scientific Secretary (OAU). The proposal formats may vary depending on the donors. It was agreed that such formats as would be identified by the Scientific Secretary (OAU) should be sent to the Coordinator within the next three months after the meeting. It was also proposed that the Scientific Secretary (OAU) provide small grants to members to enable them prepare project proposals.

EXCHANGE OF INFORMATION, MATERIALS AND PERSONNEL

It was noted that there were few opportunities, if any, available to African scientists to meet and exchange technical findings and information on common problems. Even the circulation and distribution of scientific literature within Africa is so limited that very little is known of what is being done in neighbouring countries on similar problems. Most countries were found to have a shortage of man-power and equipment for use on research on the coffee anthracnose, whilst there were hardly any exchanges in materials such as germplasm between countries. It was proposed that:

1. Each country start putting together all published information on coffee anthracnose; and individual lists be sent to the Coordinator for proper documentation and future dissemination within countries.

2. Each country gives an updated list of equipments and personnel working on the coffee anthracnose, giving details of academic qualifications, areas of specialization and deployment. The purpose of this exercise is to enable the network identify areas which require strengthening; organize training and research attachments/visits for scientists within member states; and identify expertise which can be used within the region.

3. Each country makes a list of available coffee germplasm to be sent to Coordinator for the purposes of future germplasm exchange programmes.

The above information in 1, 2 and 3 should be received by the CARNA Coordinator by the end of August 1993.

INTERNATIONAL EXPOSURE

The participants, also noted that African Scientists will need exposure to International Scientific fora such as Conferences, Workshops, Symposia, etc which bear direct relationship to Plant Pathology in general, and to anthracnose diseases in particular, to enable them keep abreast with new technologies. It was recommended that CARNA undertakes to sponsor selected candidates to such meetings in future. In addition, CARNA will undertake to organize scientific meetings within member states, where scientists working on the Coffee Anthracnose will present and discuss their research findings.

RESEARCH ACTIVITIES

From the discussions on the country situations of CBD, the following research activities were identified as needing priority attention:-

1. Most countries expressed the desire to screen germplasm for resistance to coffee anthracnose. The research would entail development and/or refinement of screening methodology. It was also noted that some countries, such as Kenya, were well advanced in breeding for resistance and the screening methods they use could be adopted and refined for use by the others. There was a feeling that the screening methods be standardized and the possibility of setting up joint screening facilities be explored.

2. Participants also identified a need for identification and documentation of pathogen variation (races) within member countries. The possibility of developing coffee varieties which would be used as differentials in race testing was suggested. It was also noted that there are other technologies such as the use of Restriction Fragment Length Polymorphism (RFLP) which could be explored for the same purpose.

3. Majority of countries were observed to be controlling the coffee anthracnose using fungicides. While it was agreed that individual countries carry out their own bio-efficacy evaluation, it

was felt that facilities for monitoring residual effects of pesticides (pesticide residue analysis) could be centralised to cut down on costs, especially because similar fungicides appear to be in use or under evaluation.

4. A report on the potential to control CBD using biocontrol was presented at the meeting. Participants recommended that research into new control measures such as biocontrol with surface microflora, or using plant extracts need to be actively supported and later incorporated to an integrated control approach to the coffee anthracnose.

5. It was observed that the distribution of CBD was not documented in some countries. Participants recommended that the spread of CBD in individual countries be monitored and documented. The spread of the coffee anthracnose to other African countries where it has not been reported, should be monitored and documented by CARNA.

PROCEEDINGS

The Scientific Secretary (OAU) offered to publish the proceedings of the 1st Constitutive Network meeting on Coffee Anthracnose in Africa, in a special issue with assistance from the Coordinator.

CARNA MEETING

It was resolved that in view of the urgency of the many activities which will need to be attended to within the starting period of CARNA, the next meeting of CARNA be held in one year's time i.e May 1994. The meeting will be held in Cameroon. The Scientific Secretary (OAU) is expected to invite potential donors to attend this meeting, where it is hoped that concrete project proposals will be presented and discussed.

Otherwise, members had agreed that CARNA should meet at least once every two years.

COUNTRY REPORT: KENYA

D. M. MASABA, P. N. KING'ORI AND C. O. AGWANDA

Coffee Research Foundation, P. O. Box 4, RUIRU, Kenya

INTRODUCTION

Coffee is a very important product in Kenyan agriculture, currently ranking third amongst the major sources of foreign exchange earnings. Up until 1988/89, the value of coffee represented 30% of the total domestic export, but the value has since dropped to 18% of the total domestic export in 1989/90 as a result of the low world market prices experienced after the suspension of the price support mechanism of the International Coffee Agreement (ICA) in 1989. Kenya coffee is produced by two Agricultural sectors, namely, the Plantation (Estates) and the Co-operative (Small-holders). The total area under coffee has increased over the years to the current figure of about 159,000 hectares. Total production has also generally increased over the years to a peak of about 129,000 tonnes clean coffee during 1987/88, but has since dropped to 87,000 metric tonnes in 1990/91 (Table 1).

Table 1: Coffee area production and export value in Kenya

Year	Area under mature coffee x 1000 ha			Production of clean coffee metric tonnes x 1000			Production per ha in tonnes clean coffee		Value of coffee		
	Small-holders	Estates	Total	Small-holders	Estates	Total	Small-holders	Estates	Mean price per tonne Kf	Total export value Kfx10^6	% of total domestic export
1962/63	14.8	28.3	42.1	8.9	25.3	34.2	0.6	0.9	204	11.1	25
1963/64	25.7	28.3	54.0	15.4	28.5	43.9	0.6	1.1	350	15.4	33
1964/65	25.7	28.3	53.0	14.8	22.4	37.2	0.6	0.8	333	14.1	30
1965/66	36.6	32.0	68.6	25.6	25.7	51.3	0.7	0.8	327	118.8	32
1966/67	36.7	31.9	68.6	27.6	25.3	52.9	0.7	0.8	291	15.7	29
1967/68	49.9	31.2	81.1	20.6	13.3	33.9	0.4	0.4	320	12.8	28
1968/69	52.3	30.7	83.0	23.3	22.3	45.6	0.5	0.7	308	16.8	32
1969/70	54.1	29.9	84.0	26.3	26.5	52.8	0.5	0.9	373	22.3	37
1970/71	55.6	29.5	85.1	27.3	29.6	56.9	0.5	1.0	314	19.5	32
1971/72	55.7	28.7	84.4	29.4	31.9	61.3	0.5	1.1	375	24.8	27
1972/73	55.3	29.5	84.8	36.0	40.0	76.0	0.6	1.3	463	33.4	28
1973/74	55.6	29.1	84.7	40.6	32.7	73.3	0.7	1.1	510	38.4	24
1974/75	57.8	28.6	86.4	35.5	30.6	66.1	0.6	1.0	477	35.2	21
1975/76	57.3	28.6	86.4	36.5	38.1	74.6	0.6	1.3	1066	84.4	36
1976/77	56.6	27.8	84.4	37.7	49.7	97.4	0.8	1.8	2214	202.7	42
1977/78	65.0	30.6	89.2	47.6	33.7	81.3	0.7	1.1	1553	129.6	34
1978/79	70.0	30.0	92.0	46.7	27.6	74.3	0.7	0.9	1234	97.3	29
1979/80	80.0	30.0	100.0	52.0	39.7	91.7	0.7	1.2	1360	118.7	22
1980/81	84.7	32.9	117.6	64.0	34.7	99.7	0.7	1.0	1176	110.9	30
1981/82	75.5	33.6	131.1	52.5	34.4	87.4	0.5	1.0	1337	144.6	27
1982/83	101.0	33.6	134.6	52.5	33.0	86.1	0.5	1.0	1767	160.1	25
1983/84	114.2	35.7	150.0	74.7	54.3	129.6	0.7	1.5	2070	203.6	27
1984/85	116.3	35.7	152.0	67.7	28.9	94.1	0.5	0.8	2196	230.6	29
1985/86	117.7	38.6	156.3	68.4	45.5	113.9	0.6	1.2	2377	388.5	41
1986/87	116.0	38.5	154.5	67.9	36.4	104.9	0.6	1.0	2226	194.6	25.8
1987/88	116.4	36.7	153.0	84.4	44.5	129.0	0.7	1.2	2638	244.5	26.6
1988/89	116.1	39.6	155.7	78.3	38.6	117.6	0.7	1.0	2348	203.8	20.4
1989/90	117.5	38.1	155.5	69.5	34.4	104.5	0.6	0.9	1906	221.0	17.9
1990/91	121.5	38.0	159.3	51.4	35.2	87.2	0.4	0.9	2434	–	–

Figures from: 1. Coffee Board of Kenya Annual Reports
2. Central Bureau of Statistics, Kenya

The decline coincided with the unstable and depressed market situation resulting in low prices already alluded to above. This led to poor husbandry practices and generally low morale on the part of the farmers. The Smallholders contribute 64% while the Estates contribute 36% of the total production.

Kenya produces the mild Arabica coffee that is renown the world over for its fine quality. Coffee in Kenya is grown in areas between 1200 m and 2100 m above sea level. These areas lie on the broad gentle slopes of Mount Kenya and eastern Aberdare Range in the Central Province area, on the slopes of Mount Elgon, bordering Uganda, parts of the Great Rift Valley and some small holdings in the Taita Hills, a short distance from Tanzania (Fig 1).

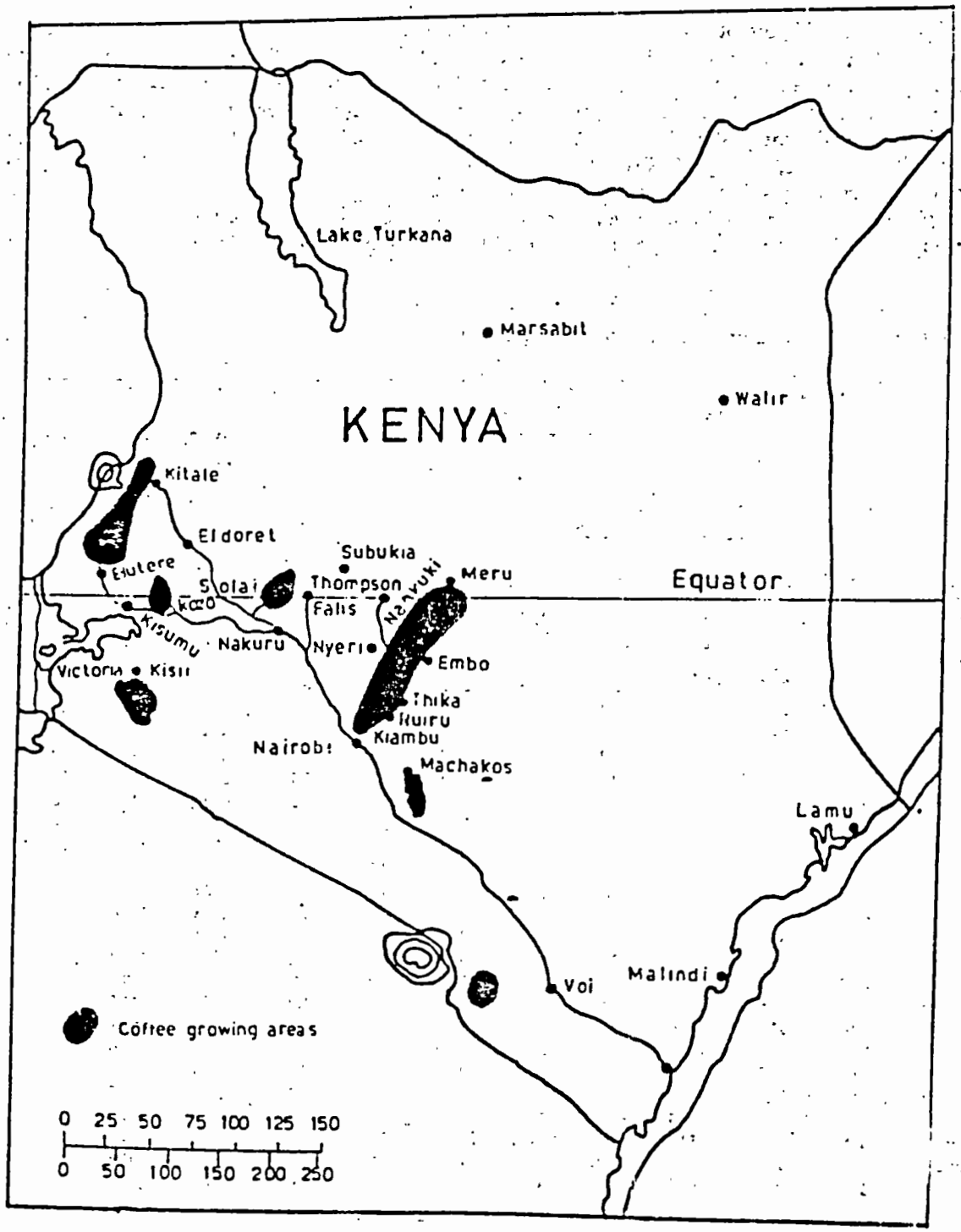

Figure 1: Main coffee producing areas in Kenya

The production cost per tonne of clean coffee in Kenya is about K£ 2,700, which is considered high. About 30% of this total cost goes into the control of coffee diseases, the most important being coffee berry disease (CBD).

COFFEE BERRY DISEASE

Coffee Berry Disease (CBD) attacks coffee berries in all stages of growth and occasionally even flowers and leaves. However, the most susceptible stages are during rapid berry expansion (6-16 weeks after flowering) and when the berry is ripening (Mulinge, 1970). On green berries, symptoms first appear as small dark, sunken patches which spread rapidly and may cover the whole berry (Fig 2a). Under wet conditions, pinkish mass of spores develop on the lesion surface. Usually, the fungus penetrates the interior and destroys the beans. Eventually, the whole berry dries out and takes the appearance of black mummified bodies locally known as 'mbuni' (Fig 2b). Infected berries may also be shed off as soon as lesions develop.

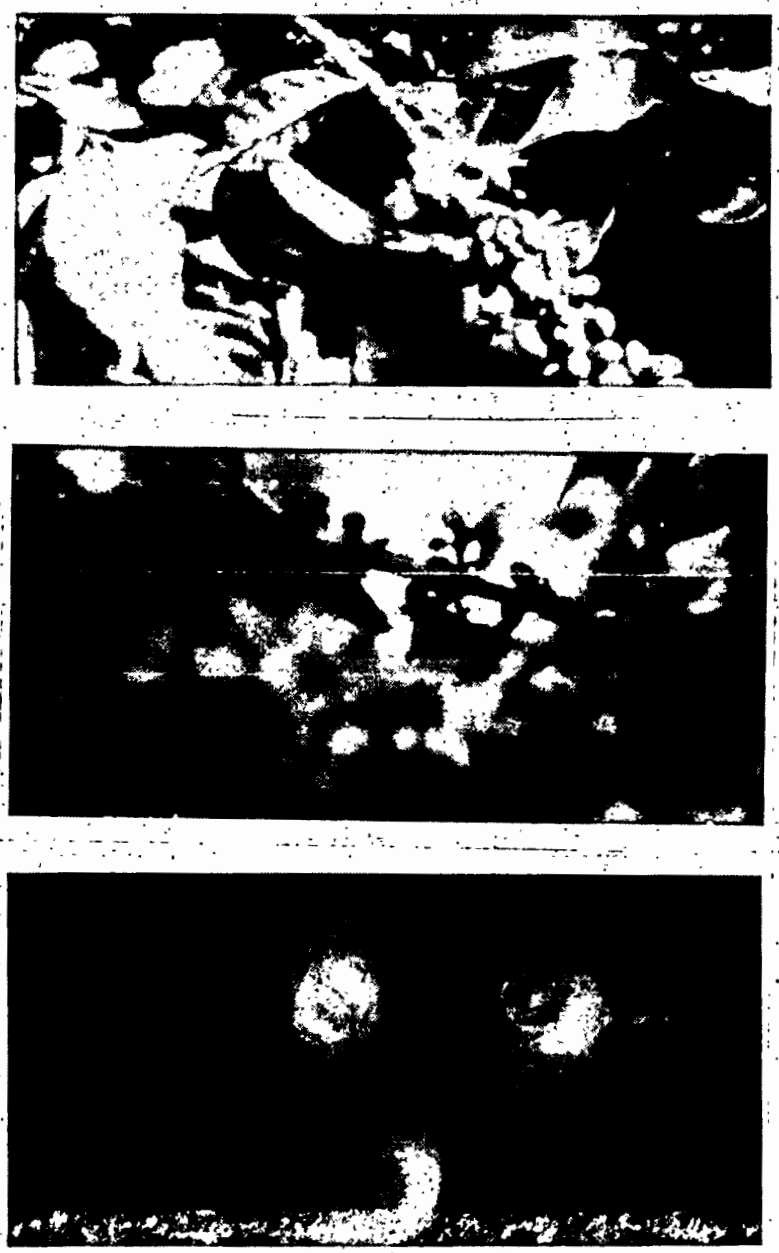

Figure 2a, b & c: Symptoms of CBD

A second type of lesion is normally formed under adverse weather conditions. This type of lesion is normally called 'scab' lesion (Fig 2c). Recently, it has been observed that some of the scabs are formed, especially on resistant coffee varieties even under weather conditions favourable to the disease and there is evidence that these scabs may be an indication of a defence reaction (Masaba and Van der Vossen, 1982).

HISTORY AND SPREAD

The history and spread of CBD in Kenya has been documented in detail in Masaba *et al* (1984). Coffee berry disease was first reported in Kenya in 1922 (McDonald, 1926), on the slopes of Mt Elgon, but has since spread to all coffee growing areas. The disease is predominant in coffee growing areas above 1608 m in altitude, but occasionally becomes very severe in the lower altitudes. For example, during 1986/87, the disease was observed to be very high in the middle and low altitudes (Thika, Kilimambogo, Makuyu and Ruiru), prompting the CRF to carry out a survey to establish the possible reasons for the anomaly. It was observed that adoption of intensive irrigation practices had resulted into overlapping crops which may have led to the increase in CBD inoculum and the susceptible berry stages constantly being available on the trees, leading to enhanced CBD incidence (Mukunya *et al*, 1987).

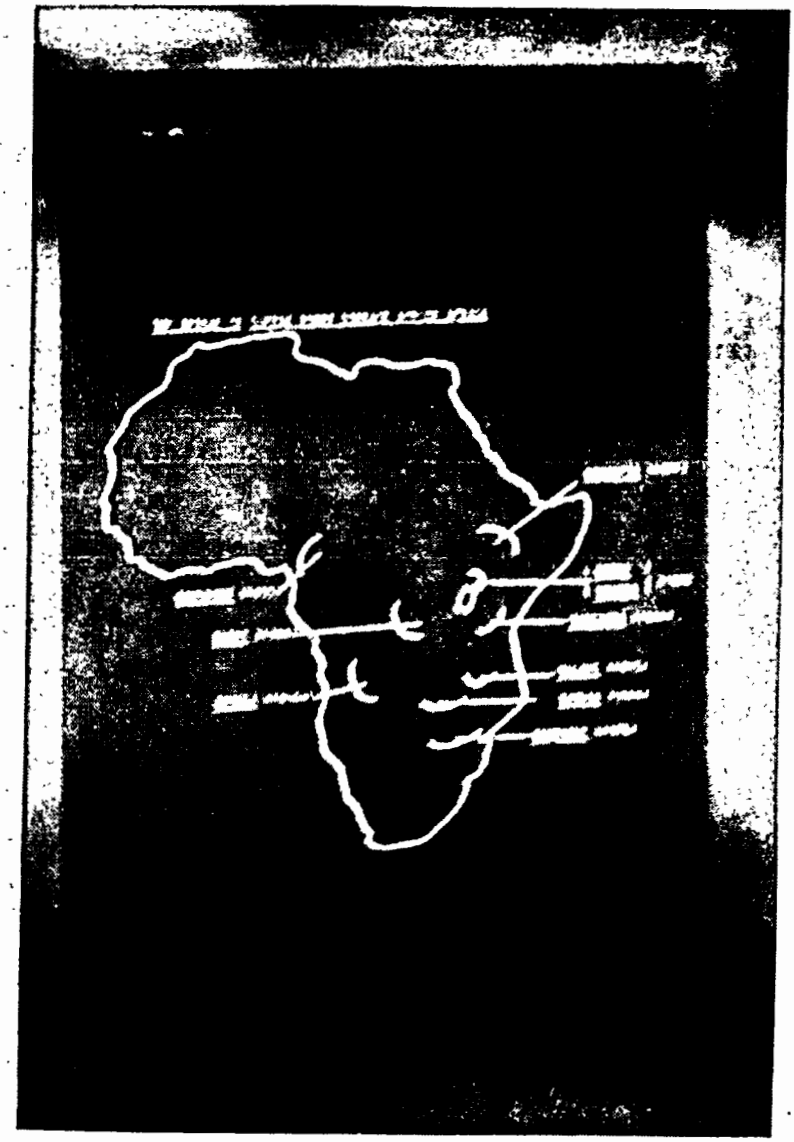

Figure 3: The spread of Coffee Berry Disease across Africa

The spread of CBD to other African countries (Fig 3) has also been documented by Masaba and Waller (1992). The same authors observed that the spread of CBD is slow compared with the more rapid spread of the air-borne coffee rust. CBD spores are only released and dispersed by rain. They may, however, travel long distances on overtly diseased or latently infected plant material or passive vectors such as birds, man and machinery.

THE PATHOGEN

The confused situation on the nomenclature of the *Colletotrichum* species on Arabica coffee was discussed in detail at the First Regional Workshop on CBD in Addis Ababa, Ethiopia, in 1982. The workshop recommended a critical review of the nomenclature of the CBD pathogen. The CBD pathogen had been given the name *Colletotrichum coffeanum* Noack (1901) which belonged to a saprophytic *Colletotrichum* species isolated on coffee from Brazil, where CBD does not occur. Subsequently, the International Mycological Institute (IMI) has carried out a detailed study aimed at distinguishing the CBD pathogen from other *Colletotrichum* species living on coffee and other crops.

The CBD pathogen habitually colonizes the maturing back of coffee shoots in close association with several other *Colletotrichum* species. However, only a small portion of the *Colletotrichum* spores produced from this source are pathogenic. Diseased berries are by far the major source of CBD inoculum (Gibbs, 1969). Fresh CBD *Colletotrichum* isolates can easily be distinguished from saprophytic *Colletotrichum* species by their distinct greenish grey cottony mycelia on malt extract agar in addition to their pathogenicity on green berries (McDonald, 1926; Rayner, 1952; Gibbs, 1969; Hindorf, 1970). However, after several subculturings or storage in culture, CBD isolates tend to revert to a white form indistinguishable from saprophytic *Colletotrichum* isolates (Waller, 1984). More recent investigations at the International Mycological Institute (IMI) have established a biochemical distinction between the coffee pathogen, *C gloeosporioides* and *C acutatum* which are the main saprophytic species on coffee (Waller, *et al*, 1993). CBD isolates cannot metabolize tartrate, or citrate as sole carbon sources, whereas the non-pathogenic *Colletotrichum* isolates from coffee, and also from other tropical woody hosts such as mangoes and citrus, can readily metabolize tartrate, citrate or both as sole carbon sources (Table 2).

Table 2: Features of *Colletotrichum kahawae* enabling it to be distinguished from *C. gloeosporioides isolates from coffee*

	Colletotrichum kahawae	*Colletotrichum gloeosporioides*
(1)	Colony characteristics (fresh single-conidial isolates on 2% MEA):	
	Slow-growing (2-4 mmd^{-1} 25°); profuse olivaceous to greenish dark grey mycelium; no acervular conidiomata produced; sporulation occurs from simple hyphae.	Faster growing (3-6 mmd^{-1} at 25°); white to pale grey mycelium; sporulation from acervuli or simple hyphae.
(2)	Metabolism	
	Cannot utilize citrate or tartrate as sole carbon sources.	Can utilize tartrate, citrate or both as sole carbon sources.
(3)	Pathogenicity	
	Pathogenic to young expanding green berries and developing seedling hypocotyls of *Coffea arabica* cv SL 28 and other susceptible cultivars, causing dark sunken anthracnose lesions.	Not pathogenic to young expanding coffee berries or seedling hypocotyls.

The results from the biochemical tests coupled with colony characteristics of fresh cultures on malt extract agar, and pathogenicity tests on expanding berries and seedling hypocotyls have formed a basis for recognizing the CBD pathogen as a distinct species named *Colletotrichum kahawae* Sp. Nov. The species name was derived from the Swahili and Arabic name for coffee, as CBD is still solely an African problem. The standard isolate used for description was from Kenya.

Recently, it has been reported that the Malawian isolates may vary in pathogenicity from the Kenyan isolates (Rodrigues *et al*, 1992) implying that there may exist physiological races of the pathogen.

EPIDEMIOLOGY

Extensive research work was done on the CBD pathogen and disease in the late 1960s and 1970s and this has been reviewed by Firman and Waller (1977) and updated by Masaba *et al* (1984). It is particularly important to appreciate the central role of rain in spore production, dispersal, germination and infection by the pathogen, and also in regulating the flowering, and consequently cropping pattern of the coffee trees.

The coffee berry takes about nine months from flowering, which occurs shortly after the end of the dry season, to maturity (harvest). During the first four weeks, the berry does not increase in size, remaining at the 'pinhead' stage which is normally resistant to CBD. The expanding berry (4-16 weeks after flowering) is the most susceptible stage, while fully expanded green berries are resistant. The berries become susceptible again when they start to ripen (Mulinge, 1970).

Typically, in countries close to the equator, there tends to be two rainy seasons in a year. In Kenya, these are the long rains (March - June) and the short rains (October - November). The coffee growth pattern is thus characterized by two flowerings, one at the beginning of each rainy season, giving rise to two crops (the early short rains and late long rains crop) in each year (Fig 4).

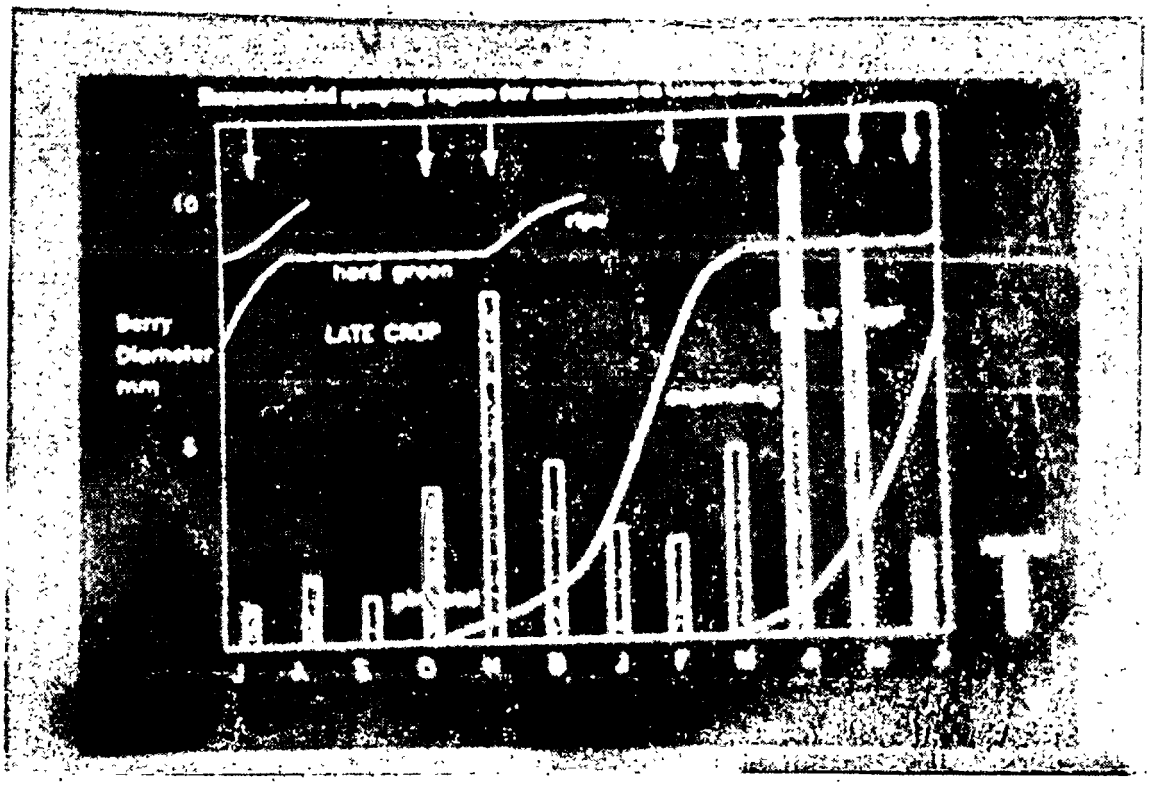

Figure 4: Annual rainfall, coffee cropping patterns and spraying regime to control CBD in Kenya

The crops thus overlap and hence provide a constant source of inoculum, which necessitates the application of fungicides throughout much of the year to protect the susceptible berry stages from infection. The cropping pattern is further complicated by fluctuations in the rainfall pattern and aberrant rainfall in the normally dry six months of the year. Irrigation during the dry season causes additional out-of-season flowerings which further exacerbate the overlapping of susceptible crop stages.

Some other factors influence the CBD epidemics. Among these are the frequent outbreaks of insect pests which attack the berry and increase its susceptibility to the disease. These include the berry borer (*Hypothenemus hampeii* Ferrari) and the berry moth (*Prophantis smaragdina* Butler). Even where CBD is not present, the dead berries resulting from insect attack are often mistaken for symptoms of CBD by farmers.

CHEMICAL CONTROL

The development of a successful fungicide control regime for CBD in Kenya has been exhaustively described in Masaba *et al* (1984). Spraying to protect the developing crop during the rainy seasons is necessary to achieve good control of CBD (Griffiths *et al*, 1971). Copper-based fungicides were used in Kenya until 1969 when Captafol and later Benomyl became available. The small-scale farmers in Kenya have continued using copper, mainly because of its relatively low cost, and also because copper gives effective control of other major coffee diseases namely coffee leaf rust caused by *Hemileia vastatrix* and in some areas, bacterial blight of coffee caused by *Pseudomonas syringae* pv *garcae*. In the estate sector, however, copper was almost wholly replaced by the more effective but expensive organic fungicides; captafol, chlorothalonil, dithianon, benomyl and carbendazim. After a few years of intensive use in Kenya, the pathogen developed resistance to carbendazim and benomyl and had to be withdrawn from the recommendations.

The fungicide-resistant strains are very stable and even without the selection pressure of the fungicide, they are still easily detected and have been found to interfere with control of CBD by contact fungicides (Masaba *et al*, 1990). The change from copper to organic fungicides also coincided with an upsurge of incidence of bacterial blight in high altitude areas within the Rift Valley (Okioga, 1978) as the bactericidal properties of copper are not shared by most organic fungicides and captafol exacerbated the disease (Kairu *et al*, 1984).

Table 3: Comparative chemical costs and yield benefits between control with straight fungicides and tank mixtures in Kenya

Chemical	Rate % formulated product	Clean coffee yield (kg/ha)	Yield benefit (kg/ha)	Cost of chemical per hectare (KSh)	Cost benefit ratio**
Captafol 80% WP	0.4	1169	735	6209	1:4.73
Captafol + Cupric hydroxide	0.2) + 0.5)	1163	729	5567	1:5.24
Chlorothalonil	0.4	741	307	7920	1:1.55
Chlorothalonil + Cupric hydroxide	0.2) + 0.5)	889	455	6209	1:2.93
Anilazine	0.4	852	418	5632	1:2.97
Anilazine + Cuprous oxide	0.2) + 0.5)	1011	577	5236	1:4.41
Unsprayed	-	434	-	-	

* Market prices for 1988;
** Based on assumption that market price for coffee was K£2000/tonne but excluded labour costs.
Modified from Masaba *et al* (1990)

It was shown in Kenya that the use tank mixtures of organic fungicides at half the normal rates, and copper-based fungicide at a reduced rate of 5 kg/hectare, improves the cost/benefit ratio (Table 3). In addition, the tank mixtures are able to control coffee leaf rust on the same programme, and bacterial blight with a few additional copper sprays (Kairu, 1983). The tank mixtures are now widely used, especially on estates in Kenya. Tank mixtures constitute such a significant practice that some chemical manufacturers have formulated the components into a single mixture. However, these seem to be inferior to tank mixtures as they are only effective at higher doses (Masaba and Opilo, 1990).

Since its recommendation in 1969, captafol, and later its tank mixtures with copper, have consistently been the most effective fungicides giving comparatively higher yields than any other fungicide or fungicide combinations. Much of the captafol's yield benefit comes from its 'tonic' effect on coffee and persistence during the rainy season. However, captafol was recently banned from use due to its possible mutagenic effects. The removal of captafol greatly limits the options for fungicidal control of CBD. The current fungicides and fungicide combinations used for the control of CBD in Kenya are shown in Table 4.

Table 4: Tested and recommended fungicides for CBD control

Common Names	Proprietary Names (Trade Names)	Formulation	Rate (Kg/ha)
1. Chlorothalonil	Daconil 2787-W75	75% W P	4.4
	Clortocaffaro	75% W P	4.4
	Clortocaffaro 500 Flow	50% S C	4.4
	Jupital 720 Flow	72% S C	3.5
	Griffinil	50% W P	4.4
2. Dithianon	Delan	75% W P	3.3
3. Anilazine	Dyrene	75% W P	4.4
	Dyrene 480 S C	48% S C	6.0
4. Anilazine/Copper	Dyrene C 47	17/30 W P	9.0
5. Chlorothalonil/Copper	Dacobre 500	25/30 W P	7.7
6. Prochloraz-Mn	Octave	50% W P	2.2
7. 50% Copper formulations:			
(a) Cuprous Oxide (Red Copper)	(i) Copper Nordox	50% Cu W P	7.7
	(ii) Copper Sandoz MZ	"	"
	(iii) Copcel	"	"
(b) Cupric Chloride (Copper Oxychloride or Green Copper)	(i) Cobox	50% Cu W P	"
	(ii) Recop	"	"
	(iii) Microp-50	"	"
	(iv) Funguran	"	"
	(v) Cuprocal	"	"
	(vi) Copsap	"	"
	(vii) Cupravit	"	"
	(viii) Vitigram Conc	"	"
	(ix) Cuprado	"	"
	(x) Cuprocaffaro	"	"
	(xi) Vericuivre	"	"
	(xii) Kopox	"	11.0
	(xiii) Perecopper	"	11.0
	(xiv) Blitox	"	7.7
	(xv) Cuprox	"	"
	(xvi) Oxycop	"	"
	(xvii) Cuprasol	"	"
(c) Cupric hydroxide (Blue Copper)	(i) Kocide 101	"	"
	(ii) Parasol	"	"
	(iii) Champion	"	"
8. Copper Sulphate Lime (Proprietary Pre-mix)	Frocida Bordeaux Mixture	25% WP	11.0

BREEDING FOR RESISTANCE

The need to reduce the cost of production of coffee and particularly the cost of controlling coffee diseases, led to the initiation of a breeding programme in 1971. The programme aimed to combine resistance to CBD and coffee rust with high yields and the good quality typical of Kenya coffee (Van der Vossen and Walyaro, 1981). This was carried out in three stages:-

1. Selection within accessible variety collections followed by single crosses between disease resistant varieties and the best local cultivars (Table 5)

2. Multiple crosses to assemble in one plant the desired traits from several varieties

3. Backcrosses of selected plants from multiple crosses to the best local cultivars to improve quality (Van der Vossen and Walyaro, 1981)

Table 5: Yield and disease resistance for parent varieties and single crosses in Stage 1 of the Kenyan coffee breeding programmes

	Yield (first growth cycle) clean coffee tonnes/ha	Resistance in the field	
		CBD	Rust
Parent varieties			
SL28	10.9	S	S
Caturra	8.6	S	S
Padang	11.7	MR	S
Rume Sudan	2.5	R	MS
Hibrido de Timor	5.0	R	R
Single crosses			
SL28 x Caturra	11.4	Progeny screened for application of further selection criteria	
SL28 Rume Sudan	8.3		
SL28 x Hibrido de Timor	12.8		
Caturra x Hibrido de Timor	10.3		
Caturra x Rume Sudan	9.7		
Padang x Rume Sudan	12.4		

The selection for resistance to CBD was greatly enhanced by the development of a reliable pre-selection test performed on six-week old seedlings (Van der Vossen *et al*, 1976), which enabled large quantities of material to be screened under optimal laboratory conditions. The test was also used to identify the genes conditioning resistance in important progenitors. Rume Sudan (2 genes on the R- and K- loci) and Hibrido de Timor (1 gene on the T- loci), (Van der Vossen and Walyaro, 1980). The programme was then refined to ensure that all three genes were present in the new material. However, histological evidence suggests that the resistance mechanism is based largely on the formation of cork barriers, a type of resistance which is usually race non-specific (Masaba and Van der Vossen, 1982). Van der Graff (1981) showed that CBD-resistance in the Ethiopian selections was quantitative and probably polygenic, characteristics which also apply to resistant cultivars used in other countries. This information together with the lack of evidence for differential pathogenicity of CBD isolates and the continuing effectiveness of resistant varieties, provide some basis for expecting that the resistance may be durable.

In an exchange of germplasm in 1975 and 1977, the Kenya programme received some F_3 and F_4 selfings of Caturra x Hibrido de Timor (Catimor) from South America. The semi-dwarf Catimor hybrids have resistance to all races of coffee rust. The cross of Catimor with the selections of the main breeding programme resulted in the production of Ruiru 11 (Van der Vossen and Walyaro, 1981).

Ruiru 11 is a composite population of genetically heterogenous hybrids, though the plants show a high degree of phenotypic uniformity because of the dominance of the compact growth character derived from Catimor, and they all possess resistance to CBD and rust. Ruiru 11 flowers within a year of planting and gives yield per tree, bean size and cup quality comparable to those of the established commercial varieties SL 28, SL 34 and K7 (Owuor, 1988). The compact growth habit allows greater planting density thus increasing yield per unit area. To date, some 4337 hectares of close-spaced Ruiru 11 have been planted in Kenya. This represents approximately 6% of the national Arabica coffee tree population.

In order to develop varieties which possess all the three known resistant genes to CBD, a series of back-crosses and selfings are made annually. The resulting back-crosses or selfed seeds are reselected and planted out on preliminary trial fields for assessment of bean and liquor qualities as well as vigour. Concurrently, test-crosses are made on such genotypes in order to determine the number of CBD genes operating in them as well as their levels of homozygosity. The policy of the breeding programme at this stage is to retain only genotypes which have a minimum of two CBD resistant genes in homozygous condition.

Some 55 lines are currently being evaluated using the above criteria. Once the desired genotypes are identified, they will form the second generation of pollen supply parents (usually referred to as the male clones) in our hybrid seed production programme by 1995.

In order to completely restore the quality background of traditional Kenyan coffee varieties, a back-cross programme involving Catimor (currently used as the mother tree in the hybrid seed programme) and SL 28/K7 varieties was initiated in 1992. This programme is expected to introgress the desired compact growth of Catimor governed by the Ct-gene and the T-gene of resistance to CBD in this variety into SL 28 and K7 cultivars.

The search for more genes for resistance is also continuing in the CRS coffee gene banks. A number of introductions from Ethiopia are already being evaluated in a dialled cross in order to determine the number of genes controlling CBD resistance in this population. It is expected that stability of resistance to CBD will be greatly enhanced as more genes controlling resistance to this disease are identified and incorporated into future breeding lines.

BIOLOGICAL CONTROL

In certain circumstances, use of chemicals on coffee has been associated with increased severity of coffee diseases in Kenya, particularly CBD (Furtado, 1969); Griffiths, 1972; Gibbs, 1972). Fungicides also have a 'tonic' effect on coffee, which increases growth and production above that expected from straight disease control. There is evidence that these effects might be mediated through changes in the microflora of coffee surfaces. The role of these surface microflora in the development of CBD in the field have been studied by Masaba (1991). Commonly occurring components of the microflora were tested in culture on detached berries and seedling hypocotyls for their effect on the pathogen. Several components were found to inhibit mycelial growth, spore germination and appressorial formation of the CBD pathogen (Masaba, 1991). It may now be possible to manipulate aspects of chemical control such as type of fungicide and application regime to favour the increase of populations of the antagonistic elements of the microflora.

CONCLUSION

Despite earlier successes in establishing a fungicidal control regime for coffee berry disease, the disease continues to be a major constraint to coffee production in Kenya. Chemical control is expensive and imposes a continuing economic burden: furthermore its efficiency is frequently reduced by fluctuations in rainfall and cropping patterns.

The eventual replacement of Kenya coffee farms with the new disease resistant cultivar, Ruiru 11 is expected to have a considerable impact on the coffee industry, and the national economy as a whole. There will be a considerable reduction on production costs and improvement on cash incomes, especially for smallholders when they grow Ruiru 11. Ruiru 11 will also save the nation valuable foreign exchange spent on fungicides, fuel and spray machinery. Furthermore, the doubling in yield per unit area through close spacing of the compact Ruiru 11 variety will gradually release thousands of hectares of high potential land to food production. It is likely that screening the wider variety of germplasm available in most of the African countries will lead to the eventual release of more CBD resistant varieties and that is why regional collaboration is advocated.

The potential for biocontrol of CBD offers the development of integrated control packages in which an element of natural biocontrol is incorporated, though this area requires much more detailed research before it can become a reality.

It is important to stress that for efficient and economic control of CBD continuous research, coupled with collaboration in the form of exchange of information as well as materials, need to be strengthened. The CRF, therefore, fully supports the formation of a network on CBD in Africa.

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DISCUSSION

E. Derso (*Ethiopia*).

1) What is the probable course of scab lesions?

2) Are there any races of *C. kahawae*

3) Is captafol still recommended for the control of CBD in Kenya?

D. M. Masaba

1) Scab lesions on susceptible coffee varieties have been associated with unfavourable conditions for disease development. However, scab lesions have also been linked with host resistance (Masaba and Van der Vossen, 1982).

2) Captafol is no longer recommended for use against CBD in Kenya due to its alleged health hazard.

F. S. Ngulu (*Tanzania*). Can you elaborate on the biocontrol and how it is affected by use of fungicides?

D. M. Masaba. This was a wide project which established the possible role of saprophytic microflora to reduce CBD. Work concentrated on isolation and identification of the saprophytic microflora from coffee surfaces. The effect of fungicides used to control CBD on the microflora was only studied in

field. We intend to study this interaction in *vitro* to establish specific effects of fungicides on ividual microflora components.

Bakala (*Cameroon*). Why do you prefer use of fungicide mixtures to control CBD?

M. Masaba. Mixtures of copper and organic fungicides have been shown to be consistent in the trol of CBD; cheaper at the rates used in the combinations; and can also control other coffee eases such as *H. vastatrix* and *Pseudomonas garcae* on the same spray programme.

Sibomana (*Rwanda*). If Ruiru 11 is not stable, is it its propagation a problem?

O. Agwanda. Ruiru 11 is a hybrid with two selected parents. We use five mother parents and up to e male parents and that is why we say it is unstable. Otherwise its yield, quality, resistance to CBD l leaf rust, and its compact growth characteristics are very stable.

COUNTRY REPORT: TANZANIA

RESEARCH SYSTEM ON COFFEE BERRY DISEASE AND ITS CONTROL IN TANZANIA

F. S. NGULU

Lyamungu Research Institute, Moshi

ABSTRACT

Coffee is the major foreign exchange earner in Tanzania; Arabica coffee accounts for over two of the total coffee output. Coffee Berry Disease (*Colletotrichum kahawae*, Waller & Bridge) spr all major coffee producing areas within 14 years since it was first reported in the country in 196 of economic importance on farms situated 1300 m.a.s.l. CBD control research programme con inoculating and assessing breeders' material for resistance as well as testing the efficacy of fun against the disease under field conditions. Regional/International cooperation would cons research efforts through germplasm exchange, standardizing research techniques, monitoring r effects of long term fungicide use and sharing research findings through exchange of reports, m and field visits.

INTRODUCTION

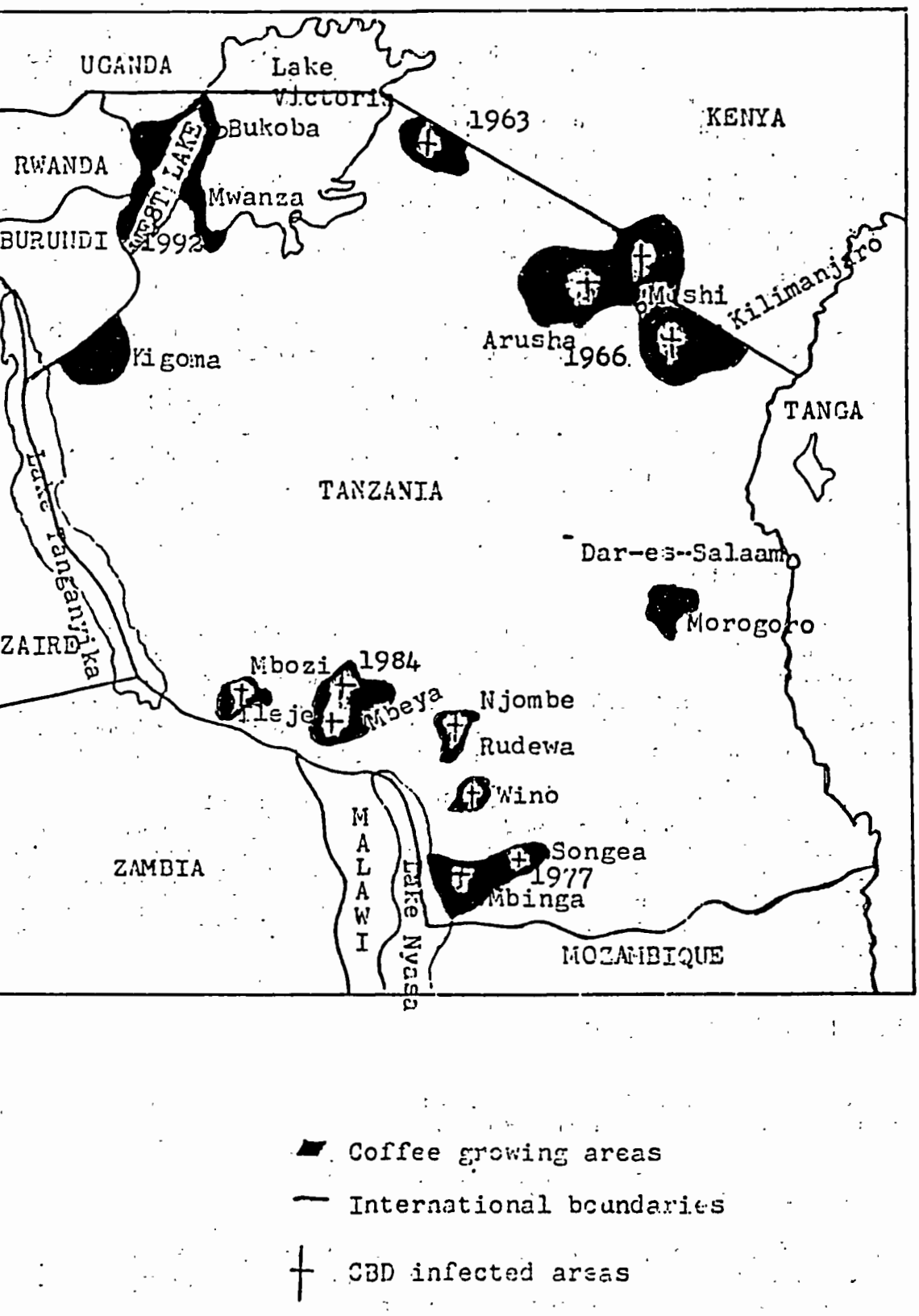
Coffee is currently the leading foreign currency earner in Tanzania. Annual coffee produc approximately 55000 MT of which ⅔ is Arabica and the remainder is Robusta coffee. The Arabica coffee producing areas are Arusha and Kilimanjaro in the North-East and Ruvun Mbeya regions in the Southern highlands. Robusta coffee is grown mainly in Kagera region Western shores of Lake Victoria.

Production of coffee is mainly by small holders, owning between 0.5 - 2.0 hectares and they a for 95% of the total output. On small holdings coffee trees are mostly capped; either as sir multiple stem, interplanted with bananas & occasionally with shade trees such as *maranguensis* and *Grevillea robusta*.

Current commercial varieties of Arabica coffee were derived from Bourbon and Kent selection are high yielding varieties with good liquoring quality but are susceptible to the two major diseases; i.e. Coffee Berry Disease (*Colletotrichum kahawae* Waller & Bridge) and Coffee Le (*Hemileia vastatrix* Berk & Br.).

Coffee Berry Disease (CBD) was recorded for the first time in Tanzania in Tarime district, (1963 and Bujulu, 1974), an isolated coffee growing area in North Western area of the country (1) First CBD incidences in the main arabica coffee producing areas in Kilimanjaro/Arusha a Southern highlands were reported in 1966 and 1977 respectively (Bujulu, 1974 and Kibani, 19 other words, geographical isolation not withstanding CBD spread to all major coffee growing a years after it was first reported.

The disease is of economic importance in coffee farms situated above 1300 metres a.s.l. whe losses on individual farms range from 30 - 60% depending on weather conditions particularly ra



gure 1: Coffee producing areas in Tanzania and CBD incidence

COFFEE RESEARCH PROGRAMME

The programme consists of five disciplines, viz. Plant Breeding, Plant Nutrition, Agr Entomology and Pathology. Like the other crop research programmes coffee research is un Ministry of Agriculture, Livestock and Cooperatives. It is headed by a National coffee r coordinator who is appointed by the Ministry. Under the Coordinator is a team of researche are required to draw up research project proposals in their respective fields of specializatio proposals are submitted to a technical committee which meets once per year. Research find approved projects have to be presented to the same committee for ratification. Subse approved research findings are communicated to the Extension services and agricultural institutes in the form of Annual reports; seminars and field days. The programme has a specific training wing.

Projects on CBD control fall under two categories viz. screening breeder's material for resistar testing the efficacy of candidate fungicides against the disease under field conditions.

Initially, screening of breeder's material was limited to the hypocotyl preselection test c described by Van der Vossen *et al* (1976). However, lately, this exercise has been expanded to assessments on individual bearing trees in the field. In the latter case, a branch with suitabl count at the most susceptible stage (soft-green) is enclosed in polythene sleeve and spraye inoculum in a manner similar to the hypocotyl test. The level of resistance of the individu relative to that of a susceptible control is determined by expressing the infected berry cou percentage of the total count. To assess the level of resistance of hypocotyls, an infection scale (see appendix 1) instead of 1 - 12 as described by Vossen *et al* (1976) is used.

Testing the efficacy of candidate fungicides against CBD is carried out under field conditions v set of candidate products is usually tested for 3 crop seasons in 2 - 3 different sites. Manual Kn sprayers are used to apply the treatments. Gross plot size commonly used is 25 trees (5 x 5) wi plot of 3 x 3 trees. On each tree in the net plot, single branches at top, medium and low elevati marked prior to CBD on set. These branches are subsequently assessed monthly for natura infection. The number of infected berries is expressed as a percentage of total berry count.

It is worthy noting at this stage that all fungicides tested to-date for CBD control are ess "protectants" and recommendations issued to coffee growers require them to apply the fun repeatedly at specified intervals throughout the period when a large proportion of their vulnerable to infection. The major snag with the above recommended package is that in years o rainfall where 150 - 200 mm ten-day rainfall total is annually recorded, it becomes diffic expensive to sustain fungicide deposit on coffee bushes and the efficiency of disease co disrupted.

LIMITATIONS AND NEEDS

Inadequate funding particularly foreign currency to replenish consumable laboratory items parts for laboratory equipment and procurement of relevant journals.

An isolated working environment. There exists no formal forum where coffee scientists can sha experience with their counterparts outside the country.

Unsatisfactory level of manpower strength and continuity. Coffee being a perennial crop requ assured continuity of the services of qualified scientists so that cost-effective packages for con adoption can be realised in the shortest possible time period.

GIONAL/INTERNATIONAL COOPERATION

onal/International cooperation would be highly desirable particularly with regard to germ-plasm ange, standardizing research techniques, exchanging research information and field visits with the to minimize chances of work duplication on common research problems.

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CUSSION

kala (*Cameroon*). Could you give more information on hypocotyl inoculation?

. Ngulu. The method was developed in Kenya (Van der Vossen *et al*, 1976) but we have just ified the scale of recording. We use five instead of the original 12 mean grades.

kala. At what age do you inoculate your berries?

Ngulu. At 14 weeks after flowering, which is still in the susceptible expanding stage.

M. Masaba (*Kenya*). How do you control the weather factor during field inoculations when you ed of the weather at Lyamungu not being favourable for CBD development?

Ngulu. We usually inoculate in April, May when the weather is ideal.

M. Masaba. How about using the hypocotyl technique for your resistance screening?

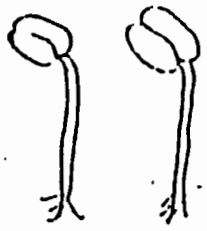
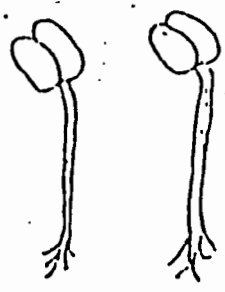
. Ngulu. We noted susceptibility in some lines which were passed as resistant by hypocotyl nique.

V. Mwang'ombe (*Kenya*). You have reduced the scale to 1 - 5, how do you rate?

Ngulu. 4 - 5, very susceptible; 1 - 3, the material goes straight into the field.

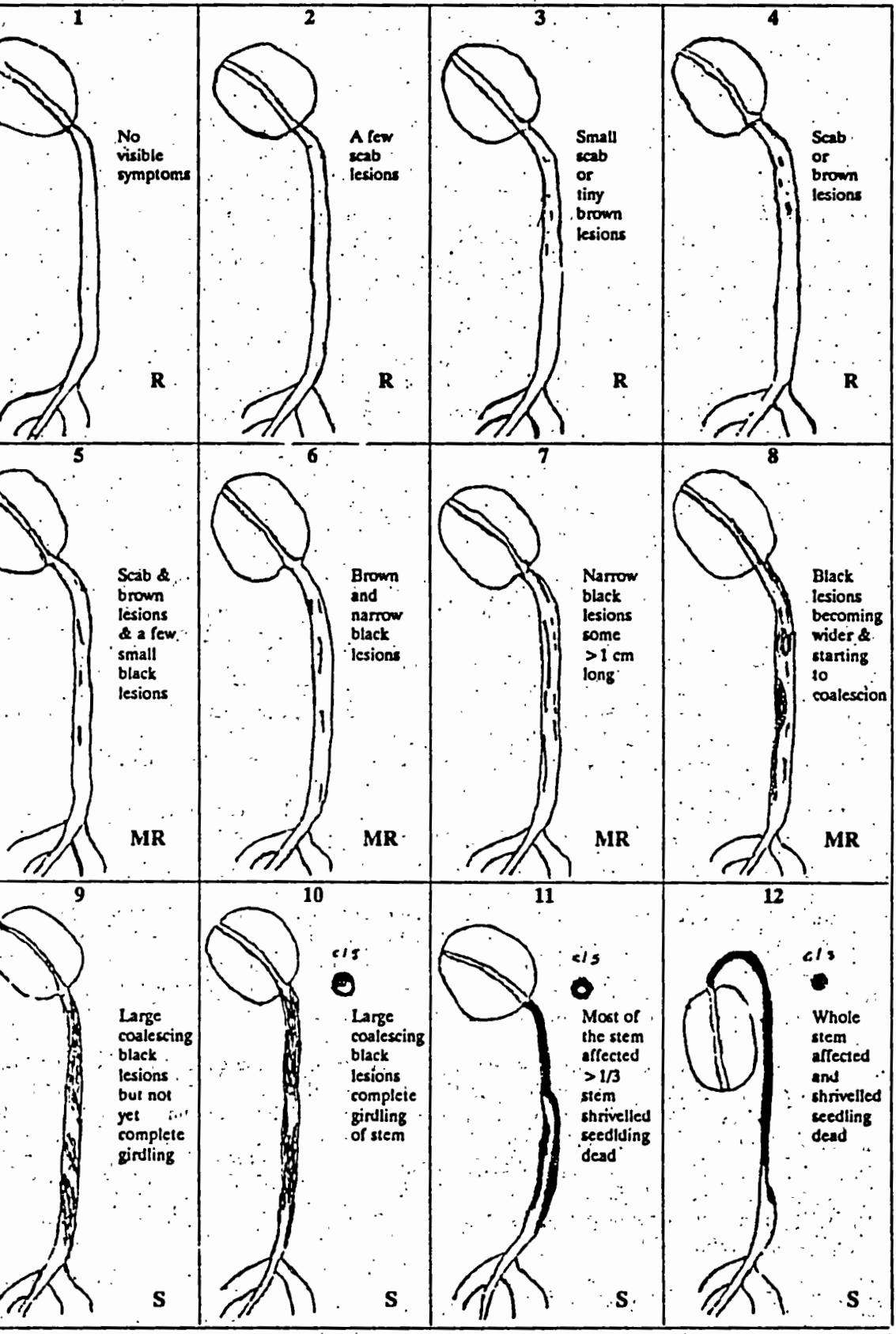
APPENDIX I:

HYPOCOTYL INFECTION: ASSESSMENT SCALE 1 - 5

Seedling appearance	Scale	Symptom description
	1	No visible disease symptor
	2	Few to several brownish le Tiny to enlarging but non
	3	Small sunken dark lesions. Starting to expand laterall vertically.
	4	Large coalescing or indivi sunken lesions. Seedling not shrivelled.
	5	Large and sunken. Seedling completely girdle shrivelled and dead.

PENDIX II:

POCOTYL INFECTION: ASSESSMENT SCALE 1 - 12



COUNTRY REPORT: ETHIOPIA

REVIEW OF THE CURRENT STATUS OF COFFEE BERRY DISEASE (CBD) RESEARCH AND DEVELOPMENT IN ETHIO

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In Ethiopia, *Coffea arabica* L. grows in almost all regions with conditions ranging fr semi-savannah climate of the Gambella plain (1500 m altitude a.s.l.) to the continuously we zone of the south-west and in gardens and back yards (1500 - 2600 m altitude a.s.l.). The so from sandy loam to heavy clay while the general soil types which are acidic (pH 4.2 - 6.8) ar reddish-brown lateritic loams or clay loams of volcanic origin. The annual rainfall varies fron 2400 mm (Sylvain, 1958; Fernie, 1966).

From a genetic point of view, arabica coffee is the most important crop of the nation. Aln entire genetic diversity is found mainly in the south-western rain forest area where almost undi patches of forest with coffee as undergrowth can still be found.

Coffee grows as shrub or small tree and as a semi-wild crop in the moist Montane forest commercial crop it is cultivated under ranges of shade conditions and where grown under irrig dry areas, it is grown without shade. As a garden plant, it is often mixed with ensate fruit tr herbs in the backyard (Tewolde and Gebre, 1990).

The area occupied by coffee varies from 500,000 to 550,000 ha and the bulk of the produce from poorly managed forest coffee. Coffee is the major cash crop in Ethiopia. It contributes 5% GDP, 12% of the Agricultural sector output, 70% of the foreign exchange earnings, 10% of t government revenue and employs 25% of the workforce of the country (Mesfin, 1989).

A major research effort was began by the National Coffee Research Centre (NCRC) which i the Institute of Agricultural Research (IAR). The Centre was established in 1966 to form National Coffee Research Policy and conduct and coordinate research in the Country.

The NCRC conducts its coffee research activities at Melko, the main research centre an sub-centres namely Agaro, Gera, Metu, Tepi, Anfilo, Wonago and Mechara which are locate different coffee growing regions of the country.

The Institute of Agriculture Research has set a national coffee commodity team composed members from the national centre, cooperating members from IAR and Non-IAR research and invited scientists or subject matter specialists from user organizations. The team revi relevance and scientific quality of new proposals and monitors the on-going programmes. Tl also has the mandate to accept or reject new proposals on scientific grounds.

Coffee research priorities are always determined by scientists in close cooperation between tl the Ministry of State Farms Coffee and Tea (MSFCT) and the Coffee research team and th thereafter approved by the Institute of Agricultural Research (IAR). Experiments are also co in the sub-centres under the supervision of the Jima National Coffee Research Centre. To adapt or develop and transfer improved coffee production technologies, the National Coffee R Centre plays a leading role. Coffee research goals are defined clearly by NCRC in light of the r MSFCT, which is the only responsible organ for the promotion of our number one foreign-c earner crop (Mesfin, 1989).

Coffee Pathology Section consists of 15 personnel among which two are research officers, one tant research officer, one Junior research officer, two laboratory technicians, four technical ants and four support staff.

ratory work with disease causing organisms need meticulous handling of the pathogens and the exempliars and this is, of course; subject to the facilities available in the laboratory and the ty of technical knowledge available. Obviously, the dearth for the above mentioned infrastructure vs becomes a limiting factor to the dissemination of new technologies to users. Currently, the on is equipped with seed germinators, most chambers, oven, centrifuges, incubators, desiccators efrigerators (with alternating temperature).

ie moment, even though the documentation system of the Institute of Agricultural Research is d on electronic data processing technology, the section lacks computer data base system and also adequate well trained and experienced personnel. The section is still confined to the entional system of filing and computing where each data is coded in a file and placed in a filing iet.

ern computer data handling facilities are essential for the Pathology Section for efficient and tive integration of information and data collection from all relevant sources and disciplines.

of the coffee research activities are resource demanding and are too costly to be handled. rnal support will therefore be needed, especially for new areas or those that represent expansion n-going activities based on pertinent national policy. Such support should be sought through borative links with regional and international institutions working in the field. In this regard, an ement has been reached between IAR and the European Economic Commission (EEC) to oy an internationally competent high calibre Plant Pathologist and two scientists in other fields, ree years, who would assist and guide coffee researchers with their research activities.

ar as training of the Coffee Pathology section staff is concerned our conviction is that every one field assistant to research officers need training and that the training of every one is of equal rtance. Training is a success and very vital for all involved in research activities and must be a nuous process, it can never be static. To our dismay, training in the NCRC remained a bread and r issue which has got no remedy. Therefore, the assistance of international institutions in the rd is of paramount importance.

nplasm distribution and exchange is performed by the crop protection and regulatory department e Ministry of Agriculture (MOA) which issues plant importation permits to relevant applicants. department checks for diseases and pests on the incoming material. Material which is dispatched ad is also certified. The IAR quarantine Officer, on behalf of the IAR staff is responsible for ining the permit for material importation and exportation.

RRENT STATUS OF CBD IN THE COUNTRY

) is an anthracnose of the green and ripening berries and causes very heavy crop losses in arabica e if not controlled. Yield losses caused by this disease remain among the major constraints to eased coffee production in many parts of Ethiopia.

n CBD was first identified in Ethiopia in 1971, it rapidly spread throughout the country and ed a great concern in coffee production. Currently according to five years mean result (1987 -) at Gera, the loss due to this disease exceeds 40%. However, the overall national loss in the try is estimated to be between 25 - 30% (Eshetu and Girma, 1992).

e the first appearance of this disease in Ethiopia, measures have been taken to keep the disease rity below the level at which it may become economically important. Accordingly screening of icides against the disease was considered as a short term control measure, while the development BD resistant coffee types was taken as a long term control measure.

CHEMICAL CONTROL AGAINST CBD

In any agricultural system, chemical means of control should be considered as a last resort an an alternative to the other principles of plant disease control. However, if this control me planned, it must be borne in mind that it should be carried out sensibly, taking into account ec and ecological considerations.

Coffee cultivars grown by the State Farms in Ethiopia are all CBD resistant and also there hundreds of hectares of peasant holdings planted with the resistant varieties. These farms, h constitute a very small proportion of the total area cultivated under coffee. On the contrary, the total production in the country comes from the peasant sector which consists of mainly gar semi-forest coffee, with variable degree of susceptibility. Hence, it goes without saying that c protection against CBD in our time is indispensable.

Besides, chemical control is well suited to coffee because the value of coffee allows the cos economical. Other methods of control which rely on changing crop varieties, crop rotat cultivation have not been used to any great extent. However, the effect of certain pesticide p on the organoleptic qualities of coffee need another consideration.

As a short term means of control, fungicide screening for the control of CBD in Ethiopia st early as 1972. Since then attempts have been made to select different fungicides. Curren considered important to continuously screen fungicides against CBD in order to provide grow ample choice of fungicides that are effective, safe and cheap (Eshetu, 1990).

Among the various fungicides which, from time to time, have been subjected to experimen against CBD at Gera (Table 1), some have shown good results both in controlling the disease yield increase. Therefore, their use in the country against CBD has been encouraged.

Table 1: Tested and recommended fungicides against CBD in Ethiopia

Common Names	Trade Names	Formulations	Rate Kg/ha L/ha
Chlorothalonil	Daconil '2787'	75% W P	4.4
Prochloraz	Octave	50% W P	2.0
Chlorothalonil	Griffinil	75% W P	4.4
Cuprous Oxide	Nordox	50% W P	7.7
Prochloraz Copper Oxychloride (Proprietary Pre-mix)	Octave Super	50% W P	6.5
Chlorothalonil + Cuprous Oxide (Tank-mix)	Daconil + Nordox	75% W P + 50% W P	7.0

Apart from these, there were some fungicides which have earlier been used in the country CBD, but they have been withdrawn from use due to the reported carcinogenic effects, obsole phytotoxicity.

VELOPMENT OF CBD RESISTANT COFFEE TYPES

diversity of *Coffea arabica* L. can be considered as a corner stone for selection of resistant coffee and this has given the country the chance to have a competitive advantage to develop genotypes ant to CBD and which can best adapt to particular regions.

the out-break of CBD, significant achievement has been made in selecting resistant cultivars to and by the end of the fifth year of research, over 15 selections were identified possessing high s of resistance to CBD. From these selections, millions of seeds were released for planting and evel of resistance of their progenies under plantations were found to be as stable as their parents fin and Bayeta, 1982).

t from the major selection programme for CBD resistant coffee types in 1973, a number of tion and collection programmes have been conducted in the eastern, southern and south-western e growing regions of the country. These new selections are planted in progeny plots at different ities under conditions of heavy CBD infection so that they can be evaluated under different onmental conditions which prevail in the areas of potential use of the selections and collections heir resistance to CBD, agronomic performances and other essential characters. Moreover, these tions were also being investigated in the laboratory at the NCRC for their level of resistance to isease using inoculation of detached berries. The main purpose of widening the scope of selection collection programmes is to avoid adaptation problems and the threat of losing potentially useful types which might be realized if the heterogenous forest coffee is replaced by few resistant coffee types selected from specific localities or regions.

but not least, there are some points of emphasis regarding CBD research in Ethiopia and these s are:

Control of CBD should be directed towards an Integrated Pest Management (IPM) strategy. A strategy which entails the simultaneous or sequential use of several methods of control. Biological control as a component of IPM is of particular importance. To fulfil this objective regional and international cooperation should be sought to consolidate CBD programmes financially and with skilled and adequate manpower.

The significance of Ethiopia as a source of important diversity in Arabica coffee can be illustrated by the germplasm flow in and out of the country since historical times. But at the moment, international exchange of seeds and propagation materials to and from Ethiopia needs special consideration since it may pose a serious problem of pest introduction and dissemination risk as the quarantine service in the country lacks essential elements that would enable it to apply appropriate measures.

Interactions between and amongst scientists are crucial to the generation of new ideas and to the best possible exploitation of existing knowledge. Every effort should be made to foster mutual understanding and trust between scientists in different disciplines in Africa.

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DISCUSSION

D. M. Masaba (*Kenya*). You talked of coffee grown in gardens and forests, can you explain this

E. Derso. Small scale farmers usually have coffee which is still under forest (semi-forest) or i gardens. Under this situation, farmers are not allowed to interfere with the habitat, but t allowed to use fungicides to control CBD.

C. O. Agwanda (*Kenya*). How come small scale farmers grow susceptible coffee and gove estates grow resistant lines.

E. Derso. Resistant lines are selected from the semi-forest coffee and passed on to government to grow.

C. O. Agwanda. To protect the forest coffee, the small scale farmers should be supported to them conserve the germplasm, especially in the light of the low coffee prices.

E. Derso. This is already being done.

P. Zvoutete (*Zimbabwe*). Is there any work that has been carried out to identify races of th pathogen?

E. Derso. None.

N. Nkouka (*OAU*). How are the plant quarantine regulations in Ethiopia?

E. Derso. At the moment not clear regarding coffee.

A. W. Mwangombe (*Kenya*). What technique do you use to screen coffee lines for resistance to

E. Derso. We use detached berry test in the laboratory and attached berry test in the field. Hy screening test was not found to be consistent in Ethiopia.

D. M. Masaba (*Kenya*). This is contrary to the results and experiences in Kenya as w consistently found the hypocotyl technique to be more correlated to attached berry test, a detached berry test to be very inconsistent in infection results.

COUNTRY REPORT: ZIMBABWE

COFFEE BERRY DISEASE IN ZIMBABWE

P. ZVOUTETE

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CBD OUTLOOK

Coffee Berry Disease was first reported in Zimbabwe in 1985 and has now been confirmed o of the thirty coffee farms in Mashonaland, West Province in Northern Zimbabwe. The mai growing areas in the Eastern Highlands which account for 90% of the country's coffee produ at the moment free from the disease. The main coffee variety grown, cv SL 28, is susceptible The other varieties cvs Caturra and Catimor, are moderately resistant. The disease was rec not being serious during the last two growing seasons (1991/92) because of the drought the experienced. Yield losses vary from year to year and from plantation to plantation dependin age of the crop, management, variety grown and prevailing climatic conditions. Yield losse CBD vary from less than 10% to more than 60% in some plantations.

The strain of the causal fungus, *Colletotrichum kahawae* in Zimbabwe appears to be identic one elsewhere in Africa according to tests carried out by IMI.

There are a few fungicides commonly used by farmers to control CBD in Zimbabwe and these anilazine (Dyrene), Captafol, Copper Oxychloride and Chlorothalonil. Within the country, qu measures are in place to regulate coffee movement from the CBD infested areas.

NATIONAL COFFEE RESEARCH PROGRAMMES

Coffee research is carried out at Chipinge Research Station in Chipinge and on some priva farms. Plant protection aspects are researched on by Plant Protection Research Institute There are also some agro-chemical companies who screen pesticides for control of coffee p diseases. Chipinge Research Institute carries out physiological and agronomic research. Th Growers Association (CGA) also supports research on coffee.

Current general coffee research programmes include the following:

A. Agronomy/Physiology Programmes

1. Irrigation trials
2. Planting depth trials
3. Variety trials
4. Row orientation trial
5. Plant growth regulators (PP 333)

Plant Protection Programmes

1. Chemical control of Antestia bugs
2. Leafminer insecticide trial
3. Leaf rust fungicide screening trials
4. CBD fungicide screening trial
5. Study of the effect of canopy on CBD development and dispersal

SONNEL WORKING ON CBD

e is a Senior Research Officer working on CBD but he is currently on study leave. Other logists at PPRI assist in CBD research. There are two Research Technicians working on CBD. A e pathologist was recently engaged and will be based at Chipinge Research Station. She is eted to take up all responsibility for coffee disease including CBD. There are crop protectionists agro-chemical companies screening fungicides against the disease.

RASTRUCTURE

ties at PPRI used for pathological research on other crops are also available for CBD work. of the work is carried out on private farms in the CBD quarantine area and the land is usually ed with assistance of CGA. The work is financed principally through a government vote to PPRI lant disease research. CGA periodically supports some projects in coffee.

EARCH STATIONS

bulk of coffee research is done at Chipinge Research Institute in Chipinge in Eastern Zimbabwe. ever, there is no CBD research at CRI because the disease has not been reported in this region. work on CBD is carried out mainly at Magunje Sub-station while laboratory work is at PPRI in re.

CUMENTATION FACILITIES

personnel have easy access to university and other libraries but these institutions do not have sive literature on coffee. CGA also provides information bulletins to PPRI on request. PPRI has with IMI in UK; CIFC in Portugal and Coffee Research Station in Kenya.

ENTIFIC EXCHANGE

e are negligible regional scientific exchanges, plant material exchanges and any other form of eration with PPRI. There are some plant material exchange between CRI and coffee research ons in the region.

TRANSFER OF SCIENTIFIC RESULTS

Scientific data generated by PPRI and indeed by the whole Department of Research and S Services (DR&SS) is transferred to the user communities principally through an agricultural e department, the Department of Agricultural and Technical Extension (AGRITEX). There ar committees comprising the two departments which meet periodically to review agricultural programmes. PPRI researchers conduct training courses for AGRITEX staff to update them pests and diseases. The different institutes under DR&SS produce annual reports wh distributed to AGRITEX's regional offices and any other interested bodies. Plant pr information is also disseminated through PPRI sub-stations which are located in some of the p growing coffee. There are also periodic meetings with commodity based associations such as C

Although the structures exist for dissemination of data, in practice the coordination is co weak and the impact is therefore less than can be achieved.

CONSTRAINTS AND NEEDS IN CBD RESEARCH

Agricultural research in Zimbabwe is bedeviled at present with many limitations. The major c in CBD research is limited finance leading to transport problems, inadequate research mate equipment and reduced scientific exchanges. Until recently, there was no pathologis responsible for coffee research in Zimbabwe. The officer carrying this responsibility also ha major crops to research on resulting in inadequate attention being accorded to coffee. There for an equipped mini-laboratory to handle CBD research in the quarantine area to re likelihood of spreading the disease and to alleviate the acute transport problems.

NEED FOR REGIONAL AND INTERNATIONAL COOPERATION

Zimbabwe feels that there is a strong case of regional collaboration as CBD is a common pr Africa. The collaboration could take the form of germplasm exchange and evaluation, field and epidemiological behaviour of the disease in the region. Collaboration may also enable in in CBD research by the international community to be spread across a range of beneficiary co

DISCUSSION

Responding to participants' reaction to the report, the country's representative, Mr. P. Z commented that:

- Both coffee berry disease and coffee leaf rust attained economic threshold levels under fa weather conditions. Use of fungicides was justified as a short term solution to the However, long term control depends on breeding for resistance.
- Trials on growth regulators were aiming at establishing effect of the substances on yield.
- Traditionally, chemical firms in Zimbabwe have been conducting screening and demo trials of their pesticides on several crops, coffee inclusive. However, the government checks the results obtained by the chemical companies.

COUNTRY REPORT: MALAWI

COFFEE BERRY DISEASE IN MALAWI

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INTRODUCTION

After tobacco, tea and sugar, coffee ranks forth among important export crops in Malaw contribution towards agricultural export earnings is currently estimated at approximately 5.6%.

In Malawi, the total area under coffee is approximately 5,000 hectares, out of which 1,800 ha is the smallholder subsector mainly in the Northern Region whereas the remaining 3,200 is under e mostly in Mulanje and Thyolo Districts (see Fig 1). Total production of green coffee is about MT.

COFFEE MANAGEMENT SYSTEMS AND DISEASE LIMITATIONS TO COFFEE YIELD IN MALAWI

Coffee in Malawi is grown under two main management systems:

(i) The low input low output management systems which is mainly practised by the smalll coffee farmers. Under this system, the farmers apply limited amounts of inputs su pesticides and fertilizers. Under such a management system, diseases are usually endemi

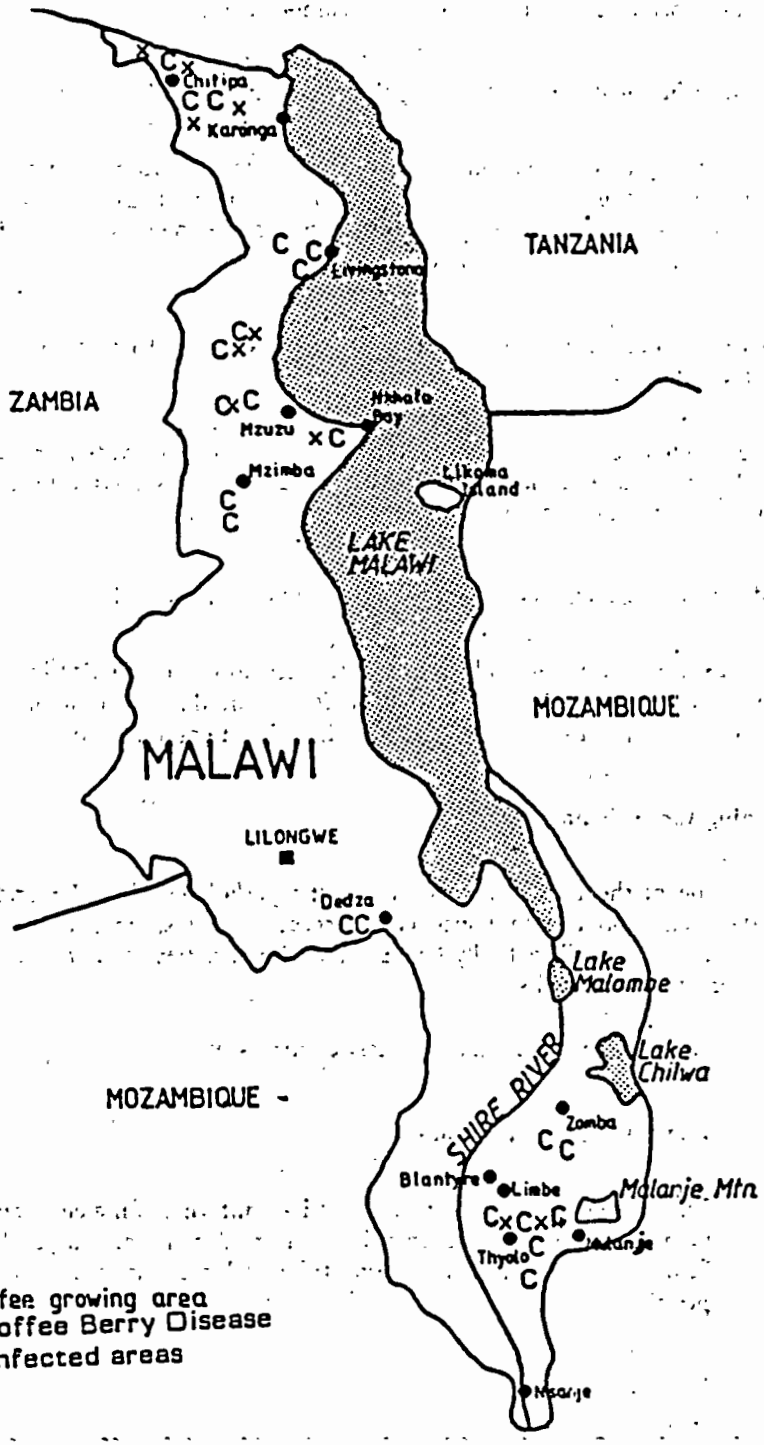
(ii) The high input high output management system which is mainly practised in the e subsector. Under this system, a lot of pesticides are applied resulting in good diseas insect pest control. However, from 1992, the estate subsector has been trying to move from this kind of management system because of low coffee prices on the world market.

Coffee Leaf Rust (CLR) and Coffee Berry Disease (CBD) are currently the two main disea economic importance. CLR has been the major disease in the south where most coffee is grown high input high output management system. The major control method has been through the preventative and/or curative fungicide sprays. On the other hand, CBD has been the major d problem in the north. As indicated earlier, inadequate application of fungicides by the latter gr farmers appear to be the main reason for the high disease problem. It is important, therefore cheaper control measures are found for the smallholder sector.

COFFEE BERRY DISEASE DISTRIBUTION IN MALAWI

CBD in Malawi was first confirmed in the Norther Region (Kishyombe and Mainjeni, 1986) smallholder coffee sector. Since then, it has spread to most smallholder coffee areas namely, M Hills, Viphya North and Nkhatabay Highlands (Fig 1). Until 1991, CBD was confined smallholder coffee plots in Northern Malawi. The occurrence of the CBD on coffee at Mban Estate, Thyolo District (Fig 1) in 1991 marked the first threat to the coffee industry in Sou region, particularly under estates management. Recently, CBD has also been observed on ar estate. Of late, more and more estates have been affected. In a recent survey (Phiri and Ma unpublished), three more estates have been identified to be affected in the south. The disease is

hreat to the coffee industry in Malawi. The reduction in inputs by most large coffee farmers brought out by the low world coffee prices is a very unhealthy state as this may lead to unchecked spread of disease. This implies that the CBD is now in both smallholder (North) and estate (South) coffee tors.



gure 1: Map of Malawi showing coffee growing areas

RESEARCH ON COFFEE BERRY DISEASE: DISEASE CONTROL STRATEGIES

The research programme on CBD is fairly young because the disease has not been in the countr long time.

The main research priorities are (not in order of importance):

(i) **Screening fungicides for efficacy against CBD in Malawi**

This is mainly to test the fungicides recommended in other countries for their effecti under Malawi conditions. New fungicides on the market are also included for evaluat addition, work on fungicide spray frequencies is also being conducted in order to det optimum number of sprays per season.

(ii) **Laboratory and field screening of varieties/lines and individual coffee plants for resistance to CBD**

This area includes work on field selection (selection of individual trees which show resi in coffee gardens and their progeny are subjected to preselection tests for confirmation work is starting this season - seed collection is in process.

(iii) **Study of epidemiology of *Colletotrichum kahawae* in Malawi**

In this experiment, we intend to look at the development of CBD in relation to the pre weather conditions in Malawi. This is in view of the difference in climatic conditions b Malawi and countries where such studies have been conducted before.

(iv) **Breeding for resistance to CBD**

This is one of the research areas where the pathologist, breeder and the agronomist together. The coffee pathologist will be screening lines, varieties and progeny from while the breeder will actually be breeding the varieties, and the agronomist will be them for agronomic traits.

Other research activities related to CBD control are:

(i) **Fungicide spray technology**

This research activity is for testing different fungicide spraying equipme manually operated Knapsack sprayer (commonly used by smallholder farmers), ULV, and motorised (high volume) sprayers. This work is not o priority.

(ii) **Cultural control**

In this aspect, we intend to monitor the development of CBD in a pruning (including free growth) and population (spacing) experiment. The aim is to i pruning systems which do not create favourable conditions for the developm and spread of CBD.

ED FOR COLLABORATION IN CONTROL OF COFFEE BERRY DISEASE

laboration in CBD is extremely essential to avoid duplication of work, and for proper use of scarce ources. Collaboration is already effective in Africa such as in research on Root and Tubers, ghum, Quarantine analysis and in Red Locust control just to mention a few research areas.

gested areas of collaboration could include the following:

- Exchange visits
- Workshops
- Exchange of plant material/technology including reports
- Training - short term particularly for technical staff

ONCLUSION

conclude, this report indicates that the occurrence of CBD in Malawi both on the smallholder and ates sub-sectors, pose a new threat to the whole coffee industry in the region. In the short term, inly due to escalating cost of chemicals and the general reservation on the use of chemicals rldwide, evaluation of fungicides for the control of CBD appears to be the immediate solution to problem. However, in the long term, the aim should be to develop disease resistant varieties like iru 11 which was developed in Kenya. Limited work on these lines has just started in Malawi but expertise is not adequate. This is where a joint effort through a research network to combat eases of economic importance, would be very beneficial to the Coffee Industry in Malawi.

SCUSSION

e report was given after the meeting because the representative for Malawi did not attend.

COUNTRY REPORT: RWANDA

SYSTEM OF RESEARCH TO CONTROL THE COFFEE BERRY DISEASE (ANTHRACNOSE) IN RWANDA

ANDRÉ SIBOMANA

Offices des cafés, B. P. 104, Republiaue Rwandaise

1. GENERAL INTRODUCTION

Presently, Rwanda has 117,000,000 coffee plants and 700,000 coffee farmers. This rep an average of 167 coffee plants per farmer. The whole coffee cultivation of the cou practised in private family estates.

The export of coffee contributes for more than 70% of the national export earnings.

The country produces an annual average of 35,000 tonnes of arabica coffee for expo only 600 tonnes of robusta.

Coffee Berry Disease (Anthracnose) has been in Rwanda for a long time and is fo many regions of the country but more significant damages are found in the coastal reg important rivers of the country. These are zones where the humidity is very high especi sanders where fog often covers the hills up to about 10 a.m.

The fundamental research on coffee has not experienced much progress at the level Research Institute (ISAR) due to lack of adequate staff (Researchers and Technician their instability. Similarly, financial and material means have been insufficient. Few ac have been carried out concerning screening tests fertilization, farming methods a phytoprotection against coffee bugs (*Antestiopsis lineaticolis*). The document a research orientations of the National Pilot Coffee Research Plan (1990 - 2000).

The Coffee Board started a massive campaign in 1989 to fight this disease through the of copper oxychloride. Also a research-development programme was undertaken to t different fungicides capable of eradicating this disease. This concerns mainly oxychloride, Dacobre, Topain, Kocide and Daconil.

2. NATIONAL RESEARCH PROGRAMME ON COFFEE IN GENERAL AND ON ANTHRACNOSE IN PARTICULAR

2.1 Constraints

2.1.1 Pests and Diseases

- the coffee bug is the most destructive pest (*Antestiopsis lineaticolis*)
- leaf rust (*Hemileia vastatrix*)
- anthracnose (*Colletotrichum kahawae*)
- die-back on old plantations on poor soils

2 Farming Practices

- lack of mulch materials
- bad pruning
- poor soil fertility
- very poor crop density especially in aged plantations

3 Post-harvest Technology

- Bad conditions of pulp removal and drying which have a high influence on the quality of coffee for export.

Objectives of the Research

Since coffee represents the main export crop of the country, efforts in research and extension work must always be undertaken to find solutions to the different production constraints. For the period 1990 - 2000 research must be centred on the following objectives:

- getting early high-yielding varieties;
- obtaining resistant varieties or tolerant to the major pests and disease;
- acquisition of varieties adapted to the different coffee producing areas;
- obtaining varieties whose organoleptic characteristics comply with world market norms;
- implementation of farming methods adapted to agro-ecological conditions of the main production areas: density, pruning, soil shading, fertilization and other appropriate cultivation systems;
- the use of methods to control the main coffee pests and diseases;
- obtaining post-harvest technologies to improve the quality coffee.

Research Activities

.1 Screening and varietal improvement

Germplasm

- Maintenance and enrichment of the collection at the Institute of Agricultural Sciences in Rwanda (ISAR).

Screening

- Screening of resistant or tolerant varieties to rust and anthracnose.
- Screening of early high-yielding varieties adapted to large producing areas.

2.3.2 Farming Methods

- research on the type of mulch and the optimal mode of application with respect to producing areas and taking into account the local availability of soil covering mater
- carrying on with research on living mulch;
- carrying on with research on a better population density according to the ty varieties (normal habit, reduced habit) and the agro-ecological production zones;
- carrying out with research for the increase of the density of old coffee pla interplanting young coffee plants;
- comparing the pruning techniques used in Rwanda and elsewhere (East Africa);
- making a synthesis of available data on coffee plants fertilization in the count evaluating the yield on production;
- research on methods adapted to the regeneration of old coffee plants

2.3.3 Crop Protection

- epidemiological studies;
- determination of the effect of incidence on production;
- availability of tolerant or resistant varieties
- experimenting new control and prevention possibilities and evaluation of their ef yield

2.3.4 Post Harvest Technology of Coffee

- Improvement of post-harvest techniques and assessment of their economic impact.

2.3.5 Production of Basic Seeds

- Dissemination of new varieties by OCIR

3. RESEARCH STAFF IN COFFEE PROGRAMME IN GENERAL

- **Researchers:** No specific researchers are attached to the research on coffee anthra
- Presently, two researchers work in the programme. Two additional researchers wo assigned to the programme as scheduled.
- Specialists in the following fields would be called in on full or part-time basis:
  - Phytotechnology
  - Screening
  - Entomology
  - Phytopathology
  - Technology

- Part-time researchers are available for entomology and phytopathology.
- **Technicians:** Presently the coffee programme has two technicians.
- The number of technicians would double that of permanent researchers making 8 technicians.

INFRASTRUCTURES

The Research Institute (ISAR) has a certain number of well-equipped laboratories to carry out its functions conveniently. These are support units to the different programmes including that of coffee. This includes mainly the laboratories of: General Agricultural chemistry, Soil Chemistry and Physics, Phytoprotection, Microbiology, Food Technology, *in vitro* Cultivation, Biometry, Climatology Service and Documentation Service.

ISAR has enough land on its stations to carry out tests.

The programme is financed by the Government of Rwanda and the French Development Fund.

RESEARCH STATIONS

ISAR has four stations (Rubona, Tamira, Rwere and Karama) but the activities of the coffee programme are carried out only at Rubona South of the country. Meanwhile, tests on the different themes are carried out also in other sites of the country namely: Mayaga (South), Banks of Lake Kivu (West of the country), Mutara (North-East) and Bugesera (Centre-South).

AVAILABILITY OF DOCUMENTATION

Research documents are kept at the Rubona centre and at the library of the National University, Rwanda. Furthermore, the Institute (ISAR) subscribes to international reviews and periodicals on coffee research.

SCIENTIFIC EXCHANGES

These exchanges are fairly intensive: training, refresher courses and seminars in different countries especially the USA, France (IRCC), Kenya, Portugal. Exchange of plant materials is also advantageous and ISAR has in its collection, plant material from Portugal, Burundi, Brazil, Ethiopia and Kenya.

Co-operation is done with IRAZ and National Research Institutes of the CEPGL countries.

TRANSFER OF TECHNOLOGIES AND THEIR IMPACT ON THE FIELD

The transfer of technologies is ensured by extension human resources of the Ministry of Agriculture: transfer of senior staff to operational units assisted by specialized technicians in coffee (belonging to the Coffee Board).

The general assignment of extension senior staff is as follows:

- Identification of regional potentials and constraints in agricultural development.
- Drawing up sub-sectorial policies compatible with regional regulations.
- Establishing realistic regional agricultural development programmes.
- Management of communal services.

In addition to these planning and programming activities of regional agricultural extension service staff are responsible for the following technical activities:

- Organizing research-development activities (analysis of farming techniques as w study of motivating farmers technically and economically);
- Undertaking the training of communal staff;
- Supervising activities.

Responsibilities during the process of development and transfer of technologie follows:

a) Diagnostic phase

This phase concerns collaboration between the Research Institute, extension struct farmers. This diagnostic is integrated within a precise framework which must be from the onset. Once farming exploitation systems and their constraints are kn possible to formulate solutions to these constraints. Some solutions shall be foun from new developments already in use and only the verification of adaptation faci suffice. Other constraints will be dealt with through specific research in research stati

b) Tests in stations

These tests, given the scientific rigour required to carry them out, must be u responsibility of research.

c) Multilocal tests

These tests are carried out to take account of the different environmental conditions to ensure the success of innovations to disseminate. In order to attain this objecti tests are conducted at the local level, on permanent multilocal sites or with farmer for this purpose.

Presently, these tests are under research but proposals have been made to improve by making the extension resources take part in the tests which shall be established at of official units.

d) Adaptation tests

These are control tests of acceptability which are carried out to verify the pertinen innovation according to the conditions of the different exploitation technologies, o scale with a rigorous but simple protocol, which must be drawn up jointly with resear

The first responsibility of these tests come under the extension structure.

e) Demonstration and follow-up of themes

This phase is done through a demonstration training activity centred on identified th is the responsibility of the extension structure. It will enable one to adopt recommended solutions.

For this last case, a feed-back of research is indispensable, hence it is equally necessary that the protocol of demonstrations be submitted for research approval also.

CONSTRAINTS

- The research staff is still insufficient and unstable. It suffices to undertake a career in research.
- All researchers must benefit from the 3rd cycle university training.
- The financing of research is not consistent. The coffee sector must support the research programmes relating to coffee in order to ease the granting of all necessary material means.

DISCUSSIONS

A. Sibomana (*Rwanda*). In Africa there are many regional organizations for instance in March 1993, a network on coffee was established in London by IACO. Then we have the OAU. How are the two going to work together?

N. Nkouka (*OAU*). We shall look at this observation under collaboration.

D. M. Masaba (*Kenya*). I have heard of this cultivar called Jackson five. How is its spread in Rwanda?

A. Sibomana. Jackson two and three other cultivars are widely grown but Jackson five is not yet recommended to the farmers. One of the four cultivars is highly susceptible to CBD.

C. O. Agwanda (*Kenya*). Some of the cultivars in Rwanda are highly susceptible to CBD. Are you trying any other coffee materials from Kenya, Tanzania, etc?

A. Sibomana. Yes, but still under evaluation.

COUNTRY REPORT: CAMEROON

PRESENTATION ON ARABICA COFFEE BERRY DISEASE (ANTHRACNOSE) IN CAMEROON

J. BAKALA

IRA/CRA de Nkolbisson, B. P. 2067, Yaounde, Cameroon

GENERAL SITUATION

Arabica coffee is cultivated in family plantations in Cameroon in altitudes ranging from 1,200 m in the high plateaux of the West and North-West Provinces. This crop covers an area of 16 with a yield of about 20,000 tonnes of coffee every year for export.

The Coffee Berry Disease (Anthracnose) caused by *Colletotrichum kahawae* Waller & Brid most serious disease which attacks this crop.

Known in Cameroon since 1958, this disease is very serious in areas above 1,500 m in altitud with a favourable climate, it destroys about 60,000 ha of coffee plants and causes a loss in pr of 80%.

This loss is so high because the plantations in high altitudes are almost exclusively made u Jamaican variety which is very susceptible to this disease.

Damages which the disease causes in lower altitude (1,200 - 1,500 m) regions are of minor im because it occurs in an uneven manner being more serious in micro-climate regions with humid mountainous climate.

Associated food and garden crops now yielding much more money than coffee constitute major handicap to this crop.

RESEARCH PROGRAMME ON ARABICA COFFEE

The objective is to improve the quantity and quality of Arabica coffee production. In order to these goals, work has been under way since almost twenty years now in the following areas:

Genetics - Screening (Varietal tests, hybrid tests, interspecific hybridization, etc ...)

Screening criteria include: vigour, early maturity, productivity, anthracnose and rust tolerance, resistance and the quality of coffee for export.

Agronomy

Tests for the improvement of cultural techniques, density tests, pruning tests, soil protection mulching or cover crops and fertilization.

tosanitary protection

emical control of antestia, coloborrhis and defoliatory caterpillars. Study of the sensitivity of plant erial vis-a-vis anthracnose and rusts, chemical control of these diseases.

hnology-Biochemistry

dy of the "stinky bean". The production of coffee quality maps.

ATION - INFRASTRUCTURE, EQUIPMENT AND FINANCING

search on anthracnose is carried out in two research stations and one research unit:

The Nkolbisson Agricultural Research Station, situated in Yaounde at about 300 km from the arabica area;

The Foumbot Agricultural Research Station situated in the arabica area at an altitude of 1,200 m;

The Santa Research Unit situated in the arabica area at an altitude of 1,900 m and at about 50 km from the Foumbot Station.

ereas the Santa Unit harbours only collections and test fields, the Foumbot Station has a field oratory and basic necessary equipment for a phytopathologist.

e Nkolbisson station has a well equipped laboratory where a variety of research work in topathology can be performed.

to 1987, the working budget of the Coffee Programme in general, and research on anthracnose in ticular, was supported by the Cameroon Government but with the economic crisis now plaguing country, this budget does not exist any more. However, a lot of work has been shelved awaiting cution except fungicide tests intended for chemical control which are financed from time to time by ticide firms or pesticide distributors. It is through this irregular financing that few field operations e been undertaken.

TAFF WORKING ON ANTHRACNOSE

have two phytopathologists, two technicians and about 10 field workers working on anthracnose in different research structures.

OCUMENTATION

ere is a well equipped and easily accessible library at the Nkolbisson Agricultural Research Station ich, of recent, was receiving numerous scientific journals from countries where research on arabica fee is undertaken. But since we started experiencing the economic crisis, only some rare journals being received. The purchase of most of these periodicals requires funds which we do not have more.

CO-OPERATION - EXCHANGE AND TRAINING

Concerning research on arabica coffee, the Institute of Agricultural Research maintains sol close co-operation ties with CIRAD - ICP which has always placed expatriate researchers disposal to achieve certain research work.

We carry out exchange of plant material with all countries producing arabica coffee in the world

Besides CIRAD, we cooperate with the university of Yaounde within the framework Biotechnology Centre where presently, studies on early anthracnose tests are underway. Two research projects on this same disease are in preparation with the cooperation of ORSTO Portugal (CIFC, OIERAS Portugal) respectively.

Junior staff in the laboratory and those who carry out field observations receive in-service trainir

Our researchers and technicians are trained in national or foreign universities through CIRAD Schools of Agriculture in the country respectively. Refresher and short term training courses levels are scarce.

DISSEMINATION OF RESEARCH FINDINGS ON ARABICA COFFEE

Counselling to arabica coffee farmers is ensured by two powerful cooperatives and the trad extension services of the Ministry of Agriculture with which the researchers maintain clo through visits and training for the transfer of research findings to the beneficiaries. Phytos chemicals purchased every year are recommended after research tests have been carried out joi all the parties concerned.

CONSTRAINTS RESEARCH NEEDS ON ANTHRACNOSE - COMMENTS AND RECOMMENDATIONS

One single constraint has shelved research on anthracnose in Cameroon. This constra economical. The sharp drop in the price of coffee and other basic products of our country is responsible for the economic crisis which is hitting us. This economic disorder does not m possible either to our Government or to financing bodies to invest on research on the basic pr in general and on arabica coffee in particular.

The price of coffee in the world market must therefore be increased because this is the one an condition which may enable the rehabilitation of the arabica crop in general and look for fur research on anthracnose which is our major constraint in the production of arabica coffee.

For the past years, the African International Scientific Community is becoming more and more that Unity is strength and it is finally necessary to unite and co-operate in order to find soluti the problems of our agriculture which is the pillar of our economies.

Promising initiatives have been taken and many technical networks have been set up. Unfortu many of these networks are not existing due to lack of funds to revive them and especially to their researchers work. This is why we think that as far as the process of Scientific Co-operat Africa is concerned, we should not only create networks but we should also look for funding ag to keep them alive.

SCUSSIONS

Bakala indicated that farmers preferred organics such as Chlorothalonil over copper based mulations due to less labour requirements by the former during fungicide application in the field. e reduced number of sprays of the organic fungicides relative to copper formulations did not seem lead to higher disease incidence.

GENERAL DISCUSSIONS ON ALL REPORTS

The participants noted the need to observe information emanating from FAO/WHO conc banned pesticides. They also shared a common view that installation of a data base system facilitate easy communication between scientists and subsequently help in the standardizat research techniques on common problems.

P. Zvoutete (*Zimbabwe*). Zimbabwe has strict quarantine measures within the country. No coffe zones with CBD is allowed to move to zones with no CBD record.

N. Nkouka (*OAU*). How many countries have quarantine stations?

- Kenya - Muguga
- Zimbabwe - Harare
- Tanzania - TPRI - Arusha
- Ethiopia - Addis Ababa

D. M. Masaba (*Kenya*). CBD was reported to be more serious along the coastal area in Cam what may be contributing to this?

J. Bakala (*Cameroon*). It is probably the high relative humidity coupled with relatively temperatures 20 - 24°C.

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