AFRICAN AGRICULTURAL TECHNOLOGY FOUNDATION

Report of Small Group Meeting (SGM)

ON

Improved Production of Bananas and Plantains in sub-Saharan Africa

THEME

Agricultural Technology Interventions for Increasing the Production of Bananas and Plantains in sub-Saharan Africa

22nd August 2003

Hotel Equatoria

Kampala • Uganda

SPONSORS

African Agricultural Technology Foundation ◆ The Rockefeller Foundation

United States Agency for International Development ◆ Makerere University

Participants in the Improved Production of Bananas and Plantains in Sub-Saharan Africa Small Group Meeting
Held 22 August 2003 at Hotel Equatoria, Kampala, Uganda

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LIST OF ABBREVIATIONS

AATF	African Agricultural Technology Foundation
ACAF	Advisory Committee on Animal Feeding
ACNFP	Advisory Committee on Novel Foods and Processes
ACRE	Advisory Committee on Releases to the Environment
AFPs	Antifreeze proteins
ARIPO	African Regional Industrial Organization
ARIs	Advanced Research Institutes
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BARNERSA	Banana Research Network for Eastern and Southern Africa
CARBAP	Centre africain de recherches sur bananiers et plantains (Cameroon)
CBOs	Community based organizations
CGIAR	Consultative Group on International Agricultural Research
CIRAD	Center for International Cooperation in Agronomy and Warm Climate Research (Centre de coopération internationale en recherche agronomique pour le développement)
COMESA	Common Market for Eastern & Southern Africa
CORAF	Conférence des Responsables de recherche agronomique Africains
CSIR	Council of Scientific and Industrial Research
CSO	Community Service Organisations
EAHB	East African highland bananas
ECA	Economic Commission for Africa
EPO	European Patent Organization
EU	European Union
FABI	Forestry and Agricultural Biotechnology Institute (University of Pretoria)
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
GM	Genetically modified
GMO	Genetically modified organism
IEHA	Initiative to End Hunger in Africa
IITA	International Institute of Tropical Agriculture
INIBAP	International Network for the Improvement of Banana and Plantain
IP	Intellectual property
FTO	Freedom to operate
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated pest management
IRAZ	Institut de Recherche Agronomique et Zootechnique
JIC	John Innes Centre
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARI	Kawanda Agricultural Research Institute
KIPI	Kenya Intellectual Properties Institute
KUL	Katholieke Universiteit Leuven
MUSACO	Réseau Musa pour l'Afrique Centrale et Occidentale
NARIs	National Agricultural Research Institutions
NARO	National Agricultural Research Organization
NARS	National Agricultural Research System
NEPAD	New Partnership For Africa's Development
NGOs	Non-Governmental Organizations
OAPI	Organisation Africaine de la Propriete Intellectuele (Yaounde)
OECD	Organisation forEconomic Cooperation and Development
PBR	Plant breeders rights
PSO	Private service organisations
QUT	Queensland University of Technology
RCSA	Recruitment and Consulting Services Association Ltd
REDSO	Regional Economic Development Services Office
SADC	Southern African Development Community
SACCR	Southeastern Association of Community College Research
SROs	Sub-regional organizations
TFs	Task forces
UK/DFID	United Kingdom Department For International Development
UKPO	United Kingdom Patent Office
UNEP-GEF	United Nations Environment Program-Global Environment Fund
UPOV	Union for Protection of New Plant Varieties
USAID	United States Agency for International Development
USPTO	United States Patent and Trademark Office
WARP	West African Regional Program
WHO	World Health Organization
WTO	Word Trade Organization

EXECUTIVE SUMMARY

The African Agricultural Technology Foundation (AATF) in collaboration with Makerere University, the United States Agency for International Development (USAID) and The Rockefeller Foundation organized a Small Group Meeting (SGM) of experts on improved production of bananas and plantains in sub-Saharan Africa (SSA) and held it on 22nd August 2003 at Hotel Equatoria, Kampala, Uganda. The meeting was organized a day after a larger meeting on transformation technologies of bananas and plantains organized by IPGRI-INIBAP/NARO/IITA. The SGM considered issues involved in increasing the production of bananas and plantains in sub-Saharan Africa under the theme "*Agricultural Technology Interventions for Increasing the Production of Bananas and Plantains in sub-Sahara Africa*". Bananas and plantains are a major food crop for many African countries. There are two major banana production systems in Africa: East African highland cooking & beer bananas and the plantain production systems in West Africa. Scattered in some countries are the dessert banana systems. There are also issues of clean planting materials, value added products, ripening and shelf life, biofortification and biopharming. The meeting considered all these issues including issues relating to intellectual property rights (IPR), marketing and trade, key role players and project concept note development among others.

The AATF mission is to provide access to agricultural technologies, materials, and knowledge for smallholder producers in sub-Saharan Africa to improve food security and alleviate poverty. The AATF, therefore, aims at improving food security and reducing poverty of smallholder farmers in sub-Saharan Africa by facilitating public-private partnerships that provide access to agricultural technologies, materials and know how and that facilitate existing institutions along the value chain to ensure delivery of products to African farmers and create sustainable markets.

Dr. Terry was particularly happy that members had come to the Small Group Meeting discussion on agricultural technology interventions for improved banana and plantain production in sub-Saharan Africa. He reported that the Bananas/Plantain Project was one of the projects to be used to test the AATF concept of project development sequence. The Project portfolio development was to be developed through participatory process to enhance institutional synergies and optimise resource use. He presented the project flow diagram and AATF pilot project prioritization matrices. He expected that this Kampala Small Group Meeting would draw many lessons from the experience of the East African highland bananas (EAHB) biotech meeting. This SGM would have its major out put as:

- Establishment of a Project Technical Steering Committee (TSC);
- Identification of key participants for project formulation and implementation;
- Defining possible project components/activities (from EAHB meeting discussions).

Prof. Rubaihayo presented a paper which showed the production of bananas in Africa region and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) prioritization of biotechnology interventions for constraints of banana production in the sub-region. He suggested that soil fertility, water stress, and poor management were among the major constraints frustrating sustainable banana and plantain production in SSA.

Dr. Frison said that biotic stresses are a huge problem in banana and plantain production in SSA. The major problems include fungal diseases, such as black sigatoka disease and nematodes especially the migratory nematodes. Host plant resistance might overcome most of these constraints. Although genes have been identified, there is a need to indicate the problems in Africa which can be addressed using the gene technology developed elsewhere. He advised that production of bananas and plantains should continue to focus on biotic and abiotic constraints.

Dr. Shah and Prof. Atkinson presented the major banana and plantain production biotic constraints. Dr. Shah suggested that so far there were no molecular technologies developed for control of banana streak virus although research was continuing. Prof. Atkinson said that field-testing of new exogenous cystatin expressing genetically modified banana lines was in progress. Both presenters presented the

short- to long-term solutions to biotic constraints in matrices. The need to identify specific areas of new technologies together with other existing technologies was stressed. It was agreed that a problem-solving approach rather than product development approach was needed if the problems of SSA were to be addressed.

Prof. Kahangi said that with the success in production of adequate clean planting materials the current problems faced include distribution of planting materials to farmers and information dissemination. The impact of the project has been reduced importation of banana and plantains, increased farmer incomes and enterprise diversification, e.g. entering into agro-processing of the produce including bananas. She said that there was need, therefore, for processing technologies to cope with the production so as to increase the shelf life of the products. Marketing has also been a problem with increased production. With regard to addressing the disease problem, she pointed out the need for quick diagnostic kits so that the materials given to farmers do not carry diseases such as viruses.

Prof. Swennen indicated that East African highland bananas contribute 30% of world banana production and plantains and highland bananas are the main stable food in Africa especially in East Africa. There is need to take modern technologies with other supportive conventional technologies (e.g. technologies to address water, fertility, pests and disease problems) if the farmers are to realize full production potentials of tissue culture (TC) plantlets.

Prof. Kunert explained the major problem of vitamin A deficiency in Africa. Targeting this problem might be an excellent project for Africa, e.g. producing a "golden banana" rich in vitamin A for Africa using technology already available for rice and maize in the developing world. Prof. Heslop-Harrison was very positive about the improvement of the nutrient composition of bananas and plantains particularly considering that bananas are a critical weaning food. He was however not enthusiastic about biopharming in bananas since there would be the problems of dose control in rural areas where the crop is heavily consumed.

Prof. Olembo said that there were differences in what countries have adopted especially in regard to plant protection and few have signed the Union for Protection of New Plant Varieties (UPOV). She stressed the importance of not only focusing on producing products for the local market but also target a wider international market, thus the need for knowledge on IPR systems elsewhere and their requirements. Some countries do not allow patenting of organisms and, therefore, genes and this has to be put into consideration. She cautioned on shortening the time to get products out by acquiring technologies from elsewhere which may not work in the African situation. Stressing the need to develop own technologies locally, she gave an example of the sweet potato case in Kenya, which may not end in a product for the farmers, but observed that it has been used to build local capacity.

She pointed out that the IP issues can be territorial in nature, i.e. what is patented in say US unless patented in another country might not be under mandatory enforcement and that if the product is not protected, negotiation can be easy and cheaper as compared to protected ones. She noted that liability issues are going to be more and more important especially with cross-pollinating crops, which may not be the case in bananas. She highlighted the need to know what liability implications are associated with given technologies.

Mr Tumushabe, a member of the AATF Board of Trustees, highlighted issues that could arise regarding advocacy that need to be addressed in the process of developing a product/technology. The prevailing political economy, marker gene choice, toxic requirements of candidate genes, their gene products etc. affect biotechnology products.

Dr. Hall said that sub-Saharan Africa's food supply and nutritional gap was widening and therefore there was urgent need to: increase productivity, increase food availability, and improve product quality through:

- Increasing competitiveness of smallholder farmers in regional and global markets;
- Improving food quality and safety.

He stressed the role of regional synergies in success of agricultural growth in Africa and increased banana production in particular. He said that banana and plantains are high on the agenda and USAID is committed to continued support to the International Network for Improvement of Banana and Plantain (INIBAP) project.

Dr. Eugene Terry proposed the TOR for the TSC. He suggested that the TSC should look at problem areas in the banana/plantain production not adequately addressed by existing mechanisms/programmes and specifically where the technology would otherwise not be accessible by resource poor farmers. The proposal should yield projects, which will enhance consumer and farmer capacity to adopt advanced technological interventions and products. Project deliverables should take the interventions from research to development. The TSC was requested to submit its report to AATF and INIBAP by early 2004.

BACKGROUND

The African Agricultural Technology Foundation (AATF) in collaboration with Makerere University, USAID and the Rockefeller Foundation organized a Small Group Meeting (SGM) of experts on improved production of bananas and plantains in sub-Saharan Africa and held it on 22nd August 2003 at Hotel Equatoria, Kampala, Uganda. The meeting was organized a day after a larger meeting on transformation technologies of bananas and plantains organized by IPGRI-INIBAP/NARO/IITA. The SGM considered issues involved in increasing the production of bananas and plantains in sub-Saharan Africa under the theme "*Agricultural Technology Interventions for Increasing the Production of Bananas and Plantains in sub-Sahara Africa*". Bananas and plantains are a major food crop for many African countries. There are two major banana production systems in Africa: East African highland cooking and "beer" bananas, and the plantain production systems in West Africa. Scattered in some countries are the dessert banana systems. This crop has major production constraints including but not limited to weevils (*Cosmopolites sordidus*), several species of nematodes, leaf spot diseases particularly black sigatoka (*Mycosphaerella fijiensis*), Fusarium wilt (*Fusarium oxysporum*), bacterial wilt, various virus infections like bunch top and streak viruses, water stress and soil fertility. There are also issues of clean planting materials, value added products, ripening and shelf life, biofortification and biopharming (Appendix I). The meeting considered all these issues including issues relating to intellectual property rights (IPR), marketing and trade, key role players and project concept note development, among others.

The AATF mission is to provide access to agricultural technologies, materials, and knowledge for smallholder producers in sub-Saharan Africa to improve food security and alleviate poverty. The AATF, therefore, aims at improving food security and reducing poverty of smallholder farmers in sub-Saharan Africa by facilitating public-private partnerships that provide access to agricultural technologies, materials and know how and that facilitate existing institutions along the value chain to ensure delivery of products to African farmers and create sustainable markets.

Objectives of the meeting included:

- Identifying and prioritising technology interventions
- Defining possible projects and components
- Identifying key participants in the project
- Forming a technical steering committee to develop a project concept note

Chair: Dr. Otim Nape

OPENING REMARKS

The Chair inquired whether there was need for an introduction of the participants. He was informed by the organizers that the introduction was contained in the folders for purposes of saving time. The Chair thereafter welcomed all present to the day's meeting. He noted that the programme was very tight hence the need to stick to time schedule. He then stated that the Small Group meeting was to focus more on AATF, which most members were already informed of. The Chair expressed his appreciation for the meeting, which had taken place a few days earlier. He noted that all new ideas needed to be tied with something to be able to achieve the objectives.

Members were urged to use the day's meeting to come up with clear guidelines on the role of AATF. All speakers were urged to follow the time allocated to them and where possible to save a few minutes for more discussion. The Chair specifically welcomed all the visitors to Uganda and noted that since he had not interacted with them in the past few days, he was happy to have the opportunity to interact with them during this Small Group Meeting. The Chair also informed members that he represented NARO in the meeting. He also appreciated the opportunity to interact with the Ugandan members during the Small Group Meeting. He encouraged visitors to take the opportunity where possible to see more of the country while in Uganda.

Members were informed of the inauguration ceremony of National Agricultural Biotechnlogy laboratory at Kawanda Agricultural Research Institute (KARI) and all members present were invited to attend and provide moral support. The Chair once again thanked everybody for having found time to attend this very important meeting.

He then introduced the first speaker Dr. Terry, as a seasoned researcher on root crops, administrator and currently the implementing Director of AATF.

Presentations

1st presentation
Title: ***The AATF – a new mechanism***
Presenter: ***Dr. Eugene Terry***

Dr. Terry started by saying that he was particularly happy that members had come to a Small Group Meeting discussion on agricultural technology interventions for improved banana and plantain production in sub-Saharan Africa. He pointed out that the theme of the meeting complemented the just ended major meeting held in the past three days on biotechnology interventions for bananas and plantains. He requested the SGM to evolve ideas from technical discussions of the last 3-day meeting. He informed members that the agenda for the meeting had been changed following what had been achieved in the larger meeting in the last three days. He apologized for the changes in the programme pointing out that these changes would shape and improve the project concept note of AATF banana improvement programme.

He pointed out that one major asset for the meeting was a working version of the decision-making matrix as a basis for discussion of different topics based on banana production constraints discussed in the last three days.

He was grateful for the tireless effort of all who made it possible to have a working background to the discussion for the Small Group Meeting, Prof. Rubaihayo for local organization and Dr. Dilip Shah, Prof. Atkinson, Prof. Kunert, Prof. Heslop-Harrison and Dr. Gerald Barry who were called on short notice to develop the matrix. He emphasized that the rationale was to use the wealth of information provided in three days to formulate ideas for a project or projects to become part of the focal point of the project that AATF will seek sponsorship for. Noting that there is only one day to achieve all this, he proposed that technical discussion should not take too much time as these aspects have been captured in the matrix to be presented by Prof. Atkinson and Dr. Shah later in the day.

The AATF concept
Dr. Terry pointed out that the rationale of creating AATF was to develop an effective mechanism to negotiate access to and transfer of technology and create long-term networks to address food insecurity and poverty in SSA.

The AATF has reached a definitive stage in the pilot projects' selection process in fulfilling its mission – "to link the needs of resource-poor farmers with potential technological (biological, chemical, mechanical and process) solutions". The foundation will play, primarily, a facilitating role, working with existing institutions to enhance and complement their efforts in agricultural technology transfer. It will act as the neutral intermediary, a "responsible party", between owners of proprietary technologies and those that need them. Its priority focus will be in the accession and development of proprietary technologies, ensuring that the subsequent constraints along the value chain are adequately addressed in a comprehensive business plan.

He also pointed out that the problems of technology access and delivery for SSA created the need for:

- Effective mechanisms to negotiate the access and transfer of proprietary rights and other technology held by the public and private sectors anywhere in the world.

- Appropriate long-term networks to manage the deployment of these technologies at all stages in the value chain.

The AATF was therefore created as an African institution "owned" and led by Africans and focusing exclusively on African priorities and as an innovative private/public partnership initiative designed to harness the best practices, resources and expertise of the public/private sectors.

The role of AATF is to link needs of resource-poor farmers in SSA with potential technological (biological, chemical, mechanical, process) solutions by:

- Identifying and facilitating royalty free transfers of proprietary technologies through negotiation;
- Entering into contractual agreements with existing institutions that will manage deployment of the technologies;
- Ensuring that subsequent constraints after access are addressed.

He noted that the challenge was to understand contextual factors affecting access and transfer of technologies, pointing out the need to understand better intellectual property rights, trade rules, shifting boundaries between private and public sectors, etc.

He clarified that AATF focus is not limited to any particular type or category of agricultural technologies. However, initial focus is on staple and commodity food crops from both conventional and genetic modification, eventually cash crops and livestock depending on stakeholder needs. The facilitation role is at all stages of product value chain which include: basic research and technology transfer, adaptive research and development trials/regulatory approvals, production inputs, extension, farm production/post-harvest handling, processing, market access and distribution. Specific aspects addressed under facilitation entail entering into output-based contracts for delivery of R&D services such as:

- Negotiating high volume/lower price agreements,
- Partially underwriting market risks in the production and distribution of new products,
- Partially financing contract demonstrations of new input packages,
- Supporting related short-term market development subsidies for smallholder technology uptake.

AATF status report

The governance of AATF

Dr Terry said that AATF has a Board of Trustees chaired by Prof. J. Thompson from University of Cape Town (UCT), South Africa and one of the board members, Mr. Godber Tumushabe, was attending this meeting. Mr. Tumushabe will be taking care of advocacy issues of AATF. The number of board members will be increased to ten (10) and different disciplines would be considered including molecular biology and genetics, among others.

He reported that AATF had been incorporated as a private limited company in the United Kingdom and Kenya and developed a 10-year business plan and selected operational host country with headquarters as ILRI in Kenya. The recruitment has been initiated for five (5) senior management positions and a pilot project selection/implementation is in progress.

AATF's partners and investors

The partners and investors comprise of the Pan-African, regional and national institutions/agencies which include: New Partnership For Africa's Development (NEPAD) New Partnership for (NEPAD)/Economic Commision for Africa (ECA)/Forum for Agricultural Research in Africa (FARA)/Sub-regional organizations (SROs)/national agricultural research systems (NARS)/. The international institutions/agencies include CGIAR/ARIs. Other partners include NGOs, agricultural technology industry intellectual property holders (Monsanto; DowAgro; Pioneer/DuPont; Syngenta);

African trade and agribusiness organizations; international investors – The Rockefeller Foundation; USAID; UK/DFID and African national governments.

Funding arrangements

He stressed the fact that AATF is not a donor in the traditional sense. Core funding was for start-up costs and institutional support structures (which to-date has been coming from Rockefeller Foundation, USAID and DFID) and project development costs. Project funding requires donor-matching funds (on a project by project basis) based on well-developed business plans for project implementation.

He pointed out that AATF would provide funds to cover 75% of upstream activities and project development costs; 25% of downstream costs, and all project follow-up costs. AATF will also seek matched funding from public/private sectors-cash and in-kind from: NARIs, CG Centers, NGOs, Multilateral/Bilateral partners.

Five year funding requirements

AATF overheads and project activities
2003–2007 – US $ 21.753 million;
Approximately 50 % of this will be devoted to project activities;
US $ 11.730 million;
2003 Funding requirement – US $ 2.473 million – adjusted for late start-up.

Problem areas identified

Eight problem areas have been identified. These include: nutrition quality improvement (maize, rice); cowpea productivity improvement; insect resistance (maize); banana/plantain production improvement; *Striga* control in maize; drought tolerance in cereals; control of *mycotoxins* in food grains and sustainable cassava production.

Questions/comments arising from presentation

QN: What is the role of AATF in transfer of other technologies and meeting the required safety standards?

ANS: This is a responsibility of our partners doing the work in the relevant institutions to bring it up and show that safety concerns are addressed from the point of view of all concerned. This question can also be tackled on a project basis and discussed. The need for some external organization to verify that suggested safety measures are addressed appropriately was expressed.

2nd presentation

Title: ***Agricultural technology interventions – bananas and plantains in sub-Saharan Africa***

Presenter: ***Dr. Eugene Terry***

Dr. Terry said that the areas to be covered in the Small Group Meeting would include:

- AATF portfolio development – principles, procedures and processes
- Highest priority pilot projects
- The bananas/plantain project – one of the projects to test the AATF concept
- Project development sequence
- Timeframe

Project portfolio development
He outlined the principles, procedures and processes in project portfolio development as to ensure that:

- Technological interventions link solutions to end-user needs
- Product and project concepts to be developed through participatory process
- Projects should enhance institutional synergies
- Projects should optimise resource use
- Results should be achieved within reasonable timeframes
- Portfolio should reflect SSA geographic balance

He noted that the bananas/plantain project could be used to test the AATF concept. The critical considerations included stakeholders' consultations (e.g. SGM Kampala), consideration of project priority components for interventions e.g. biotic stresses, nutrition, etc. and consideration of timeframes for achieving results/product. He pointed out that success of the project depends on the assumption that there is donor support; technology holders; research and production partners; and market data collected (*see* Appendix II for project flow diagram and AATF value chain).

Expected outcomes – Kampala Small Group Meeting (drawing from EAHB biotech meeting)

- Establishment of a project technical steering committee (TSC)
- Identification and prioritization of technological intervention goals
- Identification of key participants for project formulation and implementation
- Definition of possible project components/activities (from EAHB meeting discussions)
- Creation of task forces for prioritization and activity definition if necessary
- Project components elaborated by task forces (TFs) and presented to larger stakeholder group
- Draft concept note reviewed by stakeholders
- Draft concept note peer reviewed
- Concept note submitted to AATF Board for approval

He noted that AATF was still on the project concept identification stage which has been done using the matrix.

Next steps will include:
Presentation of the Kampala SGM Meeting report to AATF Board which will be done in October 2003. It is hoped that the Board will approve and put on fast track Banana/Plantain Project for Implementation. It is also hoped that a larger stakeholders meeting will endorse the Draft Concept Note in early 2004. The report would then be subjected to peer review and plans for project implementation made.

3rd presentation
Title: ***Abiotic stresses***
Presenter: ***Prof. Patrick Rubaihayo***

Prof. Rubaihayo started by saying that he had prepared a paper to help on nutrition status in sub-Saharan Africa so as to indicate importance of biofortification and biopharming. The paper also shows the production of bananas in Africa region and ASARECA prioritization of biotechnology interventions for constraints of banana production in the sub-region. He advised members to pick up the handout on their way out (Appendix III).

Meeting the challenge
The presenter noted the need to contribute to the millennium development goals of reducing hunger, child mortality and ensuring environmental sustainability. He noted that the vision for African agricultural research calls for 6% annual growth rate in agriculture by year 2020. He also noted that in the last 14 years, 50% more African have fallen into poverty noting that there are 180 million sub-Saharan Africans living on less than $1 per day which is expected to reach over 300 million by 2020.

Importance of bananas and plantains

He highlighted the importance of bananas and plantains in meeting the challenge as follows:

- Provide an important food source for over 100 million people in sub-Saharan Africa
- East Africa produces 18 million tons/yr
- 20% of the world output
- Important staple food in Uganda, Rwanda, Burundi and parts of Kenya and Tanzania
- "Beer" brewing has long been an important activity among Great Lakes communities (consumption 1.2 l per capita per day – Rwanda)

Abiotic stresses

Abiotic constraints frustrating sustainable production of bananas in SSA include: soil fertility, drought/water stress and management.

He indicated that soil fertility in the lake crescent region which to most visitors would appear a fertile region was below critical levels for banana production as shown in the Table 1.

Table 1: Soil nutrients in typical lake crescent soils

Element	Typical lake crescent soil	Banana production critical values
Available P (ppm)	1.40	≥ 15.0
Total N (%)	0.09	≥0.20
Exchangeable K (cmol.kg-1)	0.36	≥0.44
Sodium (Cmol. Kg-1)	0.04	≥1.00
Magnesium (Cmol. Kg-1)	3.35	≥0.50
Calcium (Cmol. Kg-1)	8.06	≥4.00
Organic matter (%)	2.89	≥3.00
Soil pH	5.30	≥5.20

Drought/water stress

The presenter stated that banana and plantain water requirement ranges from 900–1800 mm during the growth and production cycle equivalent of 3–6.3 mm/day. He indicated that the important characteristics of the bananas in respect of plant water requirement were: shallow root system compared to other fruit crops, poor ability to withdraw water from drying soil and rapid physiological response to soil water deficit in conditions of high evaporative demand. Most of the production areas in SSA experience marked dry seasons and yet most production in SSA is rain-fed with water conservation methods hardly practised. Yield losses due to water stress have been reported to range between 30–50%. Clearly irrigation would give a quick win but has a high capital investment which is prohibitive.

The way forward

As a way forward, he suggested genetic engineering and marker-assisted selection for abiotic stresses and nutrient use efficiency to address the problems of water stress and soil fertility. He also suggested detailed study of some microorganisms such as *mycorhiza* which may help improve nutrient and water uptake by the banana plant.

4th presentation
Title: ***Introduction to biotic stresses***
Presenter: ***Dr. E. Frison***

Dr. Frison said that biotic stresses are a huge problem in banana and plantain production in SSA. The major problems include fungal diseases, such as black *sigatoka* disease and nematodes especially the migratory nematodes. Host plant resistance might overcome most of these constraints. Genetic modification of plants might be a solution to these constraints as was shown in the last three days' presentations. This topic has taken most of the last three days' time and is a major constraint to banana and plantain production in sub-Saharan Africa.

Questions/comments arising from presentations

COMM: It is important to communicate African needs/problems (biotic and abiotic stresses) to the outside world. Although genes have been identified, there is a need to indicate the problems in Africa which can be addressed using the gene technology developed elsewhere. Constraints of growing East African highland bananas are not known to the outside world, since they are only grown in certain regions of Africa.

QN: In the presentation, it seems like bacterial wilt which is another major biotic stress has not been addressed. What are the plans to halt the spread of the diseases in the region?

ANS: Bacterial wilt is a localized problem and therefore not a general African problem. Also, no genetic modification strategy is available as yet. However, a medium-term plan could take care of the disease and will be considered in future.

COMM: Bacterial wilt disease came up in Uganda about 15 months ago. The disease spread across the entire eastern and northern Uganda, creeping to the Congo. It attacks all cultivars including the EAHB, plantains and other introduced bananas. The problem is still localized in the country but may have spread to the Kisii region of western Kenya. From the rate at which the disease is spreading, it may cause a regional problem. NARO and other partners have been trying to implement a strategy, developing plans, carrying out national and regional surveys to understand what the disease is doing in the region. A task force has been looking at the strategy for the medium term to address the issue. However, there is need for short-term strategies, e.g. training farmers to contain the disease. Therefore, there is need for regional linkages and partnerships to contain the spread of the disease. There is also need for linkages with other parts of the world where the same disease exists so as to obtain technologies used to contain it. There is need to make use of tools that have been used in S.E. Asia because lessons learned on controlling the disease in Asia are very important which could be made use of. Maybe the technologies deployed in Asia could help in Uganda as well.

QN: Does the SGM consider only EAHB or also the West African plantain bananas?

ANS: All that has been discussed relates to both bananas and plantains. The meeting was to define elements in the project taking into account regional specific constraints and this was the time to bring them up.

The lake crescent region was just given as an example, however, the same situation may appear in other regions. Issues raised on pathology are really very important. There is need to ask the international community to look into this aspect. AATF is for sub-Saharan Africa, therefore, it is not biased to only a given sub-region.

QN: Abiotic stresses are controlled by many genes. What has been achieved so far for drought resistance?

ANS: Some progress has been made in identifying sources of resistance to drought-like transcription factors. Interesting results have been obtained in laboratories. Classical breeding tools are available and targeted research achieves results. Much work is being done on drought stress but products are not expected to be ready before 2010.

COMM: It was suggested that discussion should be focused on potential stresses for AATF intervention. Banana diseases and banana problems have always been discussed in seminars to develop banana disease resistant varieties, but little has so far been done. One wants to hear that plans are in place to stop the spread of banana diseases. Currently the existing diseases are devastating. There is need to devise a means of controlling the spread of existing diseases in the region. Technical interventions to address the problem have been discussed, but there is now a need to incorporate them into a project formulation. Elements of the project have to be defined since constraints and interventions have been identified and captured in the matrix. Something has been done in other parts of the world and there is hope that something will be done in future. The focus was on bananas and plantains biotic and abiotic constraints. The biotic constraints entailed black sigatoka, Fusarium wilt, nematodes, insects and bacterial wilt to be tackled at a later stage. Abiotic stresses include water stress and soil fertility. The approaches encompass both conventional and genetic modification.

Chair: Prof. Rubaihayo

5th presentation
Title: ***Diseases***
Presenter: ***Dr. Dilip Shah***

Fungi, viruses and bacteria

The presenter noted that approaches considered would be generic and work in all places across Africa. He asked members to look at the matrix as a project. He presented the matrix (Table 2).

Black sigatoka

During the 3-day meeting it was generally agreed that the most important disease for sub-Saharan Africa is black sigatoka. Technologies to be applied might be based on proteins, which have been tested in other plants. Efficiency of the technology has been shown both in the lab and field.

Fusarium wilt

Another important fungal disease is Fusarium wilt. The same technologies will be used to control the disease. Success to control the disease has been achieved in Australia where a resistance gene to the disease was found.

Banana bunchy top virus

A breakthrough has been realized in Australia, the technology is promising in the fields both in Australia and on Hawaii. However, there is still need for basic research and molecular strategies can be expected in four years or later.

Banana streak virus

No molecular technologies have been developed as yet for control of this viral disease, but research still continues.

Bacterial wilt

Breakthrough was achieved for sugarcane and citrus. Similar strategy can be used for bananas and plantains. The technology, however, uses bovine lysozyme, which brings in issues of bioethics affecting acceptability with a gene coming from an animal. Research on resistance to the pathogen will possibly be carried out in the next 2–3 years.

Table 2: Decision-making matrix on diseases

Problem area	Horizon 1-3 yrs	4-6 yrs	7+ yrs	Funding	IP sources	Ne cu act
Sigatoka complex - plantain and banana *Mycos-phaerella fijiensis* *M. musicola*	▪ *In vitro* screening of purified AFPs ▪ Field testing of existing materials from QUT, KUL and Cirad ▪ Establish consensus field trial protocols for resistance evaluation ▪ Production of new banana/plantain with new AFPs ▪ Toxicity screens of AFPs ▪ Allergenicity tests of AFPs ▪ Germplasm screening for resistance ▪ Tissue-enhanced promoter isolation and testing ▪ Isolate and confirm R genes from Musa germplasm ▪ Production of new banana/plantain with R genes ▪ Secure IP/FTO for chosen approaches ▪ Secure funding for priority approaches ▪ Ensure that regulatory climate supports the development of the products	▪ Continued field evaluation of screened materials from previous tests ▪ Development of overall deployment plan to maximize effectiveness of the materials ▪ Expansion of range of germplasm containing effective AFPs and R genes (new GM) ▪ Tissue-enhanced promoter isolation and testing (continued) ▪ Integration of germplasm and GM approaches ▪ Continued screening of germplasm for resistance ▪ Development and submission of regulatory plan for most promising lines ▪ Develop fungal resistance management plan	▪ Regulatory package completion and submission for additional lines containing 2nd generation genes ▪ Deployment of successful materials ▪ Expansion of range of germplasm containing effective AFPs or R genes ▪ Develop a sustainable IPM approach for AFP/R gene approaches	▪	▪ QUT ▪ KUL ▪ Cirad ▪ Syngenta ▪ Monsanto ▪ DOW	▪

Problem area	Horizon 1-3 yrs	4-6 yrs	7+ yrs	Funding	IP sources	Ne cu ac
Fusarium wilt – banana and plantain *F. oxysporum* f. sp. *cubense*	▪ Glasshouse evaluation of existing materials containing R gene ▪ If positive, field test lines in South Africa and Australia ▪ Test plantain banana for susceptibility ▪ If susceptible, field test materials from KUL ▪ Test new AFPs for *in vitro* activity ▪ Production of new banana/plantain with new AFPs ▪ Toxicity/allergenicity screens of AFPs ▪ Germplasm screening for resistance ▪ Root-enhanced promoter isolation and testing ▪ Secure IP/FTO for chosen approaches ▪ Secure funding for priority approaches ▪ Ensure that regulatory climate supports the development of the products	▪ Continued field evaluation of screened materials from previous tests ▪ Development of overall deployment plan to maximize effectiveness of the materials ▪ Expansion of range of germplasm containing effective AFPs and R genes (new GM) ▪ Tissue-enhanced promoter isolation and testing (continued) ▪ Integration of germplasm and GM approaches ▪ Continued screening of germplasm for resistance ▪ Development of preliminary regulatory plan	▪ Regulatory package completion and submission ▪ Deployment of successful materials ▪ Expansion of range of germplasm containing effective AFPs or R genes		▪ QUT ▪ KUL ▪ CIRAD	
Banana bunchy top	▪ Test materials from QUT in the field in Australia and Hawaii ▪ Production of new banana (PomeAAB) with resistance to BBTV ▪ Development of preliminary regulatory plan	▪ Test materials from QUT in the field in Africa ▪ Regulatory package completion and submission	▪	▪	▪ QUT	
Banana Streak Virus	▪ Basic research on para-retroviruses on Musa and other species (tobacco and petunia) ▪ Develop molecular strategies for control of BSV	▪ Introduce the BSV resistance genes into banana and plantain varieties ▪ Evaluate for virus resistance in glasshouse studies	▪ Field evaluation of putative BSV resistant lines	▪		
Banana Bacterial Wilt	▪ Monitor progress of bovine lysozyme technology in sugarcane and citrus and make a go/no go decision based on technical efficacy and public acceptability ▪ Evaluate new germplasm for resistance to pathogen ▪ Screen antimicrobial peptides for in vitro	▪ Field test materials with the most promising genes in Africa	▪	▪		

Problem area	Horizon 1-3 yrs	4-6 yrs	7+ yrs	Funding	IP sources	Ne cu act
	activity ▪ Test materials with the most promising genes in the glasshouse in Africa					

6th presentation
Title: ***Pests***
Presenter: ***Prof. H.J. Atkinson***

Prof. Atkinson informed members that the project goal developed was based on the past 3 days' discussion.

Use of cystatin as bionematicide
Prof. Atkinson highlighted the use of cystatins as bio-nematicides indicating the various activities in different horizons (Table 3).

Horizon 1–3 years would include activities:

- Field testing of genetically modified banana
- Obtaining FTO within Africa from Syngenta
- Produce large number of exogenous cystatin expressing lines
- Screen the genetically modified lines
- Establish clear benchmarks for validating transgenic plants
- Establish consensus on field testing
- Define common needs with banana weevils

Horizon 4–6 years activities included:

- Field testing of new exogenous cystatin expressing genetically modified banana lines

The need to obtain different purified Bt's and other candidate compounds for inclusion into pathology tests and screening for new bionematicidal genes/proteins in Arabidopsis was also mentioned.

Resistance genes (R-genes) and nematodes
The need for complete evaluation of known natural resistance sources to nematodes was emphasized. The problem with an R-gene is that it may not be effective to all nematode types.

Weevils and anti-feedants (proteinase inhibitors)
The proteinase inhibitor strategy for weevil control is currently been deployed in Uganda and South Africa. There is a further need to look into the diversity of weevil digestive enzymes to improve the strategy and further to examine in more detail the type of proteinases which would, when blocked, mostly affect the feeding and protein digestion by larvae.

Weevils/nematode and Bt
There might also a potential to use Bt for banana weevil/nematode control, however, there is need for high throughput screening of isolated Bt strains and also to characterize in more detail Bt toxin receptors in weevils/nematodes and gut behavior for optimal Bt action.

Table 3: Decision making matrix on pests

Horizon 1–3 yrs	Horizon 4–6 yrs	Horizon 7+ yrs
• Field testing of existing cystatin lines • Obtain FTO within Africa for Syngenta lines for experimental evaluation only • Produce large numbers of cystatin lines • Screen lines • Establish clear bench marks for validating transgenics • Establish consensus field trial protocols for resistance evaluation • Define common needs with weevils (promoters and cystatins)	• Field test new cystatin lines	• Transform different target banana/plantain cultivars with constructs of proven value • Evaluate any yield penalty of proven, nematode resistant lines • Develop, implement and maintain a sustainable/ IPM scheme for cystatin- based control of nematodes

Other bionematicides

• Obtain purified Bts and other candidates and test for pathology at least • If necessary, use expression vector to obtain Bt protein • Test pathology on *C. elegans* • Extend to octopamine-treated *Radopholus/ Pratylenchus* • Determine if feeding tube exclusion limit/prevents Bt uptake by banana nematodes • Transform *Arabidopsis* with Bt and screen for effects on *Radopholus/ Pratylenchus* • Screen new Leeds bionematicides in *Arabidopsis* against *Radopholus/ Pratylenchus*	• Production of Bt-plus, VIPs in *Arabidopsis* or hairy roots • Transform banana with genes of high interest • Field test Bt lines • Field test other bionematicides • Secure IP FTO for chosen approaches	• Evaluate any yield penalty of proven, nematode resistant lines • Transform different target banana/plantain cultivars with constructs of proven value • Develop, implement and maintain a sustainable/IPM scheme for Bt and other bionematicide approaches for nematode control

R-genes and nematodes

Horizon 1-3 yrs	4-6 yrs	7+ yrs
• Complete evaluation of known natural resistance sources to nematodes • Determine which are single dominant R-gene mechanisms • Determine if appropriate R-genes exist Ensure that regulatory climate supports the development of the products	• Field testing of Bt lines • Secure IP FTO for chosen approaches • Stack R-genes additively with other approaches • Determine which R-genes in genomes of banana and its relatives are anti-nematode	• Develop, implement and maintain a sustainable/IPM scheme for resistance

Weevils and anti-feedants

• Develop early screens for weevil resistance in banana and relatives • Screen Leeds proteinase inhibitors against weevils *in vitro* screen • Prepare weevil intestine cDNA library	• Produce transgenic banana • Screen transgenic banana for weevil protection • Express weevil proteinases to optimise proteinase inhibitors • Mine cDNA library for other targets with known plant inhibitors	• Develop, implement and maintain a sustainable/IPM scheme for resistance

Weevils and Bt

• Obtain purified Bts and test for rapid pathology *in vitro* assays • Consult entomology/molecular biology community for other approaches	• Characterize Bt receptor if toxin obtained • Transform banana with Bts of potential • Explore potential of Bt optimisation by cloning weevil Bt receptor from cDNA library and optimising affinity • Optimising binding affinity and conduct functional assays with model intestinal membranes • Develop most appropriate approach	• Produce transgenic banana • Screen transgenic banana for weevil protection via Bt • Develop, implement and maintain a sustainability strategy for Bt approach to weevil control

Milestones

Milestones include intellectual property rights and regulatory approvals.

Questions/comments and discussion

QN: If AATF's interest is in banana production, it seems only one aspect, namely biotech, is considered; what other technologies can be considered?

ANS.: Other technological aspects appear in the matrix (Appendix I).

COMM: The need to incorporate other known technologies like use of *mycorhiza* to work synergistically with developed technologies, e.g. control of nematodes, use of *Bauveria*

bassiana, so that the technology comes as a package to solve several constraints was emphasized.

Horizon 1–3 years presents a situation of quick win, but establishes a platform for the next project activities.

Bacterial wilt: There is need to develop a mechanism to stop its spread. The disease spreads faster in poorly managed farms suggesting other vectors are involved other than farmer activities. Literature from Ethiopia suggests involvement of insect vectors. There is need for regional approach to contain its spread.

Bacterial diseases: Insect transmitted and infection through insect feeding on male buds and, therefore, regular removal of male buds would reduce the disease spread.

QN: How can biotech be included in IPM strategies?

ANS: We need to look at interaction among different groups with different ideas to be able to come up with the project but please note that IPM is in the matrix.

COMM: Looking at all the possible interventions may lead to considering many other relevant options, but currently AATF's aim is to complement different approaches (coming in a package). The need is to identify specific areas of new technologies together with other existing technologies. Try to identify the major technologies that can help solve the existing problem as soon as possible.

Emerging issues were summarized as follows:

- To take a problem-solving approach rather than product development approach if the problems of SSA are to be addressed;
- Combine both resistance to stresses and IPM strategies for control of pests and diseases as a specific target for Africa;
- No single technology will be used as a silver bullet to solve banana and plantain production constraints, but as a component of a whole range in a package. Thus biotechnology alone cannot solve the problems, and neither can traditional/conventional methods but all should complement each other.

COMM: The Chair reminded members to keep in mind what projects to come up with, what tasks, who would be involved in the project and the likely cost implications of the project would be from what was being presented.

7th presentation

Title: ***Deployment – micropropagation/clean planting materials***
Presenter: ***Prof. Kahangi***

Prof. Kahangi reported that the tissue culture project arose from the problem of availability of clean planting materials in adequate numbers required by farmers. There was high demand of clean planting materials due to the whole range of constraints (diseases, pests and drought stress) mentioned by earlier presenters. Micropropagation provided a solution to this problem and added that currently her laboratory had the capacity to produce 1 million plantlets per year. After getting encouraging results and getting funding to establish a lab at the university (JKUAT), funding was sourced for mass production of planting materials for farmers. With the success in production of clean planting materials in adequate numbers, the current problems faced include distribution of planting materials to farmers and information dissemination. To address the distribution constraint, using regional tissue culture nurseries managed by local farmers who were trained in nursery management techniques has proved to be successful. The impact of the project has been reduced importation of banana and

plantains, increased farmer incomes and enterprise diversification e.g. entering into agro-processing of the produce including bananas.

There are, however, limitations to farmers' realizing full potential of the tissue culture technology at nursery level. These include:

- Availability of the potting media; forest soil had been recommend, but this is no longer available. Also, the sterilization process requires use of a lot of firewood. The two resources have far reaching effects on environmental sustainability. The alternative to the use of firewood is exploring the use of solar energy.
- The second problem is that of the potting materials. Currently polyethylene sleeves are used; however, the high production will increase the amount of hazardous material that goes into the environment. Thus there is need to get alternative biodegradable material that can be used.
- Introduction of plantlets into an environment that is already loaded with stresses (biotic and abiotic). If possible the TC seedlings should be inoculated to ensure that they are protected from pests without resorting to biotechnology.

There is need to look at ways of protecting the plantlets from these production constraints.

- *Post-harvest handling:* Increased production did not find in place mechanisms to handle the increased products which resulted in losses of up to 50–70% with the bananas being perishable. There is need, therefore, for processing technologies to cope with the production so as to increase the shelf life of the products. A new and simple ripening method has, however, been developed at KARI and bananas can ripen in two days.
- *Marketing:* marketing has also been a problem with increased production. Planting of tissue culture plantlets leads to harvesting the crop at once which is beyond farmers' ability to handle and, therefore, there is need to have large market demand (large in Middle East).
- There is need to develop post-harvest handling and packaging technologies to meet market demands for both local and international markets. This requires training farmers to meet quality standards in competitive markets.

With regard to addressing the disease problem, she pointed out the need for quick diagnostic kits so that the materials given to farmers do not carry diseases such as viruses.

She also expressed the desire to ensure that farmers get true cultivars and expressed the fear that without DNA characterization of the available cultivars, the problem of synonyms is likely to continue confusing. She expressed the need to conserve indigenous varieties which may have useful traits but are quickly getting lost and suggested *in vitro* conservation would be helpful.

8th presentation

Title: ***East African highland bananas***
Presenter: ***Prof. R. Swennen***

East African highland bananas (EAHB) contribute 30% of world banana production. Bananas with AAB genome are very important in Africa, Latin America and Asia. Highland bananas with AAA genome only grow around the great lakes. Farmers grow a mixture of 5–20 varieties around their homesteads. There are over 70 varieties from which the farmers choose.

He noted that EA can benefit from work being done elsewhere on banana, but in the case of the EAHBs, work has to be done from EA if it has to benefit the region. This is because EAHB are only found in EAH and not in any other part of the world. He also observed that most EAHB are sterile and therefore, genetic modification would be a useful tool in complementing conventional breeding in addressing the problems of EAHBs. He therefore expressed the need to focus on:

- Transformation in suspensions as has been done elsewhere,

- Suspension of some EAHB cultivars has been achieved at John Innes Centre on flower technologies. Studies, therefore, should continue to develop cell suspensions from other EAHB cultivars,
- Narrowing down on the number of cultivars to be used and determine seasonal effects which is not yet known for EAHBs.

9th presentation
Title: ***Farming systems and networking***
Presenter: ***Dr. E. Karamura***

Dr. Karamura said that there are two broad production systems, which are recognized, namely commercial and subsistence systems. Commercial system is dominant mainly in the coastal region. In Ethiopia, the commercial system is mainly found along the rivers, the same was in Somalia, which used to supply Middle East and Italy. Commercial and large-scale production is coming up in areas like Ghana, Cameroon, South Africa, Mozambique etc. Commercial production is dominated by AAA Cavendish types. EAHBs are produced in highly populated areas characterized by low input and low output. Plantains and highland bananas are the main staple food in Africa especially in East Africa. Plantains are becoming more and more of a commercial crop than ever before.

Key players are ASARECA, CORAF and SADC. Their roles include: overall sub-regional framework formulation, financial and policy support and creation of linkages with NARS. The networks are managed at technical level by a steering committee derived from technical institutions, which supervise the agreements on research agendas. Other partners include CGIAR-centres namely: INIBAP-IPGRI, IITA which also play a very important role in this area. Sub-sub-regional organizations (IRAZ and CARBAP–Cameroon) have also played a major role.

Musa Networks
BARNERSA and MUSACO are responsible for facilitating priority setting by NARS, technical execution of agreed research and development agendas, facilitating capacity building, creating back and forth linkages with CSO, PSO, extension and NAROs.

Sub-sub-regional R&D organizations
These include CARBAP and IRAZ who play the role of technical backstopping, scaling up, germplasm multiplication and distribution, facilitating capacity building, creating back and forth linkages with NAROs, ARIs and CSOs.

Advanced R&D institutions
These are CIRAD and JIC. These institutions are involved in technology development and dissemination, specialized capacity building and technical backstopping of NARS activities.

Universities
There is collaboration with Makerere, JKUAT, Sokoine, Pretoria (FABI), KUL, and River State Nigeria universities. These are involved in constraint analysis and priority setting, technology development, capacity building, backstopping NARIs, activity execution and feedback and policy development processes.

Sub-regional agricultural research institutions
East and Southern Africa (ESA) and West and Central Africa (WCA) are involved in constraint analysis and priority setting, back and forth linkages with grass-root platforms, CSO and PSO, information gathering and exchange and policy formulation processes.

Civil society organizations/grass-root platforms

These include NGOs and CBOs that play the role of community mobilization and advocacy, constraint analysis and priority setting, technology/information dissemination, execution of activities and feedback.

Private sector organizations

These include traders, exporters and information providers. They play the following roles: technology promotion and product development, market and market structures formulation, infrastructure development, quality control, constraint analysis and priority setting.

Questions/comments

QN: What is the cost of an *in vitro* plantlet to the farmers?

ANS: Seedlings can get to the farmer through two channels. First, seedlings are sent to nurseries acclimatized at a cost of 40 Ksh. (about 0.54 US$), which they raise and sell to farmers at about 1 US$ (74 KSh.). Secondly, farmers can buy directly from the laboratory at JKUAT at a cost of 60 KSh. (0.81 US$).

COMM: Mobile diagnostic units might be used (as suggested in South Africa), where testing of plants for diseases might be done closer to farmers fields. A mobile diagnostic unit is still an idea and has not been commercialized so far and is still in the concept development phase. Such mobile diagnostic unit for plant diseases would require generators to provide electricity for equipment used in diagnostics. In Kenya, a laboratory helping farmers to test for virus-free plants would have a significant impact. It was pointed out that indexing viruses should be done where it is justified, i.e. where the existence of the disease is reported or the likelihood of existence of the disease is high.

QN: Is there any technology package supplied with the tissue culture plantlets?

ANS: There is need to take a technology with other supportive technologies (e.g. technologies to address water, fertility, pests and disease problems) if the farmers are to realize full production potentials of TC plantlets. It is, therefore, necessary that the meeting should bring these issues on board to include them as we formulate projects and project components.

COMM: Agrogenetics Laboratories in Uganda has used NARO; local authorities and CBOs to identify nursery sites and farmers both at district and sub-county levels. Farmers in Uganda have realized that there has been big increase in yield through use of tissue culture plantlets and the private sector is closely working with KARI and NARO but there is a problem of distribution; maybe the mobile unit technology could possibly help. Though some NGOs come and offer free materials to farmers (which should be discouraged as farmers could afford to buy at ½ a dollar), the problem is on distribution. Now distribution centers in form of nurseries are being established and managed by local farmers. In addition to addressing the problem of management, ¼ acre demonstration gardens are also being set up near the nurseries to help train farmers in the management of the banana plantations. There is need for a collective effort in the distribution and then in management of the farms.

Afternoon session

Chair: Dr. Gad Gumisiriza

The C/M reminded participants of salient areas that should come out in the course of the discussion. These included:

- Whether AATF should develop one or more projects from the banana programme;

- Whether it should handle one project with project components;
- Identify where each player fits and or who else fits where;
- Possible cost of the project.

10th presentation
Title: ***Biofortification/biopharming***
Presenter: ***Prof. Karl Kunert***

Prof. Kunert said that malnutrition is a serious problem especially in children and women and we have to target this problem if we are serious about investing into the future of Africa. A major problem in Africa is vitamin A deficiency. Targeting this problem might be an excellent project for Africa, e.g. a "golden banana" rich in vitamin A for Africa using technology already available for rice and maize in the developing world. He emphasized that these high value crops might also demand improved traits for drought, disease and pest resistance to produce a high quality and more nutritious product. Thus a project that will address most of the constraints for banana production in a single project focusing on improving the quality of life of people (especially children) in SSA might be an excellent target. Such a project might also allow interaction in science in the developing world by focusing together on the Vitamin A technology already initiated for producing golden rice or maize. However, he cautioned consumer acceptability has to be ultimately addressed as scientists easily forget that it is the consumer who has to accept the product in the end. For the children, we need to know if they will eat a slightly acidic banana or if they prefer only very sweet banana.

11th presentation
Title: ***Biofortification/biopharming***
Presenter: ***Prof. Heslop-Harrison***

With regard to biofortification and biopharming, Prof. Heslop-Harrison observed that there is diverse germplasm which can be used for conventional breeding and as a source of genes for genetic modification of existing varieties to enhance nutrition and health problems. The potential benefits of biofortification and biopharming highlighted included:

- Improved nutrition quality;
- Reduced toxicity and allergenicity/pharmaceutical substances for medical and veterinary use.

He was very positive about the improvement of the nutrient composition of banana used as staple foods, and noted the amount of genetic variation available. He encouraged consideration of targets for both conventional and transgenic breeding based on known nutritional deficiencies. Particular consideration could be given to infant nutrition where banana is a critical food at weaning and during early development. He mentioned that plants can be used as factories for pharmaceutical products and other high value proteins e.g. antibodies, cytokines and edible vaccines. The potential positive impacts include:

- High value speciality crops to improve crop choices and increase farm incomes
- Developing rural livelihoods where processing is co-localized
- Use of non-animal production systems thus reducing likelihood of spread of animal diseases
- Cost effective
- Low tech at point of use which will reduce storage problems

Pharmaceutical and other high value proteins, e.g. antibodies, cytokines and edible vaccines have potential negative impacts entailing:

- Containment of the genes
- Segregation of the speciality crops
- Impact on wildlife of eating the speciality crop
- Containment

- Control of dose and distribution. He, therefore, expressed the concern of use of banana for the purpose of producing pharmaceuticals due to the above listed negative effects.

He said that transgenes that are used to produce pharmaceuticals or other GM products (e.g. bioplastics and biofuels), might adversely affect human health if eaten inadvertently, and that extra consideration is required if they are transformed into major food crops since unintended mixing (germplasm or product) could contaminate varieties used as food or feed. Because of the need for exact control of dosage of most pharmaceuticals, He noted that it may be more appropriate to introduce such traits into non-food crops or that the production of pharmaceuticals should be confined to contained facilities. Formal regulation and field release should be handled on a case-by-case basis. He advised members about the EU regulations for release of genetically modified crops for guidance (reviewed in the report on www.gmsciencedebate.org.uk and provided on the CD with the meeting presentations). He also noted that for bananas, which are a staple food crop of smallholder farmers, regulation of growth and processing might be very difficult.

Regulation and specialist crops

He said that for the UK, the Advisory Committee on Releases to the Environment (ACRE) would consider and approve commercial growth of GM crops, Advisory Committee on Novel Foods and Processes (ACNFP) would approve use of GM and unusual (e.g. tropical fruit juices, oils with phytosterols) crops for human food, and Advisory Committee on Animal Feeding (ACAF) stuffs has a similar role for animal feeds.

Questions/comments

QN: What would happen if there is a protein that would suppress deficiencies/disease development in children, would this be considered pharmaceutical?

ANS: This is not pharmaceutical. It would be very desirable to breed bananas with enhanced nutritional characteristics, taking into account possible allergenicity of proteins from novel germplasm or genes and effects on cultivation.

QN: What is the importance of not using banana to produce vaccines?

ANS: Might create a major safety concern in Africa due to the problems of dosage control of the anti-parasitic protein produced.

12th presentation

Title: ***Elements of improved banana product concept***
Presenter: ***Dr. Gerard Barry***

Dr. Barry said that an overview of all the important elements of a project would help in deciding how to patch them up into one document. Unless delivery mechanisms are made for the products developed, the resources invested in development would be wasted. AATF could possibly resolve all the problems by putting together all existing germplasms.

He defined products to include *Musa* varieties and planting materials for smallholder farmers with tolerance to various stresses/constraints. He therefore pointed out that the development of *Musa* varieties and planting materials for African smallholder farmers which are improved in tolerance to diseases and pests as components would enhance improvement in food and income security for Africa. These products would be developed by the best efforts of public, private, governmental, and international entities and would be largely publicly funded.

Technical approaches will include:

- Renewed efforts of screening conventional germplasm and accessions to identify lines with the desired trait for the development of new varieties and a source of new genes,

- Plant biotechnology, using lead genes from ongoing work and those to be identified through new partnerships,
- Product performance criteria,
- Research, development, and product release and delivery activities will comply with relevant plant registration and plant biotechnology regulations and the partnerships would hope to benefit from harmonization of activities in these areas,
- Successful material will be released in locally adapted and accepted germplasm,
- Planting materials will be produced and distributed through effective and reliable entities, including local ones,
- Launch of the products will be preceded by development of integrated systems to minimize the development of resistance, education and outreach to extension services, and would be coordinated with other *Musa* improvement and smallholder development efforts,
- The products are expected to be unencumbered by intellectual property constraints that might otherwise hinder their wide adoption,
- Cost effective low tech at point of use which will reduce storage problems.

Questions/comments

QN: What are the mechanisms for acceptance of a product by countries?

ANS: These should be built in the countries' regulations.

QN: What happens to a product when it is released, who is responsible for a product which comes out of the public sector? Not clear for black sigatoka on banana – is there any thought given to the product – how it is managed? Once any product has been released there are a number of issues to be managed properly to ensure that it is not doing any harm to the environment. Who will have the ultimate responsibility for a product which comes from an institution like INIBAP?

ANS: This should be addressed in the national biosafety regulations.

QN: Economic viability of the products was not addressed!

ANS: The technology developer has to consider the economic viability of the technology before release. Also the private sector is involved in product distribution, system for example, which means the venture is economically viable since they are profit minded.

13th presentation

Title: ***Intellectual property rights issues***
Presenter: ***Prof. Norah Olembo***

Prof. Olembo said that having worked with Kenya Industrial Property Institute for 11 years, she has observed the development of efforts internationally to harmonize intellectual property systems with those of WTO, ARIPO etc. There are differences in what countries have adopted especially in regard to plant protection and few have signed the UPOV. She stressed the importance of not only focusing on producing products for local market but also to target the wider international market, thus the need for knowledge on IPR systems elsewhere and their requirements. Some countries do not allow patenting of organisms and, therefore, genes and this has to be put into consideration. She cautioned with shortening the time to get products out by acquiring technologies from elsewhere which may not work in the African situation. Stressing the need to develop own technologies locally, she gave an example of the sweet potato case in Kenya which may not end in a product for the farmers, but observed that it has been used to build local capacity.

She pointed out that IP issues can be territorial in nature, i.e. what is patented in say the US unless patented in another country might not be under mandatory enforcement in that other country and that

if the product is not protected, negotiation can be easy and cheaper as compared to protected ones. She noted that liability issues are going to be more and more important especially with cross-pollinating crops which may not be the case in bananas. She highlighted the need to know what liability implications are associated with given technologies.

She named some sources of IP information as: CD-ROMs, DVD-ROMs, Internet; KIPI, USPTO, UKPO; ARIPO, OAPI, EPO.

She also noted that such sources may give information that may allow use of genes without protection, giving example of Cryl gene for insect resistance in maize – Kenya.

She said that industrial property rights may cover: patents, utility models, industrial designs, trade marks, service marks, geographical indications, plant breeders rights (PBRs), copyrights etc.

She gave some examples of patents that could apply to bananas as follows:

Examples

International patent WO 99/00492
The invention provides plant and viral promoters that can be used to confer high-level gene expression on transgenic plants. Representative promoters can be isolated from the genome of Australian banana-infecting badnaviruses from *cultivars Mysore*, Williams and Goldfinger. The invention further provides construct which include the disclosed promoters operatively linked to a coding sequence. Still further provided are a method of expressing the product of a gene in a plant cell, plant cells having DNA constructs within their genomes, and plants comprising the transgenic cells.

US patent 6,114,285
A method of chemically suckering trees of the families Musaceae (banana) and Plantaginaceae (plantains) which comprises introducing into a mother tree an amount of a composition effective to arrest apical dominance in the mother tree. A method of protection of two or more trees of the families *Musaceae* (banana) and *Plantaginaceae* (plantains) which share a common root system.

US patent 6,372,238
A process for providing nutrient material for banana and plantain plants, comprising providing a slow release implant containing a banana and plantain nutrient material and implanting the implant into banana or plantain plants whereby the nutrient is slowly released into the plant over a period of time. The trial was continued for 3 months and infection by sigatoka was measured.

US plant patent PP13,874
A new and distinct variety of cooking banana plant, substantially as illustrated and described, which is a dwarf plant and has a high level of resistance to the black sigatoka leaf spot disease; the green fruit is further characterized by having a very good flavour and texture when boiled, to having a long green life after harvest, and to being easy to peel for cooking.

IP issues to consider include:

- IP ownership.
- Who owns the technology?
- Is it protected and if so in which countries and for how long?
- How can it be acquired?
- Donations, licensing, compulsory acquisition, government use.
- Conditions of acquisition (cost, limitations, etc.).
- Liabilities.
- MOU's, material transfer agreements etc. (i.e. what, where, when, who, how, etc.).

Applying for patent or PBR protection

In order to apply for a patent or PBR protection, one needs to know the following:

- Requirements for patenting;
- Requirements for plant breeders rights;
- Application by self or through an agent;
- Several criteria to be observed for patent and PBR;
- Fees payable at various stages and they differ from country to country;
- Term of patent protection; and
- Term of PBR protection.

Prof. Olembo pointed out that it is important for those dealing in different products to realize that they are not just national but also international dealings hence the need to look at other countries IPR – to be familiar within Africa. She emphasized the need to develop own technologies in Africa and not be complacent just because other technologies are being borrowed from other countries.

14th presentation

Title: ***Advocacy issues***
Presenter: ***Mr. Godbar Tumushabe***

Mr Tumushabe, a member of the AATF Board of Trustees, highlighted issues that could arise regarding advocacy that need to be addressed in the process of developing a product/technology. These include:

- *Technology adoption:* The need to examine cultural attachments to cultivars in place and how it will influence acceptability of the new cultivars;
- *Accessibility:* Farmers get their planting materials from neighbours, community based organizations (CBOs) supply free planting materials and now private sector companies have joined the processes. There is need to examine the effect of each of the players.
- *Information dissemination:* With movement of genes from animals to crops, there is need to consider the values and norms of people (consumers) and, therefore, this has to be addressed from information packaging not to create unnecessary resistance. How much information is provided to the consumer of technology and other stakeholders (all the people around you).
- There is need to list a range of technologies available with specific options for a particular period.
- *Time period:* 1–3 years directed to provide solutions to address immediate problems, though mid- and long-term can be considered.
- *Liability and redress:* Likely to see companies investing in biotechnology being stricter on liability regimes. Negotiations of liability regime need to be considered.
- *Biotechnology products:* These products are affected by the prevailing political economy. Therefore, there is need to understand and be able to explain the implication from a political economy perspective.
- *AATF:* Cautioned that if the first product is a GMO, the organization may confront a public relations opposition as an organization fronting for GMOs, thus there is need to think more on the approach.

15th presentation

Title: ***How to be smart in a highly regulated environment***
Presenter: ***Mr. Willy De Greef***

Mr. De Greef pointed out that a biotechnology project has a number of parallel sub-projects and the regulatory regime is one of them. He noted that there maybe regulatory time loss which may start from the day of concept of the project and may result from:

- Choosing a gene coding for a toxic protein.
- Choosing an unacceptable selectable marker.

He emphasized that regulatory compliance starts in the laboratory and that there is a difference between the biosafety project and the regulatory project, whereby

- Biosafety assessment is a technical exercise, regulatory compliance includes non-technical parameters that enter the equation

Points to consider:

- After Product Official Clearance, regulatory clearance is almost always on the critical time path of a GM crops project.
- The regulatory environment of biotechnology has not stabilized, and will change during your project therefore there is need to:
  - **Stay** informed about policy changes,
  - The best way **to stay informed is to get actively involved.**
- *Official and non-official regulators:* Consider the influence of official and unofficial regulators who may include: influential individuals and groups, economic stakeholders, e.g. supermarkets. Thus market preparation is essential for regulatory clearance.
- It is a good idea to develop the benefit file together with the regulatory file including environmental benefits and Socio-economic benefits to ease regulatory clearance

DOs

- Train your staff in biosafety and regulations.
- Check if your genes are obtained in compliance with access regulations.
- Ensure that your facilities are licensed to do GM work.
- Make a biosafety special sheet and a regulatory special sheet at the start of the project:
  - Marker gene choice,
  - Copy number and clean inserts,
  - Choice of promoters,
  - Toxic requirements of candidate genes, their gene products and events.
- Investigate where your GM crop and its products will end up, it will determine which regulators (official and unofficial) you will have to convince.

DON'Ts

- Assume that others will clear the regulatory environment for you.
- Assume that the benefits of your product are so obvious that they don't need explaining.
- Assume any knowledge about biotech or agriculture in those who will decide on your product.
- Assume that a scientific logic will prevail in a regulatory environment.

Questions/comments

QN: What areas should be considered (taken care of) to enhance product development?

ANS: Draft consensus document on biology of bananas – slow process but once available everybody who has right to regulatory application may use it and is not disputed, e.g. Mexico has such document. These may include the following:

- Substantial equivalence: this can be checked in the OECD tables,
- OECD draft on consensus documents on the biology of bananas,

If these are used, everybody will agree without dispute. A member state, e.g. Mexico, can be used to access the document.

COMM: AATF is being created where there are so many facilities to ensure choice. The organization should have access to someone to work on information searching full time. There is also need to be careful of what is chosen where it is wanted, for what purpose and how soon? Generic crops and genes in public domain can be accessed. Generic crops like bananas have a possibility of being transformed. For example, if some variety is

available in S. America and can do well in Uganda, if it is in public domain, one can get it.

QN: What should be in place so as to get the best that will work for Africa?

ANS: Sources of information have been indicated and to make use of them, one needs technical persons to identify and ensure that he/she is getting the best. With a choice of a protected and non-protected patents technology, the objective is getting the best out of the project. There is a lot around the world, which we need to search for what we want, when we want it and when we want it. Most genes are no longer protected and can, therefore, be made use of. Genes in the public domain can be accessed since IPRs have a time frame. If there are 2 options – protected and not protected, then better to go for what is better. Aim of AATF project is to access the best technology, which should not be compromised.

COMM: It is important not to lose focus and leave out local varieties.

QN: Is there any way FAO etc. can influence narrowing down the time gap for regulation?

ANS: FAO and WHO have observer status. The debate would have been enriched if FAO agronomists played part. The UNEP-GEF project is playing a big role in the region, in biosafety policy development.

16th presentation
Title: ***Sustainability of resources***
Presenter: ***Dr. Michael Hall***

Sub-Saharan Africa's food supply and nutritional gap is widening. USAID work is in accordance with US President's initiative to end hunger in Africa. The goal is to help significantly reduce hunger and poverty in sub-Saharan Africa and the objective is to rapidly and sustainably increase agricultural growth and rural incomes in sub-Saharan Africa.

The main area of intervention is in science and technology by:
- Increasing productivity;
- Increasing food availability;
- Increasing commodities available for export;
- Improving product quality;
- Relieving pressure on natural resources;
- Reducing post-harvest losses;
- Helping producers respond to markets;
- Assisting entrepreneurs to develop profitable enterprises;
- Raising farm incomes;
- Reducing the price of food.

The investment is in biotechnology.

Trade and markets
To address the issues of trade and markets, the following steps will be taken:
- Increase competitiveness of smallholder farmers in regional and global markets;
- Add value;
- Improve food quality and safety;
- Improve market efficiency and reduce costs to consumers;
- Create climate and infrastructure to attract investments in African agricultural businesses.

Regional partners in East and Central Africa

In order to accelerate technology spillover, develop broader markets, and improve the efficiency of services and investments, regional synergies are key to successful agricultural growth in Africa and increased banana production in particular. Focused investment in the key pillars of growth include countries having in place an enabling environment for successful partnerships to pursue agricultural growth, as well as for creating the impetus for growth in the entire region. IEHA initiative using regional approach has targeted three regions namely: West Africa (WARP), East and Central Africa (REDSO) and Southern Africa (RCSA) initially focusing on Mali, Uganda and Mozambique as first tier countries in 2003. Later IEHA will expand to include three other countries per region in the second and third rounds from 2004 and beyond.

The principal focus countries selected will ideally have in place:

- A government committed to and supporting an agriculture and economic growth strategy;
- An enabling environment that is conducive to private investment and growth;
- A willingness to play a leading role in the sub-region to promote regional cooperation and agricultural growth;
- A proven commitment to work with development partners in achieving goals;

Regional partners in East and Central Africa include:

- *ASARECA* which is supported by USAID and EU. The regional organization has a secretariat and 19 network institutions.
- *Biotechnology Programme (USAID):* USAID also supports the Biotechnology Programme that among others covers policy development.
- CGS programme supported by EU covers all networks, programmes.
- In the COMESA region USAID supports regional biosafety policy development and harmonization and development intellectual property rights management systems.
- *USAID/Uganda:* Uganda is in the first round of IEHA focus countries. Banana and plantains are high on the agenda and USAID is committed to continued support to the INIBAP project.

In the rest of Africa, regional partners in the initiative working together with USAID include:

- *West Africa:* CORAF; USAID in Nigeria, Senegal and Ghana.
- *Southern Africa:* SADC/SACCR; USAID Malawi, South Africa and Zimbabwe.

IEHA's strategy is to increase strategic connections and dissemination of spillovers.

Other partners in the IEHA initiative include ABSP II which focuses on commercialization of 1-2 transgenic products in the region over 5 years and development of intellectual property rights regimes. The second partner is PBS which is involved in biosafety policy development, regional harmonization and biotechnology-biodiversity interface (BBI).

The expectation from IEHA initiative includes reduction in the number of children malnourished among others.

18th presentation

Title: ***The partnerships to advance INIBAP's mission and mandate in Africa***

Presenter: ***Dr. Richard Markham – INIBAP***

Dr. Markham started by stating INIBAP's mission as "*to sustainably increase the productivity of bananas and plantains grown on smallholdings for domestic consumption and for local and export markets*".

Objectives:

- To help to coordinate the global research effort.

- To promote collaboration and partnerships … (at national, global and regional levels).
- To strengthen the ability of NARS to conduct R&D activities.
- To collect and exchange relevant information in support of the R&D effort.

Musa biotech support service

- Gather information about relevant products and IP from private sector, universities, etc.
- Promote exchange of experiences in biosafety (procedures, dossiers etc.).
- Capacity building (exchanges etc.).
- Matching needs to available resources (identifying donors, developing proposals etc.).

Cross-cutting tools and resources

- Cell suspension methods.
- Genetic transformation protocols.
- Constructs, promoters etc.
- Search for sources of resistance (links to conventional breeding programmes).
- Search for genes (links to genomics consortium).
- Common screening and evaluation technologies for transgenic materials.

Facilitate field testing

- Independent and multilocational evaluation of trangenic materials.
- Shared evaluation protocols.
- Documenting and sharing results.

Strategic supporting research

Strategic research support will be directed towards basic knowledge of pests and pathogens such as Banana streak virus, weevils and nematodes, banana bacterial wilt (monitoring developments, spotting needs and opportunities, filling gaps).

Access to technologies and intellectual property rights

Expertise is specific and relatively expensive, however, IPGRI expertise could be made use of (e.g. relating to implications of the International Treaty on Plant Genetic Resources for Food and Agriculture).

Clearing the development pathway

The pathway for development can be cleared by:

- Developing biosafety frameworks
- Multiplication *in vitro* and in the field
- Helping farmers to develop appropriate farm management strategies

Technical steering committee

Dr. Markham proposed a technical steering committee to be composed of the following scientists:

- Teresa Sengooba (NARO)
- Roger Fogain (CARBAP)
- Michael Pillay (IITA)
- Howard Atkinson (University of Leeds)
- Rony Swennen (KULeuven)
- Willy De Greef (private sector)

INIBAP offers to provide Secretariat. INIBAP stands ready to respond to evolving R&D needs.

Requirement: The meeting was asked to endorse the Technical Steering Committee or make the necessary changes.

QN: Is there no need for an advisor on genomics for future work?

ANS: By INIBAP providing secretariat, will link with the genomics person.

COMM: At the FARA meeting in Dakar, Southern African sub-region was missing and it was thought at the time that there was need to have a representative from that sub-region to bring the concerns of the sub-region on board. I would like to suggest that we include someone from that sub-region to ensure that all the sub-regions of SSA are on board.

Agreed: That a member from the Southern Africa sub-region be included on the board.

Dr. Blessed Okole who is employed at CSIR/South Africa and originally from Cameroon, once a Director (production) at African Biotechnologies in South Africa, who holds a PhD from University of Berlin/Germany was added to the Technical Steering Committee.

The TSC was adopted with the above inclusion of one member.

19th presentation

Title: ***Guidelines/terms of reference for the Technical Steering Committee (TSC)***

Presenter: ***Dr. Eugene Terry***

Dr. Terry presented the terms of reference for the Technical Steering Committee as follows:

1. Problem areas in banana/plantain production are not adequately addressed by existing mechanisms/programmes and specifically where the technology would otherwise not be accessible by resource-poor farmers. The proposal should yield projects, which will enhance consumer and farmer capacity to adopt advanced technological interventions and products.
2. Refine the matrix developed in this meeting and include aspects of biofortification and biopharming.
3. The technological interventions must be supported by:
    - Proof of concept;
    - Ex-ante impact analysis.
4. Project deliverables should take the interventions from research to Development. The product should benefit end users in terms of food security and income generation.
5. Project activities and deliverables should create new capacities and skills beyond the current capacities and skills available.
6. Projects whose success will influence and focus the attention of a wide range of stakeholders especially policy makers to appreciate and approve advanced technological interventions that address food security and poverty alleviation.

Dr. Terry requested the TSC to produce its report to AATF/INIBAP by January 2004.

Questions and comments

QN: Looking at the matrix, impact is expected in about 10 years. Will we have to wait this long?

Existing technologies are not the domain of AATF, but no one is denied to use existing technologies. AATF is concentrating on mechanisms that have not been addressed by existing mechanisms and institutions. If there is a new innovation that has sprung up then it can be looked at as an innovation but if it already exists then there is need to change course.

If there is a new innovation in the process of project formulation, this can be considered, e.g. soil fertility gene – microbe to be tested; in the meantime free fertilizers can be availed to farmers as we wait.

AATF is not setting agenda for research in Africa but looking at how available technologies can be availed to increase banana production, which is a small portion of the overall African agenda.

COMM: Need to add marketable products if we are to increase income thus improving their acceptability.

Point well taken. Trade in the region and outside catered for under marketing.

QN: Are there environmental considerations?

COMM: Somebody talked of changed polices in Uganda. Researchers need now to first think of the market for the products likely to come out of the research work before embarking on the work which has resulted from policy change favouring poverty reduction.

QN: Is there need for someone with an industrial background on the TSC?

COMM: We were told that AATF was Africa led, but the TSC does not reflect this.

ANS: There is need to make a distinction between project drafting steering committee and other committees. Such a committee needs a small number not a very big one. The committee is well represented with members from all sub-regions, they will accomplish the job with guidance from the secretariat.

In the formulation of ideas or projects, environmental consideration will have to be considered. On changing policies in Uganda, before researchers think of what research to carry out, they consider whether the product of research has market or not is a policy issue for the country. This means that ex-ante analysis must be part of the proposal for research funding.

QN: Small-scale poor farmers have had a lot of attention; however, nothing much has changed at the grassroots. How is AATF prepared to make a difference?

ANS: Science and technology is just one of the 5 major areas governments have to invest in to reach poor farmers. AATF will be involved only in novel technologies and other stakeholders will also address their areas such as infrastructure, institutional development, etc.

Closing remarks

Dr Terry pointed out that the positions reached during the meeting and earlier on will be captured in the report. The report will be sent to all members later. He thanked members for their contributions and once again pointed out that the discussion attempted to put together a proposal. He observed that the TSC had been formed, a TOR formulated and a timeframe in which the TSC is to do its job has been defined. This should enable AATF achieve its objectives.

The Chair thanked the participants for their contributions and formally closed the meeting.

AATF SMALL GROUP MEETING (SGM) AGENDA

Session Chair: Dr. Otim Nape

9.00–9.10	Opening remarks	Dr. Otim Nape
9.10–9.30	AATF	Dr. Terry
9.30–9.40	Discussion	
9.40–9.50	Abiotic stresses – agronomy, water, soil fertility	Prof. Rubaihayo
9.50–9.55	Biotic stresses – introduction to biotic stresses	Dr. Frison
9.55–10.15	Discussion	
10.15–10.30	Coffee break	
10.30–10.40	Diseases	Dr. Dilip Shah
10.40–10.50	Pests	Prof. Atkinson
10.50–11.15	Discussion	
11.15–11.25	Deployment – micropropagation/clean planting materials	Prof. Kahangi
11.25–11.35	East African Highland bananas	Prof. Swennen
11.35–11.45	Farming systems and networking	Dr. Karamura
11.45–12.00	Discussion	
12.00–12.20	Biofortification/biopharming	Prof. Heslop-Harrison & Prof. Karl Kunnert
12.20–12.30	Elements of product concept	Dr. Barry
12.30–12.45	Discussion	
12.45–2.00	Lunch break	
2.00–2.15	IPR issues	Prof. Norah Olembo
2.15–2.25	Advocacy issues	Mr. Tumushabe
2.25–2.35	Regulatory environment	Mr. Willy De Greef
2.35–2.50	Discussion	
2.50–3.05	Sustainability of resources for the proposed activities	Dr. Hall
3.05–3.20	Coffee break	
3.20–3.40	The partnerships to advance INIBAPs mission and mandate in Africa	Dr. Richard Markham
3.40–4.00	AATF advances in partnerships with stakeholders to improve banana/plantain production in Africa	Dr. Terry
4.00–4.30	Discussion	
4.30–4.45	Close	

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Participants' personal backgrounds

Name	Personal background	Address
Dr. Karl Kunert **Professor of Botany**	Prof. K Kunert has since 1999 an appointment as full-Professor in the Botany Department of the University of Pretoria. Leader of the Molecular Plant Physiology group located in the Forestry and Agricultural Biotechnology Institute of the University of Pretoria. Research group currently consists of 10 post-graduate students and one senior Research Scientist originating from five different African countries. Nearly 30 years experience in academic and industrial research. Gained technical and managerial experience by working in different academic environments and also in the South African biotechnology industry. This includes the Universities of California (Davis, CA) and Konstanz (Germany), the John Innes Institute (Norwich, UK), INRA Versailles (Versailles, France) and the Research and Development Department of AECI (Johannesburg/South Africa). Is a founding member of an US-based biotechnology company focusing on DNA marker development in plants. Author and co-author of over 50 publications in internationally recognized journals in the areas Plant Biotechnology/Plant Molecular Biology and Plant Physiology. Received several funds from both governmental agencies and industry during his career and has developed an excellent understanding of the demands of the various sectors. The research group itself focuses on stress protection in plants and specifically on the investigation of the role of cysteine proteinase inhibitors in biotic and abiotic stresses. Further research concern is the identification and isolation of changes in the composition of the plant genome caused by environmentally and chemically induced stresses and the investigation of the relationship between genome changes and expression of specific plant phenotypes	Forestry and Agricultural Biotechnology Institute (FABI) University of Pretoria Tel: 27 12 420 3908/9 Fax: 27 12 420 3960 E-mail: kunertk@icon.co.za or karl.kunert@fabi.up.ac.za http://fabinet.up.ac.za/molplantphys FABI, South Africa
Professor J.S. (Pat) Heslop-Harrison	Pat Heslop-Harrison studies the large-scale genome organization and evolution of plants. With a particular focus on banana, his group has four research interests which link to applications in crop breeding: the assessment of biodiversity and its changes at the DNA level across the genus; the large scale organization of the genome and its repetitive DNA sequences; the modulation of gene expression and interaction of the genomes in cultivars, particularly with respect to DNA methylation and tissue culture effects; and the behavior of Para retroviruses such as BSV. More details will become available on www.biobanana.com.	Department of Biology, University of Leicester, Leicester LE1 7RH UK E-mail: phh4@le.ac.uk Phone: Direct +44/0 116 252 5079 Via Department: +44/0 116 252 3381 FAX: +44/0 116 252 2791 Home phone: +44/0 116 292 6799 FAX: +44/0 116 292 6815

Name	Personal background	Address
Prof James Dale	James Dale heads a research programme directed towards the control of diseases, primarily through transgenesis, in tropical crops including bananas, sugarcane, papaya, tomatoes and taro. The programme has extensive experience and expertise in the transformation of and transgene expression in bananas. The initial disease targets in bananas are banana bunchy top virus and Fusarium wilt and potentially resistant transgenic plants are currently being screened or regenerated. Importantly, the programme has recently developed a novel strategy for generating immunity to Gemini viruses and nanoviruses.	QUT Australia E-mail: j.dale@qut.edu.au
Mr. Godber Tumushabe	Godber Tumushabe is an independent environmental law and trade policy analyst engaged in research on a broad range of environmental, trade and human rights issues in Eastern and Southern Africa. Godber is currently Executive Director of Advocates Coalition for Development and Environment (ACODE), a Ugandan based independent public policy research and analysis Think Tank. He also teaches environmental law, international law and the science of law at Makerere University, Kampala. Godber has formerly worked as a Senior Research Fellow at the African Centre for Technology Studies (ACTS) in Nairobi, Kenya. He has written extensively on environmental law, governance and human rights issues. He is co-editor with Professor Okoth-Ogendo of Governing the Environment: Political Change and Natural Resources Management in Eastern and Southern Africa, ACTS, 1999.	Godber W. Tumushabe Executive Director Advocates Coalition for Development and Environment (ACODE) Plot 96, Knjokya Street, P.O Box 29836, Kampala E-mail: gtumushabe@acode-u.org; or acode@acode-u.org Tel. 256-41-530-798 (O); 256-77-590642 (cell) www. www.acode-u.org
Dr. Andrew Kiggundu	I have been a research assistant on the National Banana Research Programme, NARO, Uganda since 1997. During this time I have worked on East African highland banana (Matooke) taxonomic characterization, nation wide surveys to elucidate banana production constraints, shifts in cultivation, cultivar diversity and farmer cultivar selection criteria. Then I worked on screeing germplasm for banana weevil resistance and aspects of resistance mechanisms while training for my MSc in Plant breeding. Most recently I am involved in evaluating the potential of protease inhibitors as transgenes in the control of banana weevil (PhD project). At the same time I am interested in Musa gene discovery and genome analysis.	**Official Address:** National Banana Research Programme Kawanda Agricultural Research Institute, P. O. Box 7065, Kampala, Uganda. (Email: andrew@kari.go.ug) **Current Address:** Forestry and Agricultural Biotechnology Institute University of Pretoria 74 Lunnon Road, Hillcrest, Pretoria, South Africa. Email: andrew.kiggundu@fabi.up.ac.za

Name	Personal background	Address
Prof. Esther Murugi Kahangi **Horticulturist/ Biotechnologist**	Prof. Esther M. Kahangi is a holder of B.Sc. M.Sc. and Ph.D. in plant sciences and is an associate professor in Horticulture Department and the Director Institute for Biotechnology Research at Jomo Kenyatta University of Agriculture and Technology. She has taken intensive training courses in plant biotechnology in Japan. Her main research work in banana include: • Commercial production of tissue cultured (TC) bananas; • *In vitro* conservation studies on the highland bananas; • DNA characterization by use of RAPD and AFLP; • Somatic embryo genesis of highland bananas; • Transfer of banana TC technology to farmers through establishment of TC banana village nurseries, training farmers on nursery management and hygiene, agronomy, entrepreneurial skills, post harvest handling, ripening and processing banana into different products; Currently exploring possibilities of organizing farmers to market bananas in local and export market	P.O. Box 62000, Nairobi, Email: kahangi@africaonline.co.ke or estherkahangi@yahoo.co
Rodomiro Ortiz **Director, Research for Development**	Rodomiro Ortiz (Lima, 1958) holds BSc-Biology (Honors) and MSc-Plant Breeding & Statistics from UNALM (Agric. Univ. of Peru), and PhD-Plant Breeding & Genetics from Univ. of Wisconsin-Madison. He worked as researcher at UNALM, CIP, Rutgers Univ. and IITA, held a Nordic professorship-Plant Genetic Resources at KVL-Denmark, and was Director Genetic Resources Enhancement Program at ICRISAT and Crop Improvement Division at IITA. He is now IITA Director of Research-for-Development. During his professional career he wrote in excess of 400 reports, of which 50% are international ref. journal articles (combined impact factor above 132 as determined by journal average according to ISI) and about 40 edited book chapters. He trained about 20 students who did their degree thesis under his advice. Together with his colleagues at IITA, KVL and ICRISAT, they wrote 33 research-for-development proposals, which attracted about US $ 35 million. As research manager, he also facilitated the funding of many special projects through professional and personal interactions with development investors of both institutes of the Consultative Group on International Agricultural Research (CGIAR). In 1994, the CGIAR awarded IITA the prestigious King Baudouin Award for the multidisciplinary research of the team working in plantain and banana improvement, in which Ortiz was both a hands-on researcher and programme leader. He reads, speaks and writes English and Spanish (mother tongue) fluently.	IITA, Ibadan, Nigeria mailto:r.ortiz@cgiar.org

Name	Personal background	Address
Dr Dave Harris	I am a crop physiologist / agronomist and deputy manager of the UK Department for International Development's Plant Sciences Research Programme (1995-present). I have worked for DFID on various crops in India (1982-83) and Botswana (1987-1992) and I worked in St. Lucia (1992-1995) for WIBDECO on various aspects of banana research and development. Currently I manage the Plant Sciences Research Programme's efforts to produce transgenic bananas, particularly in relation to nematode resistance. This work is underway at the John Innes Centre and the University of Leeds, in collaboration with INIBAP and NARO, Uganda.	Centre for Arid Zone Studies University of Wales Bangor Gwynedd LL57 2UW UK D.Harris@Bangor.ac.uk Tel: +44 1248 382922 Fax: +44 1248 371533
Dr. Theresa Sengooba	Plant pathologist. Working with NARO Coordinator for Biotechnology Research in NARO. Regional Coordinator for the Program for Bio safety Systems, a project under USAID. My interest in Banana is that it is the most widely grown food crop in the country. It is essential to improve the production and to add value. I would like to see bananas demonstrate the value of transformation. Plant pathologist. Working with NARO	Coordinator for Biotechnology Research in NARO. tsengooba@mail.kari.go.ug
Prof. Jesse Machuka	Current Research: Sweet potato and maize transformation with respect to drought, virus and insect resistance Interest in banana: Discovery of new genes and access to existing genes and transgenic technologies for use in banana improvement, including field testing of available transgenic banana in Africa. Mailing Address: Centre for Complimentary medicine and Biotechnology, Kenyatta University.	**P.O. Box 43844, NAIROBI, Kenya.** Phone: +254-2-813460; Fax: +254-2-811575 Email: ccmb@avu.org or jessemachuka@hotmail.comCentre Biotechnology [ccmb@avu.org]
Michael Pillay	Michael Pillay (B.Sc, B.Sc (Hons), UHDE, B.Ed., B.A., M.S., PhD) I am a banana breeder/cytogeneticist/molecular biologist. Employed by IITA since October 1997. Interested in breeding, molecular genetics and evolution of bananas. Developing new East African highland bananas that are disease and pests resistant. Published over 15 papers in Musa.	Michael Pillay m.pillay@africaonline.co.ug
Ekow Akyeampong	I am the Regional Coordinator of the Musa research network for West and Central Africa, Musaco headquarter in Douala, Cameroon. I am interested in all aspects of banana research and development especially the area of agronomy.	Banana and Plantain Network Centre de recherché regionales sur bananiers et plantains B.P. 832, Douala, Cameroon Tel: 237-427129, Fax: 237 425786 Email: eakyeampong@hotmail.com

Name	Personal background	Address
Carine Dochez	Host plant resistance to nematodes in Musa germplasm (focus on Radopholus similis and Pratylenchus goodeyi): screening for resistance of existing germplasm and new hybrids; reproductive fitness, pathogenic variability and genetic diversity of different population of R. similis; genetic analysis of nematode resistance and studies on mechanisms of nematode resistance.	IITA-ESARC Uganda, Nematology Email: c.dochez@cgiar.org
Dr. Leena Tripathi	I am a Plant Molecular Biologist with specialization in Tissue culture, Plant Transformation and Genetic Engineering. I have done my M.Sc. in Molecular Biology & Biotechnology in 1993 from G. B. Pant University of Agriculture and Technology, Pantnagar and have completed the Ph.D. (Plant Molecular Biology) in 1999 from National Botanical Research Institute, Lucknow, India. After that I have worked as Research Scientist at University of North Carolina, Greensboro, NC, USA. At present, I am working as Associate Scientist in Biotechnology Unit at International Institute of Tropical Agriculture (IITA). I am working in Gatsby Charitable Foundation funded project " To develop Banana Streak Virus resistance Banana and Plantain plants" in collaboration of John Innes Center, UK. I have experience working with plant tissue culture, plant genetic transformation and molecular biology. Since last 31/2 years, I have been doing research on Banana and Plantains in sub-Saharan Africa.	Biotechnologist International Institute of Tropical Agriculture C/O L.W. Lambourn & Co. Carolyn House, 26 Dingwall Road Croydon CR9 3EE, UK Tel: 234 2 241 2626 Fax: 234 2 241 2221 Email: l.tripathi@cgiar.org
Dr. Mike Hall, PH. D	Dr. Michael Hall serves as Regional Biotechnology Advisor for USAID's regional mission in Nairobi covering Eastern and Southern Africa. Prior to coming to Nairobi in 2002, he was based at USAID in Washington where he worked as biotechnology advisor for Africa and as a AAAS fellow in the Middle East Technical Grants Office. His scientific background is a Ph.D. in biochemistry focussing on protein crystallography from Washington University and a Masters in Public Policy from the University of Texas.	USAID at ICIPE Complex P O Box 30261, 00100, Nairobi Tel: 254-020- 862400/2 Ext. 2306 Fax: 254-020- 860562/949 Email: mhall@usaid.gov Cellphone No: 0733 333551
Mr. Arthur Mpeirwe	Arthur Mpeirwe is a research fellow and head of the IPR and Biotechnology policy programme at Advocates Coalition for Development and Environment (ACODE). He is a lawyer and specialist on intellectual property issues. He has done substantial research on biotechnology and biosafety policy issues. He has previously worked in different capacities in government before joining ACODE.His current focus is on biosafety and biotechnology policy development, liability and redress, IPR legal reforms as well as access to genetic resources.	ampeirwe@acode-u.org

Name	Personal background	Address
Dilip Shah	Current Position: November 2001 to present Domain Member Donald Danforth Plant Science Center St. Louis, Missouri 63132 USA Research Interest: A. Molecular plant-fungal interactions with specific emphasis on the biochemical, genetic and biological analysis of antifungal defensins in Medicago truncatula and M. sativa B. Genetic engineering of fungal disease resistance in transgenic crops using antifungal defensins My Interest in Banana: I am interested in exploring the possibility of applying the antifungal defensin technology for conferring resistance to black sigatoka and fuarium wilt in banana. There is at present no active research programme on banana in my lab. **Current Position**: November 2001 to present Domain Member Donald Danforth Plant Science Center Research Interest: A. Molecular plant-fungal interactions with specific emphasis on the biochemical, genetic and biological analysis of antifungal defensins in *Medicago truncatula* and *M. sativa.* B. Genetic engineering of fungal disease resistance in transgenic crops using antifungal defensins. **My Interest in Banana:** I am interested in exploring the possibility of applying the antifungal defensin technology for conferring resistance to black sigatoka and fuarium wilt in banana. There is at present no active research programme on banana in my lab.	Donald Danforth Plant Science Center 975 N. Warson Rd, St Louis, Mo. 63132 Ph. 314-587-1481 Fax. 314-587-1581 email. dshah@danforthcenter.org
Richard Edema	I am plant Molecular Virologist by training. I have mostly worked on maize, (Maize streak virus genotyping and now Marker assisted selection for MSV, resistance and Quality Protein maize). Interest in bananas might be applications of biotechnology for fungal resistance.	Email: redema@agric.mak.ac.ug
Prof. H.J. Atkinson	Professor of Nematology. My group develops transgenic nematode resistance for crops worldwide including banana. Work on banana is now in collaboration with Dr. Philippe Vain of John Innes centre with funding provided by DFID Plant Sciences Research Programme. Our first prototype banana plants show resistance to Radopholus similies by expressing an inhibitor of nematode digestive proteinases (a cystatin) that is naturally expressed in rice seeds. The protein is biosafe for humans and non-target invertebrates and its expression can be limited to roots (See http://www.lbiology.leeds.ac.uk/nem/for further details).	Prof. Howard John Atkinson, Centre for Plant Sciences, University of Leeds, LS2 9JT UK (E-mail: h.j.Atkinson@leeds.ac.uk) Centre for Plant Sciences University of Leeds, LEEDS LS2 9JT Tel +44(0) 113 343 2900, Fax +44 (0) 113 343 3144

Name	Personal background	Address
Mr. Nsubuga	Is a managing Director of Agro Technologies Ltd. (AGT) which is a private and independent company with limited liabilities. AGT is the first and only private company in Uganda to use biotechnology through tissue culture techniques for micro-propagation of different crops on a commercial basis.	Mr. Nsubuga, P.O. Box 11387 Kampala, Uganda, Moblie: 077585211 Email : agrogentech@africaonline.com.ug
Dr. Bananuka John Armstrong	Works with Uganda National Council for Science and Technology/National Foundation for Research and Development Sida/SAREC funded **BIOEARN Programme** as Assistant Regional Coordinator. Has carried out studies on banana agronomy and water stress physiology for both MSc and PhD. Interested in biotechnology tools to improve resistance to drought stress in bananas and plantains.	
Dr. Charles F. Mugoya	Dr. Mugaya is the Associate Executive Secretary, Uganda National Council for Science & Technology. Regional Coordinator East African Regional Programme and Research Network for Biotechnology, Biosafety and Biotechnology Policy Development (BIOEARN) – working in 4 countries (Kenya, Tanzania, Ethiopia and Uganda). National Project Coordinator – UNEP/GEF Programme on the Implementation of the National Biosafety Framework. Team Leader – Uganda Biosafety Regulations & national Biotechnology Policy	Dr. Charles Mugoya P.O. Box 6884, Kampala, Uganda Tel : 077966662/077409835 Email : bioearn@infocom.co.ug
Dr. Eugene Terry	He is currently the implementing Director of African Agricultural Technology Foundation (AATF). Spent 23 years working with the CG. Was Director General of WARDA. Worked with World Bank until 2002. 1987–1996 worked as Crops Adviser, Rural Director.	AATF, c/o ILRI, Nairobi.
Prof. Patrick Rubaihayo	He is a Professor of plant breeding and genetics at Makerere University. Current research involves finger printing EAHB and protocol development for micropropagation and cell suspensions and regeneration for the EAHB.	Department of Crop Science, Makerere University, P.O. Box 7062, Kampala. Tel : 256-41-533580 E-mail : ruba@agric.mak.ac.ug

APPENDIX 1

Improved production of Bananas and Plantains in sub-Saharan Africa

Assumptions (Selection Criteria) →

Constraints	**Horizon 1 1-3 Years**	**Horizon 2 4-6 Years**	**Horizon 3 7+Years**	**Current Funding Situation**	**Current IP Holders**	**Current stage of Technology Development**	**Technical/ Technological Barriers**	**Existence of Active Network?**	**Prospects for AATF/ Stakeholder** Collaboration	**Food Security**	**Marketing**
Micro-propagation Lack of clean planting materials Community based weaning and hardening facilities	▪ 2,000,000 plantlets / yr ▪ 200 weaning shades ▪ Training in weaning + hardening ▪ Marketing in TC	3 million plantlets / yr 300 Capacity Building Marketing of	5 million plantlets / yr 500	USAID RF Belgium NARS GOVTS.	None	TC advanced; EAHB, Plantain		CIRAD, KUL, NARO, MUK INIBAP, Kenyatta University. Du Roi – S.A Laboratory	Facilitating Collaboration with private sector	Important staple for region	Improve internal markets Develop external markets Diversify products
Pests ▪ Weevils	Identification of resistance genes Bt + others	Lab evaluation of transformed plants	Field Evaluation of transformed plants	Governments RF		Low	Resistance genes not identified	Promusa	In the framework of Promusa Facilitating collaboration with private sector	-do-	-
▪ Nematodes	Evaluate candidate genes in Musa and heterologous genes Early screening methods exist	Lab and Field Evaluation Under containment	Variety Release	Governments KUL DFID RF Belgium	Syngenta	Low for genes Suspension and transformation technology for plantains is routine High for early screening methods	Low application of technical know how in the region. No suspensions for EAHB.	Promusa	Facilitating collaboration with private sector	-do-	-
Diseases Black Sigatoka	Field testing of plantains Stability of genes in containment	▪ Field test for EAHB ▪ General release for bananas/ plantains	General release for EAHB	GOVTS, USAID Belgium RF	AFPs & Chitinase Genes by Syngenta and Monsanto	High for plantain and banana Not for EAHB	No cell suspension for EAHB	Promusa	In the framework of Promusa develop collaboration	-do-	-
Fusarium Wilt BSV Bunchy top Bacterial wilt	Heterologous genes and early screening methods available for Foc and BBTV Search for other resistance genes	Lab tests for BBTV and Foc Screen candidate genes	Field test for BBTV and Foc Laboratory Tests for other diseases	QUT (BBTV)	Syngenta		No Musa genes available No genes identified for BSV	Promusa	In collaboration with Promusa Strengthen collaboration with private sector	-do-	-
Nutritional/ Fortification in Dessert bananas & Plantains Vitamin A	Transformation of dessert bananas	Lab and Field testing/ Evaluation	General Release		Syngenta Pro- Vit A	Developed for rice	Infrastructure & trained personnel in the region	None	Develop collaboration structures	Nutrient & Human health	Prospects high
Pharming Hepatitis B in Dessert bananas	Transformation & Testing stability In the field	Food Testing/ Controlled Release	Scaling up		Axis Genetics P/c	Developed for some cultivars	Infrastructure & trained personnel in the region	None	Develop collaboration structures	Human health	Prospects high

Value Chain

Source - DFID/CEPA 2002

Assessment - Feasibility / Probability of Success

STEP 4
AATF
Management

Assumptions:
1. Donor Support; 2. Technology Holders; 3. Research and Production Partners; and 4. Market Data Collected.

Go/No Go Decision by
AATF Management

Scientific/Technical Peer Review of
Project Concept Note

STEP 3
External
Panel

Project Concept Note Development by AATF Management (Technology Operations/Senior Project Manager)

STEP 2
AATF
Management

Product Concept Identification
(Consultations with Farmers, Local/National Entrepreneurs, Researchers, Technology Providers, other stakeholders)

STEP 1
AATF
Management

Figure 3: Simplified Project Flow Diagram

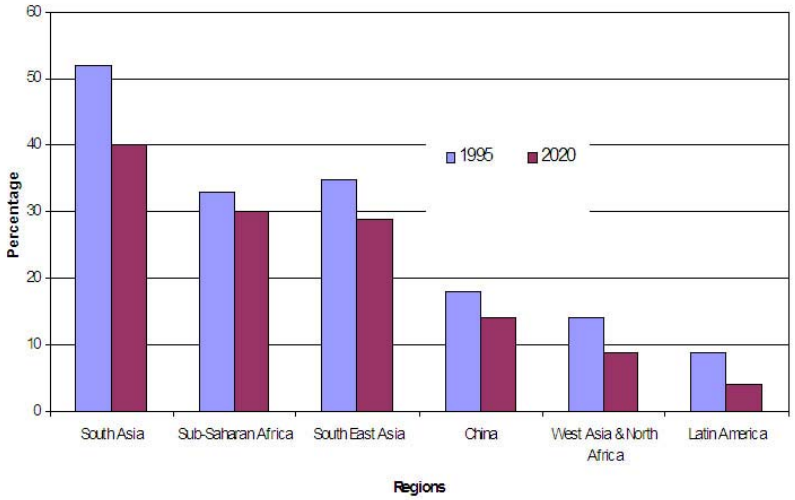
IMPROVED PRODUCTION OF BANANAS AND PLANTAINS IN IN Sub-Saharan AFRICA

P.R. RUBAIHAYO;
Crop Science Department, Makerere University
JOHN A. BANANUKA
UNCST/NFRD

Meeting the challenge

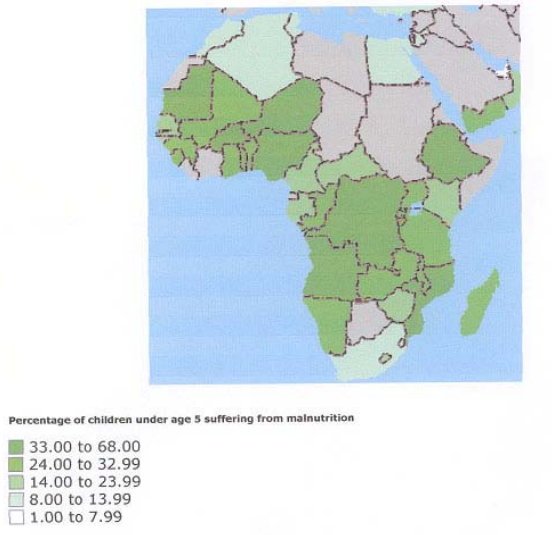
- Need to contribute to the Millennium Development Goals of reduction of poverty and hunger, child mortality and environmental sustainability

Percentage of malnourished children 1995 & 2020 (projected)



Source: IFPRI IMPACT simulations, July 1999

Childhood malnutrition in Africa

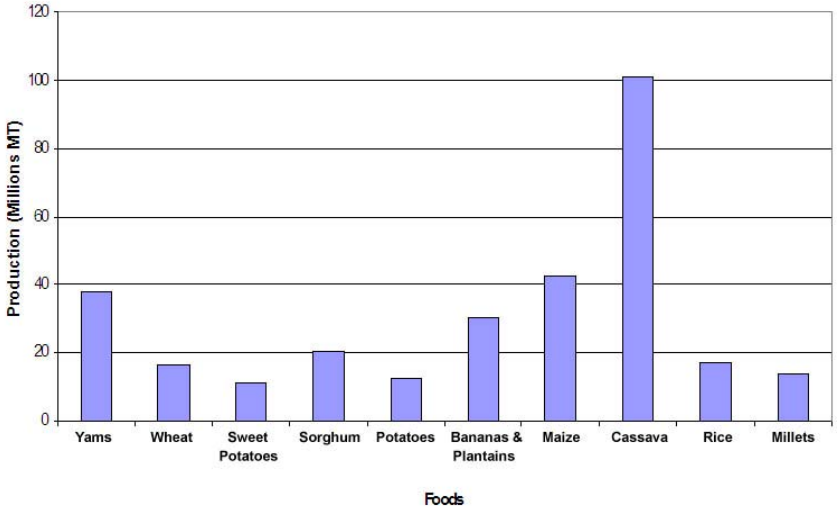


Source: Brian Carnell; Child malnutrition by country-Africa

Importance of bananas & plantains

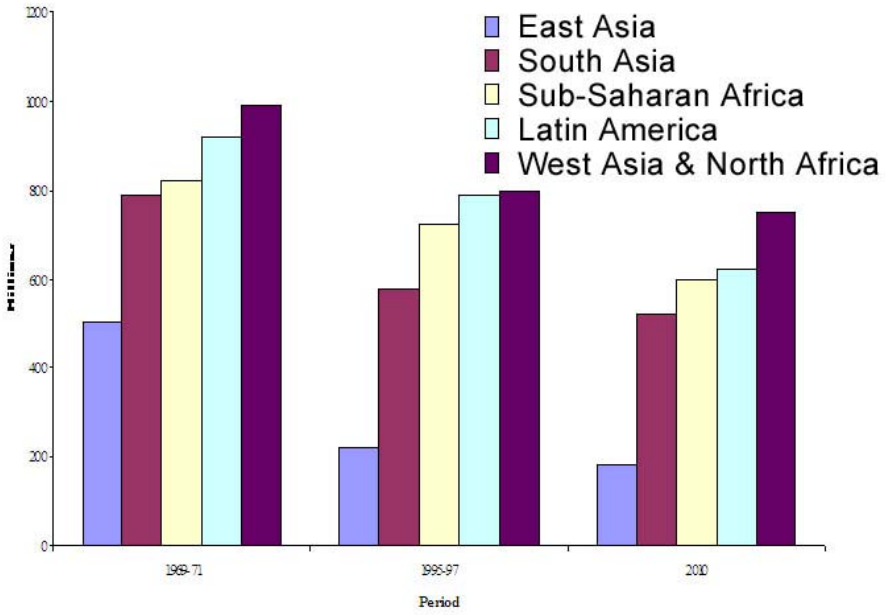
- Provide an important food source for over 100 M people in Sub-Saharan Africa
- East Africa produces 18 M t/yr making 20% of the world output
- Important staple food in Uganda, Rwanda, Burundi and parts of Kenya and Tanzania
- Beer brewing has long been an important activity among Great Lakes communities (consumption 1.2 l per capita per day- Rwanda)

Starch staple food production in Africa, 2002

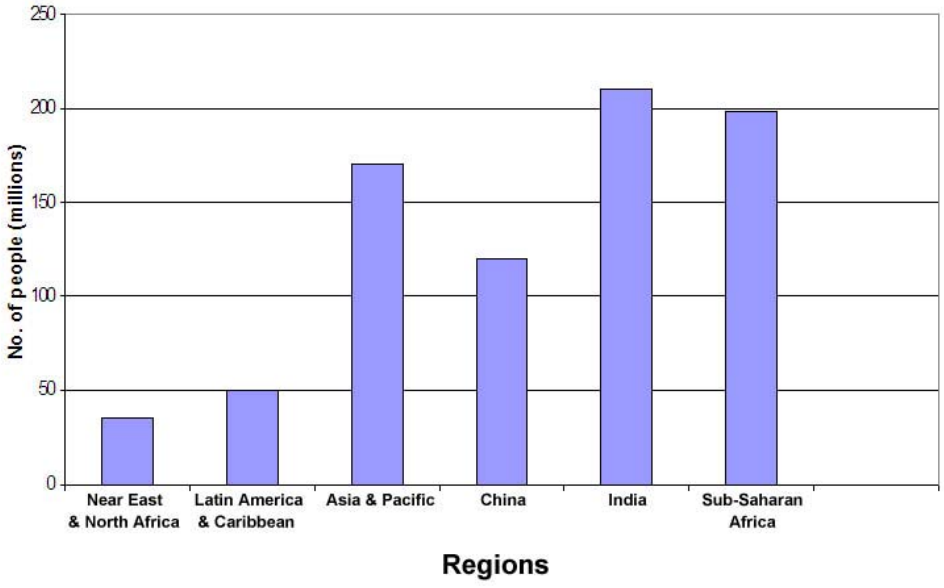


FAO Statistics, 2002

Number of food secure people 1969-71, 1995-97, and 2010 (projected)



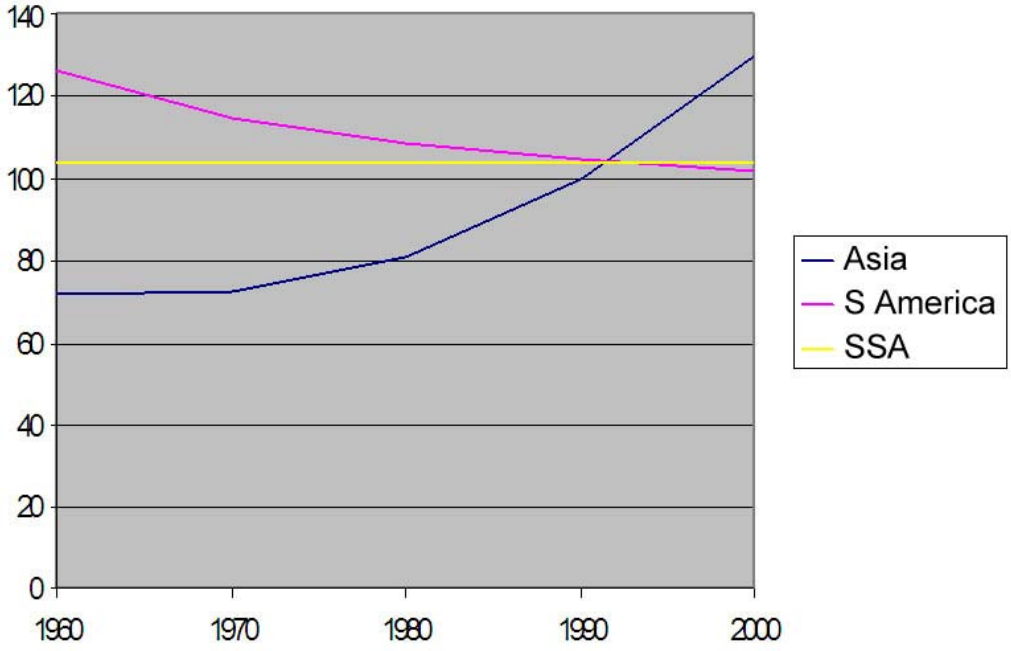
No. of hungry people in the developing world 2002



Micronutrient malnutrition

- More than 2 billion people worldwide suffer from micronutrient malnutrition
- Diets supply inadequate amounts of vitamins and minerals: vitamin A & C, iron, iodine, zinc, folate and selenium
- Children and women are the most vulnerable to micronutrient deficiency
- Between 100 and 400 million children suffer vitamin A deficiency

Food availability in Africa (PIN per caput)



Trends in prevalence of anaemia among women

	Pregnant women *Average for 1975-1997*	**Non-pregnant women** *Average for 1975-1997*
South Asia	59.7	56.0
Southeast Asia	52.1	44.7
Middle America and Caribbean	38.0	28.3
South America	34.0	22.8
Sub-Saharan Africa	**46.4**	**40.8**
Northeast and Northern Africa	37.7	25.4
China	30.3	23.2
Pacific Islands	20.8	33.6

Source: Mason et al. 2001

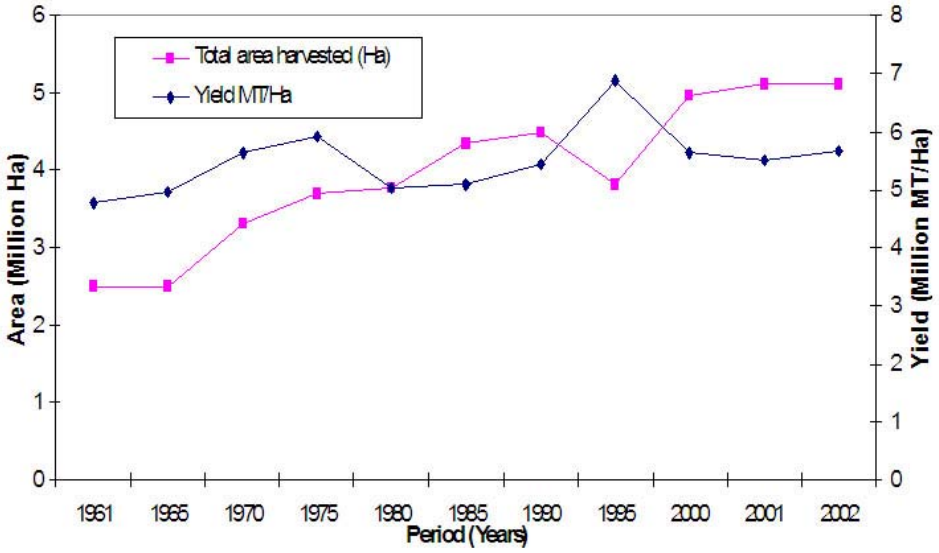
Estimated population at risk of low zinc intake, by region

Region	Population (millions)	Percentage of population at risk of low zinc intake
Asia	3,063	61
South Asia	1,297	95
Southeast Asia	504	71
China	1,262	21
Sub-Saharan Africa	**581**	**68**
North Africa/Eastern Mediterranean	342	74
Latin America/Caribbean	498	46
Developing countries	**4,484**	**61**
USA/Canada	**305**	**1**
Western Europe	**457**	**8**
Eastern Europe	**413**	**13**
Western Pacific	223	19
Developed Countries	**1,398**	**10**
All regions	5,882	49

Vitamin A deficiency in preschool children

Region	Serum retinal <0.70μmol/l	
	Prevalence (%)	No. (millions)
South and Southeast Asia	35.6	59.5
East Asia and Pacific	18.2	29.6
Latin America and Caribbean	19.6	10.2
Eastern and Southern Africa	37.1	18.6
Western and Central Africa	33.5	17.4
Middle East and North Africa	9.8	4.2
Total	26.5	139.5

Banana & Plantain Yield trends



Production area and yield trends of bananas and plantains in sub-Saharan Africa 1961-2002

Source: FAOSTAT

Production constraints

- Poor soils/drought/wind damage
- Pests: weevils/nematodes
- Diseases: Black sigatoka; fusarium wilt; bacterial wilt; Viral diseases :-BSV
- Management

ASARECA'S PRIORITY CONSTRAINTS FOR BIOTECHNOLOGY INTERVENTION

- High Priority
  - Black sigatoka
  - Virus free seedlings
- Medium Priority
  - Banana weevil
  - Nematodes
  - Fusarium wilt, Banana streak virus, Panama wilt, Cigar end rot