## Annex 3

## IITA THIRD EPMR PANEL COMPOSITION AND BIODATA

*PANEL CHAIR*

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**BIODATA**

**Cyrus G. Ndiritu, Kenya**

**Position**: Private Consultant in Rural Developmental Studies

**Expertise**: Veterinary medicine, animal diseases, livestock, agric research, research organizations in SSA

**Education:** Ph.D. University of Nairobi (1978-82); M.Sc. in Veterinary Medicine, University of California, Davis (1975-76); Bachelor of Veterinary Medicine (BVM), University of Nairobi (1970-74)

**Experience**: 2001 Feb/March consultant to review animal production and diseases research programs in Tanzania as an input to the World Bank mid-term review of the Tanzania Agricultural Research Project. August 2000 to February 2001 appointed Commissioner on International Research by the Danish Government for Development Related Research in Denmark to study research needs and make recommendations on research priorities and organizational framework. 1989-2000: Director, Kenya Agricultural Research Institute (KARI); Chairperson ASARECA Committee of Directors; 1990-: Board Chair of Kenya Veterinary Vaccine Production Institute (KEVEVAPI), and Board Member of Kenya Trypanosomiasis Research Institute (KETRI); 1990-:To review progress of the World Bank assigned Ethiopian Agricultural Research Project (EARP); 1990-91: Member of Administrative Council for the Small-Ruminant Collaborative Research Support Program (supported by the USAID); 1987-89: Director and Consultant with Agrivet Services Limited; 1980-87: Head of Research & Development Department in the Wellcome Disease Research & Clinical Programs; 1977-80: Lecturer in the University of Nairobi, Faculty of Veterinary Medicine, Department of Clinical Studies; 1975-77: Part-time work in the Department of Medicine & Surgery, Davis, CA.; 1974: Assistant Lecturer, University of Nairobi. TAC Member from 1996-2000; Member of the CGIAR Oversight Committee in 1995; Chairperson of the NARS-CGIAR Committee (1994); appointed Board Member on CIMMYT (1996)); Chair of SSA CP Review 2006

**Greg Edmeades (**New Zealand)

**Position**: 2005-present: Consultant, based in New Zealand

**Expertise**: Agronomy, plant physiology, plant breeding (maize), drought research, use of molecular approaches and knowledge of the private sector

**Education**: Ph.D., University of Guelph, Canada, 1972-76. Major: Crop Physiology. Minor: Mathematics and Statistics. Thesis title: "Aspects of plant-to-plant variability in maize (Zea mays L.)." M. Agric. Sci, Massey University, New Zealand, 1969-72. Major: Maize agronomy. Minor: Agricultural mechanization. Thesis title: "Maize in the Manawatu: a field study of the effects of spacing and variety upon the growth of Zea mays L." B. Agric. Sci., Massey University, New Zealand, 1965-68. Major: Farm management and agricultural mechanization

**Experience:** 2001-2004: Research Fellow, Pioneer Hi-Bred International, Waimea, Kauai, Hawaii, responsible for abiotic stress tolerance/trait development in Woodland CA, and Viluco, Chile; 1999-2000: Senior Scientist, Pioneer Hi-Bred International, Waimea, Kauai, Hawaii, responsible for Genetics Winter Nursery; 1991-1992: Visiting Research

Fellow, Plant Environment Laboratory, University of Reading, England, while on Study Leave from CIMMYT;; 1984-5 on study leave in New Zealand at the Plant Physiology Division, DSIR, Palmerston North); 1976-1978:; 1972 - 1976: Graduate Research Assistant, Crop Science Department, University of Guelph, Canada; 1970 - 1972: Lecturer, Agronomy Department, Massey University, New Zealand. Member of professional societies. Winner of the award Fellow, Crop Science Society of America (CSSA) in 2004. Author of a number of publications related to improving the resource use efficiency of agricultural systems at the farm level and developing genetic solutions to environmental constraints such as drought. CIMMYT: '98-'85: Maize Physiologist; 1978 - 1985: Maize Agronomist and Joint Coordinator, Ghana Grains Development Project, Kumasi, Ghana; CIMMYT: Post Doctoral Fellow Crop Physiology and Breeding, Maize Program, Ghana

**Gebisa Ejeta** (Ethiopia)

**Position**: Distinguished Professor, Plant Breeding and Genetics, Department of Agronomy, Purdue University

**Education**: Ph.D. in Plant Breeding and Genetics (1978); M.S. in Plant Breeding and Genetics (1976), Purdue University; B.S. in Plant Sciences (1973), Alemaya College, Ethiopia

**Expertise**: Plant breeding, genetics, plant sciences, sorghum, pearl millet

**Experience**: 1988-1992: Associate Professor of Plant Breeding and Genetics; 1984-88: Assistant Professor of Plant Breeding and Genetics; 1974-78: Graduate Research Assistant, Purdue University; 1973-74: Principal Plant Breeder, International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Wad Medani, Sudan; 1973-74: Research Associate, Ethiopian Sorghum Improvement Project; 1971-72: Research Assistant, Institute of Agricultural Research, Ethiopia. Member of a number of professional societies, e.g.: American Society of Agronomy, Crop Science Society of Agronomy, American Association for the Advancement of Sciences and Sigma Xi. Over the last five years he has authored or co-authored over 40 scientific publications. Sub-Panel leader for ICRISAT study for TAC's systemwide Plant Breeding Methodologies Review. The greatest achievements regard Dr. Ejeta's sorghum research efforts in Sudan which culminated with the release in 1983 of Hageen Dura-1 as the first commercial sorghum hybrid in SSA. He also catalyzed the development of a seed industry in Sudan. These efforts coupled with an aggressive farmer education program that he initiated led to the rapid adoption and expansion of acreage under the hybrid and the establishment of a commercial seed industry in Sudan. As a result, annually, a minimum of 100,000 acres of Hageen Dura-1 was grown by Sudanese farmers since its release and reached a maximum of 1,000,000 acres per year in 1999. Such a rapid and phenomenal rate of adoption and expansion of an improved crop cultivar had not been witnessed since the remarkable agricultural change in Asia under the Green Revolution. He replicated a similar achievement in Niger after developing another drought tolerant sorghum hybrid, NAD-1 was officially released in 1992 as a commercial cultivar and is currently grown in thousands of acres annually yielding four to five times the national average for sorghum.

**Pammi Sachdeva** (USA/India)

**Position:** Independent Consultant, since 2001

**Expertise**: Program and institutional assessment, recruitment, and human resource management in the agricultural research and public health sectors

**Education**: Ph.D., Social Systems Sciences, the Wharton School, University of Pennsylvania, Philadelphia, 1988. Specialization in systems approach to organizational analysis, planning and management. MBA, the Indian Institute of Management, Ahmedabad, 1971. Major in organizational behavior and human resource management.

**Experience:** Recent clients include the World Bank, FAO, WHO, Islamic Development Bank, and the Global Water Partnership. Prior to this, he worked for over twenty years in the World Bank and the CGIAR, retiring in 2001 as adviser. At the CGIAR Secretariat, he undertook or facilitated comprehensive assessments (EPMRs) of the governance, strategy, programs, organization, and management of twelve of the fifteen CGIAR-supported international agricultural research Centers; and served as member of the CGIAR gender and diversity advisory board, and of various CGIAR task forces and working groups. At ISNAR, he served as Chair of HRM working group and head of training program; and led a research project on the organization and structure of national agricultural research systems in developing countries. He has undertaken work-related travel to over thirty developing countries.

**Geoffrey Norton,** (UK/Australia)

**Expertise:** Pest management, resource management, strategic planning techniques for specific pest management problems

**Education:** B.Sc. Agriculture, M.Sc. and Ph.D. (1968) (both in Agricultural Economics) - all from the University of Wales (Bangor); D.Sc. from University of London (1988)

**Position**: Director, Cooperative Research Center for Tropical Pest Management, Brisbane, Australia, since 1992

**Experience**: 1985-92: Director, Silwood Center for Pest Management, Imperial College, UK; 1970: Biology Department of Imperial College, University of London. In this post he worked on a range of resource management issues; 1968-70: University of Manitoba. He worked on resource management problems in the Inter-lake region. The major focus of his interests has been the development and application of inter-disciplinary tools for the analysis of pest management problems, aimed at providing support to those involved in policy, research, advisory and practical pest management decision-making. Key features of this approach include the development of economic, decision analysis, workshop and computer modeling techniques, and their application to specific pest management problems. Some examples of his past projects and consultancies include rice pests (Malaysia, Philippines, Vietnam, Thailand, Indonesia, and China), cotton pests (China) and tsetse fly (West Africa). He has consulted with a variety of organizations, examples of which are FAO, ADB, ODA, IRRI and EMBRAPA.

**Mary Ncube** (Zambia)

**Expertise**: Auditing, financial management, corporate governance

**Education**: 1988-1984 Associate of the Chartered Institute of Certified Accountants (ACCA), London School of Accountancy/ Zambia Center for Accountancy Studies; BA, Economics 1982, University of Zambia

**Position**: Since 1997: Chief Executive,M T Ncube and Associates (own firm).

**Experience**: Ms. Mary Ncube has over 23 years working experience as a consultant, accountant and auditor. She spent sixteen years with KPMG Peat Marwick, Zambia where she began as an Audit Assistant in 1982. In 1991 she was promoted to Audit Manager, and was admitted to Partnership in 1995. She is the first female of African descent to have been admitted to Partnership in KPMG globally. In addition to accountancy and finance related work, Ms Ncube has worked with a number of organizations on assignments related to economic and organizational development and management of aid and project funds including USAID, NORAD, World Bank, UNDP and UNHCR. Professional memberships are: fellow member of the Association of Chartered Certified Accountants (ACCA); Fellow member Zambia Institute of Chartered Accountants (ZICA); member of the Institute of Directors of Zambia and the Economics Association of Zambia. Also a Council member of the Medical Council of Zambia; a Tribunal Member of the Zambia Revenue Tax Appeals Tribunal, Board member to the HIVOS, Zambia; Chair Bank Audit Committee- Stanbic Bank Zambia, Director Energy Regulation Board of Zambia, Director on M.T.N. Special Engagements Limited (a consultancy firm) and M.T.N. Boardroom and Conferences Limited; and a member of the UN Conference on Trade and Development (UNCTAD) Group of experts on International Standards of Accounting and Reporting. Previous Directorships include: Director on Zamnet Communications Systems Board; Council member, Zambia Institute of Chartered Certified Accountants; Chairperson ZAMCOM Lodge Board; Treasurer, Zambia Women's Lobby; Chairperson, Audit Committee of Lusaka International Community School; Chairperson, Women's Capital Development Fund, Steering Committee of Securities and Exchange Commission (SEC).

**Annex 4**
**List of Panel visits and persons met during the conduct of the review.**

**A: Outline Schedule of EPMR Panel's Interaction with IITA**

**<u>03 March (Saturday)</u>**

1100 – 1200 Panel arrives Ibadan

**<u>04 March (Sunday)</u>**

0900 – 1100 Panel meeting and introductions. (Meeting Room – I-House)
Introductory talk on background to the Review

1100 - 1230 Meeting of Panel Chair with the DG.

1400 – 1600 Panel Meeting (cont'd.): Introductory talk on IITA and CGIAR indicators.

1930 – 2200 Mixer/Reception

**<u>05 March (Monday)</u>**

0845 **Introduction of the Panel to staff**

0900 – 1330 **Formal Center presentations**:

- Challenges and strategic issues for IITA in meeting Agriculture research and development needs in Sub-Saharan Africa – *DG Hartmann*
- How IITA's Strategy and Research plans are developed – DDG-Research, *Dr. Paula Bramel*
- Responding to needs: Relating IITA's program to its partners –
  - DDG-Research – *Dr. Paula Bramel*
  - Immediate Past Dean, Faculty of Agriculture, University of Ibadan – *Dr. Janice Olawoye*
- Managing Resources -
  - DDG-Research – *Dr. Paula Bramel*
  - DDG-Support – *Dr. Campbell Davidson*

Panel Discussion Recess (closed)

**<u>05 March (Monday)</u>**

- **Presentations of Projects -** Deputy Directors

1430-1630

  - Agro Biodiversity – *Dr. Robert Asiedu*
  - Roots and Tuber Systems – *Dr. Robert Asiedu*

Panel Discussion Recess (closed)

**<u>05 March (Monday)</u>**

1630 – 1800

- **Presentations on Projects (cont'd.)** - Deputy Directors
  - Banana and Plantain Systems – *Dr. Steffen Abele*

Panel Roundup (closed)

**<u>06 March (Tuesday)</u>**

0900 – 1330

**Presentations of Projects (cont'd.)** - Deputy Directors
  - Agriculture and Health – *Dr. Steffen Abele*
  - Opportunities and Threats – *Dr. Steffen Abele*
  - Cereals and Legume Systems – *Dr. David Chikoye*

Panel Discussion Recess (closed)

  - High Value Products – *Dr. David Chikoye*
  - System wide Program-Integrated Pest Management – *Dr. Braima James*

1430 – 1730

Panel segregates to conduct visits of field and laboratory research and research-support facilities on the IITA site e.g.

- Genebank/ Breeding /Pathology
- Biotechnology Laboratories
- Support functions Library/ Training Unit/ Physical plant services and farm operations

**<u>07 March (Wednesday)</u>**

0900 – 1330

- IITA's Research Sites-
- Presentations by Officers in Charge from Uganda, Tanzania, Malawi, Kano

- Panel Discussion (closed)

**Group discussions**

*Small-group discussion with selected Scientists*
(followed by Panel Discussion)

- Agriculture and Health Project
- Agro-biodiversity Project
- Cereal and Legume Systems Project

1430 –1700

**Group discussions** with Scientists (cont)

- High Value Products Project
- Opportunities and Threats Project

- Root and Tuber Systems Project

Panel Roundup

**08 March (Thursday)**

0900 – 1030 **Group discussions** with Scientists (cont)

- Systemwide Program on Integrated Pest Management

Key players: *Dr. Paula Bramel* (DDG-Research), *Drs. James, Manu, Legg*

1100 – 1300 **Group (including Unit Heads and staff) discussions with:**

- Computer and MIS Unit
- Communication Unit
- Human Resource Unit
- Physical Plant and Farm Services;
- Finance
- Audit
- Contract and Grants Office/Training Unit

(The panel will break into smaller groups to interact with support units)

1400 – 1800 Session starts with Panel Roundup and Planning Discussion (closed)
Individual meetings, consultation and visits

**09 March (Friday)**

0900 – 1300 Panel Chair to lead open ended discussion with:
Research Development Council [elected scientists], Deputy Directors (3) and DDG-Research on research priority setting and coordination

Otherwise free for individual meetings, consultation and visits

1400 – 1800 Panel Meetings (closed)

**10 March (Saturday)**

Departure of Program Members of Panel

Morning free for individual meetings, consultation and visits if required.

**11 March (Sunday)**

19:30 Dinner in honor of EPMR Panel.

**12/13 March (Monday/Tuesday)**

Panel Chair and Governance expert may meet with arriving IITA Board Chair/ IITA Board Trustees.

**<u>14-17 March</u>**

Panel Chair and Governance expert monitor IITA Board Committee Meetings and Full Board of Trustees Meeting

**<u>15 March</u>**

Meeting of Finance Expert with External Auditors
IITA Guest House, Lagos

**<u>17th-25th May</u>** Panel visits research locations

1. BECA, Nairobi, Kenya
2. East Africa – including Mozambique, Malawi, Tanzania and Uganda
3. West Africa – including Ghana and Benin
4. Nigeria – Kano (scheduled revised to visit between the 1st to 3rd of June)

**<u>28th May to June 8th</u>** Panel drafts Report
(drafts shared for factual corrections in second week)

**<u>June 8th</u>** Presentation of Report to staff

**June 9th/10th** Panel depart Ibadan

**<u>B: Panel Visits to IITA regional locations</u>**

**<u>1. BECA</u>**
(Ejeta, Ndiritu)

**3-4 May 2007**

ILRI campus , initial joint session with IARCs on site (ILRI, AATF, ICRISAT, BECA, Rockegeller, USAID)
Morag Ferguson, Akin Adesina, Peter Matlon, Joe Devries, Peter Newell

**<u>2. East Africa – including Mozambique, Malawi, Tanzania and Uganda</u>**

**Mozambique** (Ndiritu)

**17 may 2007**

| | |
|---|---|
| am | Cyrus Ndiritu arrive in Maputo (Sicco Koljin-IITA) |
| pm | Daviid Chikoye arrives, dinner with partners (USIAD, IITA, Technoserve, CIP, ILRI, ICRISAT, IIAM) |

**18 May 2007**

| | |
|---|---|
| am | IIAM (Calisto Bias, M.Amane, Annabela)<br>USAID (Christine de Voest)<br>Technoserve (Juma Juma) |
| pm | IIAM Tissue culture lab<br>CIP, ILRI, ICRISAT (Maria Andrade, Carlos, Doinguez) |

| | |
|---|---|
| **19 May 2007** | |
| am | flight to Nampula (Gary O' Connor, Siboniso Moyo, Calo Domingues) |
| | Cassava primary multiplication site – Nampula (E.Kanju & Amaral Chibeba) |
| pm | Dinner with partners (Martin, Richard Dixon, Gary Chitio) |
| **20 May 2007** | |
| am | CLUSA (Martin Mason) |
| | Save the Children (Richard Dixon) |
| pm | PAN-IIAM/IITA (Legumes, cassava, post harvest, tour of facilities) |
| | Private sector (feed mill, poultry farm, & Tissue culture hardening facility) |

**Malawi** (Ndiritu)

| | |
|---|---|
| **21 May 2007** | |
| am | depart for Lilongwe (Nzola mahungu) |
| | Visit Packaging Industries Malawi Limited (PIM) factory |
| | Meeting with NARS, extension partners and IITA staff |
| | Visit banana farmers' fields with partners |
| | Meet NARS-Horticulture and Roots and Tubers commodity teams. Field visit |
| pm | Visit biotech, University of Malawi |
| | Meeting with cassava farmers association and processors |
| **22 may 2007** | |
| am | Visit IITA premises, Meet CG Center partners |
| | Meet the Director of Research (Dr. Mitukuso) |
| | Meeting with key partners and individual interactions |
| pm | Meeting with Ministry officials (Secretary of Ag or J.Luhanga, CAS) |
| | Leave Malawi |

**Uganda** (Ejeta)

| | |
|---|---|
| **20 May 2007** | |
| pm | Arrival (pickup by D.Coyne-D.Coyne) |
| **21 May 2007** | |
| am | ASARECA (C.Mugoya, S.Ketema), DG-NARO |
| pm | IRS presentations |
| **22 May 2007** | |
| am | Kawanda (Drs. Tush, Magunda) |
| pm | lunch with partners NaCRRI, AGT (E.Njuki), tour of IITA facilities in Namulonge & NaCRRI, AGT(A.Bua, Y.Baguma, E.Njuki, etc.) |
| **23 May 2007** | |
| am | Depart for Dar-es-Salaam |

**Tanzania** (Ndiritu, Ejeta)

| | |
|---|---|
| **22 May 2007** | |
| | Cyrus Ndiritu arrival (Victor Manyong, S.Abele – IITA) |
| **23 May 2007** | |
| am | Field visit of panel chair to Farmers' association at Bungu |
| | Meeting with Farmers Group Themes: cassava diseases in the field (CBSD and CMD) and technology transfer to end-users |
| pm | Gebisa Ejeta arrival |

| | |
|---|---|
| | Gebisa joins panel chair and field visit of both to private sector (Power Foods) |
| | Meeting with private sector (Power Foods). Theme: value addition, markets |
| **24 may 2007** | |
| am | visit to officials at the Ministry of agriculture (Dr Haki and/or PS and/or Minister) |
| | meeting with IITA+NARS at the Meeting Room of the Ministry of agriculture |
| pm | WARDA ICRAF and Mikocheni |
| | visit to MARI Biotech lab; wrap up meeting with IITA IRS at Mikocheni |
| | Gebisa, Cyrus leave for Nairobi |

## 3. West Africa – including Ghana and Benin

**Ghana** (Edmeades, Tripp) accompanied by Dr. C. Davidson, acting DDG-Support, IITA

| | |
|---|---|
| **20 May 2007** | |
| pm | meet with Isaac Gyamfi (Stephan Weise) and STCP team |
| **21 May 2007** | |
| am | Meeting with EC Delegation Ghana Head of Section - Rural Development (Koen Duchateu) |
| pm | Telephone Conference with Mars Inc. (John Lunde) |
| | Meeting at Cocoa Research Institute of Ghana (Program by CRIG) |
| | Meeting with Executive Director and several scientists; small CRIG tour |
| | depart for Kumasi |
| **22 May 2007** | |
| am | Visit Participatory Research Site (Jeninso Village) – Fertility Management |
| | Visit Participatory Research Site (Jeninso Village) –Diversification |
| pm | Meeting at Crop Research Institute (Program by CRI) |
| | Meetings with Director Drs. Ben Asafo-Adjei, Emmanuel Otoo, and J. Afuakwa |
| **23 May 2007** | |
| am | depart Accra for Cotonou via Togo |

**Cotonou, Benin** (Edmeades, Tripp)

| | |
|---|---|
| **24 May 2007** | |
| am | Biodiversity characterization (Dr. Georgen) |
| | Biocontrol technologies (Drs Hanna and Tamo) |
| | Biological pesticides (Mycoherbicide and bioinsecicides Dr. Godonou) |
| | Post harvest food quality (Dr. Hell) |
| | Capacity building and impact assessment (Drs Coulibaly and James) |
| pm | Field visit: demonstration of bio control ( Mr Atcha) |
| | Group meeting with staff |
| **25 May 2007** | |
| am | Visit to FSA/UAC (Prof. Dr. Agbossou/Dr Vodouhè/Prof. Ahanchédé/Dr. Ahohouendo) |
| | Visit to INRAB (DG INRAB, Mme Assogba-Komlan) |
| | Visit to SPV (Director SPV/Dr. Boulga) |
| | Meet with SONGHAI Director |
| pm | Field visit at SONGHAI (Director of SONGHAI) |

**4. Nigeria – Kano (scheduled revised to visit between the 1st to 3rd of June)**

(Edmeades, Tripp)

| | |
|---|---|
| **31 May 2007** | |
| pm | arrival |
| **1 June 2007** | |
| am | Tour of Minjibir Farm |
| | Visit to IITA farmers, Bichi |
| Pm | Tour of Kano Station |
| | Meet with IITA Partners |
| | Meet with IITA Scientists based in Kano and Maiduguri |

**Annex 5**
**Geographical spread of IITA**

Geographical coverage[14]
IITA focuses its research on SSA, essentially on tropical Africa. Its scientists are located accordingly (see Figure 6 below). However, some of its strategies are designed with the whole of Africa in mind. IITA views the rest of Africa, the Sahel, as an important market for food and agricultural products that could originate out of SSA. Livestock feeds, for example, can be made from cassava and sold to the Sahel countries that tend to have large livestock populations. For some subjects—phytosanitation, regional research, agricultural trade barriers, and food-related health issues—the Institute will continue to work with Africa-wide bodies such as Forum for Agricultural Research in Africa (FARA), the RECs, and the AU.

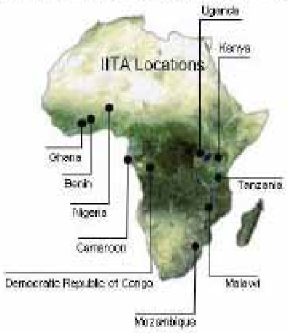


Figure 7. Current Scientist Clusters

Administratively, IITA scientists will be supported from four hubs (see Figure below). The hubs will provide some minimal level of administrative, financial, procurement, audit, and infrastructural support, as needed. The hubs will be supported by the respective Unit at Headquarters. This arrangement will evolve with improvements in technologies and access (including cost) – communication technologies, and east-west air travel.

2006

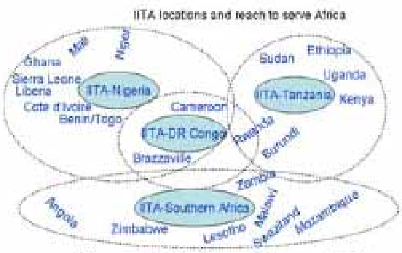


Figure 8. Regional Support Hubs.

**Annex 6**
**Indicators of Science Quality**

The heart of IITA's mission is to conduct research that addresses key issues of development in SSA. The quality of that research directly affects the impact of the center, both in the short and long terms, and is therefore of direct interest to the Panel. In seeking to address this issue the Panel recognizes that although its mandate is to review the previous five years research, a great deal of IITA's strategic research on germplasm improvement and natural resource management may take 10-15 years before its efficacy and impact can be properly assessed.

Quality of science is not easily defined, since it must always be tempered with relevance of research goals in the R4D continuum and expected return on research investment, as well as the more traditional measures of quality. The following indicators were considered by the Panel:

- Relevance of science to sub-Saharan Africa: This considers if research is strategic in nature, addresses an important constraint, whether outcomes are applicable to a large number of beneficiaries and are likely to be adopted.

- Rigor of science conducted: This includes the role of scientists in designing science components of projects; if research meets international standards of hypothesis formulation, design, methods and analysis, and if results have been published, and in what fora.

- Enabling high quality science: Is the skill set of IITA scientists adequate to meet its mandate? Is there is a critical mass of skills at IITA to address key research areas? The quality of support in statistics and information management services is considered, as well as the adequacy of laboratories and field facilities

- Maintaining science quality: Considered here is whether IITA has been successful in hiring the best scientists available, and how well it maintains and improves skills through visiting fellows, seminars, in-service training, study leaves, conferences, internet and library services. The adequacy of internal review procedures (CCERs, publications and annual research plans and evaluation of staff research) is also considered, and the challenges of short term vs. long term research are considered.

- Impacts of science: Good science should ultimately have measurable impacts, so indicators of adoption, and the rate of return on research investments are sought.

## Annex 7
## Global Importance of Bananas and Plantains

Bananas and plantains are perennial crops that grow quickly and can be harvested all year round. Records indicate that by the year 2000 there were some 9 million hectares of bananas and plantain globally with world production averaging 92 million tonnes per annum in 1998-2000 and estimated at 99 million tonnes in 2001. These figures are an approximation because the bulk of world banana production (almost 85 percent) comes from relatively small plots and kitchen or backyard gardens, where statistics are lacking. Banana and plantain are a staple food crops for millions of people in developing countries.

About 90% of production takes place on small farms and is consumed locally. Only 10%, mainly from commercial plantations in Latin America and the Caribbean, enters world trade. Much of the remaining harvest is consumed by subsistence farmers in tropical Africa, America and Asia. For most of these farmers, banana and plantain are staple foods that represent major dietary sources of carbohydrates, fiber, vitamins A, B6 and C, and potassium, phosphorus and calcium[32]. Banana is now one of the most popular of all fruits. Although it maybe viewed as only a dessert or an addition to breakfast cereal in most developed countries, it is actually a very important agricultural product in the overall global diet equation. After rice, wheat and milk, it is the fourth most valuable food. In export, it ranks fourth among all agricultural commodities.

In parts of sub-Saharan Africa and Latin America and the Caribbean, average per caput consumption is 150 to 300 grammes per day, and the crop provides 25% or more of the daily calorie intake, in addition to being a source of Vitamin B, notably B6, and potassium. Plantains are extremely rich in Vitamin A and bananas are high in ascorbic acid. During the 1980s, total production in the developing countries increased by about 15%. The importance of bananas as a food crop in tropical areas cannot be underestimated. In Uganda, for example, annual consumption per capita was some 243 kg in 1996, and between 100 and 200 kg in Rwanda, Gabon and Cameroon. In these 4 countries, bananas account for between 12 percent and 27 percent of daily calorie intake of their populations.

Diseases are among the most important factors in banana production worldwide. They are one of the major reasons for which the world's breeding programs were created and remain a primary focus of all current programs. Recently, diseases have also become principal targets of biotechnological efforts to improve this crop. The main challenges to research include breeding for resistance to Black Sigatoka disease, Fusarium Wilt (Panama disease), Bunchy Top Virus and banana weevil, alongside the development of improved production systems.

According to information available from FAOSTATS, banana and plantain are critically important in East and Central Africa (ECA) even much more than in West Africa.

For Plantain the data indicates that:
57% of plantains in SSA are produced in ECA, and 43% in WCA. In ECA the big producers are: Uganda (67%) and Rwanda (20%). In WCA production is dominated by Nigeria (24%), Ghana (24%), Cote d'Ivoire (14%), Cameroon (13%) and DRC (12%).
Production has increased at 1% /yr in ECA and about 2%/yr in WCA since 1990. Yield changes have been small or not significant in both regions.

[32] The world banana economy 19885-2002 FAOSTAT

In 1990-99 there was a small increase in production of 1-2% /yr, driven mainly by increasing yields in ECA and by area expansion in WCA.

From 2000-2005 yield increases were not significant, and increases in production were only significant in WCA.

And for the Banana:
63% are found in ECA and 37% in WCA – quite similar to the distribution of plantains. Main producers are: ECA: Uganda 45%; Kenya 16%; Burundi 17%; and in WCA Cameroon 37%, DRC 14%, Angola 14% and Cote d'Ivoire 7%.

Production in the period 1990-2000 has risen by 1.4%/yr in ECA, but is unchanged in WCA. In recent years (2000-2005) production has increased at 1.6-3%/yr from increased yields. Area planted has remained unchanged.

The importance of the banana and plantain in Africa is underscored by the priority rating these crops have been given by the sub-regional organizations like ASARECA and CORAF/WECARD, and particularly so in the ECA countries where Banana and plantain are in the top four commodity and factor research priorities.

**Annex 8**
**Recommendations of the CCER of the Systemwide Program on Integrated Pest Management (Conducted May 2007)**

[All the Recommendations were accepted by the IITA Board and Management].

**Recommendation 1**: *The SP-IPM coordinator should prepare a short report indicating how cross-cutting research on IPM addresses CGIAR System Priorities.*

**Recommendation 2**: *The cross-cutting approaches used in the SP-IPM Medium-term Plan for 2007-09 should be used as the basis for further research planning.*

**Recommendation 3**: *The Program should develop clear criteria for identifying a limited number of new thematic areas of research in which there is clear added value to the majority of the partners.*

<u>The governance and management of the SP-IPM were reviewed with regard to structure and membership of governance and operational arms, roles and responsibilities and implementation mechanisms.</u>

The structure and membership of the operational arms of the SP-IPM have evolved from a community of practice to a formalized Steering Committee and IIWG. Currently both bodies have overlapping membership and include CG and non-CG partners. The review team considers that the Steering Committee has more members than needed to perform its essential functions and be representative and effective. The merit of having an independent Chair of the Steering Committee should be considered. The roles and responsibilities of the governance and operational arms of the SP-IPM were revised and further formalized at the 2007 Steering Committee meeting. The lack of TORs for the IIWG needs to be addressed. The team also feels that the confusion regarding the equity of non-CG members needs resolution. Restricting the Steering Committee to exclusively CG members is unlikely to continue to foster the open and willing exchanges enjoyed in the past. It is also likely to be a disincentive for non-CG members to participate even in the IIWG. The added emphasis on policy analysis in the MTP 2007-2009 will require this expertise to be represented in the IIWG. The development of TORs for the Convening Center and its Board of Trustees has strengthened the governance of the program. The critical positions for effective and efficient functioning of the SP-IPM are considered to be the Chair of the Steering Committee and the Coordinator. Ideally, the Chair and the Coordinator should have global IPM vision and international reputations in IPM to enhance the profile of the program and to give it stronger visibility in the CG and the donor community. Resource mobilization is considered to be one of the most important responsibilities of both the Chair of the Steering Committee and the Coordinator.

**Recommendation 4a:** *If the SP-IPM continues with the existing structure, it is recommended that it carefully considers the membership of the Steering Committee and IIWG whereby all significant partners can participate in the processes of program planning and priority setting and decision-making is inclusive, fair and transparent.*

**Recommendation 4b:** *It is recommended that the SP-IPM resolves the current confusion and carefully considers the merit of a smaller but representative Steering Committee (largely elected on a rotational basis from members of the IIWG) to enhance the effectiveness and transparency of decision-making processes and resource allocation.*

**Recommendation 5:** *It is recommended that the SP-IPM considers seeking a Chair who is not associated with either a CG or a non-CG member for greater independence in decision-making. For enhancing the profile of the*

*SP-IPM, it would be desirable to seek a person with an international reputation in IPM. With the enhanced emphasis of the SP-IPM on policy analysis, it is also recommended that a member with policy analysis expertise be invited to join the IIWG.*

**Recommendation 6:** *It is recommended that the SP-IPM should develop TORs for the IIWG to highlight its roles as a discussion and priority-setting forum and clearly distinguish its responsibilities from those of the Steering Committee with which it currently shares many members. It is also recommended that annual evaluation of the Chair be included in the TORs of the Steering Committee and the evaluation report should also forwarded to the Convening Center.*

**Recommendation 7:** *It is recommended that the SP-IPM take account of the suggestions made concerning the required qualities of both the Chair of the Steering Committee and the Coordinator when recruiting for these positions in 2007. It is also recommended that the responsibilities of the two positions for resource mobilization should be greatly enhanced. In addition, the Chair and the Coordinator should consult with existing donors to the SP-IPM on what they expect from the program.*

As part of the revival process of the SP-IPM, an externally facilitated workshop should be organized in 2007 to discuss the recommendations of the CCER and the EPMR and to effectively operationalize those recommendations on focus, value-addition, substance and process including: improved research planning and priority-setting processes including necessary capacity building; transparent funding allocation to program activities; innovative funding streams; a phased resource mobilization plan; and accepting and operationalizing the MTP 2007-2009.

**Recommendation 8:** *It is recommended that as part of the revival process the SP-IPM implements an externally facilitated workshop in 2007 to discuss the recommendations of the CCER and the EPMR and to effectively operationalize those recommendations on focus, value-addition, substance and process.*

**Recommendation 9:** *It is recommended that the SP-IPM gives urgent attention to improving its priority setting processes and focuses on no more than three key priority themes during the revival phase. In order to achieve a more equitable, demand-driven and transparent process, external facilitation of priority-setting may be needed initially.*

**Recommendation 10:** *It is strongly recommended that a transparent procedure on 2007 funding allocation be urgently agreed among SP-IPM members based on a) achievement of the outputs in the approved MTP 2007-2009 log-frame, b) start-up development of a selected and further prioritized group (no more than 3) of the identified emerging R4D and c) other activities recommended by this review e.g. facilitated capacity building workshops for SP-IPM members. It is also recommended that the SP-IPM seek more innovative and transparent ways of funding its activities based on proven examples used in other system-wide programs.*

**Recommendation 11:** *It is recommended that the SP-IPM urgently develops a phased resource mobilization plan based on focused and realistic outputs to re-build the program and, especially, on donor intelligence.*

Based on the Science Council ruling of 2005, the SP-IPM now reports both technically and financially through the Convening Center, IITA. Unfortunately, this has fostered a perception that the SP-IPM is an IITA program. To avoid such perceptions, activities supported by the SP-IPM in individual centers should be attributed to the program in all reports. In addition, reporting to the current donor SDC must be improved.

**Recommendation 12:** *To avoid further misconceptions and confusion of attribution, it is recommended that the SP-IPM should identify centers involved in all inter-center activities in its reports and in the rolling MTPs* *and that individual centers explicitly acknowledge support from the SP-IPM in their reports and rolling MTPs. It is also recommended that the SP-IPM Coordinator clarifies future reporting requirements with SDC.*

Apart from the EPMR, annual meetings of the Steering Committee and the IIWG appear to be the only other opportunities for monitoring project activities. Currently, a robust internal system for monitoring and evaluation is lacking in the SP-IPM. The team feel that internal monitoring should be an important responsibility for the Coordinator through site and partner visits. However, this needs to be embedded in a SP-IPM monitoring and evaluation system.

**Recommendation 13:** *It is recommended that the SP-IPM builds an effective internal monitoring and evaluation system that will accommodate on-going monitoring and formative evaluation of both program management and research progress as well as ex ante and ex post evaluation of projects to demonstrate links between research and poverty alleviation. It is also recommended that the SP-IPM contract a consultant to help to develop and establish such a system in the program.*

There are some good examples of CGIAR pest management and IPM research which have resulted in significant impact. There has been limited assessment of the impact of technical interventions in the SP-IPM to date from either projects and/or pilot sites.
The review team believes that there may also be evidence of significant impact from work conducted at some of the SP-IPM pilot sites. Benefits appear to have been greatest at the Morocco pilot sites. Studies are needed in 2007 to capture this potential impact.

**Recommendation 14:** *It is recommended that priority should be given to impact assessment in those pilot sites where significant achievements appear to have been made e.g. Morocco and Kenya. It is also recommended that - funding permitted – the SP-IPM should initiate actions to ensure that as much as possible is achieved by the program in 2007 to contribute to future outputs in the MTP 2007-2009 through investment in appropriate activities as outlined above.*

Options to pursue the SP-IPM in future.

A new rolling MTP for 2008-2010 will be submitted to the Science Council in 2007. Firstly, it is hope that the timing will allow the critical recommendations made by the CCER and EPMR to be included so that there is initial buy-in and ownership by SP-IPM members and the revival process can proceed rapidly. Secondly, the team strongly feels that the MTP 2007-2009 effectively captures the concept of *adding-value* to center and global IPM activities and should be given a chance to be further operationalized. This is considered to be the best option for pursuing the SP-IPM in future. The added value is targeted at key bottlenecks especially on methodology. This area is supported by the SDC. In addition, the generic outputs on impact assessment, policy, communication and advocacy allow new areas of work i.e. new themes to be accommodated easily without major changes to the logframe from one year to the next.

**Recommendation 15:** *It is recommended that the SP-IPM accepts the MTP 2007-2009 as a rolling MTP during its remaining lifetime, with modifications for specific activities (e.g. a limited number of new R4D themes), as it effectively captures the concept of adding-value to center and global IPM activities.*

A sequence of actions for full revival of the SP-IPM to a functional system-wide program in 2008 is provided.

**Annex 9**

**Description of the thrust and achievement of the crop breeding program at IITA, 2001-2006.**

## 1. Cassava

### 1.1.Program Thrust:

**Geographical Focus**: Humid forest, moist savanna, dry savanna and midaltitude agroecological zones.

**Major constraints addressed**:

**Biotic**: Cassava mosaic disease (strains & variants), Cassava brown streak disease, bacterial blight, root rots, anthracnose disease, green mite and root and tuber scale.

**Abiotic**: Soil acidity, soil fertility, drought.

**Nutritional**: Root dry matter/starch content, mealiness (cooking quality), cyanide content, and beta-carotene and protein contents.

**Others**: Postharvest physiological deterioration (PPD).

**New Opportunities**:

- Industrial and diversified uses (e.g. high root starch content, starch quality such as waxy starch, and high sugar content for bio-ethanol production)
- Livestock feed (e.g. high root and foliage yield and protein content).

### 1.2 Major Linkages:

**NARS**: 19 NARS in West and Central Africa: *EARRNET (9 NARS in East Africa), and SARRNET (12 NARS in Southern Africa), EMBRAPA and IAC in Brazil.
*DR Congo and Tanzania common to both EARRNET and SARRNET

**ARI**: University of Copenhagen, German Collection of Microorganisms and Cell Cultures (DSMZ), Plant Virus Division, Braunschweig, Germany), Ohio University, Donald Danforth Plant Science Center (Mo), Swiss Federal Institute of Technology, Zurich (ETH), Joint FAO/IAEA Agriculture and Biotechnology Laboratory of the International Atomic Energy Agency, Austria, HarvestPlus Challenge Program (Consortium of universities and research institutions worldwide), BioCassava Plus of the Grand Challenges in Global Health initiative (Consortium of universities and research institutions worldwide), and Generation Challenge Program (Consortium of universities and research institutions worldwide).

### 1.3 Program Achievements

**No. cultivars released**: 48 varieties in 12 African countries (See appendix 1 attached).

**No. cultivars registered**: -

**No. cultivars deployed**: (area if known): -

**No. journal publications**: **268**

- Journal Article: 62
- Book Chapters: 2
- Edited Conference Proceedings: 28
- Monographs: 2
- Manuals and Technical Bulletins: 6
- Invited Conference Papers: 12
- Conference/Workshop papers: 37
- Abstracts and Newsletters: 115

Appendix 1. Official varietal releases of improved cassava by NARS between 2001 and 2006:

| Year | Country | Variety name | No. | Source material |
|---|---|---|---|---|
| 2002 | Sierra Leone | SLICASS 1, SLICASS 2, SLICASS 2, SLICASS 4, and SLICASS 5 | 5 | IITA seed populations |
| 2002 | Central African Rep | +TMS 91/02322 and TME 1 | 2 | IITA tissue culture clones |
| 2002 | Gambia | TMS 89/00959, TMS 90/01204, TMS 91/02312, and TME 12 | 4 | IITA tissue culture clones |
| | Guinea Conakry | TMS 92/0057, 91/0730, 92B/0033, and TME 12 (Tokunbo) | 4 | |
| 2002 | Malawi | CH92/077 (Sauti) and CH92/112 (Yizaso) | 2 | IITA seed populations |
| 2002 | Togo | TMS 92/0326 | 1 | IITA tissue culture clones |
| 2003 | Burkina Faso | TMS 91/02312, TMS 92/0067, TMS 92/0427, TMS 92/0325 and TMS 4(2)1425 | 5 | IITA tissue culture clones |
| 2003 | Ghana | TMS 91/02327, TMS 91/02324, and TMS 92/0427 | 3 | IITA tissue culture clones |
| 2004 | DR Congo | TMS 95/0211 (Disanka), TMS 95/0528 (Mvuazi), TMS 96/0160 (Nsansi), MV 99/0395 (Butamu), MV 99/0038 (Zizila), MM 96/0287(Liyayi), and MM 96/7204 (Namale) | 7 | IITA tissue culture clones and seed populations |
| 2004 | Swaziland | Clones 160, 48 & 65, TMS 92/0326, and Rushinga | 5 | IITA tissue culture clones and seed populations |
| 2005 | Benin | TMS 91/02322 (Manina), TMS 92B/00061(Ina – H), TMS 92/0427(Ina – Premier), and TMS 92/0067 (MR-67) | 4 | IITA tissue culture clones |
| 2005 | Ghana: | TMS 97/4962 (Abglifa), TMS 97/4414 (Bankyehemaa), TMS 97/3982 (Esam bankye), and TMS 97/4489 (Doku duade) | 4 | IITA tissue culture clones |
| 2005 | Nigeria | TMS 97/2205, TMS 98/0505, TMS 98/0510, TMS 98/0581, and TME 419. | 5 | IITA improved clones |
| 2006 | Nigeria | TMS 92/0326, TMS 92/0057, TMS 96/1632, TMS 98/0002, and NR 87184. | 5 | IITA improved clones and seed populations |
| 2006 | Sierra Leone | TMS 92/0057 (SLICASS 6) | 1 | IITA tissue culture clones |

+TMS=Tropical *manihot* selection (IITA designation for improved genetic materials distributed as in vitro clones
TME=Tropical *Manihot eculenta* = Selection of IITA genetic stocks from landraces distributed as in vitro clones
Others are selections from IITA improved seed populations by NARS

**Major research breakthroughs:**

- Seven additional sources of resistance to CMD identified in landraces collected from West Africa and used to diversify and heighten resistance for durable control.
- Shattering of cassava yield plateau through massive use of African landraces and Latin America germplasm (increased yields in many African locations by 50-100% even without the use of fertilizer).
- After three cycle of recombination and selection using existing IITA parents (baseline β-carotene - ~4μ/g) and introduced beta-carotene germplasm from CIAT and Brazil for population improvement, promising clones were identified with as high as 12 μ/g of total carotene (>10μ/g β-carotene) indicative of a high possibility of hitting the HarvestPlus target level for β-carotene content (15μ/g) in cassava that will have biological impact on human nutrition.
- Significant advances in broadening the genetic base of cassava in Africa and producing over 400 improved cassava genetic stocks and breeding materials which combines enhanced CMD resistance with improved post harvest qualities, multiple pest/disease resistance, wide

agrocological adaptation and greatly improved yield potential (which may also be used directly as varieties) and shared with NARS.

- Increasing number of improved varieties released by NARS in major cassava producing countries of the cassava belt as a result of broadening the genetic base of cassava at IITA with Latin American germplasm and the increased use of African landraces in the breeding program.

## 2. Yams

### 2.1 Program Thrust

**Geographical Focus**:

Primary = West and Central Africa
Secondary = East and Southern Africa
Tertiary = Yam growing zones outside Africa

**Major constraints addressed:**

**Biotic:**

Y*am Mosaic Virus* (YMV) *genus Potyvirus*,
Yam Anthracnose Disease (*Colletotrichum gloeosporioides*),
Nematodes (*Scutellonema bradys* and *Meloidogyne* spp.),
Yam tuber rots (*Botryodiplodia theobromae, Aspergillus* spp., *Fusarium* spp.)

**Abiotic:**

Low soil fertility

**Nutritional:**

Low tuber micronutrient density
Tuber content of antinutritional factors (phytate and tannins)

**Others:**

Low tuber yields
Poor texture of cooked tuber in *Dioscorea alata*
Enzymatic browning of tuber
Key plant characteristics (e.g. tuber morphology) responsible for high labor requirement for cultivation

**New Opportunities:**

Expansion of yam cultivation and use in East and Southern Africa in partnership with selected NARS
Application of DNA markers in marker-assisted selection
Potential for interspecific hybrids between *Dioscorea rotundata* and *D. alata*

**2.2 Major Linkages**

| Organization | Role |
|---|---|
| **NARS** | |
| Center National de Recherche Agronomiques (CNRA), Côte d'Ivoire | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Savanna Agricultural Research Institute (SARI), Ghana | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Crops Research Institute (CRI), Ghana | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Institute Togolais des Recherches Agronomique (ITRA), Togo | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Institut National des Recherches Agricoles du Bénin (INRAB), Benin | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Institut National d'Etudes et de Recherches Agricoles (INERA), Burkina Faso | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Institute of Agricultural Research (IAR), Sierra Leone | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| National Root Crops Research Institute (NRCRI), Nigeria | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Institute of Agricultural Research and Training (IAR&T), Nigeria | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| State Agricultural Development Projects (ADP), Nigeria | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Institute for Agricultural Research & Training (IRAD), Cameroon | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Kizimbani Research Station, Ministry of Agriculture and Natural Resources, Zanzibar | Development of improved germplasm; testing rapid propagation techniques; training; and linkage with extension and private sectors |
| Jomo Kenyatta University of Agriculture and Technology and Kenya Agricultural Research Institute (KARI) | Studies on the distribution, diversity and conservation of yam species in Kenya; training of postgraduate students |
| University of Cocody, Cote d'Ivoire ; and Center Suisse de Recherches Scientifiques (CSRS) en Côte d'Ivoire | Development of improved yam germplasm; and testing of technologies for rapid propagation of clean planting materials |
| Bowen University, Nigeria | Characterization of Nigerian yam landraces for food and nutritional attributes |
| University of Ibadan, Nigeria | Research on interspecific hybridization; training of postgraduate students |

| | |
|---|---|
| Michael Okpara University of Agriculture, Nigeria | Molecular characterization of yam germplasm; training of postgraduate students |
| Kwame Nkrumah University of Science and Technology, Ghana | Molecular characterization of yam germplasm; training of postgraduate students |
| Copperbelt University, Zambia | Collection, maintenance and characterization of local yam germplasm |
| West Africa Seed Network (WASNET) | Facilitation of sub-regional priority setting and information exchange on the seed sector |
| | |
| **ARI** | |
| Center de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Benin | Molecular analyses of yam biodiversity ; field evaluation of yam germplasm |
| Virginia State University, USA | Development of ESTs |
| University of Reading, UK | Collaborative studies on yam flowering and tuber dormancy |

### 2.3 Program Achievements

**No. cultivars released:** 8 official releases (7 in Nigeria and 1 in Ghana);

[Nigeria: TDr 89/02677, TDr 89/02565, TDr 89/02461, TDr 89/01438, TDr 89/01213, TDr 95/01924, TDr 89/02665
Ghana: TDr 89/02665]

**No. cultivars registered:** 0

**No. cultivars deployed:** The area covered has not been determined but our varieties are grown by several farmers (with or without official release) in at least the following countries: Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Tchad, Sierra Leone, Guinea, Uganda, Zanzibar, South Pacific Islands, and Colombia

**No. journal publications:** 25

**Major research breakthrough:** High levels of host plant resistances to the two main diseases – Yam Mosaic Virus and Yam Anthracnose Disease

## 3. Maize

### 3.1 Program Thrust:

**Geographical Focus:**

Lowland and to a lesser extent, mid-altitude locations of West and Central Africa.

**Major constraints addressed:**

**Biotic***:*
*Striga*, stem borers, diseases (ear rot, maize streak virus, downy mildew, curvularia leaf spot , blight, and rust)

**Abiotic***:*
Drought and low soil nitrogen

**Nutritional***:*
QPM, Aflatoxins, Vitamin A, Iron and Zinc,

**Others***:*
End-user preferred traits – earliness for double planting and filling the hunger gap, floury grain type.

**New Opportunities:**

i. Multiple stress tolerance (drought, low-N, *Striga*, stem borers)
ii. Nutrient dense maize (QPM, Vita A, Iron and Zinc)
iii. New breeding approaches – use of markers for rapid selection
iv. Specialty corn for peri-urban areas for income generation
v. High grit yield for the brewery industry
vi. Catalyze establishment of viable seed sector to improve adoption of improved varieties and hybrids

**3.2 Major Linkages:**

**NARS**: All the 21 CORAF/WECARD member countries of WCA

**ARI:**

*i.* Collaboration with the Purdue University to adapt laboratory bioassays to identify different pre- and post-attachment mechanisms of resistance to *Striga.*
ii. In collaboration with IITA, SRRC-USDA-ARS Louisiana has invested considerable amount of resources and effort to combat the problem of ear rot and the associated aflatoxin contamination in maize.
iii. USDA-ARS at Ithaca has a collaborative research with the IITA Maize Program to assess the suitability of an in vitro digestion model (Caco-2 cell model), which mimics the human digestive system, for determining iron bioavailability in maize.
iv. To confirm the usefulness of Caco-2 cell model for predicting bioavailability, another collaborative research was undertaken with USDA-ARS Grand Forks Human Nutrition Center using single meal trials with women.
v. A collaborative research between IITA and University of Illinois has been initiated to identify and characterize genes that are expressed under sub-optimal soil nitrogen.
vi. In collaboration with the University of Illinois, IITA has accessed inbred lines with high levels of pro-vitamin A carotenoids for use as donor parents for increasing the levels pro-vitamin A content in adapted germplasm.

**3.3 Program Achievements**

**No. cultivars released:**

9 OPVs
6 hybrids

**No. cultivars registered:**

78 inbred lines.

**No. cultivars deployed:**

More than 15 cultivars are currently being grown by farmers in different countries of WCA without formal release. For example, in Nigeria, two extra early STR cultivars (2000 Syn EE-W and 99 TZEE-Y STR), drought tolerant cultivars, TZDT Syn-W and TZE-Comp 3 DT and the stem borer resistant cultivar, Ama TZBR-W are being grown without formal release. More than 1.2 million kg commercial seed of these deployed varieties have been produced for four years, enough for planting 60,000-70,000 hectares.

**No. journal publications:**

52 articles published.

**Major research breakthroughs:**

i. Maize varieties having >15% more yield than standard checks have been developed and promoted in WCA.

ii. Recurrent selection for tolerance to low soil-N increased grain yield in one of the populations by 147 kg $ha^{-1}$ $cycle^{-1}$ at 0 kg N $ha^{-1}$ and 116 kg $ha^{-1}$ $cycle^{-1}$ at 90 kg N $ha^{-1}$.

iii. A new generation of late maturing drought tolerant varieties, whose productivity exceeds that of a common farmers' variety, TZB-SR, in the savannas by 40-60% are currently under test. Hybrids have also been developed from drought tolerant inbred lines that produce 42-128% more grain under drought stress than a widely grown commercial hybrid (Oba Super II) in Nigeria.

iv. Evaluation of new cycles of selection other populations improved for resistance to stem borers under artificial infestation with *Sesamia* and *Eldana* revealed an average yield gain of 7% from recurrent selection.

v. Recurrent selection under artificial *S. hermothica* infestation has significantly improved *Striga* damage rating, number of emerged *Striga* plants and grain yield under *Striga* infestation in two broad-based populations. The realized gain from selection for grain yield under *S. hermonthica* infestation was 14% per cycle in the intermediate and 26% per cycle in the late populations. The different extra-early, early and late maturing populations have been sources of varieties and inbred lines with consistently high levels of resistance to *S. hermonthica* across locations and seasons. Extra-early- and early- maturing *Striga resistant* maize varieties that sustain 14-43% less *Striga* damage, support 18-32% fewer emerged parasites and produced 1.0-1.8 ton per hectare more grain under infestation than the respective susceptible variety have been developed from source populations

vi. Herbicide resistant hybrids have been developed. Most of the herbicide resistant hybrids were competitive to a commercial hybrid, Oba Super I, in yield potential in *Striga*-free plots. The herbicide resistant hybrids producing 2.5-5.5 ton per hectare grain with seed treatment in *Striga* infested plots, while the commercial hybrid did not produce any grain yield with seed treatment.

vii. Diversity analysis of 41 *Striga* resistant maize inbred lines was conducted with AFLP and SSR markers to examine the genetic relationships among these lines and to determine the level of genetic diversity that exists within and between their source populations. Genetic similarities among all possible pairs of inbred lines varied from 0.45 to 0.95, with a mean of 0.61±0.002, for AFLPs and from 0.21 to 0.92, with a mean of 0.48±0.003, for SSRs. The inbred lines from each source population exhibited a broad range of genetic similarity values with the two types of markers. Further analysis of genetic similarity estimates with the two markers revealed clear differentiation of the *Striga* resistant inbred lines into groups according to their source populations.

viii. Three wild species and two QPM inbred lines, 21 inbred lines with high pro-vitamin A content, and 21 local collections have been introgressed into adapted breeding lines or populations.

ix. Four extra-early, ten early and nine late maturing drought tolerant and/or *Striga* resistant varieties adapted to the lowlands have been converted to QPM and are being evaluated through regional or on-farm trials in partnership with the NARS of WCA and SG2000.

x. Promising elite maize inbred lines with relatively high pro-vitamin A (4.5 to 9.8 $\mu g\ g^{-1}$), iron (24 to 42 $mg\ kg^{-1}$) and zinc (26 to 88 $mg\ kg^{-1}$) content identified.

xi. Several promising S5 lines with aflatoxin values significantly lower than the respective US resistant recurrent parent or the elite tropical inbred parent have been selected for resistance-confirmation tests.

## 4. Cowpea

### 4.1 Program Thrust

**Geographical Focus**: Global mandate with more emphasis in the Sub-Saharan Africa.

**Major constraints addressed:**

**Biotic**:

- Insects:
  - Aphid
  - Thrips
  - Maruca pod borer
  - Complex of pod sucking bugs
  - Bruchid
  - Lygus (in US)
  - Bean fly
  - Ootheca beetles
- Diseases:
  - Fungal diseases: anthracnose, web blight, brown blotch, Cercospora leaf sport, Septoria, scab and Macrophomina
  - Viral diseases: cowpea yellow mosaic, cowpea aphid borne mosaic, blackeye cowpea mosaic, cowpea severe mosaic and southern bean mosaic
  - Bacterial diseases: bacterial blight and bacterial pustule
- Nematodes:
- Parasitic weeds:
  - *Striga gesnerioides* and *Alectra vogelii*
-

**Abiotic**:

- Drought:
  - Intermittent moisture stress
  - Terminal drought

- Low soil fertility:
    - Low organic matter
    - Low phosphorus
- Heat and cold

**Nutritional:**

- Micronutrient:

**New Opportunities:**

- Breeding for specialty foods
- Breeding for high protein and micronutrients
- Breeding for faster cooking

## 4.2 Major Linkages

**NARS**:

- ABU/IAR (Nigeria)
- INRAN (Niger)
- IRAD (Cameroon)
- INERA (Burkina Faso)
- SARI (Ghana)
- ISRA (Senegal)
-

**ARI:**

- UVA (US)
- CSIRO (Australia)
- John Innes Center (UK)

## 4.3 Program Achievements

**No. cultivars released:**

79 cultivars released from 1985-2000
IT99K-499-35 is released in Nigeri

**No. cultivars registered**:

19 cultivars registered (13 publications in Crop science)

**No. cultivars deployed:**

About 70 new advanced lines per year through Cowpea International Trials

**No. journal publication:**

More than 110 (articles, book chapter, abstracts…)

## 5. Soybean

### 5.1 Program Thrust

**Geographical Focus**:

Mid-altitudes, forest zones, Guinea and Sudan savannas

**Major constraints addressed**:

**Biotic:**
Diseases (bacterial pustule, frogeye spot, rust, soybean mosaic virus) and insect pests (defoliators and pod sucking bugs)

**Abiotic**
Low P in some soils, mid-season low moisture stress

**Nutritional:**
Processing and utilization methods

**Others**
Ability to fix $N_2$, lodging, pod shattering, high grain and stover yields (dual-purpose), capacity to stimulate germination of *Striga,* seed size and color, seed longevity

**New Opportunities**
Demand for soybean is increasing for food and feed (establishment of poultry farms and oil extraction businesses) in Africa. The role of soybean in improving soil health (fertility) is also making it a relevant legume in cereal dominated farming system of tropical Africa

### 5.2 Major Linkages:

**NARS:**
Many NARS depend on IITA materials to develop varieties. In 2001 alone, 15 dual-purpose soybean lines with a grain yield of 2-2.5 t/ ha and stover yields of 2.5-3.5 t/ha were supplied to collaborators in 21 National Agricultural Research and Extension Systems (NARES) in Africa, three in Asia, and one in the US. In 2002, 42 sets of soybean international trials involving 20 promising soybean lines were distributed to 36 collaborators in 21 countries on request. This collaboration is undertaken every year. A material selected from TGx 1835-10E developed at IITA was released in Uganda as a variety named MAKSOY 1N. This variety combines resistance to rust with resistance to pod shattering and lodging.

**ARI:**
IITA has initiated a collaborative project with USDA-ARS at the National Soybean Research Laboratory in the University of Illinois to develop soybean lines for resistance to soybean rust.

### 5.3 Program Achievements

**No. cultivars released:**
4 [TGx 1910-11F (early), TGx 1905-2F (medium), and TGx 1910-8 (late)]and TGx 1835-10E (MAKSOY 1N)

**No. cultivars registered**:
TGx 1835-10E (MAKSOY 1N) in Uganda

**No. cultivars deployed**: -

**No. journal publications**: 13

**Annex 10**
**Geographical foci of the breeding programs**

| | |
|---|---|
| Cowpea | 23 |
| Soybean | 1 |
| Maize | 78 inbred lines registered |
| | 9 released OPVs |
| | 6 released hybrids |

| Year | Country | Variety name |
|---|---|---|
| 2000 | Uganda | NASE 10, NASE 11 and NASE 12 |
| 2002 | Sierra Leone | SLICASS 1, SLICASS 2, SLICASS 2, SLICASS 4,and SLICASS 5 |
| 2002 | Central African Rep | TMS 91/02322 and TME 1 |
| 2002 | Gambia | TMS 89/00959, TMS 90/01204, TMS 91/02312, and TME 12 |
| 2002 | Malawi | CH92/077 (Sauti) and CH92/112 (Yizaso) |
| 2002 | Togo | TMS 92/0326 |
| 2003 | Bukina Faso | TMS 91/02312, TMS 92/0067, TMS 92/0427, TMS 92/0325 and TMS 4(2)1425 |
| 2003 | Ghana: | TMS 91/02327, TMS 91/02324, and TMS 92/0427 |
| 2004 | Swaziland | Clones 160, 48 & 65, I92/0326, and Rushinga |
| 2005 | Ghana: | TMS 97/4962 (Abglifa), TMS 97/4414 (Bankyehemaa), TMS 97/3982 (Esam bankye), and TMS 97/4489 (Doku duade) |
| 2005 | Nigeria | TMS 97/2205, TMS 98/0505, TMS 98/0510, TMS 98/0581 and TME 419. |
| 2006 | Benin | 92/0427 (Ina Premier), 92B/00061 (Ina-H), 91/ 02322 (Manina 91), and 92/ 00067 (MR-67) |
| 2006 | Sierra Leone | TMS 92/0057 (SLICASS 6) |

In late 2006, an additional 5 varieties were also released in Nigeria.

Varietal Releases of a) cereals and legumes and b) root and tubers by IITA in the review period.

## Annex 11

## Natural Resource Management (NRM) Research at IITA over the past decade

**Status of natural resources related to agriculture in sub-Saharan Africa:** The agricultural environment in this region is characterized by declining soil fertility status, under-exploited water resources and aggressive weeds that are difficult to manage. Research on each of these falls within the IITA mandate, and management and conservation of natural resources is one of its major goals. Population increase is averaging 2.2% annually despite the ravages of AIDS, but annual percent increases in yield per unit area of mandated crops, with the exception of maize and soybean in WCA, and cassava and yams in ESA, are all less than this, and many are < 1% per annum. The panel is of the opinion that some key elements of NRM, especially nutrient management, have moved to the back burner of IITA's research agenda. Their continued neglect could see the soil resource of SSA irreparably damaged, while water resources remain unexploited. This paper draws heavily on an IITA-prepared paper on NRM provided to the panel.

### A brief history of NRM research at IITA

Ten years ago scientists in NRM & Agronomy were part of the RCMD and were divided into two groups (humid forest and savanna systems) with several disciplines represented in each. The forest group studied primarily soil acidity and nutrient response, while the focus of the savanna group was animal-plant interactions, biological N fixation, P interactions, and Striga. There was little or no emphasis on fertilizers, since improvement of low input systems was the major goal. Agroforestry (maize-*Leucaena*) systems were developed, but were generally not adopted, and were followed by development of herbaceous legume systems (N fixation and forage). A CCER conducted in 2001 recommended that external inputs again be considered, so fertilizers and pesticides were combined with the best technologies of the previous years. The Humid Forest NRM team has since been disbanded, and the system-wide program, Alternatives to Slash and Burn has lost momentum in SSA. The Savanna NRM team, based in Kano, is now an integral part of the Grain Legumes and Cereals MTP Project.

Over the last decade NRM research has been focused around benchmark sites that were reference areas characteristic of major target areas (agroecological zones or megaenvironments). The extent of the extrapolation of results was then determined by using AEZ definitions, climate data, and GIS techniques. Recently the importance of benchmark sites has been de-emphasized. This was mainly because of their location (often isolated), the effort taken to characterize them, and factors that rendered them less representative of large areas than first supposed, resulting in significant genotype x environment interactions between them and parts of the target area. In several instances models based on benchmark sites suggested that some technologies would not be feasible (e.g. growth of *Mucuna* in the forest and transition zones), and have been proved wrong by farmers' experience. Nonetheless, they have proved useful in allowing IITA scientists to prioritize among production constraints based on the size of expected impact.
The 5$^{th}$ EPMR noted (p50) that "continued investment by IITA on leguminous cover crop trials, animal manures and crop residues would appear to be a case of diminishing returns", and suggested a shift in emphasis from experimentation to collation of "best bet" technologies based on existing data. The Panel therefore is interested in assessing if this suggestion has resulted in change.

**A: NRM issues in the savannas, derived savannas and forest transition zone**

In the next decade it seems likely that savannas of WCA will be largely under continuous cultivation, so managing erosion, problem weeds, declines in soil organic matter (SOM) and nutrients, insect pests and diseases of cereals and legumes will be key to sustained and increased production. Opportunities for expanding crop area will be fewer. Many have regarded the savannas as the future key to large scale modernized food production in West Africa.

**Soil fertility:** The striking feature of SSA is the lack of fertilizer usage on the continent, which accounts for less the 1% of fertilizer usage globally. The average annual application rates over the cropped area are 8 kg/ha (regionally 16 kg/ha in southern Africa, 8 kg/ha in eastern Africa, and only 3 kg in Central Africa and 4 kg/ha in Sudano-Sahelian zone). This compares with 96 kg/ha in S and SE Asia, 101 kg/ha in south Asia, and 78 kg/ha in Latin America (Morris et al., 2007). In 2000 average cereal yields in SSA, E & SE Asia, S Asia and Latin America were 1.0, 3.4, 2.4 and 2.9 t/ha (FAOSTAT, 2007). Annual growth rates of yield between 1980 and 2000 were 0.7% in SSA, vs. 1.7 – 2.3% in other regions. The loss of SOM and fertility in the savannas is greater than in the forest, largely because of overgrazing, overpopulation, and the long history of annual burning of crop residues and forest. The 5$^{th}$ EPMR (p49) noted that "another well learnt, costly lesson is that low input systems without fertilizer have failed to provide adequate productivity gains in the resource-poor and degraded conditions that characterize much of SSA". Low input systems are also low output systems. These low rates of nutrient addition have been accompanied by a sharp reduction or disappearance in fallows, deforestation and soil degradation. Nutrient mining is enormous, exceeding 30 kg nutrients/ha/yr on as much as 85% of the cropped land in SSA, and could reach 60 kg/ha on 40% of it – for a net loss of at least 4 million tons of nutrients annually in SSA (Morris et al., 2007; http://www.africafertilizersummit.org/FAQ.html).

Fertilizer usage in SSA grew rapidly in the 60s and 70s, but stagnated and fell in the 80s and 90s to its current level of 1.3 million tons/yr, in part because market reforms removed fertilizer subsidies. Despite the presence of raw materials (natural gas in Nigeria; rock phosphate in Togo), almost all fertilizer is imported, and shallow ports prohibit entry of large bulk carriers. There is no regional collaboration in ordering key fertilizers for smaller countries, nor is there evidence of regional strategies for importing specific nutrients. For example, there is little evidence for response to K of crops (with the possible exception of cassava) on West African alfisols, yet much is still imported as compound fertilizer (e.g. 15-15-15).

Zinc deficiency may be widespread on Guinea savannah soils, and as it worsens it reduces crop response to major nutrients. Zinc availability in alfisols is correlated (r=~0.6) with soil organic matter level (SOM), so as this falls, zinc becomes more scarce. In many of the savannas SOM is now less than 1%. In general there is a gradient of increasing response to applied zinc from the forest through transition zones to the Guinea and Sudan savannas (Twumasi-Afriyie and Edmeades, 1983). Little or no zinc is added to compound fertilizers, however, despite its low cost/benefit ratio. In former times when vegetative cover was more adequate on the savannas, the area was often subject to annual fires, and elements such as S and N were volatilized. The loss of S was offset to some extent up till the 80s by the use of single superphosphate, but cropping intensity has increased in the last 20 years and fertilizer use has fallen away or been replaced with high analysis fertilizers that often do not contain S.

It is critical that a concerted effort be made to ensure a steady and timely flow of fertilizer to the Guinea and Sudan savannas at prices that at reasonably consistent year to year. In Nigeria the collapse of its two fertilizer manufacturing plants has been hastened by poor maintenance and an overt willingness to import fertilizer, a course of action that was dictated by interests other than those of farmers. A recent announcement that a 600,000 t/yr capacity urea plant will reopen in Nigeria (http://www.africafertilizersummit.org/Online_Press_Room/NOTORE.pdf) is welcome news, though its success will depend on it avoiding the traps of its predecessors that failed for "technical and managerial reasons".

Key factors affecting low usage of fertilizer in SSA are its high farm gate price (low volumes; inefficient infrastructure; multiple fertilizer types; inefficient distribution network) and relatively high risk of uneconomic returns (climatic risk; market risk; untimely availability) (Morris et al., 2007). Biological responses to added nutrients, especially for maize and rice, are similar to those reported elsewhere, and because of the low base level of fertility, responses often extend to higher levels of application than Latin America or Asia. Fertilizer responses in cereals are high mainly because during their improvement over the past 50 years there has been selection for responsiveness, especially to N. Other traditional crops such as cassava, yams, and banana do not have a long selection history especially at high fertility levels, and show only modest responses to applied N. Yam production is declining on frequently farmed plots. Yams respond to fertilizer, though farmers are usually afraid fertilizer will damage yam quality. Additional yam research is needed, since yams are quite nutrient demanding, yet when grown under N they may produce excess vines and leaves and fewer tubers, suggesting they are poorly adapted to high levels of N. Little or no fertilizer is used on breeding plots of yam and cassava at IITA today, and testing of cassava progenies under different fertility levels is confined to 1-2 replicates of a 3-4 replicate yield trials grown under each of two fertility levels (A. Dixon, pers. comm., 2007).

The limitation of fertility dwarfs other constraints, and is worsening. SOM reductions over time have been modeled and well documented, and the role of SOM as the major source of soil nutrients and in helping retain soil moisture has been recognized. SOM concentration is extremely low in the savannas, and is often less than 1%. Low SOM also allows soil pH to fall rapidly when acidifying inorganic sources of N are used, and this induces further micronutrient deficiencies. Perhaps because it is assumed that biological N fixation (BNF) will supply adequate N, most of IITA's recent research has focused on the role of P in crop production, despite N being significantly more limiting than P to non-legume production. P availability is critical, since this nutrient has to be supplied externally. The possible use of rock phosphate as a source of P has been extensively examined, though ICRAF research suggests that a P-scavenging species such as *Tithonia* may be needed to extract P from this source in sufficient quantities. Legumes apparently make P more available to cereals in a legume-cereal rotation. The role of P in enhancing legume growth and N fixation has been extensively evaluated over the last decade, and a screen developed for identifying cowpea and soybean lines that perform well under low soil P status. Important and useful research has been conducted on improvements to BNF, through identification of improved strains of *Bradyrhizobium*. However, promiscuous nodulation of soybean by indigenous rhizobia has created a situation where nodulation occurs but N fixation is not efficient, and N fixation often barely meets the needed of the legume itself.

IITA research has established that farm yard manure (FYM) applications have little effect on soil P status, but boost crop yield, suggesting that this scarce but valuable resource supplies mainly N and additional SOM. Unfortunately FYM is bulky and of variable quality. As an example of an improved technology for SOM generation, maize when intercropped with cowpea or groundnut can produce ~ 8 t/ha of crop residues (or 3.5 t/ha of manure) annually. Unfortunately the quality of stover for SOM or forage is usually inversely proportional to grain yield, though varieties with good "staygreen" may prove the exception. Cover crops such as *Mucuna* and *Puereria* that boost cereal yield have been identified, but offer no edible by-product to serve as an additional return for the water they use during growth. In general cover crops have given a better economic return in cassava than in maize in the transition zone, though the N contained in the cover crop has not proven to be important to maize growth in that ecology.

In summary, the combination of all reasonable sources of organic fertilizers with modest levels of appropriate forms of inorganic fertilizer has enhanced the responses from each. Cereal production will become increasingly important in SSA as population pressure and demand for animal feeds increase. As a rough rule of thumb, and based largely on on-farm yield data from Ghana, nutrients for cereal production in West Africa rank in importance as: N>> P, Zn > S, K. For grain legumes the rank would be P>> N, Zn, S. This, however, is subject to confirmation by careful assessment of existing literature and recent crop response information that reflects increasing levels of nutrient exhaustion on the more representative savannas in northern Nigeria. Zinc and sulfur deficiencies have been reported in the Guinea savannah, but not systematically evaluated across large areas.

Previous research conducted by IITA scientists has established the roles of soil erosion and nutrient mining on nutrient depletion in West African soils. IITA's research on soil fertility over the past 10 years has been well documented in peer reviewed journals, and can be classified as a mature research area. It recognizes the limitation caused by low crop nutrient status, based mainly on research conducted by IITA in the 70s and 80s, but has not actively addressed the issue from all available fronts. Over 20 articles have been published in peer review journals on factors governing N and P availability over the past 5 years. Research data from the first 25 years of research (up till 1999) were summarized as scholarly publications in a special issue of the Soil Science Society of America (Tian et al., 2001), but this is not in a form that the fertilizer industry or policy makers could easily use, nor is the summary by nutrient and crop.

*Concerns*:

- IITA-led strategies for promoting an upward spiral in yields, fertilizer use, and soil fertility are not apparent. Without any nutrient additions, cereal yields are ~1 t/ha, and variability and risk remain high. Consequently, the value of using improved input-responsive germplasm such as maize hybrids cannot be realized at the farm level, and the seed and input sectors struggle to establish. Can IITA play a part in alleviating a constraint that has complex causes and is continent wide? The NEPAD-sponsored Africa Fertilizer Summit in Abuja in 2006 has resulted in a set of resolutions that may result in coordinated regional efforts to stabilize fertilizer prices through tax reduction, coordinated regional ordering or raw materials, and the establishment of a financing mechanism. It encourages the establishment of a network of dealers, and has as its goal an increase in fertilizer usage from the current level of 8 kg/ha/yr to 50 kg/ha/yr by 2015. IITA should be fully involved in designing and supporting this strategy.
- Does further research by IITA have a role? Identification of genotypes efficient in the use of specific nutrients (N, P) is already underway, and should be expanded so all improved germplasm is characterized for response to key nutritional constraints. Secondly, the determination of the role of micronutrients, especially Zn and S, in reducing nitrogen use efficiency must be a high priority, since these can be expected to

worsen rapidly as use of NPK fertilizers begins to rise. SOM is continuing to fall, and micronutrients are increasingly scarce. Thirdly, the evaluation of crop nutrient status by remote sensing (e.g. SPAD chlorophyll meters; Greenseeker technology; satellite imagery) provides information that can be used to identify regions and even portions of fields with a quantified level of deficiency. This is of value to anticipating yield losses due to N deficits and providing a timely management response. Fourthly, and most importantly, we believe that advocacy based on a solid basis of science has an important part to play. Fertilizer use will be attractive to farmers if the biological response is high, the ratio of fertilizer price to output product price is low, and if value cost ratio is high.

- Needed is a comprehensive summary documenting the fertility responses and risks imposed by the environment and markets on IITA mandate crops over the past 35 years, to serve as a factual basis for policy formulation. This level of documentation, representing the combined efforts of soil scientists, agronomists, socioeconomists and modelers, does not currently exist in a form that can be easily used by policy makers and fertilizer manufacturers. The document should culminate in estimates of returns to specific nutrients, document and map the extent of responses, and lead to a recommendation of the 3-6 basic fertilizer formulations that can be imported in bulk or manufactured locally. IITA has an international mandate for its target crops within SSA, and advocacy for regional cooperation in manufacturing, importing, and distribution of fertilizers across megaenvironments should be exercised. Such advocacy has been effectively used within Nigeria to establish cassava as an industrial feedstock, and could be used to address fertilizer pricing and supply. Accurate advice to the fertilizer industry will be needed for the savanna zone. The summary document, supplemented by on-farm studies, and evaluation of "best-bet" technologies in fertility maintenance, and measures of SOM depletion and regeneration will position IITA well to provide that advice over the next 5-10 years.
- Breeding if key crops, including yams and cassava, should be conducted under at least two levels of fertility (farmers' conditions (low) and ~100-150 kg N/ha (high)). Selection only under low fertility results in improved varieties that respond to applied fertilizer by producing luxuriant vegetative growth, misshapen roots or tubers, or increased susceptibility to diseases and pests. Improved crop nutrition will ultimately come to farmers' fields in this region, and now is the time to select cultivars for this environment.
- Socioeconomic constraints to fertilizer use have been recognized, yet apparently not well documented.

**Soil water**

Water deficits reduce crop production in the second season of bimodal rainfall distribution areas, and are more severe in soils low in SOM. Global climate change will likely increase variability of rainfall events, increase evapotranspiration and possibly reduce the rainfall amount. IITA's crop breeders have focused on improving drought tolerance, some in collaboration with CIMMYT, and we endorse and encourage this effort. Other reviews (CIDA, final project review, Drought Tolerant Maize Varieties) have called for an increased effort in water harvesting technologies in the Sudan savanna. Collaboration with projects that have this as their primary goal is to be encouraged.

<u>*Concerns*</u>:

- We see little reference in NRM literature over the past decade to strategies that increase water use efficiency on target crops under rainfed or irrigated conditions. Large scale irrigation schemes will eventually be required, though current levels of management of existing schemes suggest their success may be elusive. Nonetheless, research investments on irrigation management, research on water use efficiency by crop within common cropping systems will provide the database of crop response needed to rationalize the use of this scarce resource.

**Soil physical conditions**

<u>*Concerns*</u>**:**

- We see no reference to changes in soil compaction, but this is one of the constraints to reduced or zero tillage technology in the savannas where the alfisols can settle into a hard compacted mass. Tillage seems essential in this zone, and the gathering of a mound of soil or a ridge for planting provides more nutrients close to the developing plant.
- There are few references to soil acidity – how it can be altered rapidly in poorly buffered low SOM soils, and what effects on pH result from applied N generally, and specific forms of N in particular (e.g. ammonium sulfate). Are high levels of aluminum a constraint to crop production, and if so where? Is there a response to lime? Is lime available, and at what price?

**Weed management**

Farmers in Africa normally will plant a greater area than they can weed adequately, so poorly weeded crops are often observed. Herbicide use in SSA is very low. Two of the world's worst weeds (*Striga hermonthica*; *Imperata cylindrica*) provide immense management challenges to crop producers in the savannas and derived savanna zones. Other weeds such as *Rottboelia exaltata, Chromolaena odorata*, *Cyperus rotundus, and Eragrostis* and *Panicum* spps can also be severe in specific areas, especially in the forest margins, and are most effectively controlled by using herbicides. Fallows have traditionally been used to control weeds, but these are disappearing under intensification. Soil fertility and weed depredations are linked through plant competition - *Striga* is a more severe problem under low soil fertility, and under higher levels of fertility crops such as maize and cassava can be planted at higher densities and out-compete many of the weeds that are problems in infertile fields. (*Striga*-related issues are considered in more detail under Cropping Systems in this paper). Availability of herbicides is limited to relatively high yield potential areas, and suffers from similar constraints to fertilizer distribution and use.

During the last decade IITA scientists have made significant progress in non-herbicide control methods for major weeds, though herbicide options remain the most effective and are generally favored by farmers for *Imperata*. Herbicide options have been shown to be cheaper (lower labor requirements) and to provide better weed control than manual weeding options, though intercropping is often ruled out by herbicide treatments. Rotations can be threatened when herbicides with residual activity such as triazines are used. However, IITA research has shown that newer herbicides such as nicosulfuron are effective against *Imperata* in maize fields. Other cultural control measures for crops adversely affected by herbicides have included the use of aggressive legume cover crops (*Mucuna cochinchinensis*) to deplete rhizome biomass of *Imperata* before planting of cassava or maize. Integrating tillage, herbicide, optimum plant density and cover cropping has given good control of *Imperata*.

Green manure cover crops (*Mucuna*, lablab, pigeon pea, *Centrosema*, Crotolaria, *Pueraria*) used during fallows have also been shown to reduce significantly weed seed banks and *Imperata* rhizome biomass, provided there is sufficient rainfall to ensure a complete vegetative cover. Intercropping maize or cassava with cover crops led predictably to yield reductions due to competition from the cover crop, though the cover crop was more easily controlled than the *Imperata*. IITA scientists have shown that reductions in maize yields from competing weeds have been proportionally more severe when water was scarce, but that drought tolerance of maize hybrids also resulted in a greater tolerance to weed competition. In a useful cross-center research study the emergence of weeds (*Imperata* and *Ageratum conyzoides*) in relation to crop growth was modeled by IITA and IRRI scientists. Output can be used to predict optimum timing of manual weed control independently of the planting date of the target crop.

<u>Concerns</u>:

- In the majority of weed control studies undertaken by IITA scientists over the past 5 years the target crop has been maize, and occasionally cassava. Little or no mention was made of research targeting weed control in cowpea, soybean, yam and *Musa*, or in more complex intercropping systems. We acknowledge that few herbicide options exist specifically for cassava and yams, and cultural management of weeds is more complex. However, weed control in these crops adds greatly to the labor burden, and merits further efforts.
- There was little evidence of in depth socioeconomic analysis that guided the potential adoption of the technologies evaluated. Net benefit analysis usually indicated that the use of herbicides such as glyphosate and nicosulfuron for *Imperata* control was cheaper than intercropping with cover crops or manual weeding. But were the opportunity costs of growing a green manure cover crop vs. application of fertilizer or growing a crop providing directly usable yield from the same land, nutrient and water resources adequately estimated?

**Cropping Systems**

There is a wide diversity of cropping systems, largely defined by the physical environment, farmer preferences and market signals. In general the commodity chain approach has proved to be more useful as a unifying research and extension theme than a specific cropping system *per se*, and is now widely used by IITA. Alley cropping, a major research theme and cropping system developed by IITA in the 80s, has largely been abandoned because of poor adoption, though a comprehensive analysis of the causes of this failure was not made available to the EPMR. A major failure in uptake of alley cropping involving maize, cassava and *Senna spectabilis* is concerning (S. Cameroon) – it seems to reflect inconsistent benefits that in turn probably reflected varying levels of water availability.

Current research emphasis has been on cereal-legume systems in the natural and derived savanna zones. Much of IITA's recent research has focused on the control of *Striga*, since about 2/3 of fields in the savanna zones of WCA and many mid-altitude locations in ESA are infested with this weed that parasitizes maize, sorghum or cowpea (each crop is favored by a different Striga species). Like other weeds, the competitive ability of the crop is key to minimizing its damage, so rapid ground cover (adequate fertility and appropriate planting density) will reduce the damage from *Striga*. A herbicide resistant version of adapted maize developed by CIMMYT allows seed to be coated with a dry formulation of imazapyr that kills Striga seedlings as they attempt to attach to the maize crop, but this mechanism has not been used in other crops to date.

IITA scientists have been at the forefront of *Striga* research in SSA for the past 30 years. During that time they have developed tolerant versions of maize and cowpea, and added greatly to our understanding of the basic biology of the weed and the mechanics of attachment and repression of the host. In the last decade *Striga* research focused on improving soil fertility and utilizing trap crops in rotation. Key aspects have been: use of rotations with soybean which is unaffected by *Striga* (though it may be attacked by *Alectra* spps); deployment of *Striga*-tolerant versions of maize and cowpea; maize-cowpea intercropping; and hand pulling and crop hygiene to prevent seed build up. When these practices are combined, yield losses to *Striga* are minimized, and sustainable cereal legume farming systems become possible. It does not, however, eliminate *Striga*, and the weed remains a long-term risk to production should key components of the technology be omitted.

Key "best-bet" methods of minimizing effects of *Striga* and reducing its seed bank have been deployed in farmers' fields over the past 10 years. Two of these have generated significant farmer interest in Northern Nigeria. They are maize-promiscuous soybean rotations, and millet-dual purpose cowpea intercropping, both of which result in a reduction in *Striga* plant density and in the seed bank of the parasite. Both have been responsible for a 50-70% increase in gross incomes of adopting farmers compared to those following traditional practices. Concomitantly, soybean production in Nigeria has increased from 50,000 t to >400,000 t per annum from 1984 through 1999. A 10% increase in legume area in Nigeria, along with a 20% increase in grain yield results in an increase in fixed N worth US$ 44M /yr (Sanginga et al., 2003). Some experimentation has also focused on the 4:2:4 planting scheme in the savannas, where 4 narrow rows of cowpea strip cropped among side two wider rows of maize. In the following season the physical positions of the two crops are reversed to facilitate N uptake and *Striga* seed reduction.

Research is refining these basic systems. More recent research findings have emphasized the need for increased density tolerance in maize hybrids, so suppression of *Striga* by shading will be more efficient. Cowpea is a highly profitable crop for savanna farmers, and maintaining a high proportion of cowpea in intercropping mixtures and in relay cropping systems has improved profitability and contributed additional N to the cropping system. Low harvest index grain legumes have shown benefits in quantities of N remaining in the soil in the derived savanna zone where cowpea grain is less profitable. Soybeans have been shown to fix from 44-103 kg N/ha/crop, and to leave up to 40 kg N/ha in the soil after grain harvest, as well as acting as an efficient trap crop for *Striga*. Maize following soybean takes up about 50% of N fixed by soybean, giving an overall utilization of soybean-fixed N by maize of around 25%. This is sufficient to boost maize grain yields by more than 0.7 t/ha, and, with an additional "rotation" effect soybeans more than doubled yields of the following maize crop. Maize genotypes have shown significant variation in multiple stress tolerance (i.e. tolerant to low N and drought), so continued improvement in performance of maize in such intercropping systems can be expected. These are however still very low yield levels, and much larger gains can be expected when balanced and adequate crop nutrition can be supplied. Low input interventions are adding no more than 1-2 t/ha to maize yields when the potential for maize hybrids in the savannas is ~9 t/ha. N is still the major limitation to cereal yield.

*Concerns*:

- IITA's cropping system research focus over the past five years has been principally on systems in the dry savannas of West Africa. What of the humid forest and ESA? Some of the *Striga* work will undoubtedly spill over to ESA, but is there sufficient research strength and commitment to long term trials to make a similar impact in ESA?

- There are no reports provided by IITA describing the deployment of CIMMYT-AATF developed imazapyr-resistance (or SU resistance) in maize hybrids adapted to the lowland tropics in *Striga*-infested areas, yet this is one of the truly exciting research findings in recent years. The IITA source of SU resistance has challenging IP issues surrounding its use, and this may ultimately sideline it. Furthermore there are no reports from farmers' fields of the performance of maize carrying *Zea diploperennis* sources of Striga resistance. And what of *Striga* resistant cowpea varieties?
- The lack of "bullet-proof " insect resistance in cowpea after 30 years of careful selection suggests that transgenic solutions (Bt cowpea, developed jointly by IITA and CSIRO) have a very real future in this crop, provided regulatory issues can be dealt with.
- There is a paucity of socioeconomic information related to *Striga* management. What is the net benefit of SU-resistant maize varieties vs. use of soybeans as a trap crop? How acceptable is herbicide treated hybrid maize seed to savanna farmers?

**B: Humid and sub-humid forest zones**

Issues of NMR in this area are considered only superficially in the IITA-prepared paper provided to the panel. We have drawn also on the CCER for Project E (P. Fabre, May 2004). Key goals for IITA in these zones is to generate and promote productive farming systems based on plantain, intensified cassava production (in keeping with the Nigerian Presidential initiative), sustainable yam production, and multi-product trees. Currently all NRM research for this zone is integrated with agronomy, plant health management and varietal screening research. Because farmers in the humid forest have shown an unwillingness to invest in soil fertility directly, emphasis has changed to crops *per se*. Germplasm is being screened under farmers' field conditions for performance and resource use efficiency. Since the humid forest area is high in rainfall, leaching of nutrients can occur, especially after the onset of the rains when crop demand is low. An early planted vigorously growing crop is the best intervention to capture nutrients, reduce runoff and generate additional yield, though leaching losses can certainly occur if rains are heavy in the first 3-4 weeks of the season. Choice of species planted during fallows (where these are still practiced) has a large effect on the natural resource base.

For crops such as plantain, the use of small amounts of fertilizer plus control of nematodes tripled yields, thereby reducing the need to clear further forest. Green manure crops (*Mucuna* and *Pueraria*) have been shown to be twice as effective as a natural fallow in restoring soil properties and reducing the labor costs of clearing forest after a natural fallow.

<u>*Concerns*</u>:

- No mention is made of soil acidity and how it is best managed. In high rainfall areas, especially where N fertilizers are applied, this can limit crop growth, especially when accompanied by a release of aluminum into the soil solution.
- What is the general nutrient status of the humid tropical zone? What levels of nutrient mining are taking place? What is the level of erosion occurring on typical ploughed land in this ecology typified by high energy rainfall events?
- Methods for maintaining and increasing SOM are not discussed. What is the role of low harvest index grain legumes (such as dual purpose cowpeas) vs. *Mucuna*? What are the

net benefits from using green manure fallows vs. inorganic fertilizers? What cropping systems involving *Musa*, cassava and cereals are possible in this zone?

**Gaps in International NMR that should be addressed over the next decade**
**(IITA's own view)**

- Explore the ability of grain legumes to thrive under low P, and to mobilize P from relatively insoluble sources.
- Evaluate the extent and severity of non-NP nutrient deficiencies in the savanna (Zn, S, K, Ca, and Mg) (Panel view: this should be a high priority)
- Long-term sustainability of best bet technologies including improved varieties, fertilizers, pesticides and cropping systems.
- Compare promiscuous inoculation of soybean with inoculating seeds with improved versions of *Bradyrhizobium*
- Determine cropping system x genotype interactions in cereal-legume cropping systems in order to identify systems with stable output across megaenvironments that are identified by a combination of biometry, GIS and crop modeling.
- Use of conservation tillage/zero tillage to improve soil cover, SOM, and the productivity of crops and labor (Panel view: this should be a high priority).

**Panel's view of gaps and future needs in NRM**

- Geographical emphasis: There has been a relatively heavy emphasis on NRM issues in the savannas over the past 5 years, and comparatively less on issues from the humid forest and forest margins. Furthermore, there appears to be little NRM/agronomy research that is sourced in ESA, surely something that should have been addressed during the last 10 years. Sustaining output from the highlands of ESA, managing weeds in target crops in the ESA region, and collaboration with other CGIAR centers operating in those areas will be important in the next decade.
- Crop emphasis: NRM and agronomy research is strongly oriented towards cereal and legume crops, and largely neglects yams, cassava and Musa. We strongly suggest that IITA hire a roots and tubers agronomist to address this imbalance.
- Partners: These were barely mentioned in IITA's prepared piece on NRM. Who are the competent NARS in the target area, and what is the nature of collaboration with them?
- Fertility: Fertility work seems to have gone on the back burner, despite a steady decline in soil nutrients status with time. There is a need for a network in the savannas, perhaps similar to the SoilFertNet established under RF funding in southern Africa, where "best bet" technologies for stabilizing and increasing fertility status of soils under constraints faced by small-scale farmers are developed, promoted and documented. As it matures, the network could also address policy, capacity building and extension issues that directly bear on soil fertility management (see Morris et al, 2007). There is also a possibility that a Challenge Project may be developed around this theme in the next round. If so, IITA will undoubtedly play a key part in its direction, and should seek to host it.
- Fertilizers: There are no clear guidelines on the relative importance of specific nutrients in SSA. Is N really the first limiting nutrient followed by P and Zn? Where is S becoming limiting, and can it be linked to an environmental available, such as the probability of annual burning of residue? What is the role and importance of K? These issues are important if IITA is to offer advice on importation of fertilizer and/or establishment of a fertilizer manufacturing facility to best serve the needs of specific regions. See above for suggested action.

- We endorse the screening of germplasm under drought, low N and/or low P to capitalize on existing genetic variation for tolerance to low levels of these limiting resources, while encouraging breeders to continue providing a good level of resistance/tolerance to biotic challenges.
- The case for herbicide use: Has there been a serious analysis of reasons for the lack of herbicide use? Given the labor savings and the possibility of breaking the cycle of weed build up, where is the analysis of short and long term benefits from use of imazapyr, glyphosate and/or nicosulfuron? Reports of possible herbicide damage to arbuscular mycorrhiza require careful evaluation, so that P and water uptake are not compromised.
- Natural resource management will be practiced by farmers if they see a clear benefit from doing so. Application of inorganic fertilizers is one of the most obvious of crop responses, as is the use of herbicides on weeds such as *Imperata*, and the use of herbicide resistant germplasm in areas infested with *Striga*. Yet there seems little socioeconomic analysis of benefits of specific practices in the short and long term, and relatively little information on farmer circumstances that would favor adoption of one technology over another. In order to keep on farm prices for fertilizer relatively stable and similar to those in other parts of the world, IITA should consider investing socioeconomic resources in researching how to make African markets for fertilizers work more efficiently. There are a number of potential partners that would support this activity (e.g. IFPRI, BMGF/RF; SG2000 has a lot of experience in this area). A second area for an IITA policy initiative is developing a crop-based strategy for regional cooperation within WCA for the importation (or manufacture) and distribution of fertilizers in volume through a single deep water port in the region – but in collaboration with NEPAD regional initiatives.
- There is only peripheral evidence of the use of models and GIS techniques to establish spatial patterns of model output over large areas. The loss of crop modeling capability within IITA is regrettable, since it allows a range of crop management options to be pretested *in silico* before taking the most promising of these to the field.
- Intercropping: While there is real value in devising planting systems that include grain and legume intercrops or relays, systems of this nature will not be adopted in an unmodified form unless the ratio of grain output from the legume and cereal components reflects market demand. We see no evidence if this type of analysis having been undertaken in the past 5 years.
- Durable insect resistance: It will be important to thoroughly test Bt cowpea when it is finally available in an adapted cowpea background.
- Weed control: Glyphosate resistance in maize and cowpea would be of considerable value to farmers of areas severely infested by *Imperata*, and possibly against Striga. There are now two sources of this resistance available, each using quite different mechanisms – one inhibiting the EPSPS enzyme pathway (Monsanto) and the other the GAT pathway (Du Pont). Access to these gene systems for experimental purposes should be sought. Owners of these genes might be persuaded to consider incorporating them in cowpea (not an important first world crop) for little or no charge, probably through AATF. This possibility should be explored by IITA on humanitarian grounds, perhaps with budgetary assistance from the BMGF.
- Livestock and crop residues: We see no mention of livestock as a component of NRM. This deficiency was also recognized in previous reviews (Recommendation 1 CCER Proj F). Trends suggest that by 2050 the majority of farmers in the savannas of WA will be mixed crop-livestock farmers (CCER Proj F). What are the implications for crops, crop residues, SOM, nutrient migration in FYM, weed seed transfer, and traction power? Do

crop residues have an immediate economic worth as feed, fuel and fencing material, and how does that compare with the value of grain? Do IITA and ILRI plan to continue to collaborate on livestock related issues in the Guinea and Sudan Savannas?

- Tillage: we endorse research on the potential for conservation/zero tillage to improve soil cover, SOM, and the productivity of crops and labor while reducing the impact of raindrops on soil structure and erosion. The endorsement is made with the understanding that this is the traditional form of land preparation in the forest and forest margins, and that it has failed in the savanna mainly because of intractable weed problems and soil compaction. Availability of effective herbicides is a prerequisite to its use in areas where *Imperata* and *Striga* are common.
- Nematodes are a common problem in intensified agriculture. How well have the populations of nematodes been assessed and characterized in the savannas and derived savannas? Does IITA know what background yield loss might be associated with chronic nematode infection in its target crops and ecologies?
- Long-term NRM sites: These were established at Ibadan (21 years) and Zaria (11 years) under minimum tillage (hoe culture). Such studies are hard to support under shorter term special project funding. Models are predicting a slower rate of decline in soil organic matter than that actually observed at these sites. Assuming the original treatments are still relevant, these sites represent a valuable research investment in sustainability. The Panel strongly suggests that these sites be retained under their long-term management, and be fully utilized to determine long-term consequences of common cropping practices.
- Managed fallows in the humid forest margins: Managing fallows is probably wishful thinking when the trends are all towards the elimination of fallows. Instead, using short term green manure crops like *Mucuna* and *Pueraria* may make more sense.
- The recent emphasis within IITA on increased cassava production has placed greater pressure on natural resources in the Guinea savanna and forest transition zones, so it is important to revisit farming systems that include this crop. Very few studies described in IITA's NRM report included cassava. The increased emphasis on commercial banana production may also apply downward pressure to the natural resource base in the forest zone, and this should be carefully monitored.
- Human and financial resources: Research time available to the leader of the weed control group, Dr. Chikoye, is sharply reduced because of his administrative load. Because of the strategic importance of weed management, we strongly suggest that his research agenda be supported through a Post Doc appointment, or that an additional permanent weed scientists be hired.
- Skills: Modern field trial management requires strong biometrical skills, and IITA does not have a senior resident biometrician. New developments in G*E analysis, pattern analysis and spatial trend analysis could increase efficiency of the field research processes, but there is no-one to lead the charge.
- Laboratory support for NRM: Equipment is aging and not being replaced, and manuscripts are sometimes rejected by journals because outdated and less precise analytical methods are being used. Plant samples cannot be analyzed for micronutrient content in house, and although outsourcing remains an option within Nigeria, quality of data is a concern. Rather than automatic replacement of out-of-date equipment with updated equivalents, we strongly suggest that a suitable modern analytical laboratory be identified in Nigeria and monitored for quality over time. Should quality consistently fail to meet IITA standards, then establishing a modern in-house analytical capability must be considered.

- Training: How is training in crop agronomy and NRM being conducted among IITA's national collaborators? Is it being handled through Kano where the savanna team is based? A training component in NRM needs to be built into every project, and key scientists from collaborating national programs should spend time with IITA counterparts at the location where cutting edge research is currently underway (e.g. Kano).

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## Annex 12

## IITA's GUIDING PRINCIPLES FOR DEVELOPMENT AND DEPLOYMENT OF GENETICALLY ENGINEERED ORGANISMS

The IITA believes that genetic engineering has an important role to play in improving production and utilization of food crops in developing countries. Genetically engineered organisms can thus contribute to IITA's principal goals of eliminating poverty and increasing food security.

IITA's decisions about, and investments in, genetic engineering will be guided by the following principles:

1. Safety consideration notwithstanding, IITA will use genetic engineering when it believes that it is more cost - or time-effective than other research techniques, or when other techniques have not been effective in achieving the desired ends.
2. IITA will take care to develop genetically engineered products appropriate for use by resource-poor farmers. This means products with needed traits, and minimum proprietary restrictions and technology-associated costs, which can be easily transferred to, and managed by, resource-poor farmers.
3. For developing genetically engineered organisms, IITA will give priority to using genes that occur naturally in closely related species.
4. IITA will conduct its work on genetically engineered organisms in a participatory and transparent manner, being sensitive to the diversity of opinions and values of its partners and stakeholders.
5. IITA will evaluate, on a case-by-case basis, and following science-based criteria, potential risks associated with application and development of environment, non-target organisms, food safety, and cultural, social and economic conditions.
6. IITA will avoid compromising farmers' rights to have fair access to the latest technologies to improve their livelihoods by limiting the deployment of genetically engineered organisms in the crop's centers of diversity (wild species and land races), but will take measures to avoid the loss of biodiversity in those regions.
7. IITA will work with national partners, using the best expertise available, to address potential risks and assure confidence in the product. If a recipient country lacks the expertise to conduct its own risk assessment, IITA will work with national partners to develop appropriate strategies and methodologies.
8. IITA will comply with national or regional biosafety, food environmental and policy regulations for deployment of genetically engineered organisms. IITA will not deploy genetically engineered organisms in any country lacking such regulations.
9. Management strategies will be applied to delay the development of resistant insect pests. This is with reference to, as an example, cowpea with Bt gene.

**Annex 13**
**Number and categorization of IITA's partners**

A) IITA had, in 2006, established formal partnerships with over 160 organizations in more than 50 countries (source IITA's MTP for 2007-2009).

- 43 Governments and Governmental Organizations
- 36 National Agricultural Research System Organizations (NARS)
- 31 Advanced Research Institutes (ARIs, including Northern Universities)
- 17 Universities in SSA (Southern Universities)
- 11 International Agricultural Research Centers (IARCs)
- 7 Private Sector Partners
- 4 Foundations
- 4 International NGOs
- 3 Local NGOs (Southern NGOs)
- 3 Sub-Regional Organizations (SROs)
- 3 Civil Society Organizations (CSOs)

In addition, IITA supports several networks (WECAMAN, SARRNET, FOODNET and EARRNET) and regional organizations (FARA, AU).

B) Relationship between R4 D category and the category of partner (source IITA)

| | **Strategic Research** | | **Applied Research** | | **Adaptive Research** | |
|---|---|---|---|---|---|---|
| **Partner Category** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| NARS | 26 | 43 | 27 | 42 | 21 | 40 |
| Governmental | 8 | 13 | 10 | 15 | 7 | 13 |
| Southern Univ. | 4 | 7 | 5 | 8 | 1 | 2 |
| Northern Univ. | 13 | 22 | 7 | 11 | 6 | 12 |
| Private | 0 | 0 | 5 | 8 | 4 | 8 |
| IARC | 3 | 5 | 1 | 2 | 2 | 4 |
| ARI | 3 | 5 | 2 | 3 | 1 | 2 |
| Northern NGO | 0 | 0 | 3 | 5 | 3 | 6 |
| Southern NGO | 0 | 0 | 2 | 3 | 4 | 8 |
| SRO | 2 | 3 | 0 | 0 | 0 | 0 |
| Foundation | 1 | 2 | 0 | 0 | 0 | 0 |
| CSO | 0 | 0 | 2 | 3 | 2 | 4 |
| Other | 0 | 0 | 1 | 2 | 1 | 2 |
| **Total** | **60** | **100** | **65** | **100** | **52** | **100** |

## Annex 14
## Acronyms

| | |
|---|---|
| AATF | African Agricultural Technology Foundation |
| ADG | Assistant Director-General |
| AEZ | Agroecological Zone |
| AFLPs | Amplified Fragment Length Polymorphism |
| AGM | CGIAR Annual General Assembly |
| APO | Associate Professional Officer |
| ARIs | Advanced Research Institute |
| ASARECA | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| AVRDC | World Vegetable Center (formerly Asian Vegetable Research and Development Center ) |
| BECA | Biosciences East and Central Africa |
| BNF | Biological nitrogen fixation |
| BNMS | Balanced Nutrient Management System |
| BSV | Biological nitrogen fixation |
| BXW | Banana Xanthomonas Wilt |
| CAADP | Comprehensive African Agricultural Development Program |
| CABI | CAB International (formerly Commonwealth Agricultural Bureaux) |
| CBSD | cassava brown streak disease |
| CBSV | cassava brown streak viruses |
| CCER | Center-Board Commissioned External Reviews |
| CIAT | Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture) |
| CIDA | Canadian International Development Agency |
| CIMMYT | Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center) |
| CIRAD | Centre de coopération internationale en recherche agronomique pour le développement (French Agricultural Research Centre for International Development) |
| CMD | Cassava Mosaic Disease |
| CMV | cassava mosaic virus |
| CORAF | Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricule (West and Central Africal Council for Agricultural Research and Development) |
| CRED | Community Research for Empowerment and Development |
| CSO | Civil Society Organization |
| DDG-R | Deputy Director-General for Research |
| DMS | Data Management System |
| DRC | Democratic Republic of Congo |
| DRIS | Diagnosis and Recommendation Integrated System |
| EACMV | East Africa Cassava Mosaic Virus |
| EAHB | East Africa Highland Banana |
| EARRNET | East Africa Root Crops Research Network |
| ECA | Economic Commission for Africa |
| EIARD | European Initiative for Agricultural Research for Development |
| ELISA | Enzytme-Linked ImmunoSorbent Assay |
| ELO | (The former) External Liaison Office (of IITA) |
| EPHTA | Ecoregional Program for the Humid and Sub-Humid Topics |

| | |
|---|---|
| ESA | East and Southern Africa |
| EST | Expressed Sequence Tag |
| ExCo | Executive Council (of the CGIAR) |
| FARA | Forum for Agricultural Research in Africa |
| FFS | Farmer Field Schools |
| GIS | Geographic Information System |
| GMO | Genetically Modified Organism |
| GRP | Graduate Research Program |
| HVP | High Value Products |
| IAPSC | Inter-African Phytosanitary Council |
| IAR | Institute for Agricultural Research (Nigeria) |
| IARCs | International Agricultural Research Centres |
| ICIPE | International Centre of Insect Physiology and Ecology |
| ICP | Integrated Cassava Project |
| ICRAF | World Agroforestry Centre (formerlyl International Centre for Research in Agroforestry) |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IFDC | International Fertilizer Development Centre |
| IIAM | Instituto Nacional de Investigação Agrária de Moçambique |
| ILRI | Internatinal Livestock Research Institute |
| INRAB | Institut National des Recherches Agricoles du Bénin |
| IPG | International Public Goods |
| IPM | Integrated Pest Management |
| IRRI | International Rice Research Center |
| IRS | Internationally Recruited Staff |
| ISAAA | International Service for the Acquisition of Agri-biotech Applications |
| ITRA | Institut Togolais de Recherche Agronomique |
| JIRCAS | Japan International Research Center for Agricultural Sciences |
| KKM | Kano-Katsina-Maradi |
| M&E | Monitoring and Evaluation |
| MAS | Marker-Assisted Selection |
| MDG | Millenium Development Goal |
| MML | Materials Management and Logistics |
| MOU | Memorandum of Understanding |
| MTP | Medium-Term Plan |
| NARES | National Agricultural and Research Extension Systems |
| NARIs | National Agricultural and Research Institutes |
| NARO | National Agricultural Research Organisation |
| NARS | National Agricultural Research System |
| NEPAD | New Partnership for Africa's Development |
| NERICA | New Rice for Africa |
| NPK | Sodium Phosphorous Potassium |
| NRM | Natural Resource Management |
| NRS | Nationally Recruited Scientist |
| NVRC | National Variety Release Committee |
| P | Phosphorous |
| PCAP | Professional Capacity Advancement Program |
| PCR | Polymerase Chain Reaction |
| PLS | Pilot Learning Sites |
| PM | Performance Measurement |

| | |
|---|---|
| ProMIS | The project knowledge system for the Rice Wheat Consortium |
| QTL | Quantitative Trait Locus |
| RAPD | Random Amplification of Polymorphic DNA |
| RDC | Research Development Council |
| RPEC | Research Program and Executive Committee (IITA) |
| SAKSS | Strategic Analysis and Knowledge Support System |
| SARRNET | The Southern Africa Root Crops Research Network |
| SGRP | System-Wide Genetic Resource Program |
| SINGER | Systemwide Information Program for Genetic Resources |
| SMEs | Small and Medium-sized Enterprises |
| SMIP | Strategic Musa Improvement Project |
| SMTA | Standard Material Transfer Agreement |
| SNP | Single Nucleotide Ppolymorphism |
| SOCODEVI | Socodevi - Société de Coopération Internationale |
| SOM | Soil Organic Matter |
| SRO | Scientific Research Organisation |
| SRRC | Southern Regional Research Center (of the USDA) Louisiana, USA. |
| SSA | Sub-Saharan Africa |
| SSR | Single-strand Repeat |
| STC | Short-term Course |
| STCP | Sustainable Tree Crops Program |
| TCBN | Tissue Culture Business Network |
| TSBF | Tropical Soil Biology and Fertility Institute (of CIAT) |
| USAID | United States Agency for International Development |
| WARDA | Africa Rice Center (formerly West Africa Rice Development Association ) |
| WASNET | West Africa Seed and Planting Material Network |
| WCA | West and Central Africa |
| WDI | World Bank Development Indicators |
| WECAMAN | West and Central Africa Collaborative Maize Research Network |
| WPW | Work Planning Week (IITA) |
| YMV | Yam Mosaic Virus |
| ZMM | Zimbabwe-Mozambique-Malawi Pilot Learning Sites of the sub-Saharan Africa Challenge Program |

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