International Association of Research Scholars and Fellows (IARSAF)

Symposium Proceedings

1995, 1996, 1997

International Institute of Tropical Agriculture
Ibadan, Nigeria

About IITA

The International Institute of Tropical Agriculture (IITA) is an international agricultural research center in the Consultative Group on International Agricultural Research (CGIAR), which is an association of more than 50 countries, international and regional organizations, and private foundations. IITA seeks to increase agricultural production in a sustainable way, in order to improve the nutritional status and well-being of people in tropical sub-Saharan Africa. To achieve this goal, IITA conducts research and training, provides information, collects and exchanges germplasm, and encourages transfer of technology, in partnership with African national agricultural research and development programs.

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IARSAF Symposium Proceedings

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Editorial Committee

Contents

Preface

The IARSAF Symposium was conceived in 1995 when the IARSAF Executive Committee under the leadership of Mr M. Tshiunza approached the Training Program Leader, Dr J.Gulley, for his suggestions on the IARSAF Week activities, which hitherto was routinely low-keyed and restricted to only a few dedicated IARSAF members. Dr Gulley and Mr Okafor, the Manager, Training Program, supported the involvement of the entire IITA community, and students from the University of Ibadan. The idea was to create an opportunity for the Graduate Research Fellows (GRFs), scientists, and others to exchange ideas, and for the GRFs to further develop themselves for the future, by writing and presenting their research findings to the public.

To ensure that GRFs were properly groomed, extra-curricular training sessions were organized for them, with resource persons from the academic community and IITA, to enhance the GRFs' ability to communicate in public, effectively manage research, acquire proficiency in computing and statistical analysis, and write winning proposals.

With the knowledge acquired from these training sessions, GRFs organized the inaugural IARSAF Symposium which was called IARSAF WEEK '95. At this symposium, there were four invited papers, nine oral presentations, and 14 posters presentations by GRFs. The following year, the new IARSAF Executive Committee led by Mr B. Ubi, built on the foundation laid by the preceding executive, and organized the IARSAF 1996 Symposium. There were three invited papers, and GRFs made nine oral presentations, and four posters.

To preserve records from these symposia for future GRFs, the 1996 Executive inaugurated an Editorial Committee to collate all the presentations in the first and second symposia. Though the task was challenging, the commitment and dedication of committee members, the response of contributors, the cooperation of the Training Program and the Training Materials Unit of IITA resulted in the production of the proceedings of the First and Second Symposia before the Third Symposium which was held from 9–10 October 1997, under the leadership of Mr P. Koona. Following suggestions by Drs Zachmann, Gulley, and the IARSAF Executive Committee of 1997, the publication of the First and Second proceedings was delayed to allow for the incorporation of the proceedings of the Third Symposium. This was essentially to cut cost. At the Third Symposium which attracted a large audience, five invited papers were presented, and the IARSAF Alumni association was inuagurated by the IITA Director General, Dr Lukas Brader.

September 1998

Emmanuel Aigbokhan
Chairman, Editorial Committee

Welcome Address

M. Tshiunza[1]

I am happy to welcome you all to the 1st Annual Symposium of the International Association of Research Scholars and Fellows (IARSAF) of the International Institute of Tropical Agriculture (IITA). IARSAF is an association of graduate students from Africa, Asia, Europe, and America, conducting research in agriculture at IITA.

IARSAF provides a forum for exchange of academic and research ideas, promotion of friendship and understanding among members, as well as for seeking solutions to problems affecting members. Since its creation in 1981, the activities of the association have been limited to interactions among members. This year IARSAF decided to extend its activities to the entire IITA community for better integration. We hope this trend will continue.

As you are all aware, the ultimate goal of IITA is to help fight hunger and alleviate poverty in sub-Saharan Africa by:

- developing systems for managing and conserving natural resources in the humid and sub-humid tropical zones of sub-Saharan Africa, to ensure agricultural production on a sustainable basis;
- improving the performance of selected food crops which can be integrated into improved and sustainable production systems;
- reducing postharvest losses, facilitating crop and food processing, and promoting crop utilization;
- strengthening capabilities of national agricultural research systems (NARS) in various ways.

This last objective justifies our presence in IITA. Strengthening the capabilities of NARS to conduct research and training for their own development is the main goal of the Training Programs in the CGIAR. IITA alone cannot tackle all the agricultural problems of individual countries, or directly reach millions of farmers in the continent.

The achievement of the training program objective mainly depends on the quality of the training received at IITA. The effectiveness of the training received at IITA is a function of a number of factors, including the quality of trainers, the academic background of people selected for training, and the technical and social environment of training. There is no doubt about the quality of our trainers. They are among the best in their respective fields as their achievements and reputation clearly testify. We thank them for their contributions to our training.

I can also assure you of the sound academic background of Graduate Research Fellows (GRFs) admitted by the Training Program. Before they are chosen, GRFs

1. President, International Association of Research Scholars and Fellows (IARSAF), 1995.

undergo rigorous and competitive selection. In fact, the Training Policy Manual states that the training program at IITA is open to 'outstanding' men and women working in agriculture and other related disciplines. In addition, most GRFs have a rich professional background in various disciplines of agriculture and other related sciences. They are either researchers, research support staff in national programs, or extension workers. Therefore, GRFs usually perform well at IITA.

Since the creation of the Graduate Research Fellowship Program (GRFP) in 1988, IITA has had 51 PhD candidates, out of which 29 have graduated, and 12 MSc candidates, out of which 10 have graduated. Since GRFs conduct research towards their higher degrees at IITA, the results of such research works are the property of the institute, and therefore part of its output. This fact has been overlooked over the years, and unfortunately, during the 25th anniversary of IITA, no recognition was given to encourage the efforts made by the Training Program towards the achievement of IITA's goal.

Statistics of IITA scientific publications reveal GRFs contribution to the achievement of IITA's goal. For example, GRFs have published several papers in various journals across the world as main authors, and many others as subsidiary authors. Our intention is not to exaggerate the contribution of GRFs in the achievement of IITA's goal, but our contribution, though small, could be improved upon if the conditions in which GRFs worked were improved. IITA has all the facilities for research work in a conducive atmosphere.

Unfortunately, we do not always have easy access to some of these facilities. Hardship for the GRF starts at the very beginning of his stay in IITA. The GRF, irrespective of the country of origin, is expected to find accommodation off-campus within two months, and also prepare a detailed work plan covering all the experiments required to satisfy the research need and the analyses (laboratory and statistics). One can imagine the stress. This stress continues and intensifies when he moves off-campus with all the problems related to food, light, transportation, and water.

Because of the small allowance given to them, the GRF cannot afford some basic needs, and frequent electricity failures do not help matters. Working late into the evening, GRFs face the problem of getting home. We are not allowed on the IITA evening shuttle, for which priority is given to nannies and IITA staff. In addition to the off-campus hardship, the GRF does not always know where to get the materials (stationeries, etc.) he needs for work.

This list of gproblems is unending. Fortunately, the new team in Training Program has has had several meetings with GRFs and their representatives, and we sincerely appreciate their efforts towards improving our welfare and the quality of our training. As a result, a number of changes are taking place. On behalf of the association, I thank the Leader of the Training Program and his team. I appeal to the Director General, the IITA management and the IITA community to support and help him in his efforts to improve the condition of graduate research work at IITA.

We are well aware that some problems such as those related to our respective universities are not under the direct jurisdiction of the Training Program. However, we think that the Training Program, in consultation with these universities could solve certain academic problems and shorten the time between the end of the GRF's research at IITA and the defence of his work at the university. This is particularly crucial for foreigners enrolled in Nigerian universities whose fellowship at IITA cannot be extended beyond a certain number of years.

The Director General, Division Directors, scientists, the Dean, Faculty of Agriculture, University of Ibadan, distinguished guests, IARSAF members, ladies and gentlemen, I welcome you to the 1st Annual Symposium of the International Association of Research Scholars and Fellows.

Contribution of Research to Agricultural Development

Dr Lukas Brader[1]

In many developing countries, agriculture is an important, if not the most important factor for economic development. However, we first have to address the provision of adequate food and create conditions of food self-sufficiency, before we can start thinking about agriculture as an engine for economic growth.

To clarify the role of the International Institute of Tropical Agriculture (IITA) in these various efforts, I would like to quote its mission statement:

> IITA aims to improve the well-being of low-income people in the humid and sub-humid zones of sub-Saharan Africa by carrying out research and related activities for increasing agricultural production in a sustainable manner, in cooperation with national and international systems and institutions.

IITA is part of a donor consortium called the Consultative Group on International Agricultural Research (CGIAR) under which 16 international agricultural research centers (IARCs) have been established.

Food production and consumption in countries of the south

Food self-sufficiency implies that adequate food is available and everybody has access to food. At the global level, enough food is produced to meet the basic requirements of every person on earth. But this does not mean that there is food self-sufficiency in countries of the south. In fact, the reality is that currently, over 700 million people (one fifth of the total world population) in the developing world do not have access to sufficient food. In certain regions, food production is inadequate while in others, people cannot afford to purchase sufficient food, or the problem is a combination of both. Poverty is considered the major cause for nonaccessibility to food and hence food insecurity. Table 1 presents the changes in food production between 1979–1981 and 1989–1991.

Table 1 shows that food production in the world as a whole has increased by 24% over the last decade. In the developing countries, this increase was 39%, and was highest in the Far East including China. However, as a result of strong population growth, per capita food production in the developing countries increased by only 13% over the same period. It decreased in Africa and the Near East by 2 and 4%, respectively. The figures for the Far East show that very significant progress can be made. The progress is a result of strong government support and the rapid adoption of new technologies in wheat and rice production—the so-called green revolution. It has also been favored by the extensive use of irrigation in agriculture.

1. Director General, International Institute of Tropical Agriculture, Oyo Road, PMB 5320, Ibadan, Nigeria.

Table 1. Change in total and per capita production of food, 1979–1981 through 1989–1991 (indices for 1989–1991 with 1979–1981 = 100)

Region	Total food production (%)	Per capita food production (%)
World	124	105
Developing countries	139	113
Africa	133	98
Latin America	128	103
Near East	126	96
Far East (excl. China)	146	122
China	154	135
High-income countries	109	102

Pinstrup-Andersen 1992.

A daily per capita energy requirement of 2,200 calories satisfies the basic human dietary needs. Using this criterion, food deficiencies mainly prevail in Africa as a whole (Table 2). However, available food is not evenly distributed and this leads to significant differences between individual countries.

Table 2. Number of developing countries with average food availability below 2,000 and 2,200 cal/person/day in 1961–63 and 1988–90.

	Number of countries in region	Number of countries below: 2,000 cal		2,200	
		1961–63	1988–90	1961–63	1988–90
All developing countries	115	40	9	74	25
Africa	44	20	7	36	18
Latin America	36	8	1	18	3
Asia	27	10	1	17	3
Oceania	8	2	0	3	1

Pinstrup-Andersen 1992.

An advantage of the overall increase in food production during the last decade is the decrease in costs for the consumer. During the 1980s, food prices dropped by 6.5% yearly and further decreases have occurred in the early 1990s.

As mentioned earlier, poverty is the main cause for lack of access to food. Table 3 shows that in 1985, over one billion people were classified as poor, of which 600 thousand were extremely poor.

The combination of poverty and inadequate food production in certain regions and countries is reflected in the nutritional status of the population. Data of underweight preschool children clearly show regional differences with respect to changes in the last 15 years (Table 4).

Table 3. Poverty in developing countries in 1985.

	Number of countries		Poor (incl. extremely poor)	
	Number (millions)	Percent of population	Number (millions)	Percent of population
Sub-Saharan Africa	120	30	180	47
East Asia	120	9	280	20
China	80	8	210	20
South Asia	300	29	520	51
India	250	33	420	55
Eastern Europe	3	4	6	8
Middle East and North Africa	40	21	60	31
Latin America and the Caribbean	50	12	70	19
All developing countries	633	18	1,116	33

World Bank, World Development Report 1990.

Note: The poverty line in 1985 is $275 per capita/year for the extremely poor and $370 per capita/year for the poor

Table 4. Regional prevalence and number of underweight preschool children in developing countries 1975–1990.

	Percent underweight		Underweight children (million)	
Region	1975	1990	1975	1990
Sub-Saharan Africa	31.4	29.9	18.5	28.2
Near East/North Africa	19.8	13.4	5.2	4.8
South Asia	67.7	58.5	90.6	101.2
Southeast Asia	43.6	31.3	24.3	19.9
China	26.1	21.8	20.8	23.6
Middle America/Caribbean	19.3	15.4	3.4	3.0
South America	15.7	7.7	4.8	2.8
Global Total	41.6	34.3	168	184
Total child population (0–4 years) in developing countries			402	536

UN ACC/SCN 1992.

While the number of underweight children is highest in South Asia, the significant increase in thier number in sub-Saharan Africa (SSA) is of particular concern. From an overall perception, considering recent trends and current figures, SSA causes the greatest concern with respect to lack of progress in agricultural development and the resulting worsening economic and food security situation. World Bank projections show that in all regions except SSA, by the year 2000, there will be a significant reduction in the number of the poor (Table 5). As a result of this, it is expected that by the year 2000, one third of the developing world's poor will be living in SSA, compared to about 16% currently. Contrary to all other regions, the number of the poor in SSA from 1985 to 2000 will increase (by almost 50%) while significant decreases are expected in Asia.

Food security depends on both the supply and the demand for food. Population growth, income change, urbanization, relative food prices, and new demands influence

Table 5. Poverty in the year 2000, by developing region

Region	Incidence of poverty (% of population)		Number opf the poor (million)	
	1985	2000	1985	2000
Sub-Saharan	46.8	43.1	180	265
East Africa	20.4	4.0	280	70
China	20.0	2.9	210	35
South Asia	50.9	26.0	525	365
India	55.0	25.4	240	255
Eastern Europe	7.8	7.9	5	5
Middle East, North Africa, and other Europe	31.02	2.6	60	60

Source: World Bank, World Development Report 1990.

food consumption. In Africa, population growth and urbanization are the overwhelming driving forces.

To further demonstrate the concerns and needs for SSA, data recently published by the World Bank (Table 6) shows the absolute necessity to increase agricultural productivity in order to meet food demands in SSA in the next 25 years. Efforts to reduce population growth, another major requirement, will, if successful, only show effect in the longer term.

Annual agricultural production increases of 4% means a doubling of the current growth rate. This may indeed be a very difficult challenge to meet. However, certain countries in SSA have achieved such production increases which proves that it is not an impossible goal. If similar results could be achieved for SSA as a whole, then the continent could be self-sufficient in food by the year 2000.

Opportunities to increase agricultural productivity: the role of research

A very important element is the availability of appropriate agricultural technologies that can allow farmers to obtain better results from their production efforts. This is an area where the IARCs and their partners have achieved major successes over the last 30 years in certain regions. The very significant improvement in the food security situation in large parts of Asia and Latin America is largely due to the beneficial effects of the green revolution. The introduction of so-called high yielding varieties has led to significant production increases.

While discussing the past successes and future opportunities for successful agricultural research, the changes in socioeconomic and environmental conditions over the last 30 years should be taken into account.

The 1960s can be characterized as follows:

- favorable grain/fertilizer price ratios
- weak national agricultural research systems (NARS)

Over the last decade, new problems have arisen linked to rapid population growth and environmental degradation. Also, as a result of the decisions taken at the United Nations Conference on Environment and Development, the 1990s and the 21st century

Table 6. Population and food security in sub-Saharan Africa.

Scenarios	1990	2000	2010	2020
Case 1: 2% growth rate for food production				
Population (millions, with fertility rate remaining at projected levels)[a]	494	664	892	1200
Food production (million tonnes of maize equivalent at current annual growth rate of 2%/year)	90	110	134	163
Food consumption (million tonnes, with unchanged average per capita consumption)	100	134	181	243
Food gap (million tonnes)	10	24	47	80
Case 2: 4% growth rate for food production				
Population (millions, as in Case I)	494	664	892	1200
Food production (million tonnes at 4% annual growth rate)	90	133	197	292
Food requirement (million tonnes, as in Case I)	100	134	181	243
Food production (million tonnes at 4% annual growth rate)	90	133	197	292
Food requirement (million tonnes, as in Case I)	100	134	181	243
Food gap (million tonnes)	10	1	-16	-49

Source: After Cleaver K, Schreiber G. The Population, Agriculture and Environment Nexus in sub-Saharan Africa. World Bank, 1992.

Note a: In case the total fertility rate would decline by 50% by 2030, the expected population level would still be 1,169 million in 2020, only 2.6% less than the current fertility rate.

pose new challenges for agricultural development and research in particular in SSA as outlined in the following:

Challenges

- Arrest and reverse natural resource degradation and declining productivity
- Double food production in the next 25–40 years

Context

- High genetic potential not limiting for most crops
- Limited or negative growth in irrigation
- Cultivation expansion to marginal areas, rain forests, and wetlands
- Population growth and poverty, forcing input intensification
- Intensification, depleting soils chemically, physically, and biologically
- Overdependence on farm chemicals polluting the environment
- Reduction in biodiversity
- Emergence of some strong NARS

Approach

Improved management of natural resources combined with

- More targeted genetic enhancement research with greater focus on yield stability
- Mobilization of research resources within the larger global system in an integrated effort

It is clearly understood that to achieve our goals, more than ever before, close collaboration with a wide variation of institutes, both in developed and developing countries will be needed.

Sustainable agricultural production in sub-Saharan Africa

On the basis of research results achieved by IITA and its various national partners, it can be claimed that it is possible to arrive at more sustainable production systems that can also adequately feed the rapidly increasing populations.

For example, by developing improved varieties of the major crops grown in SSA that are also resistant to some of the major pests, an important step will be made to ensure sustainable and improved agricultural production.

Cassava was introduced in Africa some 400 years ago. The crop has always been attacked by two indigenous diseases—cassava mosaic and cassava bacterial blight. IITA has developed varieties that are resistant to these diseases. These varieties, now widely grown by farmers, can lead to almost double the yield without additional inputs. These new varieties are for example at the basis of the two-fold increase in cassava production in Nigeria in the last 6–7 years.

In Africa, maize was regularly attacked by a disease called maize streak virus, which causes on average about 10% loss yearly. Virtually all maize grown is now resistant to this disease as a result of research carried out at IITA and other institutes. This means that an extra two million tons of maize is produced each year in SSA, enough to feed 10 million people, or equivalent to some US$ 300–400 million savings per year.

Plantains are threatened by a new disease, black sigatoka, which causes at least 40–40% losses unless pesticides are used. But it is difficult for small-scale farmers to purchase and apply these inputs effectively. IITA has now identified wild varieties that are resistant to the major pests. Biotechnological techniques are used and recent results show good promise.

Protein is generally lacking in the traditional diet in SSA. Soybean is a crop very rich in protein, but not yet widely cultivated in this continent. IITA has developed varieties that are well-adapted to the local growing conditions and in a very short time, soybean production has increased very significantly. In Nigeria, this has, for example, led to the development of a new food processing industry.

In Africa, pests and diseases cause on average, 30–40% losses in agriculture. Pesticides are too expensive, difficult to obtain, and cause too much environmental damage. Therefore, in addition to resistant varieties, IITA has developed environmentally safe plant health methods. The cassava mealybug is a good example of this.

This pest was accidentally introduced in SSA some twenty years ago. It spread rapidly over the whole continent causing on average 30–40% losses. An extensive research effort by the institute has led to the discovery of a parasite in Latin America that can effectively control the mealybug. The parasite has been multiplied in large numbers and released over the whole cassava belt of Africa. The end result is that in at least 95% of the cases, this parasite effectively controlled the mealybug. Cassava has thus been saved for Africa. IITA also works on the control of other major pest problems and we are confident that sustainable solutions can be found.

One of the biggest challenges in SSA is the development of cropping systems that ensure adequate production while improving the quality of the soils. African soils are in general of poor quality, very susceptible to erosion, low in nutrient content and organic matter, and easily invaded by various weeds. The institute has carried out studies on alley cropping—the combined growing of trees and crops. This system shows promise but is labor intensive. For now, it is only adopted in densely populated areas with poor soils.

Studies have also been carried out on the use of so-called green manure which means growing certain leguminous plants after a crop is harvested. The research results indicate that this system offers good opportunities to improve the quality of the soil. It is now being tested on farmers' fields to study possible constraints to its wider introduction. Farmers may hesitate to cultivate plants solely for the purpose of improving the soil, until they have understood the benefits that can be gained in subsequent cropping seasons.

Constraints to agricultural research

The results so far achieved in the areas of crop improvement, plant health management, and soil management research give us confidence that agricultural production in SSA can be improved in a sustainable manner and that the current challenges can be effectively addressed.

However, it will be essential to continue to carry out effective research programs at national and international levels. In that respect, the reduced funding in recent years causes serious concerns. One of the major constraints to effective agricultural research is the lack of government support for the national research systems.

In industrialised countries, some 2% of the agricultural DP is invested in agricultural research. In the developing countries, this is less than 0.5%. Moreover, in developing countries, almost 90% of the research budget goes to staff salaries, leaving too little for operational expenditures. Salaries of national staff are generally very low, leading to a continuous brain drain to better paid positions. In developed countries, almost 50% of the research budget is available for operational expenditures.

Not surprisingly, the research agenda in developing countries is almost exclusively focused on meeting the immediate food need problems. However, there is also the urgent requirement to carry out research on more sustainable production systems otherwise, there will be further degradation of the soils, leaving little hope for increasing agricultural productivity in the longer term.

Well organized and adequately supported agricultural research can deliver the goods for improved economic development. But as mentioned earlier, various other conditions must be met to achieve the overall goal of doubling food production in the coming years, while maintaining or improving the capacity of the production systems. Farmers are definitely prepared and willing to adopt appropriate technologies to increase agricultural productivity. But such efforts will only be undertaken and sustained under appropriate socioeconomic conditions both at the national and international level. To achieve such conditions, the full support of all concerned is required.

References

Pinstrup-Andersen P, 1992. Global perspectives for food production and consumption. Tidsskrift for Land Okonomi: 145-169.

Pinstrup-Andersen P, Pandya-Lourch R. 1993. World food security: prospects for the future. IFPRI.

UN ACC/SCN (United Nations Administrative Committee on Coordination Sub-committee on Nutrition). 1992. Second report on the world nutrition situation - Volume 1, Global and Regional Results.

Revitalizing the University's Contribution to Agricultural Research and Development

Professor J.A. Akinwumi[1]

Introduction

By their nature, universities have the greatest reservoir of free thinking academics willing to try out new ideas and to extend the frontier of knowledge if the atmosphere is conducive. Both the academic staff and their most brilliant students often try all sorts of ideas in their search for new results or new ways of doing things. Sometimes, the efforts become counterproductive when they are not properly harnessed and directed.

In the Nigerian situation, haphazard funding and inadequate supply of materials have led to frustrations which kept researchers functioning below their potentials. There is generally no continuity while most academics pursue minimum cost, short-term investigations in order to publish and get promoted. Therefore, it is appropriate to examine ways to revitalize the contributions of our universities to agricultural research and development.

Most observers are convinced that intellectuals within the West African sub-region are capable of greater research output than was available in the recent past. Hard core research findings are hard to come by. One should ask why the universities in particular appear to be sleeping, with respect to meaningful research and useful results that should lead to faster development in agriculture.

A few obvious underlying problems will be highlighted and followed with suggestions on how to revitalize the contributions of our universities to agricultural research and development. Most people present at this seminar are aware of a recently completed study by the International Service for National Agricultural Research (ISNAR) covering the Université National du Bénin, Cotonou, and Ahmadu Bello University, Zaria. That study came out with a lot of information which can be used to solve the problems of apathy and low research productivity in our university system in sub-Saharan Africa.

There are many facets to the problem including low and irregular funding; poor or total lack of research policy planning; haphazard execution of the poor plans; disenchantment of scholars and research staff due to uncertainties; poor remuneration of workers which, in the face of hyperinflation forces everyone to search for ways to make ends meet; the consequent inability of any researcher to put up long-term research plans or to execute such plans satisfactorily. Research capacity is severely limited in many of our younger universities.

The best researches are carried out where the researcher is reasonably insulated against the daily vagaries of economic instability. Although it is said that necessity is the mother of invention, I want to submit that a good invention requires time, care, patience,

1. Dean, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria.

and dedication all of which a hungry worker is unable to provide. Therefore, the typical university researcher in these circumstances does not put in his best, since he is not insulated.

It is rare today to find a sensitive equipment functioning well in a university laboratory in Nigeria. Breakdowns are frequent, spare parts are not available or are too expensive. Replacement or maintenance is difficult. Reagents are not only expensive but are often unavailable. Thus the training of researchers and research support staff has become haphazard. The libraries are empty or filled with outdated books and journals, keeping the researcher far from the most current advances in knowledge. In such circumstances, it is difficult to reach the frontier in innovative research. I must acknowledge the efforts of the Federal Government through the National Universities Commission to refurbish facilities, acquire books and journals for university libraries. Yet, whatever is supplied is only a small fraction of our needs in view of the long period of neglect.

The African subregion has suffered from a relative lack of understanding of the role of research and, therefore, absence of appropriate emphasis on research and its funding. For example, it is very difficult to persuade the Nigerian policy maker to allocate more money to research and training. A peep into the annual budget of IITA, when compared with the combined subventions of the 18 agricultural research institutes in Nigeria clearly shows the disappointing disparities.

Apart from inadequate facilities, we do not know how to plan and manage research for effective results. The Ahmadu Bello University case study, which is perhaps the best example of well-managed research programming within the university agricultural research system still has a lot of problems as highlighted in the ISNAR report. An important limitation is the poor coordination, collaboration, and utilization of available human and material resources. There is a tendency for persons and groups to personalize facilities, minimising their use while other potential users search in vain for these facilities. It is difficult to get people to work together in a friendly atmosphere. Indeed, many hide research results from colleagues for fear of losing valuable data to smart collaborators. In the process, they may hide their mistakes and misconceptions.

Revitalizing universities' contributions to research

Several steps must be taken to revitalize the contribution of universities to agricultural research and development:

- We must determine research priorities and classify them into short-, medium-, and long-term activities. Abstract or esoteric research should be given a place, but emphasis needs to be placed on problem solving, adaptive research. There should be regular, periodic meetings of academics in the universities and their counterparts in research institutes to formulate, review, and adopt specific research plans. Groups working on specific subjects—crops, livestock, forestry, fishery, etc. should come together and use the national agricultural policy as a guide for setting research priorities.
- Collaboration across countries, ecological zones, and among international researchers should be encouraged. This will permit cross-fertilization of ideas and build a synergy among academics from various locations. The charge in the recent ISNAR study

that "in sub-Saharan Africa, the logical thing to do is to combine the resources in the national research institutes and higher agricultural education institutions in a productive way to address national development objectives effectively, but that unfortunately, the framework for achieving this synergism is yet to emerge" needs to be taken seriously.

Not only should there be collaboration within different zones of a country, there must also be exchange programs which would permit researchers to learn from each other and bring innovations from other lands. Qualified personnel from research institutes should be free to spend their sabbatical year in universites while university lecturers should go to the research institutes. Academic staff should also have a chance to work in relevant industries to better understand their operations and identify the problems worth researching.

- Strengthening research capacity through the identification and training of brilliant graduating students who have the right attitudes.
- Monitoring research activities to ensure accountability. Central management of research, and provision of adequate quantities of consumables should be encouraged.
- Improving technical capabilities of research support staff through training, and exposure to the use and maintenance of modern equipment.
- Improving working environment for university teachers and researchers. Government should provide additional incentives for research staff. Professional staff should be given the opportunity to earn extra income through copyrights and patents. I hope to see a Nigerian researcher become a millionaire through research.
- Encouraging and strengthening linkages with external institutions and advanced laboratories in other parts of the world.
- Selecting and posting research managers to well-established research centers to learn research management. Outstanding researchers on invitation for three, six or 12 months could help set up research centers. They should help diagnose our problems and offer solutions.
- Recognizing manpower imbalance between regions and setting up of joint research programs through which the less experienced academic staff can gain experience.
- Providing adequate funds for exchange programs to expose university researchers to other research settings.
- Coordinating seminars and workshops at which research findings are discussed as well as ensuring well reviewed publications.
- Arranging proper extraction of useful research findings and disseminating information to farmers and other appropriate users.

Recently, the Raw Materials Research and Development Council (RMRDC) of Nigeria started a program of research development and training. This will bring some of its field staff who are involved in raw material processing/utilization pilot projects to universities for higher degrees. Supervisors will guide such students in the use of some aspects of the project for writing the PhD thesis. Meanwhile, the experiences gained by such students will be used in the development of the new project. This is a useful meeting point for theory and practical application. Both the students and their supervisors will gain from the efforts and the contributions of universities to research, and development will be enhanced.

Recently, a competitive bid for research funding was requested by the World Bank-assisted National Agricultural Research System. This must be continued, but the subjects of research should not be left to the bidders. There was a scramble among researchers who proposed every possible topic. It would have been better if guidelines were drawn from a well laid out research blueprint which gave appropriate priorities to subjects in view of national development needs. A beginning has been made, mistakes should be corrected, and the winners carefully monitored.

Conclusion

The universities in sub-Saharan Africa can contribute very little to agricultural research and development as long as the planning, funding, and execution of research is haphazard. More serious, especially in the case of Nigeria and countries with similar battered currencies, is the fact that equipment, reagents, and publications, are too expensive in local currencies.

An equipment costing $25,000 becomes a burden when translated to Naira (N2,000,000.00). A single computer now costs about N300,000.00, an electronic microscope costs N10 million. Where will the money to equip laboratories and provide reagents come from? I hope senior researchers and research managers will work hard to convince governments of the need to fund research continuously and sufficiently.

Duplication of equipment and programs should be minimized. Revitalizing universities' contribution to agricultural research and development is a difficult but not impossible task. I appeal to donor agencies to continue to support our universities with funds, equipment, and reagents.

Securing Adequate Funds for Research in National Agricultural Programs

Professor S.T. Bajah[1]

Abstract: The economic recession which has hit many countries of the world has not spared Africa. African nations are finding it extremely difficult to feed their teeming population. Population control has been focused. Research has clearly shown that food security is sound security. Although the majority of rural families in developing countries are farming, there is still need to massively invest in agricultural research to bring to reality the slogan, "Food for all by the year 2000".

Introduction

About fifteen years ago, the Stuttgart-based Protestant relief agency 'Bread for the world' publicly expounded the theme 'hunger through surplus'. Today, as we come nearer and nearer to the close of the 20th century, we see the ever-growing mountains of agricultural surpluses in the northern hemisphere and the increasing dependence on food imports by the south. The statistical digest of the world shows that out of the 120 poor developing countries, 107 are net importers of food (Hahn, 1995). The poor countries of the South are constantly being reminded that they have no alternative than to become self-sufficient in food. To be self-sufficient in food calls for change in our investment in agriculture and in particular agricultural research. Newer and better ways of farming must be adopted. In order to effect positive change, research information must not only be found in leading journals but should permeate the remotest villages. Agricultural research must be adequately funded. But the foreign deficiency syndrome which has plagued many developing countries must be revisited to reduce what some national leaders refer to as exploitation.

Need for research in national development

In a recent paper, Dr Hans-Otte Hahn (1995), Director of the Protestant relief agency 'Bread for the world' had a cartoon on agriculture.

Agriculture, it was comically stated is

- 10% cultivation
- 80% exploitation and
- 10% agitation

This is a stinging definition. Depending on the listener, the definition can be interpreted to mean too little of cultivation and too much of exploitation. Politicians will interpret the exploitation as taking the best from the less privileged leaving them

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poorer and more dependent on the exploiter. That will give rise to agitation and disruption of peace but that, one may argue, is only one side of the coin.

In another perspective and in line with the focus of this paper, the 80% could be interpreted as positive exploitation of the available arable land and resources. Pursuing that line of argument, the 80% exploitation should include a substantial amount of research which will provide needed information on how to grow more food for the teeming population in an environment.

One problem identified in many developing countries is that natural resources have not been properly exploited. Resources have not been properly exploited because of poor governance, culminating in self-inflicted problems. In today's world, hunger is often not only caused by disaster of crop failure. Persistent hunger is caused by economic and civil unrest, and inequality in the distribution of the benefits of development. Year after year, Smit (1995) maintains, the United Nations High Commission for Refugees (UNHCR) reports increases in the number of refugees and displaced persons, whereas most agricultural research is focused on an assumed stable population. The need has now become greater to focus agricultural research on how refugees can grow enough food, first to feed themselves, and then to strengthen their economic base.

Recent statistics show a staggering 16 million refugees globally. If agricultural research provides useful information on how to deal with refugees with respect to their food needs, poverty will, to a large extent be generally reduced in the world. Smit (1995) writing under the title 'Food for the poor' reports a new initiative of German development assistance in agricultural research. The principles of the Federal Ministry for Economic Cooperation and Development for the early 1990s include an emphasis on:

- poverty reduction
- environmental conservation and education
- enpowerment of women
- influencing development policy in places and countries where development cooperation is active

The initiative reported by Smit focuses on vegetable production. UN/FAO studies indicate that the populations of Africa and South America consume only about one-third of the UN/WHO recommended daily intake of fresh vegetables (65 of 200 g). Vegetables, according to Smit, are the best source of the micro-nutrients vitamins 'A' and 'C' from calcium and other vitamins. They are a less efficient but critical source of protein, especially where meat is in short supply as it often is for the poor, and micro-nutrients are increasingly being recognized for their disease prevention function.

This initiative, culminating in the types of relevant agricultural research is but one direction in which agricultural research should take in an attempt to provide necessary food for the 'poor'. Of particular interest is the outstanding results attributed to the vegetable production initiative.

> The people of Maputo, and other besieged towns in Mozambique did not suffer malnutrition above that of other African cities during the 20 years civil war. In each of these cases, small-scale vegetable production was the secret weapon. These towns and cities fed themselves. They produced essential micro-nutrients on derelict land, using solid waste and waste water instead of commercial fertilizer.

Many concerned people ask, 'what type of agricultural research should developing countries pursue?'

Types of agricultural research

There is enough empirical evidence in conventional literature to show that the two most common types of research are: basic research and action research.

Although all types of research tackle identified problems, there is now a preference for action research which is said to be 'pragmatic'. In agricultural research for instance, there is need to focus attention on

- provision of high-yielding varieties of common crops found in a given environment
- introduction of cheaper and better farming techniques
- preservation of crop yields from pest invasion
- education of peasant farmers on scientific and agricultural innovations
- adequate food distribution

All these areas are already being pursued in many developing countries (including Nigeria). But the problems have always been accountability and funding in national agricultural programs. While there is a widespread belief that accountability in national programs is strongly linked with good governance, funding on the other hand relies heavily on available resources. Funding by and large, is a bilateral process involving a donor and a recipient while good governance is useful for development. We shall now focus on funding of national agricultural programs in what is generally described as Less Developed Countries (LDC).

Funding of national agricultural research in LDCs

The current trainees here have just completed a week-long program on 'Writing winning grant proposals'. Our focus in the week-long program was how to secure adequate funds for agricultural research in three areas:

- individual research
- team research
- institutional research

There has been some misconception in the availability of funds especially for national programs. Nobody, indeed, no donor agency, has free money to give just for the asking. The ritual of calling for grant proposals before money is committed has come to stay. Our colleagues from the rich/developed countries tell us that it is getting more difficult to secure research grants with proper justification through the various steps laid down by the donors.

No matter where funding is sourced, the most important thing is to justify why such money should be made available to you. The advice for the trainees is simple—"If you want a research grant, you must write a winning proposal". Anyone can write a proposal, but a winning proposal requires skill.

However, one must not give the impression that the funding of national agricultural research programs must always come from external sources. Many developing countries should have, within their own development plans, research funds committed for agricultural programs. Unless this is done, it is doubtful if there can be meaningful and relevant development. If a nation state does not know that availability of adequate and affordable food for all is essential for development, then there must be something wrong. Every nation must invest heavily in agricultural research. The price may appear high but on the long run the reward will be enduring and sustaining.

Three levels of research have been identified in this paper. But as I impressed in the minds of the trainees, the trend is towards massive support for institutional research. The reason is not far fetched—there is every likelihood that an institutional research will have both sustainability and multiplier effect.

Dissemination of agricultural research results

It is an understatement to say that results obtained from action research must be widely disseminated. This need is most obvious in developing countries. If one goes by the premise that a good proportion (some documents put this at 70%) of farmers in developing countries are either not literate in western education or are women, then there is need for research results to reach them. For example, surveys in Africa and Latin America show that 60-90% of vegetable producers are women peasant farmers.

Language is usually a barrier between the research scientist and the peasant farmer. Therefore, an acceptable medium is needed through which information will get to non-literate peasant farmers. This is where agriculture and education meet. The interface for the meeting should be such that information flow is encouraged. It is now known that big-time pesticide distributors are embarking on intensive non-formal mode of education for peasant farmers who buy their products. Basic issues such as ability to read, understand, and correctly interpret 'labels' have involved action research in literacy programs.

In some developing countries, there are now medium- and large-scale farmers. They also need to be brought up to date with agricultural research results. The problem that is now becoming obvious in some rapidly developing countries is that the so-called large-scale farmers are really only 'stake-holders' and 'financiers' of the farms. In such a set up, research information should not be wasted on such entrepreneurs, rather, the target audience should be the farmhands.

Recommendations

In a rather vivid way, we have listed areas that should guide the funding of national agricultural research. As much as possible, funding should be provided for agricultural research. There should be a strategy that will raise the status of farmers.

The sure way of securing adequate funds for research in national agricultural research is to learn how to write winning proposals and to have the courage to submit them to donor agencies.

References

Hahn, H. 1995. Less food security in the South. Development and Cooperation No. 5. September/October.

Smit, J. 1995. Good governance. Development and Cooperation No. 5. September/October.

Abstracts of Poster Presentations

1995

Decomposition of roots of selected woody species and nutritional effects on maize

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An experiment was conducted at IITA, Ibadan, Nigeria to study the decomposition of maize roots (*Zea mays*) and the following woody species: *Dactyladenia barteri* (syn. *Acioa barteri*), *Senna siamea* (syn. *Cassia siamea*), *Gliricidia sepium*, and *Leucaena leucocephala*. Two classes of roots were used: fine (diameter < 2 mm) and coarse (diameter 2-5 mm). The decomposition study was carried out using stainless steel litterbags with 7.0 mm and 0,5 mm openings. The results showed that root decomposition followed the order: maize > *Gliricidia* > *Leucaena* > *Dactyladenia* > *Senna*. Fine roots tended to decompose more slowly than coarse roots, except for *Leucaena* and maize roots, where the reverse was observed. Root decomposition was higher in litterbags with 7.0 mm than in those with 0.5 mm openings. The residual mass of roots was negatively and significantly correlated with the initial lignin content of roots, whereas the correlation was positive and significant with the initial hemicellulose content of roots, respectively at 3, 6, 9, and 12 months of decomposition. Polyphenol content only influenced the earlier stage of decomposition.

A screenhouse study using fine roots of these species as sources of N, with an incubation period of 0, 2, 4, and 6 months, prior to planting was also conducted. Maize was used as a test plant. Results showed that maize shoot dry matter (SDM) and N uptake increased with the incubation period, and were linearly and inversely correlated with carbon-to-nitrogen ratio (C/N ratio) of the added roots. *Gliricidia* and *Leucaena* roots with a low C/N ratio (13.1 and 14.0, respectively) enhanced maize SDM and N uptake. Low yield and N uptake were obtained with the addition of maize roots which had a high C/N ratio (40.3). Intermediate maize SDM and N uptake were obtained with *Dactyladenia* (C/N = 28.8) and *Senna* (C/N = 21.6).

Agroecological zones of Nigeria: I. leaf area index, crop growth rate and dry biomass accumulation

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Plant age and locational effects on the dry biomass (DB), crop growth rate (CGR), and leaf area index (LAI) of six cassava clones in three agroecological zones in Nigeria were studied. Kano represented the Sudan savanna zone, and Mokwa the southern Guinea savanna zone. Both locations have unimodal annual rainfall averaging 844 mm and 1235 mm respectively. Ibadan represented the forest savanna transition zone with a bimodal

annual rainfall averaging 1253 mm. Clones in the study included three IITA clones, TMS 30001, TMS 4(2)1425, TMS 50395 and four local cultivars, Isunikankiyan (Isu), TME1, TME2, and Dakata Wariya (DW). Isu was replaced by DW in Kano.

At 52 weeks after planting (WAP) at Ibadan, TMS 4(2)1425 had the highest DB, LAI, and CGR which ranged from 780.8 to 1253.9 g (mean 1060.1 g), 1.5 - 2.8 (mean 2.0) and 2.1 - 3.4 g $m^{-2}d^{-1}$ (mean 2.9 g $m^{-2}d^{-1}$), respectively; DB was highly associated with LAI ($r = 0.64^{**}$) and CGR ($r = 0.72^{***}$). At 54 WAP at Mokwa, Isu had the highest DB which ranged from 782.8 to 1590.8 g (mean 1177.1 g); TME1 had the highest LAI and CGR which ranged from 1.8 to 3.1 (mean 2.5) and 2.1 to 4.2 g $m^{-2}d^{-1}$ (mean 3.1 g $m^{-2}d^{-1}$) respectively; DB was highly correlated with CGR ($r = 1.0^{***}$) and LAI ($r = 0.77^{**}$). At 54 WAP at Kano, TMS 50395 had the highest DB, LAI, and CGR which ranged from 606.5 to 979.9 g (mean 762.7 g), 1.52 - 2.92 g (mean 1.97g) and 1.59 - 2.57 g $m^{-2}d^{-1}$ (mean 1.99 g $m^{-2}d^{-1}$), respectively; DB was highly associated with CGR ($r = 1.0^{***}$) and LAI ($r = 0.66^{*}$).

The following clones performed the best throughout the season: at Ibadan, TMS 4(2)1425 and TME1; at Mokwa, Isu and TME1; at Kano, TME1 and TMS 50395. TME1 performed best across the three locations. TMS 4(2)1425 performed best in Ibadan and poorly in Kano suggesting sensitivity to climatic factors. The DB increased throughout the season; gradually at Mokwa; sharply at Kano, and Ibadan. Mokwa had the highest LAI and Kano had the lowest. LAI was highly correlated to CGR and DB. Clones with a high LAI could be selected for high DB production.

Abstracts of Poster Presentations

1995

The effect of mulch from three multipurpose trees (MPTs) on weed density, biomass, and composition in maize

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Field experiments were conducted during the 1995 and 1996 growing seasons to investigate the effect of mulch from three MPTs on weed density, biomass, and dynamics in maize. Treatments consisted of mulch from *Leucana leucocephala, Gliricidia sepium, Senna siamea* applied at a rate of 5 tonnes DM/ha and unmulched plots fertilize with 90 kg N/ha. Plots without fertilizer applications were controls. The mulch was cut and carried from established tree stands. Maize at 53,333 plants/ha was planted at mulching

Weed data were collected at 3 and 8 weeks after planting (WAP). In both years there were more weeds in the unmulched plots compared to mulched plots with the exception of *Leucaena* plots in 1995. These plots had 57% more weeds than the unfertilized control plots. At both 3 and 8 WAP, un-mulched plots had higher weed density, biomass and weed density and biomass than unfertilized plots. In 1995, there were 75, 7, and 47% more weeds at 8 than at 3 WAP in *Gliricidia, Senna,* and the unfertilized control, respectively. In 1996 however, there were less weeds at 8 WAP than at 3 WAP.

Weed reduction by the mulches was in the order *Gliricidia* > *Senna* > *Leucaena*. In 1995, at 3 WAP, *Leucaena* and the control plots had 22 and 25 weed species, respectively compared to *Gliricidia* and *Senna* which had 6 and 11 species, respectively. A total of 17, 19, 25 and 29 weed species occurred in *Gliricidia, Senna, Leucaena* and control plots respectively at 8 WAP. Sedges were the dominant species in all the treatments except in *Gliricidia* treatment where *Talinum* and other broadleaves were the dominant species. In 1996, weed composition was similar in all treatments at both 3 and 8 WAP.

In 1995, 40-80% of the weeds in all treatments were sedges and 20% of the weed flora in *Leucaena* were grasses. However, in 1996, *Talinum* and other broadleaf species dominated in the mulch plots. In addition to *Talinum*, grasses such as *Digitaria* were present in higher proportions in the control treatments.

Results from this study suggested that *Gliricidia* and *Senna* were effective in reducing weed biomass and density whereas Leucaena promoted weed growth. Because *Senna* mulch persisted on the ground longer than *Gliricidia*, the better suppressive effect of *Gliricidia* seemed to be not only from physical suppression of germinating weeds but could probably be attributed to allelopathic effects. There were shifts in weeds flora from grass dominated immediately after fallow to easy-to-control broadleaf weeds in the mulch treatments after two years of cropping.

Discussion

Q. What is:

1. The rationale for using DNMRT in separation of memos
2. The absence of measures of association
3. Application rate of 5 t/ha dry matter weed biomass at planting and 3 t/ha at 3 days after planting DAP.

A.

1. LSD and DNMRI were compared and due to some missing data, DNMRT was found superior and adequate for mean separation in the experiment. DNMR was able to group means appropriately and the small number of treatment means meant that there was any great risk of using DNMRT in the mean comparisons.
2. Research was on-going and so it was not yet possible to determine measures of association because other parameters that would have to be taken into account are yet to be looked at or will be looked into later.
3. Applications were done at planting and at 3 WAP, not days after planting.

Comments

Controls in agroforestry research usually incorporate N to make comparisons meaningful. MPTs have advantages in terms of releasing N into the soil, such that any control without some amount of added nitrogen should normally perform less and so the actual overall contribution of the MPTs will be difficult to appreciate.

Nigerian maize storage systems in five agroecological zones

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A survey was conducted to identify maize storage systems used by farmers in five major agroecological zones in Nigeria. The zones were: Humid Forest, Mid-altitude, Southern Guinea Savanna, Northern Guinea Savanna, and Sudan Savanna. Five villages within each zone were selected and five farmers within each village interviewed. Eight storage structures were described, including raised platforms, synthetic fertilizer bags, cribs, traditional clay silos known as 'rhumbus' and 'obas'—a woven basket made from guinea corn stalks and glass bottles. Work needs to be done to determine the efficacy of the traditional systems of storage used by the farmers and the socioeconomic implications of changing the systems.

Growth stages of *Striga aspera* on maize host

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An illustrated account of the growth stages of *S. aspera* as it develops on a maize root with time is presented. *S. aspera* development was monitored above and below-ground. The below-ground growth stages lasted 26 days while the above ground growth took 49 days. The complete life cycle of *S. aspera* lasted 75 days.

Germplasm selection of soybeans (*Glycine max* [L] Merr.) cultivars for high *Striga hermonthica* seed trapping capabilities

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Striga hermonthica (Del.) Benth., is an obligate parasite of important production constraint for cereals in sub-Saharan Africa. Rotation of host with non-host crops such as soybean, that are not parasitized by *S. hermonthica* but stimulate germination of its seeds, can be a primary part of integrated control strategy. An effective control program that includes the elimination or reduction of *S. hermonthica* seed from heavily infested soil, and the prevention of further seed multiplication which is acceptable to resource poor farmers is urgently needed.

Out of 56 soybeans cultivars screened in the laboratory using in vitro techniques, varied levels of *S. hermonthica* seed germination (17-63%) was recorded. In screenhouse pot trails, using 2 kg soil infested with 10,000 germinable *S. hermonthica* seeds, reduced *S. hermonthica* infection on susceptible sorghum cv CK60B planted in rotation with nine of the soybean cultivars which induced high level of *S. hermonthica* seed germination from laboratory selection as compared with sorghum after sorghum rotation. The relative ability of soybeans cultivars to stimulate *S. hermonthica* seed germination in the laboratory or reduce sorghum infection in the screenhouse was similar. Soybean cultivar Tax 1649-11F produced best effects in both trials.

The Role of Training in Agricultural Development in Sub-Saharan Africa

1996 Symposium

Welcome Address

B. Ubi[1]

I am happy to welcome you all to the second annual symposium of the International Association of Research Scholars and Fellows (IARSAF) of the International Institute of Tropical Agriculture (IITA). IARSAF is an association of graduate research students registered at a University and conducting thesis-based research at IITA under a senior scientist. Short-term trainees from national programs are also integrated within the association to give them a sense of belonging while at IITA.

Graduate training at IITA started in 1970 and IARSAF was formed in 1981 to provide an opportunity for Graduate Research Fellows (GRFs) from diverse academic and sociocultural backgrounds to interact closely. In this process, academic and research ideas are exchanged, a spirit of friendship and mutual understanding is fostered and solutions to problems affecting members are sought. The association therefore enables GRFs to become more united in purpose, and linkages are built among colleagues. Ultimately, a crop of professionals are enabled to work together now and in the future towards greater accomplishments.

As we are all aware, the ultimate goal of IITA is to help tame hunger and alleviate rural poverty in sub-Saharan Africa. To achieve this, IITA seeks to:

- develop systems for managing and conserving natural resources in sub-Saharan Africa to increase agricultural production in a sustainable way
- improve the performance of key (mandate) crops which can be integrated into improved and sustainable production systems
- reduce postharvest losses, facilitate crop and food processing, and promote crop utilization
- strenghten national agricultural research capabilities through research and training.

Strenghtening the capabilities of the national agricultural research systems (NARS) to conduct research and training appropriate to their development is the main goal of the training programs in the CGIAR Centers. At present, agricultural research and development in the sub-continent is limited by the number of well-trained researchers. IITA has adopted the strategy of devoting more permanent resources to training with a shift in emphasis to individualized training. So important is the training component in taming hunger in Africa that Professor A.H. Bunting, a former IITA Board member, commenting on the Cameroun National Root Crop Improvement Program (CNRCIP) stated in a review of this program:

> At the end of the day, the CNRCIP will be judged not so much by the increases in output of root crops to which improved technologies from the Program have contributed, as by the number of contented farm

1. President, International Association of Research Scholars and Fellows (IARSAF), 1996.

> families whose nutrition and income it has helped to assure their improvement and more importantly the development of a self-reliant assemblage of well-trained researchers adequately equipped to countinue to solve problems of root crops.

The crucial issue arising from this quotation is the fact that the assemblage of professionals empowered by their sound training and orientation at IITA will ably tackle the existing and emerging challenges in their regions. There are currently 110 GRFs (25 MSc. and 85 PhD) spread across IITA stations. From this pool of trainees, capabilities are being developed to keep tackling the problems of agriculture in sub-Saharan Africa. The association is proud of its members (past and present) whose impact is continously felt in research. Today, an alumnus is one of our guest speakers. Drawing from reminiscences of his training at IITA, and the experiences gained after graduation, he will be adressing a sub-theme titled : "Agricultural training at IITA—expectations and experiences".

We are particularly happy that the Director General will be delivering a keynote address on "The CGIAR and the global research agenda" as we focus on the role of training in our second annual symposium. It is hoped that this symposium will provide the way forward as we reflect on the human resource needs of NARS in the face of the socio-political and economic challenges of our time. A vital link has been in the use of the manpower developed. What do home governments do with their professionals? This issue merits thorough consideration. In this symposium therefore, strategies for retaining indigenous professionals in sub-Saharan Africa will be discussed.

Graduate students constitute a group of vibrant young men and women with creative ideas for solving scientific problems. GRFs constitute a vital component of the research mandate of IITA. The preocupation of GRFs is to conduct research under the direction of a senior scientist towards a successful thesis. Consequently, the GRF puts in all energies to achieve this goal within the duration of the Fellowship—assuming no limitations in supplies and/or other logistics. We wish for more coordination between the Training Program and the supervisors to help monitor the progress of the GRF. We are eager to complete our work and move on to new challenges. According to Murphy's law, however, sometimes it is not easy.

On the second day of this symposium, some contributions arising from the work of selected GRFs will be presented in the scientific session. We have had to limit the number of presentations (oral and poster) to give more room for interaction among the students and the supervisors. It is our hope that a detailed document containing the titles of GRFs theses successfully defended and the resulting publications, from the inception of the Research Fellowship Program at IITA, will be made available during the third annual symposium. This document will provide insights into the contributions of GRFs to the overall goal of IITA.

At this point, I would like to draw our attention to the view expressed by my predecessor in office, Mr. M. Tshiunza, during the first annual symposium, to the effect that the contributions of GRFs to the institute have been over-looked over the years. It should be noted that the results of research under-taken by GRFs remain the property of IITA and therefore should be counted as part of the output of the institute. IARSAF hopes that in the next anniversary celebration of IITA, the contributions of the GRFs will be re-cognized and encouraged in this regard.

I thank the Leader of the Training Program and his team for their efforts at improving our working conditions and enhancing the quality of our training through the complementary courses. In the course of stay at IITA, the GRF is provided the opportunity of taking some of these complementary courses—Statistical Computing with SAS and GENSTAT; Training and Communication Skills; Writing Winning Proposals; and Agricultural Research Management. These complementary courses further broaden the scope and perspectives of the GRF towards enhancing his effectiveness as a trained researcher. I also commend the untiring efforts of

Mr. C. Okafor in managing the affairs of GRFs. Through the support of the Training Program, GRFs were able to undertake this year's study visit to the IITA station in Bénin. We now have a better understanding of the wonderful bio-control activities of the institute in Cotonou. IARSAF is particularly grateful to the Director of PHMD, for making the trip such a pleasant and beneficial one.

I acknowledge and thank the invaluable contributions of our supervisors both at IITA and our respective universities. We count ourselves highly privileged to be trained under your direction, remembering that the "the seed is the same as the source". We appreciate your support, painstaking efforts, and concern to see us through our program. In re-cognition of your contributions, IARSAF has instituted a prestigious Fellowship of honorary membership award to be conferred on two supervisors in a year. Recipients are recognized as the supervisors of the year. All our supervisors merit this honor, however, only two awards are given by the association following a long process of selection and recommendation by a Honors/Awards Committee, and ratification by the IARSAF Executive.

I thank my colleagues for their unflinching support and collective resolve that has made this symposium a success. I urge us all to remain steadfast in our research, inspite of the difficulties we may encounter for "behind the hard times lie hope". Let us continue to make the best use of this opportunity.

Finally, we are grateful to the Director General in making our stay at IITA such a pleasant one. He has always opened his doors whenever we knocked. We also commend the support and encouragement of the Deputy Director General, and the Research Directors Committee. We wish you more blessings and peace.

Once again, you are welcome to this symposium. God bless you all.

CGIAR and the Global Research Agenda

Dr Lukas Brader[1]

It is very timely that this colloquium is organized so closely to the forth-coming World Food Summit. There is no doubt that research is an absolute prerequisite to meet the future food needs, particularly now as the challenges are far more complex than in November 1974 when the last World Food Summit was held.

The 1970s were the beginning of the green revolution which alleviated the threat of major food shortages in South and Southeast Asia. If we briefly compare the situation of the 1970s with that of the 1990s, then we can draw the following conclusions.

In the 1970s, technology was available to achieve significant production increases. Southeast Asia had well-functioning irrigation infrastructures, hence an environment for assured agricultural production. There was a favorable grain/fertilizer ratio, and concerns about wide scale use of pesticides were minimum. National Agricultural Research Systems (NARS) were mostly weak. The international agricultural research centers (IARCs) had developed, and were further improving broadly-adapted, early-maturing, fertilizer-responsive, high-yielding wheat and rice varieties. There was an effective transfer of improved technologies from IARCs to NARS. The result was the green revolution under favorable conditions, avoiding major famines.

Today, we face a different situation. Vision 2020 has clearly shown that serious problems are looming in less favorable areas, in particular sub-Saharan Africa. In Africa, the combination of high population growth and low productivity in agriculture will continue to lead to food shortages and increases in poor and under-nourished people. The challenges here are different, we have to arrest and reverse natural resource degradation and declining productivity. In addition, we need to double food production in the next 25–40 years. However, there is now only very limited growth in irrigation. Cultivation is expanding to marginal areas, rain forests and wetlands. Production practices are depleting soils and costs of inputs have become relatively higher. On the positive side however, the capacity of NARS has increased.

The approaches pursued today focus an improved management of natural resources combined with more targeted genetic research with greater emphasis on stress resistance and yield stability. There is a stronger effort to mobilize research resources within the larger global system.

The CGIAR led the research for the green revolution, and in recent years has changed its research agenda to effectively address these new challenges in partnership with all stakeholders. Some five years ago, the CGIAR significantly broadened its agenda to better address natural resource management. Work on plant genetic resources conservation had already expanded and new institutes became members of the Group. This included the International Center for Living Aquatic Resources Management

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(ICLARM), the International Irrigation Management Institute (IIMI), and the International Centre for Research on Agroforestry (ICRAF). The Center for International Forestry Research (CIFOR) was also established. One of the strengths of the CGIAR is the continuous scrutiny of the research agenda of the IARCs to ensure that the programs effectively address the newly emerging needs. The system's Technical Advisory Committee (TAC) plays a key role in this regard.

However, in 1994, following the adoption of Agenda 21 by the UN Conference on Environment and Development, and to ensure continuing support for the system, a program of renewal and rededication was launched to clarify the vision of the CGIAR, refocus its research agenda, reform its governance and operations, and secure renewed support for its international mission. A major milestone in this renewal program was a ministerial-level meeting held in Lucerne, Switzerland, in February 1995. This meeting took major decisions (the Lucerne Action Program) on the future of the system. The meeting report notes the following with respect to the research agenda:

The mission of the CGIAR is to contribute, through its research, to promoting sustainable agriculture for food security in the developing countries. Therefore, the CGIAR is urged to:

- Conduct strategic and applied research, with its products being international public goods
- Focus its research agenda on problem-solving through interdisciplinary programs implemented by one or more international centers, in collaboration with a full range of partners
- Concentrate such programs on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to strengthening agricultural research in developing countries
- Address more forcefully the international issues of water scarcity, soil and nutrient management, and aquatic resources
- Pay special attention to sub-Saharan Africa and South Asia, which face the greatest challenges in eradicating poverty and malnutrition
- Ensure that research programs address the problems of the poor in less-endowed areas, in addition to continuing its work on high potential areas
- Reinforce the series of notable actions already taken to protect the human heritage of genetic resources
- Work in closer partnership and collaboration with public and private research organizations in the South, including farmer groups, universities, NGOs, and international institutions to design and conduct research programs
- Work in closer partnership and collaboration with public and private research organizations and universities from developed countries to design and conduct joint research programs
- Ensure that the setting of its research agenda reflects the views and goals of global and regional fora on agricultural research

Following the Lucerne meeting, TAC developed a new strategies and priorities paper. This paper, endorsed by the CG members, lists the following priorities to be addressed in the research agenda of the Centers:

- poverty alleviation
- protection of the environment
- improvement of food security

The paper also stresses the need to widen the partnership in the implementation of the research activities. The Centers have clearly demonstrated that they are able to effectively address these matters.

The positive impact of the research undertaken by the CG Centers on food production increases has been well documented. The green revolution as well as the positive results in less-endowed areas in Latin America, West Asia and North Africa, and sub-Saharan Africa on crops like maize, cassava, beans, cowpeas, and chickpeas are a clear proof of research contributions to improving food security and alleviating poverty. The system has in recent years in particular, strengthened its capacity in natural resource manage-ment including biodiversity. Some examples of these activities will be briefly reviewed.

The CG Centers have traditionally made major efforts to ensure the conservation of genetic resources relevant to agricultural production improvement in the developing countries. Materials have been collected and stored in genebanks and live collections, and are made available to all concerned. Through the International Plant Genetic Resource Institute (IPGRI) in collaboration with the Centers and other research institutes, various studies have been undertaken on matters such as improved storage conditions, disease-free transfer of genetic materials and size of collections, to effectively represent the genetic diversity of specific species. As a result, the CG is safeguarding by far the largest collection of genetic material essential for agricultural development. Moreover, these collections have now been placed under the auspices of the FAO, further strengthening their use under the guidance of the international community.

In the 1970s and 80s, the use of insecticides led to a variety of new, serious pest outbreaks in intensive rice production. Research carried out by IRRI demonstrated that the spraying of insecticides eliminated the useful insects thus leading to rapid development of these new species, such as the brown planthopper. Moreover, these insects become rapidly resistant to the insecticides commonly used with the overall result of total crop failure over thousands of hectares. FAO took the initiative to establish the integrated pest management program for rice in Southeast Asia.

Initially, this program focused on Indonesia. Effective collaboration between IRRI, FAO, and the Government of Indonesia led to what is now known as the most successful integrated pest management program in the world. Farmers were trained to understand their crops better, in particular to identify useful organisms in their rice fields. Hence, they were able to decide if insecticide applications were necessary. This new technology has been generally applied since the 1980s and insecticide use in rice growing in Indonesia has been reduced from 4–5 applications per crop cycle to 0–1, and rice production has increased. This is an excellent example of collaboration between an IARC (IRRI), a development agency (FAO), and a national government. Rice production has increased in a sustainable manner, environmental pollution has been reduced, farmers have gained a better understanding of rice production, and the country's economy has been substantively strengthened.

The basis for this success was a combination of excellent research and the translation of these results into a package of technologies well adapted to the farmers' circumstances. Successful demonstrations at village level led the government to take the necessary policy decisions and to assure the donors that their investments would be well spent. It is not surprising that integrated pest management is now increasingly applied in other rice producing countries in Asia. In addition, IRRI has redirected its research agenda to address related research issues such as integrated disease control and integrated weed management.

Cassava production in sub-Saharan Africa was threatened by the accidental introduction in the 1970s of the cassava mealybug which was not a major pest in South America, from where it originated. The mealybug spread quickly over the whole cassava belt causing losses of 20–30%, and in certain areas total crop failure, and the consequent loss of the major food source for many farmers. Analysis of the problem led to the working hypothesis that biological control could be a potentially viable solution.

Extensive surveys by CIAT and IITA led finally to the identification of a number of parasites. After passing through quarantine in Europe, these were tested by IITA at its headquarters in Nigeria for their effectiveness to control the mealybug. One species showed good promise, mass multiplication techniques were developed and field releases confirmed the capacity of this parasite to control the mealybug. Consequently, an Africa-wide release campaign, funded by various donors was implemented.

Thus, a major pest problem has been overcome through the use of economic natural means in a non-polluting, sustainable manner. Moreover, this success was achieved at no cost to farmers. For every dollar invested in this effort, there was a return of some $180. The environmental benefits are equally, if not more important, and there are also the positive effects for food security for large numbers of farmers.

A similar success will soon be achieved with the biological control of the cassava green mite which is now the most important pest of cassava. Research is at a stage where success can be guaranteed. It is now a matter of spreading the identified predator over Africa's cassava belt.

An excellent example of success in addressing abiotic stresses is found in CIMMYT's research related to drought tolerant maize and to new maize varieties well adapted to acid soils. About half of the 60 million hectares planted to maize in the developing world is subject to drought. Plant physiology research had shown that drought during the flowering stage was most critical. Under such conditions, more energy is diverted to the male flower to the detriment of the female seed-producing flowers. It was found that this effect was minimized in varieties where male and female flowers appeared at about the same time. Selection of such varieties and testing under drought stress showed the validity of this approach. CIMMYT can now release varieties that give one-third higher yield under drought conditions.

Acid soils are a problem in the tropics, in particular in Latin America. CIMMYT has now developed six varieties of maize that can withstand acid soils much better than currently available varieties.

These and various other examples such as crop varieties with resistance to major diseases, show that the CG is well equipped to address problems related to improved natural resource management.

In financial terms, CGIAR activities represent only 4% of the agricultural research efforts related to developing countries. They have certainly led to a much higher contribution to agricultural development over the last 25 years. However, as stressed in the Lucerne Action Plan, every effort should be made to strengthen cooperation with the other 96% to ensure the most effective use of the available resources. Deliberate efforts are made to enhance partnerships with NARS including NGOs and the private sector, as well as with relevant institutions in the developed world.

Over time, various cooperative arrangements have already been put in place and further impetus has been given to this in recent years through the development of systemwide and ecoregional programs. Currently, the following systemwide programs are implemented:

- Genetic resources
- Alternatives to slash and burn
- Water management
- Livestock
- Soil, water and nutrient managemeht
- On-farm water husbandry in the WANA region
- Integrated pest management
- Participatory research and gender analysis for technology development

These programs have helped to review priorities in the various research areas and to implement more effective collaborative arrangements.

Ecoregional programs address common problems related to improved resource management in specific ecoregions. Stronger partnerships are established, as solutions to these problems are usually location specific. Currently, the following programs have been put in place:

- African Highlands Initiative
- Desert Margin Initiative
- Consortium for Sustainable Development of the Andean Region
- Ecoregional Program for the Humid and Subhumid Tropics of Sub-Saharan Africa
- Ecoregional Program for the Humid and Subhumid Tropics of Asia
- Rice-Wheat Cropping Systems in the Gangetic Plains
- Ecoregional Approach to Enhancing Agricultural Research Effectiveness in Tropical America

These programs have been developed over a relative short period of time and are a clear demonstration that the CGIAR is capable of adjusting its activities to new developments. They have all had a significant influence on the redirection of the research agenda of the various centers.

The CGIAR is a unique system consisting of a donor group that meets twice a year, various committees and 16 international research centers. It receives its funding through annual pledges, notwithstanding the fact that agricultural research is typically of a long-term nature. This system, probably due to its rather informal nature, has been uniquely successful in agricultural research. Various reasons account for this success.

The CGIAR is totally apolitical and the endorsement of Center programs is solely based on their potential impact and scientific merit. The TAC regularly revises research priorities and strategies and all research activities are regularly reviewed by External Review Panels. The recommendations of these Panels are carefully reviewed and their implementation is monitored.

One of the biggest strengths of the system is the overall high quality of its staff. All appointments are made following international recruitment procedures. Staff performance is reviewed annually. Moreover, researchers are provided with excellent research facilities and support staff. This allows to exploit their capabilities to the maximum possible extent and assures the best return on investments. There may be reasons to change the system, however, every effort must be made to maintain the high quality and performance of the staff efforts, because they are the unique strength of the group.

The donors have provided generous financial support to the CGIAR and there are some concerns about the adequacy of available funds. This is the right opportunity to express sincere thanks to the Belgium Government for the strong support it provides to the work of the Centers. This does not only concern financial support, but also the provision of highly qualified staff for long-term employment as well as short term consultancies.

Notwithstanding all the successes, the system can only be maintained if the financial requirements are adequately met. There is no doubt that the investment in the work of the CGIAR is one of the best examples of highly successful development support. If all efforts had been equally productive, the economic situation in many developing regions would be much better today.

Assessing the Impact of IITA Training

Dr J.L. Gulley[1]

Background: Each time a graduate researcher departs for home, each time a course comes to an end, the research supervisor, the trainer cannot help but wonder: "Will this training have an impact on the lives and well-being of people in Africa?" That is a question which, even if not spoken, inevitably, comes to our minds. Does the training, in which IITA and donors invest tens of thousands of dollars, have any significant impact?

End-of-training evaluations may accurately indicate how much the training was appreciated by participants. Oral defenses of theses and end-of-course tests may indicate gains in knowledge and skill, and even radical changes in attitudes. But the real proof of the value of training must be found elsewhere: on the job where the participant-trainee works, and in the broader society which has invested its resources in training its researchers.

We are happy to learn that participants were pleased with their course of study. We can even feel pride when individuals demonstrate through papers and poster presentations that they have mastered a complex set of research techniques. But the same nagging question remains. Has the outstanding training IITA provided had any significant impact, beyond the level of the individual?

Has training had any impact on the research organization where the new researcher returns? On scientific knowledge through research results? On technology generation? On farmer adoption? On levels of production? And ultimately, on producer and consumer welfare? These are the questions which we must grapple with when we think of "impact of training".

Donors, who provide funds for training, likewise want to know how much 'bang' they are getting for their 'bucks'. In response to continued donor queries, administrators are grasping for some shreds of evidence that might show that, indeed, training does have some impact, preferably positive impact, of course! If for no other reason than to justify the expenditure of training funds, we must be able to give some sort of response to the question.

We expect that our assessment of the impact of IITA training will demonstrate the value of our investment in training:

- to ourselves
- to our collaborators
- to our supporters (donors, past and potential)

The results should also help to guide us in determining the types of training most needed by NARS and the future levels of investment in training.

1. Leader, Training Program.

In this paper, I briefly review IITA's approach to training, examine a few theoretical issues related to assessing impact of training, and outline our approach to assessing the impact of IITA training.

Figure 1. Main elements of IITA's integrated research and training system.

Pre-training phase	Identify NARS rsearch priorities and problems which training can address Identify gaps in skills needed to support specific research work Design training Select participant-trainees Send training invitation with request for country report and preliminary action plan Participant-trainee and supervisor develop preliminary action plan Participant-trainee presents country report and action plan
Training phase	Tailor training (as feasible) to meet needs apparent from country report, action plan Conduct training Revise and finalize action plan
Post-training phase	Participant implements action plan Maintain communication with participant Provide feedback Visit participant on the job Participate in follow-up workshops or training Revise training content and goals, as appropriate

IITA's integrated research and training system

First, we should remind ourselves of the goal of IITA training

- to strengthen the capabilities of national agricultural research sytems
- to conduct research and training for their own development

Our only reason to exist is to serve the training needs of NARS, in relationship to IITA's research mandate.

Training at IITA has for many years been closely linked to IITA's research mandate. We like to remind everyone whenever we have the chance that we do not do training for the sake of training; at IITA, research drives training. We have even argued that training should be made more integrated with research by budgeting courses from IITA's research projects. The following diagram summarizes the key elements of IITA's integrated research and training system.

Where is this diagram?

Note that both researchers and training staff are involved in each of the highlighted key elements: from needs and skills identification before the course, through the conduct of the course and frequently in communicating with participants after the courses. When this model of training is judiciously applied, there is no doubt training is made most effective.

The practice does not always match the ideal. However, when all the key individuals are involved in each phase as appropriate, one can be much surer that any training provided is more likely to be used than if those individuals are not involved in these processes. That is why we call for supervisors to be involved in the development of the preliminary action plan. We also know from experience that when participants anticipate future contact with scientists/trainers, they are more motivated to implement their action plans, which means actually using the knowledge, skills, and attitudes gained from training.

We continue to try to perfect the implementation of this model to get the greatest value out of our training. Our impact study should enable us to see just how efffective this model of training has been so far. Before describing that study, let us look at some of the theoretical and practical issues which have helped to shape our approach to the study.

The problem

Assessing the impact of training is a tricky business because there are many levels of potential impacts which are not easily assessed. Theoretically, training impact might be assessed at five levels:

1. individual
   knowledge, skill, attitude (learning)
   behavior / performance (on-the-job)
2. organization or institution
   operations
   outputs (reports, publications, etc.
3. intermediate research or technology user
   research institutions
   extension services
   development agencies
4. ultimate technology user
   farmers
   processors
5. ultimate beneficiaries
   production
   consumption

We would, of course, like to think that all training contributes not just to individual learning, but to job performance, research results, technology development and use, and ultimately to improved producer and consumer welfare, that is, social and economic development. Since farm production or productivity and social welfare are several steps removed from training activities, it is difficult to demonstrate linkage between these levels.

Figure 2a. Levels and sequence of impact with related indicators.

Level of impact	Sequence of impact	Measurement indicators
5 ultimate beneficiaries	+ welfare • technology spread	• human welfare • consumption
4 ultimate clients	• farmer adoption •	• number of farmers, processors using technology
3 intermediate clients	technology •	• number of technologies "on-the-shelf" or with professionals
2 organization (individual performance)	research results •	• numbers of research reports, journals, etc. • number of others trained
1 individual performance	job performance	• improved quality, quantity of work
1 individual learning	knowledge + skills + attitudes • **Training**	• test performance

NB: Collinson and Tollens suggest other indicators to assess organizational and institutional development, which might be linked to training. These are characterized by contact, collaboration, and exchange:

- number of network meetins attended
- number of vistis of research workers
- number of joint experiments
- amount of germplasm received.

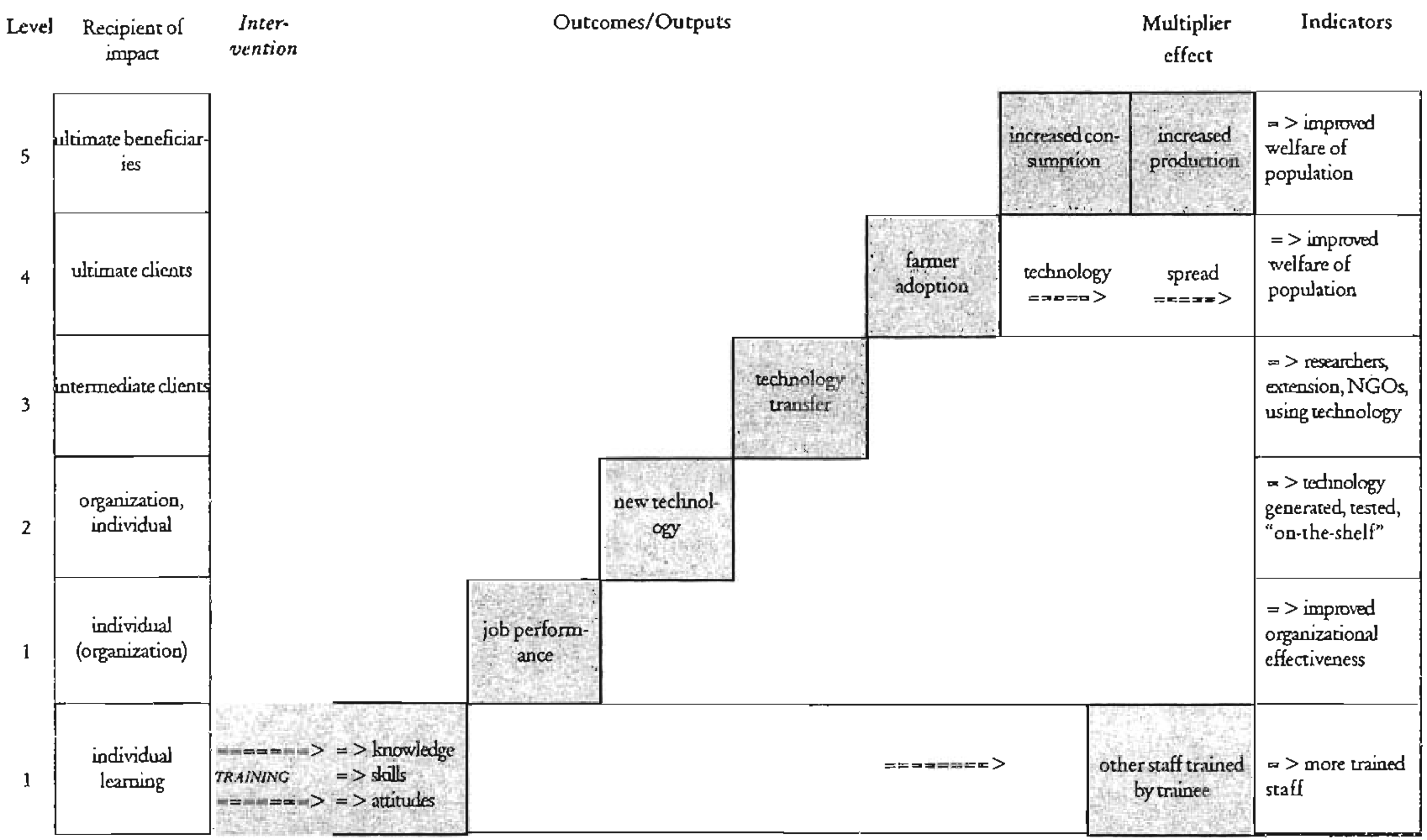
One might imagine a case in which, under ideal circumstances, a research skill acquired in training was used to develop a specific technology, which in turn led to enormous increases in production and consumption—impact at the ultimate user and beneficiary levels.

Imagining is easier than demonstrating. In actual experience, instances of linking training to increases of consumer welfare are likely to be few and far between. Yet, if such cases do exist, one would not like to miss their discovery, rare as they may be.

Searching for such cases might be like looking for the proverbial 'needle in a haystack'. Or perhaps—looking for *Epidinocarsis lopezi* in Latin America! But we need methods which have at least the potential to capture both the ordinary and extraordinary.

An impact study must account for the complex environment in which research is carried out. This is essential both to understand the more incremental but significant influences which the participant-trainee may have had within the organization—on

Figure 2b. Levels of impact assessment by recipient, outcomes/outputs and measurement indicators.



colleagues and processes—and to recognize the possible influences of other training or non-training factors on the participant.

Perhaps a more apt image for the evaluation of training impact is 'panning for gold'. It is possible to search for gold in a stream of water. One can do this by 'panning', that is, after filling a pan with material and water from the bottom of the stream, one swirls the material in the pan in a circular motion, occasionally adding water and little by little, washing out the dirt and lighter stones. Gold, even tiny flecks, being heavier than the surrounding stones and debris, are left in the bottom of the pan after everything else has been washed away. Though a tedious process, the pay-off may be great.

An approach is needed which casts a wide net (survey questionnaire) to uncover potential deposits of gold. When discovered, we can apply additional tools (interviews, data collection on-site) to sieve for the golden nuggets. Other studies have used a variety of tools for evaluating training.

Previous studies

The study of training in the CGIAR system conducted by the Technical Advisory Committee (TAC) in 1984 examined Centers' training from 1962 and concluded that the study provided "convincing evidence of the substantial contribution of the system to human resources development in the field of agricultural sciences in the developing countries" (TAC, 1986). The study's terms of reference, in short, were to describe the Centers' training, assess the result of that work in relation to national development and the Centers' tasks, and to make suggestions for the future.

The study combined the efforts of an overall survey team and individual case studies conducted in six countries. There were personal visits (18 countries), discussions with individuals providing the training (230 international Centers' staff in 10 countries), participants trained (about 700) and officials working in the national programs where participants returned (about 400).

The study team's method was not based on formal sampling (neither stratified nor random), meeting those persons who were available during their visits. However, the team also met with other contacts and friends not selected by the Centers or national agencies. The team found that "their testimony did not conflict materially with that of the people whom the Centers and national agencies helped us to meet". The team did not attempt "any formal quantitative measurement of the effects, on individuals, of the training at the Centers" due to the difficulty, time required, and uncertain outcome. The team found "the results broadly consistent over the 18 countries and the many hundreds of participants" (TAC, 1984).

In addition to the broad survey, six country studies were completed under the direction of national collaborators, including three in Africa (Senegal, Tunisia, Kenya). The study notes that "it is impressive that on the whole the country studies are so positive about what the Centers have done ... [and] that by and large their findings are not substantially different from ours ..." (TAC, 1984).

A number of individual Centers have carried out follow-up evaluation studies of training. The most recent studies on crop production and improvement training (WARDA 1994, and CIMMYT 1993) reported positive impact on the quality of the work of training participants after the training. Both studies relied on participants' responses to mailed survey questionnaires. No other sources were used to corroborate the results of the survey.

A combination of survey (the wide net) and case study methods (the finer sieve) will give us the possibility for the best results.

Of course, in the end we must select methods that are realistic, given the available time and resources. Collinson and Tollens estimate that if "full blown" impact assessments of all of the CGIAR system's research products were made, it would require a doubling of the total CGIAR budget.

Purpose and expected outcomes

Historically, training has been provided by international agricultural research centers (IARCs) to strengthen the capacity of national agricultural research systems (NARS) to conduct research. The purpose of this study is to determine, as far as possible given limited resources, the impact which IITA training has had over the past 25+ years.

Research approach

IITA's "operational theory" of training. Every program has either an explicit or implicit operational theory, that is, an operating hypothesis of how the program works to achieve its desired outcome. IITA's implicit operational theory of training can be summarized as follows:

Training provides new knowledge and practice of skills to increase *competence* which, when applied, improves *performance*, produces *research results*, and generates *new technology*. By adopting new technology, *farmers increase production and productivity*, leading to *increased welfare* of both the agricultural sector and the general population. (See fig. 2a.)

Hypothesis. This study hypothesizes that impact of training increases in proportion to the length and technical level of training. One expects greatest impact from PhD-level training than from any other level of training. Conversely, one expects least impact from short-term training.

The study will test that hypothesis by comparing impact of different types and lengths of training. Sampling procedures are being used that will allow cross-country, cross-institutional comparisons by type of training.

Other assumptions. The hypothesis also assumes that training impact is greatest where training has been:

- most frequent
- over the longest period of time
- complemented by research collaboration, special projects,
- and resident scientists

Conversely, training impact would be least where these conditions do not obtain.

Training provided by IITA has been only one among many factors influencing the professional development of former participant-trainees. The other significant intervening and environmental factors must be accounted for, including:

- other non-IITA training
- other non-IITA technical assistance
- significant policy differences
- social, political and economic factors

The **primary unit of analysis is the individual** who was trained. At the level of the individual, we want to know after training

- where have participants gone?
- what have they done?
- what have they accomplished?
- what have they produced?"

The individual's achievements may be within or may reach beyond his or her organization.

The *secondary unit of analysis is the organization* or institution which sent the individual for training. We would like to know after (the participant's) training

- how has the organization and its work been affected by the participant?
- what has the individual produced for/within the organization?
- has the participant shared his or her knowledge and skills with or affected others by his or her (changed) attitudes?

Beyond the individual within the organization, one may also look at the *linkages with others outside the organization.*

- what are the linkages between the organization and its collaborators and clients—researchers, extensionists, development specialists, etc. farmers, processors, etc?

At every level, one must ask and document: what *(if any)* evidence connects the training through the trained individual to the relevant outputs or outcomes?

Identifying impact at the individual and organizational/institutional levels is challenging, but feasible. IITA Training Program and Monitoring and Evaluation Unit have experience in using the tools of the study, including follow-up visits to assess impact of training in 1992 *(Research Farm Management).* Beyond the level of the organization, and possibly its contacts with intermediate clients, one moves into a study of adoption and diffusion of technology, well beyond the scope of this study. Measuring the extent or degree of impact, and attributing impact at higher levels, linked to specific training inputs remain somewhat elusive goals and is not included in this study.

IITA's study draws on some of the same methods used in previous Center studies, but has added features to meet our own objectives. The study is divided into three major phases: pilot studies, general survey *(questionnaire)* and in-country visits and interviews in selected institutions.

The general survey will be sent to all past participants for whom we have valid addresses. The aim is to get a cross-section of past trainees and learn about their post-training experience: where have they gone? what have they done? what have they achieved? we also have questions about their use of their training, suggestions for improving training and linkages with IITA.

Table 1. Indicators of impact by outputs, link to training and source of data.

	Level of impact	Sequence of impact	Measurement indicators	Link to training	Tangible outputs	Personal observation	Sources of data		
							Participant	Supervisor	Colleague
5	ultimate beneficiaries	+ welfare • •	• human welfare • consumption production	•	•	•	•	•	•
4	ultimate clients • farmer adoption •	technology spread	• number of farmers, processors using technology	•	•	•	•	•	•
3	intermediate clients	technology •	• number of technologies "on-the-shelf" or with professionals	•	•	•	•	•	•
2	organization •	research results	• number of research reports, journals, etc.	•	•	•	•	•	•
1	individual performance	job performance • •	• number of others trained improved quality, quantity of work	•	•	•	•	•	•
1	individual	knowledge + skills + attitudes	• test performance	x	x	x	x	x	x

The pilot studies conducted in Ghana and Sierra Leone by NARS collaborators enabled us to further test and modify the questionnaire for the survey, develop experience and categories for coding open-ended questions and produce some preliminary substantive results. As a result, the survey questionnaire was reduced in size, responses to open-ended questions have been used to formulate more closed-ended questions and ambiguous questions clarified or eliminated.

The overall response rate ranged between 27 and 30 %. Interestingly, some were reluctant to complete the questionnaire, indicating that "... IITA has long forgotten about them". One of the benefits of the general survey should be maintain or re-establish contact.

Field visits allow an observer to understand the context within which participants work, and also to look for 'critical incidents'—exemplary achievements to which training could logically be related. Critical incidents would be examined in detail to determine who within an organization played a determinative role, and whether there was an implicit or explicit link to training. These would be the "golden nuggets" of training—rare, but valuable. Critical incidents could likewise provide a basis for comparing trainees with non-trainees.

Multiple methods and sources. Table 1 is a tool to assist evaluators to systematically collect and document impact evaluation data. The table summarizes potential indicators of training impact by type of outcomes/outputs and sources of data. The framework specifies, as far as possible, all the potential domains in which knowledge and skills of training might be expressed. For each individual case (participant-trainee), the evaluator systematically documents the data he or she discovers. These data include:

- evidence of the indicator
- concrete outputs
- explicit or implicit link to training
- products linked to training
- number and kind of data sources which confirm the evidence, the output, and the link to training of an impact indicator

As the types and sources of confirming data increase, the persuasiveness of a case for training impact increases.

One must also take into account other (potentially) confounding variables, such as other training, which might just as logically be related to observed impacts. Confounding or disconfirming data, of course, reduces the persuasiveness of a case.

As indicated earlier, a combination of survey (the wide net) and case study methods (the finer sieve) will give us the possibility for the best results. Neither by itself would provide the full picture we are looking for.

Conclusion

Purpose of study: major milestone

- document achievements (where they have gone)
- renew/maintain relationships—partnerships
- clarify some issues for future training

Q. Over the years, IITA has contributed to manpower development in sub-Saharan Africa. The statistics of those who are in international, national, universities and those who have taken up other career should be shown.

A. Our study will address that. It is part of our goal.

Q. Since training aims at changing the attitude of trainees who are majorly from sub-Saharan Africa, the Training Program should show more dedication to NARS. Training Program could assist scientists from NARS to use IITA facilities for example, the library, even when they are not official collaborators.

A. Any trainee is a collaborator, what we need to do is to reshape collaboration and look for ways of maintaining it.

Q. The Training Program could also contact trainees who have gone into private farming. They could be as useful as NARS and ADPs in contacting farmers.

A. This is the program but you have helped in broadening it.

Q. Given the fact that NARS require trained personnel to orientate research priorities and address problems, does the hypothesis that the longer the training, the greater the impact hold in the light of this fact?

A. Not all training require the same time. A technician for a short time is expected to have lesser impact than a PhD trainee. The hypothesis could be disproved. It is still being studied.

Q. What is training doing to achieve improvement of resources at NARS as part of its responsibility to follow up its trainees after graduation as an impact assessment indicator?

A. That can be improved upon.

Q. IITA should be flexible in the length of time given for fellowship in order to take care of unforeseen circumstances, for example the present ASSU strike.

A. Every organ has a level of flexibility. However, there is a limit. Anytime an extension is given, money is drawn from someone else's budget. The resources are limited.

Agricultural Training at IITA: Expectations and Experiences

Dr M. Fregene[1]

I have been requested by the honorable president of IARSAF-IITA to present my limited experiences as a Graduate Research Fellow (GRF) and also speak about the expectations of graduate training at IITA. I will present my rather subjective observation and give some perspectives as to things I will want to do or would like to see done if I were to repeat my graduate fellowship at IITA.

Let me remind us that graduate training at the international agricultural research centers (IARCs) is one of the cardinal objectives, and transferring technology to local populations is the only means of sustaining sustainable agricultural production system. The role of training in IARCs is clear. In the words of the current president of Sasakawa Global 2000 Foundation, Dr Norman E. Bordang who is also the 'father' of the green revolution:

> The transfer of research results from CGIAR centers to farmers in developing countries is heavily dependent upon capacities and members of publicly-funded national research and extension systems. Any strategy to maximize investments in agricultural technology generation and transfer must find ways to fund adequately and with stability the CGIAR centers and NARS. There is a need to jointly finance both to maximize the potential from scientific networking between IARC researchers and outstanding NARS.

Partners of CGIAR centers must be able to operate at the same scientific level. Having said that, I will now describe my expectations and give my experiences of agricultural training at IITA. While it may closely represent what any young African scientist trained at IITA would say, I recognize it cannot be the complete picture.

What are the expectations of trainers at IITA?

I was opportuned to attend a priority-setting meeting for the research agenda of a key CGIAR mandate crop for the next decade. It was clear at that meeting that national programs in Asia and Latin America were sufficiently developed to the point of transferring 70% of technology developed in IARCs to farmers. But the same could not be said of Africa. We all know this is due to many reasons. But a major reason is still the shortage of skilled agricultural scientists, who can be supported to tackle prblems of sustainable agriculture in Africa. The major goal and expectation of agricultural training at IITA is to address this shortfall.

The Training Program also seeks to provide a forum for young and budding scientists including those in other fields, mostly during seminars and short courses. Interaction

1. Biotechnology Research Unit, CIAT, Cali, Colombia.

with the international scientific community is also assured with opportunities to attend major international conferences, participate in short-term training courses both at home and abroad. This, no doubt, contributes in no small way to raising the horizons and motivating young African scientists to higher achievements.

Agricultural training at IITA also provides a forum for interactions among the paticipants themselves. Life-long friendships, which could lead to cross-continent collaboration in future are established, and also scientific peer review and pressure is provided. Finally, trainers' expectations are that the returning young scientist is going back to further pursue a career of agricultural research in his home country.

In summary, that is what both the trainer and the trainee expect from training at IITA. My experiences at IITA as a graduate research fellow can also be presented along the same line of expectations. There is no doubt that the human and technical resource capacity of IITA is probably the best available in sub-Saharan Africa. Most young researchers from African countries are exposed to state-of-the-art facilities upon arrival at IITA. This is a very strong motivation to bring out excellence from young people. GRFs are encouraged to work late nights and learn everything possible.

Interaction with my research supervisor, Dr Robert Asiedu, gave me training that is not easy to quantify, but shows in all I do. He gave me so many tips about management of resources and people that I still find his methods useful at CIAT where I am based. I worked on a research topic that was a recent innovation. Dr Asiedu made the necessary contacts for me to spend some time in a laboratory where facilities were already present and laboratories properly set up. I have to thank him, Mr C. Okafor and Dr H. Gasser for also funding a trip to Colombia for the First International Meeting of the Cassava Biotechnology Network. The people I met during that meeting and the ideas gained have been and are still the propelling force of my career.

Here at IITA, interaction with members of IARSAF provided not only scientific know-how and technical expertise on the computer, but also some very rewarding friendships. The weekly Friday IARSAF meeting was a very good forum to build bridges across country and regions

My experiences in the area of continued training after IITA has also been positive. I was able to secure a Postdoctoral Fellowship at CIAT with the help of my research supervisor, Dr Robert Asiedu. This is helping to complete my training to make a positive impact in my own little way in the future.

In conclusion, the future of agricultural training at IITA still has room for improvement in the aspect of basic research tailored to meet the most relevant agricultural problems encountered in sub-Saharan Africa. Secondly, interaction with the international scientific community has to be strengthened by giving scholars an opportunity to attend and present a scientific paper at a major conference at least once during their stay here. Lastly, returning trainees must be encouraged to practice and be productive in their respective countries.

Q. How do we stimulate policy makers to put infrastructures in place that will attract African scientists to work in Africa?

A. There is the example of a proposal by Rockefeller to provide funds to Rockefeller- or CGAIR-trained scientists for research in their countries.

Q. Do we expect a communiqué at the end of this symposium?

A. Yes.

Comments
If the NARS are not strengthened, we will not make any impact on sub-Saharan agriculture. There should be a way to foster relationship between NGOs, NARS and CGIAR centers.

Comments
I support the idea of making provision for IITA Research Fellows to attend local and at least, one international conference in the course of their training.

Q. Since training is the development of the mind to solve problems, and the sub-Saharan, NARS cannot sustain the facilities in CGAIR system where sub-Saharan scientist receive some training. Should not the Training Program of IITA expose the trainees to the realities of national programmes by allowing close interaction between NARS and IITA trainees during their training.

A. I support the philosophy. We should be able to respond to the problems in the NARS.

Strategies for Retaining Indigenous Professionals in Sub-Saharan Africa

Dr. M.O. Akoroda[1]

1. Keep the professionals **happy**!
2. Professionals are most happy when their careers are:
   - organized
   - focussed
   - matching forward
3. There is need to **work** to be happy!

How the unemployed spend their time (UK in 1982)

Activities	Morning		Afternoon		Total
	men %	women %	men (%)	women (%)	(%)
Housework	19	49	7	21	19
Shopping	20	26	9	17	16
Job hunting	22	16	12	13	16
Visiting friends or relatives	6	10	12	17	10
Gardening	14	2	13	3	11
TV	4	2	14	12	8.5
Reading	9	5	8	10	8
Decorating	7	3	7	2	5.5
Walking	5	3	8	2	5.5
Nothing/sittingaround	3	3	9	6	5.5
Staying in bed	8	8	1	0	4.5
Visiting town	5	7	3	4	4.5
Playing sport	4	1	4	0	3
Drinking	2	1	3	1	2

Social Trends, 1984.

People who would work even if it were financially unnecessary.

Wish	Men %	Women %	Overall %
would work, stay in present job	31	34	32.5
would work, try to change job	35	29	32.0
would stop work, might work later	10	12	11.0
would never work	15	18	16.5
don't know	9	7	8.0

Warr (1992).

1. Agronomy Department, University of Ibadan, Nigeria.

4. Most MSc and PhD graduates will become tertiary teachers or work in an agricultural research institute, somewhere.
5. In a 'normal' university setting, lecturers spend
   3 years as Lecturer II (a fresh PhD)
   3 years as Lecturer I
   5 years as Senior Lecturer
   3 years as Reader
   Professor

The minimum waiting period for professorship is at least 14 years.

- The long period indicates the need for overlapping funds/projects.
- The effective period of apprenticeship is 3-5 years
- Good research leadership is becoming scarce due to brain drain.

6. In the research institute, the civil service structure is clearly heirarchical and is not significantly correlated to performance, thus the career must be "wait and see" always, and demands much patience.

7. To cope and stay in sub-Saharan Africa, there is need to:
   (a) train well, know your trade very well
   (b) **mentally accept** Africa as a professional base
   (c) get **NARS to provide:**
      - employment
      - housing
      - promise of a salary that makes you shun private practice
      - good security of abode and experimental fields
      - funds for research materials and equipment/tools
   (d) **develop other diverse skills**
      - driving
      - typewriting
      - computer literacy
      - proficiency in more relevant languages
      - healthy lifestyle (avoidance/reduction/abstinence),
      - development of good human relations
      - speech making/listening abilities
      - reliable professionalism
      - outgoing/principled personality
      - time management practices
   (e) **develop hunting** skills for places where your type of work can be found:
      - Ministry of Agriculture/projects/various
      - NGO/institutes
   (f) **advance professionaly** through:
      - acquisition of a sound foundation in the discipline
      - regular practice by courting wide collaboration
      - reading and writing
      - readiness to practice

(g) **IITA's role**

- **Funding initial research** after training to avoid early frustration by shifting the point of effective despair beyond the apprentice years.

Enhance NARS/IITA collaboration by cooperative research.

- Integrating the newcomers into NARS
- Old-Students Association of IITA (OSAIITA)
- Maintain links of exposure beyond ex-trainee.

(h) Be willing to grow **slowly** and **surely.**

Growth is progressive and stepwise.

lie down
sit up
crawl about
hold supports
stand unsteadily
walk slowly
run wobbly
climb obstacles ....sky is the limit.

Abstracts of Oral Presentations

1996

The effect of mulch from three multipurpose trees (MPTS) on weed density, biomass, and composition in maize

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2. University of Kassel, Germany.

Field experiments were conducted during the 1995 and 1996 growing seasons to investigate the effect of mulch from three MPTs on weed density, biomass, and dynamics in maize. Treatments consisted of mulch from *Leucaena leucocephala, Gliricidia sepium, Senna siamea* applied at a rate of 5 tons DM/ha and unmulched plots fertilized with 90 kg N/ha, or without fertilizer application were controls. The mulch was cut and carried from established tree stands. Maize at 53,333 plants/ha was planted at mulching.

Weed data were collected at 3 and 8 weeks after planting (WAP). In both years, there were more weeds in the unmulched plots compared to mulched plots with the exception of *Leucaena* plots in 1995. These plots had 57% more weeds than the unfertilized control plots. At both 3 and 8 WAP, unmulched plots had higher weed density, biomass, and weed density than unfertilized plots. In 1995, there were 75, 7, and 47% more weeds at 8 than at 3 WAP in *Gliricidia, Senna* and the unfertilized control respectively. In 1996 however, there were less weeds at 8 WAP than at 3 WAP. Weed reduction by the mulches was in the order *Gliricidia* > *Senna* > *Leucaena*. In 1995, at 3 WAP, *Leucaena* and the control plots had 22 and 25 weed species respectively, compared to *Gliricidia* and *Senna* which had 6 and 11 species respectively. A total of 17, 19, 25 and 29 weed species occurred in *Gliricidia, Senna, Leucaena* and control plots, respectively, at 8 WAP.

Sedges were the dominant species in all the treatments except in *Gliricidia* treatment where *Talinum* and other broadleaves were the dominant species. In 1996, weed composition was similar in all treatments at both 3 and 8 WAP. In 1995, 40–80% of the weeds in all treatments were sedges, and 20% of the weed flora in *Leucaena* were grasses. However, in 1996, *Talinum* and other broadleaf species dominated in the mulch plots. In addition to *Talinum*, grasses such as *Digitaria* were present in higher proportions in the control treatments.

Results from this study suggested that *Gliricidia* and *Senna* were effective in reducing weed biomass and density whereas *Leucaena* promoted weed growth. Because *Senna* mulch persisted on the ground longer than *Gliricidia*, the better suppressive effect of *Gliricidia* seemed to be not only from physical suppression of germinating weeds, but could probably be attributed to allelopathic effects. There were shifts in weeds flora from grass dominated immediately after fallow to easy-to-control broadleaf weeds in the mulch treatments after two years of cropping.

Q. What is:

1. the rationale for using DNMRT in his separation of memos?
2. the absence of measures of association?
3. application rate of 5 t/ha dry matter weed biomass at planting, and 3 t/ha at 3 days after planting (DAP)?

A. 1. LSD and DNMRI were compared, and due to some missing data, DNMRT was found superior and adequate for mean separation in the experiment. **DNMR** was able to group means appropriately and the small number of treatment means meant that there was any great risk of using DNMRT in the mean comparisons.

2. Research was ongoing and so it was not yet possible to determine measures of association because other parameters that would have to be taken into account were yet to be looked at or would be looked into later.

3. Applications were done at planting and at 3 weeks after planting (WAP), not days after planting (DAP).

Comments

Controls in agroforestry research usually incorporate N because without that comparisons will be meaningless. This is because of the obvious advantage MPTs have in terms of releasing N into the soil, such that any control without some amount of added nitrogen should normally perform less and so the actural overall contribution of the MPTs will be difficult to appreciate.

Nutritional status of preschoolers in cassava growing areas in Nigeria: anthropometric indices

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In an attempt to verify the myth associated with cassava (inferior commodity, the consumption of which causes malnutrition) anthro-pometric measurements of 437 preschoolers aged 0–5 years were taken in 378 randomly selected farm households in 63 villages from cassava-producing areas in Nigeria. Standard deviation units values (Z-scores) from median National Centre for Health Statistics (NCHS) were calculated for, weight for age, height for age, and weight for height indicators. Household expenditures on individual major commodities namely cassava, maize, yam, and millet/sorghum as well as total food expenditure were calculated. For each of these five expenditure items, the 437 preschoolers were grouped according to whether they were from high (above average) or low (average or less) expenditure households. The Z-score values were determined for preschoolers in each of the individual major commodity and total food expenditure household categories.

The standard deviation units values of all the preschoolers for weight for age (-1.11), height for age (-1.30), and weight for age (-0.43) were above median–2SD, the recommended conventional cutoff for use in Africa. The percentage prevalence of undernutrition (31%), stunting (40%), and wasting (6.4%), were all low in comparison with 35.7% (undernutrition), 43.1% (stunting), and 9.1% wasting reported in Nigeria Report on the Nutrition Situation; however, stunting seemed to be most prevalent.

The standard deviation units values of the preschoolers were less among those from high than among those from low maize- or cassava-expenditure households. The differences were however significant only in the case of weight for age. On the other hand, the standard deviation units values were more among children from high than among others from low yam or millet/sorghum expenditure households. The differences were significant only in cases of weight for age and height for age indicators between high and low millet/sorghum expenditure households.

Total food expenditure was lower among high than among low maize or cassava expenditure households, but higher among high than among low yam or millet/sorghum expenditure households. The deviations from median NCHS references were significantly less among children from high than among others from low total food expenditure. These suggest that total expenditure on all food (total food consumption) rather than expenditure on individual food items (level of consumption of individual items) determines the nutritional status of preschoolers.

Q. How do you separate and study the effect of cassava as a source of malnutrition in rural households considering that this food is hadly ever consumed in isolation?

A. From literature, it has been reported that people eat more of what they grow, and therefore it is assumed that some rural communities/households that grow cassava in relatively huge quantities consume a highly significant proportion of cassava products daily.

Conservation of West African yam biodiversity: seed preservation

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The storage physiology of the botanical seeds of 3 genotypes of West African yams - *D. dumetorum*, *D. praehensilis*, and *D. rotundata* was examined for long-term conservation of yam genetic resources. Seed viability and vigor were evaluated in freshly harvested seeds during the 1994 season. Seed viability was scored as the sum of percentage germination and hard(dormant seeds). Seed germination rate was estimated as the reciprocal of time to cummulative seed germination during 10 week of incubation. Seed vigor index was estimated as the percentage seed germination x vine length at emergence. Initial seed viability was 70% in *D. praehensilis*, 82% in *D. rotundata* and 100% in *D. dumetorum*. Seed vigor index was also highest in fresh *D. dumetorum* seeds.

After ripening, dormancy was most pronounced in *D. praehensilis* seeds. Seed survival in storage at 12 storage conditions (-20 °C, 5 °C, 15 °C, and 25 °C, in combination with seed-moisture levels ranging from 8% to 26%) was monitored for 2 years. Half-life estimates (p50) from probit analysis of the seed survival data was generally highest in low-moisture seeds at low storage temperature regimes for all the seed types. Seed longevity estimates were in the range of 3 to 5,000 years with the drying and cooling treatments. This confirms orthodox seed storage physiology pattern in yam seeds. Moreover, p50 was optimised with storage at 5 °C so that there was no significant gain in seed longevity extension with freezing at -20 °C. The implication of these preliminary results is that long-term seed conservation is feasible with the conventional cold-dry storage systems in gene banks. This provides an approach to maintaining base collections of yam genetic resources. The results are being validated in futher trials to establish standards for yam seed conservation.

Q. What guided your choice of genotypes used in the experiment?

A. The availability of seeds in large quantities was the basis for the choice of materials used in this experiment.

Q. Did you mention *Dioscorea dumetorum* as growing in the wild?

A. While it is true that *Dioscorea dumetorum* is an edible species, it must be recognized that it also exist in the wild in uncultivated form. The one used in this experiment was collected from the wild and so, was considered as wild.

Influence of agroecozones and crop age on cassava root starch content

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Starch continues to be a major industrial produce of cassava (*Manihot esculenta* Crantz) roots all over the world. Variations in percent dry weight root starch (%DWtSt) content occur due to crop age, varietal, and environmental differences. This genotype x environment effect makes selection of cassava clones with wide ecological adaptation and high %DWtSt content difficult. The influence of crop age and agroecozones (AEZ) on storage root search of six cassava clones were studied in Nigeria, during two 12-month growing seasons. The tested AEZs were Sudan savanna (Minjibir), southern Guinea savanna (Mokwa), and forest-savanna transition (Ibadan). AEZ roots were sampled at about 4, 6, 8, 10 and 12 months after planting (MAP).

Interaction between plant age and clones was not significant for %DWtSt content. Percent root starch content decreased with age in the wetter AEZ but increased with age in the drier AEZ. Highest %DWtSt content was recorded at 6, 8 and 12 MAP at Ibadan, Mokwa, and Minjibir, respectively. Percent starch and sugar contents were negatively correlated across locations ($r = -0.77^{*}$, -0.38^{*} and -0.90^{*} at Ibadan, Mokwa and Minjibir respectively). For high %DWtSt content, early maturing clones are recommended for wetter AEZ whilst late maturing clones are recommended for drier AEZ. Selection of clones for %DWtSt content can be done at any age across all AEZ. Percent DWtSt content was greater in the drier AEZ. Hence, to obtain higher %DWtSt content, high yielding cassava clones should either be grown in drier AEZ, or supplied with minimum levels of water for optimum growth.

Q. What would you say is the physiological basis for cassava in the dry areas accumulating more starch with time in the wetter southern regions of Nigeria?

A. In the South, high rainfall leads to high water content of tubers and increased autolysis (hydrolysis) of starch to sugar.

Q. What was the method of starch analysis used?

A. The hydrolysis method.

Q. Is it important that starch content of cassava varieties be related to total dry matter yield? Comment on this.

A. In order to harness to high percentage starch reported for the same varieties used in this experiment, on going those percentages to be meaningful, it is recommended that high yielding clones be grown.

Growth and yield of three cassava cultivars on the upland and inland valley in Sierra Leone

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Three cassava cultivars were evaluated for growth and yield on the upland and inland valley swamp (IVs) in 1993–94 using a randomized complete block design. On the upland, clone 80/40 outyielded clone 87/29 and cocoa and clone 87/29 in turn outyielded cocoa. In the IVs, clone 87/29 outyielded clone 80/40 and cocoa while cocoa also outyielded clone 80/40.

The highest yielding cultivars in each ecology also had the highest tuberous root bulking rate (TBR), dry matter (DM) production, crop growth rate (CGR), relative growth rate, net assimilation rate (NAR), leaf area index, leaf production rate, and leaf life in the respective ecologies. This indicated a positive correlation between these parameters and tuberous root yield.

The high yield of clone 87/29 in the IVs was partly due to its lower rotted tuberous roots percentage, while clone 80/40 had the highest. The high root rotting in clone 80/40 was partly due to the greater depth of the tuberous roots in the soil (0.3–0.6 m) as compared to the other cultivars (0.15–0.3 m). This brings the roots in contact with stressful water levels earlier than the others.

The yield and yield components, growth and leaf characters were all drastically reduced when the cultivars were grown in the IVs as compared to the upland. For example, the tuberous root yields of cocoa clones 87/29 and 80/40 were reduced by 53%, 60%, and 92%, respectively, when grown in the IVs compared to the upland. Selection of cassava cultivars with longer leaf life and leaf area maintenance leading to high CGR, TBR, NAR and harvest index (IVs and upland), coupled with shallow tuberous root formation zone (IVs) can lead to high root and leaf yields when combined with other yield determinants in the two ecologies.

Q. What was the method of leaf area measurement?

A. This research was carried out in a national agricultural research system(NARS) in Sierra Leone which lacks sophisticated equipment. A ruler was used to measure the length and bredth of the middle lobe, and the graphical method used to determine the leaf area. Using simple linear regression, a relationship was found between these two parameters, and in subsequent leaf area determination, the length and breadth of the middle lobe was measured and fitted into the regression equation to obtain the leaf area.

Viability, germinability, dormancy, and virulence of hybrids of *Striga hermonthica* and *Striga aspera*

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Striga hermonthica and *Striga aspera* have striking morphological resemblance and occur in similar agroecological zones in West Africa. Freshly harvested hybrids seeds obtained from artificial F_1 crosses between both species were tested for viability, germinability, dormancy and virulence. Seed germination and viability were tested over time. Seed germination was induced by a 10 mg L^{-1} solution of Strigol (GR24) and viability of ungerminated seeds was tested with a 1 g L^{-1} solution of tetrazolium salt. Length of seed dormancy was determined from harvest to time of maximum germination. Virulence of the interspecific hybrids was determined from pot studies with two maize cultivars. Result showed that the hybrid seeds had viability, Germinability and dormancy comparable to seeds of both species. The parasite hybrids were virulent on both maize cultivars, indicating that each species may be a source of virulent genes for each other.

Q. You made reference to inter-crossing and crossing in your presentation. How do they relate to each other?

A. Intercrossing refers to interspecific crosses which produced hybrids while intra-crosses here refers to crosses between two plants of the same species (i.e. *Striga hermonthica* or *Striga aspera*) producing a pure lines of that species.

Q. You said hybrids were morphologically different from parents. You failed to tell us how?

A. The position or length of the corolla tube before bending in *Striga hermonthica* isjust after the calyx while in *Striga aspera*, it is raised above the calyx. In the hybrids, this was found to be intermediate between what is observed in the parents.

Soil phosphate-P dynamics and nutrient uptake in soybeans sole cropping system

Modupe VO

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In recent years, dramatic increase in the per capita food production in much of the tropics has been obtained through farming programs with improved technologies viz-a-viz sustainable use of soil resources. To sustain this productivity, management options that will focus on the processes of soil nutrient transformations through the soil-plant system is crucial. Hence, studies on soil solution phosphate-P dynamics. Nutrient uptake and partitioning using soybeans as test crop were conducted at Ibadan and Fasola in 1995.

Phosphate-P ions concentration were more at Fasola at amended N and P levels (60 kg N and 60 kg P/ha). Mineral N and P partitioning in soybean tissues were in the order of pod > leaf > stem > root at both locations. Soybeans N and P uptake per kg of applied nutrient were more pronounced at amended phosphorus level. At both locations, 60 kg N combinations were found to be optimum for a good soybeans grain yield of 1.83 kg/ha (Ibadan) and 2.21 kg/ha (Fasola). The grain yield advantage of 20% at Fasola is attributed to surplus phosphate-P.

Comments

Soil organic matter actually increases with increase in soil nitrogen content since a certain proportion of soil organic matter (about 5%) is made up of soil nitrogen.

While it is true that soybeans fixes its own nitrogen, from my 1994 trials, 60 kg N was found necessary for optimum soybean yields. Beyond 60 kg N, no yield response was observed.

Q. Why did you choose the two locations—Fashola and Ibadan? Did you expect any variabilities between these two close agroecozones?

A. Location efects for Fasola and Ibadan will need more data. These will be obtained later, as the research is still in progress.

Comment

You should take N-fixation into consideration when working on P and N dynamics.

Selection of reference crops and methods for estimating N_2 fixation in field-grown *Mucuna pruriens* in the derived savanna of Nigeria

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Field experiments were conducted to investigate the effect of rhizobia inoculation, urea-N fertilizer and indigenous rhizobia; and two cropping systems on the estimate of symbiotic nitrogen fixation in *Mucuna*. Precision of the ^{15}N isotope dilution (ID) technique was compared to the total nitrogen difference (TND) method. *Imperata cylindrica* and maize (*Zea mays*) were screened as the non-N-fixing reference plants. Irrespective of the source of N, Mucuna derived 67.3% of its N from biological nitrogen fixation (BNF) using the ID method, representing 163 kg N ha^{-1}. The application of 90 kg N ha^{-1} significantly decreased Ndfa in both the solecropped and *live*-mulched systems with maize. Estimates of N_2 fixation using whole Mucuna plants followed the same trend as the shoot values. Roots gave a significantly lower estimates of Ndfa compared to the shoots or whole plants. The ID and TND methods appeared to provide equally reliable estimates of *Mucuna* N_2 fixation in the *in-situ* mulch systems. The significant reduction in soil N uptake by Mucuna in the live-mulched systems with maize, suggest a competition for soil available N, resulting in a higher proportion of atmospheric derived N in the live-mulched systems (74.7%) compared to the proportion in solecropped systems (59.8%). Given the similarity of Ndfa values estimated using *Imperata* and maize in both the ID and TND methods, and the continued growth of Mucuna and *Imperata* after maize harvest, *Imperata cylindrica* was showed value as an appropriate reference plant for quantifying symbiotic N-fixation in *Mucuna* especially in *Imperata* infested fields that are prevalent in the tropics.

Abstracts of Poster Presentations

1996

Cassava tuberization under mid-altitude and lowland savanna agroecological zones of Nigeria

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Information on onset, growth, and development of tuberous roots in ca-ssava as influenced by low temperatures is scanty. Approximately 19% of total cassava area in Africa experiences low temperatures. Therefore, investigations on the effect of low temperatures on cassava tuberization need further analysis. Twelve cassava genotypes (local and improved) were grown at two field sites (Jos: 18 °C ± 5 °C and altitude of 1260 masl (Ibadan: 27 °C ± 6 °C, altitude 210 masl) from 1994 to 1996 to examine onset of tuberization (TITO), increment of tuberous root number (RNHA) and dry tuberous root weight (DTUB). Destructive growth analyses were done at 3, 6, 9, and 12 months after planting (MAP).

Significant differences ($P = 0.05$) in RNHA and DTUB were observed (Ibadan, 1994 and 1995, Jos, 1994 and 1995) throughout the growing period. At 3 months, the mean values of 4.4, 1.9, 0.6, and 0.8 RNHA per plant were recorded for Ibadan, 1994 and 1995, Jos, 1994 and 1995, respectively, while DTUB of 0.7, 0.03, 0.06, and 0.01 Mg ha^{-1} were recorded for Ibadan, 1994 and 1995, Jos, 1994 and 1995, respectively. There were continous increases in the total number of RNHA and DTUB with plant age in Jos whereas in Ibadan the RNHA increased up to 6 months and thereafter remained constant throughout the growing period. However, DTUB increased with plant age in Ibadan.

Genotypic differences ($P < 0.05$) were observed among the genotypes either across locations or within locations for TITO, RNHA and DTUB. Early initiation of storage organs was observed in TMS 4(2)1425, TME1 and TMS 30572 across both locations. At Ibadan, TMS 30572, TMS 4(2)1425 and TME1 were the early clones to tuberize while at Jos plateau, TMS 30572 and TME1 were the earliest to tuberize. In RNHA, TMS 30572, TMS 4(2)1425, TME1 and Oko-Iyawo performed better than other genotypes for RNHA; whereas TMS 30572, TME1 and TMS 91934 had better dry tuberous root weight (DTUB) than other genotypes across locations. TMS 4(2)1425, TMS 30572 and TME1 had more RNHA than other genotypes while TMS 50395, TMS 30572, TMS 4(2)1425 and TMS 91934 performed better for DTUB in Ibadan. At Jos plateau, TMS 30572, Danwaru and TME1 had more RNHA than other genotypes whereas TMS 30572 and TME1 perfomed better for DTUB.

These results show that low temperatures can induce a delay in onset of the tuberization in cassava which results in an economic yield reduction. Deduction, from the results showed that desirable traits for mid-altitudes are genotypes with early initiation of storage organs, large number of tuberous root and high dry tuber yield. Also, some identified genotypes for mid-altitudes with relatively high yielding and early onset of tuberization may be useful for further breeding programmes targetted for higher altitudes.

Are *Striga aspera* (Willd.) Benth. and *Striga hermonthica* (Del.) Benth. the same species?

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Pure lines of *Striga aspera*, *Striga. hermonthica* and their reciprocal hybrids obtained by artificial hybridization were analyzed genetically using random amplified polymorphic DNA (RAPD) markers. Morphological analysis on these populations, compared with wild samples collected from 19 locations in Nigeria were carried out using hierarchical cluster and principal component analysis (PCA). Results suggest that *S. aspera* and *S. hermonthica* are closely related but taxonomically distinct. They were closer morphologically with 75% similarity than they were genetically with 56% similarity. The hybrids, though morphologically distinct from the parents, showed a closer genetic affinity to their maternal parents. The closeness of some wild samples of *S. aspera* to one of the F_1 *Striga* hybrid (SHXSA), suggests that this hybrid may be common in the wild.

Faunal interaction in nutrient turnover: effects of earthworms and Soil microarthropods

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Effects of earthworms and soil microarthropods on litter decomposition, nutrient release and subsequent maize growth, were tested using microcosm approach. Dry leaf litter of *Senna siamea* was incubated for eight weeks in pots with the following treatments: soil without litter, soil + litter, soil + litter + soil microarthropods, soil + litter + earthworms, and soil + litter + soil microarthropods + earthworms. Soil fauna-contributed decomposition and nutrient (N, P, K, Ca, Mg) release are in the order: soil microarthropods + earthworms > earthworms only > soil microarthropods only. Maize dry matter yield responded to nutrient release pattern. The roles of soil fauna in nutrient turnover appear to be additive.

Challenges of Agricultural Technology Generation and Transfer in Sub-Saharan Africa

1997 Symposium

Welcome Address

Paul Koona[1]

It is with honor and profound pleasure that I welcome you all to the Third Annual Symposium of the International Association of Research Scholars and Fellows (IARSAF) of the International Institute of Tropical Agriculture (IITA).

IARSAF is an association of graduate students from all over the world pursuing their research interests at IITA. IARSAF was formed in 1981 to constitute a forum for the exchange of academic and research ideas, and the promotion of a spirit of friendship and solidarity among members. This year, the association is launching a monthly seminar series called "IARSAF FORUM" to foster these ideals.

IITA defines its mission as "to improve the nutritional status and well-being of poor people in the humid and subhumid zones of sub-Saharan Africa by conducting research and related activities in collaboration with others institutions to increase sustainable agricultural production". Program goals derived from this mission statement are:

- Develop systems for the management and conservation of the natural resources required for sustainable agriculture in the humid and subhumid tropics
- Increase the productivity of selected food crops that can be integrated into improved and more sustainable production systems
- Develop ecologically sustainable and economically viable plant health strategies and technologies
- Improve quality characteristics and postharvest technologies to increase the utilization of IITA's mandate food crops
- Accelerate the generation and utilization of improved technologies by strengthening national research capacities through training, information and other outreach activities

This last objective—strengthening national research capacities primarily justifies the presence of Graduate Research Fellows (GRFs) at IITA. In the process they contribute to other IITA objectives.

Strengthening the capabilities of national agricultural research systems (NARS) by providing opportunities for sound degree-oriented training to young graduates and professionals is a necessity in the present context of the limited number of well-trained researchers adequately equipped to tackle the problems of agriculture in sub-Saharan Africa. Our association is proud of her past members. Their impact in agricultural development was recognized by the IITA Director General in his speech at IITA's 30th Anniversary. He outlined the outstanding role of the institute in building the capacity of NARS in sub-Saharan Africa, and I quote:

1. President, International Association of Research Scholars and Fellows (IARSAF), 1997.

> "IITA has always devoted a great deal of effort to training to strengthen the capabilities of NARS. Close to 10,000 people have benefited from these training efforts and former IITA trainees are now found in virtually all countries in sub-Saharan Africa, where they do a good job."

The association is aware of this permanent interest to provide high quality training to research fellows. I wish, therefore, to thank the Director of International Cooperation, Dr. M. Bassey, and most especially the Leader of the Training Program, Dr J. Gulley, the Manager, Individual Training, Mr C. Okafor, and the other Training Program staff for their efforts to improve the working conditions of Fellows and to enhance the quality of their training. We are most grateful for the provision of a new and well-equipped computer training laboratory as well as the organization of complementary courses which broaden the scope and effectiveness of the Fellows, for example, in Statistics and Statistical Computing, Research Management, Communication and Writing Skills, Effective Leadership, and Writing Winning Proposals for research grants. We also appreciate the support we received from the Training Program for the "IARSAF FORUM".

This occasion also gives me the opportunity and great pleasure to acknowledge the invaluable contribution of our supervisors, both at IITA and our universities. We appreciate your support and concern to see us through our various programs, and we consider ourselves privileged to be trained under your direction.

While acknowledging these efforts, the association is very much concerned with the relative decline in funding at IITA which, since July 1996, has prevented the Training Program from offering new fellowships under the IITA Graduate Research Fellowship Program managed by the Individual Training Unit. The association is pleading with the DG to reverse this trend.

GRFs are fully involved in new technologies being generated at IITA. We strongly identify with the views expressed by both candidates for the position of Head of Information Services at IITA this year: former IITA trainees actually in the NARS are the most effective channels for the transfer of IITA technologies to farmers.

To my colleagues and fellow IARSAF members, in a time of economic constraint like this, the best way I believe, to show our appreciation for all these attentions in our favor is through good quality and timely research work as well as the judicious use of the available resources. These, I know, we can achieve in spite of the many difficulties which come our way.

The association is particularly honoured that the DG will be delivering a keynote address on "Examples of Agricultural Technology Generation by IITA" as this year's symposium focuses on "Challenges of Agricultural Technology Generation and Transfer in Sub-Saharan Africa". With four sub-themes being addressed by special guest speakers, it is expected that discussions on the need to address the challenges of technology generation and transfer will highlight the role of past graduate trainees, especially in the area of technology transfer. We also hope to identify strategies for the effective use of available human resources. This was identified as a vital but weak link in the NARS by Mr. Ubi Benjamin, my predecessor in office, in his speech on the occasion of the second symposium.

We are also proud that the DG will be present as guest of honour for the launching of the Association of IITA Trainees and Associates (AIITATA). During last year's symposium, the idea for the creation of this association was proposed as a forum for interaction for past and present IITA trainees and associates which would promote IITA ideals and research efforts throughout sub-Saharan Africa.

The second day of this symposium will be devoted to scientific presentations, both oral and poster, by selected Fellows. The number has been limited to allow more interaction between students and supervisors. The novelty this year is that the DG will give a prize for both the best oral and the best poster presentations.

I commend the Deputy Director General, and all the Division Directors for their support, encouragement, and advice.

I once more welcome you all to this symposium.

Examples of Agricultural Technology Generation by IITA

Dr. L. Brader[1]

The original mandate of IITA was to develop, through agricultural research, alternatives to slash and burn agriculture to increase food crop production. That was 30 years ago, and at that time, nowhere else in the world would an International Agricultural Research Center be given such a difficult mandate. While slash and burn was, and still is practised on other continents, it was not as dominant as in traditional sub-Saharan Africa (SSA). Developing alternatives to an age old production system is not an easy task, and while excellent progress has been made in the crop improvement and plant health management, wide-scale application of improved sustainable production systems is still lacking in SSA.

In this respect, the time needed from initiating research to general use has been seriously underestimated. To develop and introduce a new crop variety needs 6–10 years of effort. To develop and introduce a new production system may well require double the amount of time, i.e. 15–20 years. If this is correct, then success will depend, to a great extent, on the continuity of efforts, both in manpower and financial resources.

Thus, the task of evolving from the sustainable slash and burn systems with rather low yields, to sustainable production systems with substantially higher yields is a formidable challenge. The more so, as it has to be done in countries that are generally poor, have very limited infrastructure and with generally poor soils. Moreover, unreliable weather patterns in certain regions and heavy pest pressure further complicate the task. In addition, the agricultural research capacity for food crops was extremely limited in SSA and although improvements have been made, most national agricultural research systems (NARS) are relatively weak compared to those in other parts of the world. Consequently, there is a very limited capacity and knowledge base for current research activities.

Notwithstanding these unfavorable conditions, progress in the development of agricultural technologies for improved food production has been quite remarkable as will be shown by the following examples. It should be stressed that while some of these research activities have been initiated by IITA, the progress made is the result of the combined efforts of NARS, IITA and, in certain cases, other international centers.

Development of cassava varieties with resistance to African cassava mosaic virus (ACMV) and cassava bacterial blight (CBB) permitted 50% increases in yield without additional inputs. In the early 1970s, cassava mealybug and cassava green mite spread rapidly over the cassava belt of SSA causing very severe losses, leading in certain areas to almost total destruction of the crop. Successful control of the cassava mealybug through the introduction of the parasite, *Epidinocarsis lopezi*, solved the problem at very

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low costs. Farmers benefitted from this success without any cost to themselves. A biological control solution, combined with resistant cassava varieties is now also available for the cassava green mite. The introduction of these technologies led to significant production increases and the need for improved postharvest utilization techniques. Development of appropriate equipment allows for significant reduction in losses and labor requirements. New research challenges for cassava include the spread of new cassava mosaic strains, the development of early bulking varieties and the increased spread of cassava to drier areas.

For maize, initial efforts were placed on the development of high-yielding open-pollinated varieties with resistance to the prevailing major diseases in West and Central Africa, rust (*Puccinia polysora*), blight (*Bipolaris maydin*), *Cercospora* leaf spot and maize streak virus. The high yields obtained with these varieties lead to a very significant extension of maize production in the 1970s and 1980s. During the 1980s hybrids were developed and released. Maize changed from a subsistence to a cash crop. The intensification of maize production led to very significant loss increases caused by the parasitic weed Striga spp, and as well as decreases in soil fertility. For *Striga*, research has yielded excellent results in the form of an integrated pest management package that combines crop rotation, host plant resistance, chemical control and biological control. Improved crop rotations with various leguminous species are studied to develop more sustainable production systems. In recent years, in the more humid zones, downey mildew spread has attracted research attention.

Research on yam has been more limited, but progress has nevertheless been made in reducing the high production costs related to (i) the amount of planting material needed to produce a new crop and (ii) staking. In addition, higher yielding varieties of water yam have been produced. In future, increased attention will have to be paid to various pests, including nematodes.

One of the biggest challenges for banana and plantain production in SSA, black sigatoka, has been successfully addressed by a unique breeding program. This will significantly benefit banana and plantain production in SSA. But especially, the increase in knowledge makes it now also possible to successfully address other production constraints such as banana streak virus, and possibly nematodes. Banana weevil continues to be an important constraint that is difficult to overcome.

For cowpea, the challenge has always been to reduce losses caused by the multitude of pest species. IITA has produced excellent high yielding varieties, but these required regular insecticide sprays, which farmers cannot afford, or which were not readily available when needed. Hence, towards the late 1980s, a new breeding program was initiated which was based on the improvement of farmers' varieties, by increasing productivity and resistance against a number of pest species. Various sources of resistance have been identified in wild cowpea, but notwithstanding extensive efforts, it has not been possible to transfer this resistance to cultivated cowpea through traditional breeding techniques. In recent years, therefore, biotechnological methods are increasingly being used.

Research in soybean was needed to develop varieties well adapted to the tropical conditions in SSA. This included, among others, improvement in seed longevity and development of varieties that can use local rhizobin for effective growth. Simultaneously, extensive efforts were needed to develop postharvest utilization techniques well suited to the specific socioeconomic conditions. The very significant increases in the production and use of soybeans shows that these research efforts have been successful.

Various research efforts have been undertaken to develop sustainable production systems. The best known work by IITA is probably alley farming, a technology that has been highly praised, as well as highly criticized. In particular, in the humid tropics, the concept of growing annual and perennial plant species together may well turn out to be the only solution for the sustainable production of annual food crops. Thus, over time, the concept of alley farming may prove to be increasingly useful. However, it will have to be modified to suit the specific agroecological and socioeconomic conditions. A survey carried out in 1996 showed that among the farmers who had been involved with alley farming, 39 to 53% continued to use the technology. But most of them had made modifications to the original technology, in particular with respect to plant spacing and tree species used. The results indicate that interactions between research and farmers at an earlier stage would have been useful for the introduction of these production systems, a lesson that is now generally well understood for agricultural research.

Research on short fallows, by using annual legumes, shows promise as demonstrated by the extensive use of *Mucuna* in Benin Republic. In the savanna zones, such rotations are important to maintain soil productivity. But farmers have to better understand the benefits of investing in soil improvement techniques.

The above examples show clearly that various crops and production systems require different solutions. A detailed analysis of the major production constraints is essential to determine research needs.

Production constraints change over time as is evident, for example, from the evolving cassava and maize production situation. Constant interaction with farmers is needed to ensure that new technologies fit well into their requirements and are adjusted to their needs. Research on cowpea and alley farming is a good demonstration of this.

The examples discussed clearly show the tremendous benefits that can be gained from agricultural research. The effective use of the improved technologies requires their successful transfer to farmers. As such, in SSA, there is a continued need to improve agricultural extension services and NARS.

AIITATA: Preparing For Our Posterity

Dr M.O. Akoroda[1]

Trainees are persons who are currently receiving training at IITA; whereas associates are a larger and perpetually increasing groups of persons permitted into a society or an institution without full membership and this includes current staff (to connect in one's mind) who are involved in training and research, join, link, connect, to make a colleague or partner, to consort, keep company with, friends, and companions.

We gather here today to make history. The history of an association that would later turn the minds of people to the prominent issues of food production and research capacity building in the African continent.

When the past combines with the present and allows links to the future, a continuum is created. That is the chief aim of AIITATA. Many persons have had cause to be associated with IITA, as donors, board members, DGs, scientists, and administrators of science and development. These people share a thing in common. That they passed through the corridors of the IITA buildings and for a period of their lives had serious business to do at IITA makes them have this one thread of passage.

Truly, everyone here would one day not be here. Nevertheless, each of us would still like to receive a small letter telling us of what is happening here. Only in the future will the past be understood and fully appreciated.

Some trainees will tomorrow be in places of very high authority and that is why links should be made so that we can all contribute ideas and funds and resources (items of research which could be used in Africa, but may be lying fallow, somewhere in the corner). We could enrich our different national organizations with support from AIITATA in a more enduring way.

It would be expected that AIITATA trainees should support partially a few indigent students by a small grant each academic session. The trainees know who is indigent. They can also decide the little they can contribute to alleviate the pangs of poverty preventing proper processes of their postgraduate program.

AIITATA will and should operate a links magazine, in which members would be informed about issues bordering on IITA training, research capacity issues in Africa, and the impact of IITA research on local food supply as well as the role of AIITATANs on the educational and training levels.

Finally, I am happy with what we are doing today. We are all lucky to be part of it. The New York Academy of Sciences annually sources for membership worldwide, but I ask why they need members outside America. The thought I have is that the world is much better when we associate with people of similar character and calibre and it is in this light that I see AIITATA as a major move towards an African Research Advancement

1. (IITA Trainee Alumnus) on the inauguration of the Association of IITA's Trainees and Associates (AIITATA).

Forum which all IITAs Trainees and Associates should be encouraged to join. Our future is thus in preparation as we inaugurate AIITATA.

The world is awash with slogans of alliances, networks, fora, societies, etc. This is a strong indication of the need to bring together, come together, liaise, cooperate and collaborate. Togetherness, they say, brings strength. our strength lies in pooling our efforts and contributions for AIITATA to optimize. The synergy to be expected would then, hopefully, further strengthen our common resolve to make one small step forward towards helping more students get trained and helping agricultural research in sub-Saharan Africa.

Development of Appropriate Agricultural Technologies for Sub-Saharan Africa

H. Tijani-Eniola[1]

Abstract: In sub-Saharan Africa, the demand for food greatly exceeds production. The transfer of high-input technologies involving complex engineering designs has not helped to reduce the food crisis because of the inappropriateness of imported technologies from both ecological and economical stand points.

Most transferred agricultural technologies are developed under monocropping systems. Multiple cropping is natural to the African region. The transferred technologies become inappropriate under the intercropping systems of the sub-Saharan African farmers. Little success has been made in orientating cropping patterns into straight rows.

Appropriate agricultural technologies for sub-Saharan Africa are to be home-generated using "bottom-up" approach. Considerations should be given to the improvement of indigenous technologies. The profitability and fitness of generated technologies into the farmers' production systems and circumstances should also be considered.

Agriculture remains the dominant sector in sub-Saharan Africa. It contributes about 40% of export and 70% of employment. It is the largest sector on which the vast majority of the African populace depend for their well-being and livelihood (Agboola and Tijani-Eniola, 1991).

Nevertheless, successive governments in various countries of sub-Saharan African have consistently paid very little attention to proper development of agriculture. The problem of low priority attention to the agricultural sector was identified and discussed at the 1985 OAU meeting of heads of state and government in Addis Ababa where it was agreed that 20–25% of public expenditure of African nations should be allocated to agriculture. This agreement was reconfirmed at the United Nations General Assembly meeting in New York in May 1986. Nigeria allocated a mere N6.9 million (0.1%) to the Science and Technology Ministry out of the country's capital expenditure of N6.7 billion in 1987. Virtually all African countries have continued to assign less than 4 % of their annual budget to agricultural sector.

Sub-Saharan Africa's quest for agricultural technology development has remained a mirage as different governments from various countries have been spending staggering amounts of money on what decision makers call "technology transfer". They have at best been successful in the transfer of equipment and heavy-duty machineries which they neither understand how they are made nor how to modify to suit the hot sub-Saharan environment.

1. University of Ibadan, Ibadan, Nigeria.

Natural conditions affect the development of crops differently in the hot sub-Saharan climate and the temperate regions. While maize, for example, may be regarded as an ephemeral plant (two or three cycles could be produced in a year) in the hot climate, it could be a complete annual in the temperate climate. Thus, the technology of field crop growing in the hot sub-Saharan climate considerably differs from the conventional methods commonly in use in the temperate climate.

If sub-Saharan Africa is to achieve the objective of provision of adequate food for its population, it must improve its agricultural performance through the development and adaptation of improved and appropriate agricultural technologies.

In agriculture, technologies may be classified as biological, chemical, and mechanical all of which are tested and implemented under farming systems technology. Farming systems research views the farm in a holistic manner and considers interactions in the various components of the system (CGIAR, 1978). Its major objective is to increase the productivity of farmers by generating appropriate new technologies.

What is Appropriate Technology?

The list of definitions of what an appropriate technology is continues to grow; all terms used in describing an appropriate technology are often person, institution, regional, and sometimes country specific. However, a commonality in concept, methodology, and implementation has emerged, built on productivity, profitability, stability, sustainability and equitability. An agricultural technology in which resources are orchestrated in such a way as to provide increasingly cost-effective levels of productivity with minimum adverse effects on the resource base/environments is considered appropriate (Okigbo, 1989; McNamara, 1990). It must be stressed here that a technology that is appropriate somewhere may be completely inappropriate in another.

Why some technologies developed in sub-Saharan Africa were unsuccessful

In Africa, most technologies developed responded inadequately to the continent's evolving needs. Although research to develop yield increasing and land augmenting technologies has received increasing emphasis recently, farmers' yields have been modest. Contrasted with impressive on-station yields, new technologies usually perform poorly under farmers' conditions, and demand a level of management which small-scale farmers are usually unable to provide. These failures are due to the following causes:

- Inadequate understanding of small-scale farmers' goals and resource limitations. Research objectives are therefore different from those of the potential clientele, the small-scale farmer.
- Failure of research to develop a large enough stock of appropriate technologies for farmers. This is due to over-reliance on "diffusion" or "technology transfer" model of development.

We now understand that the conservation technologies (strategies) based on high-input technologies (energy, capital, and sometimes labor) involving complex engineering designs, are inappropriate for resource poor farmers in Africa from both ecological and economical stand points. In Nigeria, examples of farmers skepticism about innovations are inexhaustible.

Intercropping systems

Contrary to the developed countries where monocropping underlies the apparent strength of agricultural productivity, mixed cropping has evolved from millenia of hit-or-miss farming and is a reverse of field-one-crop theory of developed countries.

Improved varieties

In cowpea-growing areas of Borno State, farmers showed high preference for local varieties of cowpea which fetch more economic returns as fodder source, over the improved, high grain yielding variety "harawa". Similarly, dwarf varieties of sorghum, though high yielding, were said to have been rejected because farmers use the tall varieties for yam staking. The use of leguminous cover crops for soil fertility maintenance was rejected in spite of its technical feasibility, simply because it does not bring economic benefit.

Straight row cropping is also incongruous with farmers' planting pattern. Little success has been achieved in orientating cropping patterns into straight rows.

Conservation farming

Most recommendations ignore basic facts of African peasant farming. They assume that high yield is important but often ignore consumer preferences. They assume ready availability of fertilizers and agricultural chemicals and ignore economic and ecological considerations of their use.

In short, they aim to convert the present farming systems overnight into western types of energy-dependent, highly complex enterprise. Thus, Okigbo (1989), has suggested conservation farming technologies with adequate concerns for the resource base (environments). Various agroforestry prototypes including alley farming/cropping should receive more attention.

Some research activities and findings: experience from the University of Ibadan

Tillage. In Nigeria, government recommended conventional tillage to farmers, but research has shown serious soil degradation resulting from conventional tillage, and farmers do not have enough money to hire tractors. Therefore, they continue with zero or minimum tillage without herbicides. An attempt to demonstrate to government that local farmers were right took us to Badeku, southwestern Nigeria, in 1970 where 10 farmers' fields were used for maize production using conventional (ploughed, harrowed etc.) and no tillage techniques. After nine growing seasons, the soils where conventional tillage was employed was almost completely destroyed (Table 1). Whereas, maize yield was as high as 1.5 t/ha under farmers' practice, and as low as 100 kg/ha under conventional tillage.

Alley cropping. Research effort has started since 1979 to assess the potential of intercropping woody species with arable crops as a land use system to replace the traditional slash-and-burn cultivation system. This led to development and research on alley cropping. From the scientists' point of view, alley cropping has potential for soil conservation (Young, 1986), and soil fertility maintenance (Kang *et al.* 1989). Olowu *et*

Table 1. Effect of tillage practices on some oil properties at Badeku, southwestern Nigeria.

		After 9 croppings	
Soil properties	Initial	Minimum tillage	Conventional tillage
pH	6.45	5.89	5.13
Organic C (g 100 g^{-1})	1.89	1.30	0.96
Total N (g 100 g^{-1})	0.25	0.14	0.11
Avail P (mg kg^{-1})	10.6	7.5	4.8
Exc. Ca (Cmol kg^{-1})	3.5	2.7	1.9
Exc. Mg (Cmol kg^{-1})	0.9	0.3	0.2
Ex. K (Cmol kg^{-1})	0.6	0.23	0.2
Maize yield (t/ha)	2.6	1.5	0.1

al. (1994) however, found farmers reluctant to adopt the technology because of the following major constraints:

- Low yields attributed to tree overcrowding or crop shading. Such a view indicates ignorance of the management of alley trees
- Low seed germination rate
- Inability to mechanize
- Regular destruction of row crops by rodents
- Provision of shelter for reptiles by alley trees
- Difficulty in ploughing becuse of tree roots

Most constraints cited by farmers were external to the technology. The intrinsic factors were mainly on the hedgerow management. This is an area that the technology should address.

Methods of generating and developing technology

The basic research need is to identify a new technology which farmers could adopt. One crucial aspect of new technology development is the combination of different component parts from the experimental station for testing under farmers' conditions. The final stage of the technology is fitting it into the whole farm context. Specific questions raised at farmer-level tests of technology are:

- Does the technology yield significantly more than farmers' practise?
- Is it profitable? Is it only profitable under subsidization of inputs and product prices?
- Does it fit into farmers' production system?

In summary, generation and development of appropriate technologies require farming systems research approach (FSR).

Farming systems research approach (FSR)

Norman and Baker (1983) reported that farming systems approach and its subset activity, farming systems, are products of the 1970s. They developed because of the partial or complete failure of other approaches to generate technologies relevant for use by small-scale farmers in relatively unfavorable environments. There was emphasis on increasing overall productivity of the farming systems. According to Norman and Baker (1983), the root causes of farmers' resistance to proposals for changing farming practices is the incompatibility of technologies and policies with agroecological, socioeconomic, and political environments rather than farmer irrationality or managerial mistakes. In some technologies, the distribution of benefit doest not march expectations. These is attributed to neglect of traditional research approaches of human element in the farming systems. The FSR approach seeks to ensure two-way linkages between various participants in the research process through a pragmatic "bottom-up" orientation. The primary objective of "bottom up" research strategies have been tailoring improved technologies to farmers and ultimately, greater production and improved welfare. Farmers have something valuable to contribute to technology development. The "bottom up" orientation of the farming systems approach is manifested in two types of developmental strategies:

- Farming systems research (FSR), involving the development and dissemination of relevant improved practices (technologies) through on-farm research and direct collaboration with farmers.
- Farming systems perspective (FSP), involving influencing the development of policies and support systems that create an appropriate incentive structure for adopting technologies that will improve the productivity of farming systems.

Given the right institutional setting and linkage, both FSR and FSP are possible. Problems of farming systems approach stem from the fact that not until fairly recently was farming systems conceived as a multidisciplinary approach. A more specialised or isolated method of technology development was the order in the past. Communications across disciplinary lines must necessarily involve biological and social scientists throughout the research process.

While FSR can generate improved technology by linking researchers to farmers in a more systematic way (through participatory research, on-farm trial and demonstrations), it is difficult to advocate new technologies without a better understanding of government policies on agricultural production, input distribution, and marketing. For example in Nigeria, experience has shown that input availability and cost have been major constraints to technological change. This is true with fertilizer and herbicide recommendations.

Operational constraints in national research systems are many, and these include the tendency to staff national research systems with unqualified people, sometimes with the encouragement of donor agencies. Counterparts with low qualifications work with expatriates for one to three years, after which they are left on their own and are expected to carry out new programs successfully.

More important however, is the lack of sufficient operational funds and poor financial and research management. These have impaired the effectiveness of research extension and training institutions. Untimely and sometimes unreliable budgetary allocations frequently disrupt research systems.

On-farm adaptive research (OFAR)

On-farm adaptive research is research on the whole farm, usually by an interdisciplinary team which considers physical, biological, and socioeconomic factors affecting the farm and the farm family. The team also monitors the effects of introduced changes, assesses the necessary modifications of components all in the context of farmers' goals and objectives, and examines the subsequent economic, social, and biological pressures. The methodology, implementation and achievement of OFAR have been described (Norman and Baker 1983; Mutsaers *et al.* 1984; Oputa 1986; Chedda 1990) and need little elaboration here. OFAR is currently being practised at the University of Ibadan as:

- Participatory rural appraisal (PRA), (problem identifying stage)
- On-station research (experimental formulation and design stage)
- On-farm researcher-managed trial (test phase)
- On-farm farmer-managed trial
- Joint evaluation by farmers, extension specialists, and researchers
- Small plot adoption technique (SPAT)
- Mass adoption

The objectives of OFAR also summarize the role of research in improving farming systems, to

- understand the farmer, his environment, and determine his needs
- adapt technologies to suit farmers' circumstances;
- bring about rapid diffusion of generated technologies
- develop quick feedback systems from farmer to researcher, appreciate that the farmer has something to contribute to research
- develop and establish cordial and harmonious working relationships between researcher, extensionist, and farmer
- increase farmer's productivity, improve his income and standard of living

Small plot adopting technique (SPAT)

The concept of SPAT evolved to rectify the weaknesses of macro-result demonstration with free inputs, which had almost failed to motivate farmers to adopt recommended technology packages. SPAT is essentially a demonstration on a small portion of farmer's field (25 m^2–100 m^2) to teach the farmer new techniques and practices, and enable him to compare the results of the old with new practices. No free inputs are provided. The main advantages are:

- large-scale, well-spread exposure of an improved technology in prevailing farming situation
- teaching farmers the use of technology
- providing benchmark information to scientists and extension workers on relative superiority and acceptability as perceived by farmers

Chheda (1980) suggested that each extension agent (EA) can adequately support 80–120 willing farmers to establish SPATS. This allows rapid fine-tuning and adoption of technologies.

Meaningful agricultural development will only result from technological and institutional innovations which are appropriate to the nations resource endowments. This calls for research into understanding the natural resource, institutional and socioeconomic constraints facing small-scale farmers. Attention should be given to development of technologies which can conserve natural resources such as soil conservation, tillage and agroforestry.

Since agricultural development can only be brought about by widespread, yet gradual increases in productivity by small-scale farmers adopting innovations appropriate to their proportions, research must concentrate on developing technologies for them. Material inputs should be derived mainly from local sources, and research on mechanization should concentrate on improving hand tools and animal traction where animals are available.

Major questions to answer in developing appropriate technologies for small-scale farmers in Nigeria, sub-Saharan Africa should be whether the new technology is superior to existing farmer practices and if it "fits" the farmers' production system and constraints?

Technologies which do not rely on land expansion such as alley farming and other agroforestry technologies should receive more attention, while land reclamation strategies and technologies that could utilise wastelands, swamp or hydromorphic areas should be explored.

Study of resources mixes in systems and sub-systems should be given more attention such as understanding of crop competition above and below ground under the various resource levels and mixes. Sustainable systems should be developed, tested and made adaptable.

There is still considerable lack of real progress in management and effective utilizations of multidisciplinary teams of researchers that allows for status recognition and iterating service functions. Broadening of integrated pest management research, conservation farming technologies, soil testing programs for fertilizer recommendations, breeding for improved varieties, and development of appropriate farm level equipment and postharvest technologies, co-ordinated farming systems research programs are implicit in developing appropriate technologies for small-scale farmers in Nigeria and sub-Saharan Africa.

Government policy on agriculture should be consistent, since subsidization of input and product prices have implications on technology development. There is need for rapid development of local capabilities in policy research. Agricultural policies should also have the touch of adaptive research model involving farmers.

Experience and Prospects for Commercialization of Improved Agricultural Technologies in Sub-Saharan Africa

E.N.O. Iwuafor[1]

Abstract: Agricultural growth in sub-Saharan Africa has been on the decline compared to other developing regions of the world. A number of factors responsible for this situation have been highlighted. Research efforts by international and national agricultural research institutes have developed a number of improved technologies which if properly applied, can solve Africa's food crisis. These technologies include improved cultivars of seeds and planting materials, farm tools which make animal traction possible, and other postharvest tools that reduce drugery. Improved technologies in livestock and poultry, fisheries production and preservation, food utilization and forestry, and forestry products are also discussed. The prospects for their commercialization are discussed. Some improved agricultural technologies regarded in this paper as non-commercializable but very important for sustainable agricultural production are enumerated.

Introduction

Agricultural growth in sub-Saharan Africa has been on the decline compared to other developing regions of the world—Asia, Latin America. Of these regions, only in sub-Saharan African has per capita food and cereal output been declining (Figs. 1 and 2). This situation has been aggravated by continuing environmental degradation, natural and man-made disasters, and decrease in land availability due to high population growth. Civil wars in Somalia, Sudan, Ruwanda, ethnic and urban violence, massive corruption and governmental mismanagement of public funds have worsened the situation.

In the face of these gloomy situations, agricultural research institutions in the region have been making efforts to resolve Africa's food crisis. These efforts have been enhanced largely by the large-scale donor financing for agriculture which came in full force after the Sahelian drought of 1968–1973. The international and national agricultural research institutions have introduced numerous agricultural technologies in the region.

Improved agricultural technologies

According to Sanders et al. 1996, diffusion of best-farmer practices and scientific observation of farmer techniques are important components of agricultural development. International and national agricultural scientists have always been encouraged by national governments and donor agencies to develop alternative technologies that are better adapted in their localities, that use local inputs rather than

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Figure 1. Indexes of per capita food production in major developing regions, 1961–1991.

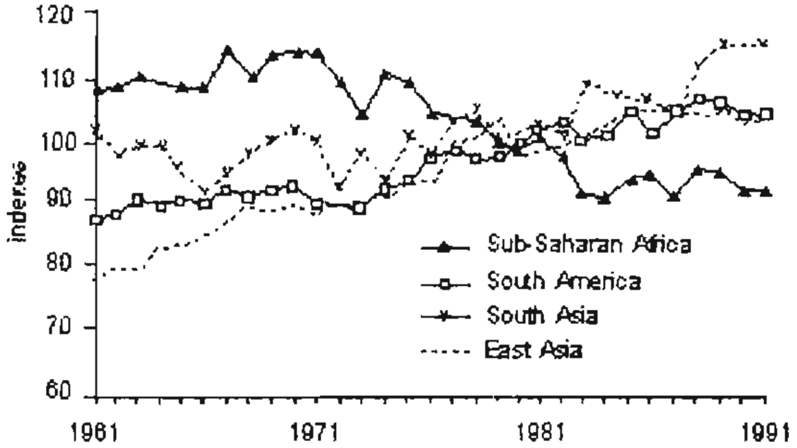
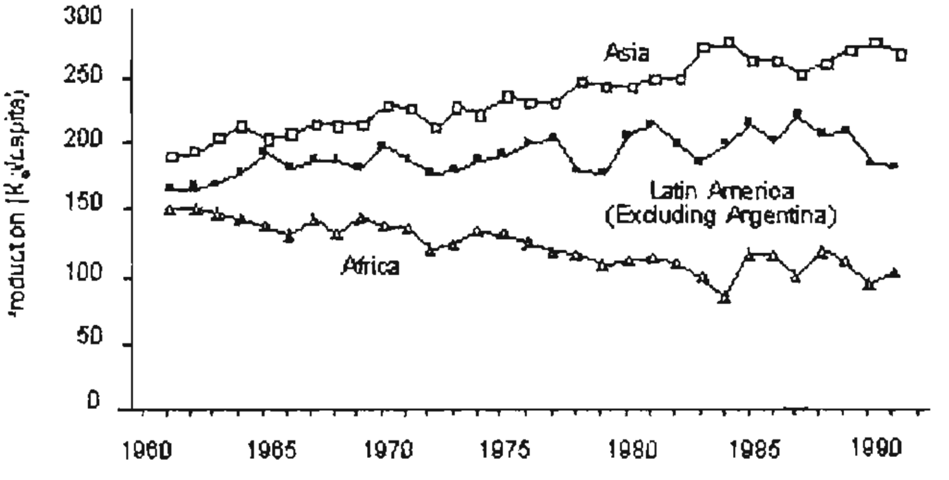


Figure 2. Cereal production in the developing world, 1961–1991.



the sophisticated imported technologies, or inputs that put farmers at high risk. Research in this direction has therefore led to improved technologies in such areas as development of new cultivars of various crops adapted to local environments, farm tools adaptable for animal traction, and other postharvest tools to reduce drugery. Research has also come up with improved technologies in crop protection using indigenous techniques, soil fertility maintenance, and conservation through judicious use of fertilizers, organic wastes, and cereal-legume intercropping and rotations. Some of these technologies are being commercialized having been taken up by the private sector with encouragement from national governments. Others are non-commercializable and stand only to be disseminated by national agricultural research institutes through extennsion services.

Commercializable improved agricultural technologies

Seeds and planting materials. Through breeding work, new cultivars and hybrids of various crops like maize, sorghum, millet, rice, wheat, groundnut, cowpea, soybean, cassava, yam, potatoes, plantain, bananas, cotton, kenafe, and vegetables (tomato, onion, okro, amaranthus, pepper, and melon), citrus mango, guava, and sugar cane have been introduced in various countries in the region and more importantly to ecological zones where these crops may not ordinarily have been grown, either due to drought conditions or pests and diseases. The development of early and extra-early varieties of maize by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, for example, has made it possible for maize to be grown in drier zones of the region. Some of these improved varieties and the numbers available in some Nigerian agricultural research institutes are shown in Table 1.

Seed production is now profitable and a number of private seed companies have been established in many parts of sub-Saharan Africa. In Nigeria for example, there are three well known private seed companies—Premier Seeds, UAC, and UTC Seed. There are also others who operate on a very low scale. These make up the informal sector comprising decentralized community/village seed production program. The only public seed unit in Nigeria is the National Seed Service, a unit in the Federal Ministry of Agriculture. Private seed companies receive encouragement and support from national governments as they have direct acess to breeder seeds of all publicly bred varieties. They multiply the seeds through contract out-growers, process and package for sale to farmers.

There are usually high demands for improved seeds as farmers now realise that procurement of treated seeds is the first step in profitable crop production. More land is being cultivated with these improved cultivars and hybrids. Table 2 shows areas planted to improved maize varieties and hybrids in sub-Saharan African in 1990. Land area grown to cotton in Burkina Faso and Mali also increased due to the regular introduction of new cultivars (Savadogo, 1990). Nweke (1992) reported increase in land area put to improved cassava cultivars in Nigeria, Côte d'Ivoire, Ghana, Tanzania, and Uganda. In Nigeria, about 60% of land area cultivated to cassava carried improved varieties.

Table 1. Improved varieties and planting materials produced by various agricultural research institutes in Nigeria.

	Improved varieties and planting materials		
Institute	Crop	Name*	No. available
IAR Samaru	Sorghum	SAMSOR G	29
	Millet	SAMMIL	7
	Maize	SAMMAZ	4
	Wheat	SAWMWHIT	7
	Barley	SAMBARL	4
	Groundnut	SAMNUT	9
	Soybean	SAMSOY	2
	Cowpea	SAMPEA	8
	Tomato	SAMTOM	16
	Onion	SAMON	6
	Pepper (chillis)	SAMPEP	9
	Cotton	SAMCOT	4
IAR & T Ibadan	Rice	Art	2
	Cowpea	Ife brown	4
	Maize	Western yellow DMR	10
		Series SWAN series hybried	3
	Soybean	TGX series	7
	Yam	Atoja	1
	Cassava	MS 6 MS 20	5
	Kenaf	Cuba 108 Tiannung No. 1	2
	Tomato	Ronita	3
	Okro	VPF 35 VPF 2	2
NRCRI Umudike	Cassava	U/30555 TMS 30211 NR/7706	17
	Irish Potato	B944-10 9435-10 Nicola, Alpha	13
	Sweet potato	TIS/146/3092 Dukukpuku Hybrid	19
	Ginger	UG 1 yellow UG 2	6
NCRI Badeggi	Rice	Lowland FARO Upland FARO Deep Water varieties	50
	Cowpea	Kano 1696 New Era, L 23 K 28 K 59	9
	Soybean	TGX Series	8
	Maize	FARZ 27	14
	Sugar cane	BD 83/019	9
NIHORT Ibadan	Tomato	NHLC 158, 30	2
	Okro	47-4	1
	Amaranthus	NHAC 3 and 35	2
	Melon	P 4	1
	Plantains	Red ogoni Agbagba, Bini	5
	Banana	Omini	3
	Mango	Julie, Zill, Palmer	6
Umudike	Pawpaw	OP, CO	2
	Guava	Weller Supreme	

Source: Prepared from Aliyu et al. 1996

*Name of one variety or two was used

Table 2. Area planted to improved maize varieties and hybrids, sub-Saharan Africa, 1990.

Country	Total maize area (x 1,000 ha)	Improved open-pollinated varieties (%) Min[a]	Max[a]	Hybrids (%)	Improved germplasm (%) Min[a]	Max[a]	CIMMYT germplasm (%)
Tanzania	1,631	6	18	6	12	24	60
Nigeria	1,500	22	87	2	24	89	59[b]
Kenya	1,500	8	8	62	70	70	1
Malawi	1,344	3	3	11	14	14	1
Zimbabwe	1,150	0	0	96	96	96	0
Ethiopia	1,050	8	24	5	13	29	33
Mozambique	1,015	17	17	1	18	18	94
Zambia	763	5	5	72	77	77	6
Côte d'Ivoire	691	14	42	4	18	46	88
Ghana	465	16	48	0	16	48	91
Benin	454	9	27	1	10	28	61[c]
Uganda	389	30	70	10	40	80	0
Togo	296	7	18	3	10	21	81
Burkina Faso	216	15	70	2	17	72	48
Cameroon	200	20	67	1	21	68	72[b]
Mali	170	36	50	0	36	50	27
Lesotho	145	12	12	70	82	82	15
Burundi	124	5	20	0	5	25	81
Senegal	117	100	100	0	100	100	100
Swaziland	84	0	0	90	90	90	0

Source: Reprinted from Byerlee et al. (1994, p. 7)
Min = area usually based on seed sales;
Max = area based on surveys or breeders' estimates
[b]Germplasm from IITA that includes some CIMMYT germplasm in its background.
c Excludes more than one million hectares of maize in Zaïre, Angola, Somalia, and Namibia not covered by the survey.

A few factors have however been identified as militating against commercialization of seeds. These include

- limited cash-flow/low credit facilities for resource-poor farmers
- unavailability and expensive prices of related agricultural inputs especially fertilizers and pesticides
- inadequate number of seed production institutions
- slow national variety release mechanism
- lack of credit within the seed production/supply systems

Farm tools

The use of indigenous/local farm tools in sub-Saharan Africa is as old as agriculture itself. In the seventies and early eighties, to resolve Africa's food crisis through expansion of land, mechanised land preparation using imported tractors and sophisticated farm implements became prominent. With the downturn in the economies of most countries in Africa, mechanisation through tractor-driven implements drastically reduced from the mid-eighties. Animal traction became promient in most African countries especially in semi-arid areas. Matlon (1987), estimated that 15% of the crop area in semiarid West

Africa was prepared by animal traction. Most farming families keep animals such as horses, oxen, donkeys, and camels for this purpose. Farm tools like plows, ridges, weeders, seed, cassava planters and harvesters, harrows of different sizes are now available because of the animal traction technology. In Senegal, over 90% of the farmers use animal traction, principally horses for seeders and cultivation (Kelly et al. 1985). In the principal cotton zone of Senegal, 87% of the farmers use animal traction, oxen and plows in the heavier soils (Kelly et al. 1995). In the Gambia, Mali, Niger, and Nigeria, similar high percentages have been reported (Decosse, 1992, Coulibarly, 1995; Bourn and Wart, 1994).

According to Sanders et al. (1996), only about 10% of farmers use animal traction in Chad and Mauritania. The primary effect of animal traction is a significant increase in crop area per farmer. This, in a way also increases commercilialization of improved technologies like seeds and fertilizers.

Development of postharvest tools increased considerably in the last decade in the region. Using Nigeria as an example, the 17 agricultural research institutes and Universities of Agriculture, and Facultires of Agriculture in other Universities have a range of tools fabricated to reduce drudgery especially for women, who are more involved in postharvest handling. These include maize shellers, groundnut and cowpea decorticatore, multiple threshers, maize dehusker sheller, soybean thresher, solar crop driers, groundnut oil extractors, milk churners, tomato-pepper millers, rice threshers, rice perboilers, and cassava peelers. In a few cases, entrepreneurs bought over the prototypes, and mass produced them for commercial purposes.

In oil palm production and processing, the postharvest handling tools designed and fabricated are more sophisticated because of the bulk handled in oil palm processing. These tools include rotary supper, nut cracker, horizontal digester, clarifier, hand press, and screw press. In palmwine processing there are palmwine mixer/dispenser and palmwine corker. Aliyu et al. (1996) recorded full description of these tools and their usage.

Fertilizer

The major soils of sub-Saharan Africa are dominated by low activity clays. They are also low in organic matter and therefore inherently poor in plant nutrients. Therefore, there are high demands for inorganic fertilizers for profitable crop production. This has made fertilizer the most highly commercialized input in the region. With the removal of government subsidies, prices have gone so high that resource poor farmers are hardly able to procure enough for their farms.

Livestock and poultry

Ruminant livestock have been an integral part of the farming systems in sub-Saharan African especially in the drier parts of the region. Through research efforts, improved breeds are now more prevalent. In Nigeria for example, research institutes have a number of improved breeds of sheep (Uda, Yankasa), goat (West African Dwarf) and cattle (White Fulani and Red bororo). These breeds fatten easily and reproduce faster than local breeds.

In fodder production, improved seeds of grasses, legumes, and shrubs are available for planting. In addition to being planted for grazing, they are also planted in fodder banks/feed gardens which are concentrated units of planted leguminous species primarily managed and reserved for dry season supplementation of livestock.

This concept favors sustainable agricultural production through the utilization of the soil N built up by the legumes and cereals in a legume/cereal intercrop. This involves the systematic rotation of cereal crops on fodder banks with minimum fertilizers. Continous crop and fodder production go on on the same piece of land while minimizing grass invasion of the banks. Crop yields have increased by 40% following 2–3 years of stylosanthes fodder banks. This extra benefit has enhanced the commercialization of improved seeds of these legumes.

In animal health management, about 16 types of bacterial and viral animal vaccines developed by research institutes are commercially available across borders in Africa. Some of those developed in Nigeria for example, are, the tissue culture rinderpest vaccine (TCRV), haemorrhagic septicemia vaccine (HSV), contagenous bovin pleuropeumornia vaccine (CBPPV), combined blackquarter vaccine (CBQV), and inactivated oil emulsion New Castle Disease vaccine. A range of livestock drugs are marketed by multinational companies like Pfizer.

Poultry industry and its improved technologies are probably the most sophisticated in sub-Saharan Africa. The new poultry breeds mature very early and are resistant to some killer diseases. Examples are Quail and Canadian geese breeds. In Nigeria, the National Animal Production and Research Institute (NAPRI) developed a breed called 'The Nigerian Breed' of layers. This is the first Nigerian parent stock of layers, because before now, all parent stocks were imported. This breed, commercialized by th~ Institute is available for entrepeneurs to produce day-old chicks in large quantities.

Feeds, feed supplements and additives are available commercially. Con :entrates include vitaminis premix, synthetic lysin, while feed additives include Terramycin, Neoterramycin, and Vitalite. Vaccines developed to take care of some poultry diseases include Layota, Kumarou, Gumboro, and fowl pox. Killed fowl typhoid vaccine (Killed FTV) and Thermostable New Castle Disease vaccine for local chicks have been produced by the National Veterinary Research Institute (NVRI) in Nigeria.

In housing, feed mill and hatchery equipments, materials like battery cages, drinkers, watering troughs, layer petches, brooder boxes, hovers, lying nests, hammer mills, mixers, bagging machines, egg trays, fumigation machines and day-old chick boxes have been developed because they are basic requirements for a poultry enterprise to take off. Prospects for the commercialization of these improved technologies in livestock and poultry are further enhanced by the increasing and growing animal-based industries and the export potentials. This is especially important in African countries like Botswana and Swaziland.

Fisheries production and preservation

In sub-Saharan Africa, research in fisheries production and preservation is not as old as research in arable crop and animal production. Fishing in natural and artificial water bodies depended on indigeneous knowledge within the fishing communities. With research institutes established for oceanography and marine and fresh water fisheries in some African countries, improved technologies in these areas are now available.

Improved fresh water fishes are available as fingerlings for sale in artificial water bodies. Research in fish feed production has produced soybean cake, soy-oil, groundnut cake, wheat offals, and other pelleled fish as alternative fish feeds. These alternatives are also used for the formulation of poultry feeds. This fast growing industry has also further enhanced the commercialization of improved varieties of the crops used in these food production.

One area that has attracted a lot of attention is fish preservation. Fishes easily go bad if not properly preserved. About 25 different types of smoking-kilns have been fabricated in Nigeria. Some are capable of drying 250 kg of fish per day. Also, in the area of preservation are the insulated ice containers and fingerlings transportation tanks, (Aliyu *et al.* 1996).

Food technology

A lot of research effort has been put into utilization of food crops for better nutrition of humans especially children. Soybean and other grain legumes have quality protein which can supplement animal protein which is not easily affordable by the poor communities in the sub-Saharan Africa. Soybean for example has been processed into different forms of food either alone or in combination with cereals. Prominent among these are soybean cheese popularly called meat without bone, soy-vita, soybean flour, soybean milk, soy *akara*, and *soya-gari*. These are popular in Nigeria. There are also different combinations of soybean and cereals which are used as complimentary food for children.

Forest and forestry products

Through breeding, a lot of improved forestry seeds are available. These improved seeds are raised into seedlings in forestry establishments and sold out to farmers. Some of these species are resistant to drought, diseases, pests, and are fast growing. Some species are harvested and used for paper production, electric poles, and other timber products like household furniture. Wood shavings in combination with cement are processed into ceiling boards, floor and bathroom tiles.

Non-commercializable improved agricultural technologies

There are a number of improved agricultural technologies in research institutes all over sub-Saharan Africa which are considered in this paper as noncommercialization but have helped farmers in sustainable production. These technologies have been disseminated to the farmers through extension systems in various countries. Most of these technologies are found in areas of resource management, crop protection, cultural and management practices. In resource management, these include time, rate, and method of fertilizer application, inclusion of trees in food crop systems, multiple cropping/rotation, mixed farming, fodder bank, recycling of crop residues, recycling of animal wastes, integrated nutrient management and soil conservation practices (strip cropping, wind breaks, shelter-belts, tie ridging). In crop protection, cultural and management practices, we have seed dressing, sprays against pests and diseases, time of planting, plant population and arrangement.

References

Aliyu, A.O., O.A. Adegbaro, and F.J.K. Ayeni. 1996. Directory of commercializable research findings of Nigeria agricultural research institutes, Vol. 1, pp. 89.

Bourn, D, and W. Wint. 1994. Livestock, landuse and Agricultural Intensification in sub-Saharan Africa. Pastoral Development Network Discussion Paper, Overseas Development Institute, London.

Coulibaly, Ousmane, N. 1995. Farm-level potential of improved crop varieties, soil fertilization and water retention techniques in sustaining sorghum based cropping systems in Mali. PhD thesis Purdue University.

DeCosse, P.J. 1992. Structural changes in Gambian agriculture: stagnation or silent transformation: Banjul, Gambia.

Kelly, V., B. Diagana, T. Reardon, M. Gaye, and E. Crawfor. 1995. Cash crop and food grain production in Senegal: Historical view, new survey evidence and policy implication. Staff report 1995. Department of Agricultural Economics, MSU, East Lansing.

Matlon, Peter J. 1987. The West African Semi-Arid Tropics. In J.W. Mellor, C.L. Delgado and M.J. Blackie, eds. Accelerating food production in sub-Saharan African. Baltimore, John Hoplkins University Press.

Nweke, F.I. 1992. Cassava production prospects in Africa. COSCA (collaborative study of cassava in Africa). Working paper No. 13. RCMD, IITA, Ibadan, Nigeria.

Sanders, J.H. B.I. Shapiro, and Sunder Ramswany. 1996. The economics of agricultural technology in semi-arid sub-Saharan Africa. Baltimore and London. John Hopkins University Press.

Savadogo Kimseyinga. 1989. Analysis of off-farm income. Binghamton, N.Y. Institute for Development Anthropology.

Can Participatory Research and New Information Technology Replace Extension?

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Preamble: While I would like to thank the International Association of Research Scholars and Fellows for the opportunity to present a lecture at their annual symposium, I must also state that they have put me in a bit of a difficult position. You see, as a rural sociologist, I can see a lot of benefits to participatory research and have seen several problems with the often top-down application of extension services. At the same time, however, I teach in the Department of Agricultural Extension. Therefore, I must be careful how to answer the question so as not to put my colleagues out of business! It is rather like the shock I received when reading a recent edition of *The Rural Sociologist* entitled, "Is Rural Sociology Worth Saving?" That headline made me quite uncomfortable. Yet, as scientists, it is good for us to consider the relevance of our disciplines and methods in the face of changing conditions and expanding knowledge.

Objectives of and problems with extension services

Agricultural extension has been defined as:

> "A service or system which assists farm people, through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living, and lifting the social and educational standards of rural life" (Maunder, 1972, p.3).

In conventional terms, refected in the definition above, extension has often been considered to be the flow of knowledge between researchers, who are assumed to have the answers to agricultural problems, and the farmer. In short, extension is often considered to be nothing more than top-down technology transfer. As Rivera (1988) states, the relationship with farmers has often been "take it or leave it; or take it or demand new packages; or take it or else...". In most cases, therefore, farmers have in the past been considered passive recipients: progressive when they adopt, and conservative when they do not.

Early extension efforts were commodity-focused, with the major interest in bringing production of optimum quantities and qualities, particularly of cash export crops. There was little concern for the producer except to ensure that the farmer adopted production methods that would lead to increased yield and better product quality. More recent extension systems such as the Training and Visit or T&V system have still operated in a

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top-down authoritative manner which allows relatively little input from farmers (Wheeler, 1988). The strategy is based upon the attempt to use "contact" farmers to transmit recommendations to other farmers. The degree to which this has occurred has been in doubt. Now that many of the Agricultural Development Projects (ADPs) are nearlyreported that farmers "physically chased the extension workers away from their fields because of their inability to back up their messages with the appropriate inputs" (BNARDA, 1991). grounded, especially as far as their extension services are concerned, there is concern that this approach may not have made much impact, neither has it been a sustainable system.

The present realities are even more complicated by the fact that much of what is being advised cannot be practised despite the desire of the farmers to do so. In most areas, farmers are convinced of the need to use fertilizer and are anxious to obtain it, but their efforts are usually frustrated. They find little use in being told about the advantages of agro-chemicals that are unavailable. In Benue State, extension agents reported that farmers "physically chased the extension workers away from their fields because of their inability to backup their messages with the appropriate inputs" (BNARDA, 1991).

The basis for the transfer of extension messages has rested upon research conducted in research institutes, with the belief that whatever was developed would be in the best interest of farmers. Even the use of the term "farming systems" research could usually not change this orientation. As Castillo (1993; p.28) reported, "Farming Systems Research has often been just another name for agronomic research. Social scientists have looked for people in FRS and have not always found them."

With the most recent extension system of the ADPs, research findings have then been transferred to farmers through on-farm adaptive research and demonstration plots. Monthly Training Research Meetings (MTRMs), as well as Fortnightly Trainings (FNTs), are held to pass the information from researchers to extension agents who would then deliver the messages to the farmers during their fortnightly visits. While in theory, the extension system was to allow for feedback from farmers to researchers via their agents, in practise, this has seldom occured. Extension agents were more interested in meeting their targets of extension visits than having the extra effort of reporting back the problems of farmers. Unfortunately, there has also often been the attitude among the majority of development agents that they know what is best for the rural population.

Safo *et al.* (1990) report that the effectiveness of extension agents depends on a variety of factors:

- to develop improved agricultural technologies in response to farmers' needs
- to develop the human resources of the farmers and collaborating organisations
- to develop the institutional capacity of farmers' groups and collaborating organizations

For our purposes, the focus will be on the first objective.

One of the advantages of FPR is the opportunity of the researcher to benefit from the knowledge and experience of the farmer. Rhoades (1987: p.3) describes the farmers' expertise as:

> Farming is about 10,000 years old. No one knows for sure when or how farming first began. Many theories have been put forward but one common thread runs through them all: the farmer is an active actor in the process—selecting, consciously observing, manipulating and experimenting with plants, animals, tools and environment to improve production output and in processing and storage as well.

It is similarly acknowledged that the process of knowledge formation is a consequence of the kinds of observations the farmer is able to make. The farmer's own point of view, while no doubt subject to observational limitations, contains dimensions of experience of which the researcher or extension agent may be unaware. These dimensions may be vital to the success or failure of rural development schemes and should be systematically incorporated into the research and technology development process (Richards, 1979). Warren (1990) agrees that indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities. Going beyond the development of more suitable techniques by integrating what is locally known, Barrow (1988) recognizes the additional benefit of building upon indigenous knowledge for extension agents because introducing innovations will be much easier when people are already somewhat familiar with the modified techniques.

But is it truly participatory research?

In nearly all development circles, the current emphasis is on "participation". In social sciences, we have gone from Rapid Rural Appraisal (RRA) to Participatory Rural Appraisal (PRA) to Participatory Learning Approach (PLA). In project implementation, the concern is always that the local population is involved from the planning to mobilization to execution of the project—total participation. In this case of FPR, the emphasis is on involving farmers in the development of new agricultural technologies, so that the technologies will be more suitable and acceptable.

Yet, the concern always arises as to how much real input comes from the local population, and how much has been decided before their involvement. Jiggens (1995) recognizes that participatory approaches assume skills of perception, listening, communication, cooperation and conflict management. This, she concludes, may be an unrealistic expectation. In addition, she warns, the right method cannot safeguard against the use of participatory processes just for extracting information or other exploitative purposes.

Farrington and Bebbington (1993) classified different degrees of participation, distinguishing between 'shallow' and 'profound' levels. They drew up a 4-way classification based not only upon the amount of involvement, but also on the scope of the subject matter, whether broad or narrow. Okali *et al.* (1994) applied this classification directly to FPR, analyzing it according to whether it was undertaken by research or development programs.

It is understood that there is no right or rigid method to conduct FPR that would be suitable for any situation. Indeed, much of the criticism of past research and extension approaches has been their attempt to develop a model applicable everywhere. Many locally-specific conditions will determine the extent and even the potential participants in the technology development process. In some cases, for example, women farmers may be the most relevant participants, if it concerns crops that they traditionally produce and/or process. In other cases, it may not be possible to involve them as participants. But it is important for the researcher to go to the field with the recognition that he or she does not already have all the necessary knowledge, otherwise, there is no point in going out of the institute.

Back to the question

It may appear that I am dodging the question: "Can participatory research and new information technology replace extension?" I would conclude that since they are set up to achieve different goals, the answer is no. FPR can definitely enhance the extension services by ensuring that the techniques developed are more appropriate and acceptable, but FPR is a means to that end, not an end in itself. It is true that FPR works with farmers, but the number of farmers that could be interacted with will be very minimal. If the benefits of FPR are to go beyond the very few participating farmers, then the activities of the extension agents is crucial.

At the same time, it is necessary to review our system of extension delivery in Nigeria carefully. It is time to assess what we have learned from our various attempts of the past, and develop a sustainable program whose benefits will reach the target population.

References

Barrow, E.G.C. 1998. "Trees, people and the dry lands: The role of local knowledge" Turkana Rural Development Programmes.

Benue State Agricultural and Rural Development Authority (BNARDA) (1991) Annual Report, Makurdi.

Castillo, Gelia T. 1993. "Sustainable Agriculture: In Concept and In Deed" in Sustainable Agriculture: Meeting the Challenge Today by C. Lightfoot (ed.) Proceedings issue of Journal Asian Farming Systems Association.

Farrington J. ,and A.J. Bebbington. 1993. Non-Governmental Organisations, the State and Sustainable Agricultural Development London, Routledge.

Farrington, J., and N. John. 1997. Using Logframes to Monitor and Review Farmer Participatory Research AgREN Network Paper 73.

Idachaba, F.S. 1992. "The technological transformation of African agriculture: Is there hope? Invited 1992 Annual Guest Lecture delivered at the 22nd Annual Research Conference of the International Centre of Insect Physiology and Ecology, Nairobi, on 30 April.

International Institute of Tropical Agriculture (IITA). 1991. Annual Report- 1990 Highlights of Scientific Findings RCMP Research Monograph No. 7, Ibadan.

Jiggens, J. 1995. "Development Impact Assessment: Impact Assessment of Aid Project in Nonwestern Countries" Impact Assessment 13(1): 47-63.

Maunder, H. Addison. 1972. Agricultural Extension: A Reference Manual FAO, Rome.

Okali, C., J. Sumbery, and J. Farrington. 1994. Farmer Participatory Research: Rhetoric and Reality. London, Intermediate Technology Publication.

Rhoades, E. Robert. 1987. "Farmers and Experimentation" London: Overseas Development Institute.
Richards, P. 1979. "Community environmental knowledge in African rural development" Rural Development: Whose Knowledge Counts? IDS Bulletin 10(2): 28-36.
Rivera, M. William. 1988. An overview of agricultural extension systems: The territory, recent developments and recommended directions. Paper presented at IFAD Seminar on "Generation and Transfer of Technology for poor Small Farmers: Issues and Options" held in Seoul, South Korea.
Safo, M; D. Topouzis, S.Horst, S. Amakoye, N. Kariithi, S. Ouattara, C.L. Morna, and L. Kilimwiko. 1990. "Making Extension Work" African Farmer 4: 28-33.
Warren, D. Michael. 1990. Indigenous Knowledge and Development Background Paper for Seminar Series on Sociology and Natural Resource Management held at The World Bank on 3 December.
Wheeler, R. 1988. Descriptions and Examples of Different Approaches and Systems of Agricultural Extension. Unpublished Monograph, University of Maryland, USA.

Incentives for Adoption of Improved Agricultural Technologies in Sub-Saharan Africa

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Abstract: Incentives available for adoption of improved technologies by farmers are tied to government agricultural policies. While these incentives can be effective on the short run, they have proved to be unsustainable on long term mainly because they are dependent on the economic fortunes of governments and also because of failures in the public sector management. This paper argues that the chances of long-term adoption of improved agricultural technologies by farmers can be enhanced by the incorporation of technical issues relevant to farmer circumnstance into the design of technologies and by closing the gap between advancements in crop improvement and resource management technologies.

Introduction

Adoption of new technology hinges on many interrelated factors. In general, farmers seek technologies that increase their incomes while keeping risks within reasonable bounds under their own circumstances, for example, the resources available to the farmer, the climatic soils and topographic characteristics of his land, the pest and disease complex of the crop, and the input and product markets in whcih he operates.

Most of the current incentives for adoption of agricultural technologies are derived from agricultural policies. Some policies affect farmer decisions directly, such as the type of inputs available. Most policies influence farmer behavior indirectly through their effects on input prices (for example, through subsidies) or product prices (for example, through marketing boards).

Subsidies and relief assistance incentives

Subsidies and relief assistance incentives have been successful in attracting farmers to crop improvement technologies, and are particularly pertinent to adoption of resource management technologies. By their nature, resource management technologies are characterized by delayed benefits. Soil conservation technologies, for instance, create an inter-temporal liquidity problem for the farmer by cutting down income in early years in order to obtain higher gains in the future. Offer of relief assistance incentives in the form of sseds, fertilizer, tools and in some cases compensation for labor have helped to retain farmer participation until the desired benefits are apparent.

While incentives derived from policy design are capable of shaping the nature and rate of technology adoption, they are very vulnerable to the economic fortunes of the government or the donor agency sponsiring the technology. Very often, it is the inability of governments to implement public policies providing incentives for long-term growth

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in agriculture which endangers long-term technology adoption. In Zimbabwe, for example, the success in maize production following independence in 1980 was driven by reorientation of government policy towards the communal sector, which led to improved price incentives and public provision of investments in essential infrastructure such as marketing depots and farm credit facilities. Five years later however, the high cost of support proved to be unsustainable and productivity declined.

A second problem with the use of incentives centers around their application. An inappropriate approach towards subsidies and incentives can destroy the long term prospects of a good technology. Direct payments to farmers for labor for example, should only be used where absolutely necessary, and should be merely sufficient to stimulate farmers' involvement without "buying" participation. This is particularly true for resource management technologies. In Ethiopia for instance, when farmers were given any form of payment by the government to conserve their land and water, they assumed that government would also be responsible for maintenance of conservation structures constructed on their farms by paying them for maintenance work done. They regarded themselves as laborers rather than participants.

Technical issues relevant to technology adoption

The general trend in the withdrawal of subsidies and donor fatigue cast has somehow dented the value of reliance on subsidies and relief assistance.incentives as future tools in agricultural technology adoption. We should therefore focus attention in other directions on how to make the adoption of agricultural technologies more attractive to farmers. The following technical considerations are likely to enhance adoption of improved agricultural technologies.

Appropriate technologies

Sub-Saharan Africa is characterized by a wide range of environmental conditions. Rainfall, temperature, altitude, topography, vegetation, and soils vary enormously within the region. By implication, location-specific solutions rather than blanket solutions to farmers' problems are likely to be more successful. We must concentrate efforts on the development of technologies appropriate to the circumstances of target groups. Farmer circumnstances are all those factors which affect farmers' decisions with respect to a crop technology (for example, rainfall, economic environment like product markets and their own goals, preferences and resource constraints. If technologies are appropriate to farmer circumstances, they will, by definition, be rapidly adopted fy farmers.

Participatory approach

It is now widely acknowledged that technical remedies can only succeeed if they are attuned to socio-economic constraints. In other words, participation of the intended beneficiaries of the technology is vital to the success of adoption. This implies making use of traditional skills, working through existing local institutions, and involving the intended beneficiaries in the process of program identification, design and implementation. It is hoped that by respondng to the needs of the target group and demonstrating the profitability of innovations, adoption will gradually gain momentum.

Technologies built on indigenous practices with which prospective users are already familiar are more likely to face fewer adoption problems than technical packages with unfamiliar components. This point is particularly important for resource management technologies.

Flexibility of technologies

Technologies meant for resource poor farmers in sub-Saharan Africa must be:

- Simple and flexible. Users should be able to install the techniques themselves without having to wait for external support. The tools should also be simple and readily available at affordable prices.
- Low cost. The higher the cost of labour and/or machinery involved, the smaller the chances that the technology can be adopted by resource-poor farmers. Even among the well-off farmers, high cost of installation and maintenance may divert farmers' attention to alternate uses of resources.

Short-term benefits

Farmers are principally interested in what immediately affects their welfare and guaranteed subsistence. Therefore, built-in, short-term benefits should, as much as possible, be part of technologies meant for resourcepoor farmers.

Training

Training is a vital ingredient of technology adoption. It is necessary for both program personnel and for participating resource users. Developing skills among the beneficiaries not only "demystifies" technology but also acts as a powerful incentive to increased involvement in technology transfer from farmer to farmer. It is important that project personnel who are going to teach the farmers are themselves comfortable with both the technology and the rational for the intervention.

At this juncture, I consider the International Association of Research Scholars and Fellow an important organ in the evaluation of technologies developed at IITA. A research scholar who had participated in the development of a technology at IITA will show more commitment and feel more comfortable with the evaluation and promotion of that technology in his own region than another scientist who has no previous ties with IITA. Research scholars should see themselves as ambassadors at large for IITA. IITA should work out a program whereby as many as possible can continue as collaborators with the Division where they carried out their research while at IITA. Such a program will keep the scholars professionally active at the national agricultural research systems while at the same time open up another channel for feedback on IITA technologies.

Bridge the gap betwen crop and resource management technology

While there is no doubt that germplasm improvement, plant protection and postharvest technologies are powerful instruments for beneficial changes in food production, it is now apparent that these interventions must be accompanied by simultaneous and equal powerful breakthroughs in resource management technologies. If farmers' resource base cannot be secured and rendered more productive, most of the benefits derivable from crop improvement technologies will be unsustainable. Advancement in crop improvement technologies have out-paced advancement in resource management technologies in sub-Sahara Africa. Bridging this gap is central to strategies of agricultural and rural development in the region. The link between land degradation and poverty is direct and intimate over much of sub-Saharan Africa. It is a physical manifestation of a complex of demographic, economic and social changes which cause rural population in many parts of the region to suffer decline in real income.

References

Atkins, J. and C. Thirtle. 1995. The productivity of communal agriculture in Zimbabwe. Oxford-Agrarian-Studies 23: 99-115. Department of Economics, University of Hull, Hull, UK.

Byerlee, D. et al. 1980. Planning technologies appropriate to farmers. Concepts and Procedures. CYMMT, Mexico.

IFAD. 1992. Soil and Water Conservation in Sub-Saharan Africa. Report prepared for IFAD, Rome by the Cebtre for Development Cooperation Services, Free University, Amsterdam.

Smith, J. 1992. Socio-economic characterization of environments and technologies in humid and sub-humid regions of West and Central africa. RCMD Research Monograph No. 10. IITA, Ibadan, Nigeria.

Abstracts of Oral Presentations

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Effect of soybean growth duration on yield of subsequent maize crop

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In soybean (*Glycine max* (L.) Merr.), nitrogen (N) fixation increases with growth duration. If consistently true, then this can be a simple selection criterion for soybean for sustainable cropping. This study was successively conducted on the same plot for two years to validate the relationship between soybean growth duration and residue management on yield of subsequent maize (*Zea mays* L.) crop. The experiment was conducted at Mokwa, Samaru Kataf and Gidan Waya in the southern Guinea savanna of Nigeria. It included six varieties of soybean of different maturity groups—TGx1485-1D, 95days, early; TGx1805-2E, 90days,early; TGx1681-3F, 98days, early; TGx1809-12E, 112 days, medium; TGx923-2E, 118days, medium; TGx1670-1F, 120days, late.) combined factorially with two residue management practices—plants handpulled, residue not returned; plants handpulled, residue returned as mulch.) giving 12 treatment combinations. Four additional plots of maize were included as a control. All plots had maize in the following year without nitrogen (N) fertilizer, while 3 of the previous maize plots were fertilized to 20, 40, and 60 kg N ha^{-1} to estimate the fertilizer N replacement value (FRV) of the soybean varieties of different maturity groups and residue management.

Highest grain yields were obtained in maize fertilized to N at all the sites. Maize grain yield increase following soybean was negligible at all the sites with no significant difference observed in maize grain yield following soybean of different growth duration and management practices. However, residue returned as mulch performed better at Mokwa and Gidan Waya though at Gidan Waya maize following soybean did not yield as much as maize following maize (1.0 Mg ha^{-1}). In Mokwa, maize following early maturing TGx1805-12E, and medium maturing TGx1809-12E with residue return as mulch contributed to increased (23%) maize grain yield. Increased maize grain yields were recorded at Samaru Kataf similar to that from 20 Kg N ha^{-1} applied at planting, and 4 weeks after planting to maize preceded by maize.

Comments. Authors name should not to be included in the acknowledgement. Only significant differences between the treatments should be shown with LSD bar (on a graph).

Variation in dry matter content and related characteristics in *Musa* spp.: genetic and cropping system effects

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The genetic variability of 36 *Musa* clones were evaluated in relation to some postharvest characteristics in two cropping systems (CS). The genotypes included plantains, dessert bananas and cooking bananas, hybrids (tetraploid), and their landraces (triploid) grown as sole crop and in the alleys of natural multispecies hedgerows.

Results showed highly significant ($P < 0.01\%$) genotype differences in bunch and fruit weight, dry pulp yield, pulp dry matter content (DMC), pulp firmness, fruit shelf-life and market value (MV). CS effect was however, non-significant for only pulp firmness. Also, there was no significant interaction between genotypes and CS for only DMC and pulp firmness. Triploid *Musa* spp. had higher DMC, dry pulp yield, and pulp firmness than tetraploids which had higher bunch weight and market value. Alley cropping system enhanced better DMC and other postharvest related traits irrespective of genome or ploidy level. The market value of *Musa* fruits was more influenced by the dry pulp yield. Generally, the plantains had higher DMC and market value.

Mitotic karyotypes of *Vigna unguiculata* and *Vigna vexillata*

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Cowpea (*Vigna unguiculata*) is one of the important tropical grain legume crops with a high protein content (20–30%). The major constraints to high productivity and long-term storage of cowpea are insect pest damages. There has been no successful hybridization between *Vigna vexillata* (which is the source of resistance genes) and the cultivated cowpea. The problem of incompatibility led into looking at the chromosome morphology to obtain information about the relationship between the two species and possible causes of incompatibility. An efficient, reliable, and simple procedure was developed to enhance the availability of high number of metaphase chromosomes. Using this procedure, clear and relatively longer chromosomes than previously reported were obtained. Diploid chromosome number of 22 was observed for the two species. Identification of individual chromosomes was carried out using chromosome length, ratio between arm lengths and centromeric position. Differences in chromosome morphology between the two species were identified.

Rate of return and its sensitivity on improved sweet potato production in the rainforest zone of Nigeria

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Sweetpotato (*Ipomea batatas L.*) has proved to be a major root crop in Nigeria as in other parts of Africa like Uganda and Papua New Guinea. This study was carried out over a four year period 1991–1994 to ascertain the rate of return of the elite varieties developed and being disseminated from IITA and NRCRI to the resource poor farmers. This takes full cognisance of the time value of money and attempts to find a "break-even" rate of discount which will make the present value of the expected benefit equal to the cost of the enterprise.

Also, attention was drawn to the critical factors or areas that can most seriously affect the enterprise. The effect of the changes in the values of these factors on the original result was tested. The internal rate of return (IRR) is estimated to be 121%, very much greater than the opportunity cost of capital. Sensitivity test on the IRR for possible cost overrun and reduced benefit shows insensitivity even under severe assumptions.

Monoclonal antibody and polymerase chain reaction-based diagnostics for the detection of yam mosaic potyvirus

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Yam mosaic potyvirus (YMV)is a major constraint to yam production in the "yam belt" of West Africa. It infects the main cultivated yams in this region, such as *Dioscorea rotundata* Poir, *D. cayenensis* Lam, *D. esculenta* (Lour) Burk, and *D. trifida* L., causing foliar symptoms from emergence to senescence, leading to reduction in tuber size. YMV is naturally transmitted through aphid vectors and infected planting materials. The symptoms include mosaics, green vein-banding, mottling, stunting and shoestringing.

Little is known about the incidence, severity and spread of YMV in West Africa due to the absence of a reliable virus detection procedure. Hence, this work is aimed at developing a sensitive and reliable diagnostic system based on the use of a monoclonal antibody against YMV and immunocapture reverse-transcriptase polymerase chain reaction (IC-RT-PCR).

A monoclonal antibody, (Mab, M24) to YMV was raised using purified virus preparations from mechanically inoculated *N. benthamiana* Domn. leaves. Detection with M24 was quite sensitive in a triple antibody sandwich (TAS)-ELISA and the testing conditions have been standardised. TAS-ELISA with Mab M24 detected YMV in yam leaf sap up to a dilution of 1/31250 in ELISA conjugate buffer. Dot-blot immunoassay (DBI) was developed with the Mab, suitable for detection at crude leaf-sap dilution of

1:100 and with a sensitivity of 1/31250 in ELISA coating buffer. Also, a direct tissue blotting (DTB) with yam tubers and young shoots from sprouted tubers produced a good reaction with M24 .

Electron microscopic studies showed that YMV can be detected by both the Immunosorbent electron microscopy (ISEM) and the normal Electron Microscopy (EM) with direct sap coating, at a crude leaf sap dilution of 1:100.

The best crude sap dilution for reliable detection with IC-RT-PCR and reverse RT-PCR was 1:100 and sensitivity was up to a leaf sap dilution of 1/156250. Amplification was obtained by IC-RT-PCR with PCR tubes pre-coated with YMV monoclonal and polyclonal antisera, and to a lesser extent with pre-immune mouse serum and non-fat milk in coating buffer. Amplification with a much higher sensitivity was obtained by direct coating of crude sap in coating buffer RT-PCR than with IC-RT-PCR.

YMV was detected in yam leaves at various ages as well as in leaf petioles, stems and tubers by the various test methods. The best plant part for ELISA is the young leaves, while crude sap from leaf petioles and stems (dilution 1:10) is preferred for DBI, because of the relatively reduced green background common in crude leaf sap.

The comparative reliability of TAS-ELISA, DBI and IC-RT-PCR will be tested by screening a large number of field samples and ISEM will be used as a confirmatory test. IC-RT-PCR and ISEM are useful in advanced laboratories but unsuitable in national agricultural research stations for large scale screening, because they require skill in handling and involve expensive equipment and materials. Hence, TAS-ELISA and DBI are recommended for routine testing, while DTB will be useful for screening sprouted tubers before planting.

Q. Are the primers used in the IC-RT-PCR random or are they specific for the virus?

A. The primers used were specific. They were designed based on the existing sequences of different isolates of yam mosaic potyvirus from Nigeria, Côte d'Ivoire, and Sri Lanka.

Q. What is the yield loss caused by YMV in Nigeria?

A. The yield loss due to YMV in Nigeria is yet to be quantified. With the sensitive and reliable diagnostic techniques already developed, this will be assessed in Nigeria and probably for the "yam belt" of West Africa.

Q. Your presentation is 'high-tech.', and your slides are beautiful. In simple terms, what message do you have for illiterate yam farmers in our villages?

A. Actually, these research results are not meant for the immediate consumption of yam farmers. They are meant for use by our NARS, including the Plant Quarantine Service. However, we will like to show the characteristic symptoms of the viral disease to farmers, and advise them to select for planting, tubers from plants that show no symptoms.

The influence of nitrogen rates on nitrogen use efficiency of some early maturing varieties of maize

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A field experiment was conducted during the 1996 rainy season in IITA Mokwa sub-station (latitude 9° 18' and longitude 5° 04'E) to investigate the influence of nitrogen rates on nitrogen use efficiency (NUE) of seven early varieties of maize. The experimental design was a split plot design laid out in randomized complete block design with four replicates. The main treatment consisted of 0 KgN ha^{-1}, 30 kgN ha^{-1}, 60 kgN ha^{-1}, 90 kgN ha^{-1} and 120 kgN ha^{-1} while the varieties which made up the sub-plots included TZECOMP4C2 AC89DMRESRW TZECOMP5C5 EV8731-SR AC90POOL16-DT, DMR-ESRY and TZECOMP3C2.

A spacing of 75 cm x 25 cm was used giving a plant population of 53,333 plants ha^{-1}. N, P and K nutrients were supplied at the rate of 60 kgN ha^{-1}, 60 kgP_2O_5, and 60 kgK_2O as basal application and 60 kgN ha^{-1} as top dressing at 35 days after planting (DAP). Parameters measured include leaf area index (LAI), total number of leaves per stem, senescence, leaf weight, total biomass weight, dry matter harvest index, anthesis-silking interval, grain filing period, days to maturity, grain yield, and 1000-grain weight. All the traits measured were highly correlated with grain yield and NUE at 0 and 30 kgN ha^{-1}. However, as the N levels increased, there was a decrease in the degree of association as well as the number of traits involved with only senescence at silking, ear rating, plant aspect, ear length and number m^{-2} and harvest index that significantly correlated with grain yield and NUE at 60 kgN ha^{-1}. Thus, in selecting for N efficient genotypes, N rates of between 0 and 30 kgN ha^{-1} should be used.

Significant interaction was observed only in total number of leaves per stem and senescence ($P = 0.01$) where AC89DMRESRW TZECOMP5C5 and TZECOMP3C2 had more leaves and less senescence at higher N rates than the rest. For almost all the traits measured, 0 kgN ha^{-1} and 30 kgN ha^{-1}, and 90 kgN ha^{-1} and 120 kgN ha^{-1} were not statistically different ($P = 0.05$). The 90 kgN ha^{-1} and 120 kgN ha^{-1} gave higher values for all the traits measured, for instance, the highest grain yield of 4908 kg ha^{-1} was obtained from 90 kgN ha^{-1}. A moderate value of 3786 kg ha^{-1} was obtained from 60 kgN ha^{-1} which shows that even if farmers cannot afford 120 kgN ha^{-1}, they can apply 60 kgN ha^{-1} and still get a reasonable yield. AC89DMRESRW, TZECOMP4C2 and TZECOMP3C2 performed better than the rest for most of the traits measured ($P = 0.05$). There was thus higher NUE with increasing level of N up to 90 kgN ha^{-1} above which there was no significant increase recorded. Over 60% NUE was obtained for most of the varieties at 60 kgN ha^{-1}.

Q. In view of the depressed grain filling period at 60 kgN ha^{-1}, why do you still recommend this rate?

From your ear rating, you showed that in low N there was higher rating while at higher N, there was lower rating. How would you explain this.

A. At 60 kgN ha^{-1}, there was NUE of over 60% for most of the genotypes and a reasonable grain yield of 3.8 t/ha^{-1} was obtained with.

N rating was done on a scale of 1–9 with 1 as the best and 9 as the worst. Thus, at low N where there was N stress, N rating was closer to 9 while at high N, it was closer to 1.

Q. What do you mean by 0 nitrogen level? Do you mean absolute zero? Bearing in mind that 0 N will affect your model output, did you take initial soil test in order to quantify initial soil N?

A. The 0 N used here does not mean absolute zero, rather it is the quantity of N applied to the soil. The various N levels applied were referred to in this report because the calculation of NUE herein was based on the formula of grain weight/fertilizer N applied. For the purpose of further NUE computation and modeling, initial soil test was done because without this, the model shall assume there was no N in the soil and predict wrong values.

Effects of pubescence of wild and cultivated *Vigna* species on the behavior of the legume pod borer, *Maruca vitrata*, Fabricius

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The effects of pubescence of stem, leaves and pods of three wild *Vigna* species namely *V. vexillata* (TVnu 72), *V. oblongifolia* (TVnu 42) and *V. unguiculata dekindtiana* (TVnu 863) and three accessions of the cultivated cowpea *V. unguiculata unguiculata* (TVu 13731, IT84S-2246-4 and IT91K-180) on colonization, feeding and damage behavior of *Maruca vitrata* Fabricius were investigated. The study was part of an effort aimed at developing acceptable levels of resistance in cultivated cowpea to the insect. There were significant differences in the density of glandular trichomes as well as length of non-glandular trichomes in young stem, leaves and pods of the *Vigna* species. Flowers of cowpea, *V. unguiculata* (TVnu 863, IT84S-2246-4, IT91K-180 and TVu 13731) were significantly more easily colonized and damaged than those of *V. vexillata* and *V. oblongifolia*. Damage to pods was highest on cowpea and least on *V. vexillata*. Density of non-glandular trichomes of leaves significantly reduced the colonisation behavior of *M. vitrata* on flowers ($r = -0.9234$, $P < 0.01$; $y = 4.7196x + 31.851$, $R^2 = 0.8526$), while density of glandular trichomes on pods significantly reduced damage to pods ($r = -0.9587$, $P < 0.01$; $y = 1.2417x + 11.598$, $R^2 = 0.9192$).

Consiquently, density of glandular trichomes on pods accounted for 94.30 percent and 94.14 percent of the variability in pod load and index of pod evaluation, respectively. This difference in the basis of resistance in flowers and pods of *Vigna* species may explain the reason why there is no significant correlation between flower and pod

damages by *M. vitrata*. It appears, therefore, that useful levels of resistance to flower damage by *M. vitrata* in cultivated cowpea can be obtained by breeding for increased density of non-glandular trichomes on leaves, while pod damage can be reduced by breeding for increased density of glandular trichomes on pods.

Q. What is the main objective of your work? Under farmers' conditions, how will imputs such as fertilizers, and herbicides affect the behaviour of *M. vitrata*?

A. The broad objective of the research is to identify sources of resistance in wild and cultivated *Vigna* species with a view to understanding the morphological, biochemical or anatomical basis of the resistance. It is known that fertilizer and herbicide application affects the general physiology of plants and the expression of resistance factors. Resistance factors mostly affected by these inputs are the biochemical ones which have to do with the levels of primary and secondary metabolites. Morphological basis of resistance are more stable under different crop management conditions. Results on the biochemical and anatomical aspects of the resistance will be presented elsewhere.

Mapping cowpea mottle carmovirus resistance gene in *Vigna vexillata*

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Cowpea is an important source of plant protein in the diets of many people of the world. The crop is prone to a number of diseases among which is cowpea mottle carmovirus (CMeV). It was first reported from cowpea in Eastern and Western Nigeria. Reports show that cowpea grain yield reduction of more than 75% was caused by this virus in Nigeria, while 65% reduction was reported in Côte d'Ivoire. There is no known source of resistance to CMeV in the cowpea germplasm. Several *Vigna vexillata* accessions, a wild cowpea relative, exibit immunity to CMeV, but are not cross compatible with cowpea.

A total of 142 wild *Vigna* accessions and 31 cowpea cultivars was screened for resistance to CMeV. Three *V. vexillata* lines (TVNu 1334, TVNu 1443 and TVNu 1544) were found to be susceptible. TvNu 72 and TVNu 73 which are immune to CMeV were selected and crossed with a susceptible parent TVNu 1443. All F_1 plants showed resistance to this virus. F_2 plants segregated in the ratio 3 resistant:1 susceptible. This result suggests a single gene controlling this trait with resistance being dominant to susceptibility. Segregation in the first backcross populations confirms this result.

Non-systemic resistance was, however, observed in two lines TVNu 390 (*V. unguiculata* ssp. *dekindtiana* var. *dekindtiana*) and TVNu 1561 (*V. unguiculata* ssp. *dekindtiana* var. *mensensis*) both of which are cross compatible with cowpea. TVNu 1503 (*V. unguiculata* ssp *dekindtiana* var. *mensensis*), a susceptible line, was also selected and crossed to TVNu 1561 and TVNu 390. All F_1 plants showed susceptibility to the virus which indicates that non-systemic resistance is a recessive trait F_2 plants of the cross between TVNu 1503 and TVNu 1561 segregated in the ratio 15 susceptible:1 resistant. This suggests that non-sytemic resistance is under the control of two recessive genes.

DNA has been isolated from some F_2 plants of TVNu 1443 x TVNu 73 for tagging resistance gene in *vexillata*. Since *V. vexillata* is resistant to insects, *Striga*, and viruses of cowpea, molecular mapping will be initiated with the ultimate aim of developing a linkage map which can be compared with cowpea.

Q. In your screening studies, did you encounter any asymptomatic plants?

A. Yes. An asymptomatic plant is one that is not showing any symptom. In my presentation I said I used a visual scoring scale of 1–5. Any plant that had no symptom had a score of 1. There were many plants like this.

Q. Did you test these asymptomatic plants serologically and what were your findings?

A. Yes. Some asymptomatic plants tested positive to ELISA showing that they had latent infection. For instance, in the F_2 of the cross TVNu 1503 x TVNu 1561, 8 plants out of 88 were symptomless, but two of them tested positive to ELISA reducing the number to 6.

Q. You mentioned that you observed non-systemic infection. Of what significance is this?

A. Some plants after inoculation were found to restrict viral movement from the site of inoculation to other parts of the plant. This we described as non-systemic infection since only inoculated leaves tested positive to ELISA. This mode of resistance was observed in two *dekindtiana* lines which are cross compatible with cowpea. We hope this trait could be incoporated into cowpea lines through conventional breeding while waiting for prospects of transfering the resistance gene in *vexillata* to cowpeas through biotechnology.

Ex-post adoption and social impact assessment of improved agricultural technologies: the case of soybean in the southern Guinea savanna of Nigeria

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Soybean has been described as a "miracle crop, golden bean, and crop of the planet" because of its high protein content, hence its potential to alleviate malnutrition and improve the standard of living of poor farmers. However, despite several years of introduction of improved varieties (IVs), little is known about the extent, the determinants of their adoption, and impact on farmers' households. *Ex post* adoption and impact studies are needed to determine their level of adoption, and their actual impact on different categories of people. This paper is based on a survey of over 300 households in Benue State, Nigeria, using a combination of household questionnaires and Participatory Rural Appraisal techniques.

There is empirical evidence that IVs have been largely adopted by farmers, and have completely replaced the traditional Malayan variety. The results of the Logit and Tobit regression models showed that adoption and use intensity of IVs was significantly and positively related to village location, farmers' assessment of varietal characteristics, and soybean production experience. Gender differences were not significant in the adoption and use intensity of IVs. Classical diffusion variables such as age, education, extension contact, farm size, and income were not significant. The adoption of IVs has had positive effects on farmer's income and welfare, food security, land use intensification, and values and attitudes, and has reduced rigidity in intra- and inter-household gender relations. Contrary to the view that soybean consumption has been limited, the study revealed that soybean has been integrated in the diets of rural people. It was found that soybean consumption had significant positive effects on children's nutritional status. There is, however, considerable scope for increasing the adoption and the full benefits of soybean by focusing attention on a sustainable production system encompassing the dissemination of home utilization technologies, improved varieties, resource management technologies, and adequate policy.

Q. In the presentation, you mentioned over 300 people. Do you have adequate record of your respondents?
Your expectations of high adoption at Gwer as a result of the processing industry were not realised; don't think you need to consider other factors that could affect adoption?

A. Yes, we do have adequate record of our respondents. We applied a combination of research methodologies to collect data including household questionnaires, focus group discussion, key informants, informal interviews, and field observations. The quantitative analysis of household survey was based on 203 valid qustionnaires (respondents). In addition, we conducted about 10 focus group discussion sessions, each with 6–10 farmers. The discussions were recorded and later transcribed. So if we add this number to the 203 farmers interviewed, plus a number of key informants, we are well above 300 farmers.

We expected that the proximity of the soybean processing factory in Gwer would be a strong incentive to boost adoption in this area since farmers could get easy market. This was one of our hypotheses. But the findings of the study show clearly that adoption is higher in villages located in Gboko than in Gwer. I agree with you that the location of a processing industry (Taraku Mills) is not sufficient to explain the differential adoption rates between Gwer and Gboko. There are other factors that account for these locational differences. I think that the fact that soybean is the primary source of income in Gboko, and the easy access to market could explain this differece in the adoption rates. Another factor could be the presence of the Yandev research station which conducted trials on soybean in the past.

Q. Women are known to contribute more to crop production than men in Africa. Could explain why you have a reverse situation in your study of soybean?

A. Yes, it is known that African women contribute 60–80% of agricultural production. However, we should avoid generalisations. There exist differences between locations, cultures, societies, crops, and even households. Some recent studies have shown that for some crops in certain regions the contribution of women is even far less compared to men. In the case of soybean in Tiv society, I think that the fact that soybean is a cash crop explains the domination of men even in traditional women's activities such as weeding and harvesting. Secondly, men provide labor in land preparation which takes a great share of soybean work. It is important to note however, that with the introduction of improved varieties, more women are increasingly involved in soybean production, which used to be a male crop.

Abstracts of Poster Presentations

1997

An impact evaluation of the crop management research training on job performance of research technicians and extension supervisors in Ghana

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The study analyses the impact of Crop Management Research (CMR) training on the job performance of former trainees. The approach used a comparison group, multiple sources of information, and multiple methods of data collection to provide a persuasive case of training impact.

The study indicates that there was a change in trainees' competence after the CMR training. It also indicate a high utilisation of their training skills. Skill learned during the training emerged as the most significant predictor variable of job performance, but the amount of variability was rather small ($R^2 = 0.4536$). While use of training was found to be influenced by organisational and personal factors, it was also found to be limited by lack of resources.

Novel approach to mitotic chromosome counts in *Striga* species

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Most of the available information on chromosome counts of *Striga* species are primarily on meiotic structures because *Striga* species have poorly developed root structures from which most mitotic chromosomes in plants are commonly studied. In this study, a new method was developed for estimating mitotic chromosome counts from colchicine treated shoot tip squashes of unemerged shoot tip seedlings of *Striga aspera* and *Striga hermonthica*. The mitotic chromosome number of *Striga aspera* was determined as $2n = 36$ and $2n = 38$ for *Striga hermonthica* for the first time.

Q. What are the advantages of this novel approach ?

A. The mitotic chromosome numbers for the two species established through this technique are close to our expectations regarding the ability of *Striga aspera* and *Striga hermonthica* to successfully hybridize. It also provides a basis for looking at the mechanism of evolution within the genus as a whole.

Q. Why didn't you use Sans Serif font.

A. I am kind of used to using the Times New Roman font. I agree San Serif would be more appropriate for poster presentations.

Soybean residue management on yield of subsequent maize crop

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High cereal yields require more nitrogen (N) than the the soil can provide. Recycling of soybean (*Glycine max* (L.) Merr.) residue may be practised in future if increased contribution to subsequent maize (*Zea mays* (L.)) crop justify the efforts to return the residue. This study was successively conducted on the same plot for two years to evaluate the effect of soybean residue management and variety on the yield of subsequent maize crop. The study was conducted at Mokwa, Samaru Kataf and Gidan Waya in the southern Guinea savanna, and Yamrat in the northern Guinea savanna of Nigeria. It included two varieties of soybean; early maturing TGx1485-1D and late maturing TGx1670-1F, combined factorially with 5 residue management practices (handpull, export (H-E), Slash, export (S-E), handpull, mulch (H-M), Slash, mulch (S-M), and Slash, incorporate in soil (S-I)) giving 10 treatment combinations. Four additional plots of maize and a fallow were included as a control. All plots were planted with maize in the following year with three of the previous season maize fertilized to 20, 40, and 60 kg N ha^{-1} to estimate the fertilizer N replacement value (FRV) of the soybean residue management and variety.

Response to fertilizer N was observed at all the sites except Samaru Kataf. Increased yields were recorded in maize following soybean than maize-maize or fallow-maize system at all the sites. The increase following the early variety was significantly ($P < 0.05$) higher than that following the late variety at Mokwa, but no significant difference was observed at other sites. The increase following H-M (0.95 Vs 0.1 [maize-maize] Mg ha^{-1}) at S.Kataf and S-I (2.15 vs 0.8 [maize-maize] Mg ha^{-1}) at Yamrat was significantly greater ($P < 0.05$) than other residue management practices. No significant difference was observed at other sites, yet H-M and S-I contributed more to increased maize yield. The increase following soybean variety and residue management was similar to that from 10.5 kg N ha^{-1} at Mokwa, 4.4 kg N ha^{-1} at Samaru Kataf, 1.4 kg N ha^{-1} at Gidan Waya, and 6.7 kg N h^{-1} at Yamrat, applied to maize preceded by maize.

Q. In one of your slides, the litter which you used as residues were blown away by wind. If you are to recommend this procedure to farmers, how do they avoid this?

A. Litter is the leaves which fall just before harvest while residue is the hulm obtained after the threshing. It was the residue which was stored in bags to be used in the following year at the time of planting maize. It was litter which was blown away by wind in Yamrat, as the ridges were almost flat by the end of the season. However, this could be controlled to an extent by tied ridges.

Q. In the northern Guinea savanna (Samaru), the winds can be very devastating on any residue put on ridges. If in the first year, you faced such a problem, what control measures were incorporated into plot management during the second year?

A. No residue was applied in the first year. Soybean was planted in the first year, and at the end of the season, residue was stored in bags after threshing to be used in the following year at the time of planting maize. Litters were blown away by harmattan wind at Yamrat as the ridges were almost flat at the end of the season due to the nature of the soil. Since bullock was used to make the ridges, it could not be made high enough to last the rainy season. Ridges and tied ridges could be made to prevent the litter blown by the wind. However, this could have been a problem in the following year at the time of planting maize, but was not a major problem as wind together with rain prevented it from being blown off.

The use of antibiotics in controlling bacterial contamination in yam tissue culture

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Tryptone soya broth and nutrient agar were used for isolating bacterial contaminants in yam tissue cultures. Isolates obtained from contaminated cultures were characterized and identified as a preliminary step in determining an elimination treatment. Six antibiotics were evaluated for activity against the contaminants by the use of antibiotic sensitivity test discs. Streptomycin, gentamicin, and rifampicin chosen for further investigation, were screened for bactericidal activity and phytotoxic effects on liquid yam multiplication (YM) medium. Single nodes from infected plants were treated by inoculating into liquid YM medium incorporated with single antibiotics. Rifampicin applied at 320 μg/ml was effective and not phytotoxic as streptomycin (1000 μg/ml) and gentamicin (160 μg/ml).

The influence of storage structures on the population dynamics of fungi on stored maize

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In Nigeria, annual grain losses is put at between 15 and 25% (Agboola, 1980). Grains when harvested dry, are not invaded to any extent by storage fungi, nor do they grow at such low moisture content. But when moisture pockets occur in the stored grain, these storage fungi begin to grow and colonise (Hudson, 1971).

Population dynamics' fundamental equation states that the increase in population numbers (N) in a unit time interval is given by births + immigrants-deaths-emigrants (Jeger, 1987). In the Population Dynamics of Fungal inoculum in storage, birth and death assume most importance.

Maize in storage, either as ears or shelled grains are prone to attack by storage rotting fungi especially when the moisture content is between 15 and 20% and temperature between 21 and 32°C (Adesuyi and Shode, 1979). Many fungi are involved but common among them are species of *Aspergillus*, *Penicillium* and sometimes *Fusarium*. These, apart from reducing the market and feed values of the affected grains also produce toxins which are harmful to animals.

The purpose of this research therefore, is to test the efficacy of three of the improved storage structures, newly designed by the Crop Storage Unit (CSU) of the Federal Department of Agriculture and Rural Development, Ibadan. The storage test will be on three IITA-improved maize varieties—8644-27, 8644-32, and Suwan 1-SR, stored over a period of 12 months.

The results of this research will be used to advise CSU on storage structures.

Transformability studies on cowpea (*Vigna unguiculata* [L.] Walp) pollen

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The pollen or sporophyte is a natural genetic transfer system which carries the male complement of the plant genome into the ovum or gametophyte. Studies are being carried out to investigate the potentials of obtaining transgenic cowpea plants through the transformation of the pollen grains. Two major techniques: microparticle bombardment and *Agrobacterium*-mediated transformation are being investigated both for feasibility and efficiency. Preliminary results indicate that genetic transformation of cowpea through the transformation of the pollen grains is possible and holds potential as a relatively inexpensive genetic transformation system.

Q. What advantages does the pollen transformation system hold over other transformation systems?

A. Pollen transformation offers the following potential advantages:

- higher transformation rates in treated material
- chimeric transformation is eliminated
- shorter time-span in obtaining transformants
- less likelihood of compromising vigor and fertility
- a higher benefit/cost ratio of producing transformed progeny because tissue culture is circumvented.
- possible adaptation of this technique to all seed-setting plants
- possibility of introducing more than one gene into transformants in one operation

Physical properties of an ultisol under slash-and-burn practices

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A study was carried out for two consecutive years from 1994–1995 at the IITA Humid Forest Station, at Mbamayo, Cameroon. The objective of this study was to determine the effects of different levels of burning in slash-and-burn on physical properties of an Ultisol and cassava and groundnut yields. The four levels of burning included (i) no burn plot (NB), (ii) slight burn plot (SB), (iii) moderate burn plot (MB) and (iv) heavy burn plot (HB). This study found no significant differences among treatments in silt and clay contents, organic carbon, total nitrogen and infiltration characteristics. However, no-burn plot in slash-and-burn decreased bulk density, soil strength, moisture content, saturated and unsaturated hydraulic conductivities and pH and increased soil temperature compared to slight, moderate and heavy burn plots. In contrast, increases in water discharge, saturated hydraulic conductivity and moisture content and decrease in soil temperature were observed in heavy burn plot. Cassava and groundnut yields were also optimal in heavy burn plot, with respective increases over the no-burn plot of 27 and 75% at that intensity. It is suggested that ashes from heavy burning have only temporary beneficial effects on soil properties and crop yields, because of leaching and eroson. In-situ burning may therefore result in deteriorating the soil properties.

Effect of fallow species on soil microarthropods in a degraded Alfisol

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Microarthropods play a major role in soil fertility through the use of litter decomposition and nutrient turnover. Alteration of the ecosystem due to agricultural practices lead to changes in population, composition, and the effects of these groups of soil fauna on nutrient turnover. The effects of three planted woody fallow species (*Acacia leptocarpa*, *Senna siamea* and *Leucaena leucocephala*), natural fallow, and continuous cropping (maize/cassava), on soil microarthropods were examined monthly in a degraded Alfisol at IITA, Ibadan, southwestern Nigeria over wet and dry seasons in 1996/97.

Results showed that soil microarthropod population densities were higher under *S. siamea* and *A. leptocarpa* by 196% and 163% compared to the continuous cropping respectively. *S. siamea* and *A. leptocarpa* also showed higher microarthropod population densities (35.0% and 12.7% respectively) than natural bush fallow (mainly *Chromolaena odorata*) during the wet season. *Leucaena leucocephala* showed the densities significantly higher than continuous cropping but lower than natural bush fallow though not significantly. Microarthropod densities during the dry season followed a similar pattern as in the wet season. Soil microarthropod population correlate significantly with the

lignin content of litterfall under fallow. Results imply that woody fallow species help restore soil microarthropods in the degraded soil with magnitude depending on lignin content of litterfall.

Variation patterns in the morphology of *Vigna luteola*

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Vigna luteola is a wild species characterised by flashy, green, tender leaflets and bright yellow flowers. It has been identified with high levels of resistance against most cowpea insect pests, thus making it a potential source of genes for crop improvement. It can also be used as a cover crop and fodder. The knowledge of patterns of genetic diversity enhances the efficiency of germplasm utilisation and conservation.

Principal component analysis was used to assess the diversity and clasify 29 accessions of *V. luteola*. Differentiation of these accessions into four distinct groups was achieved through the use of 36 plant morphological characters. Descriptors such as canopy density, standard petal width, adelphous stamens length, style length, pod width and thickness, seed width and thickness, and the weight of 100 seeds were the principal discriminatory characters. Total variation was accounted for by 50% in the first three principal components. Observations made on the stigma and the adelphous stamens indicate that the species is outcrossing in nature.

Sustainable management of fishery in a multipurpose lake: case study of IITA lake, Ibadan

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IITA lake with approximately 70 ha surface area is a multi-purpose, man-made lake, primarily for domestic use and water supply, irrigation, and secondarily for food and sport-fishing.

Over the years, IITA lake has received inflows of agricultural and domestic effluents in organic and inorganic forms, that could render water quality unsafe for domestic purposes and/or increase the cost of water purification, cause lake eutrophication, render fish either unsafe or unpalatable for consumption, and reduce fish diversity. These risks are averted by proper management of the lake environment, especially the surrounding and submerged vegetation, though this is currently managed on an ad hoc basis. One potentially important factor in lake ecology is fishery management, but the lake has been exploited for sport and food for over 15 years without an assessment of the impact and sustainability of these activities.

The main objective of this research is to assess the potential of this lake and recommend management options which would support a range of sport and food-fishing scenarios, while preserving water quality.

Fish samples will be collected using experimental gill nets, long-lines and traps. Fish identification will be based on morphometric and meristic counts. Weight and length of individual fish caught will be taken. Also, gear selectivity, food and feeding habits, water quality and aquatic weed growth will be studied. The data collected will be subjected to statistical analysis and appropriate models used to derive sustainable management options.

Appendices

IARSAF Executive Committee 1996

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Socials and Welfare
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1996 Awards

Supervisor of The Year Award
Professor F Nweke and Dr AGO Dixon

	Best Oral Presentation	Best Poster Presentation
First place	Kamara A	Akano A
Second place	Aigbokhan E	Adejuyigbe CE
Third place	Daniel IO	Akparobi S

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Ogundinwin E
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Protocol
Aadejuyigbe CO
Agindotan B
Sanginga P
Alao J
Osuigwe CO

Publicity
Abdullahi I
Ilori CO
Fred A
Oyetunji OJ

Technical
Ndimele L
Gungula DT
Aliyu B

Honors
Modupe VO
Singh A
Osei CK
Ogundinwin E

Socials/Welfare
Lahai MT
Adetula OA
Onyia N
Ubi B
Umba-di-Umba

1997 Awards

Supervisor of the Year Award
Dr (Chief) George Thottappilly

	Best Oral Presentation	Best Poster Presentation
First place	Adetula O	Osei C
Second place	Njukeng P	Singh A
Third place	Sanginga P	Aigbokhan E

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Results of Novelty Football Match

Year	IARSAF	IITA Scientists
1995	1	2
1996	1	2
1997	3	2