International Institute of Tropical Agriculture

Report 1972-73

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Report 1972 - 73

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE, OYO ROAD, PMB 5320, IBADAN NIGERIA

Contents

About This Report

The International Institute of Tropical Agriculture (IITA) is the world's largest and most comprehensive agricultural research and training body serving the lowland, humid tropics. IITA was inaugurated in 1969 and built its research program at the same time that it developed land and buildings. This brought both construction, development and staffing to near 100% by the end of 1973.

IITA issues annual reports on its research work in each of four programs as soon as the information is available. These detailed, scientific reports, issued annually by May 1, go to scientists, research organizations, governments, libraries and others interested in our work. Readers of this report may request copies of the program reports if more detail is needed on any phase of our research. Special reprints dealing with individual subprograms are also available. Contents of the 1973 program reports are included in each program's section of this report.

This general 1972-73 Report is for a wider audience. We want you to have an insight of IITA's program for making more food available to the rapidly increasing populations in the world's lowland humid tropical areas.

The total IITA program of research, training and outreach brings together a large international team of scientists for a coordinated, interdisciplinary work on how to move food production faster toward heading off hunger.

Our issue of this report, covering 1972 and 1973, reflects a partial staffing and limited program in 1972, but a near full staffing and a fully active research program in 1973. In addition the nature of much of our research is that a more comprehensive – and more interesting – report can be made on two years of work.

Correspondence about IITA reports, or about the IITA program may be addressed to Communications and Information Office, IITA, PMB 5320, Ibadan, Nigeria.

Introduction

The International Institute of Tropical Agriculture (IITA) was conceived by its originators as a comprehensive research and training enterprise serving the humid, lowland tropics. IITA's work is to improve the food crop production capabilities of tropical nations and, in a broadly based Farming Systems research effort, to devise production and management practices that will permit farmers to intensify their farming operations without causing loss of the soil due to erosion, loss of nutrients due to leaching, or deterioration of the soil's physical structure.

The idea is to find the key to a more permanent, continuing farm production pattern, which will not only be more feasible economically but will minimize, if not eliminate, the drudging, laborious, frequently profitless system of shifting, bush-fallow, agriculture practiced so abundantly in the humid tropics.

The broad mandate given IITA includes plant breeding and genetic studies with the cereals, grain legumes, roots and tubers, vegetables, and forage and soil conserving crops. It was originally expected that the Institute would conduct dairy and beef cattle management and animal nutrition research as part of its Farming Systems research effort. Marketing economics and agricultural policy research were also to be featured along with a strong program in production economics.

It was obvious, however, as IITA moved into 1972 and its first large, though still incomplete research effort was well underway that a reconsideration of its objectives was in order. More international agricultural research institutes were being formed or planned and those already established were broadening their programs. An international agricultural research network was forming, requiring increased coordination and cooperation among the institutes. IITA, for example, working with rice, serves as a regional outlet for IRRI, which has the prior international responsibility for rice research. IITA has a similar relationship with CIMMYT in the case of maize, and with ICRISAT for pigeon peas.

RESEARCH EMPHASIS

The re-examination of objectives resulted in a sharper focusing on research objectives. Because it was felt that the IITA research program should be more precisely stated in the light of staffing and funding expectations in the future, the staff recommended, and the Board of Trustees approved, that IITA:

- Accept international responsibility for finding solutions to the problems related to replacing shifting cultivation with more productive forms of land utilization in the humid, lowland tropics.
- Limit work with animals, forages, and tree crops to their role as components of farming systems.
- Develop crop improvement research with international responsibility for cowpeas, yams and and sweet potatoes.
- Develop crop improvement research with regional responsibility for:

  Rice, backstopped by IRRI

  Maize, backstopped by CIMMYT

  Soybeans, backstopped by existing national centers of strength

  Pigeon peas, backstopped by ICRISAT

  Cassava, backstopped by CIAT
- Conduct exploratory studies with crops potential usefulness in the humid tropics. Examples are lima,jack,winged and yam beans and Asian grams among the grain legumes, and potatoes and cocoyam among root and tuber crops.

IITA research activities during 1972-73 were conducted according to the above pattern. Major research achievements of the year in each of the categories are outlined in later sections of this report. These sections reflect an increasing outreach effort of IITA,especially the regional testing programs.

PHYSICAL PLANT

The years 1972-73 saw substantial progress made toward completion on the Institute's building and facilities and in clearing and preparing land for field work. Recruitment of scientists proceeded as accommodation became available and a concerted effort was made to employ the full quota of support staff.

The Institute's two laboratories were occupied during 1972: the Will M. Myers Laboratory housing agronomy, soil science, plant physiology and chemistry, agroclimatology and soil and water conservation, and the Biological Sciences Laboratory housing plant breeding, plant protection and microbiology. The Library was turned over to the Institute in October 1972. Two Residence Halls were ready to receive the first trainees in September 1972 and construction of two additional dormitories started in 1973. All housing units were completed and most were occupied during 1972. The Institute's dining and guest facility, International House, opened in mid-1973 and the Conference Center was inaugurated with its first international event in December 1973. All buildings included in the original plan for IITA were completed and operational for all established projects by mid-1973.

TRUSTEES AND STAFF

The terms of office of several members of the Board of Trustees were completed at the conclusion of the annual meeting held in June 1972. The retiring elected members of the Board, all of whom were charter members were:

A. Hugh Bunting, dean, Faculty of Agriculture, University of Reading, England.

Guy Camus, director general, Office de la Recherche Scientifique et Technique Outre Mer (ORSTOM), France.

Robert K.A. Gardiner, executive secretary, United Nations Economic Commission for Africa, Ethiopia.

Y.K. Lule, formerly principal, Makerere University College, Uganda, now executive secretary Association for African Universities, Ghana.

D.L. Umali, formerly vice president, University of the Philippines, now assistant director general and regional representative for Asia and the Far East, FAO, Thailand.

Ex-officio members who left the Board of Trustees after the meeting in June 1972 were:

H. A. Oluwasanmi, vice-chancellor, University of Ife, Nigeria.

L. K. Opeke, director, Cocoa Research Institute of Nigeria, Ibadan.

The Institute is extremely grateful to these men for their generous attention to IITA affairs during the difficult years of construction, program establishment and staff recruitment. That the Institute was able to launch objective and extensive research, training, conference and outreach programs simultaneously with construction and site development was due in large measure to the interest and active participation of its Trustees.

SEMINAR SERIES

The highly successful seminar series, which began in 1970, continued in 1972. As with the earlier seminars, those held in 1972 were conducted in cooperation with the Institut de Recherches Agronomiques et des Cultures Vivrieres (IRAT) and The Ford Foundation, which funded the series from its beginning. The 1972 seminars were on Tropical Soil Research, Land Tenure Systems in West Africa and Prospects for Irrigation in West Africa. Seminar and conference activity for 1973 is reported under Training at IITA.

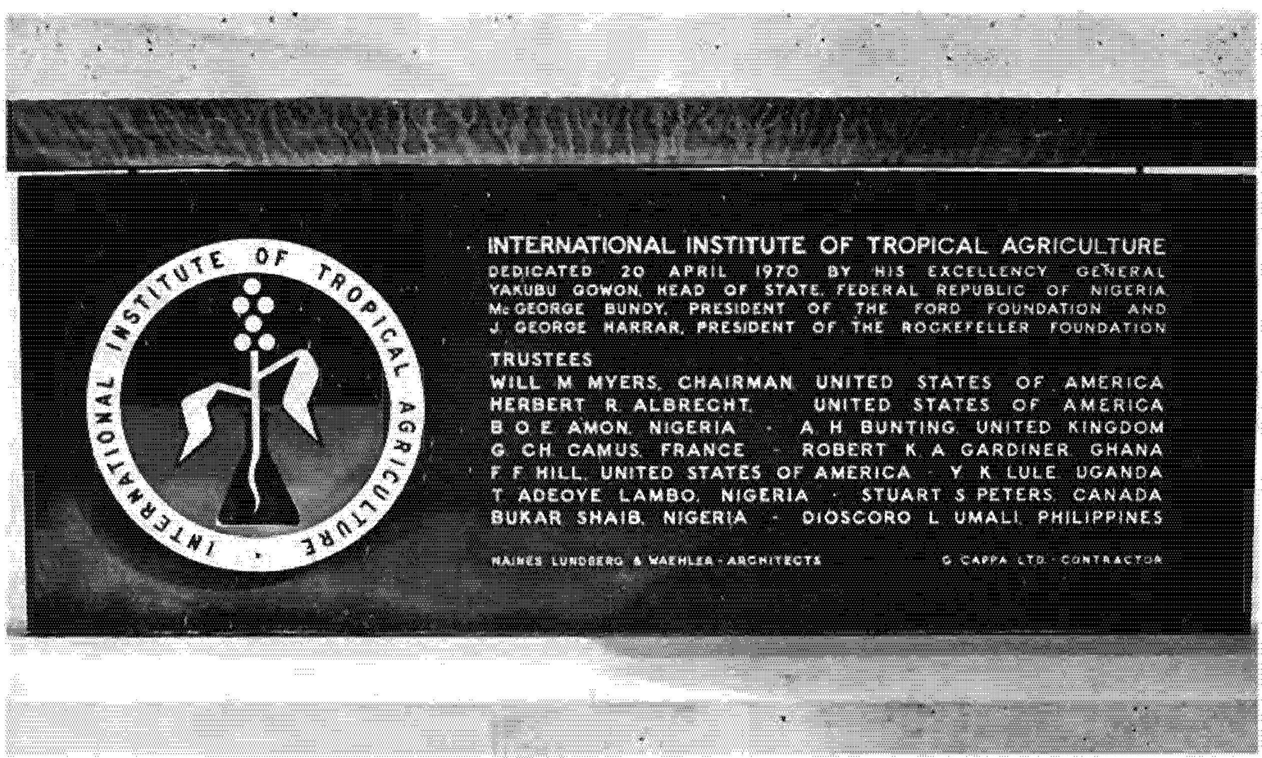
FUNDING

Costs of operations during 1972-73 increased substantially due to staff and program enlargement and fuller occupancy of facilities. Delays in the construction project in turn somewhat delayed anticipated receipts and expenditures of capital funds. The main construction project when completed in mid-1973 was almost three years behind the schedule established in 1966. Suspension of construction from the end of 1966 until late in 1968 – the project was reactivated well before the end of the Nigerian Civil War – and difficulties encountered in the receipt of imported materials and equipment and in the construction process itself were the main factors responsible for the delay.

A brief listing of funds for core operations received by IITA during 1972-73 is given below. It is to be noted with appreciation that during 1972-73 the Netherlands, the United Kingdom (through the Overseas Development Administration), Belgium, West Germany and the World Bank joined the Ford and Rockefeller Foundations, the Canadian International Development Agency and the United States Agency for International Development as supporters of the IITA program of research and training.

Source of funds (U.S. dollars) for core operations of IITA, 1972-73:

	1972	1973
Ford Foundation	467,000	750,000
Rockefeller Foundation	750,000	514,000
United States (AID)	746,000	1,200,000
Canada (CIDA)	726,000	750,000
Netherlands	206,000	125,000
Belgium	138,000	302,000
United Kingdom (ODA)	171,000	484,000
West Germany		759,000
World Bank Group		114,000



Cereal Improvement Program

Work with cereals at IITA concentrates on maize and rice because of their potential for increasing food crop production in the forested zones of the humid tropics. There is close cooperation on rice work with IRRI and on maize work with CIMMYT, making IITA an integral component of global research for maize and rice with major responsibility for regional work in Africa.

Maize Breeding

Factors that limit maize yields in the humid tropics were subject to much speculation when IITA started breeding work in 1970. Some factors pinpointed for study at that time were high soil temperature effects on seedling growth and effects of limited light and soil moisture on total yields. Breeding work started early in 1970 based on two Nigerian composites – Composite A formed by the Western State Ministry of Agriculture and Natural Resources in 1968, and Composite B formed by the Federal Department of Agricultural Research also in 1968. At the start of IITA breeding work these two composites were equal in yield to the best improved maize available in West Africa.

Based on nine generations of breeding progress, the addition of new germplasm identified from outside Africa and the conversion of the Nigerian composites from a mixed to a white kernel color, the IITA maize was given the designation TZA and TZB at the start of 1972. Yield progress can be seen from Table 1, taken from trials at IITA.

Table 1. Yield comparisons of TZA and TZB with Nigerian composites and local maize, IITA, 1972-73.

Variety	Yield in tons/ha	
	1972	1973
TZA x TZB	3.8	4.0
TZB	3.5	4.4
Comp A x Comp B	3.2	3.9
Comp A	3.1	3.6
Comp B	3.1	--
Local maize	.8	2.0

Based on average yields in trials at five locations in West Africa during 1973 the cross of TZA with TZB ranked first with 4.9 tons of grain per hectare and TZB ranked third with 4.5 tons per hectare. At each of the five locations the local farmers' maize planted in the trial was the maize normally bought by farmers in their local market. Local maize yields ranged from 1.2 to 3.6 tons per hectare, averaged 2.3 tons per hectare, and came last in the trials. Recommended improved maize and commercial hybrids ranged from 3.6 to 4.6 tons per hectare.

IITA maize breeders are certain that yields per hectare of TZB will continue to rise in the years ahead. Each year a three-generation breeding cycle is completed and progress accumulates from cycle to cycle.

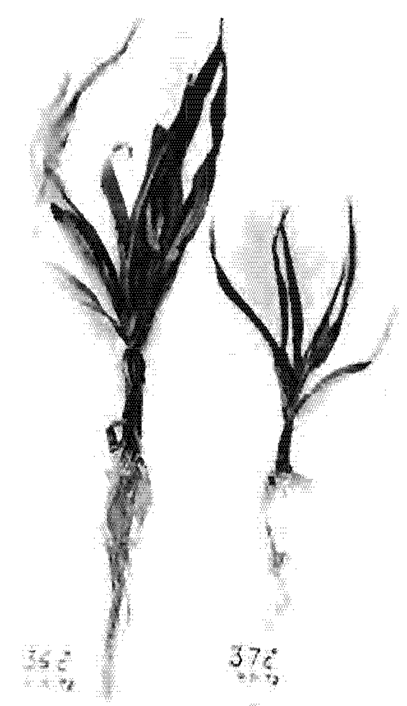
Maize Protein Quality

Breeding work started in 1970 to convert IITA maize TZA and TZB for higher protein quality by backcrossing to add the opaque-2 gene. A new high lysine opaque-2 composite was formed in 1973 that had higher lysine content and a harder kernel than the earlier conversions, giving promise of a maize with high protein that will resist weevils and ear rot, two major storage problems that have limited adoption of high-lysine maize in West Africa.

Maize and Soil Temperatures

The success of a maize crop often depends on the soil's temperature during the early days of the growing season. Plant breeders have extended the

High soil temperature affects maize seedlings.



northern limits for maize production in temperate zones in recent years by breeding maize that will germinate and grow under cold conditions. IITA scientists are at work on tropical maize for an opposite effect – the ability to withstand high soil temperatures. Maize planting in the tropics is usually done at the end of the dry season and at the onset of rains. Daytime soil temperatures at that time run as high as 40°C at a 5-cm depth. Maize roots start to die at 36°C.

The maize agronomist and breeders, working with the soil physicist, started screening IITA maize TZB for tolerance to high soil temperatures in 1972. By 1973 it was established that the gene or genes for resistance to high soil temperature were sufficient to easily and quickly develop heat tolerant varieties. Large scale screening of IITA maize germplasm by early planting in hot soils started in 1973.

Maize Under Minimum Tillage

Based on work started by the IITA Soil Physicist in 1971 to show the effect of minimum tillage or no tillage on plant growth, maize trials on several systems of tillage started in 1972. The 1972 results indicated that minimum tillage practices can give maize yields equivalent to those resulting from conventional – plow, disc plant and inter-row cultivation – tillage practices.

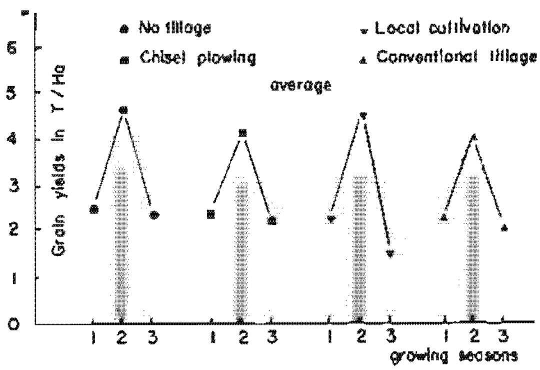


Figure 1. Comparison of four tillage practices on maize production for three consecutive seasons.

Minimum tillage of maize continued during 1973, giving equal or slightly higher yields plus the advantages of less labor, less erosion, less cost and improved chemical and physical condition of the soil. Figure 1 illustrates the 1973 results. Note that local tillage results are close to those for no tillage, which is because local farmers conduct minimal tillage in their hand operations. Conventional tillage refers to use of machinery for plowing and discing the soil before planting. (See the discussion of minimum tillage also on page 31).

Maize stover returned to the soil under minimum tillage eliminates runoff and stops erosion, reduces soil temperature, maintains soil moisture supply and increases earthworm activity, for better tilth. The plot shown has grown nine consecutive maize crops with no tillage.

Maize and Soil Fertility

Where maize is grown under the traditional bush-fallow system yields decline the second year and level off the third year thus giving rise to the system of clearing another section of bush for new planting and allowing the used land to pass to bush fallow. Soil fertility studies conducted by the IITA Farming Systems Program verify this effect but also show that maize yields can be maintained with good cultural practices. Table 2 details three years of results in a fertility study using maize.

Table 2. Yields of maize under different cultural practices at IITA, 1971 - 73.

Treatment	Yield in kg/ha on Egbeda soil at IITA		
	1971	1972	1973
No fertilizer and no weeding	4960	1486	1736
No fertilizer with weeding	5829	4556	3519
Fertilizer with no weeding	5742	5828	4700
Fertilizer with weeding	5382	6785	6619

Rice Improvement

Rice improvement work is split at about 90% for upland rice and 10% for irrigated or paddy rice. IITA work on irrigated rice,concentrates on screening new varieties received from IRRI for suitability to African conditions. Most of the rice grown in West Africa is upland, which means that water for the crop is provided by rainfall. The start of IITA's work with upland rice was in 1970 with the collection of more than 1,000 varieties or advanced lines of rice from wherever they could be found. Many of the varieties collected were classed as paddy rice, but were plant types that had shown promise for growth on the drier soils of upland conditions.

By the end of 1972 the IITA rice germplasm collection included about 1,500 accessions.Screening and testing under both upland and irrigated conditions was done and more than 450 entries were put in nurseries where the most promising were selected for 1973 yield trials. During the same period new lines were created by breeding and by 1973 IITA-bred rice, carrying the prefix TOX, was in large scale tests under upland conditions.

About 20 TOX lines from the 1973 trials at IITA will go into replicated trials both at IITA and throughout West Africa during 1974. The 10 highest yielding lines from the 1973 upland nursery are listed in Table 3.

All of the TOX 7 lines are short to medium in height and had strong stalks, which did not lodge at all. The local variety in the trials, a variety widely recommended to farmers, shows less than half the yield of the best TOX line, was 36 to 102 cm taller and fell flat with 100% lodged plants.

TOX designates an IITA breeding line. Accessions to the germplasm collection are designated TOs. Releases of lines from IITA will carry the prefix ITO.

Attention is called to the blast scores in Table 3. Blast is a serious threat to rice production especially upland rice, which because it depends on rainfall often is hit by drought periods. These drought conditions increase the plants susceptibility to blast. The IITA rice breeding pro-

Table 3. Ten highest yielding lines of upland rice in IITA nursery, 1973

Line	Yield in kg/ha	Days to maturity	Height at harvest,cm	Blast score	Protein content,%
TOX 7-3-15-7-2	6500	104	136	1	8.3
TOX 7-2- 4-3-B	6240	110	111	3	12.5
TOX 7-3-16-6-B_2	5670	113	121	3	11.7
TOX 7-3-11-6-B_2	5620	113	75	2	11.4
TOX 7-3-8-2-1	5540	109	97	3	11.4
TOX 7-3-5-B_1-B_1	5500	115	123	3	10.5
TOX 7-3-11-8-B	5220	115	94	2	-
TOX 7-3-2-9-B_2	5210	113	123	3	11.9
TOX 7-3-4-10-B_1	4980	98	141	2	11.7
TOX 7-3-2-3-B_2	4770	114	84	2	13.4
Local variety	2970	119	177	2	8.5

gram concentrates on developing plants with blast resistance. A blast score of 0 means no infection while a score of 6 indicates serious blast infection. The TOX lines with blast scores of 3 or less are sufficiently blast resistant to assure good yields.

Early Maturity and Drought Escape

Rice trials were run in 1972 to test use of early maturity upland rice varieties as a means of escaping drought damage that commonly occurs in West Africa. Two drought-escape crops were grown, one under wetter valley bottom conditions.

These trials showed two things. First the early maturity can increase chances of drought escape — rice can be planted after rains are well started and still produce a crop. Second the possibility of two crops, and high production per year becomes possible using the valley bottom soils.

The best five early maturing upland entries are in Table 4.

Table 4. Yields of early maturing upland entries at IITA, 1972.

Number	Yield in kg/ha		
	True upland	Valley bottom	Total 2 seasons
TOs 28	4010	4404	8414
TOs 15	4243	4132	8375
TOs 79	3786	4405	8191
TOs 103	3531	3774	7305
TOs 48	4145	3104	7249

All of the entries in Table 4 matured between 100 and 112 days. The tallest was 103 cm. IR 579 IR 527 and IR 790 performed well again in 1973 trials, as did some of the TOX lines developed at IITA. High yields per hectare and per year are possible with upland rice, given good early maturing varieties and a valley, or a valley-upland location.

Paddy Rice

No breeding work is done with paddy rice at IITA. Through massive screening of entries from other countries and programs high yielding, disease-resistant paddy varieties are identified. Information on these varieties, as grown under West African conditions, is available. A high percentage of the paddy varieties showing great potential for African rice growers are from the International Rice Research Institute's program.

Rice Insect Resistance

Screening rice varieties for resistance to the African pink stem borer uncovered a resistance apparently based on both biophysical and biochemical factors. Figure 2 shows the resistance of the W1263 and Taitung 16 varieties to the borer. Borer larvae that fed on the resistant rice had severely worn mandibles — and lowered feeding capacity — while larvae fed on the susceptible variety had normal mandibles. In addition, adult female borers that fed on resistant varieties had ovaries half the size those of females that fed on susceptible varieties.

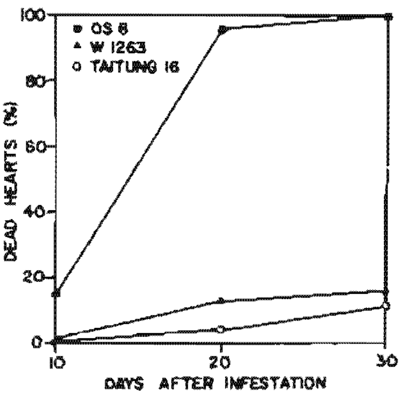


Figure 2. Development of dead hearts on three selected rice varieties exposed to the African pink borer at 50 days after sowing in the greenhouse, IITA, 1973.

DETAILED 1973 PROGRAM REPORT

Readers interested in work reported in the Cereal Improvement Program Report for 1973 may examine the contents page of that report that follows. Queries on details should be addressed to the Program Leader or to the scientist responsible for the work.

CONTENTS


TVU 1190
RESISTANT

Grain Legume Improvement Program

Grain legumes represent the most efficient and least expensive way to bring balance to human diets in the tropics. Not only are grain legumes important sources of high quality protein, but they provide significant amounts of calories, vitamins and minerals. In addition they will grow with less fertilizers than do cereals, for example.

IITA has worldwide, primary responsibility for the cowpea, a bean that is the most preferred in the tropics but one that has lowyield potential and is highly susceptible to attack by insects and diseases. The Institute assumes secondary responsibility for soybeans and pigeon peas, and Lima beans and African yam beans receive limited study to determine their potential in the tropics. Lima beans have shown unusually high reliability and productivity in preliminary work.

Plant breeding, solidly backed by the collaboration of an active multi-disciplinary team receives major attention in the Grain Legume Improvement Program and within the breeding activity about two-thirds of the total effort goes into cowpeas.

Cowpea Improvement

The cowpea germplasm collection at IITA had 4,200 entries in 1972, and increased to 6,300 in 1973. About 1,600 accessions were brought in during 1973 by a far ranging collection project that added cultivated, weedy and wild cowpea material. Organization and evaluation of the collection was done during 1973 and a computer-printed catalog was assembled for printing in 1974.

A Uniform Cooperative Cowpea Yield Trial was carried out at 11 locations in five countries — Nigeria, Ethiopia, Liberia, Ghana and Colombia. At each location the best locally available cowpea was planted as a check. At nine of the 11 locations the local check ranked eighth or lower compared with the nine IITA entries in the trials. The highest yield in the trials was an average of 1955 kg/ha. Six of the IITA entries topped 1700 kg/ha.compared to the average of 1414 kg/ha for the local check and 1239 kg/ha for Prima, an erect, determinate, short duration local strain.

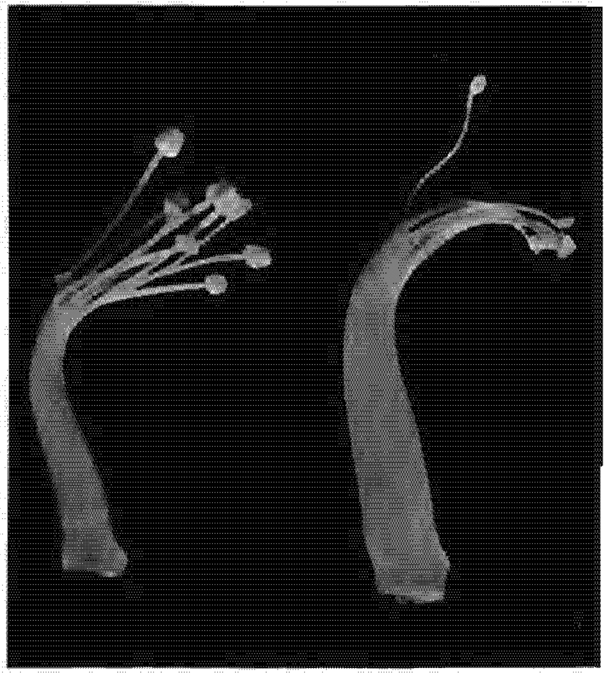
Cowpea breeding has concentrated on developing erect to semi-upright, environmentally insensitive (daylength) plant types. Excellent, robust plants were developed during 1972 and 1973, and are being advanced at a rate of four consecutive generations a year. This speed is possible through breeding under irrigation during the dry season. Table 5 gives yields and other characteristics of 12 IITA cowpea entries in an advanced yield trial at IITA, 1973.

Table 5. Yield and other characteristics of 12 elite entries in a cowpea advanced yield trial grown at IITA, 1973

Accession	Plant type *	Seed yield (kg/ha)		Mean seed yield both seasons	
		1st season	2nd season	Yield (kg/ha)	Percent of mean
TVX 30-3C	3	1958	1598	1880	136
TVX 33-5C	6	1782	1356	1569	113
TVu 1502-1C	4	1037	1444	1140	82
TVu 3406-2C	2	1514	1444	1479	107
TVX 13-2B	3	1572	1479	1526	110
TVX 24-1B	4	1290	916	1103	79
TVu 3263-1C	5	1299	1378	1334	96
TVX 27-3C	3	1742	1191	1470	106
TVX 4-5C	1	1207	1276	1242	89
TVu 95-3B	2	1304	1242	1273	92
TVX 27-2C	4	1958	1290	1624	117
TVu 76, Prima	2	745	1128	936	67
Trial mean		1451	1312	1382	

* Plant type: 1 = acute erect, 2 = erect, 3 = semi erect, 4 = intermediate, 5 = semi prostrate, 6 = prostrate.

Male sterility in the cowpea was discovered at IITA in 1972. Male sterility (right) speeds breeding work and seed set increases.



A cowpea with genetic male sterility was identified in the IITA collection during 1972. The male sterility, which eliminates the need to hand emasculate the male parts of the cowpea flower during crossing speeds the work of the plant breeder considerably and also increases seed set following hand crossing from 10 to 20% to 70 to 80%.

Cowpea Agronomy Under optimum conditions – good soil, fertilizer, water and plant protection – at Ibadan cowpeas produce more than 2,600 kg of edible beans per hectare. Table 6 shows yields for several cowpea varieties in the optimum conditions trial. Yield differences between the first and the second seasons point to some of the problems confronting farmers who grow cowpeas. Weather conditions vary between seasons, with the shortage of water a high risk in the second season. Insect and disease problems also tend to increase in the second season. The yields in kg/ha/day reflect differences in time to maturity of the crop as well as other factors.

A farmer's problems with cowpeas were underscored in a "farmer's field" experiment conducted by the IITA grain legume agronomist in 1973. In a first season experiment Prima cowpea, protected from insects for 35 days after planting, produced 612 kg/ha. A later maturing variety, Pale Green, produced only 288 kg/ha and Solojo,a local variety yielded only 134 kg/ha.

During the second season onthe same farmer's field all cowpeas were heavily attacked by disease and no yields were obtained. This points to the need for improved cowpea varieties for more yield and means of plant protection on the farm.

One encouraging result of the on-farm experiment was, however, that fertilizer use made no difference in yields, pointing to a distinct advantage of the leguminous crops and their ability to pull their main fertilizer (nitrogen) needs from the air.

Diseases and Insects Both the pathologist and the entomologist have actively screened the IITA cowpea germplasm collection for resistance to diseases and insects since 1971. Fungicides and insecticides were tested for effectiveness during the same time. The main emphasis, however, was on identifying plants with natural resistance,rather than on developing recommendations for chemical controls that many farmers could not afford.

To screen for insect resistance the cowpea lines tested are closely inter-planted with known susceptible cowpeas and the insect population is allowed to build up in the absence of insecticide applications. Sometimes insecticides are used in carefully timed applications to reduce the population of unwanted insects and permit more accurate assessment of resistance to a certain insect species.

The same procedure is used for disease screening, with disease susceptible plants placed at the end of test rows to provide a source of infection. Disease resistant cowpea lines selected as a result of 1972 disease screening were put in a field disease nursery in 1973. The results are in Table 7.

Table 6. Seed yields cowpeas grown under optimum conditions at IITA, 1973.

Variety	First season		Variety	Second season	
	kg/ha	kg/ha/day		kg/ha	kg/ha/day
Prima	836	13.3	Prima	967	14.9
Iran Grey	1691	17.3	Hanbru 58-123	1376	17.4
Pale green	1782	18.2	Iran Grey	1396	17.7
Hanbru 58-123	2620 a	27.3	Pale Green	1536	19.4

Table 7. Number of cowpea lines free from various diseases or with various categories of disease incidence after exposure of 578 lines to inoculum of the diseases in field nurseries, IITA, 1973.

Disease	Free	Disease category: Low suscep-tible	Mod. suscep-tible	High suscep. tible	Segregating
Anthracnose (anth)	275	61	12	67	163
Cercospora leaf spot *(C. cr.)*	454	31	14	37	41
Bacterial pustule (B.P.)	451	10	51	36	28
Rust	526	–	34*	–	–
Virus	433	–	144*	–	–
Corynespora leaf spot	305	–	273*	–	–
Bacterial blight	540	–	38*	–	–
Cercospora leaf spot *(C. ca.)*	574	–	4*	–	–
All diseases	32	–	–	–	–
All but sclerotium stem rot	39	–	–	–	–
Anth, C. cr., B.P., and Rust	141	–	–	–	–
Anth, C. cr., and B.P.	162	–	–	–	–

* Degree of susceptibility not recorded.

IITA has a large pool of cowpea varieties that are resistant to one or more diseases. Nearly 4,000 cowpea lines were inoculated to anthracnose and bacterial pustule pathogens in the field and incidence of nine other diseases were evaluated. This information was recorded, with other plant characteristics, on computer cards to allow massive sorting for the combinations of characters the breeders wish to use.

Entomology problems for cowpeas deal with four groups of insects: leaf feeding beetles, leaf sucking insects, pod sucking bugs and pod boring insects. An integrated insect control program, with maximum emphasis on natural plant resistance to insect and judicious application of insecticides is sought.

Tables 8 and 9 show insect damage differences and yield differences of some of the cowpea lines identified to date as having natural resistance to insects.

Soybean Improvement

In spite of higher protein content, higher yields and less problems from diseases and insects than other grain legumes the soybean has yet to establish its place among the staple foods of West Africa. Cooking time required and taste preferences are basic blocks to soybean acceptance. Research at IITA indicates that the soybean has a place in the food production programs of the lowland, humid tropics.

Cowpeas resistant to insects contrast with susceptible varieties (right). No insecticides were applied.

Soybean work during 1972 obtained yields ranging from 2,000 to 3,000 kg per hectare. These yields came from varieties with familiar names such as Improved Pelican, Chung Hsing, and Bossier. A well known soybean variety, Kent, is used as a standard of comparison because of its relatively high yield and early maturity.

Table 8. Feeding injury score, percentage leaves damaged, and insect count in resistant and susceptible cowpea varieties.

Variety	At 25 days after planting						Resistance rating **
	Visual* score	Thrips	% leaves damaged by		No. / five plants		
			Leafhoppers	Chewing insects	Thrips	Leafhoppers	
TVu 39	3	29.4	23.7	12.6	23.8	38.3	I
TVu 489	3	30.7	34.7	14.7	17.5	47.0	I
TVu 662	2	30.5	23.0	7.5	13.3	29.5	MR
TVu 1190	2	24.3	15.7	11.7	14.5	35.5	MR
TVu 1534	3	15.6	13.9	7.1	3.8	14.3	MR
TVu 1536	1	42.1	8.9	12.3	17.5	28.0	MR
TVu 1992	3	33.5	23.5	10.3	10.5	31.0	I
TVu 2772	2	38.6	30.1	11.6	9.0	42.3	MR
TVu 2912	4	32.2	25.6	9.0	14.0	30.0	I
TVu 152	5	86.9	85.3	12.6	18.5	40.8	S
TVu 189	5	80.2	81.1	18.1	13.3	53.5	S

* Visual Score 1 = healthy plant, 5 = severely injured plant.

**MR = moderately resistant, I = intermediate, S = susceptible.

In uniform trials conducted in Ghana and Nigeria during 1973 yields of half of the varieties tested exceeded the yield of Kent, with Bossier, Improved Pelican and CES 486 showing about 15% better yield overall. Yields are generally lower in the second season at IITA because of a shorter growing season (Table 10).

From the standpoint of yield, resistance to shattering (splitting of pods and dropping of seeds on the ground before harvest), and disease resistance, Bossier is currently the best soybean available for the lowland humid tropics.

Table 9. Yield of leafhopper and thrip moderate resistant and susceptible varieties, 1973.

Variety	Resistance rating*	Yield kg/ha
TVu 1190	MR	1200
TVu 39	MR	1180
TVu 489	MR	1140
TVu 2912	MR	1110
TVu 1992	MR	1060
TVu 1536	MR	1000
TVu 189	S	500
TVu 152	S	460

* MR = moderate resistance, S = susceptible.

Pigeon Peas

The breeding strategy for pigeon peas at IITA is for improvement of the crop. Seven promising pigeon pea lines bred during 1971 and 1972 were increased in isolation during 1973 and offered for experimentation and field testing by other research stations during 1974. Three pigeon pea lines (3D 8111, 3D8127 and 3D8104) were proposed for registration and unrestricted distribution.

Pigeon pea TUC 5103 will be proposed for registration and unrestricted distribution in 1974.

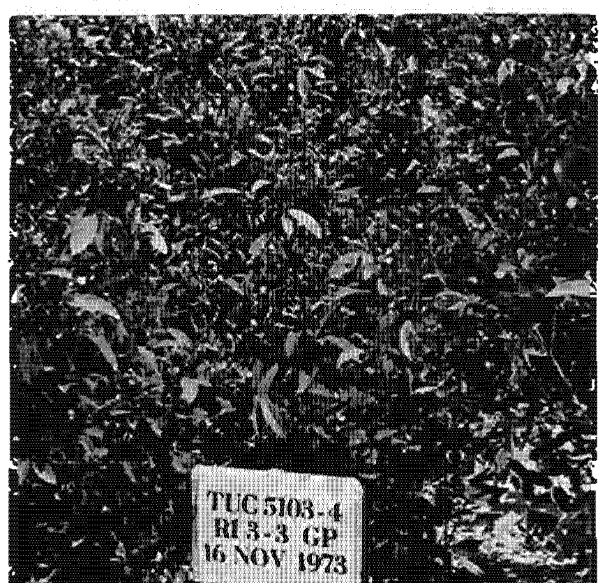


Table 10. Soybean yields in kg/ha in uniform trials in Ghana and Nigeria 1972–73.

Variety	Nigeria				Ghana		Mean	Relative yield
	Bende 1972	IITA 1972	IITA 1973		Kpong 1972	Legon 1972		
	Season		Season		Season			
	First	First	First	Second	First	Second		
Bossier	3653	2260	1960	1626	2140	951	2098	115.5
Imp. Pelican	3396	2483	1465	1247	3112	789	2082	114.7
CES 486	2212	3000	--	1124	2479	1585	2080	114.5
CES 407	2619	2803	--	1511	1483	1230	1929	106.2
Chung Hsing Nº 1	1656	2565	1450	1370	2761	1307	1851	101.9
Chippewa 64	1747	1851	1663	1693	2836	1173	1827	100.6
Kent	2472	1641	1887	1076	3137	687	1816	100.0
JGm 393(S)	1858	2078	1722	1465	1934	909	1661	91.5
Clark 63	1987	1163	1623	--	2479	697	1586	87.3
Amsoy	1576	1100	1530	--	2648	370	1445	79.6
Shelby	1615	1661	1098	--	2028	725	1425	78.5
Hale 3	1433	863	1433	1276	2817	409	1372	75.6
Hawkeye	963	1450	1336	--	1728	384	1172	64.5
CNS	878	1713	--	785	1446	387	1042	57.4
Mean	2005	1902	1561	1317	2359	829	1670	

Table 11 summarizes their yield results and plant characteristics.

Lima Beans

The lima bean received limited study at IITA during 1972-73 to determine its range of adaptation and its long-term potential in the lowland tropics. Early work on breeding lima beans demonstrates an unusual reliability and productivity in the low land humid tropics.

Six vigorous dwarf-bush lima bean lines selected from 1972 plantings were put into a replicated yield trial in 1973. Results are in Table 12.

Viny, climbing limas, selected from a 1972 trial, were grown on trellises in a 1973 yield trial. Dry seed yields from seven pickings ranged from 744 kg per hectare to 2809 kg per hectare, with six lines yielding more than 2,000 kg per hectare. Based on the exceptional potential of the lima bean, considerable crossing was done between the bush and the viny types.

Tillage Method and Intercropping

A 1972 experiment on tillage methods for grain legumes continued in 1973 with the minimum tillage practice of strip tillage, in which only a 10-cm wide strip is tilled. In the first season cow-

Table 11. Some agronomic attributes and preliminary yield results for three advanced pigeon pea lines grown at IITA, 1973.

Attribute	Pedigree 3D 8111 UC 5543	3D 8127 UC 1381-1	3D 8104 UC 5103
Days to 50% first flower	71	80	82
Days to 50% ripe pod	108	112	121
Height at first picking (cm)	120	117	152
Lateral spread - first picking (cm)	80	53	63
Angle of branching (from horizontal)	35°	60°	42°
Threshing percent	82.5	75.2	74.5
Weight (gm) of 1000 seeds	74.9	75.2	77.9
Dry seed yield in kg/ha	2128	1962	4506 *
Percent oil	0.75	0.75	--
Percent protein	19.8	20.4	--
Percent S/N	3.8	3.7	--

* Total from two pickings, others - one picking only.

Table 12. Dry seed yields and other agronomic attributes of dwarf bush lima beans grown at IITA during the irrigated-dry season 1973 based on four replications and a plot size of 9 m^2.

TPI	Days to first ripe pods	Plant height (cm)	Pod length (cm)	Pod width (cm)	Good seeds/ pod	Threshing %	Dry seed yield (kg/ha)
170	75.8	42.5	9.3	1.68	2.90	68.9	1599
176	73.3	40.5	9.9	1.73	3.25	63.9	1262
178	81.8	40.0	9.5	1.75	2.85	60.0	628
183	74.8	47.2	9.2	1.55	3.00	64.3	944
189	68.5	47.7	8.8	1.65	2.90	63.1	1234
191	72.3	51.0	9.7	1.58	3.10	66.6	1729

pea yields were significantly higher in zero tilled plots than in conventional tillage with ridges. Soybean yields were significantly higher in strip tilled plots than in both conventionally tilled plots. See Table 13.

In the second season soybean plots were replaced with intercropped cowpea and maize. The objective was to study the buildup of crop residue in monocropped and intercropped cowpeas, and its effect on subsequent crops.

Despite low population of maize (17,700 plants/ha), the intercropped cowpea yielded only about 50% of that of cowpea alone. However, intercropping had the advantage of about 2 tons of grain yield per hectare and nearly 6 tons of dry matter per hectare derived from maize. Tillage method had a significant effect on the seed yield of intercropped cowpea and maize but not on monocropped cowpea Table 13. Strip tillage was superior to conventional tillage. It appears that cowpeas and soybeans grown with little or no tillage can produce equal and sometimes higher yields than when grown on well prepared soils, suggesting that tillage is not essential in these crops.

Mixed cropping of cowpea and maize shows promise with strip tillage.

Table 13. Effect of tillage methods on grain yields of cowpeas, soybean, and intercropped cowpea and maize, first and second seasons, 1973.

Tillage method	First season Cowpea	First season Soybean	Second season Cowpea	Second season Cowpea - maize
	Grain yield (kg/ha)			
Conventional tillage, ridges	1211	1916	1252	2697
Conventional tillage, flat	1499	1814	1318	2761
Strip tillage	1496	2228	1377	3103
Zero tillage	1609	2017	1579	2888

DETAILED 1973 PROGRAM REPORT

Readers interested in work reported in the Grain Legume Improvement Program Report for 1973 may examine the contents page of that report that follows. Queries on details should be addressed to the Program Leader or to the scientist responsible for the work.

CONTENTS

Root and Tuber Improvement

Root and tuber crops, high in caloric content but low in protein, are the main staple food for the people of the lowland humid tropics. Cassava is the major source of calories for an estimated 300 million people. Any increase in yields of these crops will have tremendous impact in the battle to meet food needs. The IITA program for root and tuber improvement puts top priority on cassava, followed by sweet potatoes, yam and cocoyams (taro).

The immediate objective of cassava research is to produce plants low in hydrocyanic acid content, and resistant to cassava mosaic and cassava bacterial blight, two diseases causing drastic yield losses in Africa. Sweet potato work concentrates on high yields, resistance to the sweet potato weevil and better keeping qualities in storage.

Yams, generally considered a declining crop in Africa, receive priority work on improvement for higher yields, improved keeping quality in storage and resistance to diseases and insects, all factors that limit yam production. Yam research has been relatively neglected by researchers.

Cassava Improvement

The IITA cassava breeder launched a large-scale breeding program in 1972 with a seedling evaluation nursery of 12,000 seedlings raised from seed. Of these, 10,000 transplants went under continuous scrutiny to screen them for disease and insect resistance. The 1973 program produced 100,000 additional cassava plants from seed for screening for disease resistance and low cyanide content.

Cassava mosaic is a major cassava disease in Africa, causing losses in farmers' fields that run as high as 80%. Two years of work at IITA has identified genes for mosaic resistance that are highly heritable (60%) and will allow resistance to the disease to be easily bred into varieties now susceptible to the disease.

The size, and consequently the success, of the cassava breeding work is based largely on development of a simple germination technique for cassava seeds. The generally accepted practice for getting acceptable germination of cassava seeds called for scarifying the seed coat and special incubation procedures. The germination technique adopted by IITA was to plant the seeds directly into the soil with no special seed treatment. More than 80% germination results. An important part of the cassava breeding work has been in the development of techniques for accelerating the breeding program by population improvement.

Cassava bacterial blight, a new and potentially disastrous disease of cassava, was first identified

Cassava mosiac disease attacks the leaves (healthy leaves at right) and may cause as much as 80% reduction in farmers' yields.

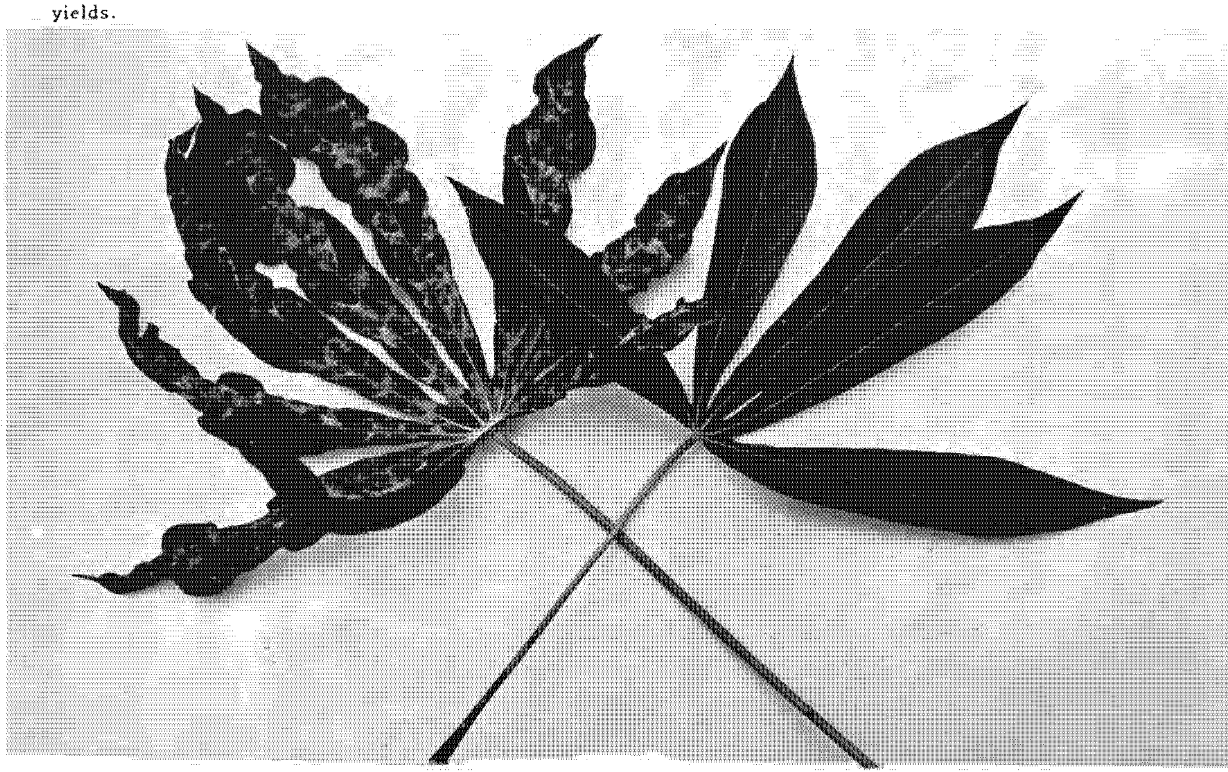


Table 14. Average scores for cassava mosaic disease (CMD) and bacterial blight (CBB) and percent lodging of cassava plants in preliminary evaluation trials at IITA, 1973.

	Clones observed	CMD	CBB	Lodging (%)
IITA Hybrids				
58308 x Isunikankiyan	97	3.21	2.01	6.87
58308 x Oyanrugba Funfun	43	3.35	2.26	7.10
58308 O.P.	191	3.02	2.03	8.40
Isunikankiyan O.P.	194	3.60	2.64	14.26
Oyanrugba Funfun O.P.	56	3.96	2.73	10.71
Latin America				
Branca de Santa Catarina	56	4.22	2.72	46.61
59 x IAC 7-127	72	4.35	2.81	55.92
India				
H 57	7	4.86	2.89	62.05
H 97	9	4.78	2.89	87.80
H 119	13	4.54	3.00	63.75
H 165	20	4.74	2.94	62.30
H 241	19	4.95	3.18	77.54
M 4	24	4.92	3.32	66.21
60444 (check variety)	177	3.50	4.00	6.04

in West Africa in 1972. A survey of blight attack in IITA nurseries was conducted in 1972. The blight starts in a leaf high on the plant and the infection moves down the plant until defoliation occurs. Some plants die but older or less susceptible plants may remain alive putting out new growth. The attacked plant that lives, however, is misshaped and stunted. An attacked crop suffers severe yield reduction.

During 1973 the breeder and pathologist worked to screen the IITA cassava germplasm for bacterial blight resistance. More than 10,000 clones produced from seed of Nigerian varieties, IITA hybrids and introductions from Latin America and India, were inoculated with disease. It was determined that resistance to cassava bacterial blight is associated with resistance to cassava mosaic disease.

Table 14 gives disease and lodging scores for about 1,000 selected clones. Scoring is based on a five-class system where 1 is apparent field resistance and 5 denotes severe disease attack with reduced yields or death of the plant.

Lodging is an undesirable characteristic for cassava because the fallen plants cause poor light interception and root rot, which in turn causes yield reduction, and the lodged plants are more easily attacked by rodents. The ideal cassava plant, and the one toward which IITA research is aimed, has a strong, erect stem, branching at a height of about 2 meters to permit either hand or machine cultivation, and a short, fat, compact root for easier harvest by either hand or machine.

Bacterial blight of cassava causes a characteristic dieback of the branches.

Yields of 10 Nigerian local cultivars at IITA are shown in Table 15.

Table 15 Cassava yield trials at two different seasons and spacings, 1972-1973 (t/ha).

Cultivar	Wet season		Dry season		Average of two seasons	
	Fresh yield	Dry yield	Fresh yield	Dry yield	Fresh yield	Dry yield
53101	15.7	4.8	21.6	6.9	18.7	5.9
Okurun-Owa	16.3	4.9	17.2	5.8	16.8	5.4
Oyanrugba F.F.	24.5	7.0	20.8	6.2	22.7	6.6
Arubielu P.P.	21.9	6.2	24.6	8.1	23.3	7.2
Oloye	22.0	6.7	21.9	7.1	22.0	6.9
Oyanrugba D.D.	21.8	6.7	24.3	7.8	23.1	7.3
Isunikankiyan	19.5	5.9	16.8	5.9	18.1	5.9
Ojunkaiye	23.1	7.4	28.7	8.8	25.9	8.1
Goro	21.8	7.2	22.4	7.6	22.1	7.4
Oyanrugba P.P.	21.1	6.5	19.5	6.6	20.3	6.6
Average	20.8	6.3	21.8	7.1	21.3	6.7

Acyanogenesis in Cassava

Cassava produces hydrocyanic acid during food preparation, which is known to cause both acute and chronic toxicity in humans and animals. High cassava intake is thought to be associated with tropical ataxic neuropathy in Africa. The root and tuber physiologist screened the IITA cassava germplasm for acyanogenesis during 1973. Using a simple technique with leaf discs and sodium picrate 88, 510 plants were screened.

Table 16 gives results and Table 17 identifies the 92 plants found as low in cyanogenesis. Note that the same parentage occurs in the cassava showing resistance to mosaic and bacterial blight (Table 14).

Table 16 Degree of cyanogenesis in cassava leaf discs.

Degree of cyanogenesis	Number of plants	Percent
High	87,747	99.14
Medium	671	0.76
Low	92	0.10
Negative	0	0
Total	88,510	100.00

Cassava breeding aims for an erect, strong plant with branching high enough to allow work between the rows.

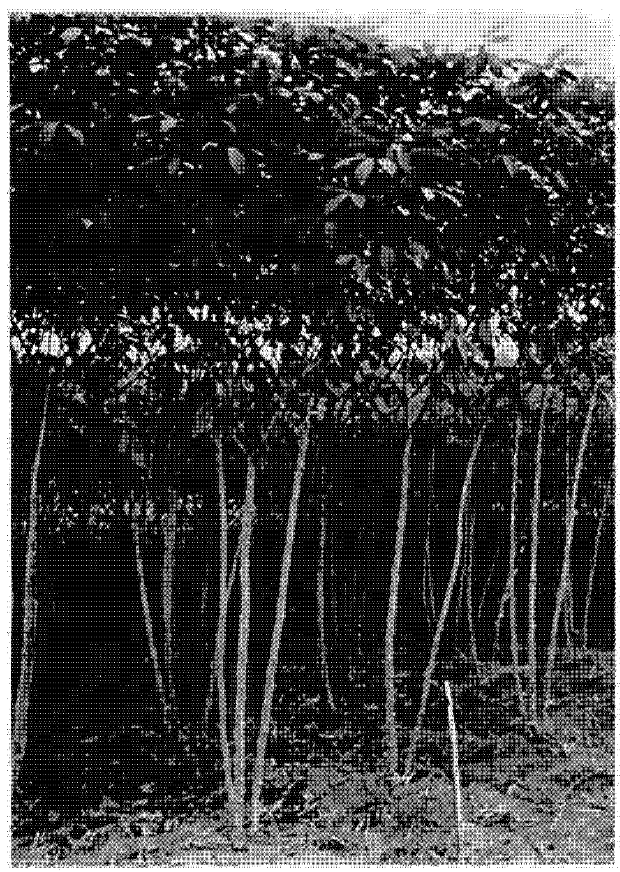


Table 17. Cassava plants low in cyanogenesis.

Percentage	Number of plants
58308 x Isunikankiyan	25
Isunikankiyan - OP	12
58308 x Oyanrugba Funfun lines	11
58308 – OP	8
Unknown	8
58308 x Wild cassava	6
58308 x Ojunkaiye	4
58308 x Oyanrugba Dudu lines	4
Oyanrugba Funfun – OP	3
Nsukka 2 – OP	2
58308 x Ogunjobi	2
Isunikankiyan x Oyanrugba Funfun lines	2
Isunikankiyan x Oyanrugba Pupa	1
58308 x 58198 – 4386	1
58308 x Aboyade – 4260	1
Ogu-ocha-OP	1
58272 – OP	1
Total	92

Sweet Potatoes

The sweet potato has tremendous potential for high yield of calories per hectare. IITA yield trials yield consistently more than 20 tons per hectare Table 18.

About 10,000 sweet potato seedlings were raised and screened for root characteristics and resistance to weevil during 1973. Major emphasis was on weevil resistance during the dry season because that is when weevil populations are always high. About 3,000 seedlings were selected for further evaluation, including many weevil resistant clones.

With weevil resistant varieties available sweet potatoes can be grown during the early dry season for harvest in January or February with yields of 20 to 30 tons per hectare and without fertilizer.

Note TIS 1499 in Table 18 a weevil-resistant clone that produced 26.9 tons per hectare in the dry season and 30 tons per hectare average in three seasons. Eight new weevil-resistant clones were identified in 1973 preliminary yield trials. Yields of these new clones ranged from 26 to 32 tons per hectare in the dry season.

Yams

Yam production in West Africa is generally considered as declining. The crop requires large inputs of manual labor, is attacked by several diseases that limit yields, and spoils easily in storage. These problems have tended to persist because of limited attention given to research into yam problems.

The IITA yam research aims at all the crop's problems but emphasis during 1972-73 was on getting yams to flower and set seed and then on getting the seeds to germinate. This will allow start of a systematic, large-scale breeding program for yam improvement.

Table 18. Sweet potato advanced yield trial, dry season

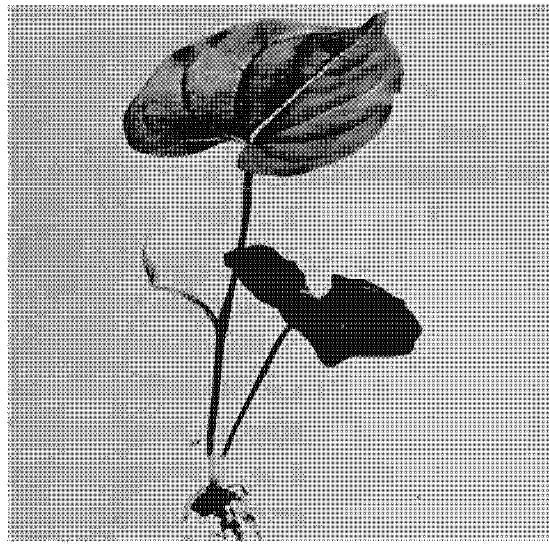
	1973 Dry Season		Three Seasons		
	Fresh yield t/ha	Dry yield t/ha	Fresh yield t/ha	Weevil*	Starch content %
TIS 1499	26.9	8.2	30.6	R	18.5
TIS 1487	22.6	8.0	26.7	MR	25.4
TIS 1145	22.5	7.3	22.5	MR	21.5
TIB 2	22.1	6.6	25.5	MR	17.9
TIS 1354	21.7	7.1	30.2	MR	22.0
TIS 1455	21.2	5.8	27.0	S	17.2
TIS 1176	20.6	6.5	26.8	MR	20.2
TIB 4	20.3	6.4	19.3	S	18.8
TIS 1491	19.4	6.7	21.7	S	22.6
TIS 1439	19.3	5.8	22.8	MR	20.0

* R stands for resistant, MR for moderately resistant resistant and S for susceptible.

Yam seeds harvested in the field during November 1972 were subjected to different techniques for germination. With a successful technique identified a mass germination program started early in 1973 resulting in more than 600 new (genetically different) yam plants added to the IITA collection.

The yam seeds were germinated in Petri dishes in the laboratory, transplanted to peat pots and finally transplanted into plastic pots in the green-house. The new yam plants grew rapidly on trellises with tuber development starting within a month of transplanting. The new tubers were harvested and stored for field planting in 1974.

Discovery of this simple seed germination technique opens the way for breeders to move rapidly toward yam improvement in terms of disease resistance, yields and storability.



Yam seedlings started in peat pots can be transplanted directly in the field at the two-leaf stage.

DETAILED 1973 PROGRAM REPORT

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CONTENTS

Farming Systems Program

Much of the food produced in the humid tropical areas of the world comes off small farms that border on a subsistence level and operate on an outmoded, traditional, farming system. These farms cannot, with their current system, meet the demand for food supplies put on them by rapidly increasing populations. But the failure comes from the system, and with changes of that system there is the potential for adequate food production in the humid tropics.

The objective of the Farming Systems Program is rapid development of permanent, productive farming systems for staple food crop production in the humid tropics. This includes improved farming techniques that are culturally and socially acceptable to farmers as alternatives to the traditional systems, and that are attractive to farmers in terms of increased incomes and better living.

Farming systems research is organised into 13 sub-programs that search for a workable, productive farming system. The search takes into account the need to maintain environmental quality and the need to minimize costly inputs such as fertilizers and heavy machinery, but at the same time to provide changes within the means of the small farmer.

Farming systems researchers made significant progress during 1972-73. Results of systems research, however, are not as easily tabulated as those of crop improvement programs. Systems' work involves the soil, the climate, crop mixes, weeds, fertilizers, machinery, and measurement of cost and return, sometimes individually but more often in interaction within the system. No attempt is made in this report to separate reporting of results by disciplines (see staff list). Instead emphasis is on reporting success toward achieving a more productive farming system.

The Weather 1972-73

Field experiments at IITA during 1972-73 were subjected to sharply contrasting weather conditions. While 1972 rainfall was about 18% below the 20-year average for the area, the 1973 rainfall ran about 10% above the 20-year average. These differences are reflected in differences in experimental results, most of which are reported in the detailed scientific reports of each IITA research program. (See About This Report).

The rainfall pattern in the IITA area is largely determined by an interaction between high pressure zones over the Sahara and the Atlantic. The boundary between the two systems, the intertropical convergence zone (ITCZ) moves toward the equator from August to January and away from the equator from January to August. A dry, rain-free period (November - January) is followed by a nearly rain-free period of high humidity. The rainbelt reaches the IITA area about mid-March.

Rainfall reaches a first peak in June and from mid-July to late August IITA is in the moist zone south of the rainbelt. Dry days occur frequently in this period and are reflected in a bimodal rain pattern with a lower average rainfall in August. As the ITCZ moves south rains increase causing a second rainfall peak in September-October. By mid-October rains diminish and IITA again comes under the influence of dry easterly winds. Total annual rainfall varies from 950 to 1600 mm. (Figure 3)

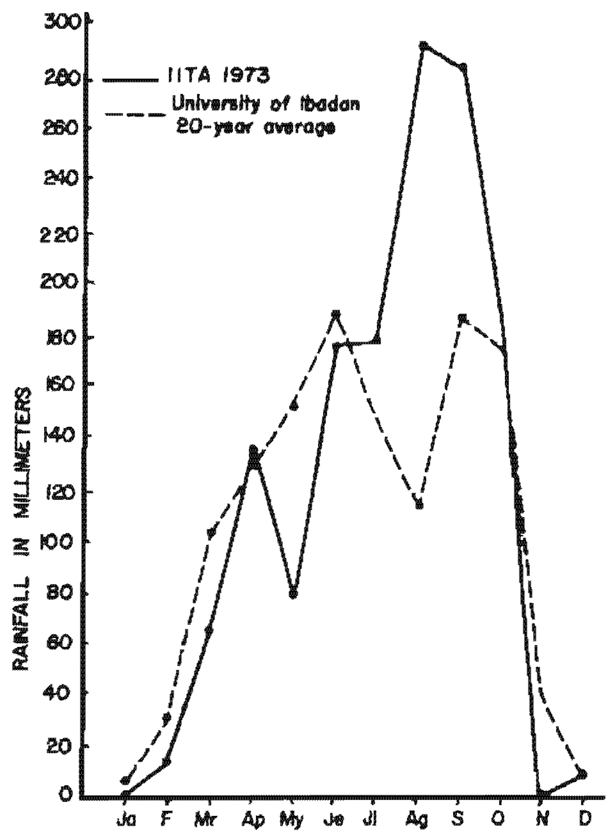

Figure 3. Mean monthly rainfall at IITA, 1973.

The Soil

It is difficult, often impossible, to interpret soil maps and other soil data for the humid tropics in terms of actual or potential crop production. This is because no experimental work has been done to determine actual soil behavior.

Field and laboratory work by IITA continued throughout 1973 on major West African food-crop producing soils. A cooperative project supported by the Overseas Development Administration (ODA, United Kingdom) started in 1973. In addition to IITA soil scientists the project involves the Land Resources Division of ODA, the University of Reading, Rothamsted Experimental Station, the International Soil Museum in the Netherlands, the Soil Institute of the University of Louvain and the Agro-Chemical Laboratory, University of Ghent.

Small Valley Development

Development of a small valley containing soils formed under the influence of water – hydromorphic soils – started in 1972. The purpose of the study is to determine the usefulness and production potential of such soils for food crop production. It is estimated that thousands of hectares of such soil exist in small valleys throughout West Africa, and while occupying a minor portion of the total landscape, they offer tremendous potential for major crop production in an area where lack of available water during the growing season often limits food production.

Experimental plots were established ranging from the bottom of the valley, where waterlogged conditions exist, to upland conditions on the side slopes where soils have no permanent ground water. Maize, rice, cowpeas and soybeans were planted in several experiments. Economic analysis of the crop yields on the valley bottom soils was done by season:

First season (with most rain) results show rice the most proficable crop on the valley bottom and maize most profitable on the upper slope. The midpoint plots were best for both crops.

Second season cropping showed maize as not economically attractive. Cowpeas were more profitable than soybeans on the upper slopes while soybeans were more profitable in the valley bottom.

Dry season results point to rice as a profitable crop on the bottomland. Vegetable production also holds promise as a dry season program on the bottom areas.

Results during 1972-73 indicate a good potential for the small valley as a site for year-round

Crops grown from the bottom toward the higher slope in the small valley research respond to ground water levels according to season. Crops are identified for maximum return under a year-round cropping system.

food crop production. Upland rice yields from two plantings keyed to the valley soils range above eight tons per hectare per year.

A rice mechanization experiment planted during the wet season, 1973, as part of the FAO Rice Mechanization Project at IITA, gives an indication of rice yields that are possible on the valley bottom soils. Note that yields under three of the tillage practices studied exceeded 5,000 kg per hectare (Table 19).

Table 19. Yield in kg/ha for rice using four tillage practices on valley bottom (hydromorphic) soils.

Tillage practice	Rice variety IR 528	Rice variety IR 20
No tillage	2761	4090
Hand hoeing	5356	5446
Japanese reversible plow	5457	5231
Rotary tiller	5752	5491

Soil Erosion

A set of runoff plots established in 1971 and operated throughout 1972-73 served to underscore the danger of exposing tropical soils to the intense rainfall of the tropical region. Annual soil erosion as high as 215 tons of topsoil per hectare was recorded on a 15% slope during 1973 with 1397 mm of total rainfall. At the same time use of mulches and minimum-tillage crop rotations to give the soil a protective cover nearly eliminated erosion (Table 20).

Yields of mulched maize in the runoff plots, was an average of 20% more than unmulched maize during two years of continuous cropping (two crops a year).

Soils managed as bare fallow on IITA runoff plots have soil losses as high as 215 tons per hectare per year on a 15% slope.

Minimum Tillage Study

Minimum tillage techniques worked out by the soil physicist during 1972-73 involve use of existing vegetation and crop residues to provide a mulch cover for the soil. Existing vegetation is killed with a non-selective herbicide (Paraquat). Planting is done through the mulch with no tillage of the soil required. Erosion is controlled. Soil temperatures are lowered giving increased germination of seed and better early plant growth. Soil moisture is conserved. Soil preparation costs are reduced, even in view of initial use of herbicide. Crop yields remain as high as for conventional tillage under normal conditions and go above conventional tillage yields when weather conditions are adverse.

Table 21 shows crop yields under minimum and conventional (plow and disc) tillage at IITA during 1973. The crop rotations were established in 1971, making the second season 1973 yields for most

Table 20. Effect of slope and soil management on annual soil erosion losses, 1973. Total rainfall 1397 mm.

Slope %	Bare fallow Soil loss (tons/ha)	Continuous maize Soil loss (tons/ha)	Continuous maize (mulched) Soil loss (tons/ha)	Maize – cowpeas (minimum tillage) Soil loss (tons/ha)	Maize-cowpeas (conventional tillage) Soil loss (tons/ha)
1	6.7	1.6	0.0	0.05	0.8
5	148.1	7.2	0.1	0.30	7.6
10	205.6	6.7	0.2	0.15	5.8
15	215.8	38.6	1.9	0.15	38.6

crops the ninth harvest. Note the first season yields especially for maize. The difference was caused by a drought at mid-season that hurt the maize grown under conventional tillage conditions. The maize crop at that time was the eighth consecutive crop under both tillage systems. Under minimum tillage maize stover is allowed to fall on the soil surface after each harvest and the next crop is planted through the stover mulch.

Table 21. Comparison of crop yields under minimum tillage and conventional tillage, first season, 1973, IITA.

Crop	Grain yield in kg per hectare Minimum tillage	Conventional tillage
Maize	4,500	3,000
Cowpeas	750	640
Soybeans	845	1,065
Sweet potatoes	22,000	17,750
Pigeon peas*	26,250	25,000

* Total dry matter.

Soil temperatures are an important aspect of the minimum tillage study. Germinating seeds and seedlings of most crops are affected adversely at temperatures approaching 38°C. From November to June soil temperatures on plowed plots at IITA run above the optimum level for crop growth. Figure 4 illustrates this. Note that mulch keeps soil temperatures low at the critical planting period.

Killing the existing cover crop with a weed killer and planting directly through the mulch without plowing gives a crop the advantage of a cooler more friable soil and more moisture available. Soil erosion is eliminated.

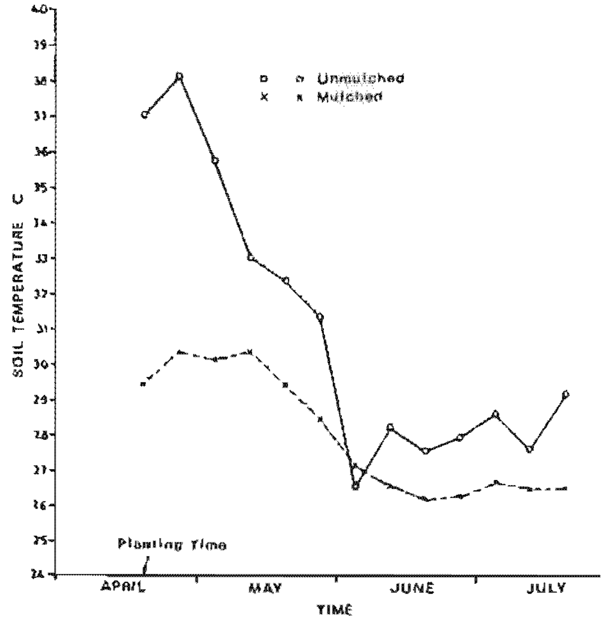

Figure 4. Effect of mulching on soil temperature at 3 p.m. and 5 cm depth.

Moisture supply for the crop increases enough under minimum tillage to make significant differences in yields if drought strikes. The mulch cov-

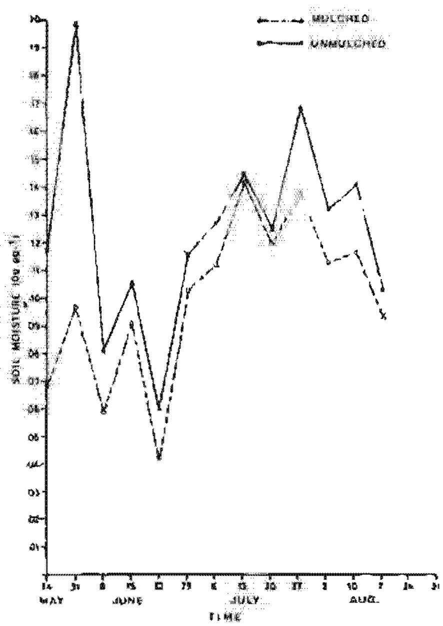

Figure 5. Effect of mulching on soil moisture storage at 0-10 cm depth.

ering the soil surface cuts losses by evaporation. In addition soil structure is maintained under minimum tillage so as to increase moisture storage in the soil. (Figure 5).

Weeding problems are reduced under minimum tillage. Weight of fresh weeds harvested eight weeks after planting maize in 1972 was significantly higher in unmulched than in mulched plots. Weeds also affect soil moisture content (Table 22).

Table 22. Effect of mulching on weed growth.

Treatment	Weed growth in kg per plot
Rice straw mulch	15
Forest litter mulch	13
No mulch	46

Weeds harvested four weeks after planting in IITA maize plots during 1972 were equivalent to 1,000 kg per hectare in the conventional tillage and 25 kg per hectare under minimum tillage.

Plant Protection Under Minimum Tillage

Crops grown under minimum tillage receive the same treatment with insecticides and fungicides as the crops under conventional tillage. To date no buildup of plant pests has been detected as a result of the mulching practices.

Nematology studies on maize, pigeon pea, soybean and cowpea, grown for seven consecutive seasons on tilled and untilled soils in adjacent plantings, found plant parasitic nematode populations in tilled plots about the same or higher than in the untilled plots. The root lesion nematode (*P. scribneri*) population under tillage was five times that under no tillage (Table 23).

Soil Properties Under Different Vegetation

The effect of crop residue on grain yields and the effect of cropping on soil chemical properties was studied jointly by the soil chemist and soil physicist during 1972-73. Grain yields for maize and soybeans show that maize yields are maintained on plots where crop residues are returned to the soil, but soybean yields decline (Table 24).

All plots received no tillage and crop residues were returned as surface mulch.Chemical properties of the soil are compared in Table 25 The results indicate that returning maize residue to the soil is as effective as bush fallow in maintaining soil organic matter. Note that cation exchange capacity (CEC), indicating efficiency of use of applied fertilizer, stays high under maize with residue is returned.

Table 23. The numbers* of *Pratylenchus scribneri, Helicotylenchus pseudorobustus, Meloidogyne incognita* infective larvae observed in soil grown to maize, pigeon pea, soybean, cowpea and weed fallow for seven consecutive cropping seasons on tilled and untilled soils.

Treatment	*P. scribneri*	*M. incognita*	*H. pseudorobustus*
Maize			
tilled soil	21.480	0.171	0.235
untilled soil	4.078	1.075	0.825
Pigeon pea			
tilled soil	1.55	0.160	0
untilled soil	0.395	0.435	0.025
Soybean			
tilled soil	1.695	0.415	0.025
untilled soil	0.745	0.340	0.075
Cowpea			
tilled soil	0.005	0.010	0
untilled soil	0.055	0.115	0.035
Weed fallow			
untilled soil	0.115	0.025	0.040

*Numbers of nematodes per cm^3 soil based on 200 cm^3 samples. Five nematodes per cm^3 = 1,000,000 nematodes per m^2.

Table 24. Effect of crop residue on grain and dry matter yield*

Treatment	Grain yield, ton/ha		Dry matter yield, ton/ha	
	1972	1973	1972	1973
Maize, return residue	7.32	8.35	16.4	16.8
Maize, remove residue	6.68	5.71	14.3	10.4
Soybean, return residue	2.71	1.85	3.2	1.5

* Total yield of two crops per year. Data presented are average value of three replications. Plot size: $100m^2$.

Soil Fertility

Results of three years of experiments with maize to study effects of continuous cropping are reported under maize improvement (page 9). The results indicate that without fertilizer and weeding maize yields start to level off after two years of continuous cropping. The influence of fertilizer on yield is greater than that of weed control. These long-term experiments will run several more years before any conclusions are drawn regarding the capability of land types.

Weed Control in the System

Weed science, as a sub-program in Farming Systems, conducts research with crops from all crop improvement programs. Studies conducted during 1972-73 included herbicides, timing of hand weeding and changes in the weed flora under cropping systems.

Upland rice yields, given adequate water, are seriously limited by weeds. Herbicide treatments that controlled weeds in rice well also caused damage to the rice plant. No herbicide was identified that would satisfactorily control weeds by itself. A comparison of herbicide combinations, hoe weeding, no weeding and weed free rice yields are in Table 26. The yield of 34 kg of rice per hectare points to the seriousness of weeds in upland rice.

Cowpeas yielded as well with one hoe weeding 7 days after plant emergence and another 28 days after emergence as with the best combination of chemical and hand weed control. Table 27 details the results.

Soybean weeds are adequately controlled by herbicides currently on the market.

Yams kept weed free for three months yielded almost as high as yams kept weed free throughout the growing season. These results, from preliminary trials in 1972, were confirmed in 1973. Eighteen herbicides were tested for weed control in yams during 1973. Treatments resulting in yields of more than 30 tons of yams per hectare are reported in Table 28.

Cassava may need weeding for only two months, after planting (Table 29) for best yield results.

Table 25. Effect of cropping on soil properties after one year as compared with continued natural bush regrowth.

Treatment	Organic Carbon	Total Nitrogen	C/N	CEC	Plant residue returned
	%	%		me/100g	ton/ha
Bush regrowth	1.40	.136	10	5.72	Litter fall
Guinea grass	1.50	.178	8	8.63	30.4 (3 cuttings)
Lucaena leucophyla (Lead tree)	1.56	.141	11	6.15	Litter fall/ratoon
Pigeon pea	1.40	.143	10	5.73	Litter fall/ratoon
Maize, return residue	1.63	.170	10	6.82	16.4 (2 crops)
Maize remove residue	1.04	.115	9	4.64	Removed
Soybean, return residue	0.96	.099	10	4.00	3.2 (2 crops)
Maize/cassava mixed crop, return residue	1.24	.140	9	5.73	8.2/litter fall

Table 26. Effect of different weed control treatments on the yield of upland rice.

Treatment	Rate (kg / ha)	Time of application*	Rice yield (kg/ha)
Avirosan + propanil	3 + 2	PE + 21DAE	2632
Melsan + propanil	1.5 + 2	PE + 21DAE	2520
Hoe weeding	–	7DAE + 35DAE	2364
Mowdown + propanil	2 + 2	PE + 21DAE	2244
Weed free	–	Weekly	2213
A 70–25 + propanil	3 + 2	PE + 21DAE	2140
Fluorodifen + propanil	2 + 2	PE + 21DAE	2129
No weeding	–	–	34

* PE = preemergence; DAE = days after emergence

Table 27. Cowpea yield as affected by different methods of weed control.

Treatment	Yield* %
Weed free	100
No weeding	7.0
Hoe weeding (7 + 28 DAE)**	103.5
Tillage (21 DAE)	40.8
Tillage (7 + 28 DAE)	42.9
Basalin + diphenamid (PE)	83.9
Basalin + diphenamid (PE) + tillage (21 DAE)	103.5

*Expressed as a percentage of the weed free control.
DAE = days after emergence; PE = preemergence.

Table 28. Effect of different herbicides on the yield of yams.

Treatment	Rate (kg a.i./ha)	Yield (tons/ha)
Atrazine + TCA	3 + 5	35.8
Chlorthal-dimethyl + linuron	5 + 1.5	35.5
Simazine	5	33.2
Weed free	–	32.9
Ametryne	3	32.7
Atrazine + alachlor	1.5 + 2	30.7
Noruron	3	30.2
Noruron + TCA	3 + 5	30.0
No weeding	–	20.3

Table 29. Effect of time of weeding on the yield of cassava.

Treatment	Yield* (%)
Weed free for 1 month	66.4
Weed free for 2 months	101.1
Completely weed free	100.0
Weed infested for 1 month	96.8
Weed infested for 2 months	71.6
Weed infested for 3 months	27.0
Completely weed infested	0.8

*Expressed as a percentage of the yield obtained for the completely weed-free plot.

Market-Garden Production Experiment

In many developing countries, migration from rural to urban areas has increased the pressure for intensive food production near cities. The lack of rapid transportation facilities and adequate storing and processing facilities makes it necessary to produce perishable commodities such as vegetables at a short "time distance" from the market. To study this type of production and to develop recommendations, a production system for a vegetable market garden was established.

All mechanical operations are done by an Agria two-wheel tractor. The work force consists of the tractor operator and two field hands. All operations are timed in order to determine the efficiency of the tractor under the prevailing conditions and the labor input required. The experiment, which is in cooperation with agricultural engineering, was in progress for nine months during 1973 and information will be available in 1974.

DETAILED 1973 PROGRAM REPORT

Readers interested in work reported in the Farming Systems Program Report for 1973 may examine the contents page of that report that follows. Queries on details should be addressed to the Program Leader or to the scientist responsible for the work.

CONTENTS

Training at IITA

The Training Office assists in planning, organizing, coordinating and effecting training. It has varying degrees of responsibility for the following activities:

- Research Training
- Production Training
- Post-doctoral Fellowships
- Outreach Training
- Seminars, Conferences and Workshops

Research Training

Research training includes all training activities where the primary goal of the participants is research oriented. Under the supervision of members of IITA's scientific staff, participants acquire or perfect research skills. All programs are tailored to meet individual needs and all are planned to contribute to the Institute's research effort.

Participants in crop production training at IITA spend at least 50% of their time in the field.

Research training is arranged for postgraduate degree candidates and for those not seeking degrees. Arrangements have been made with 13 universities of Africa, Europe and North America for students to do the research portion of their degrees at IITA.

Arrangements for non-degree research training have been made for representatives of 16 research institutes, universities, departments of agriculture and private organizations of 11 countries of Africa, Asia and Europe. By the end of 1973, the Institute had provided training in research for 56 people representing 13 countries of Africa, Asia, Europe, North America and the Caribbean area.

Production Training

Production training covers training activities that lead to a thorough familiarity with one crop. They impart:

- the ability to diagnose problems and abnormal situations as well as the application of appropriate treatments.
- the ability to evaluate alternatives of production and marketing strategies and to make decisions in light of economic advantage.
- the ability to conduct replicated field trials and test innovations for economic advantage.
- the ability to produce the crop under a variety of field conditions, using both hand tools and small machines.
- communications skills and the ability to identify behavioral changes necessary for the adoption of technology.

The broad objective of most production courses is to create extension leaders who can promote, organize and conduct production training courses. Production training is carried on in a group context. Emphasis is on in-the-field experience with adequate consideration of theory and time for discussion.

During 1973, a five-month course in rice production technology for 23 men, representing 11 West African countries, was held at IITA under the sponsorship of the West Africa Rice Development Association. The course was planned and executed as a bilingual (English/French) course and employed the services of both anglophone and francophone trainers, professional simultaneous interpreters and translators. Resource persons for the course were drawn not only from among the Institute's staff but also from universities and research stations in Nigeria.

Post-doctoral Fellowships

Post-doctoral fellowships are offered to selected qualified applicants who have newly acquired Ph.D's. The Institute identifies three important reasons for offering these fellowships:

1. To affirm the research skills and orientation of young scientists by offering them the opportunity to work with experienced research scientists on relevant problems of crop production in the lowland humid tropics.

2. To assist the Institute to achieve its research goals in priority areas where insufficient regular staff is available.

3. To assist in the identification and training of staff for the Institute or for its outreach programs.

Outreach Training

Outreach training is training associated with the Institute's outreach contracts. Outreach contracts generally include a training component under which IITA arranges for training of counterpart personnel. According to the nature and level of training prescribed by the contract the Institute either arranges for such training elsewhere or provides the training at IITA.

Conferences and Workshops

Conferences are defined as inter-or intradisciplinary meetings of generally more than 30 people who come together to report on broad aspects of their discipline(s) and to conduct such other business as may be appropriate.

Workshops are defined as meetings of small groups of scientists who meet for a brief period, generally not exceeding three days, to study a specific problem and to apportion responsibility for further study of aspects of this problem.

Seminars are defined as meetings of one to two hours at which research scientists, support unit personnel, trainees and invited guests present the results of their research or speak on subjects of importance to IITA staff. IITA seminars are scheduled on a regular weekly basis, with special seminars also arranged to permit invited guests or visitors to address IITA staff.

During 1973, following the opening of the Institute's Conference Center, seven conferences and workshops were held at IITA with a total attendance of 335 people.

Outreach Program

During 1972-73 IITA developed outreach programs with national and regional agencies throughout Africa. The Institute became active in the National Maize Improvement Program in Zaire in cooperation with CIMMYT, and programming assistance was given to the West Africa Rice Development Association. The governments of Liberia and Sierra Leone requested assistance with rice projects and study missions went to Cameroun, Dahomey, Ghana and Togo to examine and advise on special problems. IITA staff members were actively involved in preparation of the Nigerian Accelerated Food Production Project.

The Institute's Outreach Program grew rapidly during 1973 mainly through response to requests. The Director of Outreach was appointed early in the year and developed a statement of objectives and strategy to guide implementation of outreach activities. Outreach responds to the needs of developing countries in the lowland humid tropics for applied research and testing of new agricultural technology. In each case, assistance is gauged in terms of national agricultural resources and the economic priorities that they establish for themselves.

The Outreach Program also serves as a principal channel for field testing of research results from the Institute's four research programs. In this respect, the offsite experiments in each of the programs frequently lead to the development of further and more formal outreach assistance.

The Institute will arrange outreach projects outside Africa, especially in programs that can be logically integrated on a global basis in the areas of its mandate – Farming Systems, Grain Legumes and Root and Tuber Crops. In addition, funding is sought for these programs on a long-term basis in order to provide career opportunities for selected scientists and managers of proved capability.

Library and Documentation Center

Library Activities

The Library and Documentation Center moved into its permanent building during April 1972.

The Library collection as of December 1973 was about 16,000 volumes, including 5,500 books and 10,500 periodical volumes. In addition, there were 2,000 pamphlets and reprints and some microfilms and microfiches. The Library subscribes to 282 serial titles and receives an additional 500 as gifts or on exchange.

A special feature of the IITA library acquisitions program is the development of a basic collection of agricultural publications in the French language for the use of trainees, visiting scientists and other users who speak French. During 1972 and 1973 the French language collection grew to the extent that it is the largest collection of French agricultural literature in Anglophone Africa.

Documentation

Compilation started during 1972 on the world bibliographies on cowpeas, lima beans and other species that are receiving attention in IITA's Grain Legume Improvement Program. More than 3,500 references on the various species are identified. Acquisition of the papers, and abstracting and organizing is being done to eventually offer a literature and information service to grain legume workers throughout the world. Collection of references on yams and on tropical soil management also started.

During 1972, *Serials for Rice Research*, a list of journals, reports, proceedings, transactions and bulletins that publish papers on rice was published. More than 300 requests for this publication were received from all over the world. A revised and much enlarged edition of the *Union List of Scientific and Technical Periodicals in Nigerian Libraries* was published in 1973. The *Union List* covers the holdings of eighteen major Nigerian libraries and includes periodicals in all scientific and technical fields. The existence of the *Union List* promotes greater sharing of resources among Nigerian libraries.

Arrangements were concluded in 1973 for the operations of the Agricultural Libraries Network (AGLINET) established to promote rational exploitation of agricultural information through close cooperation among the world's leading agricultural libraries. IITA is the AGLINET Regional Center for West Africa.

IITA Journal series

An IITA Journal Series of numbered articles submitted for publication in journals was initiated in 1972. Journal articles published become part of the IITA Reprint Series, copies of which are available through the Library and Documentation Center.

Journal Series

1. Lal, R., Effects of Seed Bed Preparation and Time of Planting on Maize *(Zea mays L.)* in Western Nigeria, June 1972.
2. Juo, A.S.R. and Maduakor, H.O., Hydrolysis and Availability of Pyrophosphate in Tropical Soils, July 1972.
3. Lal, R., The Effect of Soil Texture and Density on the Neutron and Density Probe Calibration for Some Tropical Soils, November 1972.
4. Kang, B.T., Osiname, O.A., Schulte, E.E., and Corey, R.B., Zinc Response of Maize *(Zea mays L.)* Grown on Sandy Inceptisols in Western Nigeria, December 1972.
5. Lal, R. and Hahn, S.K., Effect of Method of Seed Bed Preparation, Mulching and Time of Planting on Yam *(Dioscorea rotundata)* in Western Nigeria, January 1973.
6. Nickel, J.L., Pest Situation in Changing Agricultural Systems – A review, Entomological Society of America Bulletin, March 1973.
7. Lal, R., Soil Temperature, Soil Moisture and Maize Yield from Mulched and Unmulched Tropical Soils, April 1973.
8. Lal, R., Effects of Constant and Fluctuating Soil Temperature on Growth, Development and Nutrient Uptake of Maize Seedlings, April 1973.
9. Juo, A.S.R., Moormann, F.R., and Maduakor, H.O., Forms and Pedogenetic Distribution of Extractable Iron and Aluminum in Selected Soils of Nigeria, May 1973.
10. Williams, R.J., Agboola, S.D., and Schneider,

R.W., Bacterial Wilt of Cassava in Nigeria, May 1973.

11. Whitney, W.K., and Sadik Sidki, Thrips Damage to Cowpeas, *Vigna unguiculata*, June 1973.

12. Bruce-Okine, E., and Lal, R., Soil Erodibility as Determined by Raindrop Technique, June 1973.

13. Lawani, S.M., and Seriki, T.A.B., Some Characteristics of the World Literature on Rice, June 1973.

14. Singh, S.R., Cassava Mosaic in Africa, July 1973

15. Lal, R., No-Tillage Effects on Soil Properties and Maize *(Zea mays* L.) Production in Western Nigeria, August 1973.

16. Whitney, W.K. and Gilmer, R.M., Insect Vectors of Cowpea Mosaic Virus in Nigeria, September 1973.

17. Williams, R.J., Report of Cassava Mosaic Workshop, International Institute of Tropical Agriculture, June 1973.

18. Lawani, S.M., Bradford's Law and the Literature of Agriculture, November 1973.

19. Kang, B.T., Effect of Inoculation and Nitrogen Fertilizer on Soybean in Western Nigeria, December 1973.

20. Lalor, W.F., Physical Characteristics of a Forest Area in Western Nigeria and its Relation to Land Clearing, December 1973.

Special Projects at IITA

Several special projects have research activities at IITA. These projects, supported by donors for specific purposes, are additions to the core and outreach programs of the Institute. Special projects active during 1972-73 were:

FAO Rice Mechanization

A special project for research on the mechanization of rice production was started at IITA in 1971 under a special grant from the Government of the Netherlands. One FAO Associate Expert is assigned to the project, which conducted research during 1972-73 as an integral part of the IITA Farming Systems Program.

COPR Pesticide Residue Study

The Centre for Overseas Pest Research (COPR) started research on DDT residues during 1973. The COPR work, supported by the Overseas Development Administration (ODA), United Kingdom, will provide valuable information on the fate of pesticides in tropical soils, and on the long-term effect pesticides may have on farming systems. Four staff members are assigned full time to the COPR work.

Nottingham/Reading/IITA Photosynthesis Project

Two researchers are temporarily assigned to IITA to study the potential of crop production in the tropics by measuring the gas exchange for crops under tropical field conditions and relating these measurements to crop yields. Support is from ODA.

Root Development Studies

A member of the Letcombe Laboratory staff, seconded to IITA as a research associate in the soil physics sub-program, conducted root development studies during 1973, with particular reference to soil temperatures. Support is from ODA.

FAO African Rural Storage Centre

An FAO African Rural Storage Centre, financed by Danish Trust Funds, is based at IITA. The Centre, which started work late in 1973, concentrates on:

1. Collection of information on farm storage losses and on storage methods used as a basis for formulating future research and extension projects on rural storage.

2. Evaluation of existing methods for drying and storing maize in the humid tropics and stimulation of extension programs on storage structures and methods appropriate to given areas.

The Centre has three storage specialists based at IITA and four associate experts based in selected countries, who support local teams and provide a link between the country and the Centre.

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A.Anjorin-Ohu, research assistant
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A.I.Fagbamiye, research assistant
A.P.O.Omayuli, research assistant (1972)
H.O.Maduakor, research assistant
A.Adegbokun, research assistant (1973)
M.O.Adeniran, research assistant (1973)
A.M.Adubi, research assistant
F.O.Akinkugbe, research assistant
S.N.Anekwe, research assistant
M.O.Awoyomi, research assistant
O.Y.Balogun, research assistant
O.Fagite, research assistant
A.C.Okeke, research assistant
E.Okoro, research assistant
B.S.O.Olaofe, research assistant

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D.V.Castro, production training officer (1973)
S.Dabiri, research assistant (1973)

Research and Training Support

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S.M.Lawani, librarian
T.M.Little, statistician
W.G.Rockwood, head of communications and information
J.O.Oyekan, research associate
F.A.Olagundoye, research assistant
E.N.Adimorah, assistant librarian
V.O.Sotubo, assistant librarian
E.Bamidele, assistant farm manager
C.Jaiyeola, research assistant

SPECIAL PROJECTS

FAO/Wageningen Rice Mechanization Project

H.P.F.Curfs, associate expert

Letcombe Laboratory Root Study Project

R.S.Harrison-Murray, scientific officer

Nottingham/Reading/IITA Photosynthesis Project

E.J.Littleton, plant physiologist
R.Knight, research assistant

ODA/COPR Pesticide Residue Project

J.Perfect, project director
A.Russell-Smith, soil biologist
A.L.Davies, technical adviser
R.Yeadon, pesticide analyst
B.R.Critchley, entomologist
U.Critchley, field assistant

FAO/African Rural Storage Centre

W.H.Boshoff, project manager
J.M.Beck, storage engineer
J.Benazet, storage biologist

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

BALANCE SHEET

December 31, 1973
(US $ 000)

	Actual 1971	Actual 1972	Actual 1973	Est. 1974	Budget 1975
CURRENT ASSETS					
Cash	2,080	1,634	2,478	416	452
Accounts Receivable Donors 1/	111	125	127	77	197
Accounts Receivable - Other 2/	111	46	154	200	220
Inventories	106	158	227	230	200
Prepaid Expenses	36	9	26	35	10
Other Current Assets	271	139	3	6	6
Total Current Assets	2,715	2,111	3,015	964	1,085
FIXED ASSETS					
Revolving Funds					
Operating Equipment	772	754	781	831	831
Research Equipment	152	236	452	452	452
Vehicles	350	580	580	580	580
Furniture, Fixtures & Office Equipment	137	320	353	413	413
Buildings	12,653	15,299	16,681	18,409	19,059
Land	-	-	-	-	-
Other Fixed Assets	-	-	-	-	-
Total Fixed Assets	14,064	17,189	18,847	20,685	21,335
Total Assets	16,779	19,300	21,862	21,649	22,420
LIABILITIES					
Accounts Payable					
Payable to Donors	-	-	-	482	475
Other Liabilities	1,669	1,173	485	172	250
Total Liabilities	1,669	1,173	485	654	725
CAPITAL BALANCES & UNEXPENDED FUNDS					
Capital Grants:					
Fully Expended	14,064	17,189	18,847	20,685	21,335
Unexpended	796	403	1,116	-	-
Sub-Total	14,860	17,592	19,963	20,685	21,335
Unexpended Operating Grants:					
Core			564	-	-
Special Projects	2	34	230	-	-
Sub-Total	2	34	794	-	-
Retained Income	248	501	620	310	360
Total Capital Balances	15,110	18,127	21,377	20,995	21,695
Total Liabilities and Capital	16,779	19,300	21,862	21,649	22,420

1/ Expenditure on Core Operations amounting to $127,399 had not been claimed from USAID at the year-end; USAID is therefore shown as a debtor at the 31st December 1973. The amount has since been received.

2/ Of which $115,241 represents advances to employees.

REPORT OF THE AUDITORS TO THE INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

We have examined the Balance Sheet and annexed Operating Statements and certify that the historical date for the year to 31st December 1973 give a true and fair view of the Operations of the Institute for the year, and that the data for the estimate and budgeted figures for 1974 and 1975 respectively are provided for information purposes only.

IBADAN, NIGERIA.
29.4.74

Spencer Thirlwell Halade & Co.
Chartered Accountants.

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

OPERATING STATEMENT
For the Year Ending December 31, 1973

	Actual 1971	Actual 1972	Actual 1973	Est. 1974	Budget 1975
Sources of Funds					
1. Operating Grants - Core [a]					
a) Unrestricted	2,150	3,033	3,755	4,448	6,441
b) Restricted	-	171	1,243	1,340	
Total Core	2,150	3,204	4,998	5,788	6,441
2. Special Projects [a]	8	45	477	1,454	1,863
3. Earned Income [b]	19	66	57	120	289
Total Operating Funds	2,177	3,315	5,532	7,362	8,593
4. Capital Grants [a]	5,443	3,529	2,773	1,838	650
Total Funds	7,620	6,844	8,305	9,200	9,243
Application of Funds					
1. By Program					
A. Research					
Farming Systems	224	492	672	866	1,008
Cereal Improvement	200	133	223	367	451
Grain Legume Improvement	103	207	372	489	617
Root and Tuber Improvement	55	135	213	384	547
Total Research	582	967	1,480	2,106	2,623
B. Conferences & Training	30	58	203	481	488
C. Library, Documentation & Information Services	51	139	124	293	382
D. Service Operations	565	918	1,464	1,693	1,700
E. Administration	888	1,063	1,019	957	1,155
F. General Operating Costs	53	125	201	378	382
Total Core Program Costs	2,169	3,270	4,491	5,908	6,730
2. Special Projects	6	10	247	1,454	1,863
Total Operating Costs	2,175	3,280	4,738	7,362	8,593

	Actual			Est.	Budget
	1971	1972	1973	1974	1975
3. By Capital Grants					
Capital Expenditures:					
Working Capital	-	-	-	-	-
Revolving Funds	-	-	-	-	-
Other Capital Items	4,647	3,127	1,657	1,838	650
Total Capital	4,647	3,127	1,657	1,838	650
4. Unexpended Balances					
Unrestricted Funds	-	-	564	-	-
Restricted Funds	-	-	-	-	-
Capital Grants	796	402	1,116	-	-
Special Projects	2	35	230	-	-
Retained Income	-	-	-	-	-
Total Unexpended	798	437	1,910	-	-
Total Application of Funds	7,620	6,844	8,305	9,200	9,243
Memorandum Section:					
Program Department Costs	582	967	1,480	2,106	2,623
Support Department Costs	1,534	2,178	2,810	3,424	3,725
General Operating Costs	53	125	201	378	382
Total Core Program Costs	2,169	3,270	4,491	5,908	6,730

a/ Attached schedule 1 to show funds provided by individual donor.

b/ Attached schedule 2 to show source and use of earned income for the current year.

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

Schedule 1: Funds provided by individual donors for the year ended December 31, 1973.

Operating Grants		
a) Unrestricted:		
United States (USAID)	$1,200,000	
Ford Foundation	750,000	
Rockefeller Foundation	514,000	
Canada (C.I.D.A.)	750,000	
Netherlands Government	125,000	
Belgian Government	302,275	
World Bank	114,000	
	3,755,275	$3,755,275
b) Restricted:		
United Kingdom (O.D.A.)	484,200	
West German Government	758,379	
	1,242,579	1,242,579
Total Core		4,997,854
Special Projects:		
Ford Foundation		179,630
Belgian Government		101,388
U.S.A.I.D.		22,668
F.A.O.		1,800
Wageningen University		24,738
W.A.R.D.A.		39,753
O.D.A.		107,800
Total Special Projects		$477,777
Capital Grants		
Unexpended balance 1972		1,152,454
Ford Foundation		675,500
Belgian Government		294,913
World Bank		636,000
West German Government		13,546
Sale of Assets		327
Total Capital Receipts		$2,772,740

INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE

Schedule 2: Detailed Schedule of Earned Income for the year ended December 31, 1973.

	Approved Budget	Actual
Sources of Earned Income	$	$
Interest on Deposits	63,000	41,178
Sale of Crops	3,000	4,559
Labor Recovery Workshop	2,000	252
Overhead Recovery Special Projects	-	2,800
Miscellaneous Receipts	2,000	8,493
Total	$70,000	$57,282

Application of Earned Income:

Applied to Core Operations	$57,282

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International Institute of Tropical Agriculture, Ibadan, Nigeria