CROP PROTECTION PROGRAMME

Evaluation and promotion of crop protection practices for "clean" seed yam production systems in Central Nigeria.

R8278 (ZA0556)

FINAL TECHNICAL REPORT

1 January 2003 – 31 March 2005

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Date FTR completed: 30 April 2005

"This publication is an output from a research project funded by the United Kingdom Department for International Development for the benefit of developing countries. The views expressed are not necessarily those of DFID." R8278 Crop Protection Programme

Contents

Acronyms and abbreviations

ADP	Agricultural Development Programme (these were established in each state of Nigeria using World Bank funding)
CSRS	Centre Suisse de Recherches Scientifiques en Côte d'Ivoire
DDS	Diocesan Development Service (Catholic mission in Idah, Kogi State)
HWT	Hot Water Treatment
IITA	International Institute of Tropical Agriculture
NRCRI	National Root Crop Research Institute, Umudike, Nigeria
NRI	Natural Resources Institute, University of Greenwich, Chatham
RATCGAN	Root and Tuber Crop Growers Association of Nigeria
YMT	yam minisett technique

1. Executive Summary

A very brief summary of the purpose of the project, the research activities, the outputs of the project, and the contribution of the project towards DFID's development goals. (Up to 500 words).

This was primarily a promotional project with the main purposes of a) evaluating crop protection practices (based on current practices, local technical knowledge and the outputs from previous projects) for clean seed yam production for applicability and economic efficacy in Kogi and Ekiti states of Nigeria, and b) developing dissemination outputs related to clean seed yam production which would lead to improved seed yam health and availability through promotion within Nigeria initially, but would also be suitable for wider applicability across the yam-growing belt of West Africa.

A survey during the first year of the project confirmed that shortage of affordable and good quality, healthy yam planting material (seed yams) is regarded as a major constraint to increased yam production and productivity in Ekiti and Kogi States. The respondents generally agreed that the use of good quality seed yams would result in better yields, but that good quality seed yams are expensive and often unavailable. The farmers perceived seed yam production as a risky business.

Building on the work of previous projects, trial plots on farmers' fields and on-station assessed the suitability and efficacy of potential seed yam production techniques. Results indicated that a simple system based on planting cut tuber pieces (*c.* 100g) treated with a combination of a fungicide and insecticide could be a viable means for yam growers to produce their own clean seed yams. Tuber pieces treated this way survived better and generally produced more and bigger seed yams for planting the following season than did tuber pieces treated by the farmers' traditional method of dusting with wood ash. Demonstration plots on farmers fields were also well received by farmers who appreciated both the greater yields achieved and also the healthy condition of the seed tubers produced from the pesticide combination, compared with their traditional practice.

In a livelihoods study in Ekwuloko, Kogi State, the costs of the planting material accounted for about 70% of the expenses incurred by the participating growers in producing seed yams. However, this figure was reduced when the costs of the growers own labour was taken into consideration. Seed yam production in this area probably will only be a viable/worthwhile activity in certain situations where there are few other employment opportunities and labour is cheap. However, the economics of seed yam production ideally should be evaluated over several seasons since after the initially expensive outlay on planting material there should be no need to buy further planting material in subsequent years.

A need for clear and simple extension materials for the identification of yam pests and diseases was identified among the project partners and participating growers. Calendars, pest and disease identification sheets, posters and a planting sett treatment guide were produced and distributed through extension services, farmer groups and at seed yam production demonstration events.

The project has succeeded in establishing a loose network of stakeholders in Nigeria, who have a strong interest in improving seed yam production. This has resulted in the call for the establishment of a seed yam growers association in Nigeria, which would not only act to support growers and extension workers, but would also provide a platform for influencing regional and national policy related to yam production and seed supply.

2. Background

Information should include a description of the importance of the researchable constraint(s) that the project sought to address and a summary of any significant research previously carried out. Also, some reference to how the demand for the project was identified.

Yams (*Dioscorea* species of family *Dioscoreaceae*) constitute a multi-species crop that is important for food, income and socio-cultural practices. The most dominant production and consumption zone for yams in the world is in West and Central Africa, stretching from Ivory Coast through Ghana, Togo, Benin, Nigeria, Cameroon, Gabon and Central African Republic to the western part of the Democratic Republic of Congo. In 2000 approximately 94% of the world's annual yam production of about 38 million tons was obtained from 3.7 million hectares in this sub-region. Most of the growth in production could be attributed to growth in area cultivated. Manyong *et al*. (1996) established that yam-based cropping systems occupied 20% of the lowland humid and sub-humid zones of nine countries in West Africa whose agricultural systems were characterised. Yams were also classified as the most important crop (in terms of area cultivated) in over 50% of the areas surveyed in the Southern Guinea Savannah (SGS) zone of Nigeria.

Average per capita consumption figures for 1994 to 1998 in West Africa varied from 88 kg/year in Nigeria to 129 kg/year in Benin. This provided from 3.8 grams of protein and 241 calories per day to 5.6 grams of protein and 353 calories per day, respectively (FAOSTAT 1998). In studies in south eastern Nigeria, Nweke *et al.* (1992) established that people in major food-producing rural areas consumed 757 calories per capita per day from yams compared to 354, 298, 185, and 149 from cassava, rice, wheat and grain legumes, respectively. The studies also showed a positive expenditure elasticity of demand for yams at all expenditure levels. It was concluded that yams would continue to have a high market potential and that production research that will increase supply is likely to increase quantities consumed at low-income levels.

Yams provide cash income for a wide range of smallholders, including many women who are very active in the marketing of yams and yam products. Results from a recent food demand and consumption survey by IITA in three cities in northern Nigeria (Abuja, Kaduna and Kano) emphasize the continued high demand for yams. They also refute reports in old literature of the potential negative impact of urbanization on the use of yams for food in Africa (IITA, 2000).

Production of yams has been important to the survival and welfare of many generations of poor people in the tropics and continues to be very important for ensuring sustainable food security and income generation. The crop brings flexibility to the annual cycle of food availability through the multiplicity of species and cultivars, broad agroecological adaptation, diverse maturity periods, as well as options for storage and utilisation. The yam tuber remains dormant during most of the unfavourable agroclimatic period between one harvest and the next planting season. This relatively long tuber dormancy ensures longer shelf life of the fresh tuber than in other root and tuber crops. Thus yams contribute to food supply during the period preceding the wet season when food is usually scarce. The tubers are also often dried to provide even longer storage and later milled into flour for reconstituting into stiff dough that is eaten with soup. The growth pattern of the yam plant guarantees tolerance to drought conditions during the field establishment and early growth phase. The combination of dormancy and early drought tolerance allows flexibility in planting and harvesting periods as well as use of labour.

The traditional long fallows that characterised yam-based production systems in the past have become impossible owing to pressure on land from increased human population. Alternative strategies that are more compatible with the trends in socio-economic and physical conditions are needed for sustainability of yam production. In many areas, the most serious constraints to productivity are the high costs of planting material and of labour, decreasing soil fertility, as well as increasing levels of field and storage pests and diseases associated with the increasing intensification of cultivation. The resultant high prices put this highly preferred commodity out of the reach of many people for significant portions of each year.

Planting materials

Yam planting materials are derived from the edible portion, the tuber, which is expensive (50% of production cost), bulky to transport, and has a low multiplication ratio (less than 1:10) in the field. Surveys in West Africa have confirmed that scarcity of seed yams often results in unplanted mounds in farmers' fields (Aighewi 1998, Ezeh 1998). Some farmers forestall this by always keeping a reserve batch of seed yams (up to a third of the quantity planted) for replacement of seeds that do not germinate. The direct cost of the replacement seed yams and the labour implications of the replacement process can be tremendous. The minisett technique for rapid multiplication of yam germplasm was developed by IITA and the Nigerian National Root Crops Research Institute. Minisetts are small pieces of tuber (25-50g) which if treated appropriately can be planted at relatively high density and will produce small tubers (up to about 400g) which are ideal to use as seed yams the following season for establishing a ware crop; they can be stored and planted whole so there are no cut surfaces making them less prone to rotting in the ground after planting. However, this technology has not been promoted appropriately or adequately in target areas. Langyintuo (1996) highlighted some of the constraints to adoption of the technique from studies in Ghana and Nigeria. Methods to artificially terminate tuber dormancy in order to speed up the cycles of yam multiplication are still being researched (Tschannen *et al*., 2005).

Pests and pathogens play a major role in the losses incurred in the field and in storage. At harvest, 10 to 30% of yam tubers are kept as planting materials for the next growing season. The remaining tubers, less storage losses (5 and 30%), are used as food (40 to 80%). The low figure of 40% comes from Nigeria where the proportion of tubers used as seed (30%) and that classified as waste (30%) are highest. In a yam storage trial carried out by the Ministry of Food and Agriculture/GTZ Post-harvest Project in Northern Ghana it was estimated that 18% of tuber weight loss was due to rots. The total loss of fresh weight was 41% by the end of 16 weeks of storage (Anonymous 1995). The farmers themselves estimated up to 25% post-harvest loss of yams in the region (Anonymous 1994) due primarily to rodents, rotting and theft. Lyonga (1984) reported losses of 28.7 to 46.7% after two months of storing yams in Cameroon. Common measures adopted to limit losses during storage are removal of rotten tubers and the breaking of sprouts. Others include curing (to heal damaged tubers) before storage, and the application of chemicals. Additional measures suggested include chemicals (plant growth regulators) to prolong dormancy and therefore delay the rapid losses associated with the post-dormant phase, physical treatments like refrigeration and low relative humidity, hot water therapy for seed yams and irradiation. Most pathological causes of losses in storage can be attributed to the activities of nematodes, fungi and bacteria, moderated by physical factors of the environment such as temperature and humidity. The majority of these losses originate from pre-harvest invasion or infection and/or damage during harvest and transit. Poor quality planting materials tend to carry pests from the barn back to the field resulting in adverse effects on field establishment and low tuber yields, and consequent carry-over to the following season.

Pests and diseases

The important role of pests and pathogens in the losses incurred during storage was highlighted in a workshop in 1995 at Ibadan, Nigeria (Green and Florini, 1996) attended by 50 yam researchers from the national agricultural research and extension system in Nigeria, overseas aid organizations and IITA. Nematodes (*Scutellonema bradys* and *Meloidogyne* spp.), often interacting with fungal (e.g. *Botryodiplodia*, *Fusarium*) and bacterial (e.g. *Erwinia* sp.) pathogens, attack tubers of susceptible varieties in the field and continue their damage during storage leading to loss of food quality and quantity as well as of planting materials. Yam production and marketing are also affected by a range of insect pests on the foliage e.g. the leaf beetle (*Crioceris livida*) and the tuber e.g. termites (*Amitermes* sp.), tuber moth (*Euzopherodes vapidella*), mealybug (*Planococcus* spp., *Phenacoccus* spp.), scale insect (*Aspidiella hartii*), and tuber beetles (*Heteroligus* spp., *Prionorcytes* spp.). Anthracnose disease (caused by *Colletotrichum gloeosporioides*) remains a major threat to the cultivation of *D. alata* in all yam-producing areas (Akem and Asiedu, 1994). Yam cultivation is also severely constrained by the accumulation of virus infections, in particular by *Yam mosaic virus* (YMV) genus *Potyvirus*.

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3. Project Purpose

The purpose of the project and how it addressed the identified development opportunity or identified constraint to development.

Forest Agriculture Interface: *Promotion of strategies to reduce the impact of pests in herbaceous crops in Forest Agriculture systems, for the benefit of poor people - To increase awareness of yam pest and disease constraints, and to evaluate and promote environmentally sound and economically beneficial crop protection practices for "clean" seed yam production in Kogi and Ekiti states of Nigeria.*

Previous projects had identified pests and diseases as major constraints to yam production in West Africa, and had researched crop management practices to improve yam crop health, including pre-planting treatments of setts, post-emergence pesticide applications and integrated crop management practices. Through these previous studies it had become apparent that there could be significant carry-over of pests and diseases between seasons in the planting material (setts/seed yams), and that good quality, "healthy" planting material was generally scarce and expensive. The purpose of this project was not to test more treatments for controlling pests and diseases of yams in the field, but rather to explore which of the technologies already developed was applicable (both practically and economically) to the small-scale growers situation in Nigeria for producing better seed yams, and to develop promotional/extension materials to start to disseminate/promote the information to these growers and more widely across the yam-growing belt of West Africa.

4. Research Activities

This section should include detailed descriptions of all the research activities (research studies, surveys etc.) conducted to achieve the outputs of the project. Information on any facilities, expertise and special resources used to implement the project should also be included. Indicate any modification to the proposed research activities, and whether planned inputs were achieved.

Note: Since much of the work undertaken during the course of the project was of a promotional nature where the activities were also the outputs, these are presented collectively as activities in this section, with only key highlights presented in the outputs section.

Baseline Survey on Seed Yam and Ware Yam Production Systems

(Activity 1) This activity was developed in order to try to provide an improved understanding of current practices and economics of the seed and ware yam production systems, and of farmers' perceptions and knowledge of the pests and disease constraints on yam production and the measures employed to control them. Only by understanding how the yam growers perceived the pests and diseases and their importance would it be possible to develop and assess improved and appropriate measures for controlling the pests and diseases. The activity was undertaken in Kogi and Ekiti states of Nigeria during the first year (2003 season) of the project. The activity was broken down into three main components:

- Farmer meetings and focus group discussions to identify key themes and inform the design of the survey questionnaire,
- Development of the questionnaire and identification of villages for the survey,
- The survey proper - conducted with 127 households in Ekiti, and 100 households in Kogi

The survey responses were analysed and reported with the methodology used by Morse and McNamara (2004).

On-Station and On-Farm Demonstration Trials of Seed Yam Production Systems

(Activities 2.1 to 2.7) A set of yam plots was set up in order to multiply yam germplasm, further validate the seed yam production systems for promotion, and demonstrate the most appropriate system to potential seed yam growers.

Virus-resistant varieties

(Activity 2.1). Yam pathology projects conducted by IITA and others over the last few years have identified disease caused by *Yam mosaic virus* (YMV; *Potyvirus*) as potentially a major constraint to yam production in the main yam growing regions of West Africa. IITA have been screening their yam germplasm collection and have identified two accessions (TDr89/02665, TDr98/00804) with apparent partial resistance to YMV in Nigeria. Material of these two accessions was multiplied at IITA Ibadan during the 2003 season for distribution and testing on-farm in 2004.

Pre-planting sett treatments for seed yam production

(Activities 2.2 – 2.4). In the first year of the project, as a means of enabling new project staff to become more familiar with the procedure for producing seed yams, to re-test different pre-planting treatments of the planting material (identified in earlier projects) and to demonstrate the system to some local growers, demonstration plots were set up at the DDS Iyegu farm near Idah, Kogi State, on land provided through the

Agricultural Development Project and Root and Tuber Crop Growers Association of Nigeria (ADP/ RTCGAN) in Ekiti State, and at IITA, Ibadan. At Iyegu, yam cv Akpaji and cv Imola were used, while at Ekiti and Ibadan, cv Ajimokun and cv Sogbe were used. The four pre-planting treatments of the planting material were 1) Chemical cocktail (fungicide + nematicide mixture), 2) Neem (dried leaf slurry), 3) Wood ash and 4) Hot water treatment (HWT) (53ºC for 25 min), and compared against 5) no pre-treatment, for each cultivar at each site. At harvest, farmers, agricultural and extension staff, and farmer association representatives were invited to a field day exposé to see and discuss seed yam production techniques and their relative performance.

In 2004 a further evaluation of the individual components of the pesticide combination was undertaken using a semi-factorial design at IITA-Ibadan. The fungicide (Mancozeb) and insecticide/nematicide (Marshal; Carbosulfan) were assessed singly and in combination, and in comparison against the farmers' traditional practice (wood-ash) for their affect on yam growth, yield and storage ability.

Seed-yam to ware-yam production

(Activities 2.2 -2.4). The seed yams produced in 2003 with the five different pre-planting treatments (above) were stored (separated by treatment and cultivar) over the dry season. The seed yams produced at DDS-Iyegu were stored in a yam barn purpose-built through project funding on the DDS farm at Iyegu. The seed yams produced in Ekiti and at IITA-Ibadan were stored in the yam barn at IITA-Ibadan. Then in 2004, the seed yams of cv Ajimokun were planted whole at Ekiti and the cv Imola were planted at Iyegu, Idah. The purpose was to assess the carry over of effect of the seed-yam pre-plant treatments into the ware crop.

Interaction between yam variety and hot water pre-planting treatment.

Earlier work, and results from the 2003 seed yam production plots indicated that the tubers of some cultivars of yam are more sensitive to HWT than other cultivars, and that there may be a negative interaction between cutting into setts and HWT. A pot experiment was therefore established in 2004 at IITA-Ibadan to compare the survival of 15 different cultivars following either with or without the recommended hot water treatment of 53ºC for 20 min, and with or without cutting. The experiment was duplicated at the IITA centre in Cotonou, Benin Republic and repeated at IITA Ibadan in 2005.

On-farm seed yam production plots

(Activities 25 – 2.7). As part of the livelihoods study during the 2004 season (see below) four farmers in Ekwuloko (Kogi State) and four farmers near Ijero-Ekiti (Ekiti State) were assisted to set up seed yam production plots on their farms. Each farmer received planting material of two yam cultivars totalling 3200 yam setts (tuber pieces of ca. 100g). At each farm, half the setts were treated with wood ash (the farmers' traditional practice), while the other half was treated with the fungicide+insecticide combination (identified the previous season as the most effective at ensuring the survival and germination of a greater proportion of yam setts). During the growing season and at harvest, farm open-days were arranged so that other farmers in the region could see how the seed yam production plots were performing (see below).

Ekwuloko and Ekiti livelihoods studies

As a follow-up to the survey conducted in 2003 and linked to the on-farm seed yam plots (see above) an in-depth livelihoods study, focussing on the costs of producing clean seed yams, was conducted on four households (HHs) in Ekwuloko (Kogi State) and four farms near Ado-Ekiti (Ekiti State) over the 2004-2005 season. The livelihoods components covered were broadly as follows:

- Mapping of cultivation and fallow farm plots of selected farmers in Ekwuloko.
- HH human capital
- HH social networks.
- HH income and expenditure
- HH assets.
- Tree crop production.
- Ekwuloko village mapping and census

The methods employed included:

- Interviews based on semi-structured questionnaires
- Informal discussions (individual and group)
- Field mapping
- Observation and participation in activities

Production of Yam Crop Protection Training/ Extension Materials

(Activities 3.1 – 3.4) In order to establish which types of extension and training materials were required, discussions were held with project staff and other stakeholders (e.g. at the start-up workshop), including some of the households included in the 2003 survey. Based on these discussions, a series of yam pest and disease identification sheets and posters were developed. These were distributed among the immediate project partners in 2003 and 2004 for evaluation, and slightly revised versions were produced and distributed in late 2003 through 2005 (see Annex 2). A simple guide to the pre-planting treatment of cut setts with the fungicide and insecticide cocktail was produced in late 2004, and after brief evaluation a revised version was distributed more widely (Table 1.). Single sheet calendars with the message “Use healthy seed yams for better yields” were produced for 2003 and 2005 and proved very popular. Templates for the identification sheets, posters and guide were passed to Centre Suisse de Recherches Scientifiques en Côte d'Ivoire (CSRS), Abidjan, and the National Root Crop Research Institute (NRCRI), Umudike, Nigeria, for adaptation to their own needs and wider dissemination; CSRS have already translated some of them into French for use in their campaign in Côte d'Ivoire. The IFAD yam regional yam project also reproduced the posters for distribution to other stakeholders across West Africa.

Farmer field days and other promotional activities

Part of the purpose of planting the on-station and on-farm plots was to be able to demonstrate to yam growers the system they might use for growing their own seed yams. During the second season of the project (2004) the planting of the plots "on-station" at DDS-Iyegu and IITA-Ibadan, and "on-farm" at Ekwuloko and Ijero-Ekiti were used as opportunities to demonstrate the treatment of the cut setts (planting material) with the fungicide+ insecticide combination to groups of invited yam growers. Similarly, groups of yam growers were invited to observe repeat demonstrations and participate in discussions when the plots were harvested in order to be able to relate the actual yields and harvest and the effect of the pre-planting treatment (Table 2.). Additional demonstrations have been undertaken during the course of the project at Nigerian Trade and Agricultural Fairs in various parts of the country, and at NGO workshops as invited participants.

Table 1. Distribution of promotional/extension materials

Year	Materials	Estimated number distributed	Locations where distributed
2003	2003 Calendars A3	8,000	Ekiti, Kogi, , Ogun , Oyo state and Abuja
	Disease Identification sheets A4 (4 separate sheets)	5 sets (for evaluation)	Ekiti, Kogi
	Yam disease posters A1 (ID sheets + general poster)	10 sets	Ekiti, Kogi, Abuja,
2004	Disease Identification sheets	10 sets	Ekiti, Kogi
	Yam disease posters	20 sets	Ekiti, Kogi, Ogun , Oyo state and Abuja
2005	2005 Calendars	10,000	All western states, Benue (Markurdi), Rivers, Delta, Nassarawa, Abuja
	Flier/guide (showing how to prepare and treat setts for seed yam production. A4	1,500	All western states, Benue (Markurdi), Rivers, Delta, Edo Nassarawa, Abuja
	Disease Identification sheets	20 sets	All ADP's in the western states
	Yam disease posters	20 sets	Workshop participants at IITA

Project Workshops

(Activity 4.1) A small project start-up workshop was held at IITA Ibadan in March 2003 to develop a work plan with the potential project partners from within Nigeria. A mid-project planning meeting of project partners was held at DDS, Idah, in March 2004. An end of project "review" workshop with over 30 participants including project partners and other stakeholders from within Nigeria, was held at IITA 10-11 March 2005 to assess the progress made during the project and to help steer the way forward for the short follow-on project (Za0648) approved in February 2005.

Table 2. Field days and demonstration events held and numbers of participants

Date	Location	Purpose	No. of extension workers	No of farmers
Dec 2003	Ekiti – Pre treatment trial site Erio- Ekiti	To show the effect of pre-treatment of setts on health and yield of harvested tubers	15	20
22-26 Feb. 2004	Makurdi	Attend Makurdi Plant Protection Conference: disuss healthy seed yam production and distribute posters	Researchers + agric staff	
Nov 2004	Ekiti : ADP office Ijero Ekiti	To show results of on-farm trials and to demonstrate sett treatment with pesticide dip	12 + press	72
4-12 Dec 2004	Ado-Ekiti	Regional Trade Fair Show: demonstrate healthy seed yam production	Many+press+TV	many
15 Dec 2004	Idah – DDS farm	To show results of on-farm trials and to demonstrate sett treatment with pesticide dip	10	65
15 Jan 2005	Ekwuloko	To show results of on-farm trials and to demonstrate sett treatment with pesticide dip	2	66
24 Feb 2005	Port Harcourt	NGO workshop, to present, discuss and demonstrate healthy seed yam production	Ca. 10	50
11 March 2005	IITA Ibadan	To demonstrate sett treatment with pesticide dip & distribution of extension materials	Workshop participants + press	

5. Outputs

The research results and products achieved by the project. Were all the anticipated outputs achieved and if not what were the reasons? Research results should be presented as tables, graphs or sketches rather than lengthy writing, and provided in as quantitative a form as far as is possible.

Baseline Survey on Seed Yam and Ware Yam Production Systems

Since the survey responses were analysed and reported in full by Morse and McNamara (2004), only a brief summary is presented here.

In both Ekiti and Kogi (Igala), most of the households surveyed indicated that there was sufficient land available for yam cultivation. However, whereas more than 50% of respondents in Ekiti said there was enough planting material available, in Kogi most said there was not enough. Poor germination (sprouting) of planting material was perceived as a greater constraint in Ekiti than in Kogi, while about half of the respondents in each region said that lack of affordable labour was a constraint. Practically all respondents in both areas saw lack of finance as an important constraint, and developing a suitable credit scheme was seen as a means of addressing this.

Very few of the respondents claimed to be using the yam minisett technique (YMT) to produce their own planting material. In Ekiti, both milking and cutting setts was used, while in Kogi the respondents relied more on buying in their planting material. Most of the Ekiti households believed that their home-grown planting material was better quality than that on the market, whereas the households in Kogi believed the opposite. Despite this, most respondents in both regions said they would like to grow more seed yams both for their own use and for sale. Approximately 50% of the Ekiti respondents said they produced enough seed yams, but less than 4% of Kogi respondents said they produced enough. In both areas there was a lack of finance to produce seed yams, and a lack of labour was a constraint in some households. Lack of land and lack of knowledge on the process were generally not regarded as constraints to seed yam production.

The 2003 data collection programme reiterated much of what was already known by DDS staff, but in addition filled in a number of gaps in knowledge. In the four villages selected in Igalaland (Kogi State) yam was obviously an important crop and farmers were buying seed yam each growing season rather than producing their own. Quality was important, and seen by them largely in terms of appearance – a function of apparent damage, pest/disease attack, as well as shape. Good quality seed was perceived to provide a significant yield advantage over poor quality seed, but purchasing seed yam is an expensive business, and unsurprisingly most respondents welcomed the idea of increasing their seed yam production. However, there were concerns over what impact an enhancement of seed yam production might have in the short term on their ware yam production and livelihood and thus this option was seen by them as risky – one which they would be unwilling to take unaided (Morse *et al.*, 2004).

Despite the wealth of information collected from the seven villages, there was obviously still much to understand before intervention by DDS or anyone else could take place. Most obvious was the lack of detail in terms of how yam production, and indeed a seed yam enterprise, fits into the overall pattern of livelihoods. How important is yam, and what other enterprises do farmers have open to them for income? How would an enhanced seed yam production fit into this? What other aspects of livelihood could compete for scarce resources required with seed yam production? It was with these questions in mind that the livelihoods study in 2004 was developed (see below).

On-Station and On-Farm Demonstration Trials of Seed Yam Production Systems

Virus resistant varieties.

Only limited amounts of the two virus resistant cultivars were available from IITA so these were propagated in the field at IITA-Ibadan during the 2003 season. Although 4.5% of the TDr89/02665 plants and 16% of the TDr98/00804 plants showed virus-like symptoms, these were very mild mosaic, without stunting, indicating that the varieties do have some resistance, or at least tolerance, to YMV infection. The seed yams produced in 2003 were used for some of the on-farm seed yam production plots in farmers fields in Ijero-Ekiti in 2004 (see below).

Pre-planting sett treatments for seed yam production.

Although these plots were originally intended as both demonstrations and as trials to compare the efficacy of different pre-planting sett treatments, the later than anticipated start to the project meant that it was not possible to obtain enough planting material of sufficient quality, and nor was it possible to plant the trials as early as required to obtain the expected yield from them. The problem of planting material was exacerbated in Ekiti by the theft of some of the planting material prior to planting. Despite these problems, the trials in Iyegu (Kogi) did sufficiently well to be analysed to compare the effects of the different sett treatments (Table 3) though because of the late start, the tuber (seed yam) yield per surviving plant was very low. Of the treatments applied to the planting setts, the pesticide combination (fungicide + insecticide) appeared to give the best and most consistent results in terms of percentage sprouting, final yield and quality of seed yams. The percentage sprouting and tuber yield (number and weight) for the other treatments (untreated controls, HWT, neem slurry and wood ash) varied depending on site and cultivar, with no obvious pattern. HWT plots appeared adversely affected in terms of sprouting however, especially in Ekiti, where an extended period (several days) without rainfall was assumed to have reduced germination across treatments, but particularly HWT. The seed yams produced from the pesticide cocktail-treated setts also appeared to store better over the dry season than those from the other treatments, with less rotting and less drying out (Claudius-Cole *et al*., 2005).

In the 2004 on-station trial at IITA-Ibadan to evaluate the effect of the components of the pesticide mixture alone and in combination, the setts treated with both fungicide and insecticide/nematicide produced more and heavier tubers than the other treatments. The wood-ash treated and untreated setts produced the fewest and smallest tubers, while those treated with fungicide alone produced slightly more tubers than those treated with the nematicide alone. This was a relatively small trial using just one variety and running for only one season. It would be interesting to determine if similar results are obtained when different varieties and different sources of planting material are used since the initial relative loading of fungal pathogens and nematodes could affect the efficacy of each pesticide component.

Table 3. Effect of pre-plant treatments of ~100 g cut yam setts on percent sprouting, mean seed tuber weight per plot, mean number of tuber per plot and yield per plant of cv Akpaji and cv Imola yam cultivars in Idah (Kogi State), Nigeria in 2003.

Treatment[a]	Percent sprouting		Mean tuber number per plot		Mean tuber weight per plot (kg)		Yield per plant [b] (g)	
Akpaji								
Chemical	73.6	a	299.8	a	29.2	a	101.3	a
HWT	38.9	d	146.0	c	8.8	c	57.5	b
Neem	57.0	b	263.0	ab	25.0	ab	118.4	a
Wood-ash	45.2	cd	189.4	bc	18.5	b	99.9	ab
Control	52.7	bc	213.0	bc	20.5	b	97.9	ab
LSD	8.0		81.9		7.7		43.7	
Imola								
Chemical	75.2	a	27.7	ab	269.6	a	135.7	ab
HWT	58.5	b	24.8	abc	219.8	ab	110.7	b
Neem	28.3	d	18.4	c	116.4	c	167.4	a
Wood-ash	52.7	bc	28.5	a	205.6	b	94.5	b
Control	41.0	c	20.2	bc	184.6	b	123.1	ab
LSD	12.6		8.1		51.1		44.5	

[a] Chemical = fungicide (Mancozeb) + insecticide (Marshal) combination; HWT = hot water treatment at 53°C for 20 min; control = untreated control; LSD = Least significant difference (P=0.05).
[b] Mean yield of harvested plants

Seed-yam to ware-yam production.

When the seed yams produced with the five different pre-planting treatments in 2003 were used in the 2004 season for ware yam production, there was little difference between the treatments in terms of percentage sprouting or final yield, probably because only whole/intact seed yams were planted (because seed yams of similar size were selected from the different treatments, there was probably an unintentional selection of seed yams with similar appearance and hence disease [or lack of] status). There did however appear to be differences in the quality/health of the ware yams produced, with those produced from the seed yams from the pesticide-treated setts appearing the cleanest (Claudius-Cole *et al*., 2005).

Interaction between yam variety and hot water pre-planting treatment.

The pot-trials in IITA-Ibadan and that at IITA-Cotonou gave essentially similar results, confirming that HWT generally reduces the survival of yam planting material whether these are whole tubers or cut setts (Figure 1). The results also confirmed that some yam cultivars do appear to be more sensitive to the HWT than others. In general, the tubers of the water yam (*Dioscorea alata*) varieties survived the HWT and cutting into setts better than the white yam (*D. rotundata*) cultivars, though there was much greater variation in survival rate among the latter. From these results and from other projects, it seems likely that the physiological age of the tubers (e.g. at start of dormancy, or after dormancy has broken) at the time of HWT or cutting will have a significant effect on the survival of the setts. The implications of these findings are that the HWT will have to be adapted/altered to suit each situation (cultivar, time of year) and cannot be promoted as a simple universal means of treating yam planting material before planting (Coyne *et al.* 2005).

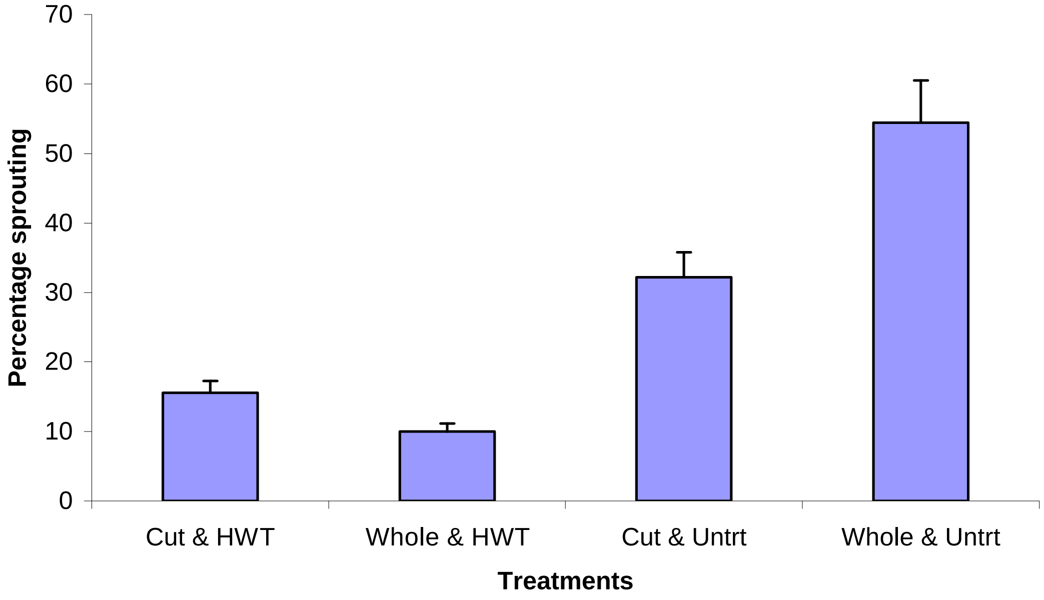


Figure 1. Percentage sprouting of yam (*Dioscorea* spp.) cultivars following hot water treatment and / or cutting into 100 g setts from whole tubers at eight weeks after treatment. Data for all cultivars and all experiments combined.

On-farm seed yam production plots

Each of the four participating households in Ekwuloko received planting material for seed yam production of two varieties; the local cv Opoko and cv Imola (multiplied at Iyegu in 2003). Although the plots were set up primarily for demonstration purposes, data was collected on the proportion of setts surviving and the number and weight of tubers produced per plant and per plot In general, the cv Opoko had a greater germination (survival) rate than the cv Imola, but the cv Imola produced slightly more tubers and a greater weight of tubers per stand. Slightly more of the setts treated with the chemical cocktail germinated than those treated with woodash. The average weight of tubers produced per stand differed between the different households, probably reflecting differences in soil fertility between the different sites. Since for seed yam production it is the multiplication ration achieved that is the important criterion, analysis of variance was performed on the total yield weight per plot divided by the weight of planting material used for each plot. This confirmed that there were significant differences in the multiplication rate achieved between the different varieties, the different pre-planting treatments and the different farms (Table 4, Figure 2).

Table 4. Analysis of variance for multiplication rate (by weight) for seed yam production demonstration plots at Ekwuloko.

Variate: Multiplication rate (finish weight/start weight)

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Variety	1	6.087	6.087	5.06	0.048
Farm	3	61.917	20.639	17.17	<.001
Pre-treatment	1	11.742	11.742	9.77	0.011
Residual	10	12.022	1.202		
Total	15	91.767			

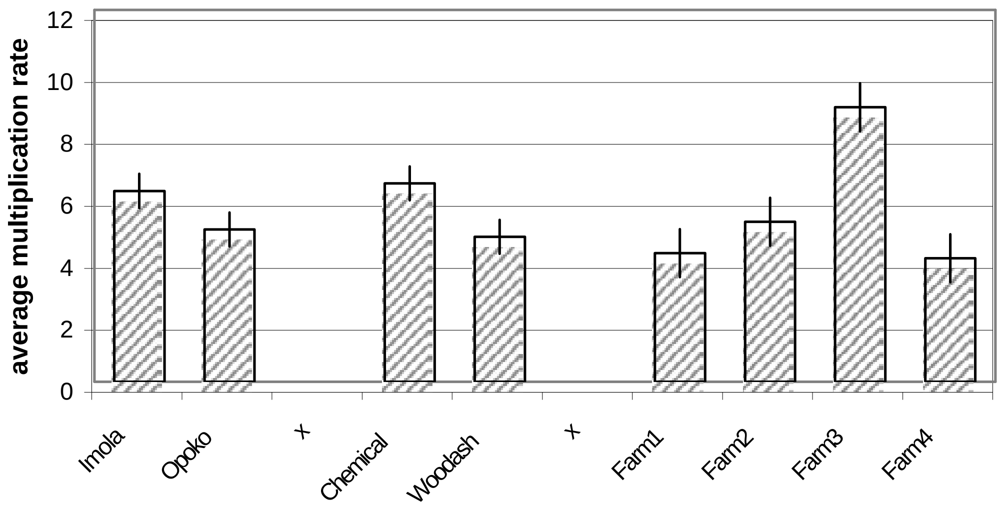


Figure 2. Comparison of average multiplication rates (by weight) for different factors in the Ekwuloko on-farm seed yam production demonstration plots (bars represent the standard error of the mean difference [s.e.d.] for each factor)

A greater proportion of the cv Imola plants showed symptoms of virus infection, and there were some differences between the four households in apparent virus infection rate. Although the apparently virus infected stands each produced less weight of seed yams than the stands not showing symptoms of virus infection, because the prevalence of stands with virus-like symptoms was relatively few, the effect of virus on the total yield of each plot/variety appeared negligible (Morse *et al.* 2005).

In Ekiti, each of the households received planting material of cv Sogbe and cv IITA-1 (TDr 98/2665) for seed yam production. Here the IITA-1 had a greater survival (sprouting) rate than cv Sogbe, and treatment with the chemical cocktail before planting significantly improved the survival rate of both cultivars compared to the farmers traditional practice of applying wood ash to the cut setts. Disappointingly, cv IITA-1 displayed a greater prevalence of virus-like symptoms at 12 weeks after planting, and despite having a better survival rate, produced fewer and smaller tubers per stand than cv Sogbe. For these reasons, cv IITA-1 is unlikely to be taken up by the growers.

Ekwuloko livelihoods studies

The findings of the Ekwuloko livelihoods study have been reported in detail by Morse *et al.* (2005), so only those aspects directly concerning yam production are summarised here. Because of logistic and funding limitations, only four households could be included in the in-depth livelihoods study in Ekwuloko. Each household comprised from five to ten adults (over 15 years old) and three to five children. Two of the households owned their land, while the other two rented. The proportion of land turned to fallow depended on the overall size of the holding, with the smaller households farming more intensively. On average, 30 to 40% of the cultivated land was planted to white yams (including the seed yam demonstration plots). Cassava occupied a greater proportion of land for each household, probably because production costs are lower than for yam; planting material is relatively cheap and easy to obtain and the crop does not require as much labour as yam for production. The seed yam production demonstration plots grown by each household (see above) were used to estimate the costs and potential income from producing seed yams. The cost of the planting material for each plot (which was provided by the project) represented about 70% of the production costs, with the cost of the pesticides to treat the planting material being negligible. With the remaining 30% of costs being for hired labour, the returns on the costs for the plots averaged at about 15% - i.e. for every 100 Naira spent on the plots, at the end of the season when the seed yams were sold there was a profit of 15 Naira. However, when the households factored in their own labour costs (at the average rate of Naira 700/day), then the plots were returning an average deficit of 18.7% (i.e. they were only earning 81.3 Naira for every 100 Naira spent). For an understanding of the potential for adoption of the seed yam technology it can be argued that the latter is a more realistic analysis as household labour can be allocated to different ventures depending upon the expected returns. If seed yam is not economically viable, and households have other choices, they may seek to allocate labour away from seed yam and the technology will not be adopted. The availability of 'choices' (optionality) is of central importance here as there is only so much labour that can be locally employed at N700/day (Morse *et al.*, 2005). These studies ideally should be followed through subsequent seasons since after the initial outlay on planting material in the first season, there should be no need to purchase such large amounts of planting material in subsequent seasons. Additionally, it is important to understand that seed yam price is at its highest shortly before planting (following a few months storage). Sale of seed yam therefore following the dry season would likely provide higher returns, particularly for good quality seed yam. This becomes even further essential, as good quality seed yam is likely to survive and store better, thus providing greater likelihood of increased returns (through reduced losses). It is necessary therefore to assess viability of such technologies through subsequent seasons for various reasons.

Ekiti livelihoods study

The data from this study is not available or compiled yet, so will be included as part of the final report for the follow-on project (Za0648).

Production of Yam Crop Protection Training/ Extension Materials

Lists of the dissemination outputs produced are presented in Annex 1 and examples of the promotion/extension materials produced are presented in Annex 2.

Project Workshops

The end of project review workshop received extensive coverage in the Nigerian press (see Annex 1). The main conclusions and outputs of the workshop were:

- The project had produced some useful information on seed yam production systems and yam production constraints, and had produced some good extension/promotional materials.
- The focus of the project on Ekiti and Kogi was too narrow and it would have been better, if funds had permitted, to cover a wider area of the West African yam belt.
- The unreliable supply of appropriate, authentic fungicide and insecticide for treating planting pieces is a major constraint to uptake of the seed yam production system being promoted by the project, and the follow-on project should seek ways of ensuring a more reliable supply, perhaps by working with a pesticide dealer.
- Lack of household finance when needed to purchase yam planting material and for farm labour (for land preparation, planting, weeding and harvesting) was reconfirmed as a major constraint to increased yam production. The plans to set up and evaluate a micro-credit scheme for seed yam production in Ekwuloko in the follow-on project were applauded (though there were again complaints that focussing just on one village was too narrow).
- The reconfirmation by the project that good quality seed yams are expensive and in short supply, and that this is one of the main constraints to increased yam production, resulted in the request for the workshop participants to investigate the possibilities of establishing a seed yam growers association or support group.
- It was generally agreed that the plan for the follow-on project to seek information on the commercial and large scale seed yam production systems that might be adapted to the small-scale growers situation was a useful next step (although if the funding were available it would be better to widen out the study to other commercial seed yam growing areas and not to concentrate only on the Illushi area).

6. Contribution of Outputs to developmental impact

Include how the outputs will contribute towards DFID's developmental goals. The identified promotion pathways to target institutions and beneficiaries. What follow up action/research is necessary to promote the findings of the work to achieve their development benefit? This should include a list of publications, plans for further dissemination, as appropriate. For projects aimed at developing a device, material or process specify:

a. What further market studies need to be done?
b. How the outputs will be made available to intended users?
c. What further stages will be needed to develop, test and establish manufacture of a product?
d. How and by whom, will the further stages be carried out and paid for?

The planned outputs of the project have largely been achieved, though the livelihoods study is being extended into the new project (R8416) and analysis and reporting of the findings will be included in the final report for that project. The findings from the livelihood studies will also need to be shared with the farmers involved for their views and interpretation. The project has confirmed that in the study areas yam production is a major contributor to sustaining the livelihoods of the people. However, productivity, and hence farm income, could be improved if the supply of good quality seed yams could be increased. The project also showed that there are relatively simple systems available to the growers for producing their own good quality seed yams, but these are regarded as risky activities by the growers and require financial investment by the growers at times of the season when currently most do not have access to such funds. Provision of credit for small-scale farmers has been an emotive issue for many years in Nigeria, and sustainable large-scale solutions have been elusive (e.g. the collapse in the 1990s of the state sponsored 'Peoples Bank' modelled on the Grameen Bank of Bangladesh). Commercial banks have little interest in the provision of credit for small-scale farmers given the risks and the relatively high transaction costs. Thus, while a targeted and sustainable micro-finance credit scheme would provide growers with funds at the appropriate time to allow them to start growing their own seed yams and increase their yam production and productivity a means of sustainable provision is required. Some NGOs in Nigeria do have long experience of such provision, and it would be possible to adapt the livelihoods approach to become a rights-based business plan, which could become the basis of a partnership between NGOs and farmers. The farmers would then become local suppliers of planting material and thereby eliminate the high costs of transportation from distant sites. By specialising in seed yam production it is more likely that they will be able to produce quality material, and these benefits should make seed yams more affordable.

The project has developed a small range of simple extension/promotional materials on the pests and diseases of yam and production of clean seed yams. These have proved popular with the individuals and groups they have been distributed to, and several groups with the capacity have requested the templates so that they can adapt them to their own needs and disseminate them more widely within their own catchment areas. Further consultation with stakeholders is required to determine what other materials are required, and what is the best way to get them more widely disseminated.

The project findings led to the development of a proposal to CPP for a 10 month follow-on phase to the project (PM321). The proposal has recently been approved as project R8416/Za0648 (*Up-scaling sustainable clean seed yam production systems for small-scale growers in Nigeria*), which has the following intended activities:

- To identify components of the commercial seed yam production systems around Illushi that are potentially applicable to the production of clean seed yams by small-scale growers in other areas of Nigeria,
- To assess the sustainability of small-scale seed yam production systems in a contrasting ecology and livelihood system by extending the livelihoods/seed yam production system study to include both Alla-Olakudu/Makoja and Ekwuloko,
- To assess the benefits and problems of a micro-credit scheme for seed yam production in Ekwuloko implemented with start-up funding from Gorta (Irish Charity),
- Seed yam production systems/ technologies transferred to promotional partners,
- To continue to promote the project outputs to farmer associations, NGO's, ADP's, commercial farmers and similar organisations through the use of demonstration plots and dissemination of extension materials, and to assess what further extension/promotional materials are needed and who should be responsible for producing and disseminating them once this short extension comes to an end.

The project findings also stimulated the development of a proposal to CORAF/WECARD for wider dissemination and promotion of improved seed yam systems across West Africa, though this was not approved. The importance of improving the supply of good quality seed yams was endorsed by the participants of the end of project review workshop, where a call was made for the setting up of a national seed yam producers association in Nigeria. This would be both a means of networking and providing technical support/guidance to seed yam producers, and would have a role in influencing policy related to yam and seed yam production within Nigeria. Following the end-of-project workshop, participants together with project stakeholders have begun a lobby to the Nigerian Government for a Presidential Initiative to support improved and healthy seed yam production in Nigeria, to safeguard the future of yam in Nigeria.

Biometricians Signature

The projects named biometrician must sign off the Final Technical Report before it is submitted to CPP. This can either be done by the projects named biometrician signing in the space provided below, or by a letter or email from the named biometrician accompanying the Final Technical Report submitted to CPP. (Please note that NR International reserves the right to retain the final quarter's payment pending NR International's receipt and approval of the Final Technical Report, duly signed by the project's biometrician)

I confirm that the biometric issues have been adequately addressed in the Final Technical Report:

Signature:
Name (typed):
Position:
Date:

Annex 1. List of Dissemination Outputs

Promotion/training/extension materials produced:

2003 Calendar: Use Healthy Seed Yams For Better Yields.
2005 Calendar: Use Healthy Seed Yams For Better Yields.
Poster: Pests and diseases of yam affecting seed health (A1 size)
Yam pests and diseases identification sheets: Virus symptoms, Insects and insect damage, Nematodes, and Fungal and bacterial diseases (A2 and A4 size).
How to Produce Healthy Seed Yams! Step-by-step demonstration/descriptor flyer for distribution at field days.

Internal Reports:

Morse, S. and McNamara, N. (2004). Evaluation and promotion of crop protection practices for "clean" seed yam production systems in Central Nigeria. Report on Socio-economic component by DDS

Morse, S., McNamara, N. and Acholo, M. (2005). Evaluation and promotion of crop protection practices for "clean" seed yam production systems in Central Nigeria. Report on the Ekwuloko on-farm trials and livelihood study.

Kenyon, L. and Coyne, D. (2005). Evaluation and promotion of crop protection practices for "clean" seed yam production systems in Central Nigeria. Report on the Project Review Workshop, International Institute for Tropical Agriculture, Ibadan, Nigeria. 10-11 March, 2005.

Other Dissemination of Results:

Claudius-Cole A. O., Coyne, D., Kenyon, L. Ayodele, M., McNamara, N. Morse, S. (2004) Seed yam production systems: assessment of various pre-plant treatments of setts for production of nematode free material. First West and Central African Nematology Meeting, Douala, Cameroon, 8-10 November 2004.

Coyne, D., Claudius-Cole A. O., Rotifa, I., Kenyon, L. Ayodele, M., McNamara, N. and Morse, S (2005) Seed yam production systems: use of pre-plant treatment of setts for production of healthy planting material at IITA. Paper presented at farmers' field day organized by the NGO Food For All International (FFAI), Port Harcourt, Nigeria, 24th February, 2005.

Danny Coyne honoured by D.Mowbray. IITA Bulletin No1772 p2. http://www.iita.org/news/bulletin/1772.pdf

DFID Project organises farmer's field day by Claudius-Cole. IITA Bulletin No. 1782 (13 December 2004) p.2 http://www.iita.org/news/bulletin/1782.pdf

IITA at Odu'a Trade Fair by I Rotifa. IITA Bulletin No. 1785 p.2 http://www.iita.org/news/bulletin/1785.pdf

IITA i-new: Seedy side of yams by D. Mowbray. 2003. www.iita.org

IITA i-new: Healthy seed yam production by A. Oyetunde. (2004) www.iita.org

Kenyon, L. (2003) Improving the health of *Dioscorea* yams. 13th Triennial Symposium of the International Society for Tropical Root Crops, Arusha, Tanzania 10-14 November 2003.

Meeting to promote clean seed yam production. IITA Bulletin: 21 April 2003

Winner in Eden By David Mowbray. IITA Bulletin No. 1752 p.3 http://www.iita.org/news/bulletin/1752.pdf

Newspaper articles:

Ekiti Farmers Boost Healthy Seed Yam, by Olukayode Oyeleye, *The Guardian Nigeria*. 5th December 2004 p. 20. http://www.guardiannewsngr.com/agro_care/article04/051204

Improving yam production, by Taye Babaleye, *Businessday, Agrilink* 15th March 2005, p 15.

IITA boost yam production in Kwara, Kogi, Ekiti, by Sesan Laoye, *National Pilot* Vol 2. No 48, 4th April 2005, p 7.

Workshop stresses need for clean seed yam, *Nigerian Tribune*, 30th March 2005, p 36.

Professionals brain storm on yam production, *Oodua News*, 7th April 2005. p 4.

Experts task farmers on improved yam production, by Ibrahim Apekhade Yusuf, *The Comet*, 27th March 2005, p 4.

Nigeria leads yam producers soon, by Bayo Akamo, *New Nigerian*, 4th April 2005, p 28.

How to produce quality yams, by Crusoe Osagie, *Thisday* Vol 11. No.3613, 15th March 2005, p 31.

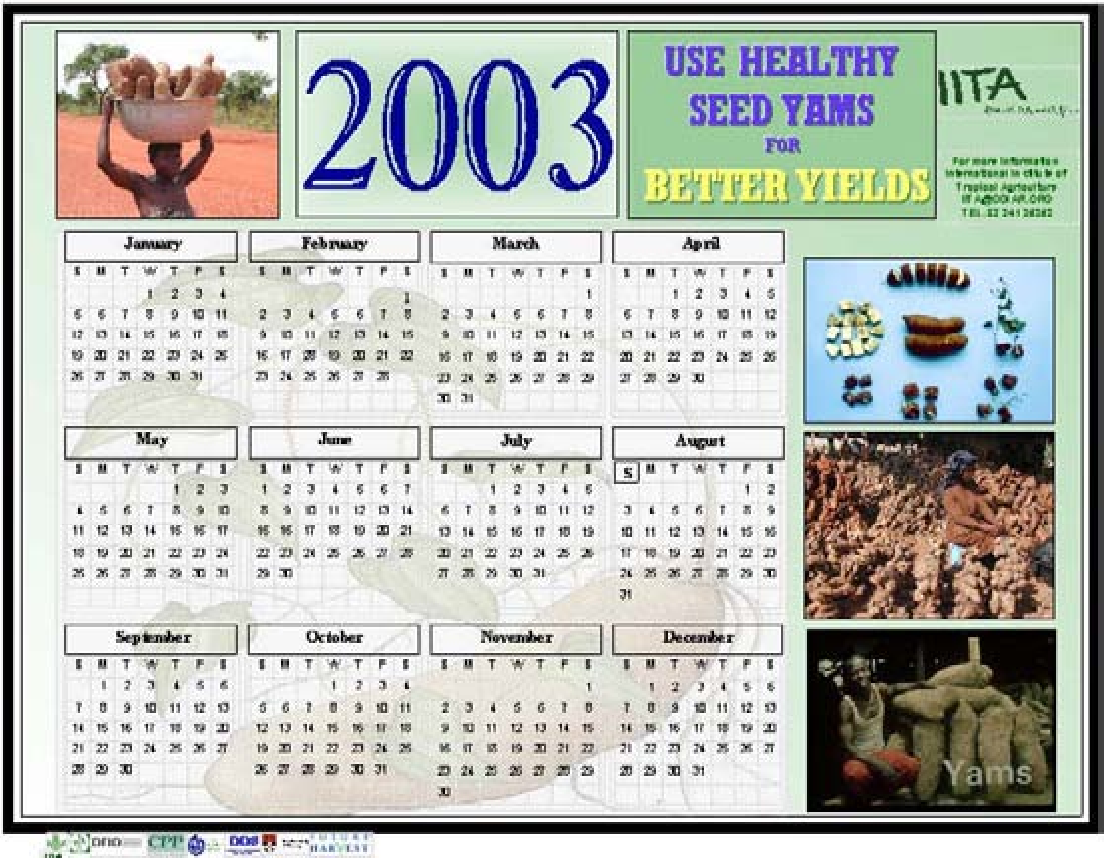
Journal Publications:

Claudius-Cole, A., Coyne, D. Kenyon, L. *et al.* (?) Seed yam production systems: assessment of various pre-plant treatments of setts for production of nematode free material. (Draft in preparation for *International Journal of Pest Management* or *Crop Protection*.)

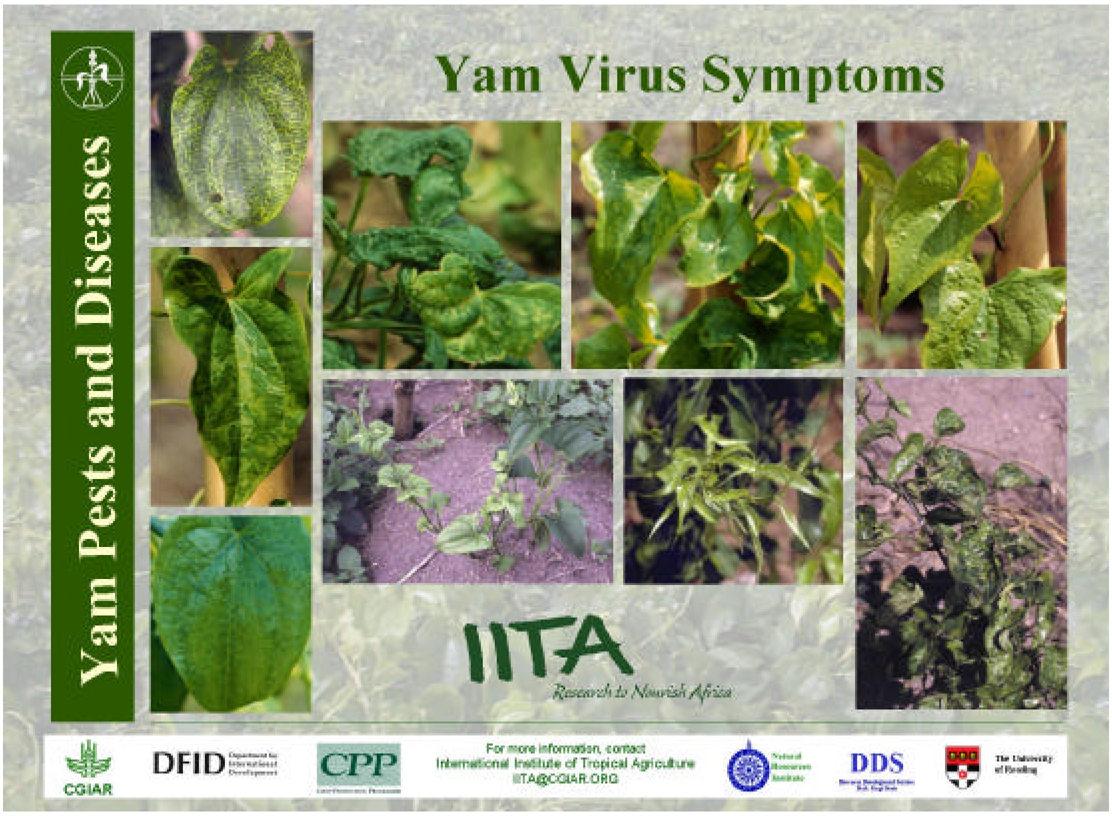
Coyne, D.L., Claudius Cole A., *et al*.(?) Effect of hot water treatment for the disinfestation of nematodes (*Scutellonema bradys* and *Meloidogyne* spp.) on whole seed yams (*Dioscorea* spp.) tubers and cut setts. (Draft in preparation for *International Journal of Pest Management* or *Crop Protection*.)

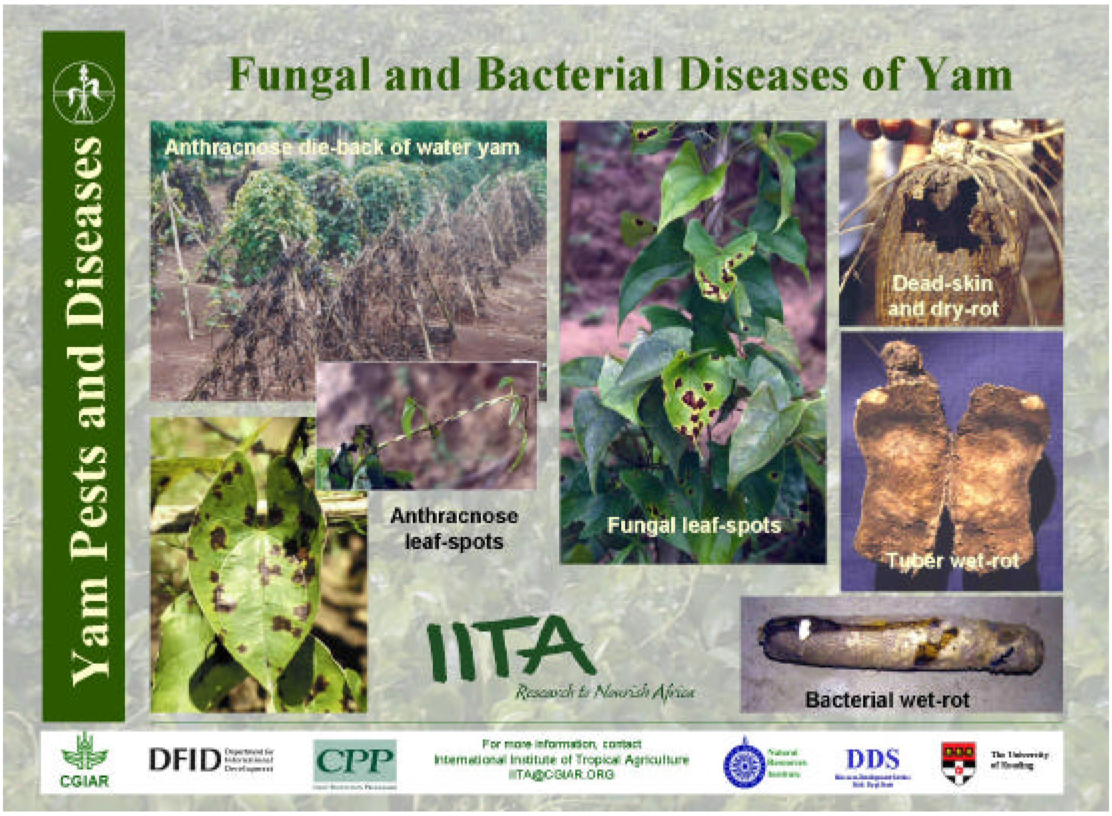
Annex 2. Promotion/extension materials produced

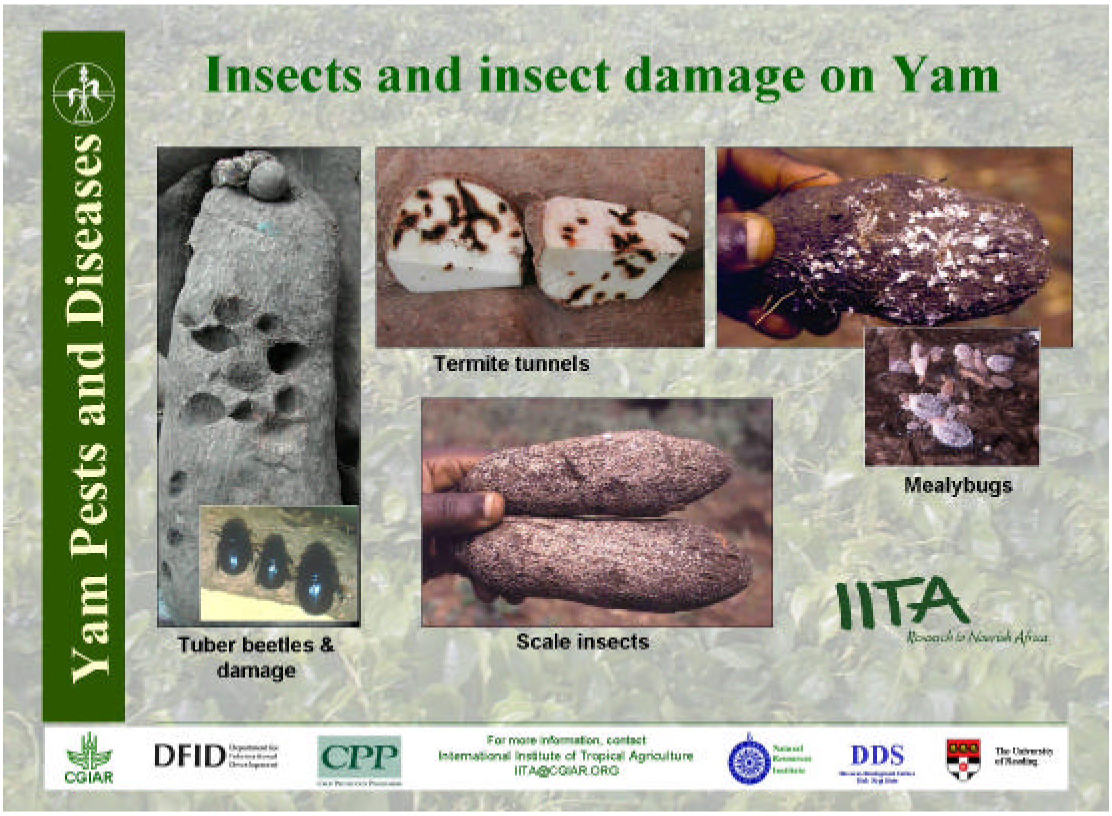
2003 Calendar

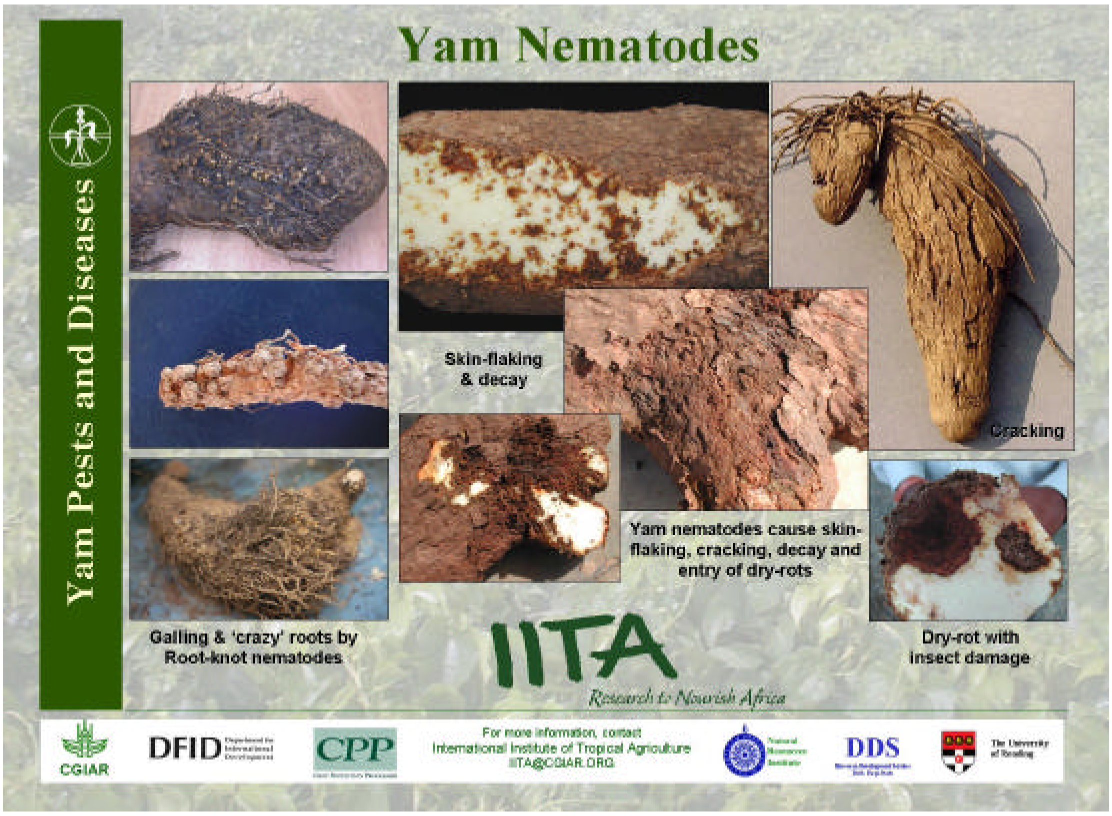


2005 Calendar


Yam Pests and Diseases
Yam Virus Symptoms
IITA
Research to Nourish Africa
DFID
CPP
For more information, contact
International Institute of Tropical Agriculture
IITA@CGIAR.ORG
DDS
CGIAR


Yam Pests and Diseases
Fungal and Bacterial Diseases of Yam
Anthracnose die-back of water yam
Anthracnose
leaf-spots
Fungal leaf-spots
Dead-skin
and dry-rot
Tuber wet-rot
Bacterial wet-rot
IITA
Research to Nourish Africa
DFID
CPP
For more information, contact
International Institute of Tropical Agriculture
IITA@CGIAR.ORG
DDS
CGIAR


Insects and insect damage on Yam
Yam Pests and Diseases
Termite tunnels
Mealybugs
Tuber beetles & damage
Scale insects
IITA
Research to Nourish Africa
CGIAR
DFID
CPP
For more information, contact
International Institute of Tropical Agriculture
IITA@CGIAR.ORG
DDS


Yam Nematodes
Yam Pests and Diseases
Skin-flaking & decay
Cracking
Yam nematodes cause skin-flaking, cracking, decay and entry of dry-rots
Galling & 'crazy' roots by Root-knot nematodes
Dry-rot with insect damage
IITA
Research to Nourish Africa
CGIAR
DFID
CPP
For more information, contact
International Institute of Tropical Agriculture
IITA@CGIAR.ORG
DDS


Pests & Diseases of Yam
affecting seed health
Virus diseases
Galling & deformed tubers by root knot nematodes
Dry rot & tuber damage caused by yam nematode
Dry rot & skin flaking caused by yam nematode
Termite tunneling
Mealybugs
Tuber cracking caused by yam nematode
Scale insects
Internal rot
Avoid using seed yam with these symptoms
IITA
Research to Nourish Africa
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IITA@CGIAR.ORG
DDS

How to Produce Healthy Seed Yams !

Accessing healthy seed yams for planting is the most important challenge for yam growers in Nigeria. Seed yams account for about 50% of the cost of production of ware yams. Seed yams that are available are often of poor quality and diseased resulting in the production of poor quality and small ware yams.

An easy technique using a pesticide dip can help produce good quality seed yams in large quantities.

Step 1: Select good quality seed yams tubers

Step 2: Cut tubers into pieces of 80 -100 g

Step 3: Place the setts into a nylon or plastic net sack

Step 4: Prepare pesticide dip using 100 g (1milk tin) Mancozeb + 70 mls Basudin in a bucket with 10 litres of water.

Step 5: Dip the setts in the mixture for 5 - 10 min.

Step 6: Leave pieces to drain and dry for a few hours or overnight.

Step 7: Plant setts 30 cm apart along ridges.

Treated setts will produce good sized healthy seed yams

Results from on-farm trials show that this method increases the percentage sprouting, number, quality and size of tubers compared to the usual traditional methods.

SAFETY

Use of gloves, eye protection and protective clothing necessary safe disposal of excess chemical is essential.

Contact: IITA and your local **ADP**