CROP PROTECTION PROGRAMME

Study of factors affecting the uptake and adoption of outputs of crop protection research on yams in Ghana

R7504 (ZA0354)
(NRI – A0897)

FINAL TECHNICAL REPORT

1 November 1999 – 31 May 2000

Lawrence Kenyon and Martin Fowler

Natural Resources Institute – University of Greenwich

Contents

Text Boxes

This study was commissioned by the UK Department for International Development (DFID) Crop Protection Programme (CPP) through Natural Resources International Ltd. The views expressed are not necessarily those of DFID.
The authors are particularly indebted to the following collaborators for their willingness to share their ideas, their help in executing the study and their hospitality in Ghana and Nigeria: Dr O-A Danquah (CRI), Dr R Asiedu (IITA), Dr J Peters (Reading), Dr S Nutsugah (SARI) and Fusaini Prince Andan (MoFA, Tamale).

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).

Yam production in Ghana faces a number of serious constraints related to crop protection, including fungal diseases (e.g. anthracnose), nematodes, viruses, yam storage diseases, seed health, and control of yam diseases and pests more generally. Considerable effort and resources have gone into researching these constraints and how to overcome them, but the products of much of this research have not reached the target beneficiaries as effectively as had been expected.

The purpose of this study was to identify and analyse the factors influencing the uptake and adoption of crop protection research outputs particularly by poor farmers in yam-based cropping systems in Forest Agriculture areas. The principal objective was to develop recommendations that could guide current and future projects to improve the uptake, and ultimately the impact, of their outputs. The recommendations were expected to be location specific but also to provide lessons more generally for the programme and other related organisations in both Ghana and other yam growing areas in West Africa.

Through discussion with key stakeholders and by reviewing the literature, some of the key outputs from crop protection research on yam in Ghana, and the methods used for disseminating them, were identified. These findings were presented as a draft report at a stakeholder workshop in Ghana on 16 March 2000 where the factors influencing the uptake and adoption of the research outputs were further explored, and recommendations developed for improved uptake and adoption.

Martin Fowler produced a study report (Section 2) based on his findings during the initial discussions with stakeholders and his review of the literature, augmented with information gathered at the workshop. The proceedings of the workshop are included as Section 3.

The study confirmed that in the past little effort had been focussed on identifying the dissemination and uptake pathways for research findings on yam in Ghana (though there was more information for other crops), and as such it would be difficult to measure the impact of much of this research.

A number of impediments to the agricultural research-extension-uptake process in Ghana were identified. Poor liaison between different groups, probably due to insufficient emphasis and funding, was one of the most important of these. They also related to some of the factors constraining the uptake and adoption of new agricultural technologies from the end-users perspective. The latter were grouped under four principal headings:

(a) the characteristics of the technology itself;
(b) the characteristics of the farmer him-/her-self;
(c) the characteristics of the farmer's immediate environment; and
(d) the characteristics of the macro-environment.

It is clear from the study that only rarely does adoption just happen. Rather, the dissemination and uptake of innovations needs to be planned in a systematic and comprehensive way with goals, responsibilities and time-bound adoption projections identified during the early project planning stage. Researchers need to play an integral part in this planning process. With monitoring of the uptake process fully integrated within future yam research and development programmes, the identification and understanding of the most effective communication pathways and the key factors influencing uptake will be realised.

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 (tubers of several of the *Dioscorea* species) are a major component of rural people's livelihoods in Ghana. They are an important source of food and income for producers' households and an important food source for both local consumption and export. A survey by GTZ of the Northern region of Ghana identified yams as the most important cash and food crop in that region. Yam also received the highest priority ranking of all crops in the National Agricultural Research Strategy Plan (NARSP) and in the Agricultural Services Sector Investment Programme (AgSSIP; the follow-on to NARSP).

Yam production in Ghana faces a number of serious crop protection related constraints, including nematodes, anthracnose, viruses, yam storage diseases, seed health, and control of yam diseases and pests more generally. Research and extension activities funded under the Crop Protection Programme being carried out by organisations and institutions in Ghana (including NRI, UoR, CABI, GTZ, CRI, SARI and MoFA) have sought to address some of these constraints to increased yam production.

The uptake and adoption of recommendations from agricultural research is a relatively poorly studied area. Technology uptake and adoption more generally has been more widely researched. The literature indicates that successful uptake is a function of a wide range of factors. These include the:

- characteristics of the research decision making process
- the quality and applicability of research outputs
- communication methods
- promotion and uptake pathways
- characteristics of end-users (particularly their access to human, natural, physical, social and financial assets, which are the five asset groups identified in the Sustainable Rural Livelihoods (SRL) framework) (Albert and Runge-Metzger, 1995, Garforth, 1996; Holden, 1993; Ezeh and Unamma, 1989; Ongaro, 1990; Stanning, 1989).

This list reveals the complex interaction of factors that affect technology uptake.

Recent Department for International Development (DFID)-funded and other studies have started to address uptake and adoption of research outputs. Garforth (1996) has looked at the selection and development of analytical frameworks and methodologies for analysing uptake pathways and ways in which the effectiveness of pathways can be improved. Norish (1999, draft) has looked at improving communication strategies for the promotion and dissemination of natural resource research outputs. The Crop Protection Programme CPP is beginning to address these issues through projects studying the uptake of specific technologies.

Despite the vast body of research, there is very little of direct relevance to crop protection interventions in yam growing areas in the Forest Agriculture production system of the Renewable Natural Resource Knowledge Strategy (RNRKS). In particular there has been little attention to the nature of the information or technology, (product, prescriptive, craft-based or cognitive), institutional and policy considerations and the communication methods and uptake pathways relevant to different types of technology and for different expected intermediate or end users.

Project Purpose

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

Forest Agriculture Production System Purpose 1, Output B: Promotion of strategies to reduce the impact of pests in herbaceous crops in Forest Agriculture systems, for the benefit of poor people

The purpose of this study was to identify and analyse the factors influencing the uptake and adoption of crop protection research outputs particularly by poor farmers in yam-based systems in Forest Agriculture areas. The principal objective was to develop recommendations that can guide current and future projects to improve the uptake, and ultimately the impact, of their outputs. These are both location specific and also provide lessons more generally for the programme and other related organisations in both Ghana and other yam growing areas in West Africa.

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.

The research activities carried out closely followed the workplan laid out in the agreed study proposal:

- *Identify key stakeholders and review of approaches and methods from broader adoption and communication literature and development of analytical framework to inform the subsequent work*

Mr Martin Fowler (NRI-SSD) undertook a short desk review of relevant literature.

- *Review of Ghana and West Africa yam literature and more general crop protection literature (including past, on-going and planned research projects)*
- *Discussions with key stakeholders in Ghana and elsewhere in West Africa*

Mr Fowler visited to Ghana and Nigeria in January/February 2000. Whilst in Ghana he held a series of semi-structured interviews with key personnel in the research and agricultural extension organisations involved, either directly or indirectly with yams. This was in order to obtain information about the research process, the promotion of new technologies, the uptake pathways[1] used and the levels of technology adoption realised. He also held meetings with representatives of some of Ghana's development partners supporting agricultural research and extension activities in the country. Much of this work was undertaken in Accra, although visits were also paid to key agricultural institutions in Kumasi and Tamale. Mr Fowler also held discussions with a number of key scientists from the International Institute for Tropical Agriculture (IITA, Ibadan, Nigeria) who have been involved with programmes of yam and other root crops' research throughout the region for many years; their insights were a further valuable input to this study. The IITA library proved to be an additional important source of both published and 'grey' literature.

- *Analysis and review of information collected, and workshop preparation*

An initial analysis and draft report of the study findings was produced following Mr Fowler's visit to West Africa, and preparations were made to hold a one-day workshop on the topic in Ghana.

- *Stakeholders workshop*

The draft report of this study was presented during a one-day workshop (Section 3) on yam research and technology uptake, which took place in Kumasi on 16th March 2000. Participants included yam research collaborators from Ghana, other parts of the West African region and the United Kingdom, and specialists involved in both agricultural research work, more generally, and in agricultural extension and training activities, as well as extension staff and farmers with first-hand experience of

[1] This refers to the route or channel by which information and technologies reach users (Garforth & Usher, 1996).

the crop. Representatives of development partners working in the country's renewable natural resources sector also attended the workshop. As well as presentation and discussion on the draft report, the workshop included a series of presentations by participants followed by round-table discussions on aspects related to yam research and its uptake. In the afternoon the participants arranged themselves into three workgroups to discuss and elaborate on the factors influencing the uptake and adoption of yam research from the perspective of the researchers, extension agents and farmers.

Mr Fowler's draft report was circulated for review to a small number of people who had attended the workshop, as well as other interested parties. They subsequently provided many useful comments to the author. Wherever appropriate, these suggestions have been incorporated into the final version of the report (Section 2).

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.

Summary of findings of the study

The study reconfirmed that although a large amount of work on the uptake of new crop technologies had already been undertaken in Ghana, little of this was on yams and almost none was related to yam crop protection research. For this reason, it was decided that experiences with the uptake of other crop technologies would be included in the study, since useful lessons were likely to be learnt that could apply equally to yams.

The final version of Mr Fowler's study report is included as Section 2 of this report, while the proceedings of the associated workshop held in Kumasi on 16th March are included as Section 3.

During the initial stages of the study, it became clear that whilst there were a number of sources of information on the Ghanaian yam sub-sector, a consolidated account of it had never been written. Thus, chapter 3 of the study report provides a detailed analysis of the sub-sector (placing it in the context of the agricultural sector as a whole); the text is supported by data presented in a number of tables that help to elaborate on some of the sub-sector's basic characteristics[2]. Chapter 4 then highlights the main factors that currently constrain yam production – since these are the areas where agricultural researchers are focussing (or will need to focus) their efforts. Recent and current research projects on yam in Ghana and West Africa more generally are outlined in chapter 5 and listed in Annex F. These projects fairly closely reflect the constraints to yam production elucidated in chapter 4.

Despite the majority of recent and current projects being aimed at addressing methods to overcome the constraints to yam production, there seems little evidence that much consideration has been given to how such methods or outputs might be disseminated to, and taken up by, the end user – the farmer. The implication with many of the projects is that once the research is done, the outputs will be taken up automatically. This situation seems particularly pronounced in Ghana where different ministries and organisations are responsible for different aspects of agricultural research, development and extension. Most researchers are in either the academic system (universities and technical colleges) or the institutes of the Council for Scientific and Industrial Research (CSIR; CRI, SARI, FRI etc.) under the Ministry of Environment, Industry Science and Technology (MEIST). Those concerned with extension and training of farmers, on the other hand, are located within the departments of the

[2] Indeed, it is hoped that this goes some way to meeting the need for such information as identified by Ezeh (1998), who feels that "…. research on the agrarian economy of yams has an immense contribution to make towards increased and more profitable yam production".

Ministry of Food and Agriculture (MoFA; PPRSD, CSD, DAE). There is a distinct impression that there is little communication or collaboration between those in the different ministries, perhaps because of scarcity of, and rivalry for, funding. Indeed, in the case of yam research, there appears to be rivalry for funding between the CRI and the SARI – two CSIR institutes assuming the mandate for work on yams.

Aspects of the national agricultural research and extension services are expanded upon in chapter 6 of the report (Section 2). This poor communication pathway between researcher and end-user was noted as an impediment to efficient research and development in the National Agricultural Research Strategy Plan (NARSP, 1994), and in the follow-on Agricultural Services Sector Investment Programme (AgSSIP, 1998-2000). The Research-Extension Liaison Committees (RELCs) were established under the National Agricultural Extension Project (NAEP) to try to bridge this gap. However, again, the poor level of funding for RELCs is given by the members as the reason they appear to have little real influence.

The nature of the funding source will also have an effect on the type of research carried out and the uptake pathways employed. National and external funding agencies will have their own specific, and often different, research and development agendas and priorities. Thus how the success of a project is measured will depend on what the project is aimed at, which will be determined by who is funding it and who is implementing it. In the case of DFID, the focus is on poverty alleviation and sustainable livelihoods; this may not be entirely compatible with the local researchers' and institutes' agendas of maintaining or improving research standing through the publication of scientific papers.

The study has concentrated on identifying constraints to the uptake of yam research results and new technologies in Ghana. It has shown that either the information does not reach the farmers, or it reaches them but they do not adopt it for one or a combination of reasons. The reasons for non-adoption can be grouped under the four principal headings listed below in **Box 1**. Inevitably, there is some over-lap between these categories and some of the factors could be placed in more than one category – credit availability, for example. These factors discussed in greater detail in chapter 7 of the study report (Section 2).

(a) Characteristics of the technology itself	(c) Characteristics of the farmer's immediate environment
Complexity	*Level of infrastructural development*
Profitability	*Agro-climate*
Riskiness	*Access to complementary inputs*
Compatibility with existing practices	*Degree of commercialisation*
Technical soundness and superiority over existing technologies	*Availability of relevant information*
Relevance to farmers' needs	*Land tenure and security of tenure*
Taste and processing/cooking properties	*Socio-cultural milieu*
Accessibility	*Credit access*
Ease of application	*Local system for produce marketing*
	Condition of rural infrastructure
(b) Characteristics of the farmer/farm household	*Effectiveness of the extension (and research) service*
Level of literacy/education	*Availability of media*
Age	*Other farmers*
Ethnicity/culture	
Standing in the community	***(d) Characteristics of the external (macro-economic) environment***
Socio-economic status	*National produce marketing arrangements*
Gender	*Changing tastes*
Labour availability	*Institutional characteristics of research and technology transfer institutions*
Land availability and farm size	*National policy environment*
Membership of farmers' organisation	*Peace and stability*
Risk status/attitude toward change	
	(e) Others
	Mix of factors
	Awareness and adoption
	Adaptation of innovations

Box 1. Factors influencing the uptake of agricultural research findings

Recommendations

The final chapter (10) of the study report recommends areas that should be the focus for the effective deployment of research, extension and other development resources in the future, to ensure that relevant production-enhancing agricultural technologies are generated by researchers and exploited fully by Ghana's yam farmers.

During this study it was noted that there are a number of 'on-the-shelf' technologies currently awaiting evaluation, multiplication, distribution and uptake by yam producers. There are several priority areas on which yam research should be focussed. Some of them are already being addressed while others are not. These are listed in detail in 10.1 of the study report, and summarised here in **Box 2** under some basic headings (though again several topics cut across more than one heading):

If the agricultural research system as a whole is to become more effective, it will be necessary for the research co-ordination to be addressed at the highest level. Detailed financial analyses will need to be included as an integral part of each of these research projects.

Detailed monitoring of the uptake process should be fully integrated within future yam research support interventions, so that a better understanding is reached of the most-effective communication pathways together with the key factors influencing uptake of the crop in Ghana. This knowledge may be applicable thereafter, both in other West African yam-growing areas and for the uptake by resource-poor farmers of agricultural research outputs' more generally.

It is important for all stakeholders in technology development activities to be realistic in their expectations. Agricultural research is a slow process and there will be a time-lag before most new technologies are developed to the point where they can start to be disseminated, particularly if one takes into account the relatively long-term nature of yam production.

From the list of constraining factors identified (above) certain specific improvements can be made relatively easily and at little cost, to the management and operations of the agricultural extension system, which have the potential to increase the efficiency of this uptake pathway. These are detailed in 10.2 of the report (Section 2) and summarised here in **Box 3**.

There are several other non-agricultural constraints that will need to be addressed if an enabling environment is to be put in place for the increased uptake of productivity-enhancing innovations and to raise farm productivity, increase household food security and reduce the incidence of poverty. Detailed in 10.3 of the report, these are summarised here in **Box 4**.

Conclusions of the study

Although yams play an important part in Ghana's economy**,** the contribution that the crop currently makes to farmer and trader incomes, food security and export earnings is significantly below its potential due to a gamut of technical, infrastructural, socio-economic, institutional and other constraints. Were these to be overcome, yam production could be increased significantly.

Fundamental institutional shortcomings have impacted negatively upon the development and uptake of new crop technologies, including those for yams. Resources earmarked for spending on research into yams have been far below what might be expected given their importance in the national diet and their contribution to the sector's GDP. In addition to structural impediments associated with the efficiency of the public research and extension services, there are a large number of factors that influence the decisions made by Ghanaian farmers to take up and use, new production and post-harvest technologies and techniques. The relative importance of specific factors in influencing uptake decisions will vary between farmers over both time and space.

Only rarely does adoption just happen. Rather, the dissemination and application of innovations need to be planned for in a systematic and comprehensive way - with goals, responsibilities and time-bound adoption projections defined at an early stage. Researchers must play an integral part in this process through reference to the funding agencies, policy makers, extension agents, and not least, the end users of the research findings – the yam growers.

Yams

- breeding: (i) higher yielding, (ii) more stable-yielding and (iii) disease-resistant varieties with tuber characteristics that facilitate harvesting and handling and that also meet consumer preferences. This work needs to take into account the impact of the "sedentarization of yam-based systems and the shortening of fallow periods", which is resulting from increasing population pressures in the rural areas;
- explore artificial means of inducing sprouting in dormant seed tubers in order to increase cycles of seed multiplication;
- improve systems for the rapid mass propagation and delivery of propagules, especially of newly-introduced or highly-desirable varieties;

Cropping system/environment

- the influence of the cropping system on the performance of yams (e.g. intercropping and tuber size);
- research on soil fertility and fertiliser application, and this work should be concentrated in the savannah zone where the shortage of fertile land is most acute;
- the development of more productive cultivation techniques (for land preparation, staking, weeding and harvesting, for example) than the current ones which are both slow and require heavy inputs of labour;

Crop Protection

- developing integrated management practices for nematodes and pathogens associated with tuber rots, for example by using hot-water treatment;
- developing improved diagnostics for the better health of propagules and safe international exchange of germplasm;
- investigate any moves towards the development of a yam seed market, with farmers specialising in growing clean seed for sale;

Harvesting, storage and transport

- seek out culturally-acceptable improvements in yam storage practices, including the way in which the shelf-life of tubers can be increased to improve household food security, boost export quality and raise returns to market-oriented yam farmers;
- explore the need for and possibility of, supplying short-term working capital to assist existing and new traders with bulk purchasing and stockholding activities;

Post harvest processing and marketing

- investigate the impact that the market queens and other actors have on the trade in yams;
- develop processing technologies to boost alternative uses of yams and to reduce the perishability of the tubers;
- monitor any changes taking place in consumer tastes in all parts of the country;

Box 2. Current and future research topics for yam in Ghana

Stakeholders

- farmers and local groups should be more systematically consulted and involved in the technology definition and development process;

Monitoring and evaluation

- simple monitoring and evaluation methodologies must be developed and systematically incorporated into the research-extension system (and/or into specific agricultural research projects), in order to provide up-to-date information on the impact of specific technologies to those working in it (budgetary provision will have to be made for this activity);

Training of extension staff

- continuing training programmes to upgrade the capacity of both field and managerial extension staff will be required, as will logistical support to enable them to undertake their work more effectively. Training is urgently needed in such areas as: (i) the causes, vectors and transmission mechanisms for yam pests and diseases; (ii) how to recognize yam tubers which should not be used as seed due to disease infestation; (iii) improved storage techniques and structures; (iv) rapid propagation practices; and (v) the efficient use of fertilizers. Extension staff need to have the capacity subsequently to pass on this information with confidence, to the farming community, and associated with this better access is required to improved extension literature;

Training of farmers

- associated with this, extension and research staff need to come together to train farmers and traders in improved tuber harvesting and post-harvest handling techniques, so as to reduce damage through bruising – possibly preceded by a thorough investigation of the losses incurred during transportation;

Extension infrastructure

- without a more viable public extension system, the chances of it being an effective cog in the adoption-process “wheel” are limited. For this reason, the recent proposal to pilot various alternative financing and service delivery systems for agricultural extension is welcome (e.g. yam traders’ associations/ yam exporters being approached for support to specific, targeted programmes).

Box 3. Interventions to increase efficiency in agricultural extension

Interventions

- urgently-needed expansion of the rural access road network;
- existing access roads and tracks need regular maintenance in order for produce to be moved to the market centres and for inputs and agricultural advisory personnel to gain access to the main areas of yam production;
- the publication and widespread dissemination of regular bulletins detailing the prices of yams and other tubers, as well as other pertinent market information;
- the training of farmers and traders in optimal yam handling practices, in understanding marketing standards and in the grading of tubers for export;
- investigate the principal characteristics and trends of the export market for yams.

Box 4. Non-extension/research interventions required to improve impact of yam research

Contribution of Outputs

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?

DFID's developmental goals are centred on poverty alleviation and improving the sustainability of livelihoods in developing countries. The aim of this study was to identify the factors influencing or constraining the uptake of research findings on yam crop protection in Ghana, and to develop recommendations or strategies to improve this uptake, and hence increase the impact of the research. Through reviewing the literature and collaboration with scientists and others concerned with yam production in West Africa (both partners on current DFID-CPP yam projects and others), a draft report has been produced. The draft report was presented for review at a workshop held in Ghana to explore further the topics of the study. A detailed final version of the report was then compiled taking on board comments and information from the stakeholders who attended the workshop (Annex 1 of the workshop proceedings – Section 3). This report, with the workshop proceedings, was distributed widely to development and research partners in key institutions both in West Africa (primarily Ghana) and UK.

The findings of the study, as well as those of similar uptake studies for other cropping systems will form the basis for a workshop to be held by the CPP at Wye College in June 2000. The plan is to use the findings of these different studies to develop strategies to help the programme improve the impact of the projects it funds.

The recommendations/strategies emanating from the Wye workshop, and particularly those associated with this study on yams, will be used in developing a follow-on (Phase II) project to the current "Yam diseases in Ghana" project (R6691), which is due to complete at the end of June 2000.

Appendix 1 - Inventory Control Form

NRIL Contract Number: ZA0354
DFID Contract Number: R7504
Project Title: Study of the factors affecting uptake and adoption of outputs of crop protection research on yams in Ghana.
Project Leader: Lawrence Kenyon

[List all single equipment items with a purchase value higher than £500 and items with a purchase value lower than £500 but deemed to be of an attractive nature (i.e. cameras, motorcycles, etc.) purchased during the quarter.]

Please fill in ALL the information requested in the table below for each item

Item	Make and Model	Serial No.	Date received	Purchase price	Location	Disposal		
						To	Date	Authorised
No equipment purchased.								

Natural Resources Institute

The uptake of yam research recommendations by farmers in Ghana

Prepared by
Martin Fowler
Social Sciences Department, Natural Resources Institute

May, 2000

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Tables

The uptake of yam research recommendations by farmers in Ghana

"In the late 1960's, one of my first tasks when seconded to the University of Nairobi was to forecast the effect on Kenya's maize supply of the uptake by smallholders of the newly available hybrid seeds. What irony, 30 year later, to be asked to review a book on Africa's *emerging* maize revolution" (Smith, 2000).

1. Background

It is important that the UK's Department for International Development's (DFID) Crop Protection Programme has tangible evidence that the improved technologies which have been generated under the various research projects which it supports, have actually been translated into impacts at the farm level. Only in this way can it be demonstrated that a contribution has been made to one of the overall development goals of the UK's Department for International Development, namely reducing extreme poverty.

Given the importance of yams to Ghana's overall food security situation and, more critically, to household food security, particularly in the rural areas (*see Section 3.2, below*), the potential benefits of any research activity undertaken on this crop are high. By improving household food security through the application by farmers of research findings, the livelihoods of the resource-poor yam producers and their families can be made more resilient.

One of the *'Means of Verification'* of the *'Outputs'* in the Logical Framework of the "Control of yam diseases in forest margin…project" was to be the "subsequent uptake by farmers" of the technologies thus developed (Anon, 1996). To this end, in September 1999 the Crop Protection Programme issued a call for short studies to be undertaken on the uptake of research technologies' developed for a number of crops.

The present study on yam research outputs' uptake[1] was commissioned following an evaluation by DFID of the proposal submitted by NRI in September 1999 to carry out the work. In the proposal (Anon, 1999), the objectives of the task were specified as being: (i) the identification and analysis of those factors which affect the uptake of yam research outputs; and (ii) the development of recommendations to be used to guide future yam research work, such that the uptake by farmers of the new technologies arising from it is improved.

It is also recognised that the importance of agricultural research in the development process and the uptake of recommendations arising from it, are areas of considerable interest to the Ghanaian authorities. For example, in 1997 the National Economic Forum recommended that information technology and networking needed to be developed in the country, "….. for disseminating research data and for making research results available to facilitate agricultural production, marketing and processing". It recommended "…. strengthening the links between research, extension and the farmer" with the research "team leader" being "part of the extension exercise" and stressing the need to "market all usable research findings vigorously" (National Development Planning Commission, 1997).

It is against this background that the current study was undertaken.

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[1] This term has been defined as the application of information and technology by both 'intermediate' and 'end' users (Garforth and Usher, 1996).

2. Introduction

In planning the execution of this piece of work, it was recognised that time and funding constraints meant that it would not be possible to undertake a field survey in order to assess the transfer of yam technologies to farmers. Such an exercise would have been a major undertaking - for example, an evaluation carried out in 1998 by a team from CRI/CIMMYT of the uptake by farmers in Ghana of three new maize technologies, had involved a four-month intensive survey followed by a period back in the office when the data was analysed and the report written (Morris *et al*, 1999). Clearly, this would have been an expensive undertaking and one which would have been difficult to manage (Alex, 1998).

The approach adopted in this instance was to undertake a short review of relevant literature found in the library and offices of key staff at the Natural Resources Institute in Chatham, UK. This was followed by a two-week visit to Ghana. Whilst there, the programme of work which was followed comprised a series of semi-structured interviews with key personnel in the research and agricultural extension organisations involved, either directly or indirectly, with yams in order to obtain information about the research process, the promotion of new technologies, the uptake pathways[2] used and the levels of technology adoption realised. Meetings were also held with representatives of some of Ghana's development partners supporting agricultural research and extension activities in the country. Much of this work was undertaken in Accra, although visits were also paid to key agricultural institutions in Kumasi and Tamale. Considerable use was made of papers, reports, conference proceedings and studies held in the offices of these informants[3] and in the libraries of these and other organisations.

In addition, given the large amount of work which has been done by staff from the International Institute for Tropical Agriculture (IITA) in the West African region on yam research and on the uptake of tropical crop research recommendations in general, a short visit was paid to the Institute's headquarters in Nigeria. During his visit to Ibadan, the author was able to hold discussions with a number of key scientists who have been involved with programmes of yam and other root crops' research throughout the region for many years; their insights were a further valuable input to this study report. The IITA library proved to be an additional important source of both published and 'grey' literature.

The Bibliography (*Annex A*) provides details of the principal documents used in writing this report, as well as a number of other documents that were consulted. Many of these reports have never been published officially, and they were kindly lent to the author by people working in Ghana. The location of each report has been recorded should anyone wish to know where they can be found.

During the study it also became clear that a large amount of work on the uptake of new crop technologies had already been undertaken in Ghana, although little of this was on yams and almost none was related to yam crop protection research. For this reason, it was decided that experiences with the uptake of other crop technologies would also be included in the study, since useful lessons were likely to be learnt that could apply equally to yams.

The author also discovered that, in preparing the Agricultural Sector Support Investment Programme (AgSSIP), the government of Ghana had established five committees to look at priority areas. The terms of reference of one of them was to help "develop strategies to overcome the major constraints that obstruct access and effective utilisation of agricultural technology…(to) identify the main constraints (including land issues) that affect the development and dissemination of agricultural technology and together with stakeholders,

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2 This refers to the route or channel by which information and technologies reach users (Garforth & Usher, 1996).
3 A list of the people met is provided in Annex C.

develop strategies to overcome such constraints" (Technology Sub-committee,1998). Unfortunately, during his visits to Ghana the author was unable to discover whether the committee had yet completed its work.

An outline of the draft findings of this study was presented during a one-day workshop on yam research and technology uptake, which took place in Kumasi in March. Participants included yam research collaborators from Ghana, other parts of the West African region and the United Kingdom, and specialists involved in both agricultural research work, more generally, and in agricultural extension and training activities, as well as extension staff and farmers with first-hand experience of the crop. The workshop was also attended by representatives of development partners working in the country's renewable natural resources sector. A list of participants is provided in Annex D. A report of the workshop is under preparation and is to be published separately.

The draft report of the study was circulated for review to a small number of people who had attended the workshop, as well as other interested parties. Many useful comments were subsequently provided by them to the author. Wherever appropriate, these suggestions have been incorporated into the final version of the report. Particular thanks are due to Dr Robert Asiedu from IITA whose detailed comments and suggested additions, based on his intimate knowledge of both the subject matter and of Ghana, proved to be of great help to the author. This notwithstanding, the usual disclaimers apply.

During the initial stages of the study, it became clear that whilst there were a number of sources of information on the Ghanaian yam sub-sector, a consolidated account of it had never been written. For this reason, Chapter 3 provides a detailed analysis of the sub-sector (placing it in the context of the agricultural sector as a whole); the text is supported by data presented in a number of tables that help to elaborate on some of the sub-sector's basic characteristics[4]. Chapter 4 highlights the main factors which constrain yam production at the present time – since these are the areas where agricultural researchers are focussing (or will need to focus) their efforts.
Given the key rôle of agricultural research and extension in the output and uptake of improved yam technologies and in light of the structural changes which have taken place in both services over the last decade or so, Chapters 5 and 6 contain a review of them. The subsequent chapter describes in some detail the principal characteristics that influence the uptake of yam technologies by farmers in Ghana. As mentioned in the Introduction (Chapter 1), due to the scarcity of studies of the uptake of yam technologies *per se*, the factors affecting the uptake of technologies developed for other crops in the country as well as in the West African region more generally, are included in Chapter 7. It is believed that many, if not all, of these factors affect, in one way or another, the uptake of new yam technologies.

Chapter 8 presents a case study of the factors affecting the uptake of a specific yam technology – the minisett technique – which has been strongly promoted both in Ghana and in the West African region, in recent years. On the basis of the information contained in the study, a number of conclusions are drawn in Chapter 9. The final chapter lists areas which, it is recommended, should be the focus for the effective deployment of research, extension and other development resources in the future, such that relevant production-enhancing agricultural technologies are generated by researchers and exploited fully by Ghana's yam farmers.

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[4] Indeed, it is hoped that this goes some way to meeting the need for such information as identified by Ezeh (1998), who feels that "…. research on the agrarian economy of yams has an immense contribution to make towards increased and more profitable yam production".

3. Ghana's agricultural sector and yam sub-sector: principal features

3.1 The agricultural sector

Agriculture plays a dominant role in the Ghanaian economy. It provides more than 47 per cent of Gross Domestic Product (GDP)[5], 46 per cent of merchandise exports, is the principal source of income for the majority, while approximately 65 per cent of the labour force is employed in the sector, mainly working on their smallholdings meeting the bulk of their food needs (Republic of Ghana, 1999[a]). However, its impact is even wider than these figures would suggest, with one study estimating that 80 per cent of the population depends directly or indirectly on the sector for its livelihood (ICRA, 1996). It is thus the mainstay of both the social and economic development of the country.

Smallholders form the vast majority of farmers and are responsible for 80 per cent of the agricultural GDP, while estate production is confined to a limited range of crops: principally oil palm, pineapples and rubber. Bush-fallowing is the predominant farming system, although with the population increasing at an estimated rate of 3 per cent per annum, the pressure of population is resulting in ever-shortening fallow periods which is causing soil fertility to decline in many areas.

Most cultivation is manual – the most common farm implements being machetes, knives, three types of hoe and the earth chisel (Tetteh and Saakwa, 1991) - while draught power is limited. Moreover, hardly any purchased inputs are applied to the soil. The production of annual food crops is the basis of the farming system with cocoa, the most important of the perennial tree crops, playing an important part in the rural economy. Head-loading is the principal means[6] by which farm produce is transported to the homesteads or the collection/marketing points after harvest due to the general lack of rural access/feeder roads.

Since 1987 the average annual rate of growth of the agricultural sector has been 1.9 per cent. Commentators have attributed the sluggish growth to a number of factors - one of the most important being the "low level of application of improved technologies" (*see Republic of Ghana, 1999[a], for example*). This clearly has important ramifications on the poverty situation nationally - the bulk of the poor earn their livelihoods from agriculture and one-half of all rural households are classified as 'poor' compared with 23 per cent of households in the urban areas. Furthermore, in excess of 80 per cent of the country's poor live in the rural areas (Republic of Ghana, 1999[b]).

Recent national economic policy pronouncements, in particular the Vision 2020 document[7], have shown that the Government is fully aware of the key rôle that agriculture plays in providing the basis for overall economic growth[8], in reducing poverty and in "increasing human development" (Republic of Ghana, 1999[a]). Consequently, one of the national development goals is to transform agriculture into a highly productive and responsive sector, growing by an average of 6 per cent per annum.

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5 Data for 1997 (Anon, 1998). Industry, by comparison provides 17 per cent.

6 IECT (1999) estimates that 90 per cent of all produce is thus carried; the Ministry of Finance (1999) estimates it to be even higher – 95 per cent. Average loads are between 25kg and 30kg (Tetteh and Saakwa, 1991).

7 Indeed, the most recent policy paper states that in Ghana where, "…. a high proportion of the population is rural, poor and engaged in agriculture, the sheer size of the agricultural GDP dictates that accelerated growth of the economy, increased employment and reduction in poverty, cannot be attained without high growth in agriculture. The role of the agricultural sector under Vision 2020 is therefore crucial" (Republic of Ghana, 1999[a]).

8 By providing raw materials for local processing, by ensuring household and national food security (and nutrition) needs are met, and by earning foreign exchange.

3.2 The yam sub-sector

Production

West Africa produces more than 90 per cent of the world's yam output, with Ghana the third most important producer, ranked behind Nigeria and Côte d'Ivoire. It produced 2.2 million tonnes in 1995, compared with 2.8 million tonnes in Côte d'Ivoire and Nigeria's 23 million tonnes (Vernier *et al*, 1997).

The crop is one of Ghana's major staples (Table 1; *see also Annex B*). Yams are ranked second in importance (in tonnage terms) after cassava in staple food production and, as a result of their relatively high unit price, are the most important food crop in terms of value of production (Table 1). Together with cassava, they provide 31 per cent of "national food security" and supply in excess of 50 per cent of the calorie needs of the average Ghanaian (Nkum Associates, 1994).

Table 1. Estimated production and value of staple foods, 1997 and 1998

	1997		1998	
	Tonnage *(in tonnes)*	**Value** *(in ¢ million)*	**Tonnage** *(in tonnes)*	**Value** *(in ¢ million*
Maize	995,953	404,516	1,015,029	412,264
Cassava	6,999,534	915,760	7,171,452	938,252
Yam	2,407,938	1,033,140	2,293,567	984,069
Cocoyam	1,529,798	528,340	1,576,687	544,534
Plantain	1,818,377	545,172	1,912,648	573,436

<u>Source</u>: Centre for Policy Analysis (1999)

The crop is grown mainly by smallholders, covering approximately 10 per cent of the country's cultivated land (Table 2) which is approximately one-third of the area planted to cassava.

Table 2. Area planted to selected food crops, 1991 to 1998 (in '000 ha)

Crop	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Cassava	535	552	532	520	551	591	589	630
Yam	227	224	207	154	176	178	187	211
Plantain	174	157	164	184	213	229	225	246
Cocoyam	203	196	173	179	205	214	206	218
Maize	610	607	637	629	689	665	652	697
Sorghum	263	307	310	299	335	314	324	332
Millet	209	210	204	191	193	190	170	181
Rice	95	80	77	81	100	105	118	130
Guinea Corn	263	307	310	299	335	314	n.a.	n.a.
Total[9]	*2,316*	*2,333*	*2,304*	*2,237*	*2,462*	*2,486*	*2,471*	*2,645*

<u>Source</u>: Ministry of Food and Agriculture, 1999

[9] Excluding 'Guinea corn'.

While cocoa provides 14 per cent of the natural resources sector's GDP, other crops, which include yams, make up 61 per cent (1994 data). More detailed analysis shows that roots and tubers accounts for 46 per cent (of which cassava: 19 per cent; yams: 17 per cent; and, cocoyams: 10 per cent) and maize for 5 per cent (Anon, 1994). Fisheries (5 per cent), forestry (11 per cent) and livestock (7 per cent), comprise the balance.

The importance of yams as a food staple is underlined by the observation that its consumption is sometimes used as a poverty indicator – thus, if *fufu*[10] is prepared only rarely, the household is considered to be poor. Indeed, it is reported that rural households seek to extend the period of tuber storage so that they can eat yams regularly in order to demonstrate to neighbours that they are not poor (Anamoh and Bacho, 1994). In addition, the crop is important to rural households for food security purposes because its yields fluctuate less than those of cassava (IECT, 1999).

The crop is grown widely – in 34 of the country's 43 agricultural districts (Anon, 1994) – although data showing the breakdown of production by region are unfortunately not published regularly[11]. The principal areas of production are the northern forest and southern savana zones[12], with about two-thirds of the national harvest being produced in Brong Ahafo and Northern regions (Table 3). (Other data show a slightly different spatial pattern[13]). The crop is consumed in all parts of the country (GTZ, 1999).

Table 3. Regional breakdown of yam production, 1990

Region	**Proportion of national harvest (per cent)**
Northern	40
Brong-Ahafo	23
Ashanti	9
Eastern	8
Volta	7
Other	13
Source: Natural Resources Institute, 1996.	

Due to the need for high levels of soil fertility, yams are usually the first crop grown on land once it has been cleared of bush. However, as a result of the heavy demand that the crop makes on soil nutrients, yams are grown on the same plot for only one year, being succeeded by maize, beans and/or cassava while another newly-cleared plot is planted to yams[14]. Following several seasons of intensive cultivation, the garden is allowed to revert to bush[15], normally for between three and five years. In general, almost no use is made of inorganic

[10] (including some yam). Fufu is a common item in the Ghanaian diet – produced by pounding boiled pieces of starchy staples such as cocoyam, cassava, plantain and yam. It is a generic term, not exclusive to yams.
[11] It is not certain how the 43 "agricultural" districts mentioned here, relate to the country's 110 administrative districts.
[12] The ICRA study (1996) refers to this as the "Forest Transition Zone".
[13] Brong Ahafo (30 per cent), Eastern (23 per cent) Northern (17 per cent), Volta (11 per cent) and Ashanti (9 per cent) – the year and source of these data are unknown.
[14] A different interpretation has been advanced. Namely, that the rapid build up of pests and diseases rather than declining soil fertility, is, in fact, the principal 'push' factor (Manyong, V., *pers. comm.*).
[15] However, it is reported that population pressure is leading to a noticeable reduction in the fallow period (ICRA, 1996).

fertilisers[16] and herbicides, while only limited amounts of organic matter are applied to the soil (ICRA, 1996).

A result of this is that farmers, particularly itinerant farmers, wishing to plant yams are compelled to move to distant areas of low population density, where the soil is more fertile. This aggravates the problems of transporting farm inputs and outputs (Danquah, O-A. and Lamptey, J., *pers. comm.*).

Yams are a prestigious crop having strong cultural ritual and religious significance and their consumption is preferred to other starchy staples at social gatherings (Dorosh, 1988; GTZ, 1999; IITA, 1998; Orkwor *et al*, 1998; Tetteh and Saakwa, 1991). They are used, for example, to fulfil social obligations - to chiefs and in-laws – in the rural areas (Langyintuo, 1993), which is why the production of *'ware'*[17] yams for daily consumption and sale continues alongside the production of (even larger) tubers which are used principally for ceremonial purposes. They are also an indispensable part of bride-price. Consequently, yams are likely to remain an important component of the crop mix in Ghana's savana and northern forest agro-ecological zones for the foreseeable future.

Harvest

There are many varieties of yams and farmers plant a mixture of early- and late-maturing ones in order both to obtain seed from those which can be double-harvested[18], and to be able to stagger the harvest in order to extend the consumption period and/or even-out the flow of income from crop sales. Langyintuo (*op.cit.*) reports that farmers cultivate an average of five varieties, of which three are early-maturing, while about 30 varieties are commonly grown throughout the country. Popular varieties include those which produce large tubers[19] and those with a strong market demand, whilst other favoured characteristics apart from the time they take to mature, include overall yield, taste, suitability for making *fufu*[20] and 'storability'. The main species in Ghana is *Dioscorea rotundata* which accounts for approximately 80 per cent of species cultivated. *D. alata* makes up most of the balance (Peters *et al*, 1997).

The tubers are delicate and are easily bruised during harvest (aggravated by the fact that the soil tends to be hard and dry at harvest time[21]), subsequent handling and transportation to market (Dorosh, 1988). Bruising results in a decline in quality (Bancroft *et al*, 1998) and predisposes tubers to infection by storage fungi.

Storage and marketing

The typical situation is that, following harvest, the bulk of the tubers are stored in mounds under trees adjacent to the fields, with cut yam vines being used to provide shade. Alternatively, tubers may be head-loaded[22] or transported by bicycle to the homesteads where they are stored inside huts or in underground pits[23]. They are either consumed there or

[16] Due both to the cost of fertilisers and the belief that it spoils the quality (taste) of the tubers (ICRA, 1996).
[17] Any tubers harvested for food (rather than for use as seed for planting); *see Footnote 18*.
[18] For a description of the process of double-harvesting ('milking' or 'pricking') *ware* yams for consumption purposes while the remaining tubers are allowed to continue growing to produce seed yams, see Kindness *et al* (1998) or Anamoh and Bacho (1994).
[19] It is reported that large *ware* yams obtain a proportionately-higher retail price than smaller tubers.
[20] The varieties which produce larger tubers are reported to produce the pounded yam preferred by consumers (Vernier, P., *et al*, 1997).
[21] And to the fact that much of the large-scale harvesting activities are carried out by casual labourers whose income is dependent upon the number of yams harvested (they are paid piece-rates), rarely, if ever, upon the quality of the harvest (Danquah, O-A., *pers. comm.*).
[22] One study (MoFA/GTZ, 1994) estimated the distances between the fields and the homesteads as being anything between 3 km and 11km.
[23] However, one factor militating against transportation to the village and storage close to the homestead is reported in Fuseini (1995). The survey he undertook reveals that by moving the yams to the village, farmers

transported to roadside collection points or villages – again by head-loading or bicycle, or else by tractors along farm tracks – and, from there, to towns in lorries[24] and pick-ups.

Tubers can be stored for between 2 and 6 months[25], depending on the variety. However, rotting after harvest is common and is aggravated by the high temperatures which prevail around harvest time. Incomes could be raised significantly if yams could be stored for longer and this has been an area on which much research has been focussed.

Tubers are attacked by pests and diseases – including nematodes, termites, Yam Beetle, fungi and viruses. There are also significant losses caused by rodent attacks and theft.

Tubers are normally sold at recognised assembly markets which open in almost all villages and towns on specific days of the week, and are usually under the control of local authorities. These markets are either wholesale or retail selling points, or sometimes a combination of the two. Conclusions arising from those analyses which have been carried out of yam marketing arrangements and of the rôles of the yam trader associations and market agents (with 'queens' at their apex), have reached markedly differing conclusions as to the competitiveness of their operations[26] - see, for example, Gray (1996), Food and Agriculture Organisation (1998), Levin (1997) and ICRA (1996) for a range of different points of view.

Processing

In the north and the forest-savana zone, yam tubers are peeled, cut into pieces, boiled and then pounded to make '*fufu*' at the household level. In the central and southern parts of the country yam is mostly eaten as '*ampesi'* – cut into pieces and boiled. Whole tubers are also boiled and eaten, although less frequently. Whilst the production of yam chips is increasingly common at the household level, there is as yet no commercial production other than in a few back-yard chip-making enterprises.

Nutrition

The national diet is heavily dependent upon starchy staples and cereals – yams are an important component of the former food group, more so in the principal producing areas. They are an excellent source of carbohydrates and also contain some vitamins (C, in particular – 10 milligrammes per 100gm fresh weight), dietary protein (2.4 per cent, compared with less than 1 per cent for cassava) and minerals (Kay, 1987). Yams' protein content makes them a more balanced food than cassava (Sékou, 1999) **-** indeed, it has been reported that children in households that have a predominantly yam-based diet have a better nutritional status than their counterparts who consume a diet based on cassava.

Nevertheless, malnutrition is still a significant problem in Ghana – for example, 24 per cent of all children aged between 3 and 36 months are undernourished, 28 per cent are under weight and 12 per cent are 'wasted' (Levin, 1997). The rural areas, and particularly the north, experience the highest incidence of each of these three conditions.

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become liable to requests from neighbours for tubers. On the other hand, however, tubers stored in the fields are more liable to losses from theft, fire and livestock.

[24] Lorries carry up to 5,000 tubers which are tightly packed in order to minimise bruising. However, regular breakdowns are a feature of these operations due to the condition of the roads and to the age of the vehicles; the resulting delays in marketing are a major cause of losses (Gray, 1996)

[25] Some farmers report being able to store tubers of the "*Matches*" variety (of *D. alata*) for about a year (Danquah, O-A and Lamptey, J., *pers. comm.*).

[26] Although this is hardly surprising given the contradictory answers provided by farmers, traders and market operators to researchers studying the characteristics and workings of the yam marketing network (ICRA, 1996). In addition, at least one research report provides contradictory assessments within the same paragraph: "The marketing system of yams appears to be reasonably efficient and competitive, with a large number of traders involved……..However, little is known about the extent of monopoly activity….it is possible that a few large wholesalers wield considerable power over the market" (Gray, 1996).

Costs, prices and incomes

Yams are a high-cost food, compared with cassava. For example, their per unit calorie costs are far higher, although their post-harvest handling and processing costs per unit of protein production are less (Nweke *et al*, 1991). In total, on an energy basis, they were measured as being between 5 and 7 times the '*gari*'[27] price in Lagos (Dorosh, 1988). In addition, the cost of transporting yam tubers is also higher than that of *gari*, while processing is time-consuming. In the urban areas of Nigeria this is resulting in a decline in the per capita consumption of yams (*ibid.*). A decade ago, Tetteh and Saakwa (1991) noted that yams were becoming an expensive item and that consumers in Ghana were turning to the cheaper cassava; no supporting evidence is provided, however, nor do the national figures show any decline in yam production.

A factor contributing to the high cost of yams are that the fresh tubers: (i) are transported over much greater distances; (ii) are larger; and (iii) need more care in handling and transportation because they are intended to be stored for future use in fresh form for longer, than other roots and tubers (Asiedu, R., *pers. comm.*).

Nevertheless, as stated earlier, yams are an important and much sought-after food, with an estimated average national annual per capita consumption of over 43 kg per head (the equivalent of more than 100 grammes per day).

In spite of their high cost, the income elasticity of demand for yams has been estimated as being positive (*ibid.*), with a recent study (Anon, 1994) estimating it to be 1.09 among Ghana's urban population[28].

Yams are not only a basic food staple, but also an important source of income in almost all of the areas of production, in some cases providing the growers with high returns. Thus, Anamoh and Bacho (1994) remark "If farmers are rich in this village it is through yam". Similarly the ICRA (1996) study found that yams were an important source of revenue for poor households - even amongst "subsistence farm households" the bulk (two-thirds) of the yam harvest is sold. Further evidence of this is provided in the National Agricultural Research Strategic Plan (Anon, 1994). It reports the findings of a survey which showed that yams (together with cocoyams) contributed 11 per cent of the total income derived by poorer households from the sale of crops (compared with 6.8 per cent of the total crop income being provided by yam crop sales among non-poor households).

Poverty

While Northern region is the most important yam-producing area, it is also one of the poorest in the country and one of the three regions in which the incidence of poverty increased in the seven years to 1998/99; the others being Central and Upper East. The same study in which these data appear (Ghana Statistical Service, 1999) records that the highest incidence of poverty is among food crop farmers – 61 per cent of them are thus classified - and this group makes up 58 per cent of the total number of poor people in the country. It is of concern that these figures changed very little over the analysis period.

Not surprisingly given their popularity, yams feature prominently in the consumption baskets used for the cost of living calculations made by the Ghana Statistical Service. Indeed, the quantity of yams in the baskets is second only to cassava/*gari*[29], while

[27] Processed cassava.

[28] Although the same source estimates the income elasticity of demand to be 0.88 among rural consumers.

[29] Between 89gm and 116gm per day, depending on the wealth ranking of the household. The consumption figures for cassava are between 135gm and 116gm, while those for *gari* range from 64gm to 76gm.

average annual household expenditure on yams is higher than on cassava[30], cocoyams or plantains.

Since the crop is widely grown by the poorest section of the rural population and 81 per cent of the poor are located in the rural areas (*ibid.*), increases in the productivity of yam-based farming systems can be expected to have a direct, positive impact on incomes of the poor, so long as these increases are complemented by programmes to support marketing and post-harvest operations for the crop.

Exports

In recent years, national agricultural planners have realised that there is limited potential for significant growth in the output of Ghana's traditional agricultural exports. Consequently, increased emphasis has been placed on the diversification of production for export. As a result, the agriculture sector now makes a significant contribution to the total value of non-traditional exports and the country is gaining a reputation as a source of organically-grown food products. This notwithstanding, the agricultural sector's contribution to the total value of non-traditional exports has fallen from its peak of 45.9 per cent in 1990. In 1996, for example, the figure stood at 18.2 per cent (Levin, 1998). From a review of more recent export data (Table 4), it seems unlikely that the sector's importance has increased significantly since then.

Table 4. Yam exports, 1960 to 1998 (incomplete series)

Year	Quantity (in tonnes)	Value
1960-65	1,200	n.a.
1966-70	3,100	n.a.
1985	27	US$ 30,400
1986	488	US$ 105,700
1987	493	US$ 106,794
1988	704	US$ 183,273
1989	1,635	US$ 390,748
1990	2,121	US$ 969,000
1991	3,051	US$ 2,528,000
1992	2,781	US$ 2,111,600
1993	3,547	US$ 2,034,600
1994	5,323	US$ 3,059,600
1995	4,755	¢3,270.8 million
1996	7,496	US$ 5,164,195
1997	7,662	US$ 5,121,508
1998	7,236	US$ 5,840,002

Source: (i) 1960 to 1970: Langyintuo (1993), who speaks of a "decline after 1980".
(ii) 1987 to 1989: Tetteh and Saakwa (1991)
(iii) 1995 to 1998: Ghana Statistical Service (2000) and Ministry of Trade & Industry *et al* (1997, 1998 and 1999)
(iv) 1985, 1986 and 1990-1994: ICRA (1996)

Recent analysis (FAO, 1998) shows that Ghana enjoys a strong comparative advantage in yam production and, for this reason, its production for export is being promoted as part of the non-traditional exports' strategy. The importance of (official) exports of yams should not,

[30] Excluding cassava products (*gari*, etc).

however, be exaggerated. In 1989, for example, the crop accounted for only 2 per cent of the total value of non-traditional agricultural exports (and yam exports have never accounted for more than 1 per cent of the national output of the crop).

A number of reasons for this have been put forward, including the inadequate promotion of Ghanaian yams in overseas markets, poor handling practices during both harvest and post-harvest operations, "internal marketing inefficiencies" and "the lack of grade and weight standards" (Directorate of Agricultural Extension Services, 1998).

Yams that are to be exported are carefully selected by exporters from those being offered for sale in the Accra market, in Volta region and in the northern parts of the country. Small tubers – weighing 2 kg on average (FAO, 1998) - with a low water content and good storage properties, are preferred.

The main markets are the United Kingdom, the rest of Europe and North America, with the principal consumers being their "West African and other yam-eating 'diaspora' communities" (*ibid.*). Between 1996 and 1998, the UK accounted for an average of 62 per cent of the market and the United States of America for a further 16 per cent. The balance was exported to a number of mainland European countries (Ministry of Trade and Industry, 1997-1999). The returns realised from Ghana's yam exports are discounted on the world market due to the poor average quality of the tubers compared, for example, to those from Brazil.

There is also a considerable, yet unrecorded, cross-border trade in yams, to Burkina Faso, Togo and Côte d'Ivoire (Gray, 1996). The FAO (1998) study estimates the amounts thus traded as being between 25,000 tonnes and 30,000[31] tonnes per annum.

[31] However, no source for these figures is cited in report.

4. Constraints to increasing yam production in Ghana

4.1 Costs of production

Planting material

The main constraints to increased yam production are the shortage and high cost of planting materials (IITA, 1998). Seed represents the highest cost item, accounting for as much as 50 per cent of operating expenses (Gray *et al*, 1997), while Osei (1993) estimates planting material makes up between 35 per cent and 54 per cent of the total cost of production. In most instances, edible tubers are used for seed purposes, which means that between 10 per cent and 30 per cent of the volume of the '*ware'* harvest is replanted as seed (Chikwendu *et al*, 1994)[32].

The shortage of yam '*setts*' has a major influence on yam production - Langyintuo (1996) notes that seed shortage is an important constraint to increased yam production in the 'Guinea savanna zone' – more so than in the 'Forest zone', where other constraints are more critical.

At first sight, purchasing seed appears not to be common practice. Farmers tend to use their own seeds for planting and only obtain them off-farm on an *ad hoc* basis. Their reluctance to exchange planting material is explained, in part, by the belief that "seed yams carry along with them the fortunes or misfortunes of the farmer who grows them" (Tetteh and Saakwa, 1991).

In spite of this, farmers do seek planting materials from external sources[33] if:

- their stocks are inadequate due to a poor harvest the previous season;
- they wish to obtain new varieties; and/or
- they plan to increase the area planted.

This finding is supported by the results of a survey of yam farmers undertaken by Langyintuo (1996) which revealed that between 30 per cent and 83 per cent of farmers had purchased seed yams at some point in the recent past. 11 per cent of the farmers in Northern and Brong Ahafo regions questioned in a recent survey, had obtained seed from external sources during the previous year (Kindness *et al*, 1998).

Unfortunately, the quality of purchased seed yams is often poor. At the same time, it is normal for farmers to sell seed yams only once their own fields have been planted. This means that the purchasers tend to plant late which results in sub-optimal yields (Marfo *et al*, 1998).

The weight[34] and, thus, the opportunity cost of seed required for planting was the principal thrust behind the development in the 1970s of the '*Minisett*' technique which uses only 4 per cent of the yam harvest for seed purposes, and also the more recent *in vitro* work (Langyintuo, 1996) to generate seed yams more quickly. The minisetts which are to be planted usually weigh only 25 gm, on average, which significantly reduces direct seed costs to the farmer. On the other hand, the costs of caring for the minisetts are high and need to be

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[32] The report of the FAO (1998) study gives average figures of 4,000 mounds per ha and a seed weight per mound of 500g; in other words, a total weight of seed of 2 tonnes per ha. The study estimates average yam yields as being close to 13.5 tonnes per ha, which would mean that seed requirements represent 15 per cent of output. Elsewhere in the same study (*ibid.* p. 21), estimates of seed requirements are stated as being both 13 per cent of harvest and 20 per cent (p. 45), while Langyintuo (1996) puts the figure at between 25 per cent and 33 per cent, and Quin (1998) estimates it to be 10 per cent.

[33] Usually neighbouring farmers.

[34] This is also an important consideration in reviewing the storage of tubers. If theft of harvested tubers means that farmers have to store their yams close to the homestead where they can better guard them, more than 10 per cent of the total harvest may, in reality, be transported from the field and then back again for planting at the start of the next season.

taken into consideration if the technique is to be extensively promoted. (The technology, and these and other considerations are discussed in more detail in Chapter 8, below).

A recent study has noted that in addition to the high cost of seed, many of the varieties currently being grown by farmers have a low yield potential (FAO, 1998)[35].

Labour

The other major item of expense in growing yams is that of labour, which has been estimated to account for as much as 30 per cent (Marchand & Girardot, 1999), 40 per cent (Nweke et al, 1991) or 54 per cent (ICRA, 1996[36]) of total operating costs. Most of the labour input is used in land preparation - making the mounds in which the yams are planted and grow, since no mechanical system of mound preparation has yet been developed (although minisetts can be – and are - planted on the ridges produced by ploughing; there is no data on how widespread this practice is).

At the same time, labour productivity is low and there is undoubtedly a need for research to be undertaken on how it might best be raised (FAO, 1998).

An additional aggravating factor is that at the time when the soil needs to be mounded, labour is needed for other farm operations, which increases its cost. Also, at this time the soil tends to be dry and hard which means that relatively more labour is required (Tetteh and Saakwa, 1991). However, another observer has remarked that one of the major advantages which this crop has over others is that the yam seed tuber can stay in the soil over the dry season. Many farmers prepare their mounds towards the end of the rainy season, before the ground is dry and hard and at a time when the demand for labour for other farm operations in low. Seed tubers are then planted into the mounds (and are protected from the sun by grass mulch placed at the top of the mound) at harvest or shortly thereafter. The seed tubers are left to sprout in their own time (Asiedu, R., pers. comm.).

Significant inputs of labour (more than 10 per cent) are required for training yam vines along stakes, a practice which has been shown to increase yields (Dorosh, 1988) – see Section 4.3. Labour is also used for weed control, an increasingly-important task as soil fertility, nationally, declines. With a shortage of labour being a recognised feature of Ghana's 'forest zone', higher output is constrained. Not surprisingly, casual labour is commonly hired by farmers (Langyintuo, 1996).

However, in spite of the high cost of seed and the high labour input (estimated to be in excess of 400 person-days per hectare per annum under most systems - nearly twice that of cassava and more than six times that of maize; FAO, 1998), production is highly profitable, with gross margins per hectare reported as being more than double those of other crops (Dorosh, 1988).

4.2 Land

Together with the limited availability of planting materials and labour, the growing shortage of fertile land – as a result of the population in the rural areas increasing by more than 3 per cent per annum - is reported as being one of the binding constraints to expanded production. It also provides the explanation for cassava, which is more tolerant of poor soils, occupying an increasing proportion of the national hectarage planted to staple foods - Table 2 (and, thus, for the crop providing an increasing proportion of national staple food production – *see Annex B*).

[35] Although others dispute this finding (Danquah, O-A., *pers. comm.*).
[36] This high figure is explained by the fact that the study did not include the cost of seed materials in its calculations – a methodological error.

Because most avenues for the extensification of agriculture are now blocked, production will have to become more intensive through the use of 'modern' inputs. As a recent review notes, the success of the intensification process will be determined by the rate of adoption and use of research findings and recommended practices (Ministry of Finance, 1999).

4.3 Stakes

Another essential input to the cultivation of most yam varieties which is becoming increasingly scarce, are the yam stakes along which yam vines are 'trained' as they grow. In areas where the fertility of the soil is low, such as the coastal savana, yam vines need to be trained if reasonable yields are to be realised. However, the practice is expensive due to the local shortage of stakes, which now have to be transported from far away[37]. Indeed, in some parts of the country the shortage is so acute that the stems of dried palm fronds and elephant grass are now used as substitutes. It has been alleged that in the forest area the search for suitable stakes has resulted in the destruction of the forest habitat, with "staking…competing with charcoal burning for the ongoing depletion of the forest" (ICRA, 1996).

4.4 Pests and diseases

Yam farmers report depredations by pests and diseases as being one of the most serious problems they experience. The farmers surveyed by Kindness *et al* (1998), for example, ranked this as their second most important problem, behind finance for labour and other inputs.

Undoubtedly, there is a relatively high incidence of disease in yams, while pests can be a periodic problem both during the period the tubers are in the ground and during storage[38]. Indeed, (IITA, 1998) reports that the incidence of pests and diseases is increasing, attributable to the fact that production systems are becoming more intensive. Thus, farmers need to invest scarce resources in combating the damage – actual and potential – caused by pests and diseases, although at present they rarely adopt regular pest and disease-control measures and many of them use diseased tubers as seed yams (Peters *et al*, 1999).

However, if an increase in production is to be realised, greater attention will need to be paid to reducing post-harvest losses.

4.5 Credit

The variation in farmers' cash flow during the agricultural calendar which is a common feature in Ghana can, in only rare instances, be addressed thorough the use of credit as a result of the generally poor provision of credit to smallholder producers. Surveys undertaken as part of the ICRA study confirmed that most of the yam producers in the study area had no access to loans from the formal credit system. There were a number of reasons for this, including the lack of collateral, the transaction costs to farmers, the time it took them to obtain loan funds, and the credit bank's bias of lending to groups rather than to individual farmers (ICRA, 1996). Indeed, the shortage of formal credit is a feature of the entire agricultural chain – from production to marketing.

The lack of access to credit funds through formal channels means that farmers obtain the bulk of their credit requirements from middlemen or from their own resources and, as Bancroft *et al* (1998) discovered, there is an intricate informal credit system operating amongst actors in the retail and wholesale markets. Recent field work in a number of agricultural produce markets confirms this finding, showing how the limited access to appropriate finance restricts

[37] Bamboo poles in some areas (Tetteh and Saakwa, 1991), tree saplings or thin branches elsewhere.
[38] Not all pests are necessarily perceived negatively - some farmers are reported to prefer yam tubers with scale insects as this is a sign that they have been stored for a long period which means that they have a reduced water content and an improved taste! (ICRA, 1996).

improvements in the livelihoods of farmers. Nevertheless, in the absence of a well-functioning formal credit system, farmers manage to obtain funds from a variety of other sources, including their own agricultural and non-agricultural enterprises, traders and input suppliers (Lyon, 2000).

At the same time, the impact of providing credit is not easy to assess. Morris *et al* (1999), for example, show that the results of introducing a credit programme to boost the uptake of a technology in Ghana (new maize seed varieties, in this instance) were complex. Certainly it was the case that loans taken out for the purchase of fertiliser were often not repaid when the use of the input did not prove to be profitable.

4.6 Transport

The lack of a well-maintained network of primary, secondary and feeder roads in the rural areas results in high transport costs which can represent, "up to 50 per cent of the marketing margin of staple commodities" (IECT, 1999)[39]. Similarly, the poor feeder road network increases the costs of input supplies and limits farmers' access to them. Indeed, this "may be the single most important factor limiting farmers' ability to participate in the market economy" (*ibid.* p.79) and it acts as a severe impediment to any increase in output. The ICRA (1996) study team also highlighted the large proportion of the total cost of production accounted for by transport.

On the other hand, Levin (1997) reports that "there is some indication that some transport and handling costs are falling with improved roads and more spare parts available for trucks, etc". Unfortunately, no evidence is presented to support her argument. Indeed, the opposite situation is more likely – since, as a result of the growth of population, increasingly-remote areas are having to be opened up for agriculture[40].

4.7 Prices, markets and marketing

Following on from the previous Section, it is reported that farmers are often unable to sell their produce due to limited access by traders to their stores arising from the poor condition of rural roads, especially during the rainy season (GTZ, 1999; FAO, 1998). In addition, production areas are scattered and move from one season to the next - a feature of the bush-fallowing farming system. At the same time, the tubers are fragile and can be damaged when transported along rough rural feeder roads and poorly-maintained arterial roads.

The retail prices of tubers climb steeply prior to the period of the harvest as the supply of the previous year's crop dries up. According to one observer, this is caused by a combination of inadequate storage capacity, poor storage practices and poor marketing systems (GTZ, 1999). Marfo *et al* (1998) maintain that the inability to keep yam tubers because of poor storage practices as well as the relatively-perishable nature of the crop[41], together with the low prices which prevail at harvest time, act as important constraints to increased output.

As touched on in Section 3.2, the yam marketing system may also be acting as a constraint to the expansion in production as those farmers considering putting a larger area under the crop may be discouraged by the perception that much of the increased returns may be siphoned off by the various market intermediaries.

[39] Gray (1996) calculates that three-quarters of "marketing costs" are accounted for by transport.
[40] Thus increasing the cost of marketing yams, and the numbers of farmers and their families isolated from the social infrastructure network.
[41] Although yams are less perishable than, for example, cassava (Kenyon. L., *pers. comm.*).

5. The history of yam research in Ghana: a brief overview

In preparing the National Agricultural Research Strategic Plan (NARSP) in the early-1990s, planners showed that while yams were both one of the preferred foods in Ghana and were of great importance in the country's agricultural economy (as has been demonstrated in Chapter 3, above), nevertheless, the crop had received only a very small proportion of total research funding. What is more, it was only in the years leading up to 1994 that any adaptive research, at all, had been undertaken on root crops in general (Anon, 1994). Moreover, what research there had been on roots and tubers had focused mainly on cassava[42], rather than on yams, sweet potatoes and cocoyams (IFAD, 1997), while no area- or variety-specific agronomic recommendations for any root or tuber crops were available. A summary of the situation, therefore, was that there were only a limited number of research publications available on roots and tubers, while yam research had stagnated almost completely during the 1970s and 1980s[43]. In addition, there had been almost no research at all carried out on the socio-economic and post-harvest aspects of root crop production.

Even though the research system up to that time had had some success in identifying and developing improved varieties of cassava, there were only a limited number of messages available to be passed on to farmers wishing to increase the productivity of their root and tuber crop operations. This meant that improved technologies were still not available to the majority of root crop farmers. Confirmation for this is provided in the report of a workshop held in 1996 on yam research, where it "was agreed by researchers that not much has been achieved in yam research to be transferred to farmers….In fact, no technological packages are available for yams while they are for other crops such as maize, cowpea, cassava, etc" (ICRA, 1996).

The absence of improved technological information which can be extended to farmers was also felt by MoFA field staff (*ibid.*) and this lacuna even percolates through to the field level according to Quin (1998) since "farmers have some perception that research is still in the process of finding solutions to production problems, rather than having some technologies available which they might adopt". Thus, most technologies being used by the yam farmers have remained largely traditional (*ibid.*) and the impact of the research on production "appears not to have been great" (Anon, 1994),

However, such a situation is not peculiar to Ghana. As Orkwor and Adeniji (1997) point out, it is "…. regrettable to note that governments in the West African yam zone have not given adequate research support in terms of funding for the development of yam". This finding is echoed by Sékou (1999) in his observation that "The attention given to yam research in the sub-region is not commensurate with the importance of the crop". This has meant that, "…. the development and delivery of appropriate technologies for yams has been uneven, and relatively less than is desirable for such an important food crop" (Orkwor *et al*, 1998).

Not surprisingly, the conclusion of the national review of research work on yams in Ghana was that it "has not made much impact on the production and utilisation of the crop" (Anon, 1994). This was in direct contrast to the situation for cereals and legumes. For example, in 1975, funds allocated to research on sorghum in West Africa were ten-times those spent on

[42] This focus on cassava continues in spite of the much-publicised first-priority ranking of yams in national research planning, as can be seen if the work plans of the largest-ever single intervention on root crops in Ghana – the Root and Tuber Improvement Programme – are examined. Indeed, yams appear to have even lower priority (or, at best, equal priority) than sweet potatoes or Frafra potatoes.

[43] The principal yam research results available at this time were: the minisett technology (which had been developed by IITA); the use of vine cuttings for the propagation of seed yams; the identification of a number of pests and diseases (but no control work had been undertaken); the effect of phosphorous and nitrogen on yields; and the use of vine stakes to increase yields (*ibid.*).

cassava research (which were, in turn, far higher than yam research expenditures) and, it is alleged (MoFA/ GTZ, 1994), this bias remains to the present day.

The research strategic planning exercise of 1994 emphasised that research on root and tuber crops in general was important for both food security and export revenue purposes. Root crops (yams, cassava, cocoyam, sweet potatoes and potatoes) were consequently ranked[44] as the commodity group which deserved the highest priority in the future allocation of research resources. Moreover, within this group, yams were ranked as the priority crop for research emphasis (Anon, 1994).

Following on from this, it is hardly surprisingly that yams were selected as a priority crop under the Accelerated Agricultural Growth and Development Strategy which was drawn up by the government shortly thereafter (Technology Sub-committee, 1998) – *see Section 6.3 for more information on the Strategy*. However, there is no evidence that this priority ranking was ever backed by the tangible provision of human or budgetary resources.

A review of the literature shows that in spite of the low level of resources which have been allocated to improvements in yam production, there are, nevertheless, a number of technologies which have been developed. These include:

- production of minisetts;
- agronomic innovations (such as planting along ridges and information on optimum plant populations);
- improved storage structures (GTZ, 1999);
- protocols for virus cleaning;
- use of *in vitro* germplasm;
- processing tubers into chips and flour;
- extension of tuber dormancy for improved storage using gibberellic acid or irradiation;
- the development/introduction of new varieties (such as "*Matches*"/"*Seidu Bile*", originally from Puerto Rico);
- hot water therapy for the sanitisation of seed tubers; and
- insect pest management during tuber storage[45].

There are also, according to Orkwor and Adeniji (1997), good prospects for biotechnology innovations.

Annex F provides details of yam research work which has been undertaken in the country in recent years, as well as ongoing and future activities.

Yam research work has also suffered from a shortage of qualified human resources. It is only very recently that one has been able to identify some scientists as full-time yam researchers, especially in connection with externally-funded programmes. This contrasts markedly with the significant number of scientists who have been trained at postgraduate and other levels, through externally-supported projects on cereals and legumes. For example, Ghana has only one trained yam breeder and he has retired, whereas there are several cereal and legume breeders.

[44] The complex ranking methodology which was adopted used criteria which were in line with: national development priorities, the needs of farmers and the sustainable use of the natural resource base.
[45] The last four examples were provided by Dr R. Asiedu (*pers. comm.*)

6. Aspects of the national agricultural research and extension services

6.1 Research

In addition to what has been said in Chapter 5 regarding the status of yam research, several observers have remarked on the way in which many of the technological advances made by agricultural researchers are not passed on to the farming community. Thus, a recent review notes that, "The link….. between the laboratory and the farm is tenuous and the shelves of these research institutions are replete with findings awaiting trial on farms…. Consequently, the desired impact of the research activities on the economy…. is yet to be felt". (Ministry of Finance, 1999). This echoes the findings of the Technology Sub-committee (1998) which commented, with some frustration, that the bulk of the new technologies which had been developed remain "on the shelves or in workshops" of the research institutions and do not reach the users for whom they are intended.

Part – although certainly not all - of the blame for this can be laid at the feet of the research community. The over-riding attitude of researchers continues to be that they have developed/are developing solutions to production constraints and all that is now required is for the farmers to catch up with them – exemplified by the statement in a West African journal that "agricultural research knowledge and output is (*sic.*) probably twenty years ahead of the farmers". Little thought is given by them to the way in which research can be made more appropriate to the needs of the bulk of producers, nor to how they might facilitate the technology dissemination and adoption process. This is well illustrated in a recent observation that although some "excellent" new cassava technologies have been developed by research, "the multiplication, dissemination and distribution of these varieties are lagging and thus preventing smallholders nationwide from fully reaping the benefits…."[46] (IFAD, 1997).

An almost identical situation relating to another technology and another crop is provided in a recent paper describing the situation where "Improved cultural practices in areas of mini-sett multiplication of yams…. have been passed on for diffusion by the extension service" – the implication being that researchers have done their job and all that is needed is for the technology to be adopted (Directorate of Agricultural Extension Services, 1998). In other words, adoption activities are "simply expected to take place and adoption (is) simply expected to occur" (Sechrest *et al*, 1999). The fact that in this instance the minisett technology has, for many reasons, been rejected by most farmers (*see Chapter 8, below*) shows the inadequacy of such an approach.

Again, however, this phenomenon is not a problem peculiar to Ghana. A recent review of the research and adoption process internationally, found that "the flow of information from research to users was at best limited, while farmers' needs were not met by agricultural technicians who in turn were dissatisfied with the technical packages handed to them by researchers" (Garforth and Usher, 1996).

Part of the reason for the apparent ineffectiveness of the research service has been the result of the declining levels of public resources made available to it. The literature is replete with references to this (for example, IFAD (1996) notes that the crop research institutes are well established but that their field programmes need considerable support, in addition to normal government funding) and to the necessity of the research service tapping into other funding sources if it is to function effectively

[46] Indeed, this situation provided the justification for a follow-up intervention to "…. support investment activities to disseminate the identified technologies" (*ibid.*)

6.2 Extension

The Ministry of Food and Agriculture (MoFA) is the principal body involved in technology dissemination in Ghana, through its Directorate of Agricultural Extension Services, while other technical Directorates of the Ministry (Animal Production and Crop Services, for example) and the agricultural research institutes also play a part. It is the government's policy that the public extension service has a key rôle to play in accelerating agricultural production. Other agencies are, however, encouraged to participate, which means that dissemination activities are also being undertaken by such non-governmental organisations as Sasakawa-Global 2000.

Part of the reason why the government encourages other agencies to get involved in the provision of extension services is that the budgetary funds allocated to the Directorate have been in decline for a number of years. This has had a highly-detrimental impact on the efficacy of agricultural extension activities. A decade ago, for example, the lack of funding was already having an impact on the services offered. Rudat *et al* (1990) illustrate this by showing that only 13 motorcycles were available for use by the 36 'zonal' co-ordinators, the managers of the extension service, while only 5 per cent of the 350 'technical officers/assistants' working at the field level, had bicycles. Fiadjoe *et al* (1997) point out that the deterioration in vehicle availability was even being noted by farmers themselves. The same review explained that the regularity of visits by extension staff depended upon the availability of transport and the state of the road infrastructure. Consequently, there was limited coverage of the clientele, with regular visits taking place only to those farmers living in the easily-accessible areas (*ibid.*).

At the same time, the extension service has had a poorly-qualified cadre of staff; for example, it was recently estimated that 50 per cent of the 2,600 extension agents had received little or no formal training in agricultural extension, while links with agricultural research were considered to be inadequate (Directorate of Agricultural Extension Services, 1999). It is hardly surprising that many important crop recommendations get no further than the reports, files and shelves of the agricultural research stations. This situation is aggravated by the low morale of the extension staff, caused by poor promotion prospects, low salaries and inadequate accommodation. Not surprisingly, extension staff consequently spend time, "finding extra income….(*spending*) time on their own farm" (Fiadjoe *et al*, 1997).

6.3 Recent interventions to bolster agricultural research and extension

In the early 1990s it was recognised that if the national agricultural development goals of greater agricultural productivity and sustainable increases in production were to be realised, it would be necessary for proven, improved technologies and farming practices to be widely promoted and adopted by farmers.

As has been hinted at in earlier Sections, both the research and extension systems and the infrastructure associated with them had been "shattered" as a result of the economic difficulties experienced by Ghana during the 1980s (Republic of Ghana, 1999[a])[47]. For example, due to the government's budgetary cut-backs, funds allocated to most agricultural research institutes met little more than personal emoluments and limited operational expenses. The impact of this under-investment is clear at the present time.

[47] By way of illustration, the share of the Government's budget allocated to the sector fell from 12 per cent in 1980 to 6 per cent in 1987 and, by 1997, it was 2.9 per cent. It is therefore of no surprise to learn that in 1997, Ghana's development partners were funding 89 per cent of the development budget of the sector (Levin, 1997). Dormon *et al* (1999) highlight that the increases in 'real' budgetary allocations to the sector which took place between 1995 and 1997, were reversed over the subsequent two years.

For this reason, and as mentioned in the two previous Sections, the performance of these two public services in recent years has been closely correlated with the availability of external funding. For example, participants at a post-harvest research workshop held in the early 1990s stressed the need for a new source of external funding to be found (as current funding was about to end), “to ensure that this project does not suffer the fate of many others which fold up when the initial funding is exhausted” (Nkum Associates, 1994)[48]

The importance of rehabilitating and increasing the effectiveness of these two services had been recognised for some time and provided the main justification for the two large, multi-agency projects – the National Agricultural Extension Project, NAEP (launched in 1992) and the National Agricultural Research Project, NARP, which started at about the same time.

Under the NAEP, crop and livestock extension services were unified and a modified Training and Visit system for the management of the extension system was adopted. Staff skills were upgraded through an intensive technical training programme provided by subject-matter specialists from the various technical departments of the Ministry of Food and Agriculture. Under the new extension strategy, extension staff were relieved of direct responsibility for input provision – up until then this responsibility had been a constant source of problems. Input supply (including credit) systems are now privatised.

In light of the fact that “the poor rate of acceptance of new technologies” could, in part at least, be attributed to the poor relationships and linkages between extension and research, it was planned that the (approximately) simultaneous implementation of the NARP would strengthen these linkages. This undoubtedly happened, while the extension service was better supervised and managed than had been the case prior to the implementation of the NAEP. In addition, the extension intervention led to an improvement in the infrastructure and logistics of the extension service, and a programme of regular staff training[49].

The principal mechanism for closer collaboration between the two key links in the information-flow chain (von Bargen, 1993) was the Research-Extension Liaison Committees (RELCs), which were established under the NAEP. They sought to involve farmers, extension staff and researchers in the problem identification, and technology development and dissemination process. It was hoped that the problems of farmers would thus be brought to the attention of research in a structured way which would lead to more relevant technologies subsequently being developed. Ideally, the RELCs are made up of heads of MoFA technical departments, staff from research institutes, the regional Director(s) of Agriculture, subject-matter specialists, and representatives of non-governmental organisations (NGOs), farmers and input suppliers.

In practice, the workings and effectiveness of the different RELCs has been variable. One commentator, for example, observes that there have been few serious attempts by them to study the “farmers’ reality, circumstances and problems” (Finnish Cooperative Development Centre, 1999). They have also been criticised as being research-driven and distant from the problems faced by the agricultural extension agents working with farmers on problems at the field level. This is perhaps inevitable given that there is only one Committee for each of the country’s five different major agro-ecological zones.

A review of the impact of the extension service carried out towards the end of the NAEP[50] shows that its effectiveness was limited, among other things, because of the small number of research recommendations made available to the extension staff for passing on to farmers,

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[48] No new external funding was in fact found and research on this topic has been moribund for the past five years.
[49] Although its impact has been less than it might have been due to the lack of an overall training policy (IECT, 1999).
[50] Implementation finished in late-1999.

and the large geographical areas (and numbers of farmers) for which each extension officer is responsible (Fiadjoe *et al*, 1997). Nevertheless, the survey does note that the project led to increased contacts between extension and research staff and to improvements in the identification of farmers' agricultural production constraints.

A subsequent review states that the government's policy of decentralisation which began to be implemented in the mid-1990s, together with the introduction of "improved dissemination methods" (through training) would lead to an improvement in the diffusion of innovations (IECT, 1999). At the same time, cost-benefit considerations would be integrated permanently into the research process to "ensure that all technologies have been assessed for their economic benefits and relevance to the farmer"[51]. However, no evidence is presented to show that adoption rates have "improved", nor that the financial or economic implications of research recommendations have ever been calculated. The review also notes that during implementation of the project it was proposed that high priority would be placed on researching technologies that reduce labour inputs. Again, there is little evidence that this took place.

It had been intended that under the NAEP/NARP, a system would be set up to determine the extent of adoption by farmers of improved technologies generated by the national agricultural research system, as well as to investigate the problems associated with their adoption. This would be done by means, among other things, of a series of adoption and impact studies. It was felt that the feedback thus obtained would be vital in guiding the strategies of both research and extension relating to the generation and transfer/diffusion of agricultural technologies (Anon, 1998) - which it, clearly, would have been. Unfortunately, such a system was set up many years after the inception of the project and its first report was published only recently (IECT, 1999).

Nevertheless, some reviews of the NAEP do provide an assessment of impact, even though these are not based on objective surveys. For example, a recent study notes that, "…. the basic messages of planting in rows, using improved seeds, maintaining proper plant populations, using improved post harvest management and storage of crops are being widely disseminated and are being adopted by farmers who are being reached by the service" (Directorate of Agricultural Extension Services, 1998)[52].

In collaboration with a number of its development partners, the Government recently drafted a new "Accelerated Agricultural Growth and Development" strategy (AAGDS), replacing the Medium-Term Agricultural Development Strategy which had been the main 'road map' for the agricultural sector during the 1990s. The new strategy was formulated following the publication of the Vision 2020 national development policy document which was launched in 1995 to "consolidate the gains made under the Structural Adjustment Programme".

The AAGDS recognises that small-scale farmers currently produce the bulk of both the national food needs and cocoa for export. It therefore lays heavy emphasis on seeking to ensure food security, creating employment opportunities in the rural areas, reducing rural-urban disparities and supporting agricultural and other service provision at the local level. The Strategy and other documents (Anon, 1998; Ministry of Finance, 1999) also stress the continued rôle for the public sector in, among other things[53], importing, adapting, generating and disseminating improved agricultural technologies, whilst it recognises that the agricultural input industry will take a progressively increasing share of the task of identifying new technologies and extending them to farmers. (However, the Strategy does not provide

[51] Which echoes the NARSP's stipulation that, "The profitability of research recommendations must be adequately tested before being passed on through extension staff to farmers" (Anon, 1994).
[52] Although no evidence (data) is provided to support this statement.
[53] The other key agriculture-related "public" goods and services which the Strategy states will be provided by Government are rural feeder roads, and marketing and irrigation infrastructure.

any indicators as to how these tasks will be done, nor any time schedule for them[54]). Indeed, one of the five elements of the Strategy is the development of and improved access to, technologies for sustainable natural resource management. The Strategy will involve improving "the generation, transfer and dissemination of cost effective technologies that are responsive to the needs of farmers, but which ensure sustainability" (Republic of Ghana, 1999[a]).

The Strategy recognises that new technologies may not have been adopted in the past because inappropriate methods of introduction and transfer were used. For this reason, it proposes that a "unified code of technology introduction and dissemination will be adopted to ensure improved adoption rates" (*ibid.*). Unfortunately, no details of the "code" other than that it will be based on a demand-driven participatory approach, are provided.

One of the recommendations of the Agricultural Services Sector Investment Programme (AgSSIP – *see below*) "Technology Sub-committee" evokes similar concerns. It proposes the implementation over a ten-year period of an "Improved Extension Services Project" in order to increase the capacity of extension agents for "effective delivery". The result will be the realisation of higher adoption rates (Technology Sub-committee, 1998). However, no information is provided on the strategy to be adopted by the (now more-productive) extension staff and others, for higher rates of technology uptake to be realised other than a vague reference to increasing the links between researchers, extension staff and farmers (Directorate of Agricultural Extension Services, 1998).

The overall goal of the Strategy is for the annual growth rate of the agricultural sector to be increased substantially, from an average of between 2 to 3 per cent to at least 6 per cent, with sustainability and equity considerations being emphasised. Such rates of growth will mean that broad-based poverty reduction and food security concerns can be fully addressed.

In order to implement the Strategy, the AgSSIP, a sector-wide programme, is currently under preparation which will, among other things, co-ordinate support earmarked for the agricultural sector by Ghana's aid partners. Although the AgSSIP is still at the preparation stage, one of the nine problem areas which it is to address is the development of and access to, technology (Finnish Co-operative Development Centre, 1999).

It is planned that the Programme will seek to standardise in a number of areas. For example, in spite of the NAES having been fully implemented, there remains a bewildering variety of organisations involved with agricultural extension and extension strategies. Consequently, different extension methods are being used, some of which are contradictory and which compete one with another. They include: training and visit, participatory technology development, farming systems research & extension, nucleus estate/outgrower, farmer field schools (FAO), those of NGOs (such as Sasakawa-Global 2000), private contract and commodity (cocoa and cotton) related[55] (Dormon *et al,* 1999). There are also conflicting policies on credit provision and on the counterpart contribution expected from farmers.

The AgSSIP also seeks to consolidate the progress made under the NAEP/NARP in ensuring that close ties are maintained between research and extension services, and farmers. The draft documentation makes mention of a "crop services development sub-programme", which is to include a project to develop planting material for (unspecified) selected crops, as well as a

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[54] And it is probable that yams, having low returns relative to many other crops, will receive little attention from the private sector. Indeed, as Levin (1997) puts it, the private sector is unlikely to "tolerate patiently the long learning processes of farmers, traders and consumers to ensure the widespread acceptance of new technologies and new varieties".

[55] Others feel, however, that such pluralism in extension delivery is healthy, allowing flexibility in responding to the fast-changing and diverse nature of the rural sector. Thus, they argue, the full range of possible approaches should be tried and evaluated (Directorate of Agricultural Extension Services, 1999).

project for the promotion of selected food crops. Since no details are provided, it is not known if yams would be included in either project. A further focus of the Programme will be to encourage producer organisations in order to improve farmers' access to inputs and to ease produce marketing. It is expected that these interventions will, in turn, facilitate the adoption of new technologies (Republic of Ghana, 1999[b]).

As regards research, it is worrying that the country appears to be where it was less than a decade ago – agricultural research at all levels is constrained by inadequate funding to support the staff on the establishment, while operating budgets are cut to levels which curtail all but the most basic (largely station-based) activities[56,57]. Indeed, the country's research programme is not far from a situation where, "…. donor interest is the overriding factor which determines the subject and duration of research, due to the financial dependence of renewable natural resources research institutions", whereas "…. the single most important determinant of research priorities should be farmers and their organisations" (Garforth & Usher, 1996).

[56] The same appears to be true of the extension service, where most of the MoFA budget is spent on staff salaries, while less is being allocated each year for the purchase of the goods, services and transport required for the staff to function effectively and have an impact at the field level (Dormon *et al*, 1999).

[57] And, what is more, the gazetted budget figures do not necessarily reflect the actual picture – in 1998, for example, only 72 per cent of the Ministry's allocation of recurrent budget funds were actually released to it, as a result of "budgetary problems" (Republic of Ghana, 1999[b]).

7. Factors influencing the uptake of new agricultural technologies

7.1 Introduction

The first studies into the diffusion of agricultural innovations were carried out by rural sociologists in the 1920s. Their general conclusion was that adoption tended to follow an S-shaped relationship over time, with slow initial uptake resulting from the creation (by extension, the media, etc.) of awareness of the new technology, followed by more rapid uptake as greater numbers of farmers became exposed to it. This was followed by a slowing down as the limit of the 'adopters' was reached. Similar conclusions were reached in the famous study on the diffusion of hybrid maize amongst farmers in Iowa. Davis (1999) has written a detailed review of the theory and recent work on, the diffusion of agricultural innovations which can be consulted by those seeking such information (*see Bibliography*).

As was stated in the Chapter 1, little information is available on the adoption by farmers in Ghana of improved yam technologies *per se*. For this reason, this chapter considers factors influencing the adoption of new technologies which have been developed for various crops, and reviews examples in the literature of agricultural technology uptake by smallholder producers in other countries in the region.

Studies have shown that while farmers may be aware of a new technology, they may fail to adopt it for a number of reasons. The factors constraining adoption can be grouped under four principal headings, namely: (a) the characteristics of the technology itself; (b) the characteristics of the farmer him-/her-self; (c) the characteristics of the farmer's immediate environment; and (d) the characteristics of the macro-environment. These are discussed in turn, below.

Inevitably, there is some over-lap between these categories and some of the characteristics relate to more than one category – credit availability, for example, could be discussed under both (c) and (d).

7.2 Characteristics of the technology itself

Complexity

A complex technology is less likely to be adopted than a simple one. For example, the complexity of the minisett technique is one of the reasons advanced for its limited adoption – the technical (and tedious!) nature of the technique is given as a principal reason for its slow rate of adoption in Cross-River State in Nigeria by Okoli & Akoroda (1995). More details of this and of other factors constraining its uptake are provided in Chapter 8, below.

Another example of this characteristic of an innovation is provided by Sechrest *et al* (1999), who show that innovations which can be adopted gradually, rather than in a step-wise or all-or-nothing manner, are likely to be more readily adopted by farmers[58].

Profitability

The high cost (and therefore lower net returns) which would be incurred by farmers in adopting new technologies has been recognised by many researchers investigating new technologies – Langyintuo's (1996) analysis of the financial returns resulting from the use of tissue culture to produce seed material, for example. Although such planting material is shown to provide a 60 per cent increase in yields, its cost would be seven times higher than

[58] Since adoption is often a dynamic process, with farmers proceeding "by increments" in order to hedge their bets on new technologies, maintaining some production under traditional methods as an insurance against failure of the new (Sechrest *et al*, 1999).

the cost of material produced from minisett technology[59] and would require very careful handling. Thus, unless the Government decides to subsidise the production of yam seed material using *in vitro* techniques – which could have substantial implications for the national budget, not to mention for issues of equity, etc. - such technology is unlikely to be adopted (unless costs were, over time, to be reduced considerably).

A detailed probit analysis of the relative importance of a number of socio-economic factors affecting the uptake of improved technologies by small-scale farmers was carried out by Aiyedun and Atobatele (1995) in Nigeria. They found that of the many variables tested to explain difference in adoption rates, by far the most significant was the profitability of the farm enterprise in the previous season and, by extension, the "expected profitability of the (*new*) farm enterprise" (*ibid*.). Other variables considered included the age of the farmer, farm size, accessibility of credit and distance to input supplies.

Johnson (1999) shows that high cost of grain storage structures – in particular, the rat guards - were a significant reason for their low uptake. Indeed, no financial analysis/partial budgeting appears to have been carried out to show that the investment would provide the adopters with positive net returns.

It has also been shown (Sechrest *et al*, 1999, for example) that other (indirect) costs which have to be born by the user also affect the decision on whether or not to adopt a new technology. For example, if innovations for yam farming require significantly higher inputs of labour, they are unlikely to be adopted.

The time element of money is also important when investigating the uptake of new technologies. For example, the Fiadjoe *et al* (1997) survey shows that adoption of technologies was constrained by the length of time between the dates when funds were invested in the innovation and when the benefits were realised (maize cribs, for example). This same factor is one explanation for the low rate of uptake of the minisett technique by farmers (Langyintuo, 1996) – *see Chapter 8*.

Given the fact that smallholder producers tend to be cash constrained, it is surprising that many of the research recommendations appear not to have been subjected to any simple financial analysis in order to assess whether adoption will provide significant positive net returns to the adopter. It is, therefore, hardly surprising to read that "a large number of agricultural technologies are available but many are unaffordable" (Technology Sub-committee, 1998).

Clearly, if there is no market for the crop which is being promoted, the negative returns to the farmers will mean that the technology will not be adopted. This has been the experience with the yam minisett technology as there is almost no market in Ghana for the seed tubers produced by it (Okoli & Akoroda, 1995). The same study highlights the high labour demands made by the technology (and the relative scarcity of this factor of production and, therefore, its high cost) as being an additional factor militating against its adoption.

Finally, it is important not to over-emphasise this factor. As Jones (1967) points out, many studies "have shown that the economic traits[60] are not the sole nor necessarily the most important considerations affecting adoption".

[59] Although it is recognised that there would be some potential for such material were a serious effort to be made to expand commercial production for the export market, with its demand for disease-free, uniformly-sized (smallish) tubers, and the ability of the technology to meet this need.
[60] The "short-term profit maximisation" referred to by Runge-Metzger (1993).

Riskiness

In light of the risk-averse nature of farmers, particularly those close to the poverty line, the uptake of innovations which can lead to high net losses will tend to be low. A slightly unusual way in which risk can have an impact on uptake is provided by the example of Ghanaian share-croppers surveyed by Fiadjoe *et al* (1997) refusing to plant their maize in rows. Their view was that such a practice made it easier for land owners to estimate yields, and therefore to demand their 'rental share'. The same study provides an example of an inappropriate technology which was not adopted due to the increased burden of risk to which it gave rise: communal grain stores were not accepted by farmers as they preferred to store food in structures over which they had complete control.

Compatibility with existing practices

Donnhauser and Kipo (1992) explain how even though research in Ghana had shown that the adoption of an improved cowpea variety together with changes in agronomic practices would lead to far higher gross margins per hectare, the technology was adopted only by a few farmers. The reason was that the normal practice was to grow cowpeas together with other crops whereas the new variety had to be sole-cropped. The farmers explained that they were also were not confident in using the equipment needed to spray the new variety if insect damage was to be avoided.

A similar example is provided by Okoli and Akoroda (1995), who note that the minisett technique is not compatible with existing farming systems in the areas in which it was first introduced. Intercropping is the farming practice traditionally followed, while monocropping is required for minisett production to be successful.

Technical soundness and superiority over existing technologies

Given the uncertain physical environment and the vagaries of the weather which are features in much of Ghana, new technologies which perform poorly under sub-optimal conditions are unlikely to be adopted. For example, high-yielding maize was found to perform poorly on infertile soils compared to the local varieties (Ibrahim, 1992). This resulted in the uptake of the new variety being less than expected. Otoo and Osei (1997) make reference to the erratic rainfall throughout much of the yam growing area – a factor which any newly-developed variety must be able to cope with if it is to be adopted by farmers.

Clearly, to be accepted by farmers, any new technology has to outperform an existing variety or practice, in a number of areas - one of the reasons cited (Nweke *et al.*, 1994) for the rapid increase in cassava production in Nigeria in the 1970s and 1980s is the fact that the improved varieties developed in the research stations were clearly superior in most of their attributes to the varieties hitherto planted by farmers.

Relevance to farmers' needs

An example of the limited uptake of a new technology resulting from its lack of relevance to the needs of farmers, is provided by Johnson (1999). The author explains that the fundamental factor which led farmers to try and subsequently abandon an improved grain storage structure in Ghana in the 1980s, was that reducing the level of post-harvest losses of maize was not one of their priority concerns![61,62] The new system for storing grain necessitated by the structure was incompatible with the traditional practice of grain storage. The existing system was for the grain to be stored within the family compound, whereas the improved crib had to be constructed away from the homestead. Farmers were concerned about the resulting risk of theft. This shows clearly that the researchers made little or no

[61] As revealed by subsequent evaluations of the work.

[62] Indeed, later interviews with farmers showed that they believed storage losses were inevitable and therefore did not see the need for the improved crib.

attempt to understand the existing system and to elaborate the problems being experienced at the farm-level for which a solution was needed, prior to the research being started.

A large amount of work was done in the late-1970s and 1980s on increasing maize production in Ghana through the use of improved varieties of maize, the application of fertiliser and the use of optimal plant spacing. A study of the uptake of this 'package' showed that it was considered to have been a success in that at least two-thirds of maize producers, the bulk of whom are small-scale farmers, were using at least one of the three improved technologies (Morris, *et al*, 1999). More than one-half of farmers were using the improved varieties, although the adoption rate for fertilisers was far lower. An important reason for the success of the package is that maize is an important component in the diet of the farm households, so any increase in productivity is widely felt. Other key factors had more to do with the way in which the research and extension process was organised (researchers ensured that farmers participated actively in the development of the new technologies; extension staff were also closely involved in the research and testing process; and the process required a high degree of collaboration between extension, research and donor agency staff - in practice, such interaction proved to be highly effective).

Similarly, because cassava is one of the basic food staples and is thus a key to household food security, there is a demand for yield improvements from farmers in Ghana. Thus several new technologies which have been developed for the crop over the past two decades have been readily accepted and adopted by farmers (IFAD, 1996).

The production of relatively-small tubers using the minisett technique is an important reason why it has not been adopted, as Ghanaian yam farmers are less interested in the net weight or total yield of yams, but rather with the size of the tubers harvested. This is a major problem for those promoting the minisett technology as a means of overcoming the shortage of planting materials (*see Chapter 8, below*).

Taste and processing/cooking properties

Were Ghanaian consumers' current preference for large tubers to give way to a demand for smaller *wares* which has been the recent experience in Nigeria, it is probable that there would be a rapid increase in the number of farmers adopting the minisett technology which can be used deliberately to produce small to medium-sized tubers. The same change is likely were there to be an increase in the consumption of yams in the form of flour that could then be reconstituted into a paste for eating with stew or soup. Such a change would have the added advantage of rapidly expanding the production of disease-free seedlings (*see Chapter 8*).

Accessibility

Adoption requires substantially more than simply producing a new technology. Problems experienced by farmers in obtaining seeds/planting materials[63] which have been developed by the research service, as well as accessing other inputs, is regularly cited in the literature as a reason for the low uptake of new technologies. Thus a recent review in Ghana notes that "Whereas improved roots and tuber crop varieties, with superior yield potential have been released by the research centres, the lack of a system for propagating planting material for these appears to pose a major constraint in their rapid diffusion" (Directorate of Agricultural Extension Services, 1998).

[63] The shortage of yam planting materials is addressed directly by one of the series of draft project proposals drawn up under the AgSSIP. The "Development of planting materials for selected crops project" proposes the multiplication of planting materials particularly by farmers' groups (AgSSIP Task Force, 1999). Unfortunately, the proposal contains no details of the envisaged institutional arrangements, pricing structure, etc.

Ease of application

The ease with which a new technology can be applied and whether or not the adoption of a new technology can be reversed are factors which will be considered by farmers in deciding whether or not to use it. An example of a 'reversible' technology is fertiliser use – if conditions alter, it can easily be abandoned.

7.3 Characteristics of the farmer/farm household

Level of literacy/education

Farmers' average level of education often plays a crucial role in explaining technology adoption, as better-educated farmers have a greater ability to understand and manage more-sophisticated technologies (Morris *et al*, 1999). Atala's (1992) study, for example, highlights the important rôle that formal education, awareness of the innovation and the use of sources of information had on rates of adoption of soyabean processing innovations by women in Nigeria. For this reason, the paper strongly advocates promotion using a wide range of different media - extension staff, radio, television and extension leaflets, etc.

Runge-Metzger (1993) used simple partial budgets and regression analysis in order to investigate the key determinants of the uptake of cotton and irrigated rice (new crops to the area), inorganic fertiliser and animal traction by farmers in Ghana's Upper region. He found that the educational levels of the farmers (as well as their level of assets and labour availability) explained much of the adoption behaviour: "Formal education and health are important determinants influencing the profitability of new technologies and the access to supporting services", and, therefore, uptake.

Age

Although adoption literature, more generally, highlights the age of the farmers as being an important determinant of uptake rates, Morris *et al* (1999) failed to find any significant difference between the mean age of adopters and non-adopters of new maize technologies in Ghana.

Ethnicity/culture

Orkwor *et al* (1998) explain that there are a wide variety of beliefs and taboos governing the planting, harvesting and consumption of yams. Under these circumstances the adoption of new technological innovations is unlikely to be a simple operation.

Standing in the community

Although this factor accounted for less than one-third of adoption variability in a study in Nigeria, it led the author to recommend that extension staff should work closely with "opinion leaders", as they are known in Ghana (Voh, 1982). The important rôle played by "socio-cultural" factors such as this, in explaining adoption behaviour was also recorded by Subair (1988) in his study of hybrid cocoa uptake (although his study findings highlight the important role also played by annual income and age).

Socio-economic status

As stated earlier, a study into the factors which determined the adoption by smallholders of hybrid cocoa showed that annual income of the farmer is key (*ibid*.). A study in Ghana of the uptake of new maize seed and the agronomic practices that go with it, shows clearly that adoption rates of both seed and fertiliser were higher amongst farmers with larger land holdings – in part because these households would have been the ones better able to afford the new technologies. They were also most likely to have been those with the greater stake in agriculture in general (Morris *et al*, 1999). Runge-Metzger's analysis (1993) of the use of inorganic fertilisers and draught animal power also highlights the importance of the financial assets held by adopters.

Gender

The importance of not overlooking the different roles played by men and women in farming operations is highlighted in Kipo's (1993) study, in which at least part of the limited adoption of a higher-yielding cowpea variety is attributed to the fact that researchers failed to ensure the participation of women in the trial programme. Since women, alone, are involved in cowpea production in the area where the innovation was being promoted, this was a significant oversight! This is not an unusual phenomenon, however: Fiadjoe *et al* (1997) in their survey of the assessment by farmers of the extension service, found that many of the technology recommendations were of limited relevance to women farmers[64]. Furthermore, the fact that women farmers in Ghana are contacted less than their male equivalents is clearly a reason why their use of many new technologies is limited (Division of Agricultural Extension Services, 1998).

For yams, the bulk of cultivation and post-harvest-related activities in northern Ghana are undertaken predominantly by men, while the input of women is limited to transporting and marketing operations (Anamoh and Bacho, 1994)[65]. Indeed, another study notes that "In the Northern and Upper West Region (*sic.*), farmers quite categorically stated that yam farming is considered too demanding for women", with women yam farmers being restricted almost totally to the southern regions (Peters *et al*, 1997).

It is important for researchers to realise that so-called gender-neutral technologies may not be this. If adoption depends on the availability of land, labour, credit and other resources such as education levels, and if men have better access to these than women, then in a specific context, new technologies may not benefit women and men equally. For this reason, it is important that both the technology itself and the physical and institutional environment into which a technology is to be introduced, are appraised in order to forecast whether or not it will be successfully adopted by both women and men (Morris *et al*, 1999)

Labour availability

The limited supply of farm family labour means that if innovations require additional labour inputs, they may fail to be adopted or else are taken up only over time. For example, resistance to the use of draught animal power in the Sahel region in the 1970s has been attributed to the high demand for labour for some of the associated post-planting operations, for which draught animal power was not suited (Okuneye, quoted in Ibrahim, 1992). In Ghana a similar picture is painted by Runge-Metzger (1993) in his analysis of the adoption by farmers of animal traction in Upper region. He shows how the availability of labour was a key determinant of the use of animal traction.

The key rôle played by labour availability also explains the strong positive relationship between the uptake of minisett technology and household size in Nigeria (Chikwendu *et al*, 1994).

Land availability and farm size

In a study of the factors determining the uptake of hybrid cocoa, Subair (1988) shows how both tenure status and farm size were key explanatory variables.

Membership of farmers' organisation

The report of a survey by Chikwendu (1994) shows that membership of a co-operative or a farmers' association was one of a list of important factors determining the rate of uptake of

[64] Tending to focus more on production than post-harvest technologies. Women are, in general, more involved in the latter.

[65] Although it likely that this division of labour is different in other parts of the country.

new technologies. Such bodies facilitate the efficient and rapid dissemination of information on improved inputs and techniques and also enable mass media (radio and printed materials) to have a greater impact.

In a research uptake study in Nigeria, it was recognised that co-operative societies were beginning to play an increasingly-important rôle. On the basis of this finding, it was recommended that they should be supported wherever possible (Monu & Omole, 1982). However, it is important that their rôle in technology uptake is not overstated – it is of concern, for example, to read in the AAGDS document (Republic of Ghana, 1999[a]) that there will be a focus on producer organisations under the Programme in order to "facilitate technology adoption". No evidence is provided that co-operatives have played such a rôle in the past in Ghana, nor is any strategy laid out as to how these organisations might be supported and encouraged to fulfil such a function.

Risk status/attitude toward change

The risk-averse nature of most small-scale agricultural producers means that they will, in general, allocate their scarce production resources to known technologies before considering any new technology of which their knowledge is less than perfect. It is therefore unlikely that farmers will adopt a new technology immediately, which means that adoption rates do tend to be slow. Most farmers
have a wait-and-see attitude – varying "in their disposition to adopting new technology" (Marfo *et al*, 1988). In addition, some technologies require farmers learning a number of technical details, which requires several visits from extension staff.

Nevertheless, experience shows that given time, changes will be accepted if there is sufficient need for the technology – the time required will depend upon a combination of the benefits of the technology and the ability of the farming system in which it is introduced, to evolve (Sechrest *et al*, 1999).

The importance of the way in which farmers look at an innovation will also influence its rate of adoption – for example, if it is perceived to be risky (even if the actual risk is low or non-existent) a technology may not be adopted – thus the attitude of a farmer to risk is clearly closely related to the riskiness of the technology itself, which is discussed in Section 7.2, above.

Onu's (1991) study of the uptake of improved soil conservation practices by farmers in Nigeria highlights the important role played in the adoption process by the "attitude towards change"[66] of those farmers who were questioned.

7.4 Characteristics of the farmer's immediate environment

Level of infrastructural development

The impact of the poor road network on the decision by individual yam farmers to expand production has been highlighted in Section 4.6. Donnhauser and Kipo (1992) explain that the limited uptake of a new cowpea technology in Ghana can be attributed, in part at least, to the poor rural infrastructure since farmers faced the possibility of essential inputs not necessarily being available at the time when they were needed.

Agro-climate

An example of how the climate of a particular area can determine the uptake of technologies is the fact that yam technologies tend to be less-easily adopted in the southern forest zone

[66] Although not clearly defined, this can be thought of as being a combination of several of the socio-cultural attributes mentioned in this chapter. The study enumerated a number of other factors which were critical to the decision of whether or not to adopt the technology.

than in the northern savana areas, which is considered to be the optimum agro-ecological zone for the production of the crop.

Access to complementary inputs

This is the ‘factor availability’ constraint referred to in the innovation adoption literature. Ruben and Lee (2000) in their review of adoption experience world-wide, note that small farmers are less likely to abandon adoption when access to complementary external inputs is guaranteed. Fiadjoe *et al* (1997) in their survey in Ghana of the assessment by farmers of the extension service, found that all farmers interviewed – whether or not they had been contacted by an extension worker – were aware of many key crop husbandry recommendations[67]. However, a key factor constraining adoption of the new technology by farmers was their lack of access to essential inputs[68]. Similarly, the absence of locally-available materials (poles in particular) was one explanation given by grain producers in Ghana for the low rate of uptake of a new storage technology (Johnson, 1999).

It is reported (Otoo and Osei, 1997) that those farmers wishing to expand their production by adopting the minisett and other production-enhancing technologies have been discouraged by the scarcity of stakes which would be needed as trellises for the increased area under the crop, while Okoli and Akoroda (1995) refer to the problems experienced by farmers in obtaining supplies of the seed dressing chemical required for the minisetts.

Another example of the importance of this factor is provided from Namibia, where complementary public investment in seed production (as well as in marketing, and in demonstration activities) has been one of the key factors ensuring the rapid uptake of a new millet variety by smallholder producers (Rohrbach *et al*, 1999).

‘Access’ has another manifestation, namely the high cost of the input which may result from it not being readily available. This may mean that it is beyond the reach of farmers. For example, it is the high cost of the seed dressing chemical and fertilisers which Chikwendu (1994) cites as a factor contributing to their low uptake. Similarly, the high cost of draught animal power is cited as a reason for its low uptake by Ibrahim (1992).

Degree of commercialisation

The literature provides no information on the importance of this factor for the uptake of yam technologies (other than in the case of the minisett technology – *see Chapter 8*). In spite of the apparent logic behind assuming that the more commercial a farmer, the more open he or she is likely to be to adopting innovations, Morris *et al* (1999) failed to find any difference in Ghanaian adopters of maize technology between those farmers who sold a portion of their harvest and those for whom the production goal was own-consumption.

Availability of relevant information

Various examples are provided in Chapter 5 and Section 6.1, above, of technologies which have been developed in research stations in Ghana but which, for various reasons, have not been made available to farmers nor to the extension service in order to be passed on to farmers.

Johnson (1999) provides a telling example of the importance of the way in which information is presented to potential adopters. One of the reasons for the low rate of adoption by Ghanaian farmers of an improved grain store was the fact that the demonstration models built

[67] These included: planting in lines, optimum plant populations, regular weeding, applications of pesticides, treatment of grain prior to storage, etc.

[68] Both physical access to the inputs and the shortage of credit with which to purchase them. This is a finding common to many uptake studies: Sechrest *et al* (1999) talk of the lack of necessary inputs (“seeds, germplasm or skills”), as being “one of the largest constraints on adoption” revealed by a number of uptake case studies.

by the researchers and extension staff were made of different materials to those which it was proposed the farmers should use in constructing their stores. The farmers felt that they were being 'sold' an inferior structure and, as a consequence, were reluctant to invest time or money in the innovation.

Land tenure and security of tenure

As might be expected[69] Morris *et al* (1999) found a strong relationship between the use by farmers of fertilisers on a maize improvement programme and the tenure arrangements on the land of those producers. Thus, fertilisers were used most extensively on land owned outright, less on rented land and least of all on share-cropped land.

Socio-cultural milieu

Ibrahim (1992) has drawn attention to the important part played in technology uptake by the intra-community barriers to information transfer which exist in many parts of Ghana.

Credit access

The availability of credit is a constraint to the uptake of innovations and, as has already been shown (in Section 4.5, above) access by most yam producers to formal credit channels is limited. Its key role is highlighted by the fact that surveys consistently show that farmers rank the lack of credit as being the most important constraint to increased production (*see Kindness et al, 1998, for example*). The shortage of 'spare' funds which can be used by households to invest in the new technologies that are being promoted and the allied limited access to formal credit channels in Ghana, have also been noted by Otoo and Osei (1997) as a factors limiting the uptake of new yam technologies.

An analysis of the factors influencing the uptake of cowpea technology provides concrete evidence of the negative impact arising from the collateral requirements and high transaction costs[70] associated with obtaining credit through formal channels. The result, as described by Donhauser and Kipo (1992) is that few farmers were able to purchase the essential, yet costly, complementary inputs required for the new cowpea technology.

Local system for produce marketing

It is logical that if an increase in the production of a crop is planned, there will need to be a market for that output. Kipo (1993) highlights the importance to a farmer's decision of whether or not to expand production, of the availability of product markets with the capacity to handle an increased volume of output.

Condition of rural infrastructure

Associated with the previous factor, the state of the infrastructure in the rural areas is a key determinant of the adoption by farmers of productivity-enhancing innovations. Most reports on rural Ghana draw attention to the limited rural road infrastructure network and its generally poor state of repair (see Section 4.6, above). Such sentiments are echoed on a more regular basis in the national press. Clearly, new technologies, supplies of crop inputs, and extension personnel will be able to reach little more than a small proportion of the farming community unless this situation is improved, while the additional output will not be able to be marketed efficiently (Donnhauser and Kipo, 1992). Consequently, the adoption of more-productive techniques by farmers living in these areas will be hampered and the expansion of yam production restricted.

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[69] Although an alternative hypothesis is put forward – that farmers may use share-cropping arrangements to gain access to highly-fertile land which, therefore, requires less fertiliser.

[70] The terms of the loans are described as being "merciless"! (*ibid.*)

Effectiveness of the extension (and research) service

Evidence has already been provided (*see Section 6.2, above*) to show that in many instances and in many parts of the country, the extension service is failing to expose farmers, in a well-managed way, to new technologies and methods of farming. For this reason, the rate of uptake of recommended technologies is lower than it could be were the extension system to be functioning efficiently. An example of an efficient extension system in Ghana is provided by the Sasakawa-Global 2000 programme which has demonstrated that farmers can be highly responsive to extension advice, readily adopting new technologies.

Almost a decade ago Rudat *et al* (1990) were drawing attention to the fact that the transmission of research results to farmers was being hampered by the very low extension officer:farmer ratio. Similarly, Donnhauser and Kipo (1992) highlight the lack of mobility of the extension staff as being a weak link in the cowpea technology diffusion process.

Onu (1991) found that the availability – and frequency of use - of extension agents (and staff from the local research institute) was a key determinant of the uptake of soil conservation recommendations in Nigeria. Similarly, Chikwendu (1994) found that the "intensity" of farmer contacts made by the extension service was a key factor explaining the uptake of minisetts in Cross-River State, Nigeria. The study by Morris *et al* (1999) came up with a similar finding: there was a significant statistical relationship between the intensity of contact that farmers in Ghana had with extension staff and the rate of uptake of improved maize seed varieties and associated inputs. Through such contacts the farmers had been made aware of the seed and the benefits of fertiliser use and, in the case of seeds, had acquired an initial 'trial' supply.

Conclusions from the studies of both Okuneye (quoted in Ibrahim, 1992) and Kipo (1993) stress that farmers need to be taught by extension staff the improved management techniques required in using the technology package. Only in this way can the full potential of the package be realised. In some instances, too, extension staff are able to arrange for other components which are essential for technologies to be adopted, to be in place. These include credit and supplies of the necessary inputs (*ibid.*).

The type of extension service being offered can also influence the rate of uptake. For example, following field work and a series of surveys in Nigeria, Laogun (1986) concluded that the most effective way of ensuring the uptake of improved agronomic practices by smallholders growing a new cowpea variety, was through individual, one-on-one contact by extension staff. The next most effective extension method was group extension work, while the printed media (such as posters and newsletters) was the least effective.

A recent study (Fiadjoe et al*, 1997) in Ghana shows that farmers make use of a number of sources of information in addition to extension staff (and the demonstrations and field days they organise*[71]*) in order to obtain information on more productive technologies. These include: other farmers, non-governmental organisations (NGOs), radios, veterinary workers and directly from research stations. Consequently, and because of the fact that agricultural extension staff are able to reach only a relatively small proportion of the country's farmers, it has been proposed that in the future increased use will be made of alternative sources of information (including pamphlets and posters – see Peters* et al*, 1999, for example) in order to disseminate information on improved technologies, to farmers (Directorate of Agricultural Extension Services, 1998).*

[71] Under the DFID-supported Yam Diseases Project (ZA0138), two one-day workshops were held for farmers at which researchers demonstrated the importance of maintaining 'healthy' seed. Yam producers were shown examples in the field of the consequences of planting 'good' and 'bad' seed, and they were given a leaflet (Peters *et al*, 1999) explaining yam diseases (Peters, J., *pers. comm.*).

Various commentators have emphasised that the current skills of many of the extension cadre are limited. For example, if they are to be required to play more of a facilitation rôle in the future, rather than the traditional somewhat top-down, technology transfer function that they have been following up until now, their skills would need to be upgraded. In following such a 'facilitation' approach, extension staff would analyse the local situation and design solutions to overcome their problems, in full consultation with farmers. Extension staff are also poorly-skilled in the area of business management – unable, for example, to provide advice to farmers with yam stores on the most appropriate time that their produce should be marketed (GTZ, 1999).

It is perhaps surprising that in spite of all the evidence and examples from elsewhere, the lack of an efficient extension service (and input supply network), which is so critical to the uptake of research recommendations, is often overlooked by those at the research 'end' of the yam technology chain. And, yet, getting technology transferred to those who will use is it the "bottom line" (Wilson and Bouwkamp, 1982). Thus Marchand & Girardot (1999) list a number of seemingly logical areas in which further research work in the yam sub-sector is urgently required, while failing to appreciate that in Ghana (and possibly other, neighbouring countries as well) they may never get further than the drawing board. For example, they urge the rapid multiplication and distribution of good quality, healthy (physiologically, and disease-free) planting material, and the improvement and dissemination of the most promising technologies including new varieties, and improved cropping practices and post-harvest techniques. However, they fail totally to address the complex issues associated with the mechanism by which the improved technologies are to be disseminated (see, also, Annex F, for an illustration of the low priority placed on the dissemination of research outputs).

As with many of the factors which are believed to have an impact on technology uptake, there is sometimes evidence to the contrary. For example, studies have been undertaken which reveal the minimal rôle played by the extension service in the dissemination of research outputs – Akoroda *et al* (1985), for example, remark that the improved cassava varieties put out by IITA spread among the farming community by "self-propulsion", with stem material being transferred from one farmer to another in an "incidental, haphazard and undirectional" manner. They conclude that the public extension service had "no evident effect" on the process.

Availability of media

As hinted at it in the previous section, the potential of the radio as a relatively low- cost extension medium is perhaps not being exploited to the full – a study of cocoa farmers in Nigeria shows that even twenty years ago radio consistently appeared as the most important source of information for cocoa smallholder farmers. It was particularly effective for awareness creation, but less so during the testing and adoption stages of the innovation process when other means of communication, such as print media, were felt to be more important (Monu & Omole, 1982).

There is undoubted potential for the increased use of this medium for agricultural extension purposes in Ghana, in light of the widespread ownership of radios. Recent figures, for example, show that 51 per cent of all households in the rural areas own radios and even in the poorest agro-ecological zone (the rural savana) and amongst the poorest group in society (the lowest quintile), ownership is common – 44 per cent and 35 per cent respectively (Ghana Statistical Service, 1999).

Other farmers

Associated with the previous factor is the impact that other, nearby farmers and friends can have on the innovation process. Laogun (1986), for example, stresses the important role they can play, while Onu's study (1991) reveals the critical rôle played by 'village heads'.

Sechrest *et al* (1999) in their review of adoption case studies conclude that farmer-to-farmer exchanges and other 'informal' means of dissemination, play a much greater rôle in facilitating adoption than previously recognised.

7.5 Characteristics of the external (macro-economic) environment

Decisions by farmers on whether or not to adopt a technology also depend crucially on the wider environment in which they, as a group, operate. Unless these macro-economic factors are also addressed, little change will be seen in the productivity of agricultural enterprises. They include such factors as:

National produce marketing arrangements

Unlike its interventions in the marketing of several other crops, Government involvement in yam post-harvest operations has been limited, which means that its ability directly to influence production has been small. Thus, the adoption of innovations by yam farmers is not likely to have been affected compared with the situation for crops such as rice and cocoa, the pricing and marketing of which have been strongly influenced by Government action.

Although limited, nevertheless, some public controls on the transport of people and commodities are understood still to be in place and, therefore, may be having an impact on the marketing of the crop (Gray, 1996). There are also still some food marketing operations conducted by the Ghana Food Distribution Corporation[72]. In this way, national marketing arrangements may still be influencing decisions by farmers to expand production through the uptake of new technologies.

Changing tastes

Clearly, a change in consumer preference in favour of smaller yams (a trend already witnessed in Nigeria), would most likely result in the rapid growth in production making use of the minisett technology. This would have the added advantage of a rapid and expanded production of disease-free seedlings (*see Chapter 8*).

Institutional characteristics of research and technology transfer institutions

The adoption of a number of root crop technologies in Ghana has been helped by the research activities which have been able to be mobilised to deal with specific production issues as they have arisen. In addition, the timely and competent technical research support for yams which has been available from the nearby IITA has been an important factor contributing to the adoption of new technologies by farmers (IFAD, 1996).

National policy environment

The importance for the uptake of innovations of a favourable policy environment is underlined by Levin (1997) who notes that the policy reforms of the early 1990s in Ghana were "limited in their capacity to accelerate agricultural growth, adopt new technologies and develop an efficient marketing system". However, the opposite point of view is expressed in an IFAD study (1996) in which it is explained that one of the key factors behind the uptake of several crop technologies in recent years in Ghana has been the strong support for the sector by the government, as seen in the agricultural development policies and strategies which it has drawn up (IFAD, 1996).

A strong government commitment to agricultural research and extension – and particularly to increased adoption rates - is essential. This involves not only direct support but also policy decisions which recognise that technological change is a dynamic process endogenous to the

[72] Although as long ago as 1996, Gray (*ibid.*) reported that the involvement of the Ghana Food Distribution Corporation in distributing yams "has been almost completely eliminated as part of government policy of privatising state marketing boards".

economy, and that successful adoption is not merely a function of research and extension, but is also highly correlated with national economic policy and the effective development of the overall institutional framework (Oram, 1993). Thus, stable and remunerative market prices are required to attract farmers to use yield-increasing inputs, land tenure security is needed to enhance investment in farm enterprises and rural financial systems should facilitate farmers' borrowing for input purchases.

The importance of investigating the impact of macro-economic policy measures[73] on farm-level incentives to adopt new technologies is provided by Smith (1993). His study shows how the limited adoption of soyabeans by farmers in Nigeria during the 1980s was the direct result of a distorted policy environment and how, following policy changes which led to the establishment of a local processing industry, soyabeans were rapidly incorporated into smallholder farming systems. Up until this time, the local tax system had meant that local processing was not financially viable and those farmers who had grown the crop had been unable to dispose of their harvest.

In addition to those facets of national policies impacting on uptake which have already been mentioned, there are a number of others. For example, according to a recent study, only when "appropriate" food quality standards have been introduced into the country is market-oriented yam storage using improved methods likely to be a success (GTZ, 1999).

Peace and stability

In their study of the rapid uptake of improved cassava varieties in Nigeria, Nweke *et al* (1994) attribute a significant part of the success, to the peace and political stability that prevailed in the rural areas in the critical period while the technology was being developed and during the initial months of the dissemination process. The peaceful situation which has prevailed in Ghana in recent decades must have served to strengthen the enabling environment for technology dissemination and adoption.

7.6 Others

Mix of factors

In the preceding sections of this chapter, it has been shown that, in a number of cases, it is not possible to attribute the adoption of a new technology to a single factor. Rather, there is significant interaction between a number of variables which result in the innovation being adopted (Johnson *et al*, 1999).

The complexity of factors influencing the uptake of new technologies is well portrayed in a study of the uptake of a new cowpea variety by Ghanaian farmers (Kipo, 1990). Research shows (and farmers demonstrated) how the innovation was more profitable than varieties in use at the time and that the improved variety was recognised by farmers as having better cooking properties and taste than the existing ones. However, even though the new variety was widely accepted in the first few years after its introduction, there was wide variation in the attitudes and performances of the adopters. Indeed, the researcher notes that rather than being genuinely interested in the innovation, farmers participated in the programme in order to gain access to inputs which were in short supply at the time[74]. (However, as might be

[73] Which include international trade policies.

[74] The same phenomenon is noted by Ibrahim (1992) in looking at the adoption of high-yielding maize varieties in Ghana – farmers were happy to try the new seed as long as it was free! Similarly, Ruben and Lee (2000) note that worldwide experience with 'Low External Input Agriculture' is that adoption is often limited to farmers who receive direct technical of financial support – without such assistance, such practices are often readily abandoned.

expected when dealing with a risk-averse group, they only planted the new variety in the "very poor" parts of their holdings).

The author concludes that the uptake of the technology was determined by a number of related factors, the most prominent of which was farmers' risk aversion[75], but which also included the input supply situation. Another key factor was assessed as being the compatibility of the innovation with the socio-economic/socio-cultural situation of the producer and the community in which he/she was operating. Thus adoption was "not simply a reflection of perceived needs and access to resources, but also a question of the institutional arrangements within and between households which govern access to and allocation of, resources" (*ibid.*).

In another paper, a summary of the key factors determining the adoption by farmers of improved technologies in general is presented (although no evidence is provided of these having been derived from any survey work). The principal factors which are judged as having a 'direct' impact are:

- the level of literacy of the farmer;
- the sex of the farmer; and
- whether or not the farmer is a '*stranger*'[76].

The 'indirect' factors include:

- whether or not the farmer is a member of a group (for extension and input supply/output marketing purposes);
- land ownership; and
- access to credit (IECT, 1999).

The AgSSIP sub-committee, which was set up to look into aspects of innovation uptake, came up with a list of the principal constraints to adoption (Technology Sub-committee, 1998). The list has an institutional flavour and includes:

- inadequate public funding of the technology generation process;
- insufficient involvement by stakeholders in the research process;
- the insecurity of land tenure;
- the poorly-trained extension staff and the logistical problems they face;
- the low capacity of the (decentralised) MoFA services at the field level;
- the weak links that exist between the extension service and farmers' organisations, NGOs and agribusiness; and
- the fact that, for the most part, the RELCs have been insufficiently-equipped to undertake adaptive trials in the 'zones' which they serve.

Awareness and adoption

Research has shown that although many farmers may be aware of a new technology or agronomic recommendation, this does not necessarily mean that the technology will be adopted. For example, Chikwendu's survey reveals that 80 per cent of his sample of yam farmers were aware of the minisett technology, whereas only 49 per cent were using it, in spite of a "vigorous extension campaign". Similarly Ibrahim (1992) reports that many more farmers in Ghana than those adopting high-yielding varieties of maize and the package that goes with it, were aware of it (which he terms "acceptance").

Adaptation of innovations

There are several examples in the literature of how following the adoption of an innovation, farmers have further refined it, better to suit their particular requirements or else they have

[75] This characteristic was also recognised by Ibrahim (1992).
[76] A term used in Ghana for those who have migrated into an area to farm. The bulk of 'strangers' are tenants and are usually from the northern part of the country.

adopted only part of it. For example, only part of the minisett technology package was adopted by farmers - practices such as chemical weed control were soon dropped. As Marfo *et al* (1998) remark, agricultural researchers have much to learn from this phenomenon.

8. The minisett technique: a case study of the uptake of a new yam technology

The low multiplication rate of yams means that up to one-third of farmers' fields have to be set aside for the production of seeds each year (*see Section 4.1, above*). This has a number of consequences (Bakang, 1998), including the slow rate of exchange of planting material between farmers which is one explanation for the "insufficient diversity of yam germplasm" (Vernier *et al*, 1999), and the limited potential for a rapid expansion in the area planted to the crop. In order to address this problem, which is recognised by farmers as being one of their most important production constraints, yam *"minisett"* technology was developed.

The process involves the selection of clean and apparently healthy tubers, cutting them into various pieces (or *minisetts*) each weighing about 25 gm to 30 gm and each of which have at least one side covered by the skin (from where the sprout can emerge). The minisetts are then chemically treated, nursed, transplanted into ridges or mounds. The seed yams thus produced are then carefully harvested in order to avoid damage. From this short description, it is clear that the technique is more complex (and costly) than traditional methods of seed yam production[77].

The potential of the technology is not only that it produces seed yams quickly (although this speed is at the expense of the size of the tubers – *see below*[78]) but also that it allows the multiplication of good quality (disease-free) planting material. Through the careful choice of healthy tubers and/or the application of pest control treatments in the production of the seed yams the fungus complex and nematode infection which are all seed-borne, can be countered. It, therefore, directly addresses the principal limitation to a rapid increase in the productivity of yam farming, which is the scarcity of healthy and reliable planting material.

The technology can also save an estimated two-thirds of the area which would otherwise be given over to the production from yam pieces of tubers that are to be used subsequently for seed (Marchand & Girardot, 1999).

In light of these advantages, one might expect the technology to have been adopted by many Ghanaian farmers. In some parts of Nigeria, for example, studies have shown that it has been adopted by a high proportion of farmers in some areas - minisetts were being used by 51 per cent of those exposed to the technology in a study by Okoli & Akoroda (1995) and 49 per cent of those in Cross-River State (Chikwendu *et al*, 1994)[79]. However, overall there has been limited adoption of the technique in Nigeria and, as in the case of Ghana, it is likely that the promotion of the technique has been at fault (*see Footnote 77*), with it having been targeted at neither the appropriate farmers nor the correct situation.

In Ghana, little enthusiasm has been shown for the technique by yam growers. Indeed one recent study (Bakang, 1998) states that there was "not a single district within the traditional yam zone in which any positive farmer responses were recorded". Observers (Ekekpi, 2000; Kissiedu *et al*, 1992; Langyintuo, 1996; Marfo *et al*, 1998; Okoli and Akoroda, 1995), attribute the low rate of uptake to a number of factors, including:

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[77] Furthermore, it is reported that the only really successful production of minisetts in Ghana has been when *Dioscorea alata* (water yam) has been used. Unfortunately, *Dioscorea rotundata* (white yam) is the type generally preferred by consumers (Anon, 1996). However, this can be probably be attributed to poor minisett production practices since, wherever the technique has been used properly, the number of genotypes (even for *D. rotundata*) for which it does not work effectively, is only a small fraction of the total (Asiedu, R., *pers. comm.*).

[78] A relatively large '*sett*' is preferred for planting, since it will result in the production of larger tubers (and higher incomes – *see Footnote 19* - for those farmers who sell part of their harvest).

[79] The technique was also rapidly adopted in Jamaica (Chin Sue & Wickham, 1998). Farmers there remarked that the technology was easy to use and that it led to a reduction in labour use, a higher tuber yield (and, therefore, gross returns) and the increased marketability of the yams.

- the low (or negative returns) which result from the time lag before large *ware* tubers are produced;
- the poor availability and high cost of the essential inputs;
- the tedious and technical nature of the technique;
- the most popular market varieties of white yam respond poorly to the technique;
- the high input of managerial time required of the farmers;
- the unavailability of chemical seed dressing; and
- the fact that the new technology is not compatible with the intercropping farming system followed by those farmers to whom the technology was directed.

Marfo *et al* (1998) demonstrate how the poor way in which the technology was demonstrated by extension staff to farmers in the area they surveyed, resulted in a negative assessment of the technology by the farmers. Consequently the limited adoption of the minisett technique was not 'maintained'[80].

In one detailed minisett technology uptake study, a number of the institutional arrangements surrounding the research and extension process are critically evaluated (Bakang, 1998). For example, the one-day training course on the technique given to the non-yam-growing agricultural extension staff provided them with insufficient technical knowledge to extend the technique with confidence to farmers. In addition, the subsequent farmer-training programme was too ambitious (with minisetts only one of six topics delivered to extension staff during the pre-season programme). Furthermore, the initiative for the extension of the technique came from above – there was no consultation at the field level with farmers nor with local extension staff to gauge if the technology met a felt need amongst local producers.

Nor was there any participatory development of the technology which might have shown that because it results in the production of small-sized tubers, it would be doomed to failure in a culture where the status of farmers has traditionally been correlated with the size of the yams produced from their land (Ekekpi, 2000). Such participatory work might also have revealed that the farmers who produce a large quantity of yams tend not to be commercially oriented; rather they are fully involved in reciprocal arrangements – which include yams - within the community. For this reason, the whole societal balance resulting from relationships between tuber donors and recipients is threatened by the new technology[81]. Bakang (1998) shows that minisett demonstration plots were established in non-core yam growing areas, while those identified by the extension programme as being clients for the technology were not the prospective commercial yam farmers in the traditional yam-producing areas.

Finally, insufficient funds were made available for a continuous programme of on-farm demonstrations, which is a requirement for the promotion of almost all new technologies. It comes as no surprise therefore to learn that the short promotion time proved insufficient to demonstrate fully the advantages of the new technology - farmers reported that on the basis of what they had been shown, they saw no net financial benefits of the minisett technique over the traditional practice of *milking* the yam mounds to produce seeds.

It is, therefore, hardly surprising that the minisett system in Ghana currently remains at the demonstration stage "with only a few trials by curious innovators" (*ibid.*).

A more fundamental problem has been highlighted by one observer who remarks that those who have promoted the yam minisett technique to farmers have done a great disservice to the

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[80] Contrasting with, for example, a new variety of maize which extension staff demonstrated to farmers as being 'effective' and which was, subsequently, widely adopted and the adoption was maintained (Sechrest *et al*, 1999).
[81] Consequently, the promotion exercise might have had more impact had it been directed to the non-traditional yam growing areas, where the demand for planting materials is high and production is less dominated by cultural considerations.

development of the crop in Ghana (Asiedu, R., *pers. comm.*). He notes that the principal use of the technique is for the production of seed yams in one season that can be used in subsequent seasons for the production of ware tubers. With a slight modification of the size of the setts, uniformly shaped tubers can be produced for export and other 'niche' markets. By failing to appreciate the correspondence between the size of the sett and the size of the resulting seed tuber and/or the opportunity to influence the size of the seed tuber through agronomic practices, those promoting minisetts have 'obliterated' the essential flexibility and adaptability of the technique.

9. Conclusions

The study shows that yams play an important part in Ghana's economy. They provide a valuable source of incomes to those who sell a part of their harvest, exports of the commodity generate valuable foreign exchange earnings for the national economy, while yams make a valuable contribution to national and household food supplies. Their contribution to ensuring food security is partly attributable to the fact that the crop is less susceptible than grain crops to the vagaries of the weather – irregular rains being the norm in many parts of Ghana.

However, the contribution that the crop currently makes in each of these areas is significantly below its potential due to a gamut of technical, infrastructural, socio-economic, institutional and other constraints. Were these to be overcome, yam production could be increased significantly.

The study has highlighted the characteristics and trends in Ghana in recent years of agricultural research and extension activities in general, showing how growing institutional shortcomings have impacted negatively upon the development and uptake of new crop technologies, including those for yams. Moreover, resources earmarked for spending on research into this food crop have been far below what might be expected given the importance of yams in daily food consumption and the contribution they make to the agricultural sector's GDP.

However, if this situation can be reversed, with more financial and human resources directed at the crop and if the research and extension activities, themselves, can be made more efficient, it follows that more productive technologies are likely to be developed, and adopted by farmers. This would, in turn, mean that yam-based farming systems would become more resilient, opportunities for income generation would be expanded, the demand for labour would increase and nutrition levels amongst the population would improve. Furthermore, since food purchases account for an average of 35 per cent of total household expenditure, any action taken to raise the efficiency of yam production will provide a boost to the livelihoods of the bulk of the population in the rural areas[82], which is where the majority of Ghana's poor are located. Not only will such action improve the food security status of the poor but it will also enhance food security nationally.

Each of the above outcomes resulting from the adoption of new technologies is fully in line with the Government's current agricultural development strategy, stressing, as it does, improved food security, a reduction in poverty and the creation of more employment opportunities in the rural areas. In addition, a more productive yam sub-sector will contribute to meeting the growth targets which have been set in national economic planning documents for the agricultural sector as a whole.

Without a steady flow of research results which are of immediate use to yam producers and which are subsequently adopted, the costs of producing this root crop will continue to rise, resulting in a change from the current situation where it is a staple food, to one where it would become a luxury item. Furthermore, research is urgently required since, as has been shown earlier, current yam production systems are unsustainable. Farmers need to have access to new technologies enabling them to grow yams on soil with low to moderate levels of plant nutrients and/or financially-viable means of improving the fertility of their land.

In addition to structural constraints associated with the efficiency of the public research and extension services, it has been shown that there are a large number of factors which influence

[82] And will address directly the recent plea that "Food producing farmers, especially in the northern regions, deserve particular policy attention" (Ghana Statistical Service, 1999).

the decisions made by Ghanaian farmers to take up and use regularly, new production and post-harvest technologies and techniques. These can be grouped under the headings of: the characteristics of the technology itself; the characteristics of the farmer him- or her-self; the features of the immediate environment in which the farmer is living and working; and the characteristics of the broader, macro-economic environment. The relative importance of specific factors in influencing uptake decisions will vary between farmers - over time, spatially and according to the crop under consideration. A review of the literature reveals that the apparent significance of particular adoption-inducing factors is often related to the background of the observer – thus, for example, sociologists place an emphasis on the influence of social structures while economists stress the role of demand-side factors.

It is important to bear in mind that concern over the uptake of new agricultural technologies is not new. Rather it has been a recurring theme in reports on the country's agricultural sector – perhaps the most recent observation being in a national economic policy document which states that a key challenge for the development of the sector is "the transfer of research work from the numerous research institutions to the farm" (Ministry of Finance, 1999). Nor is it a concern that is peculiar to Ghana (nor to yams). In their review of technology uptake internationally, Garforth and Usher (1996) reveal the typical situation to be that "..the flow of information from research to end users was at best limited, while farmers' needs were not met by agricultural technicians (extension staff) who in turn were dissatisfied with the technical packages handed to them by researchers".

It is clear from the study that only rarely does adoption just happen. For this reason, if rates of uptake are to be increased it is not enough for improved technologies targeted at enhancing the productivity of yam-based systems to be developed and then responsibility for their testing and dissemination simply to be handed over to the extension service in the hope that the innovations will be evaluated and disseminated (*see Annex F*). Rather, the dissemination and application of innovations' uptake need to be planned for in a systematic and comprehensive way - with goals, responsibilities and time-bound adoption projections laid down[83]. And researchers need to play an integral part in this planning process[84].

An important indirect effect of showing that particular research findings have been delivered to and adopted by, yam producers is that it would provide both farmers more generally and Ghana's aid partners with a good example that productivity of the crop can, indeed, be increased. A strong case can then be made to the latter to support further technology development work on yams. Such evidence of technology uptake will also boost the confidence of the research and extension services in their ability to promote productivity-enhancing change among smallholder producers (Rohrbach *et al*, 1999). In addition, examples of adoption could have a positive impact on policy makers – both directors of agricultural research institutes and politicians.

At the same time, if detailed monitoring of the uptake process can be fully integrated within future yam research support interventions, a better understanding of the most-effective communication pathways together with the key factors influencing uptake of the crop in Ghana will be realised. This knowledge may be applicable thereafter, both in other yam-growing areas of West Africa and for the uptake by resource-poor farmers of agricultural research outputs' more generally, in order to raise farm productivity, to increase household food security and to reduce the incidence of poverty.

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[83] This echoes a recommendation contained in a recent review of uptake (Sechrest *et al*, 1999). The authors found it impossible to evaluate whether or not the 54 per cent rate of adoption of an improved maize variety in Ghana was satisfactory: "As few specific goals were set for adoption of any of the innovations, nothing more than an impression of success or failure can be reached".

[84] The ostrich-like attitude of some researchers to this issue was brought home when a reviewer of an early draft of this study report commented that, "The uptake of research recommendations by an …. extension service is not the mandate of the researcher".

10. Recommendations and proposed priority entry points for the increased uptake of yam technologies

During the course of the study, it became apparent that there are a number of priority areas on which research into yam technologies should be focussed (and several of these have been highlighted in earlier chapters). Some of them are already being addressed while others are not. In addition, certain specific improvements could be made to the management and operations of the agricultural extension system, relatively easily and at little cost, which have the potential to increase the efficiency of this uptake pathway. There are also several other non-agricultural constraints that will need to be addressed if an enabling environment is to be put in place for the increased uptake of productivity-enhancing innovations. They have been touched upon earlier in the paper but are repeated here as they are felt to be important constraints.

Key activities, grouped under these three general headings, are discussed below.

10.1 Yam research[85]

Whilst there may be a number of "on-the-shelf" technologies (IFAD, 1997) awaiting multiplication, distribution, and uptake by yam producers, research activities in Ghana need to be re-invigorated in order for a pipeline of new technologies to be developed and maintained. Indeed, much research work lies ahead if it is to have a widespread impact on yam production (Quin, 1998). The principal topics for future yam research – some of which have been mentioned in earlier chapters of the paper – include the following:

1. Increased production of yams is now constrained by a shortage of fertile land, while a reduction in the fallow period is occurring nationwide. For this reason, research on soil fertility and fertiliser application is needed and this work should be concentrated in the savana zone which is where the problem is now manifest. Such research is also needed since, if it makes possible a reduction in the fallow period, it could result in the bulk of yam cultivation being concentrated closer to the existing feeder road network, thus improving the efficiency of many post-harvest storage and marketing operations. As an adjunct to this work, the response of different yam varieties to inorganic fertiliser application and its effect on the cooking, taste and shelf life of tubers should be investigated (since, as Marchand & Girardot (1999) note, research in these areas has so far consisted of "numerous studies with contrasting results").

2. The whole issue surrounding the impact that the market queens (and other actors – FAO, 1998) have on the trade in yams. As mentioned in Section 3.2 (and Footnote 26), above, researchers and observers have sharply contradictory views on whether the market queens: (i) restrict trade, maintaining artificially low prices for producers and high prices for consumers – making "excess profits" in the tradition of all monopsonists, on the 'spread' between the two (ICRA, 1996), or (ii) provide a valuable market intermediation service, facilitating trade and ensuring the smooth functioning of the yam marketing system.

3. The influence of the cropping system on the performance of yams. For example, the impact of intercropping on tuber size.

4. Culturally-acceptable improvements in yam storage practices, which would include an investigation of the way in which the shelf life of tubers – the *Puna* and *Lariboko*

[85] Most of these are not new topics/suggestions – indeed the bulk of them are also to be found in ICRA (1996), while several of them (in particular, increasing labour efficiency, producing better quality planting materials, and improving techniques of tuber storage and processing) are highlighted by Ezeh (1998).

varieties, in particular – can be increased so as to improve household food security, boost export quality and raise returns to yam farmers[86]. An integral part of this work would be a much-needed detailed financial appraisal, at the household level, of the different storage structures and options (Nkum Associates, 1994).

5. The development of processing technologies to boost alternative uses (such as flour and semi-processed frozen and sliced yams, as well as yam-based products[87]) and reduce the perishability of the tubers.

6. The need for and possibility of, supplying short-term working capital to assist existing traders and to encourage the entry of new traders into bulk purchasing and stockholding activities.

7. The breeding of: (i) higher yielding; (ii) more stable-yielding and (iii) disease-resistant varieties with tuber characteristics that facilitate harvesting and handling and that also meet consumer preferences (building on farmers' indigenous knowledge, since they have, themselves, always tried to reduce losses by growing varieties possessing at least one of these characteristics). This work needs to take into account the impact of the "sedentarization of yam-based systems and the shortening of fallow periods", which is resulting from increasing population pressures in the rural areas (Sékou, 1999).

8. The development of more productive cultivation techniques (for land preparation, staking, weeding and harvesting[88], for example) as they are currently both slow and require heavy inputs of labour. For example, given the increasing scarcity of stakes, it is important to find varieties which yield well when they are not staked. Research on this topic should also investigate methods for live-staking – such as using *Gliricidia sepium* – and the use of maize and sorghum stover. More-productive farm tools also need to be developed (Nkum Associates, 1994). This research focus is supported by, among others, Marchand and Girardot (1999), who note that "the most feasible strategies for reducing production costs must be developed and implemented".

9. It will also be important to monitor any changes taking place in consumer tastes in all parts of the country. It has been noted in Nigeria and Benin, for example, that the urban population is increasingly demanding smaller (1 kg-2 kg) tubers at a competitive price, rather than the typical tuber that weighs between 5 kg and 20 kg. This, in turn, is resulting in changes in production techniques in both countries. There are no references to a similar change yet having taken place in Ghana, although this may not be far away given the rapid growth in the country's urban population.

10. An investigation is needed into moves, if any, towards the development of a yam seed market – in other words, towards farmers specialising in growing seed for sale[89]. This is an important development which is taking place in the yam sub-sector in neighbouring countries, yet there is virtually no evidence of it happening in Ghana[90]. If evidence of it is

[86] Anamoh and Bacho (1994), for example, talk of annual movements in retail prices of yams of between 100 per cent and 400 per cent due to changes in the availability of the crop on the market. However, much lower figures of wholesale price fluctuations (of between 100 per cent and 140 per cent) are recorded by the authors of the NARSP (Anon, 1994). These latter fluctuations can be compared with those recorded for the wholesale price of maize of between 69 per cent and 146 per cent.

[87] building on the considerable amount of research already undertaken in this field within the West African region (see Vernier, P. *et al*., 1999, and IFAD, 1999, for descriptions of some of this work). It must be recognised, however, that such research has a lower priority than, for example, improved storage, in light of the continued preference of Ghanaian consumers for fresh yam tubers.

[88] Possibilities for international co-operation need to be urgently pursued given that mechanical tuber harvesters are common in the Caribbean (Quin, 1998).

[89] Kindness *et al* (1998) make a similar recommendation.

[90] Although Langyintuo (1996) states that "….seed yams are beginning to appear on the market".

found, areas of possible support for this infant commercial development need to be identified. If no evidence is found of a seed industry, the reasons for its absence should be investigated.

11. The development of integrated management practices for nematodes and pathogens associated with tuber rots, for example by using hot-water treatment. Although some work on this latter intervention has already been undertaken in the region, it is important that trials now be carried out to adapt the technique so that it can be used by smallholders in Ghana.

12. Coming up with improved diagnostics for the better health of propagules and safe international exchange of germplasm.

13. The development of artificial means of inducing sprouting in dormant seed tubers in order to increase cycles of seed multiplication (or cropping). Currently, the long growth period of the crop and the tuber dormancy period restrict cropping to once a year. The loss of seed during storage could be reduced and the pace of seed multiplication doubled if dormancy could be broken when needed.

14. Developing improved systems for the rapid mass propagation and delivery of propagules, especially of newly-introduced or highly-desirable varieties[91].

It goes without saying that detailed financial analysis, taking into account the “with” and “without” innovation situations, needs to be incorporated as an integral part of each of these research projects. So, too, does the dynamic perspective; changing circumstances – such as the prices of inputs, weather and output markets - are the norm in smallholder yam farming operations, and need to be modeled so that the appropriateness of any new (and existing) technologies can be assessed.

Similarly, stakeholder participation (regularly eliciting the views and preferences of farmers in all stages of the research and development process) is important. This would be important, for example, during the very necessary regular assessment of the adoption potential of technologies in the pipeline, and in assessing the impact of released ones. Although this may seem an obvious point, it does need reiterating as it is so often overlooked (Sechrest *et al*, 1999).

If the agricultural research system as a whole is to become more effective, it will be necessary for the whole issue of research co-ordination to be addressed at the highest level. An integral part of this exercise, will be for human and material resources to be allocated to specific crops in line with objectively-identified priorities.

Finally, it is important that all of the stakeholders in technology development activities are realistic in their expectations. Agricultural research is a slow process and there will be a time-lag before most new technologies are developed to the point where they can start to be disseminated[92], particularly if one takes into account the relatively long-term nature of the crop itself. Yet more years have to have elapsed after the recommendations become widely

[91] Points 12 to 14 were suggested by R. Asiedu (*pers. comm.*).

[92] Collinson & Tollens (1994), cited in Sechrest *et al (*1999), report that the average length of time that a research project takes to produce a usable technology in one of the CGIAR centres is 10 years, with a further 10 years needed for its widespread adoption. In a similar vein, Alex (1998) estimates the lag time for the impact of agricultural research (crop varietal development) to be felt, as being “up to 30 years”, while Jones (1967) explains that a farmer’s decision to adopt an innovation is bound to take time, given that “uncertainty is a dominant socio-economic characteristic” of agriculture.

adopted before impact indicators[93] begin to show any response. It is for this reason that the early outcomes of research are usually very difficult to assess.

10.2 Agricultural extension

Farmers and other local agencies (farmers groups, co-operatives, NGOs, local government) should be more systematically consulted and involved in the technology definition and development process[94].

Following on from the discussion in Chapter 9, simple monitoring and evaluation methodologies must be developed and systematically incorporated into the research-extension system (and/or into specific agricultural research projects), in order to provide up-to-date information on the impact of specific technologies to those working in it. This is necessary if adoption is to be anything other than a "haphazard enterprise of highly uncertain success" (Sechrest *et al*, 1999). Norrish (1999) is correct in highlighting that budgetary provision will have to be made for this activity. (However, the proposal in the recent CGIAR review paper (Sechrest *et al*, 1999) for an international agency to be established with personnel dedicated to planning and carrying out strategic adoption campaigns, would appear to be unrealistic in light of current and projected limited volume of resources being earmarked by aid partners for the agricultural sector).

Continuing training programmes[95] to upgrade the capacity of both field and managerial extension staff will be required, as will logistical support to enable them to undertake their work more effectively. Training is urgently needed in such areas as: (i) the causes, vectors and transmission mechanisms for yam pests and diseases; (ii) how to recognise yam tubers which must not be used as seed due to disease infestation; (iii) improved storage techniques and structures (Kindness *et al*, 1998); (iv) rapid propagation practices; and (v) the efficient use of fertilisers during cultivation (Asiedu, R., *pers. comm.*). Extension staff need to have the capacity subsequently to pass on this information with confidence, to the farming community.

Associated with 3, above, extension and research staff need to come together to train farmers and traders in improved tuber harvesting and post-harvest handling techniques (including transportation), so as to reduce damage through bruising – possibly preceded by a thorough investigation of the losses incurred during transportation.

Without a more viable public extension system, the chances of it being an effective cog in the adoption process "wheel" is limited. For this reason, the recent proposal by the Directorate of Agricultural Extension Services to pilot various alternative financing and service delivery systems for agricultural extension under the AgSSIP (Dormon *et al*, 1999) is to be welcomed[96]. (It is, however, surprising that some lessons have not already been learned given that most of these different systems have been in operation for several years). Along these lines, it has been suggested that specific yam development activities (both extension and research) might be supported by yam traders' associations/yam exporters[97].

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[93] Such indicators include; costs of production, the area planted to the crop, production levels, a change in a specific subsidy, post-harvest losses and factor prices (Alex, 1998).

[94] The AgSSIP sub-committee responsible for technology utilisation emphasises that since not all farmers can take part in the process, communities should be closely involved with research/extension technicians in identifying those individuals most suited to being intensively involved in such activities as running adaptive trials, etc. (Technology Sub-committee, 1998).

[95] Information on gender roles in such farming activities as the selection of yam planting materials, would be needed prior to such training to ensure relevant information is imparted to those most likely to benefit from it.

[96] Although, as the authors note, it is highly likely that core extension functions in respect of smallholder food crop farmers will continue to be provided by the Ministry of Food & Agriculture (Dormon *et al*, 1999).

[97] R. Asiedu (*pers. comm.*).

10.3 Other: non-extension/research-related interventions

As has been shown, there are a number of non-agricultural variables constraining the adoption of new yam technologies in Ghana, which will need to be addressed if the full potential of productivity-enhancing innovations is to be realised.

Principal amongst these is the urgent need for the rural access road network to be expanded. Associated with this, existing access roads and tracks will need to be regularly maintained in order for produce to be moved to the market centres and for inputs and agricultural advisory personnel to gain access to the main areas of yam production. This means that MoFA extension staff and yam researchers should be integral members of any teams which are set up to plan the rehabilitation and expansion of the feeder road network in major yam-producing areas.

Another important intervention with the potential to increase the efficiency of yam marketing (in addition to the marketing research activity proposed in Paragraph 10.1(2), above), would be the publication and widespread dissemination of regular bulletins detailing the prices of yams and other tubers, as well as other relevant market information. Associated with this support, would be the training of farmers and traders in optimal yam handling practices, in understanding marketing standards and in the grading of tubers to select those of export standard.

There is also an urgent need for detailed work to be carried out on the principal features and trends of the export market for yams. Only in this way can the potential of the crop be exploited to the full.

If we think about rural lands, it’s night
more swiftly over village earth humid
with vegetal rotting. Our feet halt. After
the manioc-pounded day, the hot yam
fields haunched with women, the blaze
has gone out of it……

the kerosene
lamp by an enamel cooking pot, the fufu
in it…..

What can we add to so little, us with
what we think is so much?
We leave a nothing by the mud wall; it’s
the oval trademark in a Western shoeprint.

Extracts from: *Few possessions in Togo,* by Douglas Oliver (2000)

Annex A:

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Annex B

Production of selected food crops in Ghana (in '000 tonnes)

Crop	***1991***	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***
Cassava	5,702	5,662	5,973	6,025	6,611	7,111	7,150	7,172
Yam	2,632	2,331	2,720	1,700	2,126	2,275	2,417	2,703
Plantain	1,297	1,082	1,322	1,475	1,637	1,823	1,878	1,913
Cocoyam	1,297	1,202	1,236	1,148	1,408	1,552	1,535	1,577
Maize	932	731	961	940	1,034	1,008	1,021	1,015
Sorghum	241	259	328	324	360	353	320	356
Millet	112	133	198	168	209	193	139	162
Rice	151	132	157	162	221	216	197	281

Area planted to selected food crops in Ghana (in '000 ha)

Crop	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Cassava	535	552	532	520	551	591	589	630
Yam	227	224	207	154	176	178	187	211
Plantain	174	157	164	184	213	229	225	246
Cocoyam	203	196	173	179	205	214	206	218
Maize	610	607	637	629	689	665	652	697
Sorghum	263	307	310	299	335	314	324	332
Millet	209	210	204	191	193	190	170	181
Rice	95	80	77	81	100	105	118	130
Guinea Corn	263	307	310	299	335	314	n.a.	n.a.

Source: Ministry of Food & Agriculture, 1999
Ministry of Finance, 1999

Annex C

PEOPLE MET[98]

S. Adongo	Co-ordinator, Smallholder agricultural development project (IFAD), Ministry of Food & Agriculture (MoFA), Tamale
E. Aggrey-Fynn	Acting director, Statistics, Research & Information Directorate (PPMED), MoFA, Accra.
A. Ebert	GTZ adviser, MoFA (leaving Ghana).
Dr K. Amezah	Assistant director, Department of Agricultural Extension Services, MoFA, Accra
Dr K. Anane	Group formation officer, Root & Tuber Improvement Programme, MoFA, Kumasi
C. Annor-Frempong	Agricultural adviser, World Bank Office, Accra
Dr S. Asante	Entomologist, Savannah Agricultural Research Institute, Nyankpala, Tamale
Dr R. Asiedu	Plant breeder, IITA, Ibadan
T. Bagamsah	Agronomist, Savannah Agricultural Research Institute, Nyankpala
B. Blay	Deputy director (Crop Pest & Disease Management), Plant Protection & Regulatory Services Directorate PPRSD), MoFA, Pokuase.
Dr A. Cudjoe	Biological control specialist, PPRSD, MoFA, Pokuase
Dr B. Dadzie	Acting NRI liaison officer, Accra
Dr O-A. Danquah	Plant pathologist, Crops Research Institute, Fumesua, Kumasi
Ms J. Dennis	Deputy director, Directorate of Agricultural Extension Services, MoFA, Accra.
F. Donkor	Deputy director (field services), Department of Agricultural Extension Services, MoFA, Accra
A. Fayossewo	National & regional institutions officer (agrarian reform), FAO Regional Office for Africa, Accra
H. Fuseini	Regional post-harvest officer (and NRI) co-ordinator, MoFA, Tamale
Dr J. Hesse	Agricultural economist & adviser, Department of Agricultural Extension Services, MoFA, Accra
Dr J. d'A. Hughes	Virologist, IITA, Ibadan
Dr P. Johnson	Senior research officer (storage & processing), Food Research Institute, CSIR. (Ministry of Environment, Science & Technology)
Dr S. Kassapu	Senior science & technology officer, FAO Regional Office for Africa, Accra
C. Kwoseh	Ph.D. student, Dept of Crop Science, UST, Kumasi
Dr J. Lamptey	Virologist, Crops Research Institute, Fumesua, Kumasi
Dr V. Manyong	Agricultural economist, IITA, Ibadan
Dr K.A. Marfo	Socio-economist, Crops Research Institute, Fumesua, Kumasi
Dr K.O Marfo	Director, Savannah Agricultural Research Institute, Nyankpala
J. Meerman	Yam nematologist,(associate expert), IITA, Ibadan
Dr E. Moses	Plant pathologist, Crops Research Institute, Fumesua, Kumasi
S. Ng	Tissue culture specialist, IITA, Ibadan
Dr S. Nutsugah	Plant pathologist, Savannah Agricultural Research Institute, Nyankpala

[98] In Ghana, unless working at IITA (Ibadan, Nigeria)

Dr F. Ofori	Director, Crop Services Department, MoFA, Accra
Ms M. Owens	Regional agricultural extension specialist, FAO Regional Office for Africa, Accra
J. Poku	Deputy director, Crop Services Department, MoFA, Accra
I. Siddiq	Public affairs officer, UNDP
Dr V. Suglo	Deputy director, Pesticides Management Division, PPRSD, MoFA Pokuase
Ms H. Wedgwood	Rural livelihoods co-ordinator, DFID Office, Accra
J. Wumnaya	Director (Northern Region), MoFA, Tamale

Annex D

YAM UPTAKE WORKSHOP, KUMASI (16/03/00): PARTICIPANTS

Name	Designation	Location
A. Adjekum	National Programme Co-ordinator	RTIP, MoFA
T. Appiah	Agric. Extension Agent	MoFA (Brong-Ahafo region)
Dr R. Asiedu	Plant breeder	IITA
Dr T. Avav	Lecturer (Weed Science)	Uni of Ag., Makurdi, Nigeria
T. Bagamsah	Agronomist	SARI
J. Bokoro	Farmer	Northern region
Dr A. Cudjoe	Entomologist	PPRSD, MoFA
Dr O-A Danquah	Plant breeder	CRI
Dr A. Ebert	Physiologist	WASDU (GTZ)
Ms B. Hemeng	Nematologist	KNUST, Kumasi
G. Ekekpi	Regional Dev. Officer (extension)	MoFA, Tamale
M. Fowler	Agricultural Economist	NRI
Dr L. Kenyon	Plant virologist	NRI
L. Krampa	SMS (post-harvest)	MoFA, Sunyani, B-A region
C. Kwoseh	PhD student	University of Reading, UK
Dr J. Lamptey	Plant pathologist	CRI
K. Marfo	Economist	CRI
Dr S.Nutsugah	Plant/seed pathologist	SARI
F. Ofori	Director of Crop Services	MoFA, Accra
C. Osei	Agronomist	SARI
E.Otoo	Plant breeder	CRI
Dr J. Otoo	Director	CRI
Dr M. Owens	Extension, Educ. & Comm. Officer	FAOR
Dr J. Peters	Plant pathologist	University of Reading, UK
A.Salifu	NRI post-harvest project	MoFA, Tamale
S. Stevenson	Programe co-ordinator	CAPSARD, Tamale
F. Tsigbey	Plant pathologist	SARI
Dr J. Twumasi	Plant pathologist	CRI, Kumasi
N. Yaw	Farmer	Sunyani, Brong-Ahafo region
M. Zinnah	Lecturer (Agricultural Extension)	School of Ag. UCC

Annex E

ACRONYMS & ABBREVIATIONS

AAGDS	Accelerated Agricultural Growth and Development Strategy (Gh)
AESD	Agricultural Engineering Services Department (MoFA)
AgSSIP	Agricultural Services Sector Investment Programme (Gh)
ARI	Animal Research Institute (CSIR; Katamanso)
CABI	CAB International
CAPSARD	Community Action Prog. for Sustainable Agric. & Rural Development
CGIAR	Consultative Group for International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre (Mx)
CORAF	Conference de responsables de recherche agronomique africains
CRI	Crops Research Institute (CSIR; Kumasi)
CSD	Crop Services Department (of MoFA)
DAE	Department of Agricultural Extension Services (MoFA)
DFID	Department For International Development (UK)
FAO	Food and Agriculture Organisation
FAOR	Food and Agriculture Organisation (Regional Office for Agriculture)
FORIG	Forest Research Institute of Ghana (CSIR; Kumasi)
FRI	Food Research Institute (CSIR; Accra)
GAEC	Ghana Atomic Energy Commission (Kwabenya, Nr. Accra)
GDP	Gross Domestic Product
GGDP	Ghana Grains Development Project
GTZ	Gesellschaft für Technische Zusammenarbeit GmbH (German Technical Aid)
gm	gramme
ICRA	International Centre for Development-Oriented Research in Agriculture
IFAD	International Fund for Agricultural Development
IITA	International Institute for Tropical Agriculture (Ibadan, Nigeria)
kg	kilogramme
km	kilometre
KNUST	Kwame Nkrumah University of Science & Technology (Kumasi)
FLS	Front Line Staff (DAE)
MEIST	Ministry of Environment, Industry Science and Technology (Gh)
MoFA	Ministry of Food and Agriculture (Gh)
NAEP	National Agricultural Extension Project (Gh)
NARP	National Agricultural Research Project (Gh)
NARSP	National Agricultural Research Strategic Plan (Gh)
NGO	Non-Governmental Organisation
NRI	Natural Resources Institute, University of Greenwich (UK)
NRIL	Natural Resources International Ltd. (UK)
PGRC	Plant Genetic Resources Conservation Unit (CRI/CSIR)
PPMED	Policy, Planning, Monitoring and Evaluation Department

PPRSD	Plant Protection & Regulatory Services Department (MoFA; Pokuase, Nr. Accra)
RELC	Research-Extension Liaison Committee
RNRKS	Renewable Natural Resource Knowledge Strategy (DFID)
RTIP	Root & Tuber Improvement Programme (IFAD/MoFA)
SARI	Savanna Agricultural Research Institute (CSIR, Nyankpala, Tamale)
SMS	Subject Matter Specialist
SRI	Soil Research Institute (CSIR; Kumasi)
UCC	University of Cape Coast (Cape Coast)
UGL	University of Ghana at Legon
UG-Kade	University of Ghana at Kade
UK	United Kingdom
UNDP	United Nations Development Programme
UST	University of Science and Technology – *see KNUST*
WASDU	West Africa Seed Development Unit (GTZ/Accra)
YEA	Yam Exporters' Association
YFA	Yam Farmers' Association
YSA	Yam Sellers' Association
¢	The symbol used to denote Cedi, the currency of Ghana (March 1999: US$ 1.00 = ¢ 3,800 approx.)

Annex F

YAM RESEARCH PROJECTS IN GHANA IN RECENT YEARS

Ref. Codes	Title	Lead Institute & Collaborating Inst.	Duration (a)	Crop Protection?	Dissemination Component?
?? A0502	Strategic review: Yam and cocoyam - post-harvest research issues	NRI-FSD MoFA	17-01-1996 to 31-03-1996	N	?
ZB0016 R6505 A0497	Post-harvest constraints and opportunities for marketing of yam	NRI-FSD MoFA	01-01-1996 to 31-03-2000	N	?
ZA0138 R6691 C0948	Control of yam diseases in forest margin farming systems in Ghana.	UoR, NRI-PMD MoFA, CRI, SARI, UGL	01-07-1996 to 30-06-2000	Y	Y
ZB0234 R7582 A0946	Development of integrated protocols to safeguard the quality of fresh yams	NRI-FSD MoFA	01-02-2000 to 31-03-2003	(Y)	Y
CRI/001	Conservation of (yam) crop germplasm in Ghana	CRI, Bun	3 yrs 1994 new	N	
CRI/043	Fertilizer work on yam in Ghana	CRI	4 yrs 1994 new	N	
CRI/004	Introduction, evaluation and breeding of yam in Ghana	CRI IITA	4 yrs 1993	(Y)	
CRI/103	Growing yams on live stakes	CRI	4 yrs 1992	N	?
CRI/112	Determination of dormancy periods of different variety of yams under various temperature regimes	CRI	3 yrs 1994 new	N	N
CRI/108	Screening of growth hormones for early sprouting of yams	CRI	3 yrs 1994 new	N	N
FRI/005	Development of improved bulk storage technique for different commercial varieties of yam	FRI CRI, DAE, GAEC	4 yrs 1995 new	(Y)	?
FRI/006	Post-harvest handling during marketing and distribution of yam	FRI DAE	4 yrs 1995 new	N	?
FRI/007	Suitability of different varieties of yam for processing (eg. Yam flour, *fufu* flour, dehydrated yam chips, extruded yam snacks)	FRI ARI	4 yrs 1995 new	N	?
GAE/001	Micro-propagation for increased production of yam	GAEC CRI	5 yrs 1994 new	(Y)	N
GAE/003	Sprout inhibition, storage and processing of yam using gamma irradiation	GAEC YFA, YSA, YEA	5 yrs 1994 new	(Y)	N
GAE/009	Breeding for self-supporting yam	GAEC CRI	5 yrs 1994 new	N	?
MCS/005	Use of *Mucuna* and Neri (egushi) for weed control in yam	CSD CRI	3 yrs 1994 new	Y	?
MCS/013	On-farm yam adaptive trials (fertiliser & staking)	CSD CRI, SARI	3 yrs 1994 new	N	?
MCS/014	Development of post-harvest systems for durable and perishable crops	CSD CRI, FRI, DAE	3 yrs 1991	N	?
MEG/004	Appropriate farming tillage systems	Ag.EngSD CRI, SRI, DAE	4 yrs 1994 new	N	?
SAI/033	Yam improvement in the Guinea savannah zone	SARI	4 yrs 1995 new	(Y)	?

		GGDP			
SAI/034	Rapid multiplication of yam	SARI GGDP	4 yrs 1995 new	(Y)	?
SAI/035	Development of appropriate husbandry practices for yam production	SARI GGDP	4 yrs 1995 new	?	?
SAI/068	Identification and control of micro-organisms responsible for soft rot in cassava and yam storage	SARI	3 yrs 1994 new	Y	?
SRI/003	The effect of soil management practices on yam production using the minisett technique at Kwadaso	SRI	5 yrs 1992	(Y)	?
SRI/004	The effect of sources and rates of potassium fertiliser on rootcrops – yams at Kwadaso, Wenchi & Atebubu	SRI CRI	6 yrs 1991	N	?
SRI/008	The effect of time of application of N,P,K on the yield and quality of yam	SRI CRI, FRI	4 yrs 1993	N	?
UGL/008	The production of the bio-regulator N-carboxymethyl chitosan from chitin extracted from local crustacean shells to increase the protein content of yam and cassava in Ghana	UGL TA&M	3 yrs 1994 new	N	?
UGL/013	The use of random amplified polymorphic DNA markers to fingerprint yam cultivars in Ghana	UG-Kade UGL	2 yrs 1994 new	N	?
UGL/014	Yam, cocoyam & sweet potato improvement	UG-Kade CRI, UST, UCC	6 yrs 1994 new	(Y)	?
UGL/024	Conservation of yam germplasm in Ghana	UGL	3 yrs 1994 new	(Y)	?
UST/005	Organic residue and fertilizer management for sustainable crop production	UST AED, CSD	3 yrs 1994 new	(Y)	?
UST/007	Design and implementation of appropriate market information systems for root crop and cereals	UST CRI	5 yrs 1994 new	N	(Y)
UST/011	Trade and marketing improvement strategies for yam and cassava	UST SARI, CRI	3 yrs 1994	N	?
GTZ	Post-Harvest project (post-harvest systems of yams and cassava in northern Ghana)	GTZ MoFA	~1990 - 1998	Y	Y
R6694	Identification of resistance to the major nematode pests of yams (*Dioscorea*) in West Africa	CABI CRI, UST	1996 - 2000	Y	N
?	Promotion and adoption of yam minisett technology in Ghana	UST UoR	1995-1997?	(Y)	(Y)
IFAD	Ghana root and tuber improvement programme (RTIP)	MoFA/IFAD	1999 – 2004?	Y	Y
IFAD	Poverty alleviation and enhanced food availability in West Africa through improved yam technologies	IFAD/IITA/NARS	2000 – 2005?	Y	Y

Notes:
Duration of project ("New" indicates that the project was included within the NARSP report (1994), although the project did not necessarily become active).
Under the "Crop Protection?" column, Y = Yes, (Y) = Yes implied by title, N = No or no information.
Under the "Dissemination Component?" column, if the project has some dissemination or uptake pathway component, Y = Yes, (Y) = Yes, implied by title, N = No, ? = no information.

SECTION 3

Proceedings of the

WORKSHOP HELD IN GHANA ON

THE UPTAKE BY FARMERS OF YAM RESEARCH RECOMMENDATIONS

Sir Max Hotel, Kumasi, Ghana.

16th March 2000

Contents

1 INTRODUCTION

Yams (tubers of several of the *Dioscorea* species) are a major component of rural people's livelihoods in Ghana. They are an important source of food and income for producing households and an important food supply for both local consumption and export. A survey by GTZ of the Northern region of Ghana identified yams as the most important cash and food crop in that region. Yam also received the highest priority ranking of all crops in the National Agricultural Research Strategy Plan (NARSP) and in the Agricultural Services Sector Investment Programme (AGSSIP; the follow-on to NARSP).

Yam production in Ghana faces a number of serious crop protection related constraints, including nematodes, anthracnose, viruses, yam storage diseases, seed health, and control of yam diseases and pests more generally. Research and extension activities funded under the Crop Protection Programme being carried out by organisations and institutions in Ghana (including NRI, UoR, CABI, GTZ, CRI, SARI and MoFA) have sought to address some of these yam production constraints.

The uptake and adoption of these and other crop protection recommendations is a relatively poorly researched area. The purpose of this workshop (held in Kumasi on 16th March 2000) was to discuss and seek opinions on what are the main constraints to the uptake and adoption of yam crop protection research findings and developed technologies, and to try to identify improved or alternative dissemination pathways. The 30 participants included agricultural researchers (from both various regions of Ghana and from abroad), extension staff, specialists working for a range of agricultural development agencies, farmers and the representative of an NGO working in the north of the country. The participants are listed in Annex 1.

The workshop programme is shown in Annex 2. Although, in practice, several of the presentations ran over the time given for them, nevertheless each of the sessions on the programme was presented.

Most of the presentations were made using an overhead projector. Copies or transcripts of the transparencies that were used are included in this document.

Martin Fowler and Lawrence Kenyon

Natural Resources Institute

University of Greenwich

May 2000

2 PRESENTATIONS AND ASSOCIATED DISCUSSIONS

Following the presentation of a group of three or four papers, questions on specific issues highlighted in those papers were raised, while more general discussion also took place.

A. Yam research and development in West Africa

(by Dr R. Asiedu, International Institute of Tropical Agriculture, Nigeria)

With respect to yam production in West Africa, there are many similarities in:

- agroecologies
- biotic and abiotic constraints
- species and cultivars
- modes of utilisation

In addressing the constraints and opportunities in the production and utilisation systems on a regional basis, there are:

- some complementarities in approach
- local specificities
- gaps in knowledge

The following are some of the relevant regional and sub-regional Projects or societies that are in progress:

(1) IITA's Yam Project: Improving Yam-based Systems

Purpose:

Improved technologies targeted at enhanced productivity of yam-based systems evaluated and disseminated by NARS

Results/Outputs:

1. Farmers' management strategies in yam-based systems and the potential for the acceptance of improved technologies characterised

2. Strategies for integrated management of pests and soil fertility in yam-based systems developed

3. Yam genotypes with high and stable yield of tubers with good food and storage qualities produced and disseminated to NARS (emphasis on *D. rotundata* and *D. alata*)

4. Technologies for improved post-harvest systems developed and disseminated to NARS

5. Research, training and leadership skills strengthened for NARS scientists and personnel working on yam-based production systems

(2) IFAD/IITA/WECARD Project on 'Poverty Alleviation and Enhanced Food Availability in West Africa through Improved Yam Technologies'

Purpose:

Availability of improved technologies for enhanced productivity of yam cultivation in West Africa increased

Outputs:

1. Programme for selection and dissemination of *D. rotundata* and *D. alata* varieties with high and stable yield of tubers with good food and storage qualities expanded

2. Program to identify systems to provide soil organic matter, replenish nutrients and improve soil structure for increased productivity of yam cultivation implemented

3. Program for integrated management of pests and diseases enhanced

4. Availability of information on environmental and human resources as well as technologies relevant to yam cultivation and utilisation enhanced

5. Linkages established between on-going regional yam post-harvest research projects and NARS in Ghana and Togo

(3) E.U. INCO Project on Yam Post-harvest and Consumption

Purpose:

Decrease losses and improve the quality of fresh yam tubers and dried products for African markets

(4) OFDA/USAID Community-based Promotion of Food Security Crops

Purpose:
Accelerate the widespread adoption by farmers of recommended varieties of cassava and yams through the use of end user participatory methods for evaluation of varieties, production practices and post-harvest technologies as well as multiplication and delivery of healthy planting materials

Outputs:

1. Several high-yielding, pest resistant and drought tolerant varieties of cassava and yams available for farmer production

2. Good quality planting materials for recommended varieties of cassava and yams readily available to farmers

3. Greater community and gender-related awareness of income-generating opportunities from cassava and yams in target domains

4. Greater capacity for disaster for the relief through a fully operational emergency delivery system enabling mass production and safe international dissemination of planting materials for cassava and yams

5. Recommendations on improved technologies for production, processing and product development of cassava and yams available to farmers and processors

6. Traditional varieties and indigenous knowledge of cassava and yams in the target countries conserved

(5) GTZ/IITA/CSIR Regional Seeds Project

Purpose:

Key seed and planting material sector personnel of West African countries take actions to improve seed/planting material production and delivery systems focused on small-scale farmers.

Outputs:

1. National programmes supported according to respective demand in the provision, multiplication, distribution and maintenance of healthy planting material of root and tuber crops.

2. Human resources for the private and public seed and planting material sector developed.

3. Development of model-site in Kumasi for cereal/legumes seed completed and successfully operated.

4. West African regional seed/planting material sector network initiated and operations started.

5. Formal and informal seed/planting material sector in selected countries assisted in setting up functioning models for marketing, management and quality control of seed and planting materials.

(6) International Society for Tropical Root Crops-Africa Branch (ISTRC-AB)

Broad Objective:

Stimulating production and utilisation of root and tuber crops through:

(a) Promotion and encouragement of research, extension and training;

(b) Organisation of symposia, workshops and special training courses for root and tuber crops.

Specific Objectives:

Exchange of visits amongst workers on root and tuber crops

Exchange of genetic materials

Provision of opportunities for enhancing utilisation of new developments in techniques and equipment for work in root and tuber crops

Publications (e.g. technical bulletins, newsletters, etc.)

(7) Central and West Africa Root Crops Research Network (CEWARRNET)

Goal:
Enhance food security and cash income of people in the 22 countries of West and Central Africa through improved technologies related to the production, commercialization and utilization of cassava, yam, cocoyam and sweet potato.

Expected Outputs:

1.A substantial quantity of basic planting material of improved varieties and prototypes of tools, etc. for eventual increase and/or fabrication locally for users

2. An improved availability of more appropriate technologies (equipment and varieties to facilitate more adoption and usage)

3. A cadre of well trained higher scientific staff and technicians to strengthen the capacity of the NARS to conduct agricultural research

4. A body of new root crops research data and relevant technical information and new technologies that will make an impact on the output and use of these crops in the region

5. An enhanced level of regional collaboration that would use regional research resources synergistically

Challenges

At the regional level the key challenges ahead include:

- Documentation and regional information exchange
- Collection, characterisation and conservation of indigenous germplasm
- Monitoring the distribution and genetic variability of pests and pathogens
- Socio-economic studies on issues such as the potential for adoption of technologies in the pipeline or being planned

B. Yam research at CRI

(by Dr O-A. Danquah, Seed Pathologist, Crops Research Institute, Kumasi)

(No notes supplied by Dr Danquah)

Dr Danquah spoke about the role of CRI in the CPP-funded yam diseases project. CRI had conducted trials comparing seed yam from areas identified as having high disease pressure (dirty seed) with seed from areas with apparently lower disease pressure (cleaner seed). There was a better survival rate, and hence greater ultimate yield from the “clean seed”, and this improvement was enhanced if the seed setts were also treated with a fungicide and insecticide at planting time. Production was increased by up to 50% when setts were treated. Dr Danquah also pointed out the need for good storage conditions for the seed yams for the period between harvest and planting; without regular inspection and removal of diseased tubers, rot can rapidly spread through a yam barn resulting in a shortage of planting material. Nematodes are a particular problem during storage causing damage in their own right, but perhaps also predisposing the tubers to other types of rot. Thus, post-harvest treatment of yams before storage may also be beneficial.

Though the CRI staff have in the past tended not to work directly with farmers, but rather have worked through the extension system and RELCS, they do now see the need to have greater contact with the end user as well as with the extension services. Dr Danquah then went on to describe his approach to taking to farmers about the effects of plant diseases and pests. The analogy of a plant as a factory where the leaves are the production line receiving the raw ingredients from the air and from the soil via the roots and the fruits or tubers being the warehouses where the product is stored, was useful in emphasising the need to avoid disease in order to keep the “factory” producing well.

“Reduced functional leaf or root area = reduced productivity”.

Understanding and correctly identifying the problem is half the battle in improving the productivity.

C. Yam research and extension messages

(by Dr J. Peters, University of Reading)

I would like to present a brief background to the work we on the Yam Diseases Project have been doing over the past 3 1/2 years. But first, I would like to take this opportunity, on behalf of all those working on the yam project, to thank all the researchers and Ministry of Agriculture staff who have helped to make this project possible. But special thanks must go to the farmers who allowed us to visit their yam farms to see the pests and diseases that affect their crops; and answered out questions on yam pests and diseases. I would also like to thank on behalf of the donors, the Department For International Development (DFID), and project management at the University of Reading and NRI, all the Ghanaian collaborators who have worked so hard since the project started. I don't need to tell you how important yams are to West Africa, which produces over 95% of the world’s yams. Ghana in particular, is the third biggest producer of yams worldwide.

When we started the Ghana project back in June 1996, we did not know what the important pests and diseases of yams were. Nor did we know how much knowledge farmers had acquired concerning control of these pests and diseases. So our aims were to:

- ask farmers about their main concerns facing yam production;
- measure natural levels of pests and diseases on the crop;
- determine economic losses due to constraints;
- and try to determine strategies for improving yam yields by reducing levels of disease.

I will now briefly run through some of the findings from our farmer surveys, later my colleagues and I will tell you a bit more about the disease surveys and on-station trials.

During the Farmer Participatory Survey, we questioned over 400 yam farmers between October 1996 and January 1998 in the Northern, Upper West and Brong-Ahafo Regions.

The farmers were asked to list their main yam production and marketing problems. The farmer groups were then asked to rank them according to importance. Farmers were then asked to discuss yam pests and diseases. Once the farmers had named all the pests and diseases they could think of, they were shown diseased tubers and photographs of diseased plants and tubers in order to verify which pests and diseases the farmers were referring to. Farmers were then asked as a group to rank the pests and diseases in order of importance.

Table 1. Farmers' ranking of the yam production problems in order of importance.

Problem	Northern & Upper West	Brong-Ahafo
(lack of) Finance	93	100
Pests & Diseases	79	86
Drought	50	0
Poor & expensive tools	36	
Lack of transport	7	
Low market prices	21	43
Acquiring land		29
Storage		29
Poor soils		14

Conclusion: finance related problems were of 1st concern but next most important were pests and diseases.

Table 2. Ranking order of the pests and diseases mentioned:

Pest & Disease	Northern & Upper West	Brong-Ahafo
Termites	28%	15%

Mealybugs	19%	27%
Anthracnose	19%	12%
Nematodes	17%	23%
Viruses	6%	8%

Conclusions: Termites and mealybugs (or scale insects), anthracnose, nematodes were considered important with viruses less so.

What do farmers do about these? Not much, apart from removing seed tubers with obviously high infestations of nematode and insect. However, as my next overhead shows, despite farmers telling us that they are aware of the need to plant clean seed, a large percentage of seed yams were found during surveys to have visible signs of infestation. The table also shows that farmers perceptions of problems are in good agreement with actual levels of pest/disease severity.

We also found anthracnose, at levels likely to reduce yields, in around 10% of farms sampled.

Farmers can recognise whether or not their seed tubers are infested with termites, mealybugs, scale insects, and to a certain degree, nematodes. However, farmers have no way of telling, once a tuber has been harvested whether or not that the parent plant had been infected by fungal pathogens. Highly infected plants will produce small tubers but in some cases, as these tubers cannot be eaten or sold, farmers may use these tubers as seed. One of the most damaging disease of yam is anthracnose. We set up trials at CRI and SARI to try to determine the impact of this disease on yield losses in yams by comparing disease levels on individual plants with tuber weight. The results showed that yields were severely reduced when anthracnose levels reached high levels at around the time when the rains were ending in October. For example, if anthracnose reaches levels which prematurely kills the plant, the tuber will be less than 0.5kg. However, as well as reducing the size of tuber, the fungus that causes anthracnose can survive in these small tubers.

If a farmer then plants these tubers then one of two things will happen:

- the seed tuber may not germinate;

- or will produce plants which develop the disease. The disease will then spread to neighbouring plants by rain splash.

We looked at the effects of planting healthy and diseased tubers: we measured disease levels in yam farms throughout the major yam growing regions in Ghana, so were able to divide the farms into those that had high disease levels and those that had low disease levels. We collected seed tubers of puna and seidu bile from representative farms. We then set up trials at the CRI and SARI research stations, to compare yields from plants grown from seed tubers collected from high diseased farms and those from low diseased farms. We also looked at the effects of applying a fungicide and nematicide. The results showed that overall yields were increased by around 60% by planting clean seed.

Therefore, farmers must be made aware that as well as the visible signs of infestation on their seed tubers, small tubers from diseased plants must not be used as planting material. To this end around 100 farmers were invited to attend one-day farmer field days at SARI/MoFA in order to see for themselves the benefits of planting clean yam seed.

The extension message is simple:

‘Only plant clean/healthy seed tubers’

However, this may be difficult to put into practice because:

- How do farmers get clean seed?
- Farmers may not be able to detect low levels of nematode/fungal infections.

These are areas where MoFA and researchers need to work together in order to assist the yam grower.

D. Uptake of research project outputs

(by Dr L. Kenyon, NRI)

Most donor-funded agricultural research in developing countries goes through a project cycle similar to that I have outlined in Figure 1.

Stakeholders (Who)	**A**	Farmers – extensionists – researchers – Government – NGO – Funding agencies		MONITORING
		↓↓↓↓↓↓		
Project development (what)	**B**	Identification of needs and priority researchable constraints		←
		↓		↑
Purpose/Aims (What, Who)	**C**	Research Planning (& identification of funding) (& confirmation of target beneficiaries)	→	Concept review Programme advisory committee
		↓		↑
Activities (How)	**D**	Basic research Applied research Interpretation – analysis Technology development Development of recommendations	→ → → → →	Research evaluation *(Relevance)* *(Quality)* Technology evaluation *(functionality + relevance)*
		↓		↑
Outputs (what)	**E**	Recommendations Information Technologies / processes	→	Output review *(Applicability, relevance,* *quality, efficiency)*

		↓		↑
Transfer	**F**	Technology transfer Dissemination of outputs	→	Uptake assessment *(constraints)*
Uptake		↓		↑
Goal Impact	**G**	**Sustainable development** **Enhanced livelihoods** **Poverty alleviation**	→	Impact assessment

Figure 1. Typical flow diagram for a developing country research project

The ultimate goal of any research project is to have some sort of impact (otherwise, what is the point of doing it?). In the case of DFID-funded, or developing country research this is generally as sustainable development, enhanced livelihoods and/or poverty alleviation.

Many of us here at this workshop are scientists, and so we should be competent at performing stages C-E in the diagram. Where we researchers may have less experience is in our contact with the end users of our research - either at the needs-identification stage (A/B) or the technology transfer/uptake stages (F/G) of the diagram. One of the aims of this workshop is for scientists to meet with other people concerned with the yam crop in Ghana (including extension workers, farmers, NGOs and policy makers), to examine the factors that might be influencing the uptake of research findings on yam in Ghana. I hope that we can go away also with some guidelines on how we can try to improve the impact/uptake of our current and future projects.

From my point of view (as a scientist) I feel we should be considering the nature of the outputs we want to have disseminated, the methods used for that dissemination, the people doing the dissemination or preparing the dissemination materials, and the stakeholders to whom the outputs are targeted. In Figure 2 I have listed some of these factors in more detail, though I am sure that others will come to mind during the course of the day.

Outputs

Recommendations

Information

Technologies

Procedures

Dissemination Methods

Bulletins

Reports

Guidelines

Recommendations

Workshops

Conferences

Extension Literature

Posters

Radio

Television

Newspapers

Magazines

Journals

Teaching

Farmer Field Schools

On-farm trials/demonstrations

On-station demonstration trials

Extension staff training

People doing the dissemination

Researchers

Teachers

Extension staff

Farmer/community leaders

Commercial agents

NGO agents

Extension staff trainers

Target stakeholders

Farmers

Farmer families

Traders

Consumers

Researchers

Extension staff

Teachers

Figure 2. Some of the aspects to be considered in studying the uptake of research outputs.

In the case of the Yam diseases project (R6691), rapid rural assessments (surveys) in the first two seasons using a participatory approach with farmers revealed that, farmers in the main yam growing regions of Ghana perceived pests and diseases as the second most important constraint to yam production after lack of finance (for labour, seed, staking and transport). Subsequent farmer field-days and workshops identified the need for simple extension materials depicting and describing the main pests and diseases of yam in Ghana through which farmers could identify the problems and possible means to control them. Based on these findings, we have developed a series of colour posters on the pests and diseases of yam, drafts of which I have displayed at this workshop. I would appreciate comments and suggestions for improvement on these from any of the participants here today.

Discussions on Papers A to D

It was pointed out that farmers tend not to comprehend the term "virus", nor what its implications are. What, exactly, are the implications on output (quality and quantity) of virus infestation? What practices might be adopted to counter the effect of viruses?

The principal constraints to yam production appear to be the lack of finance for the purchase of seed yams and to employ casual labourers. The underlying need to use healthy seed material was reiterated, since they would be more effective in combating soil-borne diseases than are the planting materials being commonly used (although soil-borne diseases were felt not to be a major problem at the present time in areas where bush-fallowing could still be practised). Farmers report that healthy planting material is simply not available in most areas (and most farmers would not trust using seed obtained from someone they did not know to be a good yam grower).

The importance of more effective networking among scientists working on roots and tubers in general, in West and Central Africa was highlighted. This is one focus of the just-started IFAD regional project. In addition, the project is making provision for all of the research findings to be documented by IITA, but this requires the collection of all the relevant information which will need a considerable effort. As part of this exercise, national focal points are to be trained in database management. RTIP is undertaking this collection activity for Ghana

Workshop participants were asked to spend time during the day to appraise critically the posters (referred to in Paper C) on the pests and diseases of yam, prepared under the DFID project. Drafts of the posters were on display during the day. Dr Kenyon requested that comments be fed back to him.

Other comments included:

- pathology problems in the mother seed yams resulted in problems in developing the minisett technique;
- soil fertility has definitely become a problem in several, geographically-distinct parts of Nigeria – particularly on the heavily-settled land;
- nematodes have the potential to have a severe adverse impact on tuber weights during storage;
- the need for research to focus not only on pests and diseases, but also on management issues to ensure that practices which have a positive impact on the agricultural environment are adopted; and

- the importance of post-harvest treatment of tubers and, in this context, the use of botanicals rather than limiting research to the use of inorganic chemicals;

E. A brief overview of major pests and diseases of yam: an IPM approach to minimise losses

(by Dr A. Cudjoe, PPRSD)

Dr Cudjoe presented and discussed a matrix (*see the following 5 pages*) which is to appear as part of a plant disease/protection handbook, currently being developed by the PPRSD (with support from GTZ?):

YAMS (Dioscorea spp)			
PLANT PROTECTION PROBLEM		**CONTROL RECOMMENDATION**	**ANNOTATION**
Name	**Symptom or Damage**	**Cultural Practice and Direct Interventions**	**Target Groups, Economy, Target Areas, Technical Remarks**
Anthracnose *Colletotrichum gloeosporioides*	Major disease. "Scorch" or "die back". Necrotic lesions on leaves and stems. Can lead to total destruction of foliage. High tuber yield loss from severe attack	▪ Practice crop rotation and good cropping system or crop combination. ▪ Use tissue cultures and mini tubers, which are disease free. ▪ Apply fungicides in alternation with broad spectrum foliar fungicides e.g. Dithane M 45	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting after AESA. Infected tubers, alternative host and crop debris are source of infection. *Dioscorea alata* most affected in humid forest. High rainfall promotes spread of the disease. Vegetative phase, foliage.
Fusarium wilt, ***Fusarium oxysporum***			
Leaf spot diseases *Cercospora* spp.	Minor disease. Necrotic lesions on leaves and vines. Total foliage cover and leaf abscission possible	▪ Gather and burn infected leaves. ▪ Use healthy planting material. ▪ Apply fungicides in alternation with broad-spectrum foliar fungicides e.g. Dithane M 45.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting after AESA. Vegetative phase, foliage
Leaf spots	Minor disease.	▪ Control as *Cercospora* spp.	Relevant preventive IPM

Curvularia spp. *Cercospora* spp.	Necrotic lesions on leaves sometimes with chlorotic halos.		recommendations, suitable for both small scale and commercial farmers. Difficult to distinguish between leaf spots and anthracnose. Vegetative phase, foliage
Concentric leaf spots, *Sclerotium* spp.	Minor disease. Lesions with concentric rings. Soil borne. More damage on lower leaves. Sometimes Sclerotia visible on leaves	▪ Staking and mulching to reduce water splashing. ▪ Ensure good drainage. ▪ Destruction of plant debris after harvest ▪ Use high mounds depending on area.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Vegetative phase, foliage

YAMS (Dioscorea spp)			
PLANT PROTECTION PROBLEM		**CONTROL RECOMMENDATION**	**ANNOTATION**
Name	**Symptom or Damage**	**Cultural Practice and Direct Interventions**	**Target Groups, Economy, Target Areas, Technical Remarks**
Bacterial rot, Erwinia carotovora	The organism causes soft rot of tubers with a pungent smell. Spread by rain, insects and mechanical damage of tubers. Reduces yield by as much as 60-80%	▪ Practice careful weeding harvesting and handling. ▪ Use wood ash and lime: wash yam to reduce rots. ▪ Treat tubers with Benomyl at 600-11OOg/ha. ▪ Avoid bruising of tubers. ▪ Check store and remove infested tubers.	Relevant preventive IPM recommendations in the store suitable for both small scale and commercial farmers. Integrated control of yam disease aims at healthier seed yam and plants and longer shelf life of tubers by preventing or reducing damage prior to storage.
Storage rots *Penicillium oxalicum*, *Rhizoctonia* spp., *Fusarium* spp., *Botryodiplodia theobromae*, *Aspergillus* spp. and others	Occasional storage diseases. Dry and soft rots: at times, mycelia can be seen growing on the tuber. Spread by wind, rain, insects and mechanical damage of tubers	▪ Practice careful weeding harvesting and handling. ▪ Use wood ash and lime: wash yam to reduce rots. ▪ Treat tubers with Benomyl at 600-11OOg/ha. ▪ Avoid bruising of tubers. ▪ Check store and remove infested tubers.	Relevant preventive IPM recommendations in the store suitable for both small scale and commercial farmers. Integrated control of yam disease aims at healthier seed yam and plants and longer shelf life of tubers by preventing or reducing damage prior to storage. During high humidity and high temperature.

YAMS (Dioscorea spp)			
PLANT PROTECTION PROBLEM		**CONTROL RECOMMENDATION**	**ANNOTATION**
Name	**Symptom or Damage**	**Cultural Practice and Direct Interventions**	**Target Groups, Economy, Target Areas, Technical Remarks**
Leaf blight, *Rhizoctonia solani*.	Extensive water-soaked leaf and shoot lesion leading to leaf blight.	▪ Staking and mulching to reduce water splashing. ▪ Ensure good drainage. ▪ Destruction of plant debris after harvest. ▪ Use high mounds depending on area.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Vegetative phase, foliage. *D. rotundata* mostly affected.
Root rot (field) *Polyporus sulphureus*.	Rotting of roots in the field.	Sanitation (remove diseased roots).	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Vegetative phase, tubers.
Nematodes *Scutellonema bradys*	Attacks yam in field providing entry for pathogens to reduce yields and tuber quality, causing dry rot. Cracking of tuber skin. Allows entry of other rotting pathogen. Affect quality of yam.	▪ Practice acceptable sanitation measures when importing yams for seed. ▪ Hot water treatment to obtain clean tubers ▪ Careful land selection. ▪ Rotation with non-host crops, e.g. cereals.	Relevant preventive IPM recommendations in the store suitable for both small scale and commercial farmers. Vegetative phase, tubers.

Root-knot nematodes, *Meliodogyne* spp.	Minor problem. Attack yam in field providing entry for pathogens to reduce yields. Malformation and galls on tubers.	▪ Practice acceptable sanitation measures when importing yams for seed. ▪ Hot water treatment. ▪ Careful land selection. ▪ Rotation with non-host crops, e.g. cereals..	Relevant preventive IPM recommendations in the store suitable for both small scale and commercial farmers Vegetative phase, tubers
Virus diseases: Yam Mosaic, Potyvirus, Water Yam, Chlorosis Virus	Minor diseases. Chlorosis, mosaic, leaf distortion, scorching and stunted growth. Vectors: aphids.	▪ Use resistant varieties. ▪ Use viral free seed yams. ▪ Use tissue culture material.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Tissue culture material only available to few, commercial farmers. Diseases widespread, but no major constraint Vegetative phase, foliage and tubers

YAMS (Dioscorea spp)			
PLANT PROTECTION PROBLEM		**CONTROL RECOMMENDATION**	**ANNOTATION**
Name	**Symptom or Damage**	**Cultural Practice and Direct Interventions**	**Target Groups, Economy, Target Areas, Technical Remarks**
Yam Tuber Beetle, *Heteroligus meles*	Major pest. Adults bore and tunnel through yam mounds and attack yam tubers soon after yam setts	▪ Site selected should be away from swampy area. ▪ Dip yam sells in contact insecticide e.g. OP or Actellic before planting. ▪ Re-mound to cover exposed tubers.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting at planting time. Beetles breed at marshy areas. Prevalent in larger production areas. Vegetative, tubers and shoots.
Yam Leaf Beetle *Crioceris livida, Lema armata*	Both adults and larvae feed on yam leaves causing vine dieback and defoliation. Minor pests	▪ Timely hoeing to expose pupae in order to break life cycle.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting after AESA. Vegetative phase, foliage. Mechanical (handpicking) is suitable for small- scale farmers.
Scale insects	Small, flat insects with no visible legs attached firmly to the leaves sucking sap. Minor pest	▪ Use clean planting material. ▪ Apply Dimethoate to yam setts before planting.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting after AESA. Vegetative phase, foliage. Dimethoate may kill natural enemies, which are effective against scale Insects.

Mealy bugs.	Affect mainly tubers and young sprouts. Found on tuber surface Suck sap Minor pest	▪ Use dean planting material ▪ Dusting infected tubers. ▪ Hot water treatment for nematode control would take care of the mealy bug ▪ Dip setts in OP or Actellic before planting	Farmer centred and simple cultural practices, which can easily be implemented by all categories of farmers. Chemical treatment only suitable for commercial settings. Vegetative tubers
Millipedes	Bore into tubers and feed, causing secondary infections (rotting): occasional pests	▪ Observe good crop husbandry, like sanitation, good land preparation, sites away from forests (breeding sites), cover exposed tubers, close cracks ▪ Use varieties with tubers deeply buried	Good/relevant IPM recommendations, suitable for both small scale and commercial farmers on a wide range of ecologies.

YAMS (Dioscorea spp)			
PLANT PROTECTION PROBLEM		**CONTROL RECOMMENDATION**	**ANNOTATION**
Name	**Symptom or Damage**	**Cultural Practice and Direct Interventions**	**Target Groups, Economy, Target Areas, Technical Remarks**
Termites, *Macrotermes* spp. *Odontermes* spp.	Feeding on the sprouting vines of the yam setts inhibit sprouting.	▪ Replant losses. ▪ Dip setts in contact insecticide e.g. OP or Actellic.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting. Insecticidal treatment of sells as a sanitation method may not entirely exclude damage by termites.
Stored yam Beetle, *Araecerus fasciculatus*, *Carpophilus* spp., ***Palorus subdepressus***	Occasional pests. Adults bore in tubers, reduce quality of tubers	▪ Careful harvest and transport, no bruising of tubers. ▪ Clean store.	Relevant preventive IPM recommendations, suitable for both small scale and commercial farmers. Chemical treatments suitable only for commercial setting at planting time. Storage pests, also attack stored cassava, maize and others.

F. Nematode pest of yams (Dioscorea spp.) in Ghana

(by C. Kwoseh[1], R. Plowright[2] and J. Bridge²)

Why nematode pests of yams?

In Ghana, the yam industry is of paramount importance to communities in the forest-savannah transition and the guinea savannah agroecological zones. But yam is one of the crops that have no cultural or geographic barriers. Many farm-families depend on the tubers for food, cash and other traditional uses. It is gradually being realised as an important non-traditional crop for export. However, yams are severely damaged by plant parasitic nematodes reducing yield, food quality, and market value. At least three potential nematode pest species namely *Scutellonema bradys*, *Meloidogyne* spp. and *Pratylenchus coffeae* are known to exist. *S. bradys* is the most important and widespread, particularly, in West Africa. *S. bradys* is a migratory endoparasite which infect yam tubers and causes necrosis within them resulting in a disease known as dry rot. *P coffeae* infected tubers have symptoms similar to that of *S. bradys*. Galling tuber surfaces often covered with excessive rooting are some of the disease symptoms caused by *Meloidogyne* species. Reduction of 20-30% in tuber weight at harvest has been reported. Long term storage losses of about 50% due to nematode infection has been observed.

- **How do we manage the pests & diseases?**

1.Chemical control

Plant- parasitic nematodes can be controlled by chemicals, but their use is

limited due to high costs and adverse effects on the environment and mammalian toxicity

2.Cultural methods

Cultural methods such as hot water treatment of seed yams can reduce nematode infestation of tubers, but the yams can suffer physiological damage. In addition, there a requirement for energy input, in the form of, electricity, gas or firewood.

3.Crop rotation

Crop rotation, though is an effective measure of control, it often involves three to five years of alternative crop production and includes a fallow year therefore, in certain agricultural production systems such as single crop or fruit crop production, this method may not feasible.

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1 [1] **University of Reading, UK & IITA, Ibadan, Nigeria**

[2] CABI Bioscience, UK

4. Integrated management

Minimum use of chemical nematicides to quickly lower high populations of nematodes, and manage such lowered populations with pre-plant herbicides, crop rotation, and soil amendments like cocoa-pod ash, cassava peels, and inorganic has been suggested. However, a rise in population of root lesion nematode with nitrogen application has been reported There is still the need to formulate an adaptable package that will suit the circumstances of the majority of yam farmers.

5.Use of resistant varieties

Most plant- parasitic nematodes by their nature and habitat are restricted in their movement from field to field and area to area. The emergence of new physiological races that break resistance probably would be slow. Yam cultivars with resistance to nematodes would provide an attractive nematode management option appropriate to smallholder farm families. There is therefore the need to begin to search for nematode resistance in yams.

- **Assessment of farmers' perception of nematode disease**.

If farmers do not perceive a pest problem they are not likely to be interested in a resistant variety. Based on this, a farmer participatory appraisal of pests and diseases in stored yam was made in Ghana. The symptoms of nematode injury were clearly identified by farmers; there can be few cases where a nematode problem is culturally so important and so well understood. Most farmers were very familiar with both the dry rot of tubers, caused by migratory endoparasitic nematodes, and with the misshapen tuber surface caused by root knot nematode. In parts of the country, more than 90 % of farmers had local names or terms for the disease symptoms e.g. 'nkronsa nkronsa' or 'edwie' (rashes). Farmers could readily identify tubers with dry rot symptoms and these were rejected at planting or consumed early. Root knot nematode was generally considered to be unimportant since infected tubers rarely rot and knotted tubers were only observed on the fourth consecutive crop.

- **Farmers' estimates of the proportion of tubers affected by nematodes in Ghana**

Although most farmers had surplus yams, they remarked that losses from 'nkronsa nkronsa' or 'adwie' were high in some years. Farmers estimated losses from dry rot to be 21% (0-100) in the Forest zone and 30% (2-100) in the Savannah. Losses from root knot nematode were estimated as 11% (0-40) in the forest and zero in the savannah. In most years farmers grew 10-15 yam varieties mostly of *Dioscorea rotundata*, but also *D. alata*, *D. cayenensis*, *D. dumetorum* and *D. bulbifera*. All were thought, by farmers to be susceptible to dry rot but some *D. rotundata* varieties e.g. Lili and species of *D. alata* were said to store better. Traditional yam varieties were often described to be free of dry rot. In all sites, dry rot symptoms were associated with *Scutellonema bradys*, never with *Pratylenchus coffeae* although known to be widespread in Ghana on *Musa* (Table 1).

- **Prevalence of dry rot and root-knot nematodes in Ghana**

It is important to know the prevalence of different pest nematode species so that we are sure that resistance screening is targeted at the correct species. The prevalence of *S. bradys* was 81% of sites, in the forest zone and 100% in the savannah, whilst the prevalence of root knot nematode was 72% and 24% in the respective zones (Table 2). The dominant crop components are also shown.

- **Assessment of the nematode pest species and variations in virulence**

From the survey results, *S. bradys* and. *Meloidogyne* spp. are widespread but, once again, there was the need to get information on which species exist and variations in virulence on yams. Using morphological and molecular identification and characterisation, populations of *S. bradys* and *Meloidogyne incognita* from different parts of the country were found to be the same and so would not differ in virulence or pathogenicity on yams.

P. coffeae is known to be a pest of yams in the Caribbean, Pacific and central America but nothing was known of its pest status on yam in Ghana, although it is widespread on plantain. Trials on the host range of *P.coffeae* on yam in an assessment of the pest status of this nematode on yams in W. Africa have been interesting. *P. coffeae* can multiply in roots of a number of species of *Dioscorea*. However, the nematode is unlikely to be a threat to yam production because tubers do not generally support nematode reproduction. Pots studies in the UK have shown that the Ghanaian population of *P. coffeae*, is a *Musa* host race and contrasts with Central American populations which do cause dry rot in yams.

- **Highlights of achievements on the search for resistant cultivar**

1.Technique for rearing *S. bradys* has been developed

2. Screening methodology and sampling protocol have been developed

3. Yam germplasm screened for resistance to nematodes has been completed and trials have confirmed resistance in two of accessions of *D. dumetorum*.

- **Conclusions and recommendations**

1. Nematodes were well known to farmers and farmers displayed this through the attempts to control nematodes using fallow and selecting good planting material

2. The high cultural significance of nematode disease is also shown by the local names given the disease symptoms

3. All this tends to suggest that farmers would readily adopt a resistant variety, if such is developed.

4. Farmers grow a large number of varieties for different reasons, so any new variety should fit this background

5. Farmers in the Guinea-savannah did not think that *Meloidogyne* caused any losses

Table 1. Farmers' estimates of the proportion of tubers affected by dry rot and root knot nematode in Ghana

Agroecological zone	**Dry rot (%)**		**Root knot (%)**	
	Mean	Range	Mean	Range
Forest-transitional	21	0-100	11	0-40
Savannah	30	2-100	0	0

Table 2. Prevalence of dry rot and root knot nematodes in Ghana

Agroecological zone	**Dry rot (%)**	**RKN (%)**	**Dominant component crops**
Forest-transitional	81	72	Cassava, chilli/maize
Savannah	100	24	Millet, cassava, maize/sorghum

G. Yam diseases control research in northern Ghana: achievements and constraints

(by S.K. Nutsugah[3], F.K. Tsigbey[1], J.C. Peters[4], L. Kenyon[5] and F.H. Andan[6])

OBJECTIVES

- Determine the principal diseases and pests infecting yams in northern Ghana
- Investigate the impact of seed sanitation on disease development in yam vines in the field with a view to developing disease control methods
- Develop appropriate control strategies

METHODOLOGY

- Field surveys and observations
- Individual farmer interview
- Laboratory diagnosis of unknown aetiology
- On-station evaluation of treatment options

SURVEY COVERAGE

NORTHERN REGION

District	**Village**
Bimbilla	**Demon-naya*** **

[3] Savanna Agricultural Research Institute, P. O. Box 52, Tamale, Ghana.

[4] The University of Reading, Department of Agriculture, Early Gate, Reading, RG6 6AT, UK

[5] Natural Resources Institute, University of Greenwich, Chatham Maritime, ME4 4TB, UK

[6] Ministry of Food and Agriculture, Tamale, Ghana

Bole	Dafierli, Jentilpe & Mandari
Damongo	Laribanga & Sori # 2
Gushegu/Karaga	Gaa & Komoayili
Salaga	Massaka
Yendi	**Gbungbalga***** & Sambu
Tolon/Kumbungu	**Tuunayili*****

UPPER WEST REGION

District	**Village**
Wa	Boli & **Mangwe*****

IMPORTANT FINDINGS

- Paucity of information on the primary yam pathogens causing economic losses of yam
- Anthracnose has been identified as the most important biotic constraint
- Anthracnose is found over 70% of all yam foliage randomly sampled
- Viral diseases are present in 22% of yams grown in the surveyed area
- Yam nematode, *Scutellonema bradys* was frequently isolated from tuber tissues in the laboratory
- Fungicide and nematicide treatment effect in the field trial restored yields in high disease seed to levels found in low disease seed

ACHIEVEMENTS

- Awareness and impact of diseases/pests on yam production have been created through PRAs and Farmers' Field Days

- Information on the identification and control of the main tuber-borne diseases and pests have been documented

- Yam Disease Workshop, February 8, 1999

- Yam Disease Farmer Field Day Northern Zone, October 7-8, 1999

- Yam Disease Farmer Field Day Southern Zone, October 11-12, 1999

- Technology for Livelihood on "Yam Production in northern Ghana" (1999)

- **Publications**

(i) Survey of field diseases in yam in forest margin farming systems in Ghana (1997)

(ii) Farmers' perceptions of yam pests and diseases and management practices, particularly relating to yam seed, in the Northern and Brong-Ahafo Regions of Ghana (1998)

(iii) Yam diseases in Ghana. International Congress of Plant Pathology 98, Edinburgh, UK, August 9-16, 1998.

(iv) Yam diseases in northern Ghana. 7th Triennial Symposium of the International Society for Tropical Root Crops-African Branch, Cotonou, Benin, October 11-17, 1998.

(v) Extension bulletin on "Yam Diseases in Ghana" , 1999.

(vi) Viruses of yam in Ghana (1999).

CONSTRAINTS

- Financial constraint
  (Demand for on-farm demonstration plots cannot be met)

POSSIBLE RESEARCH AREAS

- Live mulching (use of False yam, *Icacinia senegalensis*)

- Develop protocol for on-farm disease-free seed yam

- *In-situ* evaluation of seed treatment for the control of yam diseases in northern Ghana

ACKNOWLEDGEMENTS

Thanks to the UK Department For International Development (DFID) for funding the project.

Discussions on Papers E to G

- It was pointed out that most of the presentations so far had concentrated on the research and its findings, but that little had been said about what were the extension messages, how were they being disseminated, and what were the constraints to uptake and adoption.

- The appropriateness of hot-water treatment for 'curing' yam seeds in the smallholder-farming environment was queried. Dr Asiedu pointed out that it had been tried successfully in other countries in the region – it is to be tried shortly in Ghana, under the regional root and tubers project (IFAD-supported) and should include an economic analysis.

- The importance of the correct accreditation being included on any publications emanating from research projects undertaken in Ghana, was stressed. So, too, was the need for copies of all these publications to be circulated widely – in particular to concerned staff within MoFA.

- As a rider to the previous point, participants were asked to note that the technical report on the yam diseases project which is just coming to an end, must be approved by DFID (the financier) prior to it being circulated to concerned parties in Ghana. This is standard practice.

- While the original DFID project was now coming to an end it was important for on-farm work to be undertaken in other geographical areas not yet covered by the research since only 8 on-farm trials (in 2 Districts) had been conducted so far. Transportation and other financial constraints had hampered and curtailed an extensive programme of fieldwork. Detailed justification would be required for any further intervention. RTIP might be a source of funding for such work.

- The experience/observation of Dr Cudjoe had shown him that 'Scale' was a clear indicator of low soil fertility, although this had yet to be proved through scientific experimentation.

- The uptake of the recommendations emanating from the DFID-supported research would be the focus of a new intervention which was currently being formulated (and which DFID might be requested to support). A recommendation of the workshop would be for DFID to be requested to provide financial assistance for this essential "second stage".

- Since the need for healthy seed yam had been repeatedly stressed, would it be economically advantageous for a number of farmers to set themselves up as specialist seed yam producers? This is a topic that should probably be explored in any future work on yam crop improvement.

- The production and printing of the PPRSD handbook has been hampered by a shortage of funds – for example, colour photographs of pests and disease infestations which would be very useful for extension staff/subject-matter specialists, could not be included. It is being published using GTZ funds. Might it be appropriate for IFAD, PPRSD/GTZ and DFID to combine forces in producing a good quality publication on the pests and diseases (and other production constraints) of yam in West Africa?

- There is a general lack of understanding by farmers of the nematode infection problem – how it is transmitted, etc.

(After Lunch)

H. Factors influencing the uptake of new yam technologies
(by M. Fowler, Natural Resources Institute, UK)

As an introduction to the talk some data and information were presented in order to provide the context within which the yam sub-sector is currently operating in Ghana (*see Item G.5, below*). These data and further information are provided in the study report, "*The uptake of yam research recommendations by farmers in Ghana*", published by NRI in May 2000.

1. Characteristics of the technology itself (perception by the farmer)

- complexity
- profitability (given that farmers tend to be risk-averse and both financially- and labour-constrained)
- riskiness
- compatibility with the existing practices of the farmer (farmer participation in the technology identification/development/validation/ extension process? totally new?)
- technical soundness i.e. relevance and clear superiority over old technology (for example: flexibility, yield, early-maturing, drought tolerance)
- taste & processing/cooking properties
- accessibility (physical availability of the innovation to farmers)
- ease of application

2. Characteristics of the farmer/farm household

- level of education of principal decision-maker(s)
- age
- ethnicity/culture
- financial resources (off-farm income, DAP owner, etc)
- gender
- labour availability (including family size)

- land availability/farm size
- membership of a farmers' organisation/co-operative/credit club
- risk status (determined by some of above, plus history, upbringing, etc)

3. Characteristics of the farmer's immediate environment

- level of infrastructure development
- agro-climate and any recent trends (riskiness of the natural environment)
- delivery systems for complementary inputs (are such inputs available?)
- degree of commercialisation of the area
- availability of relevant information (extension service, etc);
- land tenure system and security
- credit access
- local product marketing system (infrastructure and institutions)
- rural infrastructure status
- effectiveness of extension service (i.e. to whom does it make info. available?) and research service
- availability of media for extension (radio, TV, newspapers, posters)

4. Characteristics of the external/macro-environment

- product marketing system
- international trade policies
- macro-economic policies (interest rates, credit policies, budgetary funds made available for complementary public investment - the extension and research services, seed production, etc)
- changing tastes at the national level (uptake of minisett technology would be boosted by proportionate increase in demand for smaller yams *cf.* Nigeria)
- institutional, management and human/cultural characteristics of the research and technology transfer institutions and their personnel;
- national policy towards agricultural research and extension programmes (supportive and sustained);

- peace and stability;

5. Proposed chapter headings for study report: *"A review of the factors affecting the uptake of yam research outputs in Ghana"*

1. Background (purpose/problem)

2. Introduction (methodology)

3. The agricultural sector and rural livelihoods (scene setting)

4. The yam sub-sector (including production, marketing, exports, constraints, research highlights)

5. The national research and extension services (and other sources of info)

6. The uptake of yam technologies - and those for other crops (literature review, etc); determining factors

7. Government of Ghana policies for the sector (focus on research & extension)

8. Proposals for increasing technologies' uptake

9. Conclusions

Discussions on Paper H

The bulk of the discussion on this presentation was on the question of the need for those involved in generating new technology to be aware of aspects of gender as they relate to the various different activities undertaken in producing the crop and in post-harvest operations. The influence of geography/location on gender roles and family membership in farming operations was stressed by a number of the participants.

- Various reasons for the poor uptake of the minisett technology in Ghana were presented by G. Ekekpi and discussed by participants. They included: poor germination rates of seed thus produced, poor storability, seeds were too small, lack of response to the technique by some varieties, the fact that seed purchase is rare – farmers want control over all stages of yam production, the poor demonstration of the technique to farmers.

- The utilisation of research outputs by farmers is not a component of the agenda of the research institutes ("when researchers plan, the tail-end is not their concern"); adoption is not a criterion for promotion amongst researchers, the publication of papers is!

- The importance of farmers (and other stakeholders) being actively involved in the problem-diagnosis activity of the research process.

- The need for extension activities to be carefully directed, compared with the current situation where the well-connected, "big men" tend to be the main point of contact for extension staff, while the poor are ignored; there is a need to distinguish between production for commercial and home use.

- The important role of on-farm demonstrations in convincing farmers of the true worth of an innovation was underlined.

- The need for an intensive, all-encompassing approach to technology demonstration and uptake – as had been the case under the Ghana Grains Development Project – was stressed. There is generally need for better communication between researchers and extension staff – how can the activities of the RELCS be improved?

There were no specific points raised nor comments made, on the proposed outline of the study report.

3 GROUP SESSIONS (Afternoon)

The final part of the workshop saw participants working in three groups. Each group was asked to think about and discuss the key issues which, from the perspective of the stakeholders which their group represented, they felt hinder the uptake by crop farmers of new technologies. These issues were to be written down on meta-cards by the participants and then pinned to a board. The issues were then to be grouped under headings wherever possible. Ways in which these constraints might be removed or addressed were to be proposed by the participants, and the person or agency which could best do this and within what time-scale, were also to be listed.

The results are detailed below[7] as issues raised listed under the primary headings for each group. For each group a matrix is then presented of the main constraint (heading), the suggested interventions/solutions, perpetrator and time-frame.

(a) Farmers' Group:

Financial constraints:

- lack of resources to meet (implement?) recommendations
- lack of funds to acquire and adopt new technology
- high associated input costs
- most of we farmers are poor and we fear that the new technologies may involve a lot of money
- financial constraints

The technology:

- complex techniques involved;
- technicalities of the technology transferred;
- inconsistent performance
- poor packaging of technology

[7] These have not been edited. There is no significance in their ordering.

- requires extra work;
- most technologies are for large-scale monocrops.

Lack of farmer involvement:

- may not address pressing issues;
- less or no involvement in development of technology;
- incompatibility with farmers' needs;
- needs identification;
- lack of demonstrations on the farmers' fields;
- farmer not involved in on-farm demonstrations.

Social limitations:

- land tenure system in farming areas;
- many of the farmers are illiterate;
- conservative attitude of farmers.

Marketing:

- poor infrastructure;
- production area far from market;
- farms difficult to access for produce transport.

Technical support:

- lack of knowledge on developed technologies;
- access to extension messages (thus extension officer to farmer ratio);
- follow up after introduction of technology is virtually lacking.

Constraint	Solution	By whom ?	Time-frame
Technology	- participation of all stakeholders in tech. dev.	-research -extension -farmers	as soon as possible
Lack of farmer Involvement	-farmer needs' assessment -farmer involvement in tech testing- farmer involvement in finding solutions	-all stakeholders (farmers, extension workers, researchers)	as soon as practicable
Technical support	-reduce farmer: extension ratio -involvement of extension in tech generation -effective training of extensionists in tech. Development - follow-up with technical support	-government & NGOs -extension, farmers & researchers	mid-point from the onset of technology development
Financial constraints	Formation of farmer associations ss farmer access to credit facilities	donor agencies central gov. NGOs	
Social limitations	[*During the presentation to the plenary, it was stated that this should be addressed through training from NGOs and government, as soon as possible*]		
Marketing	*[During the presentation to the plenary, it was stated that this should be addressed by the government and by community development]*		

(b) Research Group:

Heading 1:

- researcher-extension interface poorly defined or non-existent
- poor linkages between research & extension;
- ineffective RELCs
- poor communication with extension services
- poor communication between research & extension
- need to get research publications diverts attention from uptake

Heading 2:

- limited access to information
- research not demand driven;
- research not targeted
- farmers are not interested in carrying out research because they are always occupied
- needs' assessment not thorough
- little or no on-farm research
- farmer perception of ownership of technology generated through top-down research
- projects sometimes limited to research output only

Heading 3:

- lack of recurrent budget funds
- finance
- inadequate funding
- limited resources for linking-up technology development and transfer

- poor funding – government
- lack of funding for technology development
- lack of logistic support
- inadequate research facilities
- lack of mobility for on-farm work
- limitations in disciplinary balance in research teams (lack of critical mass)

Heading 4:

- general poor attitude towards research on yam
- promotion criteria emphasised mainly on research publications

Heading 5:

- lack of education of farmers
- lack of access to modern methods of farming

Heading 6:

- limitations in motivation and the review/reward system
- poor service conditions of government scientists
- poor personal motivation

Others (individual cards, not grouped):

- technology transfer isn't researchers' mandate
- research too complex
- non-involvement of farmers at planning stage

Constraint	**Solution**	**By whom?**	**Time-frame**

Poor research/ extension linkages	increase communication & interaction between researchers & extension promote reciprocal participation in planning/review meetings	Directorates of MoFA & research all stakeholders in	immediately
Poor motivation	improve conditions of service	Minister of Education, Science & Technology	Next financial year (2001)
Inadequate funding	increased & timely release of funds diversify sources of funding for research	Ministries of Education & Finance Directorates of CSIR institutions & researchers	next financial year (2001) - now
Research uptake not in mandate	ensure inclusion in mandate of research	Directors of research institutes	ongoing
Limited education	encourage literates of farmers to go into farming embark on (adult) farmer education	national policy makers NGOs	ongoing, but not effective
Poor assessment of farmers' needs	systematically involve farmers in planning research projects train researchers in communication skills	Directorates of MoFA and research inst.	now
Poor policy formulation	Influence formulation of policy	Deans of universities, Directorates Scientists, farmers' groups & NGOs	immediately

(c) Extension Group:

Heading 1:

- lack of incentives (e.g. mobility, accommodation)
- poor mobility (transport)
- inadequate staff
- finance/ financial constraints in the transfer of technology to farmers
- extension-farmer visits too few
- inadequate on-farm demonstrations
- inadequate focus and funding of technology transfer

Heading 2:

- appropriate extension materials
- wrong packaging of extension materials
- inadequate communication skills
- lower education level of extension staff
- possible limitations in extensionists knowledge of technology itself
- mastery of technology by extension

Heading 3:

- relationship between extension and farmers
- low farmer involvement in yam research and product development
- weak linkage with researchers and farmers
- inadequate integration of research and development
- weak involvement in research
- poor access to technology, inaccessibility

Others (individual cards, not grouped)[8]*:*

- level of literacy of the farmer
- gender- and age-sensitivity of technology
- ID of farmers
- incompatible technology

Constraint	**Solution**	**By whom ?**	**Time-frame**
Resources(Finance)	combine research & extension	donors & researchers	now
Extension materials	dissemination of info. through radio, TV, posters & fact sheets	research & extension teams at District levels	now
Education of farmer			
User ≠ tech	define target users from initial stage	research & extension teams	now
Linkages RELC	same as 1	RELC	now
Education of extensionists	formal & informal training	donors, MoFA, etc.	ongoing

[8] The following meta-cards were found while clearing-up following the workshop: “poor technical support”; “marketing”; “financial constraint to adopt high input technology”; “wrong target”; “lack of improved planting materials”; social limitation”; high yield of yam”; and “access to extension messages”.

3.1 Discussions of the Group Sessions' presentations

After the group sessions, there was a plenary session where a representative from each workgroup presented the findings of his or her group to everyone at the workshop. The main points of the discussion raised during and after each presentation are listed below:

(a) Farmers' Group

- marketing is also dependent upon infrastructure; this is to be addressed under the AgSSIP;
- access to credit is to be increased under the AgSSIP – private commercial banks are coming on board;
- the alleged "conservatism" of farmers seems to be a contradiction if the research identification process ere to be working well;
- enlisting inputs from NGOs is to applauded;
- some concerns were raised about the use of groups, particularly where production is concerned – their strengths are best harnessed for marketing and credit purposes. The government needs to do more work on groups and group formation.

(b) Research Group

- it is important for researchers to adapt themselves to the capacities and resources of the small farmers – in developing extension materials, etc. The message must reach the audience, rather than *vice versa*;
- the institutional split between MEST and MoFA creates puts many obstacles in the way of fruitful co-operation over agricultural development activities in Ghana.

(b) Extension Group

- Research and extension staff need to work in teams;
- donor agencies need to consider supporting extension work, rather than the current focus on the research services.

4 CLOSING REMARKS

Mr Fowler indicated that the workshop proceedings would be assembled on his return to the United Kingdom, and the study report would be finalised. Copies of the draft study report would be sent to a selection of the workshop participants for their comment. He estimated that the two documents would be sent to (all) participants by end of May.

The workshop was closed by the Chair, Dr Ofori, who remarked that the presentations had been most informative and the discussions generated by the papers, together with the group session, had been most useful for those involved in developing the future of this important staple food commodity.

He thanked the participants for the contributions which they had made to the day' proceedings.

Acknowledgements:

Our sincere thanks go to:

Dr Danquah for his effort towards the local arrangements in Ghana and for his assistance in organising the workshop.

Dr Peters for his help in running the workshop

Dr J. Hesse for providing use of workshop materials (meta-cards etc.)

Dr Otoo for chairing the morning session of the workshop

Dr Ofori for chairing the afternoon session of the workshop

DFID-CPP for providing the funding to hold the workshop

5 ANNEX 1:

5.1 Workshop Participants

Name	***Designation***	***Location***
A. Adjekum	National Programme Co-ordinator	RTIP, MoFA
T. Appiah	Agric. Extension Agent	MoFA (Brong-Ahafo region)
Dr R. Asiedu	Plant breeder	IITA
Dr T. Avav	Lecturer (Weed Science)	Uni of Ag., Makurdi, Nigeria
T. Bagamsah	Agronomist	SARI
J. Bokoro	Farmer	Northern region
Dr A. Cudjoe	Entomologist	PPRSD, MoFA
Dr O-A Danquah	Plant breeder	CRI
Dr A. Ebert	Physiologist	WASDU (GTZ)
Ms B. Hemeng	Nematologist	KNUST, Kumasi
G. Ekekpi	Regional Dev. Officer (extension)	MoFA, Tamale
M. Fowler	Agricultural Economist	NRI
Dr L. Kenyon	Plant pathologist/virologist	NRI
L. Krampa	SMS (post-harvest)	MoFA, Sunyani, B-A region
C. Kwoseh	PhD student	University of Reading, UK
Dr J. Lamptey	Plant pathologist	CRI
K. Marfo	Economist	CRI
Dr S.Nutsugah	Plant/seed pathologist	SARI
F. Ofori	Director of Crop Services	MoFA, Accra
C. Osei	Agronomist	SARI
E.Otoo	Plant breeder	CRI

Dr J. Otoo	Director	CRI
Dr M. Owens	Extension, Educ. & Comm. Officer	FAOR
Dr J. Peters	Plant pathologist	University of Reading, UK
A.Salifu	NRI post-harvest project	MoFA, Tamale
S. Stevenson	Programe co-ordinator	CAPSARD, Tamale
F. Tsigbey	Plant pathologist	SARI
Dr J. Twumasi	Plant pathologist	CRI, Kumasi
N. Yaw	Farmer	Sunyani, Brong-Ahafo region
M. Zinnah	Lecturer (Agricultural Extension)	School of Ag. UCC

6 ANNEX 2:

6.1 Agenda For Workshop on the Uptake by Farmers of Yam Research Recommendations

(**Kumasi, 16/03/00)**

1. House-keeping matters (layout of facilities, break times, other arrangements, etc). Confirm workshop agenda.

2. Opening prayer, welcome and introductory remarks.

3. Summary reports on recent CPP-supported yam research work by UK scientists, and on yam research or other yam-related activities supported by the Government, in Ghana:

   - Dr R. Asiedu, IITA. *"Yam research work: the regional perspective"*;
   - Dr O-A Danquah, CRI . Topic to be announced
   - Dr J. Peters, University of Reading/L. Kenyon, NRI . "*Yam research and extension messages*"[1];

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[1] After this final agenda had been distributed, it was decided that a further presentation would be made immediately after that by Dr Peters, namely: "The uptake of research project outputs" by Dr L. Kenyon (*see above*).

- Dr A. Cudjoe, PPRSD. *“A brief overview of major pests and diseases of yam: an IPM approach to minimise losses”*;
- C. Kwoseh, Ph.D. student (Kumasi and Reading). *Nematode pest of yams (Dioscorea spp.) in Ghana*;
- Dr S. Nutsugah, SARI *“Yam diseases’ control research in northern Ghana: achievements and constraints”*.

REFRESHMENTS

4. General clarification on and discussions arising from, Agenda Item (3).

5. “*Factors affecting the uptake of yam research recommendations in Ghana – a preliminary overview*” (M. Fowler, NRI)

6. General clarification on and discussions arising from, Agenda Item (5)

LUNCH

7. Review of morning session.

8. Working groups – 10 people/topic, maximum (ensure that researchers – both nationals and outsiders - are divided between all three groups)[2].

   Based on the morning’s deliberations, discuss the principal constraints to the increased uptake of yam research outputs according to the work

[2] Each group will appoint its own moderator and rapporteur.

activities of the three different groups of actors listed below. Rank and make recommendations for overcoming such constraints; those responsible for overcoming constraints should be identified, as well as the means which they should adopt to do this:

(a) yam[3] researchers;

(b) agricultural extension staff;

(c) the farmer and his/her environment

REFRESHMENTS

9. Report back to plenary

10. Closing remarks and next steps

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[3] Although participants may not wish to limit their discussions to yams, since lessons from work on other crops are likely to apply across the board.

Natural Resources Institute

Chatham Maritime

United Kingdom *May, 2000*