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A synthesis / lesson-learning study of the research carried out on root and tuber crops commissioned through the DFID RNRRS research programmes between 1995 and 2005.

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Executive Summary

Roots and tubers provide an estimated average of 20% of the daily per capita calorie intake for the 640 million inhabitants of Sub-Saharan Africa, where with the growing population there is increasing demand for these crops both for food and for feed. However, there are many constraints to maintaining or increasing production and productivity of the crops in the region. The UK Department for International Development (DFID) has, through its Renewable Natural Resources Research Strategy (RNRRS; 1995-2006), been funding research to alleviate some of these constraints. This study was commissioned to review the achievements of the DFID-funded projects, how they had been implemented and what the main lessons to be learnt from the projects' outputs and their implementation are. The approach taken was to collate information from the research programme and project reports and publications, and to supplement this with information obtained directly from project leaders, project partners/collaborators and other people involved in root and tuber crop research and development.

The research funded by DFID in the roots and tubers sector was primarily commissioned through the Crop Protection Programme (CPP) and the Crop Post-Harvest Programme (CPHP) and focussed on cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatus*) and yam (*Dioscorea* spp.) in Ghana, Kenya, Nigeria, Tanzania and Uganda. Some work was also funded on potato (*Solanum tuberosum*) in Bolivia and Kenya, but that is outside the scope of this study. The DFID/RNRRS advised that the projects funded under these programmes should be a maximum of three years duration and primarily research; the RNRRS log-frame did not give a target of achieving farmer impact until after 2005, with the intended impact achieved during the programmes' lifespan being on intermediate users of the knowledge or technologies. As such, the research programmes were not encouraged to collect base line information for purpose level impact assessments on ultimate beneficiaries until the last four years of the programme by which time it was difficult to assess or document the developmental effects or impacts of the technologies and knowledge generated through the various projects. Although some of the follow-on projects funded more recently have been concerned with dissemination and promotion of project outputs, this function more often has been the domain of the national and regional programmes. Because of the above, it was not possible to make definite conclusions about the outcomes or impacts of most of the projects. However, since each project addressed one or more of the important constraints to crop production or utilization, identified through the various national and regional needs assessments and reiterated by the people consulted for this study, it is fair to assume that the projects will have positive impacts in the long-term.

The important researchable topics relevant to root and tuber crop production and utilization were identified as:

- Germplasm health & supply of planting material
- Crop management & crop protection, pests and diseases
- Crop improvement (breeding and selection, including participatory methods)
- Post-harvest handling, storage and marketing
- Processing technologies, value-addition and alternative uses
- Improving methods for disseminating and promoting technologies/varieties/procedures
- How to provide a conducive/enabling environment (socio/cultural/financial) for resource-poor farmers to grow the crops sustainably/profitably.

The projects funded under the RNRRS generally addressed one or more of the identified constraints and fell into the following broad themes:

- *Cassava mosaic disease*
- *Cassava brown streak disease*
- *Participatory breeding of cassava*
- *Cassava pos- harvest constraints*
- *Sweet potato integrated crop management*
- *Sweet potato virus disease*

- *Sweet potato post-harvest constraints*
- *Yam crop protection*
- *Yam post-harvest constraints*

Because these crops are so important to the people of Sub-Saharan Africa, many other agencies, both national and international, have been funding research on many of the same themes and often in association with the DFID-funded work. It was not in the scope of this study to do an in-depth analysis of each of the DFID-funded projects, and indeed, because so many of the projects were linked to projects funded by other agencies it was not possible always to attribute specific outputs or outcomes or lessons to specific projects or programmes.

The major outputs of the projects and programmes could be grouped under six categories:

- Technology/knowledge generation – including better understanding of diseases and other constraints, improved methods/procedures for crop production/ handling/ storage, and new crop varieties.
- Capacity building – mainly in terms of human capacity through training of scientific staff, extension agents, farmers, NGOs and other civil society organisations, but also in the provision of equipment/physical infrastructure and development of training materials.
- Publications – in the form of journal articles, conference papers/proceedings, reports, workshop papers, leaflets, manuals, internal reports, posters, books and magazine and news paper articles.
- Advocacy/policy dialogue – mainly through helping make national and regional authorities more aware of current needs/priorities.
- Technology transfer – through workshops, farmer-field-days, the various publications and posters, seminar presentations, plays, poems, training courses and farmer field schools.
- Established linkages and products – linkages/partnerships with IARCs, regional networks, national programmes, NGOs and others have facilitated scaling-up and scaling-out of technologies.

Through this study, a number of areas with respect to priority setting, planning, monitoring, evaluation, impact assessment and project management were identified. The key recommendations with respect to future research undertakings are:

- Internalize monitoring, evaluation and impact assessment as an integrated part of project planning and implementation (it is imperative to establish baseline-data and continuous monitoring of selected variables to measure and quantify the farm level benefits of project/programme outputs).
- Incorporate explicit strategies for knowledge management, utilization, and dissemination to enhance the developmental impacts of research activities (adopting the innovation systems perspective and value-chain/impact-pathway concept could facilitate this process).
- Ensure multidisciplinary and multi-stakeholder participation (including better involvement of social scientists) in the design and implementation of projects and programmes.
- Sustainability and continuity beyond the project period should be given due consideration.
- Revisit the current three year project cycle and the review process (a longer term perspective, and working on a few selected key problem areas would lead to efficient utilization of resource and enhanced socio-economic impact of the investment).
- Reviews should go beyond looking at the quality of research and direct outputs (a mechanism should be put in place to measure the efficiency and development impacts of the projects and programmes).

1 Introduction

1.1 Background to the Study

Through its Renewable Natural Resources Research Strategy (RNRRS), the UK Department for International Development (DFID) has, since 1995, been funding research projects to improve the livelihoods of the poor through sustainable enhancement of the renewable natural resource systems. The RNRRS has been implemented through ten research programmes, of which the Crop Protection Programme (CPP), the Crop Post-Harvest Programme (CPHP) and the Plant Sciences Research Programme (PSP) have provided significant funding for research on food crops which are essential commodities for poor people. Of these crops the International Food Policy Research Institute (IFPRI) and Centro Internacional de Papa (CIP) estimated that total use of root and tuber crops (which are generally low value staple crops) will almost double (+96.9%) in Sub Saharan Africa over the period 1993 to 2020 (Scott *et al*., 2000).

At the request of DFID, the CPP sought to commission a synthesis study with the objective of reflecting on research conducted on root and tuber crops with a special emphasis on that funded through the RNRRS – knowledge gained, lessons learned and compatibility with other initiatives (both from other funding sources and from pre-RNRRS programmes). The direction was to seek input from the three main research programmes (CPP, CPHP and PSP), and the study would address issues in East and West Africa considering activities in Uganda, Tanzania, Kenya, Ghana and Nigeria. It would consider low value staple crops with an emphasis on the root and tuber crops: cassava, sweet potato and yam. This reflection would also be used to provide evidence-based recommendations of further researchable constraints which would lead to poverty elimination.

1.2 Terms of Reference (as provided by CPP)

a) Through review of the literature and CPP documentation, and discussion with CPP staff:
   - a1. Review the livelihood context of those involved in root and tuber crop production and processing systems in Ghana, Nigeria, Kenya, Uganda and Tanzania, and detail how important these crops are and how important they are to the poor.
   - a2. Assess which are the major constraints affecting root and tuber crops in East and West Africa, including an assessment of any changing trends (rather than a snapshot).
   - a3. Assess what criteria have been used by the CPP management to select target locations and pest/ researchable constraints, considering biological chances of success and social and economic impact. This should bear in mind research funded/ conducted by other donors and NARS.

b) Through review of project documentation and discussion with CPP management, project leaders and other project participants (both in UK and in East and West Africa):
   - b1. Assess what are the major achievements of the CPP research projects and programmes in the cassava, sweet potato and yam production systems.
   - b2. Assess how the research projects and programmes have achieved impact at research (biological and research practice), extension and farmer levels (socio-economic) and strategic/ political levels, quoting any available quantitative as well as qualitative data as evidence.

b3. Assess the CPP's utilization of available skills, expertise and institutions.
b4. Assess what are the other major national government and donor initiatives in the roots and tuber system and how the RNRRS initiatives have linked with them.
b5. Assess what are the main factors affecting farmer adoption of outputs from the roots and tubers projects.
b6. Justify, in terms of poverty elimination for poor small-scale farmers (and other relevant groups of target beneficiaries), the emerging priority research opportunities in terms of crop protection, other pre- and post-harvest crop sciences.
b7. Assess what are the key lessons learnt from the projects for policy makers (DFID, other donors and research managers).
b8. Assess what institutional issues and components of the enabling environment need to be addressed to maximize the impact on the poor.

1.3 Procedure Followed

This study of the lessons learnt from the DFID/RNRRS root and tuber crops research projects comprised four main activities:

a. Assembly of background information source documents from the research programmes and other sources.
b. Development of a series of questionnaires and seeking responses to these questionnaires from regional and national root crop coordinators, project leaders, research managers, advisers or collaborators on root and tuber crop research projects in the five countries covered.
c. Seeking direct feedback from key informants/researchers during visits to the five countries.
d. Compiling the background information and the questionnaire responses and incorporating the feedback from the key stakeholders, then synthesizing the information, and identifying the important lessons learnt.

1.4 Outline of the Report

This report is divided into five main sections. This first section gives a brief background and outline to the study and the report. Section 2 introduces the crops and cropping systems covered, and the livelihoods context in which the crops are grown (ToR a1). Section 3 describes the research programmes that have managed the research projects, the major/changing constraints affecting the crops (ToR a2), and also describes the different groups of projects included in this study and how they were selected (ToR a3). The detailed findings of the study, based on analysis of the reports provided, the meetings held with programme managers, project leaders and key informants in the study countries, and on the returned questionnaires, are presented in Section 4 to address ToRs b1-b6. The conclusions and recommendations from the study, including the key lessons-learnt (ToR b7) are presented in Section 5.

The schedules for the visits, the list of respondents to the questionnaires and key stakeholders consulted in the five countries, the list of root and tuber crop projects funded through the RNRRS, and a list of the main documents consulted are included in the Annexes.

2 The Importance of Roots and Tubers in the Study Countries

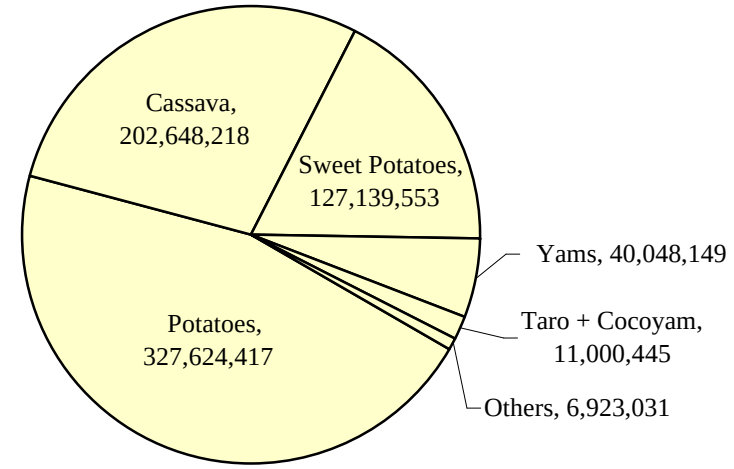
2.1 Introduction

Roots and tubers, most notably cassava, sweet potato, yam and potatoes (*Solanum*/Irish) are some of the most important primary crops. They play a critical role in the global food system, particularly in the developing world, where they rank among the top 10 food crops (Scott *et al* 2000, 1; Phillips *et al*., 2004; Nweke, 2004). By 1997, the production of roots and tubers in developing countries had an estimated annual value of more than 41 billion U.S. dollars or nearly one fourth the value of the major cereals (Scott *et al* 2000, 1). Roots and tubers 1) contribute to the energy and nutrition requirements of more than 2 billion people; 2) constitute an important source of income in rural and marginal areas; 3) have multiple uses, most notably as food security crops, regular food crops, cash crops, and; 4) are increasingly used as livestock feed and raw material for industrial purposes. They have long served as the principal source of food and nutrition for many of the world's poorest and undernourished households and are generally valued for their stable yields under conditions in which other crops may fail (Alexandratos, 1995; Scott *et al*, 2000, 1).

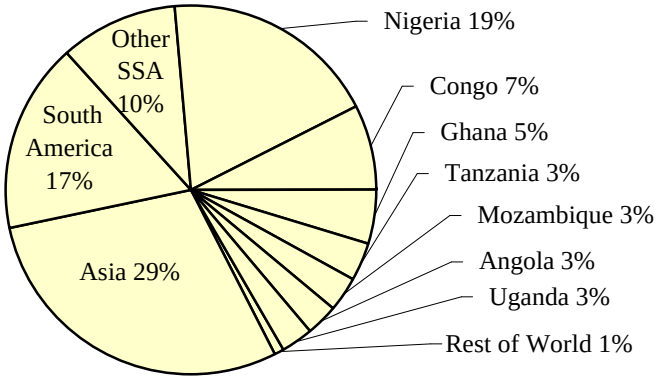
Because in developing countries these crops are often grown in relatively small plots or in home gardens, it is not possible to obtain very accurate or reliable estimates of the extent of production or consumption in these areas. Thus, most of the figures quoted are based on the records in the FAO production database, many of which are marked as estimates. Based on these figures, roots and tubers are a major source of sustenance in Sub-Saharan Africa, accounting for about 20% of calories consumed in the region (Annex 3, Table 5).

2.2 Importance of Roots and Tubers in the National Economies

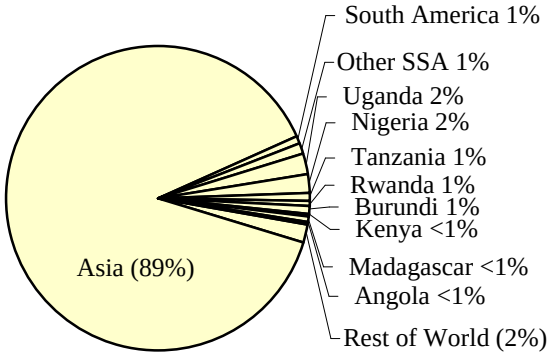
Nigeria produces roughly 40% of all the root and tuber crops in Africa, being the biggest producer of Cassava (35% of SSA production) and of yams (ca. 70% of SSA). See Figure 1 for a more detailed breakdown of the production of these root and tuber crops in 2004.



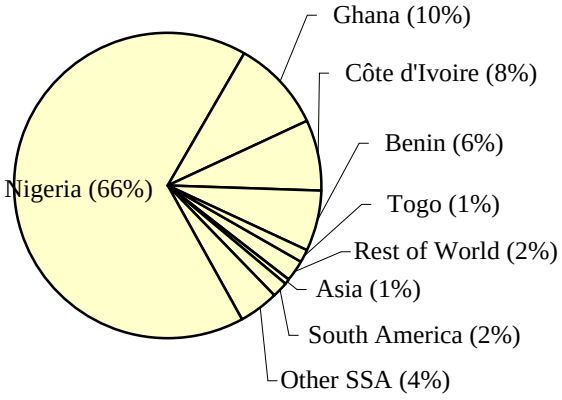
World production of root and tuber crops (Mt[metric tonnes) in 2004



Cassava production in 2004



Sweet potato production in 2004



Yam production in 2004

Figure 1. Production statistics for root and tuber crops (data from FAOSTAT, 2005)

Root and tuber crops contribute more than 600 calories per capita per day in the following countries: Angola, DRC, Congo-Brazzaville, Central African Republic, Mozambique, Ghana, Côte d'Ivoire, Rwanda, Togo and Benin (FAO, 2000). Despite the importance of roots and tubers in Africa, African food policy over the last half a century has focused on achieving growth and self-sufficiency in cereals such as wheat, rice and maize, with growth rates in roots and tubers over this period largely driven by area expansion as opposed to yields (resulting from technological innovations such as improved varieties and production techniques) (Scott *et al*, 2000, 5; Nweke, 2004). Historically, the production of roots and tubers in Africa has been restricted to assuring food security. Due to a lack of participatory policy making and institutional development, virtually all colonial governments neglected their production and trade in favour of cash crops such as tea, coffee, cotton, and cocoa or cereals (Nweke, 2004). The technical (research), marketing and state support that was extended to most cash crops and cereals during this period was not extended to roots and tubers (Nweke, 2004). This meant that, amongst other things, the private sector driven participatory plant breeding that characterized some of the cash crops bypassed roots and tubers, leading to prolonged use of (not necessarily high-yielding) traditional varieties and production techniques.

Many postcolonial governments continued these policy and institutional biases for much of the first two decades of independence (Phillips, 2004; Nweke, 2004; Rosegrant *et al*, 2004). This was due partly to the stigma surrounding roots and tubers as inferior, low-protein crops whose per capita consumption, it was hypothesised, would decline with increasing per capita incomes; and partly to colonial market/consumer preferences that prioritised traditional cash crops and cereals over traditional roots and tubers (Jones, 1959). This combination of stigma and preferences led to colonial policy distortions that included forcing indigenous farmers to plant roots and tubers as famine reserve crops, whilst subsidising maize, rice and wheat (mainly grown by settlers then), making cereals to appear more glamorous compared to the root and tuber crops (Jones, 1959; Nweke, 2004).

This lack of participatory policy making and participatory institutional development resulted in national food policies and institutions that biased market signals and institutional incentives in favour of traditional cash crops and cereals. Not only did this undermine food security in Africa, but it also shifted consumer preferences away from roots and tubers. In part, this led to a gross underestimation of the value of roots and tubers in Africa. As Scott *et al* (2000) have shown, the diversification in the utilisation of roots and tubers in developing countries (as food, animal feed, industrial raw materials) has occurred in an uneven fashion, beginning in the 1960s and 1970s in Asia and Latin America, with Africa only taking preliminary steps in this direction from the mid-to-late 1990s.

Scott *et al* (2000) show that the supply, demand and uses of roots and tubers began to change significantly in the 1960s and 1970s, fuelled by a trend towards greater diversification in use and greater specialization in production by crop and region. Between 1983 and 1996, for example, the consumption of roots and tubers in developing countries increased by 22 % or 45 million Mt to reach 253 million Mt, with cassava (at 93 million Mt) accounting for the largest share of roots and tubers consumed as food, followed by sweet potato (65 million Mt) and yam (16 million Mt). Indicative of the changing trends in utilisation of roots and tubers, sweet potato used as food contracted during this period, whilst its use as animal feed increased rapidly, especially in China. All developing

countries use roots and tubers as animal feed on some scale, with China and Latin America accounting for the largest share of this utilization of sweet potato. In the 1983-1996 period, the use of sweet potato as animal feed in the two regions increased by 50% to stand at 96 million Mt (Scott *et al* 2000).

Variation in the utilisation of roots and tubers is attributed to differences in population and economic growth, cultural factors and urbanisation (ibid). Scott *et al* (2000) argue that, in much of Asia and North Africa, rising incomes and urbanisation and a desire by consumers to diversify away from strictly cereal-based diets have increased the use of potato as either fresh food or in processed form; whilst the same forces have influenced the use of cassava and sweet potato in Asia towards starch, livestock feed and processed foods. In Sub-Saharan Africa, they posit, population growth, low and stagnant per capita incomes and rapid urbanisation continue to generate demand for cassava (and the other roots and tubers) as a cheap, starchy staple. More recent studies, however, point to signs of changing trends. Phillips *et al* (2004), for example, demonstrate for Nigeria that cassava is increasingly gaining an urban market presence as a result of its increased use as processed food, with rural and urban consumption patterns becoming increasingly similar. *'Cassava appears to be a food of choice even in the face of alternative food options in urban areas'*, (Phillips, *et al* 2004). This means that it is finally challenging its stigma as a less glamorous crop, which can only portend well for its future. Similar reversals in fortune can also be seen with increased sweet potato processing in other parts of Africa (Mkamilo, 2005; PRAPACE, 2003).

2.3 Trends in Production and Consumption

2.3.1 Roots and Tubers in General

The production of roots and tubers in developing countries is projected to increase by 58% (232 million tonnes) to 635 million tonnes between 2003 and 2020, with cassava increasing by 44 % , potato 29%, sweet potato 27% and yam 27% (Scott *et al* (2000, 2). For cassava and potato, food demand will outpace feed demand whilst the situation will be reversed for sweet potato. Sub-Saharan Africa is projected to experience the fastest growth in demand for all roots and tubers over this period (ibid). Table 5 shows the production, consumption and proportion of per capita daily calorie intake provided by roots and tubers in 2002 in Sub-Saharan Africa as a whole and in the five target countries covered by this report. It was estimated that, in 2002, potatoes accounted for an average of about 2.1% of the per capita daily calorie intake for each person in the world, and a greater weight of potatoes are grown than any other root crop when assessed on a world-wide basis. However, less than 2% of potatoes are produced in Sub-Saharan Africa and, for this reason, little reference will be made to potatoes in this report.

Yield growth rates in Sub-Saharan Africa have been disappointing except in the case of yam. Increases in yield are often difficult to achieve in the region because of nutrient-poor soils, lack of irrigation, and weak infrastructure (Spencer and Badiane, 1995). As aforementioned, roots and tubers have also suffered from the tendency of governments to focus their policies and resources on cash crops for export or, in parts of East and Southern Africa, on cereals.

Yields have increased more rapidly in Asia as compared to other regions. In the case of potato, yield increases have been catalyzed in part by the introduction of high-yielding varieties, which made the crop more profitable for farmers (Bofu *et al*., 1996; Scott, 1988).

In Latin America, as a whole, cassava and sweet potato productivity have been affected by weak demand. Most farmers have had little incentive to use yield-increasing technologies because potential commercial opportunities have yet to be exploited. Existing market outlets are limited, with the exception of cassava for feed or processed food in Colombia and northeast Brazil.

2.3.2 Yield, Consumption and Utilization of Cassava

Cassava is the only one of the three main crops included in this report that is grown to any great extent in all five of the target counties of this study. It is estimated to provide over 12% of the daily per capita calorie needs of the people of Sub-Saharan Africa (Table 5). Average yield (hg/ha) of cassava in Sub-Saharan Africa as a whole has been steadily increasing over the last 40 years (Chart 1); and, with the steady increase in area of land used for cassava cultivation, the annual production of cassava has increased from less than 40×10^6 Mt in 1965 to over 100×10^6 Mt in 2005. Average yields for cassava appeared to increase by about 9% in SSA countries over the period 1994-2004 (11% for world-wide production), but this increase is probably accounted for by the massive increases in just a few countries (e.g. Chad, Mali, Rwanda and Uganda) where there appears to have been expansion and intensification in the cultivation of cassava (Table 6).

Ghanaians were estimated to have derived more than 23% of their daily calorie intake from cassava in 2002 (Table 5). Although cassava yields in Ghana were relatively unstable for the 25 years up to 1990, they then gradually increased and have now levelled off at about 12Mt/ha (Chart 4), which is well above the SSA average. Of the five countries focused on in this report, Kenya produces the least amount of cassava and yields have fluctuated around 8 Mt/ha for the last 40 years (Chart 7). Kenyans only rely on cassava for about 2.5% of their daily calorie intake. In Nigeria, the biggest producer, on the other hand, yields appear to have ranged between 9 and 12 Mt/ha (Chart 9) and cassava made up almost 10% of the per capita daily calorie intake in 2002. Cassava is very important in Tanzania, making up about 15% of per capita daily calorie intake (Table 5) in 2002. In Tanzania, cassava yields rose rapidly from about 4Mt/ha in the early 1970s to peak at about 12.5Mt/ha in the 1980s, though they seem to have declined to just over 10Mt/ha in 2005 (Chart 12). In neighbouring Uganda, cassava also accounted for about 13% of average calorie intake in 2002. Here annual yields appear to have fluctuated considerably, though with an underlying trend of increase, until the early 1990s when yields dropped back down to around 6Mt/ha. This trough in yields (1994-8) may represent the period when the epidemic of Cassava mosaic disease (CMD) was having its greatest impact in Uganda. Average yield appear to have been restored to around 13 Mt/ha.

Cassava roots are rich in energy, containing mainly starch and soluble carbohydrates, but are poor in protein. It is estimated that people eat more than 60% of all cassava produced in Africa, with about a third of the harvest being fed to animals and the rest transformed into secondary products. Although raw cassava is occasionally consumed in the Congo region, Tanzania and West Africa, this is relatively rare (Scott *et al*, 2000). A wide range of products can be processed from cassava as demonstrated by data from the Collaborative Study of Cassava in Africa (COSCA). The fresh peeled tubers are eaten as a vegetable after boiling or roasting. Boiled and pounded into a paste, the tubers are often added to soups and stews ("Fufu" in Nigeria). Because the fresh tubers deteriorate rapidly once they are harvested (post-harvest physiological deterioration; PPD), they are often preserved as sun-dried chips ("Kokonte" in West Africa) and consumed after cooking or being ground into a flour (Kay, 1987).

Cassava roots contain the glycoside linamarin which is converted into hydrogen cyanide (HCN) by the enzyme linamarinase. HCN is toxic to man and hence much of the processing of cassava tubers is to promote release and removal of the HCN prior to consumption. Fermentation is an effective means of removing HCN and in West Africa the principal form in which cassava is eaten is as a fermented meal known as "Gari". Apart from the processing of cassava into foods, the crop can also be processed into chips for animal feed and into starch for many food and non-food uses. Cassava flour is used in the preparation of bread, biscuits, confectionary, pasta and couscous-like products and in the production of adhesives. Cassava starch is used in the foodstuff, textile and paper industries, and in the manufacture of plywood and veneer adhesives andglucose and dextrin syrups. Through fermentation, it can also be used for alcohol production, and as a waste material it can be processed to biogas.

2.3.3 Yield, Consumption and Utilization of Sweet potato

The area annually planted to sweet potato in SSA has gradually increased over the last 40 years (Chart 2) and yields appear to have remained static at between four and five tonnes per hectare. However, in Nigeria, which produces about a quarter of all sweet potato produced in SSA, yields appear to have declined from about 12 Mt/ha in the mid 1960s to less than 5Mt/ha in the mid 1990s (Chart 10). This may reflect a shift from relatively limited commercial cultivation of the crop using fertilizers and other inputs to more wide-scale production under low-input/subsistence systems. A similar pattern of declining yield is also observed in Tanzania, where yield in 2004 was reported to average only 2Mt/ha (Chart 13). In Uganda, which also produces about a quarter of all sweet potato produced in SSA, yield has fluctuated between 3 and 5 Mt/ha since the early 1970s (Chart 16). Yield in Kenya appears to have fluctuated between 7 and 11 Mt/ha over the same period (Chart 8), perhaps reflecting the observation that sweet potato tends to be grown more intensively as a cash crop for the urban markets in Kenya. This may also be the reason for the high average yield in Ghana (14Mt/ha), where production only grew to levels sufficiently high to be reported in the mid 1990s (Chart 5).

Over 80% of the sweet potato produced in SSA is consumed fresh by man. The remainder is either processed for starch or used for animal feed. The tubers are mainly starch and soluble carbohydrates, but the leaves and vines are high in amino acids, essential minerals and vitamins. Starch and protein digestibility of raw sweet potatoes has been cited as an obstacle to increased use for animal feed (Collins, W.W., 1997). In Africa, sweet potato is generally eaten boiled or roasted. However, when sliced, dried (usually in the sun), and ground, it gives flour that remains in good condition for a long time. The flour is used as dough conditional in bread manufacturing and as a stabilizer in the ice-cream industry. Sweet potato has been processed into chips in much the same way as potato and the product is now popular in Asia. In Japan, sweet potato starch is used in the production of noodles and is also fermented in the production of distilled spirits called shochu. There is increasing experimentation with multiple uses of sweet potato in Africa. Uganda for instance, has seen the development, on a small scale, of sweet potato processed products such as juice, cakes, chips and chapattis. There is also currently considerable interest in promoting the production of orange-fleshed sweet potato (OFSP) varieties as a source of beta-carotene that the body uses to produce Vitamin A. Vitamin A deficiency (VAD) is prevalent in many parts of SSA and is a leading cause of early childhood death and a major risk factor for pregnant and lactating women (VITAA, 2005).

2.3.4 Yield, Consumption and Utilization of Yam

On a world scale, yams represent less than 10% of all root and tuber crops produced and, of these, 75% are grown in West Africa. Of the five target countries included in this study, only Nigeria and Ghana grow significant quantities of yam, though Tanzania is reported to produce some 11 x 10^3 Mt pa (Nigeria = 26 x 10^6 Mt pa). Yield of yams in Ghana has increased from about 5 Mt/ha in the late 1980s to about 14 Mt/ha in 2004. The pattern of yields over the last 40 years in Nigeria is difficult to interpret (Chart 11), though the gradual decline in yield from about 12 Mt/ha in the late 1980s to about 8 Mt/ha in 2004 has been attributed the use of shorter fallow periods and use of more marginal lands for yam production because of demand to feed the increasing human population. In Tanzania, where yams are mainly a low-input, food security crop grown on a very small scale, yields are reported to have remained relatively static at about 6 Mt/ha. Yams are relatively more expensive to grow compared to the other root crops because they require staking in many areas, and they require greater labour input for land preparation (clearing and mounding), stake-tying and careful harvesting.

Yams are essentially carbohydrate foods with relatively high protein and ascorbic acid (Vitamin C) content compared to cassava or sweet potato. By far the greater part of the world's yam crop is consumed fresh; the tubers are commonly eaten as a vegetable either boiled, baked or fried. “Fufu”, a stiff, gelatinous dough (= pounded yam) prepared by pounding boiled tuber pieces in a mortar, is the preferred form in most of West Africa. Under tropical conditions sound tubers will store for up to about four months depending on variety and species, and thus extending the shelf-life through drying or other processes has not had such a high priority with yam as it has with cassava or sweet potato. However, injured tubers are often peeled, sliced and sun-dried soon after harvest to extend their useful life. The dried slices are generally milled into flour (often brown/purple in colour due to oxidation of phenolics during drying) which is reconstituted with water and boiled to produce “Amala” (in Nigeria). To a limited extent, yam flour is also produced in Ghana where the reconstituted dough is known as “Yam Kokonte”. Traditionally, processed yam products are made in most yam-growing areas, usually as a way of utilising tubers that are not fit for storage.

Since pounded yam has so much prestige and is the most popular way of eating yam, two attempts have been made to commercialize the process. The first was the production of dehydrated pounded yam by drum drying. This product could then be reconstituted without further processing. This production was first attempted in Côte d'Ivoire in the mid-1960s, under the trade name "Foutoupret", by air-drying precooked, grated or mashed yam. Attempts to manufacture fried yam chips, similar to French fried potatoes have been reported from Puerto Rico (see:http://www.food-info.net/uk/products/rt/cassava.htm ; Scott *et al*, 2000). Recent attempts at more sophisticated processing of yam for export or the production of starch or alcohol have not been commercial successes, largely owing to the high cost of the raw material.

3 The DFID Research Programmes and Projects

3.1 Introduction

The goals of the DFID Renewable Natural Resources Research Strategy (RNRRS) for 1995-2005 (published in May 1994 and known colloquially as the "Yellow Brick") were to be "the alleviation of poverty, the promotion of economic growth and reform, and the mitigation of environmental problems". The strategy aimed to achieve economical and environmentally sustainable enhancement of productive capacity in the renewable natural resources sectors through contracted out management of competitive research funds. Research projects were to be demand-led, contributing to the achievement of a programme purpose by responding to the clearly defined problems of a closely specified group of beneficiaries.

The RNRRS was to adopt a production systems perspective, with all research focused on one or more of seven RNR commodity/resource production systems (semi-arid, high potential, hillside, tropical moist forest, forest-agriculture interface, land-water interface, peri-urban interface). It was structured around ten contracted-out research programmes:

1. Animal Health (AHP)
2. Aquaculture and Fish Genetics (AFGP)
3. Crop Post-harvest (CPHP)
4. Crop Protection (CPP)
5. Fisheries Management Science (FMSP)
6. Forestry Research (FRP)
7. Livestock Production (LPP)
8. Natural Resources System (NRSP)
9. Plant Sciences (PSP)
10. Post-harvest Fisheries (PHFRP)

This synthesis study focuses on the research carried out on the root and tuber crops sector and the majority of this research has been funded through the CPP and the CPHP, primarily under the Forest-Agriculture interface production system. Latterly, PSP jointly funded with CPP work on the participatory breeding of cassava. Some research on potatoes (*Solanum tuberosum*) was also funded through PSP and CPP, but potatoes were not included in the terms of reference for this synthesis.

3.2 Programme Goals and Objectives

3.2.1 Crop Protection Programme (CPP)

The goal of the CPP was "*To improve the livelihoods of poor people through sustainably enhancing production and productivity of RNR systems"*.

The purpose of the CPP was to generate benefits for poor people in target countries by the application of new knowledge to the protection of specified crops. The tropical root crops covered in this study all fall within the Forest Agriculture Interface Production system where the aim was "*To reduce the impact of pests and to stabilise yields and productivity of annual and herbaceous crops and tree crops for the benefit of poor people*".

The projects commissioned by the CPP can be broadly divided into six groups; three groups relating to cassava, two groups concerned with sweet potato and one group focussing on yams.

3.2.2 Crop Post-harvest Programme (CPHP)

The CPHP commissioned research on processing, marketing and storage of cereals, root crops, legumes and oilseeds, and horticulture. The CPHP was designed to benefit people involved in post-harvest commodity systems by providing them with opportunities for enhanced income, employment and food supply. A common objective in all work was to improve food security of poor households.

As was the case for the CPP, the key organizing principle for the CPHP at its start was production systems, with most of the root and tuber crop projects falling within the Forest Agriculture Production System. Priority setting was based on Country Framework documents drawn up in line with national agricultural research and development policy and the results of needs assessments. However, by 2000 it was apparent that there were several weaknesses in this approach:

- the production systems did not fit any clear geographical unit that would allow poverty reduction to be monitored with national statistics;
- the production systems were not necessarily geographically exclusive from each other; and,
- policy research does not fit in the framework of production systems, but rather a regional framework.

Recognising this and the growing importance of partnerships in successful output delivery, the CPHP decided to move to having Regional Strategies with more thematic projects implemented by coalitions of in-country partners. This coalitions approach came to be known as 'Partnerships for Innovation'.

3.3 RNRRS Projects on Cassava

3.3.1 CPP Projects on Cassava Mosaic Disease

In the late 1980s reports started emerging from Uganda of a major new epidemic of cassava mosaic disease that was affecting the welfare of many farmers in the North-east of the country. National and international agencies started trying to tackle the problem. CPP (and predecessor IPMS) joined in this effort through a series of projects targeted at developing a better understanding of the factors affecting the epidemiology of the disease and the whitefly vector, and developing strategies to control them. Varieties resistant to the virus, developed by national and international centres, were regarded as the most effective means of combating the disease, and some of the CPP-funded work concentrated on identifying and evaluating strategies for the sustainable deployment of these varieties. Much has been written about CMD and the projects to understand and control it (e.g. Thresh and Cooter 2005, and references therein)

Code	Start-end	Title
R5740CB F0010	01/04/1992 31/12/1995	Strategies for the control of African cassava mosaic disease (Adaptive Research Initiative)
R6614 A0516	01/01/1996 31/12/1998	Control of African Cassava Mosaic Virus
R7505	01/11/1999 31/10/2002	Strategies for the sustainable deployment of cassava mosaic disease resistant cassava in Eastern Africa
R8303 A1105	01/04/2003 31/03/2005	Maximising, disseminating and promoting the benefits to farmers of cassava varieties resistant to cassava mosaic disease
R8456 A1178	01/04/2005 31/01/2006	CMD and whitefly control

3.3.2 CPP Projects on Cassava Brown Streak Disease

Also in the late 1980s, Cassava brown streak disease (CBSD) was reported to be becoming more important in the coastal areas of east and southern Africa. Perhaps because the epidemic was not as dramatic as the CMD epidemic in Uganda, CBSD was largely ignored by most of the international aid agencies. However, DFID (then ODA) through IPMS did fund work to better identify the causal agent of the disease, develop reliable diagnostic techniques, and more recently to screen for resistant/tolerant land races of cassava and to investigate the epidemiology and vector relationships of the identified causal agent, *Cassava brown streak virus* (CBSV).

Studies on the needs assessments conducted for Cassava Brown Streak Disease can be accessed through the CPP website on the following page: http://www.cpp.uk.com/cbsd/

Code	Start-end	Title
R5880CB F0050	01/04/1992 30/11/1996	Adaptation and development of diagnostic reagents for cassava brown streak disease for use in less developed countries (Adaptive Research Initiative)
R6617x X0347	01/04/1996 31/08/1999	Molecular characterisation of cassava brown streak virus
R6765 A0598	01/04/1996 31/08/1999	Control of cassava virus diseases in coastal coconut-based farming systems in Tanzania.
R7563	01/01/2000 31/12/2002	Management of cassava brown streak disease and mosaic disease in eastern and southern Africa
R7796	01/07/2000 30/06/2001	Cassava brown streak virus, virus isolates and the application of the diagnostic test
R8227 A1071	01/01/2003 31/03/2005	Promotion of control measures for cassava brown streak disease
R8404 A1150	01/04/2005 31/01/2006	Control measures for Cassava Brown Streak Disease

3.3.3 CPP and PSP Projects on Participatory Breeding of Cassava

Although the most useful means of addressing the CMD epidemic in East Africa was the introduction of resistant varieties of cassava, it became apparent that the resistant varieties produced through conventional breeding were not very popular with the growers where they were introduced. They either did not taste good, or were not adapted to the local agro-ecologies/cropping systems. The Plant Sciences Research Programme (PSP) had previously funded work on the farmer participatory breeding and selection of rice, and it

was anticipated that the participatory approach would be more efficient in producing cassava varieties that were more appropriate and acceptable to the growers. For this reason, the CPP and the PSP jointly funded a series of projects on the participatory breeding of cassava in Ghana.

Code	Start-end	Title
R7565 A0945	01/01/2000 31/03/2003	Participatory breeding of superior, mosaic disease-resistant cassava
R8302 A1112	01/04/2003 31/03/2005	Participatory breeding of superior, mosaic disease-resistant cassava: validation, promotion and dissemination
R8405 A1161	01/04/2005 31/01/2006	Participatory breeding of superior, mosaic disease resistant cassava: enhancing uptake

3.3.4 CPHP Projects on Cassava

The CPHP projects on cassava were mainly concerned with improving technologies for the post-harvest handling, storage and processing, and with understanding and widening the market opportunities for cassava. This included assessing and promoting the use of cassava starch as an industrial commodity in West Africa, for example in the production of adhesives for the plywood industry and the production of dextrose syrups for the bakery and confectionary industry. More up-stream work was also commissioned to study the mechanisms of, and opportunities for modulating, post-harvest physiological deterioration (PPD) of cassava roots.

Code	Start-end	Title
R5448CB	01/09/1992 31/03/1996	Low cost cassava fresh root storage technology transfer project - adaptive transfer from Latin America and field testing in Sub-Saharan Africa
R6332	01/04/1995 31/03/1996	Improved cassava processing technology for vulnerable households in Tanzania.
R6500 A0492	01/02/1996 31/12/1996	Control measures for the reduction of losses for cassava and sweet potato products in Tanzania
R6506	01/01/1996 31/03/1999	Development and orientation of cassava chip production in relation to national and international markets for food consumption and animal feed in Ghana.
R6508	01/01/1996 01/10/2000	Improving the quality and value of non-grain starch staples
R6639	01/07/1996 30/04/1999	Improved cassava utilisation in Tanzania
R7495	01/11/1999 31/05/2003	Identification of an approach to the commercialisation of cassava fufu processing in West Africa that maximises benefits to sustainable rural livelihoods
R7497	01/10/1999 31/03/2003	Commercialisation of cassava processing to enhance rural livelihoods in Eastern and Southern Africa
R7550	01/07/2000 30/06/2001	Generation and dissemination of knowledge on post-harvest physiological deterioration in cassava
R8156	01/04/2002 31/03/2005	Knowledge and tools for the modulation of post-harvest physiological deterioration in cassava
R8268 A1094	01/01/2003 31/12/2004	Sustainable uptake of cassava as an industrial commodity
R8283	01/01/2003 31/12/2004	Packaging and processing of sweet potato and cassava (PPOSPC)
R8432 A1170	01/01/2005 31/12/2005	Cassava as an industrial commodity - improving access to knowledge on approaches and options for expanding markets for cassava

3.4 RNRRS Projects on Sweet Potato

3.4.1 CPP Projects on Sweet Potato Integrated Crop Management

Even before the RNRRS/CPP, Sweet potato weevil (*Cylas* spp.) was recognized as a major constraint to sweet potato production, and more particularly it was known to reduce the shelf life of the harvested tubers. Two early DFID-funded projects sought to identify pheromones for use in monitoring and control of the weevils. The CPHP had also reported sweet potato weevil as a major constraint that farmers were facing. As the International Potato Centre (CIP) had also identified this problem, the CPP funded participation in their fact finding mission in 2000. This was followed up with correspondence with GTZ and then an open call which lead to the commissioning of R8040 and R8167. It was estimated that by the end of it's first year R8040 had improved the access of 30-40,000 farmers in Central Uganda to improved varieties of sweet potato that have increased ß-carotene content and resistance to SPVD. These varieties were also incorporated into the activities of R8167 where the main aim was to assess the use of farmer field schools in developing improved productivity of sweet potato and increasing sustainable production by resource-poor growers.

Code	Start-end	Title
R6124 A0368	01/04/1994 31/03/1996	Identification of sex pheromones of sweet potato weevils
R6115 A0657	01/01/1995 31/03/1997	Development of Pheromones for Monitoring and Control of Sweet Potato Weevils (*Cylas brunneus* and *Cylas puncticollis*)
R6769	01/11/1996 31/03/1999	Investigating the potential of cultivar differences in susceptibility to sweet potato weevil as a means of control
R7024*	01/04/1998 31/03/2001	Farmer Participatory Research on Integrated Crop Management for Sweet Potato in North Eastern Uganda (Competitive Research Funds)
R8040	01/07/2001 30/06/2003	Rapid multiplication and distribution of sweet potato varieties with high yielding and ß-carotene content
R8167	01/04/2002 31/03/2005	Promotion of sustainable sweet potato production and post-harvest management through farmer field schools in East Africa.
R8458	01/04/2005 31/01/2006	Expansion of sustainable sweet potato production and post-harvest management through FFS in East Africa and sharing of the lessons learnt during the pilot schools

3.4.2 CPP Projects on Sweet Potato Virus Disease

Sweet potato virus disease (SPVD) had been shown to be widespread in East Africa since the 1970s, but it was not until 1994 that a "Hold-back fund" project was initiated to assess the influence of the disease on yield in Uganda. The importance of using clean planting material to increase yields was also highlighted. Then CPP funded a project to study the etiology and epidemiology of the whitefly-borne component of the disease. This led to the development of strategies for controlling the spread of the disease, including the selection, multiplication and promotion of disease resistant varieties. Subsequent work centred on working with farmers to evaluate and promote the resistant varieties more widely.

Code	Start-end	Title
R5878*	01/04/1994 01/03/1997	The influence of viruses on sweet potato yields in Uganda: Assessment of the potential to use clean planting material to increase yield (Holdback Funds)
R6617 A0519 X0347	01/04/1996 31/08/1999	Identification, characterisation and epidemiological significance of the whitefly-borne component of sweet potato virus disease in Africa.
R7492	01/11/1999 31/10/2002	Promotion of and technical support for methods of controlling whitefly-borne viruses in sweet potato in East Africa
R8243 A1076	01/11/2002 31/03/2005	Working with farmers to control sweet potato virus disease in East Africa
R8457 A1177	01/04/2005 31/01/2006	Extending the control of Sweet potato Diseases in East Africa

3.4.3 CPHP Projects on Sweet Potato

The CPHP projects on sweet potato covered aspects of improving the post-harvest handling, storage and marketing of sweet potato, as well as identifying varieties less susceptible to harvesting/transport damage and rotting. Since the later projects had links with, or even shared staff with, some of the CPP projects on sweet potato, similar sets of sweet potato varieties were promoted, including the VITAA varieties with high ß-carotene content.

Code	Start-end	Title
R5079 A0302	01/04/1992 31/08/1995	Development and field testing of needs assessment methodologies in traditional root crop post-harvest systems (Non grain starch staples post-harvest and technology transfer project: Uganda)
R6204 X0287	01/12/1994 01/03/1996	Post-harvest evaluation of local sweet potato cultivars in Tanzania.
R6317 A0425	03/04/1995 31/03/1996	Development and field testing of mechanisms to identify and address opportunities in non grain starch staple
R6507	01/01/1996 31/12/2000	The extension of storage life and improvement of quality in fresh sweet potato through selection of appropriate cultivars and handling conditions.
R7036	01/10/1997 30/09/2000	An enterprise approach to commodity system improvement: sweet potato in Uganda and Kenya.
R7498	01/12/1999 31/01/2003	Maximising incomes from sweet potato production as a contribution to rural livelihoods
R7520	01/11/1999 31/12/2002	Sweet potato cultivars with improved keeping qualities for East Africa
R8273	01/01/2003 31/12/2004	Improving the livelihoods of small-scale sweet potato farmers in Central Uganda through a crop post-harvest-based innovation system
R8282	01/04/2003 31/12/2004	Enhancing the livelihoods of the rural and urban poor through improved market access for sweet potato
R6049 X0263	01/05/1994 31/05/1997	Collaborative programme with CIP to identify and respond to the needs of the post-harvest sector for sweet potatoes in East Africa

3.5 RNRRS Projects on Yam.

3.5.1 CPP Projects on Yam

The earlier programmes and the early part of the CPP had funded research which greatly enhanced the understanding of the causes, means of dispersal and management of yam diseases and pests (see Table 16). One of the major constraints to increased yam production was found to be the shortage of affordable and good quality planting material, and subsequent projects focussed on identifying systems to overcome this constraint (Table 17). However, the value of the research was not being felt by yam farmers as there were uptake constraints concerning the knowledge that was generated. The CPP therefore funded in 2001 a programme development study to identify if anything could be done, and then in 2002 funded multi-stakeholder meetings in Ghana and Nigeria to validate the proposed interventions and consider how the outputs could be practically achieved. The subsequent report was also shared with IFAD, Gatsby Foundation, WASDU and GTZ. The latter projects focussed on evaluating the systems developed earlier for the cost-effective, sustainable and environmentally sound production of clean planting material (seed yams). Appropriate ways of packaging and disseminating the project findings were also identified, and the final phase of the work was to start to promote the systems more widely in Nigeria.

Code	Start-end	Title
R5735CB* F0006	01/11/1992 31/03/1996	Improving the health of seed yams in West Africa (Adaptive Research Initiative)
R6691 X0362	01/07/1996 30/06/2000	Control of yam diseases in forest margin farming systems in Ghana
R6694 X0353	01/04/1996 31/03/2000	Identification of resistance to major nematode pests of yams. (*Dioscorea*) in West Africa
R7504 A0897	01/11/1999 31/05/2000	Study of factors affecting the uptake and adoption of outputs of crop protection research on yams in Ghana (Programme Development)
R8278 A1096	01/01/2003 31/03/2005	Evaluation and promotion of crop protection practices for "clean" seed yam production systems in Central Nigeria
R8416 A1159	01/04/2005 31/01/2006	Up-scaling sustainable clean seed yam production systems for small-scale growers in Nigeria

3.5.2 CPHP Projects on Yam

It had been reported that considerable amounts of yam were regularly lost between harvest and market. A project was developed in 1995 to examine the post-harvest handling and marketing systems within Ghana to determine the nature, causes and implications of the losses, and to then develop appropriate technologies or protocols to reduce the losses. Since much of the loss was found to be due to rotting of diseased or damaged tubers, a subsequent project was established in 2000 to establish strategies for grading yams by quality, and for excluding diseased tubers from entering the marketing chain. An “electronic nose” system was tested for identifying diseased tubers in batches destined for export from Ghana.

Code	Start-end	Title
R6505	01/01/1996 31/03/2000	Relieving post-harvest constraints and identifying opportunities for improving the marketing of fresh yam in Ghana.
R7582 A0946	01/02/2000 31/05/2003	Development of integrated protocols to safeguard the quality of fresh yams.

4 Results

4.1 Conceptual Framework

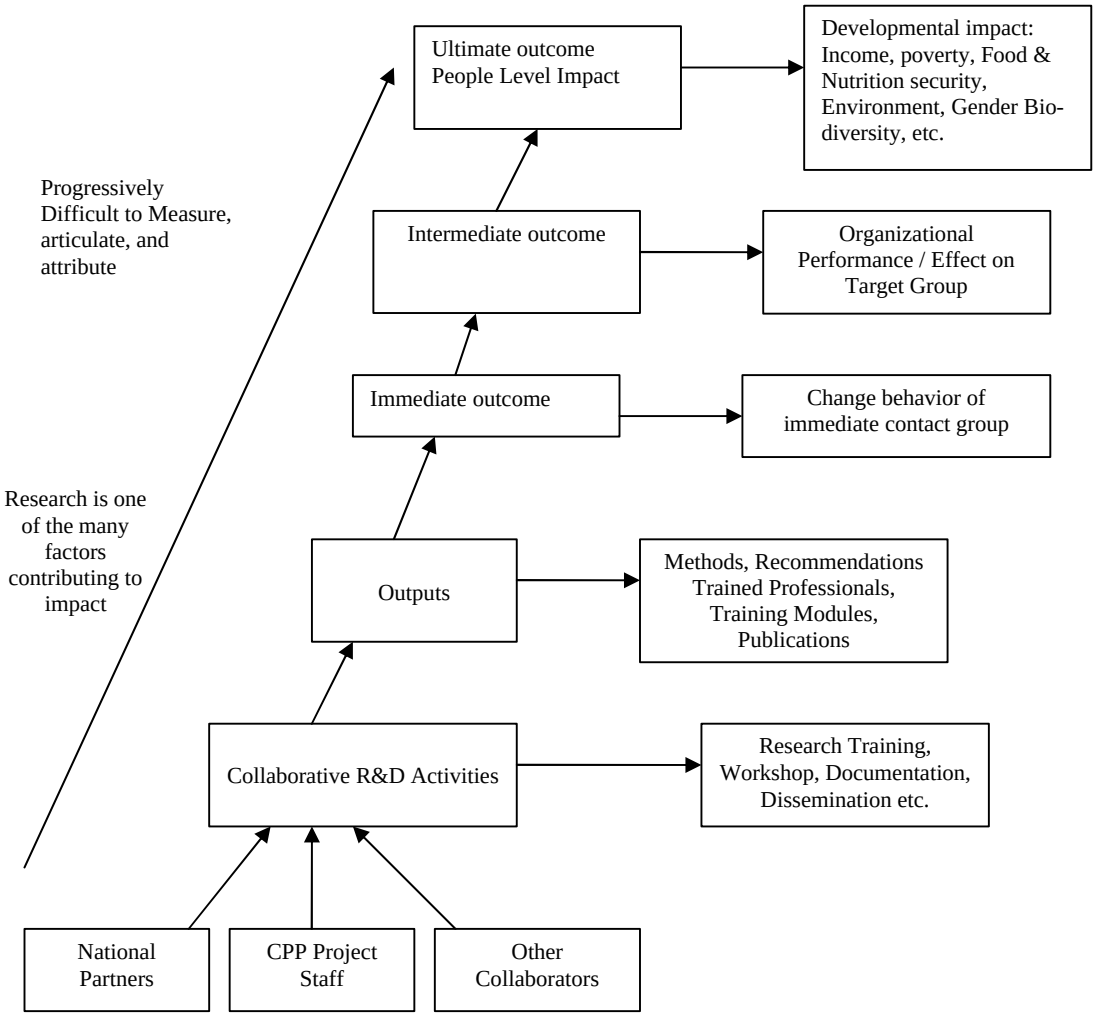
The specific terms of reference for this study are presented in Section 1.2 above. The overall purpose of the study was to assess the relevance, quality, performance (effectiveness), efficiency and impact of the R&D activities undertaken by CPP (and to a lesser extent by CPHP and PSP). The projects commissioned by these programmes have generated both tangible technologies as well as some intermediate products (e.g. screening methods, isolation techniques *etc*.). These intermediate products are then used in a much broader innovation processes ultimately leading to developmental impacts. Therefore, any conceptual framework to assess the performance and impact should accommodate both types of outputs.

In terms of assessment, performance compares the achievements of the various projects in relation to the target set at the design stage. Quality of research deals with the adherence to accepted standards of scientific work and precision. The quality of research is determined almost exclusively though some form of peer/expert review. Relevance is closely linked to the priority problem/constraints faced by the target group under consideration. Efficiency of a project compares the costs and the associated benefits. For R&D activities, the commonly used conventional measure of efficiency is the rate of return on investment. Impact on the other hand deals with the effect of the research outputs on the ultimate beneficiaries; often referred to as 'People level impact' or socio-economic impact (closely linked in the developmental goals). Impact begins to occur when there is a behavioural change in the target population.

The tools that are often used to trace the impact of any intervention are the impact chain analysis and outcome mapping. A typical impact chain (shown in Figure 2) starts from the set of activities of a project/programme and proceeds to the most highly aggregated development results, such as food and nutritional security, poverty reduction, environmental protection, gender equality etc. The chain also specifies the main intermediate steps, namely the activities of a project, its outputs, uses that others make of these outputs, direct as well as possible indirect effects, and the eventual impact of the outputs on the ultimate beneficiaries. Output, outcome and impact generally occur sequentially and become more difficult to identify, measure and attribute as one moves from outputs to impact.

A conceptual framework for analyzing the effectiveness relevance, quality, efficiency and impact of any intervention/project is presented in this Section. The information generated through the various reviews, questionnaires and face-to-face interviews are summarized and presented.

Figure 2. Impact Chain

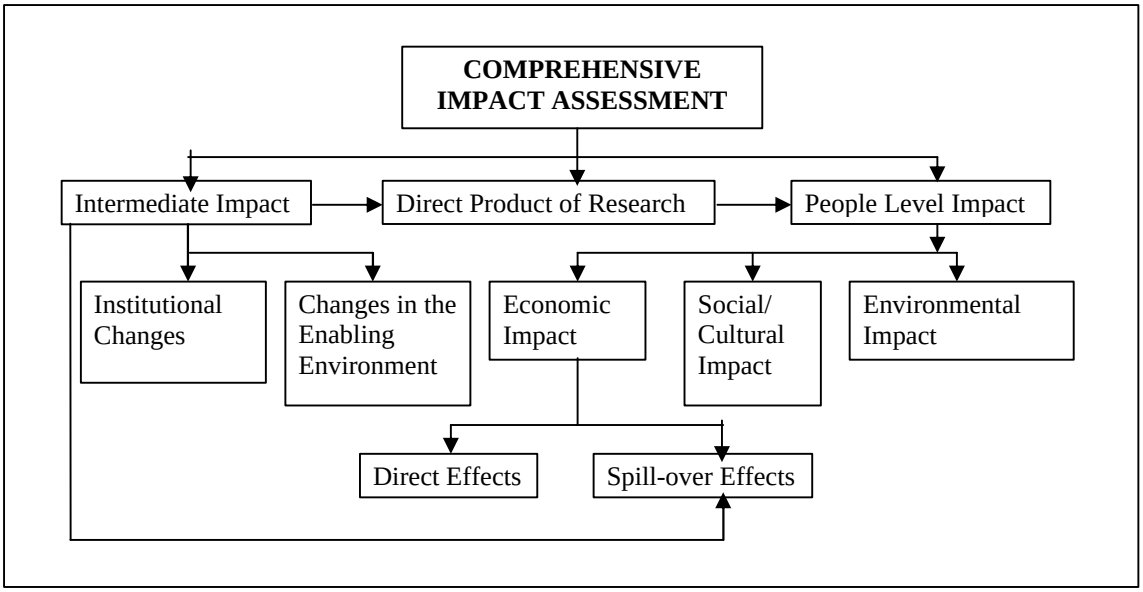


The term 'output' refers to the results of project/programme activities i.e. goods and services produced by the set of collaborative activities. The term 'immediate outcome' refers to the first-level effect of these outputs, i.e.; the observed or documented behavioural changes in those directly affected by the project or programme. 'Intermediate outcome' refers to the benefits and changes resulting from the application of outputs. Outcomes are thus measures of the utility of project outputs to clients and partners. Thus, in order to produce an outcome, a project or programme has to cause a change in behaviour. The impact of a particular programme or project could therefore be assessed by trying to identify and document expected changes in the attitudes, knowledge, perceptions and decisions of those targeted by the programme. The immediate and intermediate outcomes can be measured and documented directly. Such an approach involves identifying the various clients of the program and the ways in which their behaviour is expected to change. Observations and documentation of such short-term changes then provides evidence that these impacts can be attributed to the project or program. The three major issues that need to be addressed in any impact study are causality, attribution and incrementality.

This study adopts a comprehensive framework that has been used to study the impacts of R&D intervention in a number of empirical studies in East and Southern Africa (presented

in Figure 3). This framework uses multiple criteria to analyze the several aspects (including intermediate products, direct products and field/people level impact) simultaneously (Anandajayasekeram *et. al*. 2002). The people level impacts are broken down into economic, socio-cultural and environmental. This framework also enables one to incorporate the spill-over effects.

Figure 3. Framework for Comprehensive Impact Assessment



The impact chain and the comprehensive conceptual framework were used as the starting point for this assessment. However, it is worth noting that the projects examined were not set out to go beyond the direct outputs. In some cases, follow-on projects were designed to promote the dissemination. In the majority of cases, responsibility for multiplication and dissemination was left in the hands of the national partners and other collaborators. No follow up mechanisms were established to document the dissemination and adoption of technologies being developed. Time series data on costs and benefits associated with the development dissemination and utilization of technologies were also not available. Therefore, this study primarily focuses on the direct products of research and where possible, based on the secondary data, field observations, and information from collaborators and researchers an attempt has been made to comment on the possible outcomes of the project. Given the large number of projects implemented by research programmes over the ten year period and the short duration of this study, it was also not possible to do a project by project analysis. Therefore, the assessment deals with the programmes as a whole.

4.2 Methods and Procedure Followed

The synthesis was conducted in accordance with the framework outlined in Section 4.1 above using both primary and secondary data. The focus countries for the study were identified by the programme manager of CPP.

Data and information were collected from various sources. In addition to the available project reports and secondary data, primary data were collected from the following: NRIL programme managers, individual project managers, national collaborators of the various

projects, national coordinators of root and tubers in the selected countries, root and tuber researchers, regional roots and tubers networks coordinators, donors involved in supporting root and tuber research and development, and farmer groups. Standard questionnaires and guidelines (see annex) were used to collect the necessary data. At least one member of the team visited each of the selected countries and where possible face-to-face interviews were held to collect additional information. The individuals contacted are listed in Annex 2. The information generated through the various sources is summarized in the following sections.

4.3 Major Outputs

The activities of the research programme projects are conducted through partnerships with a number of stakeholders. Such collaborations have taken various forms including research, provision of advisory services, involvement in training, documenting and disseminating practical experiences and good practices. The purpose, objectives and expected outputs from each of the completed and on-going projects are summarized in the Annex. For the purpose of this study, the major outputs of the CPP project activities are grouped under:

- Technology/knowledge (production technology and R&D technology) generation
- Training materials development
- Capacity building (both human and institutional)
- Publications
- Policy Advocacy/dialogue
- Technology transfer and,
- Establish linkages and partnerships

4.3.1 Technology or Knowledge Generated Through the Projects

Through the activities of the CPP, CPHP and PSP, a number of technologies and recommendations have been developed to increase productivity, income and livelihood of those engaged in cassava, sweet potato and yam production in the case study countries. These are categorized into five parts as:

A. Disease resistant varieties e.g. local and improved varieties resistant to CMD evaluated and suitable varieties identified for dissemination, Varieties resistant to SPDV identified; attributes desired by farmers established, and phytosanitation procedures to control SPDV established for Southern and Western Uganda and North Western Tanzania (R7492).
B. Pest resistant varieties e.g. improved understanding of the linkages between the whitefly vector and the virus disease vector preference for healthy areas of CMD affected leaves.
C. Disease control technologies e.g. rational, socially acceptable control strategies appropriate for different situations and degrees of inoculums for the control of Cassava Mosaic Disease (CMD) developed for Kenya, Tanzania, and Uganda (R6614); also improved production systems for increasing the availability of good quality yam planting material.
D. Pest control technologies: different pest control mechanisms were identified and communicated by the projects.
E. High yielding/longer storage varieties e.g. participatory methods for varietal selection of sweet potato in Uganda and Tanzania – developed three clonal generations in communal participatory breeding (R8243). A similar programme in Ghana led to the selection and testing of 39 superior clones in multi-locational community trials. A cost effective and sustainable system (informal and farmer

based) for continuous multiplication and timely distribution of quality sweet potato planting materials.

4.3.2 Training Materials Development

Projects implemented under the programmes have undertaken different training workshops and developed training materials that are distributed to the beneficiaries. There is evidence to indicate that the projects have addressed the issue of capacity building. In addition to supporting short term skill building, long term degree oriented training and on the job training, in a number of projects considerable resources were devoted to training materials development. For example, the cassava brown streak disease project developed a training manual on PCR diagnosis; a manual of research methods for work with CBSD; posters and leaflets on control and symptoms of CBSD (in multiple languages – Kiswahili, English, and Portuguese), and radio programs on biology and control of CBSD. Similarly, the sweet potato projects produced a "*Manual for sweet potato IPPM farmer field schools in Sub-Saharan Africa*"; and other manuals on sweet potato production. These are just examples to illustrate the systematic efforts made by a number of projects to build the local capacity.

4.3.3 Capacity Building

The projects have contributed significantly to the capacity building (both human and institutional) at different levels. The short term skill building initiatives among others included:

- Methods to control CMD (farmers, extensionists, students of agricultural learning institutions)
- All aspects of diagnosis, field trails, and screening for resistance to CBSD (researchers and laboratory technicians)
- Biology and control of CBSD (school teachers and extension staff)
- Post-harvest and survey skills (researchers)
- Sweet potato FFS (FFS facilitators and farmers) – on sustainable sweet potato production
- Quality (seed yam, and cuttings) planting material production (farmers and extension staff)
- Participatory plant breeding methods for cassava and sweet potato (researchers and farmers)
- Technology validation (farmers)
- Sweet potato processing and packaging (farmers and traders)
- Cultural practices to control sweet potato virus disease (farmers and facilitators)

Capacity building was a key element of many of the projects. For example, the project on the promotion of sustainable sweet potato production and post-harvest management through FFS in East Africa made a significant contribution to capacity building and empowerment of the community. A total of 18 FFS were conducted in North East Uganda where 492 farmers (332 females) were trained. Six of them were facilitated by farmers. Additional four FFS were implemented in Tanzania where 92 farmers were trained. Seven extension staff trained as master trainers (3 from Kenya, 2 from Uganda, and 2 from Tanzania). A total of 27 farmer facilitators and 37 sweet potato IPPM FFS facilitators were also trained through the project. This capacity building of participatory FFS members enabled them to seek additional resources from other sources. For example, the Abuket FS sweet potato processors group in Soroti, Uganda successfully applied for funds from DIFID

– COARD to participate in tailor made sweet potato quality processing course. The FFS participants were also used by district councils to help raise awareness about other topics such as HIV-AIDS.

In addition, the CPP also supported a number of M.Sc and Ph.D degrees (see Box 1 for details). A number of NGO staff also participated in various skill building programmes. One project facilitated the inclusion of the cassava biology, pest management and utilization into the curricula of six schools in Southern Tanzania.

Box 1. Postgraduate thesis supported through the CPP

1. Ekefan, J.E. (1996). *Epidemiology and Control of Yam Anthracnose in Nigeria.* PhD Thesis, The University of Reading. (Ph.D)
2. J Manu-Aduening (2005). Participatory breeding for superior mosaic-resistant cassava in Ghana. Doctoral Thesis, University of Greenwich (Ph.D)
3. M. James (1997). Evaluation of Enzyme Linked Immuno Sorbent Assay (ELISA) in the Direct Detection of *Colletotrichum gloeosporioides* in Yam Tuber Tissue. MSc Thesis, University of Reading. (MSc)
4. Olatunde, O.J. (1999). Viruses of Yam in Ghana. MSc Thesis. Natural Resources Institute, University of Greenwich. (MSc)
5. Sserubombwe, W. (1998) Progress of cassava mosaic virus disease (CMD) and its effect on growth and yield in different cassava varieties under epidemic conditions in Uganda. MSc Thesis, Makerere University, Kampala, Uganda.
6. Siddick, S. (2001) Mechanical transmission of *Cassava brown streak virus* to cassava and other hosts. MSc University of Greenwich, 95 pp. [student from India]
7. T. Alicai. (1997). Studies on sweet potato chlorotic stunt virus and sweet potato feathery mottle virus, the whitefly- and aphid-borne components of sweet potato virus disease. MSc Thesis, University of Makerere, 115pp.
8. V. Aritua (1998). Studies on the resistance of sweet potato to sweet potato virus disease. MSc Thesis, University of Makerere, 111pp.

4.3.4 Publications

Non copy-protected publications are the true public goods that any program can produce. A summary breakdown of the publications produced through the CPP projects is presented in Table 1. It is worth noting that all projects published their results in one form or another, and recognition was given to the local collaborators as co-authors. However, it was made apparent that many of the local/national collaborating organisations did not have the capacity or infrastructure for archiving project reports or other documentation. Often it was only the lead collaborator in a country who had a copy of the project annual reports and final report and when he/she moved on, the local institutional memory of the project was lost. Members of this study team were asked on several occasions during the visits to the study target countries for copies of reports that were no longer available in-country.

Table 1. Counts of the different publication types produced by CPP projects.

Category of publications	Number of publications
Papers in peer-reviewed journals, peer-reviewed proceedings or bulletins of conferences, symposia or workshops; papers, abstracts and posters included in such proceedings or bulletins, books and book chapters	76
Oral Presentations; non-peer-reviewed proceedings or reports of conferences and workshops, and papers, abstracts, posters in such proceedings or reports	152
Internal publications/reports	70
Briefing notes; newsletters, technical leaflets; manuals; hand books and booklets	28
Postgraduate theses	9
Training manuals	2

Data from CPP annual reports

4.3.5 Policy Advocacy

The projects have played a limited role in this area. One would naturally expect this given, the fact that most research activities are bio-physical in nature. In some cases, attempts have been made to link up with groups which make policies regarding variety release – for example the CPP cassava participatory breeding project has initiated dialogue with the Ghanaian variety release committee to integrate participatory breeding into formal release mechanisms. Another example is the involvement of local government players in promoting sweet potato IPPMFFS approach amongst their constituencies and lobbying for funds to support further activities, and in linking the work to national level policy makers and local level programmes such as school feeding programmes. The seed yam growers (Nigeria) are lobbying for the formation of their own association that can lobby government on behalf of their (newly emerging) industry.

In some cases, the CPP also took the lead role in initiating activities which were subsequently expanded by the CGIAR centres and other R&D practitioners working with root and tuber crops. For example, the CPP work on cassava mosaic and cassava brown streak virus disease pre-dated any involvement from the CGIAR institute, but sharing knowledge, resources and combining respective areas of expertise, working in partnership with these organizations and others has ensured that the efforts to combat these diseases has been greatly enhanced. The CPP management ensured that the CGIAR Tropical Whitefly Initiative incorporated technical outputs and lessons learnt from the CPP's roots and tubers cluster in their proposal. The efforts of the CPP to support the sweet potato virus disease research also enabled the project teams to secure matching funds from the EU.

4.3.6 Technology Transfer

It was noted that a large number of projects implemented focused on technology/ knowledge generation i.e. emphasis on research. Only a small number concentrated on the wider dissemination of research findings. In some cases, this was achieved through follow up projects. Despite the limited activities, the programme has made significant efforts to disseminate findings. Another activity that facilitated technology adoption is the

development of sustainable cost effective local system for the production and distribution of planting materials.

As mentioned in the previous section, the linkages with IARCs, regional networks, NGOs and Civil societies, and participation in key workshops and meetings further enhanced the dissemination process. Examples:

- A session on sweet potato virus at the African potato association congress
- A multi-country and multi-stakeholder regional workshops on cassava participatory breeding and cassava mosaic disease management in small holder cropping systems
- Working with the National Agricultural Advisory Services (NAADS) in Uganda
- Results of the microbial control of sweet potato weevils were circulated to CIP SPW bio-control programme in East Africa
- The project on control of cassava disease in Eastern and Southern Africa assisted in the production of a BBC programme on CBSD to be shown on BBC world service
- Publication of hand books through SARRNET in multiple languages

Thus, there is evidence that follow up activities in many cases were planned and implemented to widely disseminate results and/or to take activities to the next level. Scaling-up and scaling-out activities have been undertaken to disseminate results, findings and technologies across the national borders. Cross country projects also facilitated the inter-country spill-overs.

4.3.7 Linkages and Partnerships

Given increasing pluralism in the provision of agricultural services and emphasis on wider stakeholder participation in agricultural R&D activities, networking and partnerships have become increasingly important. Although there were no definite plans for follow up activities beyond the individual projects, the linkages established during the implementation of the projects have contributed significantly to the wider dissemination and applications of the project findings.

There is evidence that the sub-regional networks are using the project outputs. For instance, a number of NGOs have adopted the CBSD management strategies recommended by the project. A USAID funded SARRNETT program in Mozambique included CBSD management, and a new CBSD project funded by IFAD and managed by IITA was initiated in 2002 using the results from the project. A handbook was published through SARRNET to provide researchers and extension workers with a guide to the symptoms of CBSD and CMD information on control measures in a number of languages (English, Portuguese, and Kiswahili). There are excellent relationships with NGO led rehabilitation programmes and regional networks further enhancing the utilization of project findings.

The CPHP's change in 2002 from the 'Production Systems' approach to having Regional Strategies and adopting the coalitions approach ('*Partnerships for Innovation*') led to the development of stronger links and coalitions between regional organizations/partners. Unfortunately, in some instances this appears to have been to the exclusion of northern (mainly UK) partners and, with the promotion or moving-on of national partners there was a consequent loss of international expertise/perspective and long-term development memory to some projects (see also Section 4.3.4 above).

4.4 Other actors involved in root and tuber crop R&D

The various reviews and discussions also revealed that in addition to the national programmes there are a number of other actors involved in R&D activities related to roots and tubers in the case study counties. Three of the international agricultural centres (IITA, CIP and CIAT) have a mandate and are actively engaged in the R&D activities. The Comprehensive Africa Agricultural Development (CAADP) of NEPAD, FARA, CORAF ASARECA, EARRNET, SADC, SARRNET, SSA-CP, IFAD all have some activities related to yams, sweet potato and cassava. Phase II of the IFAD/CORAF/IITA Yam project covering six counties in West Africa is due to start soon. The Phase I activities focused on increasing production (varieties, cultural management, pest/diseases control) and Phase II will focus more on food quality/safety, sociological aspects and improved processing. The West African Seed and Planting Materials Network (WASNET) funded by Belgium and implemented by IITA (Covering 12 countries) is currently working on harmonizing seed production/supply/marketing system across the countries for 11 crop species including cassava and yams. The Gatsby Charitable Foundation supported projects are also selecting diseases resistant yams and developing molecular biology tools to do the selection (market assisted selection) better for Anthracnose and Yam mosaic virus (YMV).

A number of donors are also supporting activities which complement the activities of CPP. For example, in Nigeria USAID is supporting a project known as the "Pre-emptive strike against African cassava Mosaic Programme", which is again co-coordinated by IITA. The aims of this programme are to increase production and speed up the screening for and release of CMD resistant varieties. In Ghana, since 1999, most of the yam research work has been carried out under the umbrella of the adaptive research component of IFAD-RTIP. The phase II of this programme is to start in January 2006. The Danforth Center is looking at the molecular diversity of ACMV strains in Ghana. Thus, in addition to DFID activities a large number of other actors are also involved in root and tuber crop research and development in SSA.

4.5 Effective Utilization of Available National R&D Capacity

An attempt was made to assess whether the nationally available human resource were effectively utilized in the implementation of RNRRS-funded activities in the various countries. From the limited responses received it is difficult to make any definite conclusion. Since the RNRRS activities were only a segment of the broader R&D agenda, it may not be possible to utilize all available skills and expertise. Some respondents indicated that they were not aware of the activities. Limited participation of the national scientists in the design/preparation of projects was identified as one area which may require further attention. Another issue of concern was the limited involvement of the social scientists in the design, implementation and evaluation of many of the projects and activities. This also to an extent contributed to the relatively limited attention given to the socio-economic effects of the outputs produced. There were however some notable exceptions to this. The design and implementation of the CPP work on CMD in Uganda was strongly influenced by the local natural- and social-scientists, while local socio-economists were responsible for much of the impact assessment on this work. Similarly, in 2001 a CPP-commissioned programme development study consulted with, and brought together in workshops in Ghana and Nigeria, a wide range of natural and social scientists to evaluate the findings/outputs of the earlier research on yam and to set the priorities and research/dissemination approach for future work (Asiabaka et al., 2001).

4.6 Broader Developmental Impacts

As aforementioned, the RNRRS log-frame (known as the yellow brick) did not give a target of achieving farmer-level impact until after 2005, and intended impact was to be on intermediate users of the knowledge and technologies developed. As such, the research programmes were not encouraged to collect base line information for purpose level impact assessments on ultimate beneficiaries until the last four years of the programme by which time it was difficult to assess or document the developmental effects or impacts of the technologies and knowledge generated through the various projects. However, it is important to note that the three crops addressed by the programme are staple crops in the case study countries, and a large number of rural poor depend on them for their livelihood. Cassava is the staple crop in large parts of coastal Tanzania, Northern Uganda, and Mozambique where the incidence of cassava virus diseases is around 50-80 percent. Approximately 20 million people in the region depend on cassava as a staple food. It is also increasingly grown for cash income generation by farmers in the case study countries. Two hundred million poor people in Africa are at risk from crop failure and hunger from CMD. It has destroyed 150,000 hectares of cassava in Uganda since the early 1990s. Over the seven years to 1998, DFID and other donors had invested over £3 million to combat the disease with an estimated gross monetary benefit of about £80 million. It was estimated that by 1998, CMD-resistant varieties were planted on 95,000 hectares in East Africa, which with an average yield increase of 10 Mt /ha was equivalent to950 $x10^3$ Mt of additional cassava production (DTZ Pieda consulting, 1999).

It has been estimated that the cassava yield loss to CBSD is 18-25% where the disease is prevalent. In Malawi, this translates to an annual loss based on farm-gate prices of US$ 5-7million (Gondwe *et al*, 2003). The potential net benefit from DFID-funded research on this constraint in East Africa is immense.

Sweet potato is a vital crop in the Lake Victoria zone of East and Central Africa where it is largely consumed by the poorer sector of both rural and urban populations. CPP and CPHP projects have been active in this region in promoting sweet potato production and post-harvest innovations systems, including orange-fleshed and virus resistant sweet potato varieties. In Central Uganda, the cost benefit to the farmer of producing sweet potato was estimated to be up to 1:2.1, while the cost benefit of producing vines for planting was slightly greater at 1:2.4. Investing in storage structures so that sweet potato tubers could be stored until times of shortage and increased market value provided the greatest cost-benefit ratio (up to 1:15.9) while investing in processing sweet potato to flour showed a potential cost benefit of 1:3.7 (R8273, 2004). It was also estimated that through CPP project R8040, access to improved sweet potato varieties had been improved for about 40,000 farmers. Consequently, on-farm productivity was at least tripled. A conservative estimate was that over 34,000 metric tons of improved sweet potato worth over UK £1,200,000 was produced in the project area during the lifetime of the project (R8040, 2004). Sweet potato virus disease (SPVD) is one of the most important constraints in Southern Uganda and North Western Tanzania. Sweet potato is also widely grown in Rwanda and Southern Sudan.

Roots and tubers have not had high levels of pesticides applied on them and so reducing pesticide use has not been the target. Cassava and sweet potato are particularly valued for their tolerance of poor soils and drought. However, land (particularly forest and fallow) is often cleared for yam production. It has been shown that yam productivity has declined in some areas and production has only been maintained through increasing the cropped area.

Reducing the pest incidence and increased productivity would enable the current demands to be met from smaller areas. Alternative cropping systems can also contribute to improving soil fertility.

Smallholder farmers rarely use purchased inputs such as fertilizers and chemical pesticides. Since most of the CPP activities are concentrated on disease resistant varieties and cultural practices to control diseases, the chance of adoption are much greater. The development of sustainable cost effective local systems for the production and distribution of clean planting materials will enhance the adoption of resistant cultivars thereby increasing the productivity. The use of orange flesh, ß-carotene-rich sweet potato will address the vitamin A deficiency issues faced by mothers, babies and children in some regions. Reduction in post-harvest losses will increase the availability of food. Some targeted interventions such as the sweet potato virus disease control project worked directly with small scale farmers mostly women including refugees, HIV/AIDS affected families and farmers in refugee affected areas. Planting materials of superior varieties have also been provided to such groups. Thus, the various outputs of the CPP program will no doubt benefit the relatively poor sector of the community contributing to food and nutritional security. The cash income generated through the sale of these crops will also contribute to poverty alleviation.

4.7 Constraints to Production and Utilization of the Study Crops

The stakeholders consulted were asked to identify the critical constraints to production and utilization of the crops under study. Although they were asked to rank these constraints in order of importance, due to lack of consistency in the response it was difficult to harmonize the responses. Thus, the constraints identified by the various respondents were combined with those identified by the study team through reading project reports and other documents, and are summarized in the boxes below. It should be noted that some of the constraints listed are context-specific and under different circumstances might be regarded as advantageous.

Box 2. Constraints to Production and Utilization of Cassava

- Low nutritional value (just carbohydrate, little protein/vitamins so need supplementing for a balanced diet)
- Shortage of (good quality) planting materials (low multiplication ratio),
- Planting material is bulky (need to plant large sticks to ensure survival, but these are more difficult to transport and store, and bigger sticks = lower multiplication ratio)
- Lack of appropriate storage methods for planting materials (need to keep planting sticks viable over the dry period from harvest to planting),
- Break-down of tolerance/resistance to CBSVD,
- Cassava mosaic and other pests and diseases,
- Lack of early-maturing or high-yielding varieties suitable for intercropping,
- Lack of varieties well adapted to local conditions and growers/consumers tastes,
- Lack of useful, high-starch content varieties for specific uses (e.g. Alcohol production)
- Post-harvest physiological deterioration (short fresh storage life),
- Processing constraints:- varieties unable to be pounded into "fufu"; high dry matter for processing into "GARI"; - high starch content for specific use (alcohol production); a range of preference by end users (easy peeling, attractive skin colour); costly processing methods (peeling and drying)
- Processing can be long and tedious and expensive (time consuming) – particularly with hard/bitter/high-cyanide varieties,
- Shortage of cheap and reliable processing equipment (chippers, driers, mills)
- Information/guidelines on quality control, packaging, shelf-life, nutritional quality of processed products not widely available or enforceable
- Poor infrastructure to deliver to the market.
- Perceived as a poor mans crop in many regions so often commands only a low price
- Market options often limited - sometimes to a single form of traditional use, where poor quality and low processing efficiency restrain market expansion.
- Most traditional cassava markets are confined to a few products, can only absorb given quantities of roots, and have relatively low demand elastic ties
- Limited resources for investment and poor orientation of research and development institutions to cassava,
- Policy and institutional environments are not sufficiently conducive to cassava development.

Box 3. Constraints to Production and Utilization of Sweet Potato

- Low multiplication rate (in comparison to cereals)
- Shortage of methods for preserving planting materials over the long dry season,
- Shortage of varieties that are high yielding, early maturing, drought-tolerant and high in dry matter and beta-carotene content,
- Pests (weevils & nematodes), diseases and viruses: Root quality, quantity and storability are affected.
- Inadequate knowledge to identify, understand and manage options for weevils and virus diseases.
- Perpetuation of viruses and diseases in the planting material result in phytosanitary restrictions on germplasm movement,
- Low dry-matter varieties are bulky, readily damaged, tend to shrink and easily perish after harvest making them difficult/expensive to transport.
- Expensive processing equipment (chipping machines)
- Short shelf life of tubers after harvest,
- Post-harvest losses due to poor packaging and transport,
- Poor access to information on alternative recipes, and poor knowledge on quality chip production,
- Irregular supply- inability meet the large and regular demand,
- Field and storage pests.
- Stigma of being "poor people's food" in some areas so does not command a sustainable price.
- In SSA, generally grown by resource-poor farmers who cannot articulate research/ development needs,
- Has tended to be regarded as the poor relation compared to cassava and yam in SSA, so until recently has attracted little interest from policymakers or national/international programmes
- High per-unit cost as a raw material (especially low-dry matter varieties)
- Market for processed products not well developed so products don't always command a good price.

Box 4. Constraints to Production and Utilization of Yam

- Shortage of (good quality) planting materials, and methods for rapid multiplication of quality seed yams, (absence of a formal seed system in most areas)
- Vegetative propagation results in perpetuation of pests and diseases in the planting material – leads to phytosanitary restrictions limiting germplasm exchange,
- Planting material is bulky and difficult to store and transport – so is expensive
- Lack of suitable varieties –early and late maturing varieties for different cropping systems or for export market,
- Scarcity of flowering, poor synchronization of male and female flowering phases, lack of efficient pollination mechanisms, and lack of knowledge of the genetics mean genetic improvement (by breeding) is very difficult and slow,
- Relatively expensive crop to produce – high labour requirement for land preparation, planting, weeding, staking and harvesting,
- Requires staking (costly) in many areas
- Easily damaged during harvesting and transport – leads to rotting
- Poor storability of the preferred varieties (e.g. Puna in Ghana).
- Lack of knowledge on affordable and reliable storage options.
- Field and storage pests and diseases.
- Long dormancy (with respect to cropping cycles)
- Poor infrastructure and poor access to markets,
- Generally neglected by policy makers.

As might be expected, the constraints are broadly similar for all three crops and only differ in their detail. They can be separated into several broad classes:

- Germplasm health & supply of planting material
- Crop management & crop protection, pests and diseases
- Crop improvement (breeding and selection, including participatory methods)
- Post-harvest handling, storage and marketing
- Processing technologies, value-addition and alternative uses
- Improving methods for disseminating and promoting technologies/varieties/procedures
- How to provide a conducive/enabling environment (socio/cultural/financial) for resource-poor farmers to grow the crops sustainably/profitably.

These constraints are also reflected in the research priorities identified by the various stakeholders in section 4.9 below.

Issues around germplasm health and the supply of sufficient and appropriate healthy planting material were common to all three crops and were identified and researched by several of the projects. All three crops are vegetatively propagated (true seed is rarely

sown for any of them) and so are prone to the carry-over and perpetuation of pests and diseases in the planting material. For cassava and yam the problem is compounded by the relatively low multiplication ratios and the bulkiness of the planting material, while for cassava and sweet potato part of the difficulty is in storing the planting material over the dry season until the next rainy growing season. Based on the outputs from some of the projects, systems for the production and storage, either at the small-scale or the commercial scale, of more and better quality planting material have been identified and have the potential for having big impact in increasing production and productivity if promoted appropriately.

Both cassava and sweet potato were introduced into Africa relatively recently (about 300 years ago) and they are probably more likely to succumb to epidemics of new-encounter diseases and pests because the crops have relatively narrow genetic diversities in the region. Some of the projects have sought to gain a better understanding of some of these new-encounter diseases (e.g. CMD, CBSD and SPVD), and from this methods for delaying disease spread or mitigating the effect of the disease have been developed.

Traditional methods of plant breeding have also been effective with cassava and sweet potato in producing varieties resistant to the main diseases and pests. However, these varieties have not always been taken up widely because often they are not adapted to the local environments or to local peoples' tastes. Adopting a more de-centralized and participatory approach to plant breeding and selection and with the inclusion of more germplasm from the centres of diversity of cassava and sweet potato appears to be producing new cultivars with more of the locally desired characteristics. There is huge potential for greater expansion of sweet potato production in Africa (particularly West Africa) if orange-fleshed (high in ß-Carotene) varieties with resistance to the local strains of viruses and diseases that are adapted to local conditions and are acceptable to local growers and consumers can be developed.

The centre of diversity for the white yam (*Dioscorea rotundata*) is in West Africa, but the continued selection pressure exerted by man has resulted in the species generally losing the ability to reproduce readily sexually by true seed. With the increasing human population in West Africa, there is a need for yam varieties that are more suited to a more intensive, less labour-demanding, system of production. Again, the decentralized, participatory approach to breeding and selection using varieties and conditions demonstrated to favour the production of true seed, shows good potential for producing new varieties that can be propagated more rapidly, have good tolerance to the main diseases and pests, and are acceptable to the local growers and consumers.

4.8 Priority Setting

The CPP, CPHP and PSP had flexible but systematic approaches to identifying needs, demands and opportunities for research for poverty reduction. Initial priorities were set by the then ODA, through the Renewable Natural Resources Research Strategy (RNRRS) 1995-2005 (The "yellow brick"). The initial priorities for CPP were identified by the "Integrated Pest Management Strategy Area (IPMSA) which came to an end in 1995. In 1997, DFID published the white paper on "Eliminating World Poverty". At same time CPP also commissioned an output to Purpose Review of the CPP Strategy (completed in January 1998). This review assisted in identifying priorities in an objective manner, and had a strong influence on the strategy followed by the programme. This review also

resulted in the clustering of projects along the thematic lines leading to a coherent approach to addressing researchable issues affecting the poor.

The research activities of CPP focused on food security issues, research into virus epidemiology, IPM development and promotion, innovative promotional strategies and private sector linkages – all aimed at developing pro-poor knowledge and technologies. The programme also realized the limitation of the three year project cycle. As a result, many projects have had a second or third phase. At the end of a 3 year project, the CPP would take stock of the process and progress of the project including quality of outputs and how the general enabling environment may have changed. With support from an advisory committee and programme cluster advisor the management team would then take a decision as to whether or not to fund additional work in the area. In addition the CPP management also sought to identify needs assessment studies undertaken by national governments and/or regional bodies, NGOs and donors and utilized these information in determining project priorities. This not only provided sources of baseline information, but also independent expressions of demand.

The close working relationship with the on-going national and regional programs activities of the International Agricultural Research Centres (IARCs) and networks (e.g. PRAPACE, EARRNET, SARRNET) also helped the CPP to focus on the identified needs- i.e. pursuing a demand driven research agenda. The available evidence indicated that there is a great degree of congruency between the priorities identified by the various stakeholders and research agenda pursued by the CPP projects. Most projects funded through CPP were competitively tendered and those that were not i.e. follow-on projects or unsolicited proposals were scrutinized by management, advisors and the Programme Advisory Committee (PAC). This procedure to an extent ensured that the best and credible organizations were selected to implement the various projects. However, it was noted that, for the root and tuber crops cluster of projects (i.e. The projects targeted in this study) the CPP cluster adviser and the social development adviser were both funded on CPP project work. Although there was no evidence of bias in favour of the projects the advisers were involved with (in one case the opposite might be true), because of the potential conflict of interests for these advisors, it might in future be more appropriate to use completely independent advisers. However, it may not always be possible to find independent advisers who have a sufficient level of expertise and understanding of the current research and development agendas.

Similar observations were also made on the activities and research projects commissioned through the CPHP. Here the priorities were again guided by the RNRRS, country Framework Documents (1995-2000), Needs Assessment Projects (1995-1998); Issues Papers, and Regional Strategies (2002). Attempts were also made to share findings and lessons between the programmes. The annual meetings of the programme managers, DFID's natural resources advisers' conference, and jointly managed themes workshops also facilitated the information sharing. Another important feature in the CPHP development was the adoption of "partnerships by innovation" which enabled the programme to look beyond knowledge and technology. The innovation system perspective should enable the programme to focus on innovation i.e. giving due consideration for knowledge generation, dissemination as well as utilization.

4.9 Priority Areas for Future Research

The projects in the roots and tubers sector funded through the RNRRS were supposed to be demand driven and to target some of the important researchable constraints to the production and utilization of the crops. One of the aims of this study was to assess what the important research constraints are now; this might help inform the priority setting for the new DFID research strategy, and could indicate if the projects funded under the RNRRS had had some impact. The various stakeholders consulted were asked to identify the research areas they felt currently required greatest attention. Unfortunately, again, the responses were too few and too disparate to be able to rank the identified research areas in order of importance. Thus, the responses from the stakeholders were combined with information gleaned by the study team through reading project reports and associated documents, and the results are summarized in Table 2.

It is evident from Table 2 that the priority research agenda includes a range of topics in the areas of crop improvement, crop management and post-harvest technologies, and it is not surprising that many of these research priorities address constrains identified in section 4.7 above. It is also worth nothing that some are specific to a country, and some cut across the region. Crop protection and post-harvest research are identified as crucial areas for continuous further investigation in all three crops. However, as a number of other agencies are also working in the same areas, future R&D investments should be chosen in consultation with the other players to avoid duplicated effort and ensure optimum synergies and maximum impact. Account should be taken of the potential for "scaling out" and "scaling up" i.e. maximizing the spill-over effects.

4.10 Enhancing the Impacts of Project Activities

As mentioned earlier in this report, the three year project cycle and lack of an explicit strategy to disseminate and promote the adoption of the knowledge/technology generated through the projects made it impossible for the team to reliably assess and quantify the developmental impacts of the programmes/projects. However, a question was posed to the various stakeholders consulted asking them to indicate how the impacts of the projects'/programme's output be enhanced. The responses received are summarized below:

- Rapid multiplication and distribution of varieties/seedlings that are selected from on-farm trials (cassava)
- Enhancing the co-operation between district councils and R&D community (Tanzania)
- Improved links between plant breeders and market requirements/needs
- More efficient systems for informing growers about improved varieties, integrated crop management practices and storage and processing methods
- Market promotion for sweet potato products (Kenya)
- Credit for growers to sustainably produce, store, and market quantity and quality of seed yams
- Integrating knowledge management initiatives in all projects
- Improved communication between the major donors supporting root and tubers research
- Creating a structure and mechanism to link researchers and policy makers
- Better linkage with and better management of the sub-regional networks to ensure that they have a coherent strategy to draw out and promote lessons from the various projects and programmes.

Table 2. Research Priorities for Cassava, Sweet potato and Yam

Crop	Research Priorities
Cassava	• Identification of a wider range of sources of resistance to Cassava mosaic viruses including vector (white fly) resistance. • Improving the fresh shelf-life of cassava • More work on participatory plant breeding- comparative analysis with conventional breeding methods. • Studying the effects of environment on development and expression of root necrosis (CBSD) • Alternative use of cassava leaves and tubers e.g. for livestock rations, • Breeding early maturing varieties with high dry matter and less cyanide content, drought tolerant, suitable for piece meal harvesting, CMD and CBSD resistance with good eating/processing qualities adapted to local condition.
Sweet Potato	• More work on PPB - Validating and dissemination of appropriate clones - Comparative analysis with conventional breeding methods • Breeding/selection for resistance to *Blosyrus* spps (another weevil spps) • Research on cultural practices to control sweet potato weevils • Alternative propagation methods (propagation from storage roots) • Agronomic research/cropping systems research – Intercropping with pigeon peas • Survey of occurrence of viruses to breed for virus resistant varieties (Ghana)
Yam	• Identification and characterization of genotypes with better agronomic qualities (including better storage), pests and disease resistance, and reliable flowering/seed-setting for inclusion in breeding programmes • Breeding/selection for better tuber quality, acceptability (both growers and consumers), suitability to agro-ecologies and cropping systems (short or long duration; short or long dormancy); short stature, good storage and processing quality. • Identify methods for improving fresh shelf-life for both seed and ware yams, including cheep/secure system of storage • Bio-fortification - develop crossing populations and screen germplasm for accessions with increased levels of micro-nutrients e.g. Carotinoids, iron and zinc • Investigation into cropping systems that maintain/increase soil fertility (e.g. legume intercrops/cover crops) that farmers are willing and able to adopt • Investigation into viable alternatives to the traditional methods of staking. • Assessment of national genetic diversity to supplement with appropriate varieties from outside for breeding and selection, • Investigations into how establish a more formal, secure and sustainable seed yam supply (and certification) system, and how to promote adoption of such a system.
Cocoyams	• Breeding/selection of high yielding, pest and disease resistant varieties that are suitable for the (inter)cropping system.
Source: Survey conducted by Study Team	

From the various suggestions it is clear that adopting an '*Impact Pathway (chain) Perspective'* to research planning and orientation (Hardwich and Springer-Heinze, 2004), as well as promoting better linkages and co-ordination among the various actors, and improved knowledge sharing could enhance the impact of the projects and programmes.

4.11 How to Enhance the Efficiency and Effectiveness of Project Management

A number of suggestions were also made by the various stakeholders contacted to improve the efficiency and effectiveness of the current project management. These include:

- Making the duration of the projects longer (5 years) and provide adequate funding for project leaders/managers to be able to concentrate on managing project work rather than worrying about how to fund the next phase of the work. Larger and longer term programmes would allow for economies-of-scale, and longer term planning that could lead to measurable developmental impacts.
- Paying project funds in advance and/or establishing a revolving fund arrangement rather than arrears would help – especially projects led by developing countries.
- Incorporating more regular external project, progress monitoring reviews that aims to be constructive rather than critical. Not a post-mortem but critical review at key stages so that the suggestions can be incorporated in the project implementation (but it was not clear how such reviews should be funded without taking away funds from the research itself).
- Developing a baseline-data set at both output and purpose level and an effective M&E system that would allow one to trace the output, outcome and subsequent developmental impacts of the projects and programmes (though again, would researchers accept the consequence that this would probably mean there was less money for research?).
- Raising the awareness and visibility of the programmes and their activities at the national level (the regional coordinators are doing this at the regional level for [primarily] the CPHP).
- Facilitate the archiving and mechanisms for making project reports and other dissemination outputs more widely available from collaborating national organisations.
- Review the structure of the project final reports so as to provide additional information to assess the performance, impact as well as the lessons learnt.

5 Conclusions and Recommendations

5.1 Introduction

Roots and tubers are amongst the most important food security crops in Sub-Saharan Africa, representing a vital source of calories for more than 400 million Africans. Most of the world's yams are produced in West Africa where they are a high value food staple and also can be readily sold for cash income. Africa's more than 100 million tonnes of cassava also represents more than half of the world's total and is grown throughout the humid and sub-humid zones in SSA. Sweet potato is most important in the Great Lakes areas of East and Central Africa and also an important source of livestock feed. The importance of these crops is highlighted in the national strategies of the case study countries. For example, in Ghana since 1995, the national strategy is to produce all four crops (cassava, yams coco yams, and sweet potato) in more than sufficient quantities at all times to satisfy human and industrial requirements with emphasis on food security and poverty alleviation. In Nigeria, it is a policy requirement that all bread contains at least 10% Cassava flour as a means of reducing dependence on expensive imported wheat flour.

Since 1995, the RNRRS programmes have commissioned over 30 projects to address the constraints to production, productivity and utilization of root and tuber crops in Africa (cassava, sweet potato and yam). This study was commissioned by CPP to review and synthesize the outputs and lessons learnt from these activities. In addition to the available secondary data, field visits and questionnaire based surveys were conducted to collect primary data to address the terms of reference provided. The results and key conclusions are summarized in the following sections.

5.2 The Major Outputs of the Programmes

CPP projects are conducted through partnerships with a number of stakeholders. Such collaborations take various forms including research, provision of advisory services, training, and documentation and dissemination of practical experiences and good practices. The major outputs of CPP programmes are grouped under six categories namely: technology/knowledge generation, capacity building, publications, advocacy/policy dialogue, technology transfer, and established linkages and products. These are the results of the joint efforts between the project staff, and their national and regional collaborators.

- The programme has made a number of contributions to various aspects of roots and tubers innovations in the case study countries. These include: release of a number of cassava and sweet potato varieties (Virus resistant sweet potato varieties, virus resistant cassava varieties high yielding B carotene sweet potato varieties); better understanding of the causal organisms, vectors, bacterial and viral evolutionary changes; better crop management practices (integrated crop management practices, phytosanitation procedures), methods and procedures (participatory breeding approaches, improved techniques for disease diagnosis and assessment, screening techniques for assessing resistance to nematodes, cost effective sustainable systems for multiplication, virus identification procedures), information on factors influencing adoption of new technologies (both varieties and crop protection technologies) and their economic impacts, farmers decision on cassava varieties; as well as post-harvest technologies (diversified products, market access, food safety and quality). These innovations have led to increased production and productivity of roots and tubers in the case study countries as well as other countries in the African continent.

- The projects have contributed to both long-term training (M.Sc. and Ph.D.) as well as short term skill building, in production and utilization of roots and tubers. The training activities covered scientific and extension staff, farmers, NGOs and other civil society organizations. There is considerable evidence to show that the programme has made conscious and systematic efforts to build capacity of the various stakeholders. The participation of school teachers, extension staff, farmer facilitators, and NGO staff in the training activities contributes significantly through the multiplier effect. In a number of cases, considerable resources were devoted to training materials' development.

- The projects have also made a limited contribution to institution building in terms of provision of hard wares and equipment.

- Considerable efforts were made to publish and disseminate the findings of the various projects. Publications were in the form of journal articles, conference papers, conference proceedings, reports, working papers, leaflets, manuals, internal reports, posters books and press items catering for a wider set of audience. A fair number of peer reviewed publication is an indication of good quality research. Therefore it could be concluded that the projects have generated a number of national and regional public goods, which will contribute towards pro-poor innovations. Systems to store and make these publications more readily available locally need to be implemented.

- The projects have also contributed to technology dissemination. The approaches used have included technology transfer workshops, farmer field days, various publications, posters, videos, broadcasts in television, seminar presentations, plays, poems, manuals, hand books, news paper articles conference reports/proceedings, training courses, extension leaflets. In addition, working with farmer groups and active farmer involvement in field activities contributed to farmer to farmer extension of knowledge and technologies. In a number of projects, the FFS approach has been used as an approach for technology dissemination. It is worth noting that the effectiveness, efficiency and suitability of FSS as an alternative approach to technology dissemination are being questioned by many development practitioners. The evidence is inconclusive. Therefore it is worthwhile to undertake a thorough analysis of the experiences before undertaking any new projects in this area.

- Almost all projects have had close collaborative working relationships with the national root and tuber programmes. In addition, linkages and partnerships have been established with International Agricultural Research Centers (IITA and CIP); sub regional networks (EARRNET, SARRNET and PRAPACE), non governmental organizations (World Vision International, Norwegian Peoples Aid (NPA), GTZ sedentary farming project in Sunyani); Vitamin A initiatives for Africa (VITAA), FAO global IPM facility, as well as a number of community based organizations. These linkages have contributed to the dissemination of technologies to the target groups and also facilitated 'scaling up' and 'scaling out' of selected technologies.

- There is also evidence to show that a number of other development practitioners are also involved in supporting the roots and tubers R&D activates both at bilateral and sub-regional level.

5.3 Relevance, Effectiveness, Programme Efficiency and Impact

- It is worth noting that almost all projects achieved their stated objectives and direct outputs. Thus one could conclude that nearly all the projects have been effective, but it has not been possible to assess their contribution to developmental impact.

- Quality of output is often assessed though peer review process. As a regular practice, all projects were reviewed by an external reviewer. In most cases, the reviewers were satisfied with the quality. In some cases issues were raised concerning the data. In many cases, suggestions were made for follow up. From the available documents, it is difficult to assess whether these recommendations have been implemented. For example, in the project R7492 "Promotion and technical support for methods of controlling white fly borne viruses in Sweet potato in East Africa", the reviewer was concerned about the results based on a single season experiment. Similarly with respect to R7565 "Participatory breeding of superior, mosaic resistant cassava", the reviewer also commented about the lack of comparison with the existing varietal developmental processes.

  Another example is R7796 "Cassava brown streak virus, virus isolates and the application of the diagnostic test", where the reviewer made a number of comments related to the quality of research. The reviewer also questioned the long term sustainability of RT-PCR based diagnostics within the East/Southern African environment in view of the high cost of this method (vs ELISA). Finally, the reviewer recommended that the team should aim for "a clearly presented protocol (Laminated/bored perhaps) describing not just summary steps but full details of the technique including methods for producing reagents, storage conditions, details of specialist chemical suppliers, basic information on the RT-PCR approach and trouble shooting techniques. This should be combined with training courses".

  Although in the latter example, training in PCR diagnostics for CBSV subsequently was provided to researchers at Mikocheni Agricultural Research Station in Tanzania, it was not always clear from the available reports what steps had been taken to address the concerns of the reviewers. However, not withstanding this, the projects resulted in a number of peer reviewed publications. This is an indication of the high quality of research conducted under this programme.

- Since neither the programmes nor most of the projects made much attempt to identify, quantify and document the costs and benefits associated with the projects, including the costs borne by the collaborators, it was not possible to assess the efficiency of the programmes in terms of costs and benefits.

- In one form or another, the programmes/projects focused on the constraints identified by the broad categories of stakeholders. This suggests that the projects undertaken were relevant to the needs of the various end users and there was no evidence that they were directed by supply driven agendas?

- Because of the relatively long growing season for most of the root crops (in comparison to other crops such as cereals), and given the differences in conditions from one growing season to the next in SSA, it would be unreasonable to expect a three year research project to address all the issues that will enable the poor to benefit from the

improved management of pests, diseases, and crop varieties. This type of work with root and tuber crops often requires replication over several seasons to develop clear conclusions. A number of projects were aimed at diagnostic research to understand the nature and severity of the problems and to develop methods and techniques for the validation of existing knowledge. The general arrangement was that if it could be well justified, then a project could be extended by up to a further three years to provide management with the opportunity to review the effectiveness of the project as well as to make necessary modifications. Although there were a number of linked projects, no explicit mechanisms were put in place to follow up beyond the direct output. However, since many of the projects focused on disease resistant varieties and production technologies, the chances of adoption are much greater. The development of sustainable cost effective local systems for the production and distribution of clean planting materials for all three crops should be readily adopted if promoted appropriately, and will have a major impact in increasing productivity. Promotion of orange-fleshed (ß-carotene rich) sweet potato will address vitamin A deficiency. In some cases, there is evidence that the projects have worked very closely with the marginalized and vulnerable groups. Thus, one can conclude that the programmes had direct impact in poverty reduction at the people level, effectively contributing to food and nutritional security of the most vulnerable groups.

- The programmes and projects had very limited roles in policy dialogue and policy formulation. Available evidence indicates that in some cases activities were subsequently expanded by IARCs and other R&D practitioners working with roots and tuber crops. However the projects/programmes played a major role in highlighting the importance and seriousness of some constraints, making them high priority on the research agenda of other partners/agencies.

5.4 Constraints and Research Priorities and Enhanced Impacts

From the available information there is enough evidence to show that the programmes had made every effort to identify priorities based on various needs assessment studies. In a number of cases they have also consulted the regional and national partners. However, it was not possible to identify the explicit criteria used in this final selection of the projects. The selection of the location to a large extent was determined by the collaborators and in many cases seems to be appropriate. The selection of location also facilitated the “Scaling up” and “Scaling out” out the technologies developed. Multi-country studies also enabled the teams to exploit the available comparative advantage, and the split-over effects of the technologies.

The key constraints to increased production, productivity and utilization of roots and tubers are the declining soil fertility, insufficient and poor quality planting materials, un-suitable varieties for different cropping systems (lack of well adapted varieties); lack of knowledge on pest management, improved processing and market information, post-harvest losses; poor infrastructure; lack of appropriate processing equipment, short shelf life *etcetera*.

Policy and institutional constraints include poor infrastructural facilities, poor access to markets, deliberate policies that inhibit expanded production (ban on the export of yams from some West African countries), weak national programmes for sweet potato in some countries) absence of industry forum, policy neglect (very little interest from a policy markets for crop such as sweet potato), lack of credit, and inadequate multiplication and distribution of planting materials. Thus the intuitional and policy constraints that need to be

addressed are related to input supply (planting materials) and issues related to processing, marketing and utilization of the products.

The priority research agenda for the future include a range of issues in the areas of crop variety improvement, crop management and post-harvest technologies. It is worth noting that crop protection and post-harvest research were identified as priority areas for continuous investigation in all three crops. However, in order to avoid duplication of efforts, priorities for future interventions should be chosen based on consultations with other R&D actors involved in roots and tubers research.

It has been suggested that rapid multiplication strategies, better storage facilities, improved knowledge sharing and better co-ordination and linkage with other actors within the national and sub-regional arena should be encouraged so as to enhance the effectiveness, efficiency and impact of the programme

Since the crop under consideration are largely grown by the poorest of the poor, development of pest and disease resistant varieties, cultural practices (requiring low external inputs), and techniques and approaches to reduced post-harvest losses, and enhanced utilization will certainly contribute to poverty elimination; and food and nutritional security.

5.5 Project and Programme Management

The study team were not provided with information or reports of reviews (annual/mid-term/external) or monitoring and evaluations for any of the projects by the programme managers, so lack of these and of base-line data were identified as critical areas of management deficiency. However, during the final editing of this report mention was made of 'Output-to-Purpose' reviews which may go some way to addressing this deficiency.

The three year project cycle also needs to be revised. It is worth considering long term projects divided into phases. To enhance people-level impact, planning, monitoring, evaluation and impact assessment should be institutionalized from the inception of projects. In a majority of the projects the focus was on knowledge generation. The wider dissemination was left to the other actors. To an extent this approach had limited the potential impacts of the programmes. Therefore, in future project designs more explicit knowledge/technology dissemination and utilization strategies should be incorporated. Again, adopting an Innovations Systems Approach and Impact Pathway Perspective to project design and management could improve efficiency.

Although most of the problem areas addressed by the programmes/projects were in line with the various constraints identified by the stakeholders, better priority setting exercise involving various stakeholder would enable the programmes to identify clearer niches i.e. to work on key constraints that are not adequately addressed by the other development practitioners; which are in line with the expertise and skills available within the various local and UK based institutions.

5.6 Limitations of the Study

Due to the limited time, resources and lack of cost-benefit or impact data, it was not possible for the team to comment on the efficiency of the various projects and to quantify the developmental effects. It may be worthwhile to commission a study to assess the developmental impacts of the different programmes.

5.7 Recommendations:

Throughout the report a number of areas of concern with respect to priority setting, planning, monitoring, evaluation, impact assessment, and project management were identified. However, the key recommendations with respect to future undertakings are:

- Internalize monitoring, evaluation and impact assessment as an integrated part of project planning and implementation. It is imperative to establish baseline data, and continuous monitoring of selected variables to measure and quantify the farm level benefits of project/programme outputs.
- Incorporate explicit strategies for knowledge management, utilization, and dissemination to enhance the developmental impacts of programme activities. Adopting the innovation systems perspective, value chain concept and impact orientation could facilitate this process.
- Ensure multidisciplinary and multi-stakeholder participation (including better involvement of social scientists) in the design and implementation of projects and programmes.
- Sustainability and continuity beyond the project period should be given due consideration.
- Revisit the current three year project cycle and the review process. A longer term perspective, and working on a few selected key problem areas would lead to efficient utilization of resource and enhanced socio-economic impact of the investment.
- Reviews should go beyond looking at the quality of research and direct outputs. A mechanism should be put in place to measure the efficiency and development impacts of the projects and programmes.

All these recommendations can take time and resources to implement effectively. Thus, with only a limited pool of research funds, it will be important to consider the relative cost-benefits in terms of efficiency and research impact of spending the funds on these management/monitoring activities as compared to on the scientific research activities.

6 Annexes

Annex 1 Documents and Information Sources Consulted

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Annex 2 Key Informants/Stakeholders Consulted and Questionnaire Respondents

Table 3. Key Informants/Stakeholders Consulted

Meeting date	Collaborator name	Role	Current organization
18/07/2005	Gibson Richard W	Project leader	UK_NRI
20/07/2005	Donaldson Tim	Programme manager	UK_NRIL
20/07/2005	Kimmins Frances	Programme manager	UK_NRIL
20/07/2005	Richards Wyn	Programme manager	UK_NRIL
20/07/2005	Ward Andrew	Programme manager	UK_NRIL
20/07/2005	Wilkin Karen	Programme manager	UK_NRIL
25/07/2005	Coyne Danny	National Project Collaborator	NG_IITA
26/07/2005	Asiedu Robert	IARC yam coordinator	NG_IITA
27/07/2005	Claudius-Cole Abiodun	National Project Collaborator	NG_IITA
31/07/2005	McNamara Nora	National Project Collaborator	IE_DDS
31/07/2005	Morse Steve	UKl Project Collaborator	UK_Reading
04/08/2005	Danquah OA	National Project Collaborator	GH_CRI
04/08/2005	Moses Emmanuel	CRI root & tuber programme leader	GH_CRI
04/08/2005	Otoo Emmanuel	CRI yam programme leader	GH_CRI
05/08/2005	Maroya Norbert	Regional network coordinator	GH_WASNET
05/08/2005	Offei Sam Kwame	National Project Collaborator	GH_Legon
27/08/2005	Hillocks Rory	Project leader	UK_NRI
05/09/2005	Ewell Peter	Regional Agricultural Advisor	KE_USAID
06/09/2005	Ateka Elijah M	Root & Tuber Researcher	KE_KARI_Biotech
06/09/2005	Githunguri Cyrus	Root & Tuber Researcher	KE_KARI_Katumani
06/09/2005	Kihurani Agnes W	National Project Collaborator	KE_KARI
07/09/2005	Lemaga Berga	Project leader	UG_PRAPACE
07/09/2005	Namanda Sam	National Project Collaborator	UG_CIP
07/09/2005	Potts Mike	Root & Tuber Researcher	UG_CIP
08/09/2005	Agona Ambrose	National Project Collaborator	UG_ Kawanda
08/09/2005	Bua Anton	National Project Collaborator	UG_NAARI
08/09/2005	Mwanga Robert	National Project Collaborator	UG_NAARI
08/09/2005	Omongo Chris	National Project Collaborator	UG_NAARI
09/09/2005	FFS facilitators		UG_Soroti
10/09/2005	Martin Amev	Root & Tuber Researcher	UG_Soroti
12/09/2005	Muhanna Marton	National Project Collaborator	TZ_SRI
12/09/2005	Ndunguru Gabriel T	National Project Collaborator	TZ_TFNC
13/09/2005	Herron Caroline	Root & Tuber Researcher	TZ_IITA
13/09/2005	Kanju Edward	National Project Collaborator	TZ_SRI
13/09/2005	Mkamilo Geoffrey S	National root & tuber programme leader	TZ_Naliendele
23/09/2005	Dadzie Ben	Regional Programme coordinator	GH_NRIL

Table 4. Questionnaire Respondents

Collaborator name	Current organization	Role
Donaldson Tim	UK_NRIL	Programme manager
Ward Andrew	UK_NRIL	Programme manager
Gibson Richard W	UK_NRI	Project leader (x3)
Hillocks Rory	UK_NRI	Project leader
Kenyon Lawrence	UK_NRI	Project leader
Stathers Tanya	TZ_NRI	Project leader
Coyne Danny	NG_IITA	National Project Collaborator
Kihurani Agnes W	KE_KARI	National Project Collaborator
Manu-Aduening Joe A	GH_CRI	National Project Collaborator
Offei Sam Kwame	GH_Legon	National Project Collaborator
Abila Nelson	NG_Abeakuta	Root & Tuber Researcher
Adeleye JO	NG_RTEP	Root & Tuber Researcher
Adeniji Mutiat Olapeju	NG_IITA	Root & Tuber Researcher
Asadu Charles	NG_Nsukka	Root & Tuber Researcher
Issaka Roland Nuhu	GH_SRI	Root & Tuber Researcher
Oluwatayo	NG	Root & Tuber Researcher
Oyebanji Femi	NG	Root & Tuber Researcher
Toukourou Adissa	BN?	Root & Tuber Researcher
Otoo Emmanuel	GH_CRI	CRI yam programme leader
Ntawuruhunga Pheneas	UG_EARRNET	Regional Network coordinator
Maroya Norbert	UG_WASNET	Regional network coordinator

Annex 3 Production Statistics for Cassava, Sweet potato and Yam

Chart 1. Cassava Production in Sub-Saharan Africa

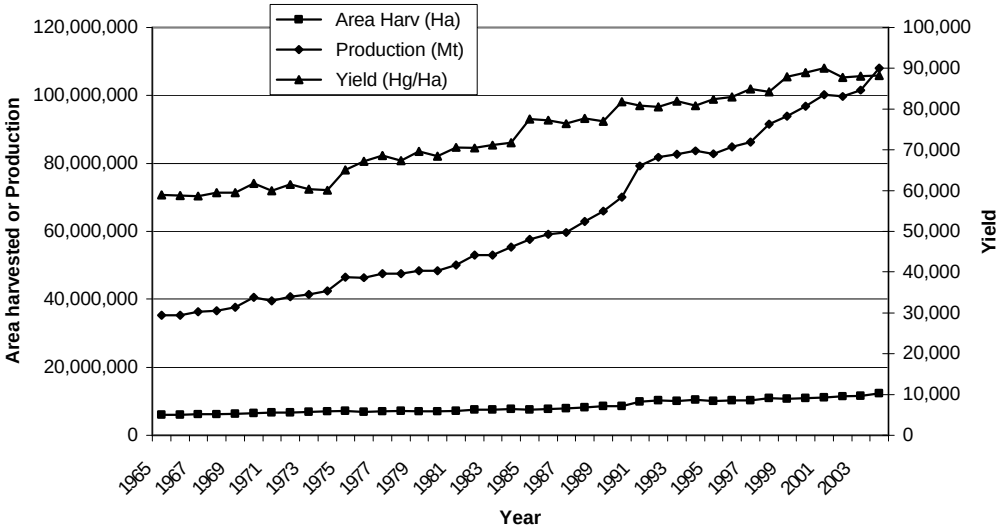

Chart 2. Sweet potato Production in Sub-Saharan Africa

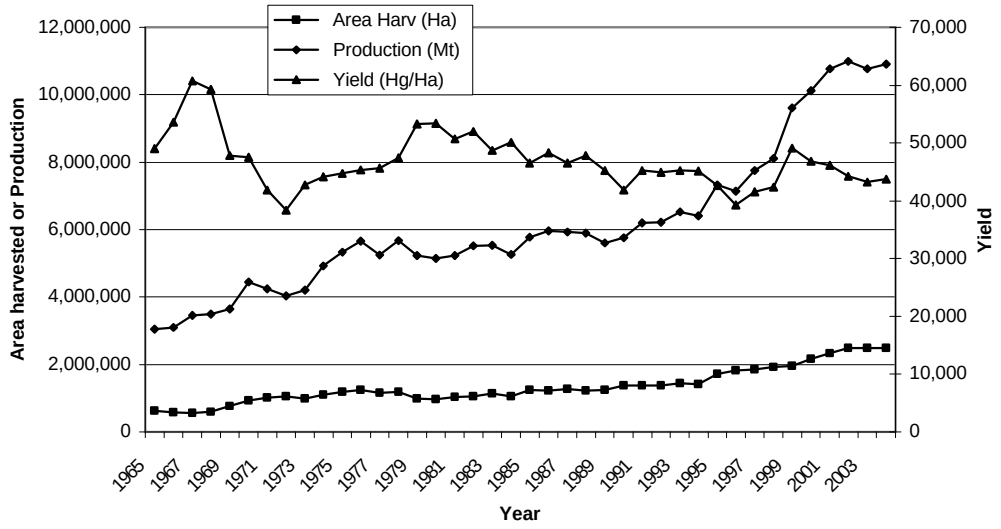

Chart 3. Yam Production in Sub-Saharan Africa

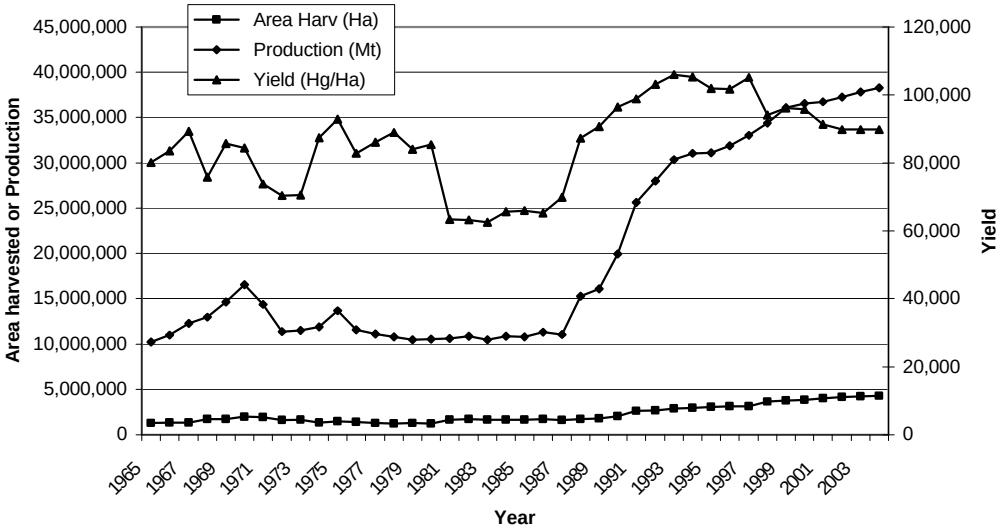

Chart 4. Cassava Production in Ghana

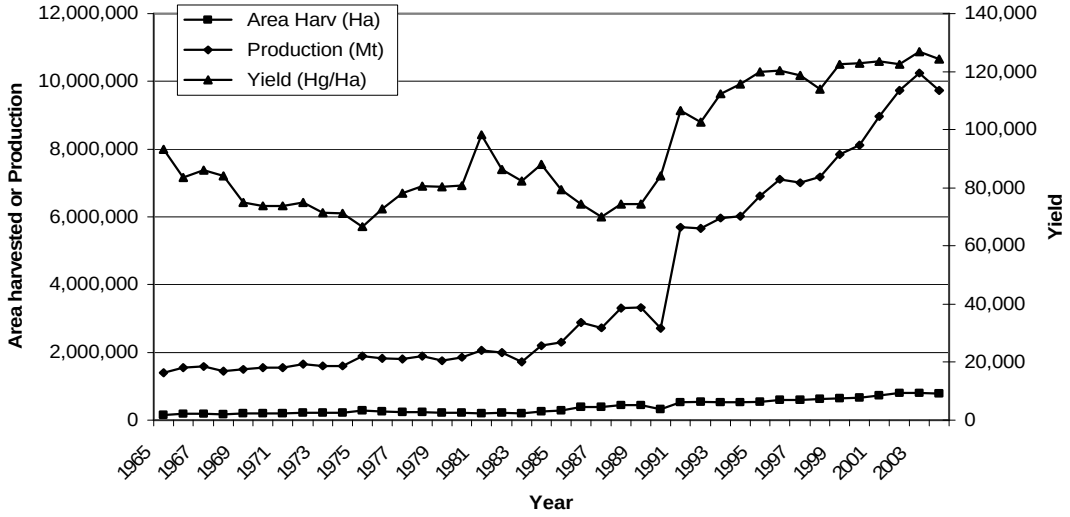

Chart 5. Sweet potato Production in Ghana

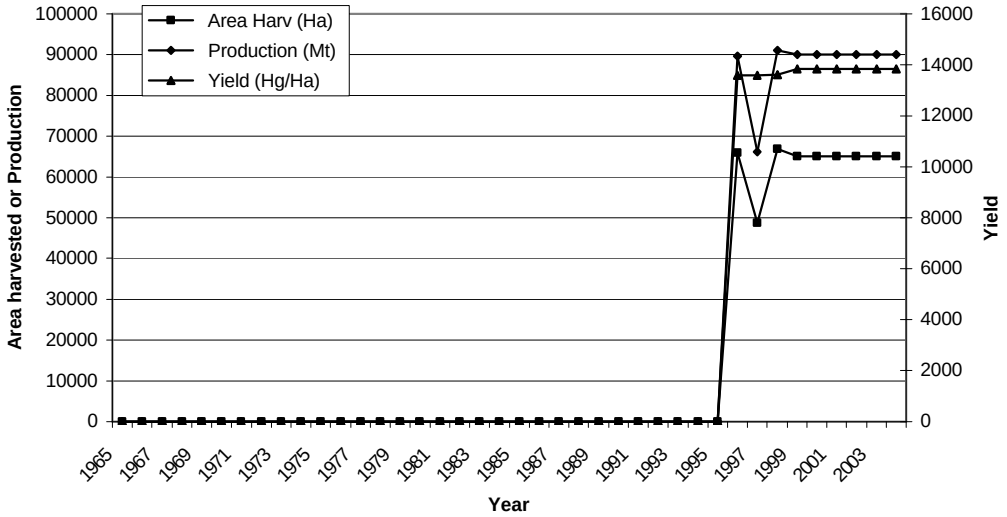

Chart 6. Yam Production in Ghana

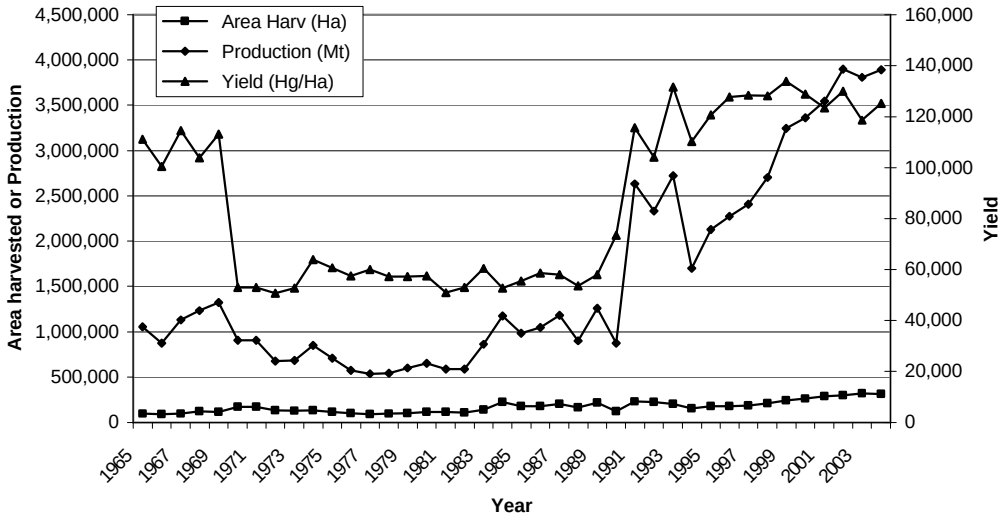

Chart 7. Cassava Production in Kenya

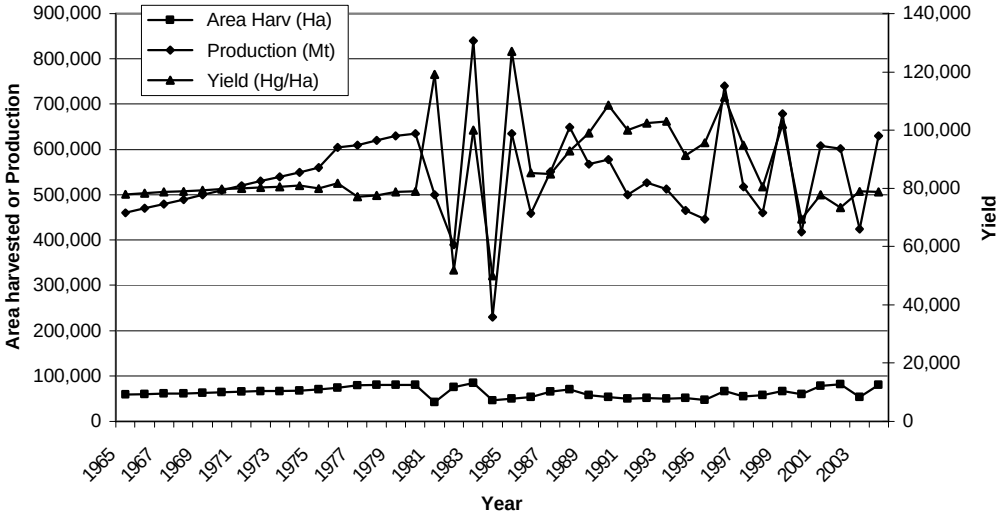

Chart 8. Sweet potato Production in Kenya

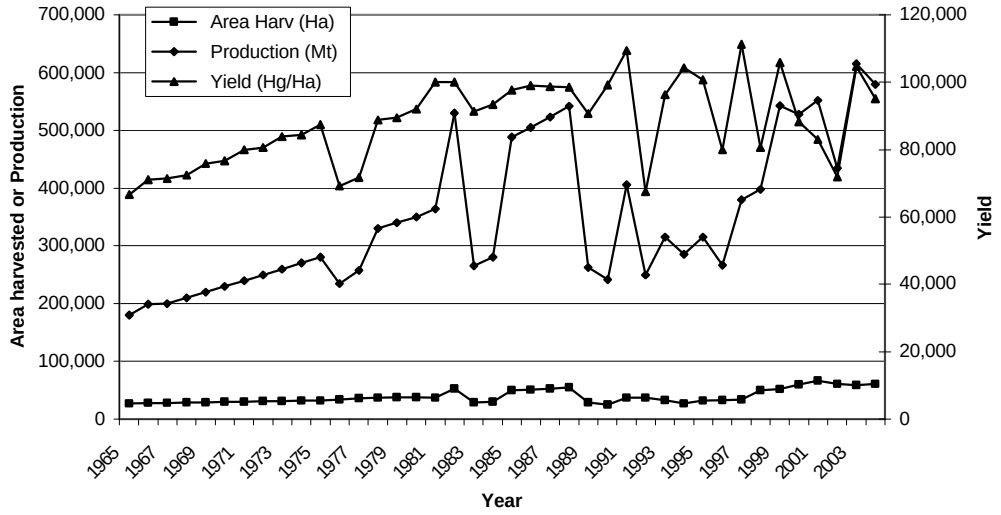

Chart 9. Cassava Production in Nigeria

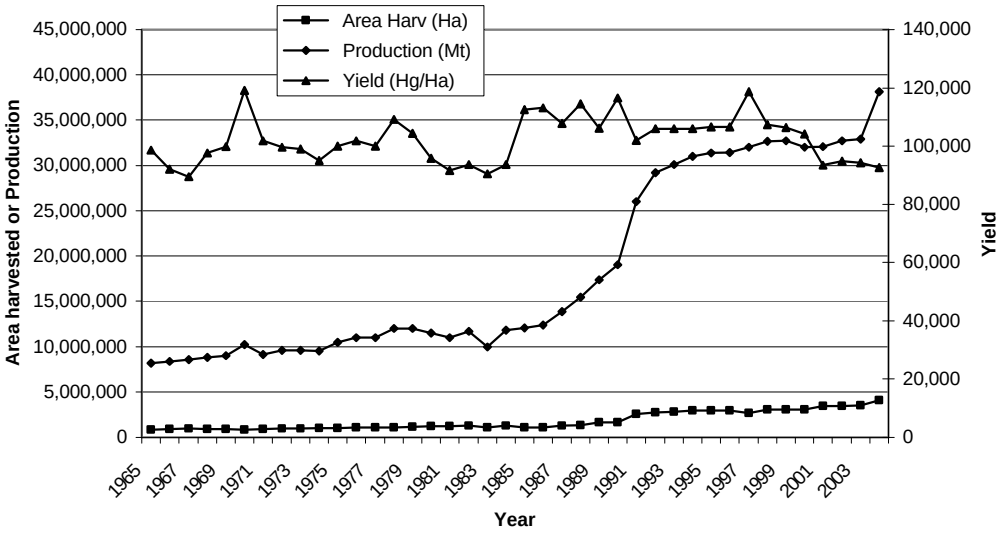

Chart 10. Sweet potato Production in Nigeria

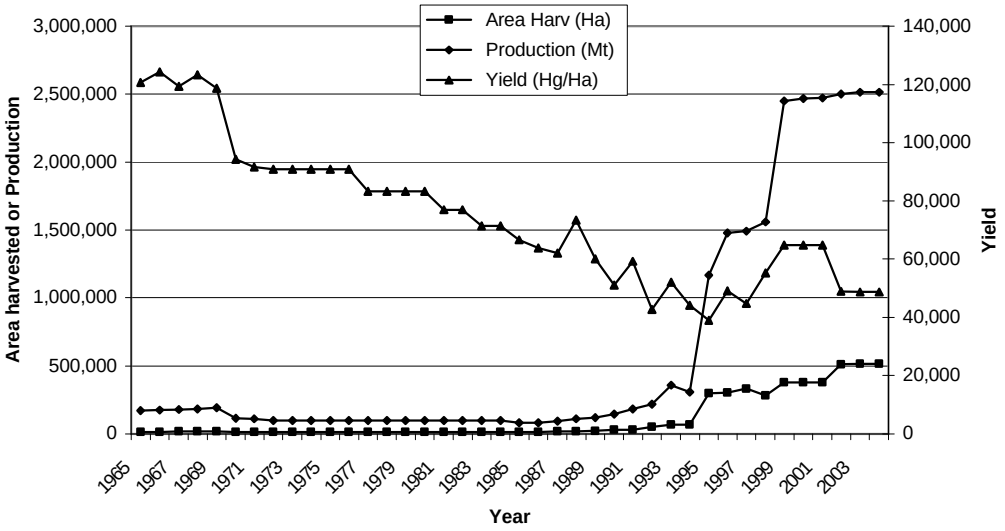

Chart 11. Yam Production in Nigeria

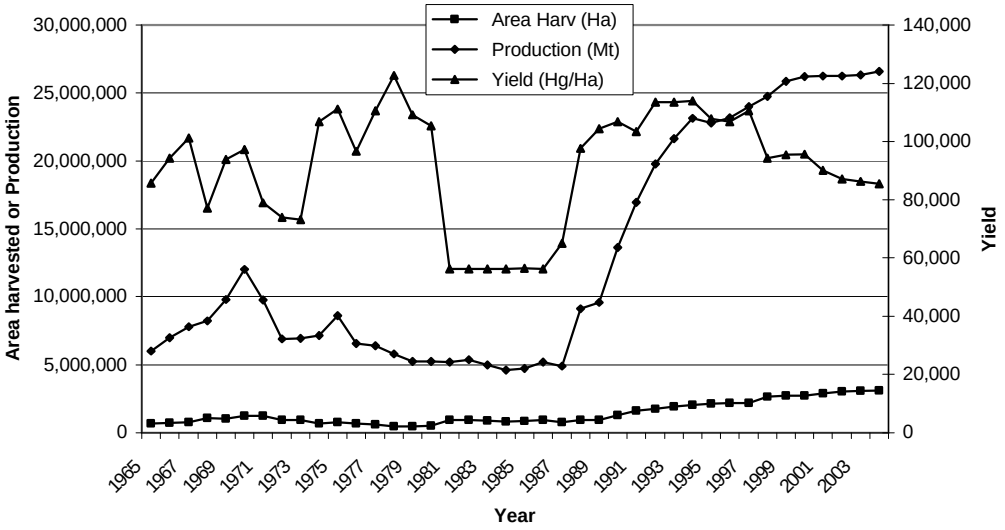

Chart 12. Cassava Production in Tanzania

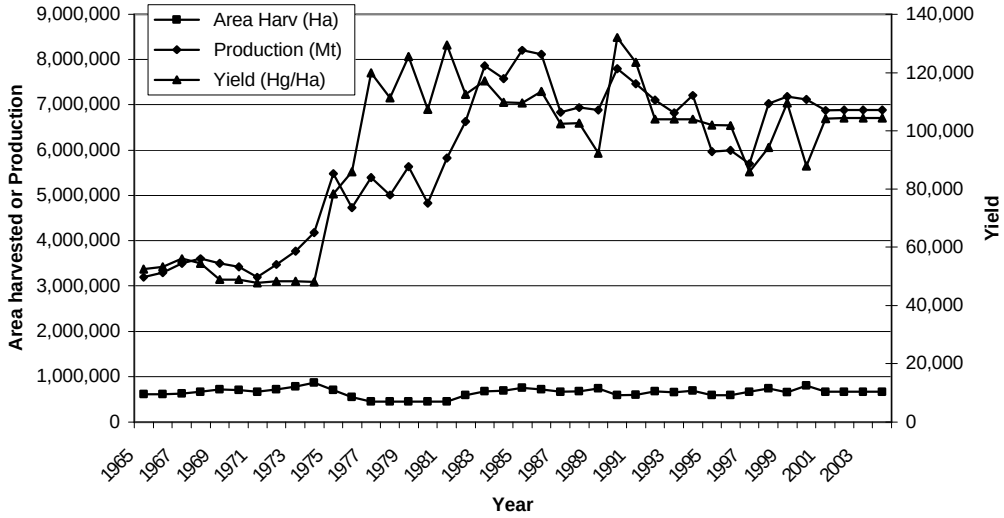

Chart 13. Sweet potato Production in Tanzania

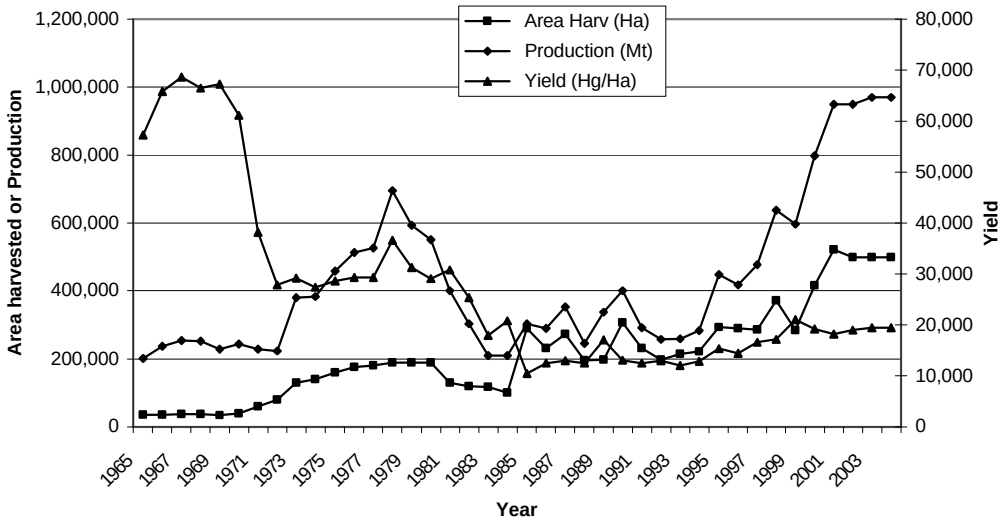

Chart 14. Yam Production in Tanzania

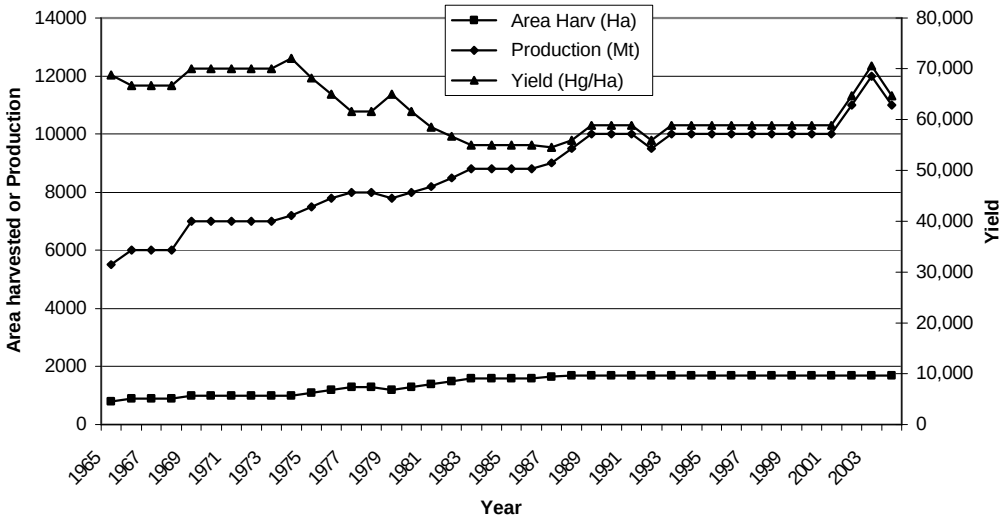

Chart 15. Cassava Production in Uganda

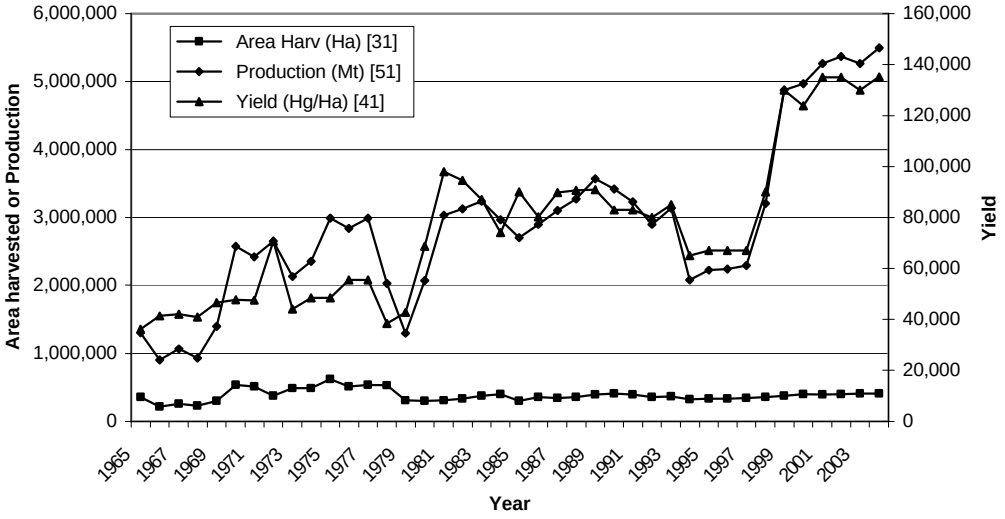

Chart 16. Sweet potato Production in Uganda

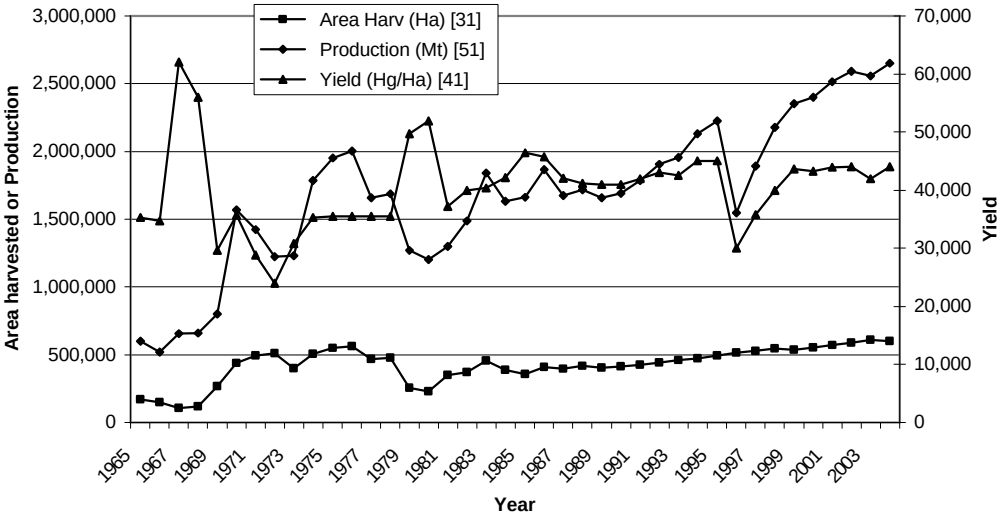

Table 5. Production and Utilization of Root and Tuber Crops in 2002

			Cassava			Potato			Sweet Potato			Yams			Other roots & tubers		
Region (Population)	Per Capita intake CAL/day[a]	Total provided by starchy root crops	Prodn (1000MT)	Food Utilizatn (1000MT)	Per capita Kg/yr. (% CAL)[b]	Prodn (1000MT)	Food Utilizatn (1000MT)	Per capita Kg/yr. (% CAL)	Prodn (1000MT)	Food Utilizatn (1000MT)	Per capita Kg/yr. (% CAL)	Prodn (1000MT)	Food Utilizatn (1000MT)	Per capita Kg/yr. (% CAL)	Production (1000MT)	Food Utilization (1000MT)	Per capita Kg/yr. (% CAL)
World (6,205,205,000)	2804	149 (5.31%)	186072	100494	16.2 (1.5%)	311567	202013	32.6 (2.13%)	138821	73496	11.8 (1.14%)	39711	17997	2.9 (0.28%)	17448	11906	1.9 (0.21%)
SSA (637,053,000)	2207	431 (19.53%)	101562	64598	101.4 (12.23%)	5719	4862	7.6 (0.68%)	11048	9330	14.6 (1.72%)	38137	16714	26.2 (3.26%)	12363	7430	11.7 (1.68%)
Ghana (20,471,000)	2667	1130 (42.37%)	9731	4359	212.9 (23.81%)	-	22	1.1 (0.07%)	90	90	4.4 (0.41%)	3900	2387	116.6 (11.96%)	1860	1414	69.1 (6.11%)
Kenya (31,540,000)	2090	139 (6.65%)	600	582	18.4 (2.58%)	900	713	22.6 (2.11%)	520	468	14.8 (1.91%)	-	-	-	10	10	0.3 (0.048%)
Nigeria (120,911,000)	2726	540 (19.81%)	34476	14846	122.8 (9.79%)	629	386	3.2 (0.22%)	2503	1752	14.5 (1.39%)	26849	9397	77.7 (7.81%)	3929	786	6.5 (0.55%)
Tanzania (36,276,000)	1975	372 (18.83%)	6888	5638	155.4 (14.99%)	240	196	5.4 (0.51%)	950	902	24.9 (3.29%)	11	10	0.3 (0.05%)	-	-	-
Uganda (25,004,000)	2410	568 (23.57%)	5373	2576	103 (12.74%)	546	374	15 (1.20%)	2592	2203	88.1 (9.62%)	-	-	-	-	-	-

[a] Average calorie intake per person per day

[b] Percentage of the daily calorific intake provided by this commodity

Source: Food balance sheets for 2002 (FAOSTAT 2005)

Table 6. Change in Cassava Production in SSA from 1994 to 2004

	Area of production (ha)			Yield (hg/ha)			Production (Mt)		
	1994	2004	%change	1994	2004	%change	1994	2004	%change
Angola	406,000	640,000	57.6	58,596	87,500	49.3	2,379,000	5,600,000	135.4
Benin	140,674	300,000	113.3	81,451	133,333	63.7	1,145,800	4,000,000	249.1
Burkina Faso	500	1,000	100.0	20,000	20,000	0.0	1,000	2,000	100.0
Burundi	60,000	82,000	36.7	87,884	86,533	-1.5	527,304	709,574	34.6
Cameroon	135,000	145,000	7.4	127,037	134,483	5.9	1,715,000	1,950,000	13.7
Cape Verde	260	260	0.0	123,077	115,385	-6.2	3,200	3,000	-6.3
Central African Republic	167,000	190,000	13.8	30,988	29,632	-4.4	517,500	563,000	8.8
Chad	45,000	27,000	-40.0	41,089	120,370	192.9	184,900	325,000	75.8
Comoros	9,000	10,500	16.7	53,611	55,238	3.0	48,250	58,000	20.2
Congo, Dem Republic of	2,473,469	1,850,000	-25.2	77,226	80,814	4.6	19,101,680	14,950,500	-21.7
Congo, Republic of	95,000	96,000	1.1	76,068	91,667	20.5	722,642	880,000	21.8
Côte d'Ivoire	310,000	300,000	-3.2	50,454	50,000	-0.9	1,564,080	1,500,000	-4.1
Equatorial Guinea	18,000	18,000	0.0	26,111	25,000	-4.3	47,000	45,000	-4.3
Gabon	43,000	45,000	4.7	45,814	51,111	11.6	197,000	230,000	16.8
Gambia	2,000	2,500	25.0	30,000	30,000	0.0	6,000	7,500	25.0
Ghana	520,400	783,900	50.6	115,776	124,235	7.3	6,025,000	9,738,812	61.6
Guinea	72,969	270,000	270.0	71,942	50,000	-30.5	524,956	1,350,000	157.2
Guinea-Bissau	900	2,500	177.8	164,789	152,000	-7.8	14,831	38,000	156.2
Kenya	51,019	80,000	56.8	91,297	78,750	-13.7	465,789	630,000	35.3
Liberia	40,000	75,000	87.5	62,500	65,333	4.5	250,000	490,000	96.0
Madagascar	350,000	352,815	0.8	67,429	62,112	-7.9	2,360,000	2,191,420	-7.1
Malawi	72,149	150,000	107.9	34,660	170,621	392.3	250,066	2,559,319	923.5
Mali	163	2,100	1188.3	73,436	115,238	56.9	1,197	24,200	1921.7
Mauritius	9	14	55.6	166,667	92,857	-44.3	150	130	-13.3
Mozambique	908,305	1,050,000	15.6	36,899	58,571	58.7	3,351,565	6,150,000	83.5
Niger	5,500	5,000	-9.1	118,909	200,000	68.2	65,400	100,000	52.9
Nigeria	2,927,000	4,118,000	40.7	105,928	92,712	-12.5	31,005,000	38,179,000	23.1
Réunion	400	250	-37.5	50,000	72,000	44.0	2,000	1,800	-10.0
Rwanda	180,000	133,876	-25.6	11,778	68,131	478.5	212,000	912,108	330.2
Sao Tome and Principe	650	600	-7.7	100,000	96,667	-3.3	6,500	5,800	-10.8
Senegal	30,659	36,000	17.4	25,087	50,000	99.3	76,915	180,000	134.0
Seychelles	30	30	0.0	50,000	50,000	0.0	150	150	0.0
Sierra Leone	41,500	75,000	80.7	58,675	52,000	-11.4	243,500	390,000	60.2
Sudan	4,000	6,000	50.0	21,250	17,333	-18.4	8,500	10,400	22.4
Tanzania, United Rep of	693,200	660,000	-4.8	103,999	104,394	0.4	7,209,200	6,890,000	-4.4
Togo	90,403	120,000	32.7	58,795	60,417	2.8	531,526	725,000	36.4
Uganda	320,000	407,000	27.2	65,000	135,135	107.9	2,080,000	5,500,000	164.4
Zambia	120,000	165,000	37.5	62,000	57,576	-7.1	744,000	950,000	27.7
Zimbabwe	33,000	43,500	31.8	39,394	43,678	10.9	130,000	190,000	46.2
SSA	10,367,159	12,243,845	18.1	80,754	88,232	9.3	83,718,601	108,029,713	29.0
World	16,783,589	18,511,889	10.3	98,067	109,469	11.6	164,592,242	202,648,218	23.1
Africa	10,370,659	12,252,345	18.1	80,760	88,236	9.3	83,753,601	108,109,713	29.1
Asia	3,838,247	3,515,131	-8.4	129,349	167,623	29.6	49,647,437	58,921,555	18.7
Caribbean	174,638	208,002	19.1	35,740	54,656	52.9	624,151	1,136,851	82.1
Central America	21,664	32,663	50.8	106,671	88,083	-17.4	231,093	287,704	24.5
Oceania	17,622	16,204	-8.0	112,278	108,372	-3.5	197,857	175,606	-11.2
South America	2,360,759	2,487,544	5.4	127,663	136,748	7.1	30,138,103	34,016,789	12.9

Table 7. Change in Sweet potato Production in SSA Countries from 1994 to 2004

	Area (ha)			Yield (hg/ha)			Production (Mt)		
	1994	2004	%change	1994	2004	%change	1994	2004	%change
Angola	21,000	115,000	447.6	85,714	37,391	-56.4	180,000	430,000	138.9
Benin	8,873	15,000	69.1	53,125	50,000	-5.9	47,138	75,000	59.1
Burkina Faso	2,035	6,000	194.8	55,351	61,667	11.4	11,264	37,000	228.5
Burundi	100,000	125,000	25.0	60,149	66,752	11.0	601,489	834,394	38.7
Cameroon	20,000	27,000	35.0	75,000	64,815	-13.6	150,000	175,000	16.7
Cape Verde	600	720	20.0	52,500	55,556	5.8	3,150	4,000	27.0
Chad	18,000	25,000	38.9	26,111	25,600	-2.0	47,000	64,000	36.2
Comoros	2,100	2,350	11.9	22,381	23,404	4.6	4,700	5,500	17.0
Congo, Dem Republic of	82,372	44,000	-46.6	49,454	51,011	3.1	407,359	224,450	-44.9
Congo, Republic of	1,700	850	-50.0	64,706	70,588	9.1	11,000	6,000	-45.5
Côte d'Ivoire	16,000	20,000	25.0	22,500	21,500	-4.4	36,000	43,000	19.4
Equatorial Guinea	13,000	14,000	7.7	26,923	25,714	-4.5	35,000	36,000	2.9
Ethiopia	19,500	36,000	84.6	79,487	100,000	25.8	155,000	360,000	132.3
Gabon	1,200	1,600	33.3	19,167	17,500	-8.7	2,300	2,800	21.7
Ghana	0	65,000	**	0	13,846	**	0	90,000	**
Guinea	23,324	10,000	-57.1	61,288	60,000	-2.1	142,949	60,000	-58.0
Kenya	27,300	61,000	123.4	104,396	95,082	-8.9	285,000	580,000	103.5
Liberia	1,700	1,900	11.8	100,000	100,000	0.0	17,000	19,000	11.8
Madagascar	104,000	105,735	1.7	53,846	51,282	-4.8	560,000	542,234	-3.2
Mali	2,500	4,700	88.0	52,488	158,511	202.0	13,122	74,500	467.7
Mauritania	2,000	2,000	0.0	10,000	10,000	0.0	2,000	2,000	0.0
Mauritius	20	55	175.0	135,000	90,909	-32.7	270	500	85.2
Mozambique	8,700	9,000	3.4	68,966	73,333	6.3	60,000	66,000	10.0
Niger	5,000	2,100	-58.0	90,000	142,857	58.7	45,000	30,000	-33.3
Nigeria	69,000	516,000	647.8	44,203	48,760	10.3	305,000	2,516,000	724.9
Réunion	50	30	-40.0	25,000	216,667	766.7	125	650	420.0
Rwanda	148,000	163,070	10.2	49,953	55,700	11.5	739,300	908,306	22.9
Senegal	405	150	-63.0	85,778	50,000	-41.7	3,474	750	-78.4
Sierra Leone	15,700	10,500	-33.1	27,962	24,286	-13.1	43,900	25,500	-41.9
Sudan	615	650	5.7	121,951	133,846	9.8	7,500	8,700	16.0
Swaziland	1,300	1,300	0.0	17,692	17,692	0.0	2,300	2,300	0.0
Tanzania, United Rep of	220,800	500,000	126.4	12,840	19,400	51.1	283,500	970,000	242.2
Togo	2,023	3,000	48.3	55,363	11,667	-78.9	11,200	3,500	-68.8
Uganda	473,000	602,000	27.3	45,011	44,020	-2.2	2,129,000	2,650,000	24.5
Zambia	3,600	3,600	0.0	147,222	147,222	0.0	53,000	53,000	0.0
Zimbabwe	700	800	14.3	22,857	21,250	-7.0	1,600	1,700	6.3
All SSA	1,416,117	2,495,110	76.2	45,170	43,693	-3.3	6,396,640	10,901,784	70.4
World	8,932,298	8,618,866	-3.5	140,554	147,513	5.0	125,547,042	127,139,553	1.3
Africa	1,441,028	2,523,110	75.1	46,020	44,708	-2.9	6,631,567	11,280,262	70.1
Asia	7,083,810	5,688,224	-19.7	163,480	197,616	20.9	115,806,349	112,408,225	-2.9
Caribbean	144,124	138,670	-3.8	32,294	52,529	62.7	465,439	728,415	56.5
Central America	2,255	3,400	50.8	149,126	154,847	3.8	33,628	52,648	56.6
Oceania	108,766	113,552	4.4	52,159	56,723	8.8	567,317	644,100	13.5
South America	113,506	109,347	-3.7	120,060	113,421	-5.5	1,362,756	1,240,223	-9.0

Table 8. Change in Yam Production in SSA Countries from 1994 to 2004

	Area of production (ha)			Yield (hg/ha)			Production (Mt)		
	1994	2004	%change	1994	2004	%change	1994	2004	%change
Benin	115,326	185,000	60.4	108,429	135,135	24.6	1,250,465	2,500,000	99.9
Burkina Faso	6,871	3,000	-56.3	53,043	83,333	57.1	36,446	25,000	-31.4
Burundi	1,400	1,700	21.4	56,621	58,306	3.0	7,927	9,912	25.0
Cameroon	17,000	28,000	64.7	70,588	94,643	34.1	120,000	265,000	120.8
Central African Republic	42,000	58,000	38.1	66,667	60,345	-9.5	280,000	350,000	25.0
Chad	25,000	24,000	-4.0	96,000	95,833	-0.2	240,000	230,000	-4.2
Comoros	630	750	19.0	53,079	53,333	0.5	3,344	4,000	19.6
Congo, Dem Republic of	42,517	13,000	-69.4	69,219	64,615	-6.7	294,300	84,000	-71.5
Congo, Republic of	2,900	1,500	-48.3	41,890	80,000	91.0	12,148	12,000	-1.2
Côte d'Ivoire	315,000	310,000	-1.6	89,640	98,387	9.8	2,823,650	3,050,000	8.0
Ethiopia	65,000	74,000	13.8	40,462	41,892	3.5	263,000	310,000	17.9
Gabon	18,000	22,000	22.2	69,444	70,455	1.5	125,000	155,000	24.0
Ghana	154,200	310,834	101.6	110,256	125,220	13.6	1,700,140	3,892,259	128.9
Guinea	9,500	3,500	-63.2	120,000	114,286	-4.8	114,000	40,000	-64.9
Liberia	2,300	2,300	0.0	86,957	86,957	0.0	20,000	20,000	0.0
Mali	2,500	3,700	48.0	42,104	129,189	206.8	10,526	47,800	354.1
Mauritania	400	400	0.0	62,500	62,500	0.0	2,500	2,500	0.0
Nigeria	2,031,000	3,106,000	52.9	113,998	85,599	-24.9	23,153,000	26,587,000	14.8
Rwanda	1,300	1,500	15.4	30,769	26,667	-13.3	4,000	4,000	0.0
Sao Tome and Principe	160	257	60.6	56,250	58,366	3.8	900	1,500	66.7
Sudan	46,000	57,000	23.9	27,826	24,035	-13.6	128,000	137,000	7.0
Tanzania, United Rep of	1,700	1,700	0.0	58,824	64,706	10.0	10,000	11,000	10.0
Togo	49,305	55,000	11.6	98,169	103,636	5.6	484,023	570,000	17.8
All SSA	2,950,009	4,263,141	44.5	105,367	89,859	-14.7	31,083,369	38307971	23.2
World	3,140,128	4,425,973	40.9	103,408	90,484	-12.5	32,471,388	40,048,149	23.3
Africa	2,950,009	4,263,141	44.5	105,367	89,859	-14.7	31,083,369	38,307,971	23.2
Asia	13,180	14,400	9.3	152,428	144,364	-5.3	200,900	207,884	3.5
Caribbean	109,932	62,285	-43.3	44,529	87,185	95.8	489,520	543,030	10.9
Central America	5,911	6,339	7.2	69,944	77,340	10.6	41,344	49,026	18.6
Oceania	16,508	21,651	31.2	154,856	153,767	-0.7	255,636	332,920	30.2
South America	44,454	58,027	30.5	89,896	104,299	16.0	399,622	605,218	51.4

Source: FAOSTAT2005

Annex 4 Details of CPP, CPHP and PSP Projects on Root and Tuber crops

Table 9. CPP projects on cassava mosaic disease

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5740CB F0010	01/04/1992 31/12/1995	Uganda	Strategies for the control of African cassava mosaic disease	NRI	
R6614 A0516	01/01/1996 31/12/1998	Kenya Malawi Tanzania, Uganda	Control of African Cassava Mosaic Virus	NRI (Cooter)	The project aims to characterise the mechanism underlying the current epidemic of African Mosaic Virus in Uganda and its spread into N-W Kenya. The effectiveness of the main approaches to control and the inter-relationships between them were to be evaluated under the range of inoculum pressures that then existed in Uganda. The socio-economic and other factors influencing their adoption were to be assessed to promote sustainability over time.
R7505	01/11/1999 31/10/2002	East Africa (Kenya, Tanzania, Uganda,)	Strategies for the sustainable deployment of cassava mosaic disease resistant cassava in Eastern Africa	NRI (Gibson)	To study the interaction between the viruses, the whitefly vector, cassava variety, and the phenomena of disease reversion and recovery that currently confound farmers' selection of clean cutting material. Farmer participatory research was to produce recommendations on how best to deploy resistant material to ensure a sustained supply of cassava in the future.
R8303 A1105	01/04/2003 31/03/2005	East Africa (Kenya, Tanzania, Uganda,)	Maximising, disseminating and promoting the benefits to farmers of cassava varieties resistant to cassava mosaic disease	NRI (Gibson)	To understand the potential and nature of resistance to whiteflies in African cassava germplasm. To develop training approaches and materials to assist farmers in the control of cassava mosaic disease
R8456 A1178	01/04/2005 31/01/2006		CMD and whitefly control	NRI (Gibson)	To extend previous project outputs and further characterise whitefly-resistant cassava

Table 10. CPP projects on cassava brown streak disease (CBSD)

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5880CB F0050	01/04/1992 30/11/1996	Malawi Tanzania	Adaptation and development of diagnostic reagents for cassava brown streak disease for use in less developed countries	NRI (Hillocks)	1. To test previously developed ELISA techniques for cassava brown streak disease (CBSD) under field conditions, 2. To train local staff in use of technology, 3. To use technology and/or usual symptoms, and information from local scientists and farmers to make a preliminary assessment of distribution and frequency of CBSD in eastern and southern Africa.
R6617x X0347	01/04/1996 31/08/1999	Tanzania	Molecular characterisation of cassava brown streak virus	NRI/Bristol University (Hillocks)	To characterize the causal agent of CBSD and assess available diagnostics
R6765 A0598	01/04/1996 31/08/1999	Tanzania	Control of cassava virus diseases in coastal coconut-based farming systems in Tanzania.	NRI (Hillocks)	To develop a control strategy for the two main cassava virus diseases, focussing mainly on cassava brown streak virus disease (CBSV), based on resistant varieties and farmer selection of disease-free planting material.
R7563	01/01/2000 31/12/2002	Malawi, Mozambique, Tanzania	Management of cassava brown streak disease and mosaic disease in eastern and southern Africa	NRI (Hillocks)	To build upon the findings of the previous project to design and evaluate a management strategy for CBSD. Disease management was based largely on tolerant local cultivars, as these were already adapted to local conditions and could be quickly disseminated.
R7796	01/07/2000 30/06/2001	East Africa	Cassava brown streak virus, virus isolates and the application of the diagnostic test	Bristol Univ (Foster)	To develop a reliable detection system for the causal agent of cassava brown streak disease, namely cassava brown streak virus (CBSV), by: 1) Confirming the reliability of the RT-PCR test developed in previous projects. 2) Complementing the RT-PCR test with a serological based assay by raising antibodies against synthetic peptides representing regions of the CBSV coat protein.
R8227 A1071	01/01/2003 31/03/2005	Malawi, Mozambique, Tanzania	Promotion of control measures for cassava brown streak disease	NRI (Hillocks)	Collection and evaluation of local varieties for tolerance to CBSD in Malawi and Mozambique. Further development of farmer groups in villages in Tanzania for on-farm evaluation and secondary multiplication of CBSD-tolerant cultivars. Development of education programme in schools in southern Tanzania to disseminate knowledge of CBSD and its control. Design and production of radio broadcasts for wider dissemination of knowledge on CBSD in Tanzania. Continuation of research to identify the vector of cassava brown streak virus (CBSV).

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R8404 A1150	01/04/2005 31/01/2006	Malawi, Tanzania, Uganda	Control measures for Cassava Brown Streak Disease	NRI (Hillocks)	To promote CBSD-tolerant varieties to be grown for cassava processing. To undertake research to demonstrate and measure the effects of root necrosis on cassava processing qualities. To evaluated on-farm in Malawi, recently identified tolerant varieties.

Table 11. CPP/PSP projects on participatory breeding of cassava

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R7565 A0945	01/01/2000 31/03/2003	Ghana	Participatory breeding of superior, mosaic disease-resistant cassava	NRI (Gibson)	To develop and evaluate conventional and participatory approaches for breeding superior varieties of cassava in Africa (Ghana), paying particular attention to the efficacy of this approach for obtaining resistance to mosaic disease (MD) caused by African cassava mosaic viruses, utilising seed-stocks derived from various resistant and agronomically superior parents, recording how farmers select for resistance and examining the need for training in this selection. To investigate how landraces of cassava evolve and spread in Africa so that traditional farmer plant breeding methods can be incorporated where appropriate into the breeding approach. To facilitate uptake and cost-effectiveness, and promote sustainability through the utilisation of local institutions.
R8302 A1112	01/04/2003 31/03/2005	Ghana (West Africa)	Participatory breeding of superior, mosaic disease-resistant cassava: validation, promotion and dissemination	NRI (Gibson)	To continue the validation process and promote a method by which farmers and researchers work together to develop cassava varieties appropriate to local needs and conditions (including resistance to pests, weeds and diseases, particularly cassava mosaic). To identifying opportunities for improving communication between end-users and those working on varietal development so as to enable germplasm improvement to enhance cassava utilization. To examine how the participatory breeding approach can fit within official variety release requirements, the latter being required to achieve widespread dissemination of cultivars.
R8405 A1161	01/04/2005 31/01/2006	Ghana (West Africa)	Participatory breeding of superior, mosaic disease resistant cassava: enhancing uptake	NRI (Gibson)	This is a continuation of the participatory breeding activities of the previous projects, but with an end-user focus.

Table 12. Crop Post-harvest Programme projects on cassava

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5448CB	01/09/1992 31/03/1996	Ghana	Low cost cassava fresh root storage technology transfer project - adaptive transfer from Latin America and field testing in Sub-Saharan Africa	NRI (Bancroft)	During the 1980s scientists of Centro Internacional de Agriculture tropical (CIAT) and NRI developed a simple low-cost technique to extend the useful shelf-life of fresh cassava roots. The methodology was used successfully in South America and in the project and adaptive transfer of the technology to sub-Saharan Africa was investigated.
R6332	01/04/1995 31/03/1996	Tanzania	Improved cassava processing technology for vulnerable households in Tanzania.	NRI (Westby)	To develop improved cassava processing methods that have enhanced post-harvest qualities, including low cyanogen levels and/or product storability. The work was in two parts: (i) improved cassava processing technology for vulnerable households in Tanzania; and (ii) optimisation of processing variables for *fufu*, a fermented cassava paste of Nigeria.
R6500 A0492	01/02/1996 31/12/1996	Tanzania	Control measures for the reduction of losses for cassava and sweet potato products in Tanzania	NRI (Wareing)	To assess the significance of quantitative and qualitative losses occurring during storage due to insects (including the larger grain borer, LGB) and mould in dried cassava and dried sweet potato products in at least two zones of Tanzania. Should losses be significant then a second phase will be developed that examines means of controlling the losses.
R6506	01/01/1996 31/03/1999	Ghana	Development and orientation of cassava chip production in relation to national and international markets for food consumption and animal feed in Ghana.	NRI	To develop more effective, cost efficient methods of processing cassava to produce dried chips in order to reduce processing losses, increase income generation potential and increase market diversity for cassava processors.
R6508	01/01/1996 01/10/2000	Tanzania	Improving the quality and value of non-grain starch staples	NRI	To characterise root crop commodity systems in Tanzania examining specifically issues of quality and their relationship to value and the potential to exploit new markets. Specific attention will be given to the fresh sweet potato and processed cassava products, but other opportunities will be considered.
R6639	01/07/1996 30/04/1999	Tanzania	Improved cassava utilisation in Tanzania	NRI	To develop low-cost processing methods that are capable of reducing potentially toxic compounds found in cassava to safe levels in one day, by up to 90%. To produce extension leaflets to disseminate awareness of these techniques at community level.

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R7495	01/11/1999 31/05/2003	Ghana, Nigeria	Identification of an approach to the commercialisation of cassava fufu processing in West Africa that maximises benefits to sustainable rural livelihoods	NRI (Westby)	Analysis of existing contribution of traditional cassava processing to rural livelihoods; Validation of the options to improve fufu processing and commercialise it; Definition of how cassava processing could be commercialised to give the maximum benefits to sustainable rural livelihoods Confirmation of uptake pathways and dissemination of outputs.
R7497	01/10/1999 31/03/2003	Mozambique, Tanzania	Commercialisation of cassava processing to enhance rural livelihoods in Eastern and Southern Africa	NRI (Westby)	To determine markets for cassava flour; To assess the potential for cassava-growing communities to access market opportunities; To identify the most sustainable means of farmers organising themselves; To adapt processing systems to the needs of cassava farmers; (5) To disseminate knowledge from this and other CPHP-funded projects.
R7550	01/07/2000 30/06/2001	Ghana, Nigeria, Colombia	Generation and dissemination of knowledge on post-harvest physiological deterioration in cassava	Bath (Beeching)	To generate the contextual framework from which to identify means to modulate PPD in cassava.
R8156	01/04/2002 31/03/2005	Global	Knowledge and tools for the modulation of post-harvest physological deterioration in cassava	Bath (Beeching)	To identify the full set of genes involved in post-harvest physiological deterioration (PPD) in cassava; To isolate the genetic tools that could be used for the modulation of PPD via biotechnical approaches To disseminate these to national and international research programmes.
R8268 A1094	01/01/2003 31/12/2004	Ghana	Sustainable uptake of cassava as an industrial commodity	NRI (Graffham)	To improve rural livelihoods, through industrialisation of cassava, via the establishment of an integrated supply chain to provide manufacturers with an assured supply of consistent quality cassava products at a competitive price.
R8283	01/01/2003 31/12/2004	Mozambique	Packaging and processing of sweet potato and cassava (PPOSPC)	CARE (Futterknecht)	Improve local knowledge on processing and packaging techniques for cassava and sweet potatoes. This will increase the value of agricultural production for marketing, will increase the shelf life of products and will enhance market options and thus food security. Key methodologies of PPOSPC are a detailed market analysis, testing of products and applied research through extension

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R8432 A1170	01/01/2005 31/12/2005	Ghana Zambia	Cassava as an industrial commodity - improving access to knowledge on approaches and options for expanding markets for cassava	NRI (Graffham)	Research in Ghana has shown that conversion of cassava into products for the food, plywood, paperboard, pharmaceutical and textile industries contributes to rural livelihoods. Innovative public-private sector partnerships were used to establish a market chain from producer to end user, and an institutional framework to support market development and manage uptake of knowledge. The project supports integration of these concepts into the national system so as to ensure sustainable support for market development, and to influence institutional thinking on future agro-industrial initiatives. In addition these concepts will be introduced to Zambia where cassava is considered a national priority

Table 13. CPP commissioned projects on sweet potato weevil and ICM for sweet potato

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R6124 A0368	01/04/1994 31/03/1996	Uganda	Identification of sex pheromones of sweet potato weevils	NRI (Hall)	1) To identify and synthesise the female sex pheromones of the sweet potato weevils Cylas puncticollis and Cyals brunneus. 2) To optimise pheromone blends, dispenser and trap designs for trapping male weevils in the field.
R6115 A0657	01/01/1995 31/03/1997	Uganda	Development of Pheromones for Monitoring and Control of Sweet Potato Weevils (*Cylas brunneus* and *Cylas puncticollis*)	NRI (Gryzwacz)	1) To complete identifications of the female sex pheromones of *C.puncticollis* and *C.brunneus* to develop lures and traps for the two species suitable for use by Ugandan farmers and to explore the use of pheromone baited traps for monitoring and control of sweet potato weevils in Africa. A 2) To carry out an etiological investigation to isolate and identify the causative organisms of a disease which infected stocks of *Cylas puncticollis*, and to assess its potential as a biocontrol agent for sweet potato weevil.
R6769	01/11/1996 31/03/1999	East Africa (Tanzania, Uganda)	Investigating the potential of cultivar differences in susceptibility to sweet potato weevil as a means of control	NRI	To examine the factors that determine the susceptibility of sweet potato to weevil, and determine strategies for selection of cultivars in East Africa. Activities in Tanzania and Uganda included laboratory studies to investigate levels of root antibiosis and field studies to investigate plant characteristics contributing to reduced susceptibility.
R7024 (CRF)	01/04/1998 31/03/2001	East Africa (Uganda)	Farmer Participatory Research on Integrated Crop Management for Sweet Potato in North Eastern Uganda	CIP	Yields and income from sweet potato in semi-arid agro-ecosystems in East Africa increased and their sustainability enhanced. Socio-economic issues related to the impact and adoption of 'new' technologies in sweet potato production addressed. (Competitive Research Fund (CRF)-commissioned project)
R8040	01/07/2001 30/06/2003	Uganda	Rapid multiplication and distribution of sweet potato varieties with high yielding and B-carotene content	PRAPACE	To develop a cost effective and sustainable system for continuous multiplication and timely distribution of quality sweet potato planting material in target areas. It was conceived that this would contribute to alleviating food insecurity, poverty and malnutrition among small-scale farmers in central Uganda through increased production of sweet potato varieties that are high yielding and rich in vitamin A. In a country devoid of a formal system to take charge of the proper multiplication and dissemination of vegetatively propagated crops like sweet potato, setting up informal farmer-based seed systems to produce quality planting material on a commercial basis contributes to improving incomes.

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R8167	01/04/2002 31/03/2005	East Africa (Uganda, Kenya)	Promotion of sustainable sweet potato production and post-harvest management through farmer field schools in East Africa.	CIP	To increase the returns from sweet potato enterprise through improved production and post-harvest management by East African smallholders. This feeds into the more general purpose given by the Crop Protection Programme of promoting strategies to reduce the impact of pests in herbaceous crops in Forest Agriculture systems in order to improve the livelihoods of poor people.
R8458	01/04/2005 31/01/2006	East Africa (Kenya, Uganda, Tanzania)	Expansion of sustainable sweet potato production and post-harvest management through FFS in East Africa and sharing of the lessons learnt during the pilot schools	NRI	

Table 14. CPP commissioned projects on sweet potato virus disease (SPVD)

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5878*	01/04/1994 01/03/1997	East Africa (Uganda)	The influence of viruses on sweet potato yields in Uganda: Assessment of the potential to use clean planting material to increase yield (HOLDBACK FUNDS)	NRI (Gibson)	The wider objectives of the project is to know the identities, rates of spread and yield effects of viruses of sweet potato in Uganda, and to develop methodologies for producing and propagating virus-free material in Uganda. The immediate objectives are: To assess the yield benefits of virus-free sweet potato to Ugandan farmers To document the main viruses affecting sweet potato in Uganda To assess the rates of re-infection of virus-free sweet potato in Uganda To develop the capacity to free sweet potato from viruses in Uganda and to propagate them in quantity in virus-free conditions.
R6617 A0519 X0347	01/04/1996 31/08/1999	East Africa	Identification, characterisation and epidemiological significance of the whitefly-borne component of sweet potato virus disease in Africa.	NRI (Gibson)	To identify and characterise the whitefly-borne component of sweet potato virus disease, and cassava brown streak virus (also considered to be whitefly-borne) in East Africa. To determine the epidemiological significance of the whitefly-borne component of sweet potato virus disease. Characterisation of the viruses was to provide methods for diagnosis allowing improved methods of virus disease management to be developed, as well as facilitating the selection of virus-resistant genotypes.
R7492	01/11/1999 31/10/2002	East Africa (Tanzania, Uganda)	Promotion of and technical support for methods of controlling whitefly-borne viruses in sweet potato in East Africa	NRI (Gibson)	The main aim of the project was to identify sweet potato varieties suitable for areas of Tanzania and Uganda where SPVD is particularly severe through on-farm trials and surveys of farmers' needs, and to study the eventual adoption (or otherwise) of the varieties. It also evaluated different means of local phytosanitation as a means of controlling SPVD. Information on the control of SPVD achieved by the previous project was to be reported including at a session at a regional conference organised on SPVD. The proposed work also aimed to check a claim that sweet potato mild mottle virus is whitefly-borne, though this target was down-graded as new research results indicated that this virus is relatively unimportant economically.
R8243 A1076	01/11/2002 31/03/2005	East Africa	Working with farmers to control sweet potato virus disease in East Africa	NRI (Gibson)	The broad aim of the project was to increase the productivity of sweet potato in East Africa by enabling farmers to grow the crop without the constraint of sweet potato virus disease or other pests and diseases. The aim was to achieve these using participatory approaches to select superior resistant varieties and seedling accessions, identify appropriate cultural control measures, develop training tools and materials and train farmers and extensionists in disease control methods.
R8457 A1177	01/04/2005 31/01/2006	East Africa	Extending the control of Sweet potato Diseases in East Africa	NRI (Gibson)	The project will extend the knowledge of how to control sweet potato virus disease in Uganda and Tanzania and complete participatory breeding work there

Table 15. CPHP projects on sweet potato

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5079 A0302	01/04/1992 31/08/1995		Development and field testing of needs assessment methodologies in traditional root crop post-harvest systems (Non grain starch staples post-harvest and technology transfer project: Uganda)	NRI	The validation of needs-assessment methodologies through case studies on the most important commodities in the country: cassava, sweet potato and cooking banana. Adaptive research in support of these needs-assessment studies was initiated as appropriate.
R6204 X0287	01/12/1994 01/03/1996	Tanzania	Post-harvest evaluation of local sweet potato cultivars in Tanzania.	NRI	To determine the post-harvest characteristics of the most important sweet potato cultivars in each agro-ecological zone of Tanzania, concentrating on factors effecting perishability and quality. To establishing appropriate strategies for future routine evaluation of cultivars to be carried out by the national programme.
R6317 A0425	03/04/1995 31/03/1996		Development and field testing of mechanisms to identify and address opportunities in non grain starch staple	NRI	The validation of needs-assessment methodologies through case studies on the most important commodities in the country: cassava, sweet potato and cooking banana. Adaptive research in support of these needs-assessment studies was initiated as appropriate. (follow-on from R5079.
R6507	01/01/1996 31/12/2000	Tanzania	The extension of storage life and improvement of quality in fresh sweet potato through selection of appropriate cultivars and handling conditions.	NRI	To improve quality and shelf-life of fresh sweet potato roots, through the identification/ selection and promotion of appropriate cultivars and identification of optimal storage and handling conditions in Tanzania.
R7036	01/10/1997 30/09/2000	Kenya, Uganda	An enterprise approach to commodity system improvement: sweet potato in Uganda and Kenya.	CIP	The project aims to identify factors contributing to success or failure of existing small enterprises, and determine technical factors that constrain potential entrepreneurs from starting processing and selling sweet potato-based food products. This will include comparing the returns from sweet potato with other crops (cassava, maize, sorghum, and millet) and with other similar small-scale enterprise activities

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R7498	01/12/1999 31/01/2003	East Africa (Tanzania)	Maximising incomes from sweet potato production as a contribution to rural livelihoods	NRI	To develop, validate and promote improved storage and handling innovations that offer farmers and traders a choice over when to sell and how to manage their crop post-harvest. (1) To develop and validate systems for improved storage and handling; (2) To quantify the benefits on a case study basis.
R7520	01/11/1999 31/12/2002		Sweet potato cultivars with improved keeping qualities for East Africa	NRI	• To identify the physiological basis for cultivar differences in shelf-life (in particular, whether the dry matter content and wound-healing efficiency are physiologically linked) and methods for selection suitable for breeding programmes; • To determine the significance of cultivar differences in long-term storability, in order to • establish whether breeding is feasible in this case; • To refine and disseminate methods for post-harvest evaluation of cultivars as developed in this and previous projects.
R8273	01/01/2003 31/12/2004		Improving the livelihoods of small-scale sweet potato farmers in Central Uganda through a crop post-harvest-based innovation system	PRAPACE	• Link rural sweet potato farmers in central Uganda to local and export markets; • Enhance post-harvest capacity of rural sweet potato farmers and processors in Central Uganda; • Create sweet potato based income-generating opportunities for resource-poor youth and women; • Develop an institutional mechanism that empowers poor farmers and rural processors toparticipate in sweet potato technology and knowledge innovation systems.
R8282	01/04/2003 31/12/2004		Enhancing the livelihoods of the rural and urban poor through improved market access for sweet potato	TFNC	To maximize economic returns and improve food security of poor farmers through the development of a range of institutional arrangements that effectively and sustainably improve access to post-harvest knowledge and market opportunities. This was to be mainly be through the validation and promotion of appropriate storage and handling innovations that enable farmers to have choice over how they manage their sweet potato crop.
R6049 X0263	01/05/1994 31/05/1997		Collaborative programme with CIP to identify and respond to the needs of the post-harvest sector for sweet potatoes in East Africa	NRI	To to work towards the broadening of the market for fresh and processed sweet potato products for human and animal consumption and obviate technical problems experienced in the storage, processing and marketing of such produce in the sweet potato producing areas of East Africa.

Table 16. CPP projects on yam diseases

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5259 A0209	01/04/1992 31/03/1996	West Africa (Ghana, Nigeria)	An examination of *Dioscorea* spp (yam) for nematode resistance and its incorporation into improved cultivars	Reading (Hillocks)	To identify yam cultivars/somatic hybrids with nematode resistance To elucidate the mechanisms of resistance and To liaise with yam breeders so that the outputs are used in improvement programmes.
R5441 X0220	01/04/1993 31/01/1996	West Africa	Biodiversity of Badnaviruses (Focus on yam badnaviruses)	JIC (Hull)	To produce a panel to monoclonal antibodies to yam badnavirus and use to develop diagnostic test and to assess the variability within the coat protein of yam badnavirus To utilise detection methods for badnaviruses and potyviruses to assess occurrence and importance of viruses in yam in Nigeria and Sri Lanka, and to determine if alternative hosts exist.
R5688 X0235	01/04/1993 31/03/1996	Nigeria	Strategies for the control of yam anthracnose	NRI/Reading (Simons)	To investigate the pathogenicity of Colletotrichum gloeosporioides from yam and non-yam hosts in mixed cropping systems especially in west Africa To study the initial stages of infection and determine the mode of inoculum transmission from seed tuber to short trips To screen resistant yam varieties in association with IITA and identify mechanisms of resistance To develop control strategies appropriate to small-holder farmers, especially in West Africa.
R5738 X0212	01/10/1992 31/03/1996	Nigeria	Epidemiology and control of anthracnose disease of yam in Nigeria	Reading (Simons)	To survey anthracnose in Nigeria and relate to cropping practices. To examine the survival of anthracnose between seasons. Investigate the host range and variability of Colletotrichum on yam in Nigeria.
R5897 A0346	01/10/1993 31/03/1996	West Africa (Nigeria)	Development of rapid tests for identification and differentiation of yam virus variability	NRI (Seal)	To develop rapid method(s) for preparing yam extracts free of compounds that inhibit reverse transcription and amplification enzymes in polymerase chain reactions To clone and sequence PCR products representing parts of the variable region of yam potyviruses from Africa and Asia and use this information to develop a rapid diagnostic test based on sequence diversity To use differential tests to investigate geographic variability to yam potyviruses To utilise detection methods for badnaviruses and potyviruses to assess occurrence and importance of viruses in yam in Nigeria and Sri Lanka, and to determine if alternative hosts exist.
R5983 X0258	01/10/1993 31/03/1996	West Africa (Nigeria)	Factors influencing the occurrence of yam tuber rots in West Africa	UEA (Oliver)	Phase I To survey for principal courses of yam storage rots in Kogi State, Nigeria, and to produce a report justifying further funding for Phase II. Phase II (dependent on findings of Phase I) To identify pathogens to species and rank their importance. To evaluate and assess relationship between cropping/storage practices and rotting incidence.

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R6694 X0353	01/04/1996 31/03/2000	West Africa (Ghana)	Identification of resistance to major nematode pests of yams. (*Dioscorea*) in West Africa	CABI (Plowright)	To identify and characterise yam cultivars that have nematode resistance.

Table 17. CPP projects on yam ICM and improving the health of seed yams

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R5735CB* F0006	01/11/1992 31/03/1996	Nigeria	Improving the health of seed yams in West Africa	NRI (Kenyon)	The wider objective of the project is to develop a menu of phytosanitary treatments/practices applied to minisett or seed tubers to control major yam pests and diseases. The immediate objectives of the project are to: evaluate the use of fungicide dusts applied to minisetts or seed tubers examine whether large seed tubers are a more appropriate source of minisetts than medium/small ware yams. test whether hot water treatment can be used to eliminate nematodes from minisetts in a low technology manner, and identify alternatives to aldrin for minisett protection.
R6691 X0362	01/07/1996 30/06/2000	Ghana	Control of yam diseases in forest margin farming systems in Ghana	Reading (Peters)	The objectives of the project were to integrate the current knowledge and determine the principal diseases infecting yams in Ghana. In addition, interactions between fungal pathogens and nematodes attacking yams in the field were investigated, and their effect on the health of tubers in storage ascertained. The importance of using clean or treated planting material was determined by assessing the extent to which the diseases are tuber-borne. Based on these results and on the findings of previous projects, improved and sustainable control practices were developed and tested, and their acceptability to smallholder farmers assessed.
R7504 A0897	01/11/1999 31/05/2000	Ghana	Study of factors affecting the uptake and adoption of outputs of crop protection research on yams in Ghana	NRI (Kenyon)	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 concern was to develop recommendations that could 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.
R8278 A1096	01/01/2003 31/03/2005	Nigeria	Evaluation and promotion of crop protection practices for "clean" seed yam production systems in Central Nigeria	NRI (Kenyon)	To assess if scarcity and expense of clean planting material was the/a major constraint to yam production, and then to work with yam farmers through local partner organisations in Kogi and Ekiti States to evaluate systems for the cost-effective, sustainable and environmentally sound production of clean planting material. Appropriate ways of packaging and disseminating the project findings were also to be identified.

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R8416 A1159	01/04/2005 31/01/2006	Ghana (West Africa)	Up-scaling sustainable clean seed yam production systems for small-scale growers in Nigeria	NRI (Kenyon)	1. Components of the commercial seed yam production systems in Illushi potentially applicable to the production of clean seed yams by small-scale growers identified. 2. The cultural and economic sustainability of small-scale seed yam production systems (developed during project R8278/Za0556 and before) assessed in the contrasting ecologies and livelihood systems of the yam growers in the riverine and upland areas of Kogi state. 3. Benefits of a micro-credit scheme to improve the ability of yam growers to access or grow their own clean seed yams in Ekwuloko evaluated and compared with a similar system being piloted in Alla-Olukudu; lessons learnt documented and available to guide the establishment of similar schemes after the end of the project. 4. Technologies and systems for producing, and/or improving access to, healthy seed yams transferred to appropriate GOs and NGOs (including NRCRI, CRI, AGIP Green-Rivers Project - initially identified through a workshop financed from R8278 in January 2005); private-public partnerships strengthened and organisations equipped and their capacity to further develop and promote these technologies and systems after the close of the project increased. 5. A dissemination strategy developed; content and style/format of (and need for) extension/promotional materials based on outputs/lessons learnt from this and previous projects identified and organisations to lead the development of each identified.

* Note R5735CB predates the CPP

Table 18. CPHP projects on yam

R code AX code	Start date End date	Country focus	Project Title	Lead Institution	Project Purpose
R6505	01/01/1996 31/03/2000	West Africa (Ghana,)	Relieving post-harvest constraints and identifying opportunities for improving the marketing of fresh yam in Ghana.	NRI (Bancroft)	To develop and promote Post-harvest technologies and methodologies to reduce constraints within existing marketing systems. The project was to contribute to this purpose by examining the yam marketing systems within Ghana, and determining the nature, causes and implications of the losses, and then developing appropriate technologies or protocols to reduce the losses.
R7582 A0946	01/02/2000 31/05/2003	West Africa (Ghana)	Development of integrated protocols to safeguard the quality of fresh yams.	NRI (Rees)	By improving the quality of yams entering both the local and export-trading systems, the project sought to reduce biological and economic losses and to expand the market potential of the crop. Research outputs were to include: strategies to reduce the chronic infection of yams and improve the shelf-life potential of tubers, as well as grading and handling protocols to safeguard the quality of yams and exclude diseased tubers from entering the marketing chain.

Annex 5 Abbreviations and Acronyms

ACMV	*African Cassava Mosaic Virus*
AGSIP	Agricultural sub-sector improvement projects (Ghana, WB funded)
ASARECA	Association for Strengthening Agricultural Research in East and Central Africa
CAADP	Comprehensive African Agricultural Development Program of NEPAD
CBSD/V	Cassava brown streak disease/Virus
CIP	Centro International de la Papa (International Potato Centre)
CMD	Cassava Mosaic Disease
CORAF/WECARD	Conseil Ouest Africain Pour la Recherche et le Développement Agricoles / West and Central African Council for Agricultural Research and Development
CPHP	Crop Post-harvest Programme (of DFID)
CPP	Crop Protection Programme (of DFID)
CRI	Crops Research Institute (Kumasi Ghana)
DFID	Department for International Development
EAPGREN	East African Plant Genetic Resources Network
EARRNET	East African Root Crops Research Network
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agriculture Organisation Statistical Database
FARA	Forum for Agricultural Research in Africa
FFS	Farmer Field School
GM	Genetic Modification
GMO	Genetically modified organism
ha	Hectare (1ha = 10,000 square metres)
hg	Hectogram = 100g (10,000hg = 1Metric ton)
IARCs	International Agricultural Research Centres
IDM	Integrated Disease Management
IDRC	International Development Research Centre
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
KARI	Kenya Agricultural Research Organization
KEPHIS	Kenya Plant Health Inspectorate Services
M&E	Monitoring and Evaluation
MAS	Marker Assisted Selection
Mt	Metric ton (tonne) = 1,000kg
NAARI	Namulonge Agricultural and Animal Production Research Institute
NARIs	National Agricultural Research Institutes
NARO	National Agricultural Research Organization
NARS	National Agricultural Research Systems
NEPAD	New Economic Partnership for Africa's Development
NGO	Non-Governmental Organization
NPA	Norwegian Peoples Aid
NRI	Natural Resource Institute
NRIL	Natural Resources International
OFSP	Orange-Fleshed Sweet potato (Varieties)
PPB	Participatory plant breeding

PRAPACE	Programme Régional d' Amélioration de la Pomme de Terre et de la Patate douce en Afrique Centrale et del' Est.or The Regional Potato and Sweet potato Improvement Network in Eastern and Central Africa
PSP	Plant Sciences (Research) Programme (of DFID)
R&D	Research and Development
R4D	Research for Development
RAIN	Regional Agricultural Information Network
REDSO	Regional Economic Development Support Office
SADC	Southern African Development Community
SARRNET	Southern Africa Root Crops Research Network
SPVD	Sweet potato virus disease
TFNC	Tanzania Food and Nutrition Centre
USAID	United States Agency for International Development
VAD	Vitamin A deficiency
VITAA	Vitamin A for Africa
WASNET	West African Seed and Planting Materials Network