

Report on ACIAR sweet potato workshop, Madang, PNG 28–29 June 2006

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Introduction

The Australian Centre for International Agricultural Research (ACIAR) is funding five projects in Papua New Guinea (PNG) that have a major sweet potato component. The projects are:

1. ASEM/2003/010: Farmer evaluation and multiplication of sweet potato varieties on the north coast of PNG. Commissioned organisation: World Vision Australia in collaboration with World Vision Trust Pacific Division, Papua New Guinea; PNG National Agricultural Research Institute (NARI); and The Australian National University. The project commenced in August 2004 and will run for three years. In practice it is mostly being conducted by World Vision PNG.
2. SMCN/2005/043: Analysis of biophysical and socioeconomic constraints to soil fertility management in the PNG highlands. The focus is on sweet potato, as this is the dominant crop in highland agricultural systems. A scoping study was conducted by the School of Land and Food Sciences, University of Queensland, over the period July 2005 to March 2006. It is anticipated that this will lead to a proposal for a full study of soil fertility management in the PNG highlands.
3. ASEM/2005/044: Sweet potato marketing in PNG. Conducted by the University of Canberra, July to December 2005. The objective of this study is to provide an assessment of current knowledge of sweet potato marketing in PNG and to develop a recommended course of action for further related studies. A proposal for a large study, to be conducted by the University of New England in collaboration with NARI and the Fresh Produce Development Agency (FPDA), is being submitted to ACIAR for consideration.
4. CP/2004/071: Management of pests and diseases of sweet potato in Papua New Guinea. This project is being conducted by staff from the Queensland Department of Primary Industries and Fisheries (QDPI&F) in collaboration with others institutions in Australia and PNG, including NARI and FPDA. The project commenced in mid 2006.
5. CP/2005/134: Improving informal seed systems for sustainable sweet potato production under resource-poor farming conditions in Indonesia and the Pacific (PNG and Solomon Islands). International Potato Center, Bogor, Indonesia (to commence in September 2006).

An ACIAR-sponsored workshop on sweet potato was held in Madang on 28 and 29 June 2006. It was attended by scientists and technicians involved in sweet potato projects from PNG, Australia and Indonesia. Staff from a number of other institutions in PNG also attended. Altogether, the workshop was attended by 53 people (see Table 1 for list of participants and email contacts).

The workshop organising committee comprised Dr Mike Bourke and Ms Tracy Harwood (Land Management Group, The Australian National University, Canberra), Ms Sharryl Ivahupa (World Vision, Madang), and Dr Sergie Bang and Mr Elick Guaf (NARI, Bubia). The workshop was held over 1.5 days, followed by a half-day visit to Murukanam village north-west of Madang, which is one of the field sites for the project evaluating sweet potato cultivars being conducted by World Vision PNG (ASEM/2003/010).

Nine papers were delivered at the workshop (Table 2) and introductory remarks were given by Dr Ken Menz (ACIAR), Dr Sergie Bang (NARI) and Mr Joseph Kata (World Vision PNG). As

well, on two occasions, the workshop broke into three smaller groups to consider six aspects of research and development of sweet potato in greater detail. These 'break-out' sessions addressed:

1. Cultivar evaluation
2. Soil fertility issues
3. Pest and disease issues
4. Marketing
5. Processing and new products
6. Adoption and dissemination of technology

A summary of conclusions from the break-out sessions is given in Table 3, and some overall conclusions in Table 4.

The objectives of the workshop were:

1. To share information between staff of the five ACIAR-funded projects and PNG-based individuals who are engaged on sweet potato projects.
2. To examine the implications of preliminary findings from those projects for the other current and planned projects.
3. To set priorities for future research and development of sweet potato in PNG.
4. To establish mechanisms for sharing results from research and development projects.

The first objective of the meeting, that is to share information, was achieved. Many participants commented that they now had a much greater awareness of other research and development projects on sweet potato in PNG.

The second objective, that is, to examine the implications of preliminary findings from those projects for the other current and planned projects, was done to a limited degree. Some preliminary findings from the World Vision variety evaluation project were noted for the planning of some other projects. Importantly, lessons from sweet potato research being conducted in Queensland were disseminated and many of these will be valuable in planning research in PNG, including the need for more rigorous attention to standardising experimental techniques.

The third objective was to set priorities for future research and development of sweet potato in PNG. This was partially achieved in that priorities were noted at each of the break-out sessions at the workshop. However, the workshop was too large and there were too many non-specialists participating to set research and development priorities.

The final objective was to establish mechanisms for sharing results from research and development projects. It was agreed that ACIAR would commission a moderated electronic distribution group, such as that organised by Dr Grahame Jackson for PestNet. This will facilitate ongoing sharing of results and experiences with sweet potato in PNG and elsewhere in the Pacific.

It was also suggested that a further workshop be held in 18–24 months time, with attendance restricted to scientists working on ACIAR-funded projects. This would be an opportunity to share the findings of the projects commissioned by ACIAR, as well as to re-examine priorities for further research and development.

Table 1. List of participants, ACIAR sweet potato workshop, Madang

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Revised 30 June 2006

Table 2. Revised schedule, ACIAR sweet potato workshop, Madang

Wednesday 28 June 2006

SESSION 1	Chair: Sharryl Ivahupa
8.00 – 8.30 am	Introduction of participants, administrative matters (chair)
8.30 – 9.00 am	Introductory remarks (Ken Menz, Sergie Bang and Joseph Kata)
9.00 – 10.00 am	Sweet potato in Papua New Guinea: an overview (Mike Bourke)
SESSION 2	Chair: Robert Lutulele
10.30 – 11.00 am	Sweet potato in Australia (John Maltby, Eric Coleman and Mike Hughes)
11.00 – 11.30 am	Reducing pest and disease impact on yield in selected PNG sweetpotato production systems (Eric Coleman)
11.30 – noon	Research on sweet potato at University of Technology (Tom Okpul and Maia Wamala)
SESSION 3	Chair: Norah Omot
1.00 – 1.30 pm	Evaluation of cultivars in lowland Madang Province (Sharryl Ivahupa)
1.30 – 2.00 pm	Analysis of biophysical and socio-economic constraints to soil fertility management in the PNG highlands (Gunnar Kirchhof)
2.00 – 2.30 pm	Sweetpotato work at the International Potato Center (Asep Setiawan)
SESSION 4	Chair: Eric Coleman
2.30 – 3.30 pm	Break-out session (three smaller groups) focusing on: (i) cultivar evaluation (led by Eric Coleman) (ii) soil fertility issues (led by Gunnar Kirchhof) (iii) pest and disease issues (led by Birte Komolong)
3.30 – 4.30 pm	Reports by groups and general discussion
6.30 – 9.30 pm	Conference dinner

Thursday 29 June 2006

SESSION 5	Chair: Birte Komolong
8.15 – 9.15 am	Sweet potato research conducted by NARI (Sergie Bang, Elick Guaf and Joel Waramboi)
9.15 – 10.00 am	Towards a demand-side research agenda for sweet potato in PNG (John Spriggs)
SESSION 6	Chair: TK Lim
10.00 – 11.00 am	Break-out session (three smaller groups) focusing on: (i) marketing (led by John Spriggs) (ii) processing and new products (led by Norah Omot) (iii) adoption and dissemination of technology (led by Barbara Chambers)
11.00 – noon	Reports by groups, general discussion, conclusions of workshop, the way forward
SESSION 7	Organiser: Sharryl Ivahupa and World Vision field technicians
1.00 – 7.00 pm	Field trip to Murukanam village, one site for cultivar evaluation being conducted by World Vision in lowland Madang Province (prayers; field visit; traditional dances and refreshments)

Table 3. Conclusions from break-out sessions, ACIAR sweet potato workshop

Six aspects of research and development of sweet potato were examined in greater depth by 'break-out' groups during the workshop, with three sessions held on two occasions. A summary of the main conclusions of these sessions follows.

1. Cultivar evaluation

One group focused on criteria for evaluating sweet potato cultivars. Seven characteristics were considered. For each characteristic, selection criteria were noted and ranked. (The selection criteria following each characteristic, below, are listed from most important to least important.)

1. **Tuber yield** – tuber weight; number of tubers
2. **Eating quality** – flavour; sweetness; texture
3. **Tolerance to parasites and environmental extremes** – stability (ability to grow in different environments and tolerate pests and diseases); drought tolerance; resistance to sweet potato scab disease; resistance to sweet potato weevil
4. **Chemical characteristics** – nutritional (eg high protein, beta carotene, anthocyanin); dry matter (important for processing)
5. **Tuber characteristics** – shape; cracking; skin colour; flesh colour; texture (eg fibrous, hard or soft)
6. **Growth characteristics** – earliness (time to maturity); development of tubers on the runners or at the base
7. **Post-harvest characteristics** – shelf life; bruising; dormancy

Some other factors that could be considered in selecting cultivars are:

1. Cropping style – continuous harvest (for domestic use) or one-off harvest (for selling)
2. Suitability for cooking and other processing (ease of production)
3. Yield – genotype versus environment
4. Post-harvest shelf life both above and below ground

A broader issue for researchers working with sweet potato was highlighted in the findings from research conducted in Queensland. Sweet potato is a difficult crop to conduct research on and experiments typically have high variability. Hence it is very important that all experimental techniques are standardised to a degree that would not be necessary with many other crops. This includes, for example, using pathogen-tested planting material; using cuttings of identical length; having the same number of nodes per cutting; using the same planting technique; and treating planting material in an identical manner.

2. Soil fertility issues

The group considered that soil fertility issues were becoming important in PNG, particularly in parts of the highlands and on some small islands where land pressure is very high. However, objective evidence that soil fertility is declining remains scarce. In much of the PNG lowlands, pressure on land has been relieved by the adoption of introduced crops, which have replaced the older Asia Pacific crops. The newer crops are sweet potato, cassava, *Xanthosoma taro*, new banana cultivars and maize. The crops being replaced are taro, yam and older banana cultivars. This phase is now coming to an end, but it has relieved the pressure on land in the lowlands even as the population has risen rapidly. However, in the highlands, sweet potato replaced taro and the minor food crops yam and banana some 300 years ago. So rapid population growth in recent decades has increased the pressure on land in the highlands and this is reducing soil fertility. On many of the very small islands, population density is high (more than 100 persons per km²), pressure on land is intense and the physical environment makes the land more

vulnerable to degradation, so that even hardy cassava and sweet potato give poor yields on many islands. Hence soil fertility issues are also important on small islands.

The two components considered were nutrient balances and soil physics.

Nutrient balances

We need a better understanding of long-term issues of soil nutrients, in the context of high population growth.

Removal of biomass, including sweet potato tubers, leads to a loss of nutrients from the soil. Indirect losses also occur through leaching and runoff. Further assessment is required because data on nutrient losses in PNG is limited.

Nutrient recycling. Data in PNG is limited on how much nutrient is restored during the fallow phase. There is a need to review published literature on this topic (H. Manner and other authors), then soil nutrient balances can be quantified. This is particularly important for soils in the highlands. The influence of pH regime has to be considered on nutrient cycling.

Many highland soils are derived from volcanic ash and their unique characteristics present problems with analysis. Alternative methods for soil analysis may need to be identified.

In low-input production systems, plant breeders may want to consider low-input sweet potato cultivars.

Soil physics

We have relatively little current knowledge about soil physics (eg soil–water relationships) in PNG. We need a better understanding of soil water balance, including how fast water moves through soil in relation to mineralisation of organic matter, plant nutrient demand and soil nutrient supply.

Another poorly understood topic, but a very important one for sweet potato, is the soil water and nutrient interactions. Our understanding of the effect of water content on sweet potato tuberisation and the interaction between water and nitrogen is limited.

Soil erosion rates in the PNG highlands are relatively low. And despite the high rainfall intensity in the lowlands, soil erosion is generally not a big issue there because of the agricultural systems (including use of mixed crop species) and relatively low-intensity agriculture. However, in some lowland locations soil erosion is a problem, including the Gazelle Peninsula in East New Britain Province. Soil erosion is a greater potential problem in the highlands because of the use of steep land, more intensive cropping systems and the dependence on a single staple food (sweet potato). Research conducted by Geoff Humphreys in Simbu Province indicates that rates of soil erosion are low. However, the fact that villagers use soil erosion barriers in much of that province, and elsewhere, suggests that soil erosion is an issue in the highlands and that it should be investigated further.

3. Pest and disease issues

There is a need for baseline data for most, if not all, pests and diseases of sweet potato in PNG.

With intensification of production, shortening of the fallow and extension of the cropping period, as is occurring widely in PNG, pest and disease problems are likely to increase.

We do not know much about the impact of nematodes on PNG agriculture, with the study by Bridge and Page (1982) as the only major report on the topic. Nor do we have good information

on the relative importance of free-living and parasitic nematodes. One study by Alfred Hartemink recorded an increase in nematode populations with more intensive land use.

The use of good management practices, including crop rotations, is important to control pests and diseases of sweet potato. In practice, sweet potato is cropped continuously in many locations, especially in the highlands.

It is known that sweet potato scab is widespread and that its incidence varies widely between cultivars, but the impact of scab on tuber yield is not clear. The high incidence of leaf scab on some cultivars in the Madang area, and much lower incidence on the same cultivars at Keravat, suggests the presence of different races of scab. The fact that some susceptible cultivars have given some of the best tuber yields in the World Vision evaluation in Madang Province suggests that scab may not reduce tuber yield a lot, but this needs to be investigated properly. The experience from the World Vision project highlights the fact that a cultivar that has been high yielding in one location needs to be tested elsewhere before it can be recommended.

Alternaria in high-altitude areas can be a problem, especially in areas with high humidity.

Other pests of sweet potato include mirid (*Halticus tibialis*) in the lowlands, particularly in south Bougainville, hawk moth (hornworm) (*Agrius convolvuli*) and gall mite (*Eriophyes* sp.).

We do not know which pests and diseases are potential problems. Many factors may affect pests and diseases. Researchers need to be mindful of potential diseases, and evaluations should always be a part of trials conducted for other purposes.

The more that villagers intensify land use, the more pest and disease problems are likely to be encountered. This leads to the need for a whole system approach and the need for specialists to work together, for example, by getting pathogen-tested planting material to those involved in the highlands soil fertility project.

It is apparent from research conducted in Queensland that complexes of diseases, particularly viruses, are likely to mask results.

4. Marketing

The group was clear that the main focus should be on fresh tubers, not on a processed product.

The price of sweet potato is fairly high in Port Moresby. There is a high demand for sweet potato and other foods in Port Moresby, but the supply is insufficient. We do not have adequate information on market requirements.

Transport costs and availability present a significant constraint to marketing sweet potato. This applies to both land and sea transport.

There is a need for greater coordination and sharing of information about market demand to help even out oversupply and undersupply.

Inappropriate packaging is a major issue that results in loss of tubers. The use of large flour bags can lead to post-harvest damage such as asphyxiation of tubers and development of fungal diseases. It seems that some colour types spoil more quickly than other colour types. For taro, the shelf life can be increased by washing corms.

Most marketing of sweet potato is done by the growers themselves, without the use of intermediate traders. This results in an inefficient supply chain, particularly when growers are travelling from the highlands to Port Moresby by air to sell their produce.

The group queried whether long distance transport of sweet potato had a future, or whether it was more logical to supply markets from production nearer the market. It is estimated that less than 2000 tonnes of sweet potato is moved from the highlands to Port Moresby each year. This is a small, but unknown, proportion of marketed sweet potato in PNG. Mike Bourke has crudely estimated that 25,000–50,000 tonnes are sold per year, but he cautions that this could be a gross underestimate and the figure could be more than 100,000 tonnes per year.

It was noted that much of the sweet potato in PNG is produced for subsistence use, with the surplus sold, although many producers near most urban areas produce sweet potato specifically for the market. Our overall understanding of marketing of fresh food in PNG is woefully inadequate, given that fresh food provides more cash income to the rural population than any other activity, aside from sales of Arabica coffee in the highlands.

We need to develop supply chain strategies. We need to ask the questions: what activity will give the greatest return for public spending on marketing and who should we be targeting?

It was suggested that more central depots should be established, although caution was expressed as these have consistently failed in PNG in the past. Other issues that the group identified included those relating to land ownership; and a reported oversupply of sweet potato in Lae market.

Possible export of sweet potato to Australia would require a pest risk analysis, including provision of a complete list of pests and diseases at each growing stage of the crop. The prospects for exporting sweet potato to Australia are very low. Recent studies by Andrew McGregor clearly indicate the best market prospects for fresh food in PNG are for domestic, not export, sales.

Overall, it was concluded that our understanding of a number of important marketing issues is inadequate. We do not know how much sweet potato is being sold in PNG. Little is known about the source of produce, or consumer requirements. It was noted that it would not be an impossibly difficult or large task to conduct surveys of different types of markets (major urban locations, smaller urban areas, high schools, mining camps, roadside markets, etc) so as to derive a reasonably accurate estimate of the quantity sold each year.

5. Processing and new products

The group considered that it was better to start with small-scale processing at the household level, rather than large-scale processing.

It would be worthwhile to develop products such as sweet potato noodles that can be easily made in the village. After development of products, economic analysis should be conducted to establish the costs of producing various products and returns on people's labour. Information is needed on a retail price for noodles.

Different recipes using sweet potato should be disseminated to encourage more use of the tuber. Economic analysis should be done on new products to evaluate their profitability for sale.

After products have been developed, surveys should be undertaken to assess consumer reactions to new products compared with existing products. Products should then be refined to suit consumer requirements.

People and organisations who can work in a collaborative manner to develop and transfer information on the products should be identified.

The different characteristics of sweet potato cultivars make them suitable for different purposes. So it is important to consider their characteristics when assessing cultivars for various uses. For

example, those suitable for livestock feed have different qualities to those suitable for cooking as fresh tubers.

Surveys need to be done to determine what the market actually requires.

Possible products that could be developed from sweet potato include canned soups, fries, beverages, starch, noodles and wine.

6. Adoption and dissemination of technology

Dissemination of findings and maintenance of adoption are important, but often neglected, aspects of research. This is made more difficult in PNG because of the inefficiency of the various levels of government and the limited resources allocated to them, especially at the provincial level. The problem is compounded by the way that supervision is organised in the provinces, whereby agricultural advisors based in provincial capitals have no authority over district-level staff.

Such outreach and dissemination that does occur in PNG is mostly done by non-government and community-based organisations, with some done by para-government organisations such as NARI and FPDA. Many communities in PNG do not have access to information about superior production practices, improved cultivars, or basic marketing information.

A strategy is needed where we can extend knowledge to the producers and maintain innovation. Producers need to see a reason for change, otherwise they may not adopt technology. There is a need to educate growers about the reasons for new practices and cultivars. The media is a useful tool, particularly radio, but is not sufficient on its own. It is important for people to work closely with villagers to show them superior techniques and how to use improved planting material. Gender divisions that may impede changes in production, harvesting and marketing of fresh produce need to be addressed. Participatory methods can be a powerful tool to do this.

There are major financial constraints in maintaining an information and outreach network, exacerbated by short-term project funding. It is important to set up resource centres that farmers can easily access.

The question was raised: what is the main focus that drives the strategy for disseminating research findings? It was deemed necessary to operate at a number of levels along the supply chain, including that of producers, transporters, supermarket managers, consumers and government. It was noted that PNG villagers are always enthusiastic adopters of new ideas and crops and the term 'pathological innovators' was applied to Engan villagers in the 1960s by one researcher there (Eric Waddell).

The main focus should be on empowering growers. The 'train the trainer' technique, widely used by the Lutheran Development Service in PNG, was seen to be a good model. It is important to work with both women and men for gender balance. Further use of NGOs and CBOs was seen to be one of the most promising ways to proceed.

Table 4. Summary: ACIAR sweet potato workshop

Some of the main issues that emerged from the workshop were summarised by the chair of the final session (TK Lim) as follows:

PNG is fortunate to have comprehensive agricultural literature databases and these should be used much more widely for project preparation and research.

There is a considerable body of unpublished papers, reports and data (grey literature) on PNG agriculture, including on sweet potato.

Cultivars need to be developed for fresh consumption, livestock feed and for processing and new products.

There are a number of significant issues with soil fertility and water management.

Pests and diseases are a potentially important limitation to production and marketing, including post-harvest. We have scant information on the economic impact of the various pest and disease problems. For viruses at least, information on their impact is likely to come from a pathogen-tested scheme soon to be established in the highlands by NARI and FPDA working in collaboration with QDPI&F.

Poor dissemination, limited adoption of research findings, and the lack of a good extension network are significant bottlenecks towards improving agricultural productivity.

Many issues need to be addressed to improve marketing of sweet potato and marketing systems, including market intelligence and information such as basic data on price fluctuations and the volume sold each year.

There is potential to develop processed products (chips, flour, noodles, beverages) and new products (for example, cultivars with high carotene or anthocyanin antioxidant properties). However, this will depend on the price at which the raw material (sweet potato tubers) can be purchased, the cost of equipment and labour costs, as well as the price at which processed products are sold.

ACIAR is currently funding three large projects and two small projects; several more are in the conceptual stage.

It is important to enhance synergistic links between all the sweet potato projects in PNG, including those funded by ACIAR and the Agricultural Innovations Grant Facility as well as others being conducted by NARI. There is a need for greater sharing of information. This could be done through the use of a moderated electronic distribution group, such as that organised by Grahame Jackson for PestNet. It was agreed that we should hold more workshops/symposiums where participants in the various sweet potato projects could meet. The possibility of a broader Food and Nutrition Conference was raised and this was recommended by the participants at the PNG 2000 Food and Nutrition Conference. The proceedings of the 2000 Food and Nutrition Conference, which ACIAR published, are used widely in PNG and overseas.