CTA
Working Paper
17/05

Roots and Tubers Value Chain Development and Food and Nutrition Security - PNG

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Series: Agriculture and nutrition

CTA Working Paper 17/05 | February 2017

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Lessons for Papua New Guinea from the World Congress on Root and Tuber Crops, China, 18–22 January 2016

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Please address comments on this Working Paper to Judith A. Francis, Senior Programme Coordinator, Science and Technology Policy at CTA.

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List of acronyms

ACIAR	Australian Centre for International Agricultural Research
FPDA	Fresh Produce Development Agency
IPM	Integrated pest management
NARI	National Agricultural Research Institute
PNG	Papua New Guinea
PNGUOT	Papua New Guinea University of Technology
PT	Pathogen-free tested
RTCs	Root and tuber crops
SPISARD	South Pacific Institute for Sustainable Agriculture and Rural Development

Acknowledgements

I am grateful to CTA for the funding provided under the Intra-ACP APP to facilitate my participation in the China Congress, and its staff, notably Judith Francis and Caroline Andriessen for making this trip a successful one. To my head of department, Professor Abdul Halim, I also say thanks for his encouragements.

Executive summary

Root and tuber crops (RTCs) have been the mainstay for 85% of Papua New Guineans, contributing to food security and household income. Although RTCs have special importance in Papua New Guinea (PNG), research and development on increasing their production has been minimal. Eighty percent of the population is reliant on agriculture, but the government focusses on non-renewable minerals and petroleum production.

Sweet potato is the primary crop grown in PNG with an estimated production of 3 million t. The main constraints that smallholder farmers face in sweet potato production include declining soil fertility, pests and diseases, limited market access and post-harvest losses.

A new plant protection technology that the PNG University of Technology (PNGUOT) is attempting to introduce, is the development and use of microbial-based insecticides and barrier plants. These innovations are expected to minimise the prevalence of economic pests such as sweet potato weevils. The unsatisfactory pest and disease status of sweet potato has limited international trade throughout the Pacific Islands region.

In this paper, the status of RTCs in PNG is outlined. Linking the private sector with farmer groups and government support, is key for RTC development. Research by PNGUOT and its part in developing RTCs is discussed, as well as lessons learned from the World Congress on Roots and Tuber Crops (WCRTC) held in China.

Introduction

Eighty-five percent of the Papua New Guinean (PNG) population is based rurally and relies wholly upon work in agriculture and fisheries to earn a living. In the main, households grow vegetables and spices or cultivate livestock for income. At higher altitudes, tree crops such as coconuts, cacao and coffee are grown. Before the harvesting season of cash crops, such as coffee commences, horticultural crops are cultivated mainly for family consumption and for sale at local markets to increase earnings (Allen *et al.*, 2009a). The favourable climatic conditions allow for horticultural crops to be grown all-year-round. With root and tuber crops (RTCs) constituting 90% of all locally grown crops, they are a staple in most households. Further, these crops contribute significantly to the country's food security as RTCs constitute at least 80% of the average PNG dietary needs.

Sweet potato is the primary crop of rural areas and production has greatly increased over the last 40 years. Sweet potato crops account for over two thirds of all locally grown crops in PNG, with an estimated 3.5 million t produced annually (Allen *et al.*, 2009a). During production, the crop that cannot be sold due to pest infestation is used as feed for pigs and poultry. However, there are factors restraining production which include soil fertility declines, limited market access, post-harvest losses and pests and diseases.

Important pests of sweet potato and their control in PNG

In PNG, weevils are the most detrimental pests to sweet potato production, causing tubers to become inedible for human and livestock consumption. Infestations of the common sweet potato weevil (*Cylas formicarius*) can lead to losses in crop yield of up to 50%. Infestations are exacerbated during dry spells when soil cracks develop, facilitating the entry of weevils into tubers. The El Niño event of 2015 hit the PNG highlands hard and weevil infestations on tubers reached 100% (S. Bang, pers. comm.). Another species of weevil causing significant crop damage is the West Indian sweet potato weevil (*Euscepes batatae*) (Hughes, 2013). A recent discovery (identified in 2014), the *E. batatae* weevil has been found to be more destructive than *C. formicarius*.

Almost all smallholder farmers depend upon traditional methods such as intercropping with legumes, rotation and use of weevil-free planting materials, to control and manage weevil infestations, but they are having minimal effects on pest populations. Only a handful of farmers and farmer groups have resorted to the use of synthetic insecticides for weevil control.

Minor insect pests include the tobacco whitefly (*Bemisia tabaci*), aphids, gall mites (Eriophyidae) common in the highlands of PNG, vine borers (*Omphisa spp*., *Megastes spp*.) and the false armyworm. Many farmers are inclined to use pathogen-free tested planting materials to avoid infestations of aphids and whiteflies, which act as a vector of viral diseases. Yields obtained from original planting materials are in gradual decline.

Within the agriculture department at the PNG University of Technology (PNGUOT), the plant protection team is investigating the development and application of microbial-based insecticides for the management of sweet potato pests. Previous studies have shown that insect-pathogenic agents have the potential to control sweet potato weevil populations

(Dotaona *et al*., 2015). The plant protection team at PNGUOT is involved in a study on the use of plant barriers as an insect-repellent and deterrent characteristics in sweet potato fields for pest management. These innovative approaches have not been investigated in depth in PNG, and represent an unexploited opportunity for pest management not only for horticultural crops, but for agricultural tree crops in as well. These technologies are ecologically-friendly and can be integrated into the tactics of smallholder farmers for crop management. Annually PNG spends approximately US$9 million on pesticide imports. Until such technologies are adopted by farmers, expenditure on pesticide imports for farming will continue to spiral.

The PNG government wanted all tertiary institutions to be entrepreneurially focused. Research carried out by PNGUOT, goes some way to achieve this goal by commercialising integrated pest management (IPM) technologies. In order to complete its plant protection research, PNGUOT partnered up with the following institutions: PNG National Agricultural Research Institute (NARI), Fresh Produce Development Agency (FPDA), Australian Centre for International Agricultural Research (ACIAR), Charles Sturt University and Southern Queensland University.

The department of agriculture has also collaborated with ACIAR in developing early learning modules for primary school students, such as botanical pest control. Teachers will be trained in how to deliver these modules for primary education. PNGUOT's outreach branch - the South Pacific Institute for Sustainable Agriculture and Rural Development (SPISARD), conducts training sessions for horticultural farmers on botanical pesticide preparations and use.

Connecting farmers: Adoption of technology

The main threat to the success of IPM technology, is adoption by its end users - farmers. One of the key lessons learned at the World Congress on Roots and Tuber Crops (WCRTC), is that adoption of technologies by farmers in developing countries, like PNG, takes time. A case study in Uganda, which involved farmers in cassava production initiatives such as mobilising farmers and training them to effectively respond to disease outbreaks, demonstrates how perspectives can be influenced through farmer participation in the research stage of new technologies. Ugandan farmers typically take a long time to adopt new crop varieties recommended by the agricultural research station, however their involvement in yield studies as well as workshop training, resulted in the rapid uptake of the new variations.

In PNG, similar scenarios regarding the slow uptake of new taro varieties were reported by Tanabi and Halim (2012). Due to the established market, farmers prioritised the production of local cultivars as opposed to the new, high yielding varieties recommended by NARI.

PNGUOT's research on the use of biological pesticides (fungus-based) as an IPM option is new, and therefore farmer adoption in PNG is likely to be quicker. Moreover, almost all sweet potato and taro farmers practice organic farming, whereby outdated, cultural methods are relied upon for pest control. Research and development of bio-pesticides is well suited for organic farming practices, as their environmental impacts are non-existent.

Bio-pesticides generally have a low level of uptake due to their slow kill characteristic (Rossell *et al.*, 2008), however advantages over traditional insecticides include: reduced environmental damage; specificity of pest target(s) and low production costs for cottage industries (Grimm, 2001). The production initiative models used in Uganda can be applied in PNG; where women are more involved in farming (Kinch, 2007; Tanabi and Halim, 2012) and technology transfer. Through the department of agriculture's SPISARD outreach programme, training can be channelled to increase the involvement of women farmers in PNG into using the new technology. Training on simple pest identification and their biology to farmers is vital and will enhance successful management of principle pests. Many farmers lack knowledge in this area and consider it of high importance (Tanabi and Halim, 2012).

Lessons learned

Many notable lessons were learned during the course of the WCRTC held in China, the most important will be discussed in this section.

Linking farmers with researchers remains a challenge. This can be seen through the introduction, spread and dominance of the *E. batatae* weevil in PNG. First detected in sweet potato crops in 2014, *E. batatae* was previously unidentified because of its minute size and similar infestation characteristics to that of *C. formicarius* (i.e. the tunnels made on the tubers by these two species cannot be easily distinguished).

The adoption of new technologies by farmers is not just a problem in PNG, but an issue globally. However, I am optimistic that the research of PNGUOT will be accepted, especially if considered alongside examples of success from other countries.

Pest and disease management in PNG is yet to reach the stage of utilising genetic manipulating tools for IPM, as seen in China and other developed countries. The focus remains on reducing the use of synthetic pesticides and promoting ecologically-friendly management tools.

Sourcing disease-free planting materials is one method for minimising the dominance of pests and the spread of disease to new areas. In PNG, farmers have problems with sourcing pathogen-free tested (PT) planting materials and this, in return, contributes to yield declines. Recently PT materials have been multiplied and made available by NARI to farmers in the higher altitudes. However, although the PT materials may stop the spread of disease, they are still subject to weevil infestations.

The involvement of the private sector in RTC research is lacking. This may be because RTCs, especially sweet potato, are yet to become commercialised due to the prevalence of infestations by pests and diseases. However, PNGUOT is taking steps to involve companies of the private sector in RTC research such as AgMark Ltd and the FPDA.

Moreover, the involvement of women farmer groups must be promoted to improve RTC research. Due to the cultural 'gender-bias' of PNG, the participation of women farmers has thus far been discouraged. Sixty percent of farming is carried out by women, hence this attitude has had a negative impact on agricultural developments (Allen, 2009). Countries in the sub-Saharan region, such as Guinea, Ghana and Uganda have commercialised seed sources, which are owned by women and youth farmer groups.

Another notable lesson is the need for the involvement of state and national governments in supporting research and development. This is non-existent in PNG although the government stresses the importance of agricultural development. Support through research grants and human resource development in the area of agricultural research is not available, and is needed to assist the majority of the population who are rural-based. The lack of available and suitable facilities should also be addressed by the PNG government to aid mass production.

Conclusions, recommendations and way forward

RTCs play an important role in food security and income generation in PNG, particularly for those based in rural areas. Sweet potato production constitutes more than 50% of all locally grown produce, however, pests and disease are damaging yields. Management of sweet potato weevils (*C. formicarius*, *E. batatae*) can be achieved through the development and integration of fungal-based insecticides, and barrier plants in smallholder farms. Such developments can be used to deter pest infestations and improve tuber yields, whilst reducing environmental degradation. Not only would such technology improve crop yields, it would also reduce farmers' reliance on traditional insecticides, thus decreasing imports and costs. The challenges and successes of sweet potato IPM can be applied for other RTC and cash crop protection.

The involvement of the private sector in plant protection and pest mitigation strategies is crucial for development. Equally important is the increased involvement of female farmer groups in research and training, as more women than men are involved in farming in PNG.

PNGUOT has been working with farmers and the private sector through its agricultural department and outreach programme SPISARD. Farmers received technology training such as product value-adding, horticulture training and livestock husbandry, both in-house and on model farmer fields.

The alliance of PNGUOT with agricultural research institutes, such as NARI, addresses farmers' needs through collaborative research and training. The SPISARD model has been effective in extending the research findings of PNGUOT to the farmers that need it. Funding has been, and remains, a limiting factor.

A large proportion of the PNG population dwell in rural areas, and is largely dependent on agriculture for their livelihoods. Therefore, agricultural developments in PNG should be the priority of the national government. Developing infrastructure and transport for farmers to reach local markets; allocating budgetary allowances for agricultural research project; capacity building for the national research institutions; and reviewing trade policies should be of primary concern. For PNG to move forward with research and development of RTCs, these recommendations and lessons learned from prior case studies should be taken into careful consideration.

References

Allen, B. 2009. 'Agricultural development, policies and governance'. In Bourke, R.M. and Harwood, T. (ed.) Food and Agriculture in Papua New Guinea. Australian National University Press, Canberra ACT, Australia.

Allen, M., Bourke, R.M. and McGregor, A. 2009a. 'Cash income from agriculture'. In Bourke, R.M. and Harwood, T. (ed.) Food and Agriculture in Papua New Guinea. Australian National University Press, Canberra ACT, Australia.

Allen, B., Barclay, K., Bourke, R.M., Gibson, J., Quartermain, A. and Kennedy, J. 2009b. 'Food production, consumption and imports'. In Bourke, R.M. and Harwood, T. (ed.) Food and Agriculture in Papua New Guinea. Australian National University Press, Canberra ACT, Australia.

Coll, J., Guerrero, A., Quero, C. and Rosell, G. (2008). 'Biorational insecticides in pest management'. Journal of Pesticide Science 33 (2):103–121.

Dotaona, R., Holloway, J., Stevens, M.M., Wilson, B.A.L. and Ash, G.J. 2015. 'Screening of tropical isolates of Metarhizium anisopliae (Hypocreales: Clavicipitaceae) for virulence to the sweet potato weevil (Cylas formicarius)'. International Journal of Tropical Insect Science 35 (4):1–11.

Grimm, C. 2001. 'Economic feasibility of a small-scale production plant for entomopathogenic fungi in Nicaragua'. Crop Protection 20 (7): 623–630.

Halim, A. and Tanabi, S. 2012. Production and Marketing of Taro in Papua New Guinea. Paper presented at the 16th Triennial Symposium for the International Society for Tropical Root Crops, held at Federal University of Agriculture, Abeokuta, Nigeria.

Hughes, M. 2013. 'Identifying appropriate strategies for reducing virus and weevil losses in sweetpotato production systems in Papua New Guinea and Australia'. In Hughes, M. (ed.) Final Report HORT/2011/053. Australian Centre of International Agricultural Research, Canberra, Australia.

Kinch, J. 2007. Market Linkages and Business Analysis for the Huon Gulf District, Morobe Province, Papua New Guinea. Report prepared for the New Zealand Agency for International Development, Port Moresby, Papua New Guinea.

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