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Sustainable production of root and tuber crops (potato, sweet potato, indigenous potato, cassava) in southern Africa

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Africa, including South Africa, is faced with a problem of increasing rural poverty that leads to increasing urbanisation, joblessness, crime, food insecurity and malnutrition. Root and tuber crops such as sweet potato and potato, as well as cassava and indigenous potato are important crops for food security. The latter are also important due to their tolerance to marginal conditions. Potato and sweet potato are of great economic value in South Africa, with well-organised marketing chains and, for potato, a large processing industry. There is one cassava starch extraction factory in operation in South Africa. A number of diseases are of importance in potato in South Africa: early blight, late blight, bacterial wilt, scab and virus. Insect pests such as tuber moth and leaf miner are also constraints. In sweet potato the occurrence of viruses and weevils, as well as the availability of healthy planting material are the most important limiting factors in production. African Cassava Mosaic Disease (CMD) caused by a virus, is a problem in growing cassava. Plant biotechnology applications offer a number of sustainable solutions. Basic applications such as *in vitro* genebanking where large numbers of accessions can be maintained in a small space, meristem cultures to produce virus-free plants and mass propagation of popular cultivars in order to make planting material available for sustainable production. More advanced biotechnology applications that may be of value are molecular marker technology and genetic engineering. The latter can play a role in overcoming virus and potato tuber moth in potato, in resistance to CMD in cassava and possibly in sweet potato to incorporate virus and weevil resistance.

Introduction

The root and tuber crops are staple foods for many people in developing areas, and the people most dependent on them are the very poor. Collectively, these crops occupy about 50 million ha world-wide and annual production exceeds 550 million tonnes, about two-thirds of which is harvested in the developing world (Wheatley *et al.* 1995). These crops generally have low labour requirements and can be stored in the ground for periods when the main staple has failed (FAO 1988). Although the potato (*Solanum tuberosum* (L.) and sweet potato (*Ipomoea batatas* (L.) LAM) are very well known root and tuber crops, several others are also utilised in South Africa. Amongst them are the indigenous potato (*Plectranthus esculentus* N.E.Br.) and cassava (*Manihot esculenta* Crantz). Some of these lesser known root and tuber crops have received attention from agricultural scientists at least for the last 20 years due to their tolerance to marginal conditions (Plucknett 1983). This tolerance is considered to be of great importance in South Africa where many rural people need to produce crops in areas where the soil and/or climatic conditions are marginal.

Cultivation of potato, which belongs to the Solanaceae, may have originated in the Andes of northern Bolivia and southern Peru and may date back 7 000 (Hawkes 1994) to 8 000 years (Steyn 2003) ago. The crop was introduced into Europe between 1570 and 1590, and from there spread to North America, and later to the rest of the world (Hawkes 1994). Potato is probably the first crop where breeding for resistance to diseases was initiated. This was caused by the late blight attack that led to the Irish potato famine.

The potato is the world's fifth largest food crop after wheat, rice, maize and barley and plays an increasingly important role in the daily nutrition of resource-constrained farmers. Potato has a high nutritional value and great yield potential and can produce more calories, proteins, vitamins and mineral salts per surface and time unit than the principal cereals or other tuber and root crops (Sasson 1990).

The sweet potato, a member of the Convolvulaceae or morning glory family, is grown for its enlarged storage roots; sometimes the tender leaves and shoots are consumed as a green leafy vegetable. The centre of origin is probably northern South America and southern parts of Central America. It was rapidly introduced to Europe, and later spread to Africa, perhaps from Spain or directly from tropical America. The Portuguese also carried sweet potatoes to India and Southeast Asia (Hall and Phatak 1993, Martin and Jones 1986). The crop was introduced to South Africa shortly after the Dutch colonised the Cape in 1652 (Du Plooy 1986).

The storage roots of sweet potato are a good source of carbohydrates, but also contain substantial quantities of vitamin C and moderate quantities of thiamin, riboflavin and niacin (Woolfe 1992). However, the major potential is with orange-fleshed cultivars since they have high quantities of pro-vitamin A. Recently, it became clear that the orange-fleshed sweet potato (OFSP) can play an important role in alleviating micronutrient deficiencies and since 1999 has been used in food-based approaches for this purpose (Faber *et al.* 2002). These micronutrient disorders are known to impact negatively on the growth and development of children and also to reduce resistance to disease in both children and adults. Micronutrient deficiencies, specifically vitamin A, iron and zinc, are public health problems in South Africa (SAVACG 1996) and elsewhere.

Cassava, a member of the Euphorbiaceae, has been cultivated in tropical America for more than 5 000 years, and appears to have originated in Central America. From there it was introduced to Africa and Asia by the Portuguese during the 16th century, and is now cultivated in more than 90 countries providing food for more than 500 million people worldwide (CIAT 2001). It was first introduced to Mozambique by Portuguese traders in 1750 (Mathews 1999), and it is believed to have been introduced into South Africa during the major tribal movements of the 1830s and 1860s (CIAT 1980, Daphne 1980). The cassava plant is a short-lived shrub propagated through stem cuttings and grown for the five to 10 starch-rich tubers that develop on the adventitious roots a short distance from the stem by a process of secondary thickening (Purseglove 1974).

The indigenous — or Livingstone — potato, a member of the Lamiaceae, is endemic to Africa, apparently having been selected from wild populations in the Upper Niger valley and in the Central African Republic (Portéres 1962, Harlan *et al.* 1976). From these centres of origin the plant spread through the migration of people, and is presently found in a number of African countries, including South Africa.

The indigenous potato is an erect to decumbent perennial aromatic herb or shrublet ranging in height from 60–120cm (Codd 1975, 1985). The shallow fibrous root system produces edible stem tubers, ranging in colour from yellow to brown, which have a high nutritional value at the base of the stems (Temple *et al.* 1991, Allemann 2002a, Allemann and Hammes 2003, Allemann *et al.* 2003). These softly hairy tubers, which can be branched, are roughly cylindrical, 5–30cm long and up to 2cm in diameter. Locals use the delicately flavoured tubers as a substitute for potato or sweet potato, as they can be eaten either raw or cooked. All parts of this plant can be used, with the stems being used to sweeten gruel in some areas of Africa, while the flowers can be pickled (Kew 1996, Allemann 2002a). Although the leaves are strongly aromatic and bitter, they do have medicinal uses in some areas, being used in the treatment of intestinal worms (Burkill 1995).

Value of the Crops for Commercial and Small-scale Agriculture

Today, three of these crops (potato, sweet potato and cassava) are of economic importance in South Africa. Cassava is limited in its commercial usage, and it is still mainly grown as a subsistence crop in South Africa, although there is increasing interest in its use as an industrial crop.

***Potato*:** The annual production of potatoes is on approximately 46 000ha with a yield of around 1.44 million tonnes, valued at approximately ZAR2 billion or USD286 million (Theron 2003). The market for potatoes is well developed in South Africa, with potatoes being sold fresh on the 22 national fresh produce markets (60%), for seed (13%), for processing (19%) and for export (8%). During the 2002–2003 season some 733 173 tonnes of potatoes were delivered to the national fresh produce markets, realising a total turnover of around ZAR1 662 million. Approximately 22% of the table crop is used for processing of which 16.5% is for fresh French fries, 43.9% for frozen fries and 37.4% for crisps (Theron 2003).

The potato sector in South Africa is broadly divided between the large-farmer commercial sector that supplies about 80% of total production and the smallholder sector filling the remainder. Of the 2 100 potato farmers, over 50% are small-scale farmers who sell potatoes to help supplement household income. The small-holder sector is found in the KwaZulu-Natal, Eastern Cape and Limpopo production areas (McCarthy 2002).

***Sweet potato*:** The sweet potato industry is considerably smaller than that of the potato. The average annual production of sweet potato in South Africa from 1991/1992 to 2000/2001, was 57 000 tonnes according to official production figures (National Department of Agriculture 2002). In 2000/2001, 1.4% of the total vegetable production of 3.75 million tonnes was sweet potato. The gross value is estimated at ZAR30–35 million (USD400 000–460 000). However, it must be taken into account that large quantities of sweet potato are produced and sold by the informal sector, which is not reflected in the official production figures. Sweet potato plays an important role as a food security crop in resource-poor farming. The informal sector comprises approximately 50% of the total vegetable production. The total production can, therefore, be estimated at 100 000–120 000 tonnes per annum.

The estimated area under sweet potato production is 2 000–3 000ha. Limpopo (Hoedspruit, Marble Hall, Burgersfort, Levubu), Mpumalanga (Nelspruit), KwaZulu-Natal and Western Cape provinces are the major production areas. Most of the sweet potato produced is consumed fresh. The largest portion (26 000 tonnes) is marketed on the national fresh produce markets (National Department of Agriculture 2002). A considerable quantity is marketed directly to chain stores and sold per kilogram or pre-packed (Thompson *et al.* 1999). The export of approximately 2 500 tonnes per annum to Europe and United Kingdom (PPECB 2003) is a profitable industry. Approximately 2 000 tonnes are taken up by processing plants, of which 1 000–1 500 tonnes are dehydrated and 650 tonnes are frozen. Baseline studies during 1996/97 in target communities of rural areas in Limpopo, Mpumalanga and KwaZulu-Natal provinces showed that consumers eat boiled sweet potato either as part of a meal or cold with tea. (Van der Mescht *et al.* 1997, Thompson *et al.* 1999). To a lesser extent, sweet potato is mixed with groundnuts or maize meal. Processing is limited to sporadic drying and freezing, and making chips or bread. The leaves are sometimes consumed.

However, for both industrial and home processing there is a large potential to expand. In many countries of the world, sweet potato is used extensively in household and industrial processing (Wheatley *et al.* 1995, Woolfe 1992). Sweet potato can be used as filler, e.g. pie fillings or in sauces, in production of starch, beverage, snacks, baked products, or for canning only, to mention a few (Woolfe 1992). ARC–Roodeplaat has developed/adapted recipes for the use of sweet potato in baking products (bread, biscuits, scones, cake bread), fried products (stir-fried leaves, doughnuts, chips), bottled products (juice, jam, chutney) and cooked products (curried sweet potato, sweet potato soup) (Laurie *et al.* 2003a).

***Cassava*:** Commercial interest in cassava began in 1948 for the extraction of starch, but interest quickly waned, with a brief resurgence during the 1960s due to a low sugar price. During the 1970s the crop was looked at for the production of ethanol and cattle feed, as well as for the production of starch (Daphne 1980). During the late 1990s a company started producing cassava commercially in order to extract high quality starch (Allemann 2003). Currently there are two commercial estates in South Africa, both run by this company. The first is a planting of some 2 000ha in the Dendron area of the Limpopo province, where a starch extraction facility operated by the company is located. Recently, they expanded and are involved in establishing a commercial estate in the Barberton area of the Mpumalanga province and are cultivating more than 3 000ha of the crop on commercial scale. Farmers in the Nkomazi region of the Mpumalanga province are also interested in commencing production of cassava for industrial applications (Allemann 2003). Cassava is mostly cultivated in the warmer lowveld regions of the Limpopo and Mpumalanga provinces, as well as in the Makatini flats area of KwaZulu-Natal (Allemann and Dugmore 2003). In these areas it is cultivated mainly on a small scale by subsistence farmers, although there are some farmers who cultivate areas up to 5ha for sale (Van der Mescht *et al.* 1997, Mathews 1999).

***Indigenous African potato*:** The Livingstone potato is very limited in its use at this stage, although it does appear to be very popular where it is cultivated, or was cultivated in the past. Many communities have lost their planting material due to a variety of reasons, not least of which is a shift in the rainfall that has taken place over the last century with rains now starting later in the season. This results in plants dying before the rains start, with consequent loss of material. Communities are interested in planting the crop again, but have been unable to source planting material. People claim that the crop could make them rich if only they were able to get sufficient material. In the Spitskop area of the Limpopo province a saucer full (±250g) of tubers is being sold for ZAR5. Yields of this species are very variable, being determined to a large degree by the climatic conditions in the area as the plant is cultivated under dry land conditions. Average yields obtained by small-scale farmers range from 6–10 tonnes ha^{-1} (Allemann 2002b). Although yields are fairly low in the communities, research has indicated that improved selections cultivated with improved agronomic practices and with good management have the potential to yield around 60 tonnes ha^{-1} (Allemann 2002a). Although the tubers of this crop are usually used as a substitute for potato or sweet potato in the diet, there is no reason why they could not be used for the extraction of starch.

Problems Encountered with the Crops

***Potato*:** A number of diseases are of economical importance in South Africa. Fungal diseases of importance are early blight (*Alternaria solani*) and late blight (*Phytophthora infestans*) (Denner *et al.* 2003). Important bacterial diseases are bacterial wilt (*Ralstonia solanacearum*) and scab (*Streptomyces* sp.) (Gouws *et al.* 2003). Potato leaf roll virus (PLRV) and potato virus Y (PVY) are of concern to South African producers (Thompson and Strydom 2003). To a large extent most of these can be controlled by using certified seed potatoes (Theron 2003). Having to buy fresh seed every year can be a problem for resource-poor farmers, and this can lead to the spread of viral and other diseases where resistant varieties are not used. Only three insects of the wide variety of insects that attack potatoes are considered to be major pests. These are the potato tuber moth (*Phthorimaea operculella*), the potato leaf miner (*Liriomyza huidobrensis*), and aphids, although the latter are only pests for seed producers as they are virus vectors (Visser *et al.* 2003).

During community projects by ARC–Roodeplaat in three provinces in SA, communication with farmers revealed the following information. Average yields for small-holder farmers are 13 tonnes ha^{-1} as compared to 30 tonnes ha^{-1} for the large-farm commercial sector (Theron 2003). The yields are generally lower due to lack of money to buy pesticides and fertiliser, as well as lack of access to good quality planting material and irrigation water and lack of knowledge on production of potatoes. Moles and late blight are a major pest problem encountered in KwaZulu-Natal and the Eastern Cape. Drought is a major concern in the drier areas. Because of the low input used, small farmers need different types of varieties than do commercial farmers and the varieties have to be compatible with the taste and market preferences of the areas.

The ARC–Roodeplaat potato breeding programme has developed new cultivars that are better adapted to South African conditions, more disease resistant and better suited for niche markets such as processing (Theron 2003).

***Sweet potato*:** Usually low yields are obtained by resource-poor sweet potato farmers in South Africa. This is caused by using old land races and re-using planting material resulting in build-up of virus infection (Laurie *et al.* 2002). Samples collected during a number of baseline surveys, showed that up to 90% of cuttings samples were found to be infested with virus (Jericho and Thompson 2000, Laurie *et al.* 2001). Virus infection is the main disease-limiting factor in sweet potato production and worldwide the major cause of yield loss (Salazar and Fuentes 2001). Yield loss occurs even though no symptoms might be seen on the leaves (Laurie *et al.* 2001). In South Africa it is predominantly Sweet Potato Feathery Mottle Virus (SPFMV) that occurs (Laurie *et al.* 2001) and is transmitted by aphids (Moyer and Salazar 1989). In terms of pests, sweet potato weevils are the most destructive pest of sweet potato world wide (Janson and Roman 1990). Likewise in South Africa, weevil damage caused by *Cylas formicarius* is frequently found (Thompson *et al.* 1999). Except for disease/virus-free material, the availability of planting material as such is also regarded as one of the main limitations in sweet potato production (Van der Mescht *et al.* 1997).

In South Africa, a Sweet Potato Plant Improvement Scheme was initiated by ARC–Roodeplaat in the 1970s (Laurie and Stork 1997, Laurie *et al.* 2001). Virus-tested stock plants are produced at ARC–Roodeplaat and serve as source of material for multiplication by registered vine growers. An estimated 80–90% of sweet potatoes produced commercially in South Africa, originated from these virus-tested stock plants issued by ARC–Roodeplaat no longer than two to three years ago. Replacement on a three-year basis is adequate to retain yields. Much has also been done at ARC–Roodeplaat to develop improved cultivars with the taste that resource-poor farmers prefer in order to replace the low-yielding old land races (Laurie and Van den Berg 2002, Laurie *et al.* 2002). Recently seven new cultivars were released (Laurie *et al.* 2003b). Initiatives to establish nurseries with improved cultivars to resource-poor farmers from the ARC–Roodeplaat breeding programme commenced in 1997. Virus-tested stock material of cultivars selected in evaluation trials with participation of farmers, are supplied to nurseries at target sites (Laurie *et al*. 2003a). Without a sustainable supply of clean planting material, production of sweet potato cannot be sustainable.

***Cassava*:** Two major problems have been noted with cassava in South Africa. The most important of these is African Cassava Mosaic Disease (CMD), which is caused by a geminivirus. The vector for this disease is the sweet potato whitefly, but the major spread of the disease has been through planting of infected cuttings (Van der Mescht *et al.* 1997, Mathews 1999). CMD can cause yields to fall by as much as 90% over time as the leaves become badly deformed and reduced in size and efficiency (Thresh *et al.* 1994). The major insect pest is the cassava mealy bug (*Phenococcus manihoti*), which attacks the growing points of the plants and is very difficult to eradicate (Van der Mescht *et al.* 1997, Allemann 2003). At this stage the best control methods for these two pests are the removal and burning of infested plants. A large problem for the small-scale producers of this crop is the poor availability of improved planting material. The commercial estates produce their own planting material, but small-scale farmers rely on either their own material, or obtain material from friends or relatives (Allemann 2003). In many cases this material is already infected with CMD.

***Indigenous African potato*:** Producers of the Livingstone potato complain that they cannot get enough planting material to be able to keep up with demand. This becomes a major problem during very dry years, when all material gets used as food, and new material needs to be supplied (Allemann 2002b). At this stage no virus problems have been identified on this species, and the only diseases noted have been caused by facultative pathogenic soil-borne fungi (Allemann 2002a).

Potential Solutions Presented by Biotechnology

Plant biotechnology applications offer solutions to several problems encountered by producers of these root and tuber crops, many of which can be solved using similar techniques for all the crops. Routine basic tissue culture techniques such as meristem cultures to produce virus-free plants, *in vitro* genebanking, and *in vitro* mass propagation are very useful tools. The use of more advanced applications such as molecular markers to assist breeders to identify proprietary cultivars as well as to avoid duplication in genebanks, can possibly contribute. Biotechnology can also be used to assist in breeding of vegetatively propagated species when no seed is produced and thus making conventional breeding techniques impossible. Mutation breeding could also prove successful. Finally genetic engineering has a role to play, with the development of genetically modified plants that are resistant to insects and virus diseases and abiotic stress.

Sustainable Biotechnologies for Root and Tuber Crops

Being vegetatively propagated species, it is not possible to store the genetic material of these root and tuber crops in seed genebanks. Genebank accessions have to be conserved in vegetative form. In the past this was done by keeping the material in open field genebanks, which led to several problems related to the control of pests and diseases, and was not an ideal situation. Today genetic material is conserved *in vitro* resulting in almost no danger of pests and diseases, and at a considerable saving in terms of space. At ARC–Roodeplaat, 950 potato breeding lines, 96 commercial potato cultivars, 55 cassava accessions, 257 sweet potato accessions and 10 indigenous potato accessions are being maintained *in vitro*. For potato, growth is slowed by addition of Alar 85 to the culture medium and maintaining the cultures at 4–7°C (Brink 2000). Cultures remain viable for up to two years before they need to be transplanted to fresh medium. This collection is the foundation of the Seed Potato Certification Scheme of South Africa. A total of 7 800 *in vitro* plants of six potato cultivars prepared at ARC–Roodeplaat, have been used to produce mini-tubers for shipment to Zimbabwe.

Sweet potato is kept at 18°C and can be stored for a year. The sweet potato *in vitro* collection serves as back-up for the *in vivo* collection and is only propagated for the sweet potato breeders on a very small scale. The *in vitro* collection is also a safe way to distribute new cultivars from the

ARC–Roodeplaat breeding programme to SADC countries for evaluation. *In vitro* plants of 18 sweet potato cultivars and breeding lines were recently shipped to Namibia.

The multiplication ratio of vegetatively propagated species is far lower than that of seed propagated species, and this results in a fairly long period of multiplication before plants are released to producers. Using tissue culture techniques this period can be reduced, and all plants are identical to the original mother plant. In the ARC–Roodeplaat potato breeding programme, promising selections are micropropagated (c. 50 000 plantlets annually) for further evaluation. Micropropagation provides a secure base for potato seed production in the South African Potato Industry. Currently approximately one million plantlets are produced in four laboratories. More than 3.5 million Generation 0 (G0) minitubers are produced from these ex-vitro plantlets (Nortjé 2003).

Virus elimination through meristem-tip culture coupled to heat therapy, has been done at ARC–Roodeplaat since the 1970s for sweet potato and since 1979 for potato, and recently also for cassava and the African potato. Approximately 161 potato lines and 25 sweet potato land races have been made virus free. The technology also contributes to sustainable production in other countries in southern Africa. Six sweet potato varieties from each of Uganda, Zambia and Tanzania, and one from Malawi have been made virus-free at ARC–Roodeplaat. Four cassava varieties from Malawi and five from Tanzania have also been freed of virus at ARC–Roodeplaat. Virus-free planting material of these varieties is now being shipped back to the countries of origin (Bothma and Vcelar 2003).

Pilot trials into the reproductive behaviour of the variety of *Plectranthus esculentus* being cultivated in South Africa have revealed that no seed is set, although the plants do flower. This problem can occur with species that have been vegetatively propagated over many years. This makes conventional breeding impossible with this variety, and other breeding methods need to be investigated. Selection from the existing gene pool could improve the situation, and possibly polyploidy, as this has been shown to increase the size of underground storage organs in plants such as ginger (J Vos, ARC–ITSC, Private Bag X11208, Nelspruit 1200, South Africa, pers. comm.). But this too has its limits, therefore further work on improvement moves into the field of more advanced biotechnology applications. The only possibility for true changes in the plant appears to be mutation breeding where irradiation is done on *in vitro* plant material.

At this stage the use of genetic engineering would appear to be limited mainly to three crops, viz. potato, cassava and sweet potato. The work on cassava is limited to attempts to engineer resistance to CMD. Although the coat protein sequence has been known for many years, problems are encountered when the plants are tested in the field. It therefore appears as though it will still be some time before this technology becomes readily available to producers, and how sustainable the intervention will be, remains to be seen. On the other hand, conventional breeding practices appear to have achieved some success in developing tolerant varieties (Whyte *et al.* 2003).

Molecular marker technology is valuable for a number of reasons. First, to avoid duplication in genebanks; second, to characterise cultivars in order to maintain them true to type; and third, to protect proprietary cultivars (Smith 1998). DNA fingerprinting for cultivar identification has been used at ARC–Roodeplaat for potato and sweet potato. With this method 48 potato cultivars and 21 sweet potato cultivars can be identified (Brink 2000, McGregor *et al.* 2000). DNA-profiles for the commercial potato cultivars ensure that the source in the National Cultivar Collection is true to type.

Potato was among the first crops to be genetically modified. At ARC–Roodeplaat research has been conducted on producing GM potatoes resistant to PLRV and PVY (Brink 2000) as well as resistance to fungi and drought (GJ Thompson, ARC–Roodeplaat, Private Bag X293, Pretoria 0001, South Africa, pers. comm.). Transgenic lines challenged with PLRV in the glasshouse showed some resistant lines but when tested in field trials, the resistance was not as good as in the glasshouse and tuber quality was negatively affected (Brink 2000). Genetic engineering protocols have been developed for eight potato cultivars (Brink 2000). GM potatoes, containing a gene from *Bacillus thuringiensis* (Bt), are presently being tested in a number of localities in South Africa for resistance to potato tuber moth. Indications are that this GM potato is very successful, with 100% resistance to the pest, in both leaves and tubers (D Visser, ARC–Roodeplaat, Private Bag X293, Pretoria 0001, South Africa, pers. comm.). This intervention should have a fairly large impact on potato farmers once the material is released. The impact of this technology for small-scale producers will depend on the establishment of a sustainable and affordable seed supply system for this sector.

In Kenya, South Africa and the USA research work is being conducted on genetic engineering of sweet potatoes for virus resistance (ISAAA 2003). Although sweet potato improvement via genetic engineering is well documented (Brink 2000), some of the best South African sweet potato cultivars seem to be difficult to regenerate (Daniels 2001). Also genetic modification may be the only solution for resistance to sweet potato weevil since no resistance has been found through conventional breeding (D Zhang, International Potato Centre, Lima, Peru, pers. comm.).

Conclusions

Plant biotechnology should be able to provide support for initiatives on these root and tuber crops. The utilisation of biotechnology applications have already been significant in the potato crop in South Africa and certainly have made a huge contribution to the prosperity of potato producers, the industries, as well as the South African economy (Brink 2000). This provides an example of the possible value of biotechnology to other African countries and to the other crops.

Research networking will be very important towards achieving sustainable production of root and tuber crops. ARC–Roodeplaat is linked to various stakeholders and networks nationally and internationally, especially in Africa. Two major recent efforts include the involvement in the Vitamin A for Africa (VITAA) initiative, which aims to contribute towards health of rural populations in Africa through food-based approaches utilising OFSP. The Southern African Root

Crops Research Network (SARRNET) focuses on research to promote production and processing of cassava and sweet potato and thereby increase household food security and income generation.

A key issue is to make deliberate investments in technology development and transfer that will create increased market opportunities and production potential for these crops. Such technologies could lead to increased and more stable access to and availability of micronutrient-rich foods (fresh and/or processed) throughout the year, more stable income for farm households, processors, traders and exporters. The increased income generated from sales of fresh and/or processed products would also lead to increased food security for various groups in South, southern and central Africa.

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