Sustainable agriculture for the future

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Water

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Hydroponics – linking food security and finance

Introducing cassava

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Manihot esculenta Crantz Subspecies *esculenta*

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A crop with significant potential for climate risk mitigation, improved household food and feed security and import substitution for industrial starch and related industries

Cassava is an important root crop and a source of dietary energy to over 700 million people in tropical and subtropical regions of the world. It is a drought tolerant crop where 30 - 40 tons per hectare of yield can be achieved under rain-fed conditions. However, research demonstrates that this yield can be more than doubled if the crop was to get moderate production inputs such as supplementary irrigation and fertilisation. The starch derived from cassava, per unit land, water and agricultural inputs, is higher than that of food crops currently cultivated in SA. In addition to food and feed products, cassava starch has multiple industrial applications in products such as confectionery, sweeteners, textiles, paper, animal feed and alcohol industries. In Africa, unlike SA, cassava is mainly grown as a staple food crop. However, there is a growing demand for cassava in South Africa owing to the combination of the crops' adaptability, erratic rainfall in rain fed smallholder agriculture, market opportunities created by migrant population from other African countries, acknowledgement of the crops' value and research investment by state role players as well as the needs for product diversification and import substitution.

Preliminary public sector research on the crop demonstrated that, cassava can play a significant role in economic and social empowerment of the smallholder agriculture sector. It is reported that, in South Africa about 2.5 million households practice small-scale and subsistence farming. Supporting and strengthening the smallholder farmers will have multiple benefits towards enhancing productivity and food systems resilience; cassava can be a major tool to achieve these through a holistic value chain development approach in transferring relevant and appropriate technologies to farmers.

Cassava for food and nutrition security

Cassava is the fourth most important source of calories in the developing world after wheat, maize, and rice. In Africa, it is the second most important staple food crop after maize and consumed by more than 40% the African population. Cassava roots are rich in carbohydrates and have the potential to produce and store more carbohydrate per unit area than any other major grain and root crops. Cassava roots produce a starch content that is 40% higher than rice and 25% more than maize. The roots are the main economic part of the mature cassava plant

and consumed as boiled or fried and also prepared as fufu, bread, cake, snacks and local alcoholic drinks. Cassava roots can also be converted into many agroprocessed food products, such as chips, pellets, pasta, flour, purified starch and beer (Figure 1). As a food crop, cassava is a good source of Vitamin C, thiamine, riboflavin, and niacin. Tubers have many health benefiting attributes like gluten free, fat-free, and can be part of a vegetarian diet. The nutritious leaves are also used for human consumption as a green vegetable and/or animal feed. The leaves are rich in calcium and proteins and scientific studies show that 100 g of cooked cassava leaves provides about 3.7 g of protein. Moreover, the leaves contain essential amino acids such as lysine, isoleucine, leucine, valine, and arginine that are not common in green leafy plants.

Cassava as food bank

After the crop attained maturity, cassava roots can be stored in the ground for up to two years; harvested at any time of the year when the household needs food. As the plants stays longer on the field, more dry matter and starch is accumulated. It was reported that, for varieties with longer growth cycle, yields of fresh and dry roots as well as starch increased progressively from 8 - 18 months after planting. This flexibility in harvesting is the most important feature of subsistence farming when the crop is used for food security; no storage and cold-chain technologies are required. The wide harvesting window allows cassava to act as a famine reserve food. Furthermore, the natural high storability of cassava in comparison to other root crops allows farmers to better access market opportunities, earn higher market prices and enable farmers to manage labour schedules. At a household level, a family of 5-7 people can have access to food for an entire year from not more than 300 plants. Considering the average planting density of over 10 000 stems per hectare, it takes less than a third of a hectare

Figure 1. Diverse food and food products made from cassava roots (Photo Curtesy of Google Images)

to provide the annual starch requirement of a family in addition to the leafy green that can be harvested year-round to provide essential nutrients. At a recent (September 2021) two-day farmer engagement workshop held in Tzaneen, seven harvested cassava plants were able to cater two lunches for ± 40 participants (1 X starch and 1 X Leafy veg dishes each day).

Cassava for climate risk mitigation

South Africa is a water-scarce country and only 12% of its land is suitable for agriculture. Only 1.3 million hectares of the arable land is under irrigation and consumes more than 60% of the available water. Besides, few crops such as maize, potato, wheat, sugar cane, sunflowers and fruits that require irrigation dominate the agricultural productions' water demand. It was reported that the north-eastern and eastern parts of the country, where most agricultural productions take place, showed high climate vulnerability risk. The current climate changes observed in rainfall amount and distribution, increased temperature and reduced water quality and availability call for more sustainable solutions. Diversification of the crop base through introduction and selection for more climate-resilient crops will contribute to food, nutritional and income security without contributing significantly to an existing water deficit. Cassava has been proven to be resilient to changing climates and could provide South Africa with options for adaptation, whilst other major staples crops like potato, maize and wheat face challenges. These crops have been grown under irrigation and fertilization for optimal production, while underutilized crops such as cassava could produce a reasonable yield under rain fed and minimal input conditions. Cassava can be grown in marginal lands, low-fertile acidic soils, and under variable rain-fed conditions ranging from less than 500 mm per year in the semi-arid tropics to more than 1000 mm per year in the sub-humid and humid tropics. The low input land-use systems on a sustainable basis could be of great benefit to rural resource-poor farmers.

Cassava for import substitution

South Africa has a market-oriented agricultural economy that is highly diversified. However, in 2020, South Africa spent about R101 billion ($6.3 billion) to import agriculture and food products. Maize is the largest locally produced grain crop, and the most important source of carbohydrates in South Africa for animal and human consumption. It is estimated that in South Africa, maize accounts for approximately 95% of the country's industrial starch production; where 37% of the crop is used for food, 40% for feed, 18% for export, and 5% for industrial starch. Competition between industries utilizing corn products

has resulted in the failure of the local starch industries to meet the starch demand of the country. Hence, South Africa is importing more than 66,000 tons of starch annually. It was reported that cassava starch is the preferred starch in South Africa in terms of imports and fetches a higher price on the market than maize, potato, or wheat. Hence, more than 33% of the imported starch is cassava (tapioca) starch. This signifies that the estimated demand for cassava starch alone is 20,000 tons per annum. South Africa sources its cassava starches mainly from South East Asia and spends about R6.8 million to import cassava starch annually. Should we decide to produce the imported starch locally, it would require more than 300,000 tons of cassava roots for milling and about 26,000 hectares of land under cassava production. If small-scale farmers with 5-10 hectare of land would participate in the production of cassava roots, it will create a job opportunity for 3000-5000 farmers in addition to the foreign currency savings from import substitution. Hence, setting up rural cassava producers and associated enterprises will create sustainable jobs, income sources and improved livelihoods of rural community. Moreover, exploitation of cassava as animal feed (cassava hay, chips, and pellets) and industrial applications (biofuel feedstock, flour, sweeteners, alcohol, plywood, textiles, and paper) will provide an alternative to the maize industry contributing positively to food price inflation. Producing starch from cassava locally will satisfy local starch demands, avoid competition among staple food commodities, relieve the country's economy from foreign currency strains, and reduce import volumes.

Cassava research at the ARC

Cassava research at the ARC dates back to the early 2000; the early research attempts however, were exclusively on cassava for industrial application and use. They were done in collaboration with the Department of Science and Innovations' Technology Innovation Agency (DSI-TIA). The focus of research back then was on importation and evaluation of industrial cassava cultivars through the ARCs' then Industrial Crops Research Institute. Though this research laid foundation on basic understanding of the crop, it did not progress as required due to a combination of lack of sustainable research investment and limited understanding of the value of the crop by the industry.

The climate uncertainty and increasing demand for starch triggered the need to reboot. TIA then initiated the process to revisit past work and plan new set of research aimed at informing investment on this crop. The TIA-ARC cassava project that evaluated the agronomic performance of multiple cultivars in three provinces (KZN, Mpumalanga and Limpopo) was a direct outcome of this initiative. The preliminary report on the scientific outcomes of this research project is currently under-review. Figure 2 provides some insight into some of the promising varieties under investigation. Concurrently, the ARC is also working at plans to expand the cassava value chain such that the R&D also caters for food cassava.

Outlook of cassava production in South Africa

There are evidences that show cassava (Mitsumbula and Mathapi; Tsonga names for whole plant and leafy part respectively) was once among the staple food crops of South Africans in the frost-free zones of KZN, Mpumalanga and Limpopo. Its production and use, based on personal communication with elders, however, gradually declined due to negative publicity about the crop (related to cyanide) and simultaneous expansion of other crops such as maize. Informed the contrary and having witnessed the crops' resilience against unfavourable climate themselves, farmers in these areas of SA are willing to embrace the crop once again. The research initiative on this crop therefore, came at an opportune time and no problem is anticipated in terms of promoting the crop. In addition, one of the key success stories of the TIA-ARC cassava project was the farmer participatory set up it deployed. Through this project, the ARC has been working on establishing production system, evaluation, and selection of agronomically suitable cassava genotypes in KwaZulu-Natal, Limpopo and Mpumalanga in collaboration with selected farmers. The participatory nature of the project attracted interest and

participation beyond the participating farmers. Consequently, large number of farmers have shown a growing interest in cassava farming in the country. During the past two years, we have been receiving planting material requests from farmers, government and academic institutions regularly. Unfortunately, the supporting technologies required for vegetatively propagated crops such as cassava development of nuclear material in vitro and establishment of production nurseries are not in place; hence planting stocks cannot be accessed by farmers. In addition to the need to urgently invest on these enabling technologies, thorough understanding of the possible drivers of cassava industry in South Africa is important. The short, medium and long term outlook of the industry will depend on these drivers. Some of these include;

- The key to exploiting the full potential of cassava largely lies in the establishment of national R&D strategy that focuses on satisfying the local starch demand in the short term and export oriented starch production in the long ran. Cultivar development to enable this demand is among the highest priorities.
- Traditionally, cassava is exclusively propagated using stem cuttings. To address the growing demand, development of efficient propagation protocol and establishment of field propagation nurseries and supporting in vitro technologies are critical.
- Adequate training on cassava production, processing and marketing is essential for farmers to acquire the necessary knowledge and skills to exploit the full economic potential of the crop
- Awareness creation on the economic and ecological benefits of cassava to researchers, policy makers, producers, and processors through workshops, conferences, news channels and promotional platforms is vital
- Market creation and diversification for cassava food products is one of the key drivers of cassava value chain development in South Africa. Currently the demand for food cassava is relatively small, however, there is the potential to develop cassava products that are affordable and attractive to consumers in South Africa
- The processing industry should play a key role in driving cassava product development and engage small and large starch processing enterprises in South Africa. Investment in cassava processing and product development can contribute to food and income security, job creation and revitalization of the rural sector

Cover photos by:
Professor MW Bairu and Dr W Jansen van Rensburg; From the Technology Innovation Agency-funded multi-location cultivar evaluation trials in KZN, Mpumalanga and Limpopo. Enquiries at bairum@arc.agric.za

Figure 2. Some promising cassava cultivars under evaluation at the ARC (Photos by Roelene Marx and Prof MW Bairu)