SUSTAINABLE AGRICULTURE

Could SA's food secure future lie in the fruit of its indigenous trees?

Indigenous fruit trees could help feed our hungry and create jobs. But how water-wise are these 'Cinderella species'? A new study provides some answers. Matthew Hattingh reports.

Fruit is fab. Eating the fleshy seed-bearing structures of angiosperms can do wonders for one's health, a slew of studies tell us. Fruit contains important trace elements including iron, zinc and copper. Many are chock-a-block with carbohydrates and vitamin C. It is said to defy diabetes, head off heart disease and even keep cancer in check.

The World Health Organisation is so sold on it, it reckons we should be eating at least 600 g of fruit and veg a day. The reality though, is that South Africa's poor cannot afford to. The country is rightly famous for its Outspan oranges, gorgeous table grapes and other orchard exotics. But much of these are grown for export or the well-heeled and for many of our countrymen remain like those delicious peaches at the top of the tree – beyond reach.

But what if more people, particularly the two-fifths of South Africans living on communal lands in rural areas, were encouraged to grow indigenous fruit? After all, the country is blessed with a bounty of indigenous fruit – more than 35 species – and many are tasty or nutritious. Marula (*Sclerocarya birrea*), for example, has an appealingly tart flavour (which famously finds its way into a top-selling liqueur brand) and, according to the literature, contains up to four times more minerals and vitamin C than commercial oranges.

The fruit of the baobab tree (*Adansonia digitata*) is said to be even better for you, offering nearly 10 times as much vitamin C as supermarket oranges. Only, good luck finding any at your local Spar.

Perhaps best of all, indigenous fruit trees are adapted to local conditions and bring wider, ecological benefits. They resist pests and diseases and survive without irrigation. This makes indigenous fruit well suited to subsistence farmers eking out a living from the frequently parched and degraded soils of our country's former homelands.

It's this drought resistance and a widely held perception they are more frugal water users than exotics that has fuelled fresh interest in propagating and ultimately growing indigenous fruit commercially. Much of South Africa is semi-arid and water is increasingly scarce. Meanwhile, the spectre of climate change looms. We face a growing likelihood of more frequent droughts, higher temperatures and water losses to evaporation. Alternative crops to support our economically important agricultural sector and to feed the less fortunate must be found.

All of which brings us to a Water Research Commission study published in August, titled ***Water use and yield of selected indigenous fruit tree species in South Africa*** (**WRC Report No. 2720/1/22**).

So, do indigenous fruit trees use less water than the exotics in commercial orchards?

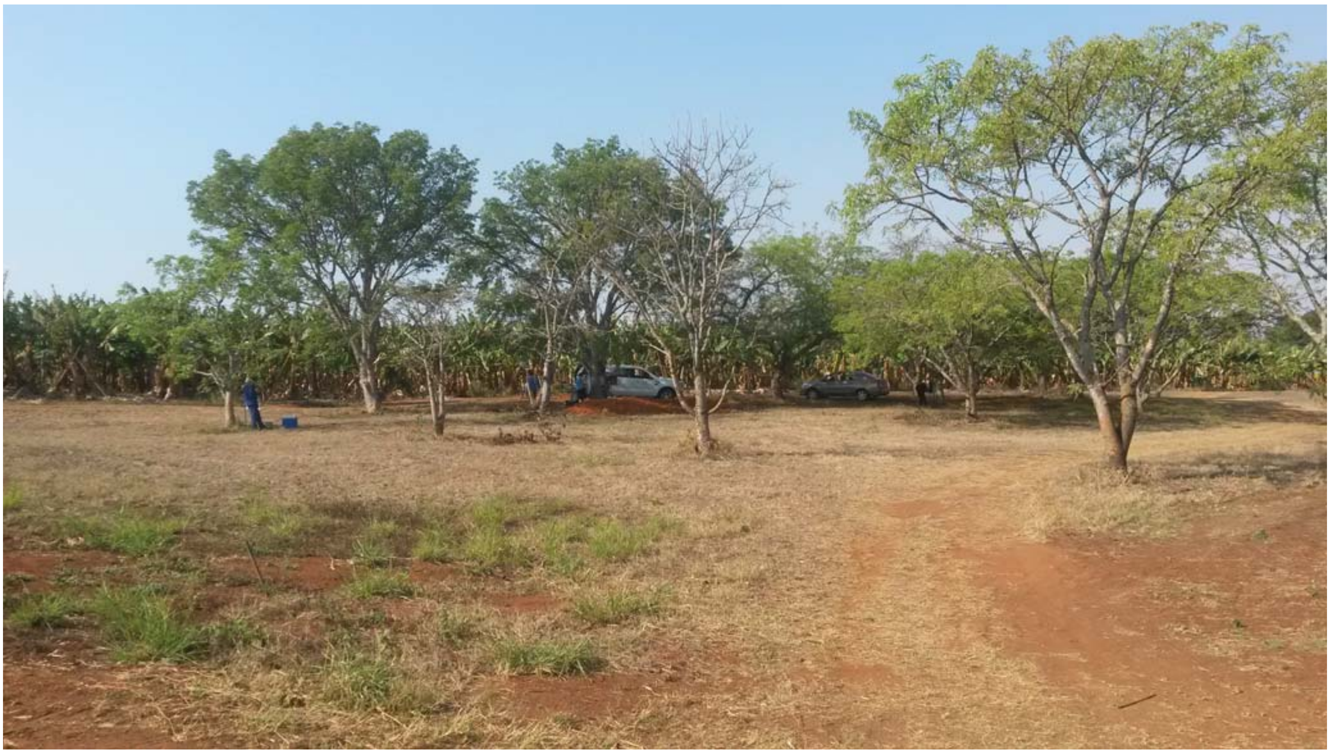
The study, completed over five years, found that some certainly do. However, when water was plentiful some trees set aside their slow-sipping ways and turned to drinking like so many lapsed drunks falling off the wagon. The report also cautioned against generalising. Species and conditions vary significantly, and yield must be considered too. While indigenous trees may use less water than exotics, this should be measured against the quantity of fruit produced for a given quantity of water.

The authors – Zanele Ntshidi, Sebinasi Dzikiti, Nompumelelo Mobe, Nontuthuko Ntuli, Rosemary du Preez, Noluthando Nkosi, Lindokuhle Buthelezi, Lumko Ncapai, Leopold Wilkens and Mark Gush – made the point that the production and consumption of indigenous crops have long been declining as farmers switched to higher-yielding and more valuable exotics. Part of the reason for this, they said, was a dearth of research and information on indigenous species and the authors hoped their findings would support the development of indigneous fruit trees as a crop.

"Our goal at this point was really not necessarily to end up with a fully-developed commercial crop, but rather to provide baseline information to other researchers they can use down the line in transferring from wild unmanaged trees to a fruit crop," said Dzikiti, addressing a workshop on Mainstreaming Indigenous Fruit Trees and Food Crops, hosted by the WRC in August 2022. The report aimed to quantify water use by selected species and to understand how these responded to variables, including soil conditions and climate so recommendations could be made on species suited to specific areas.

With limited time and money, the authors – representing the Council for Scientific and Industrial Research (CSIR); the University of Zululand's Botany Department; the National Port Authority, Richards Bay; the Agricultural Research Council (ARC) Institute for Tropical and Subtropical Crops; Stellenbosch University's Horticultural Science Department; and the UK's Royal Horticultural Society – were anxious to narrow the field of study, so at the outset roped in other experts for guidance.

Twenty-six participants gathered at the University of Zululand to talk about indigenous fruit trees. They wanted to agree on species that produced an abundance of fruit with some commercial



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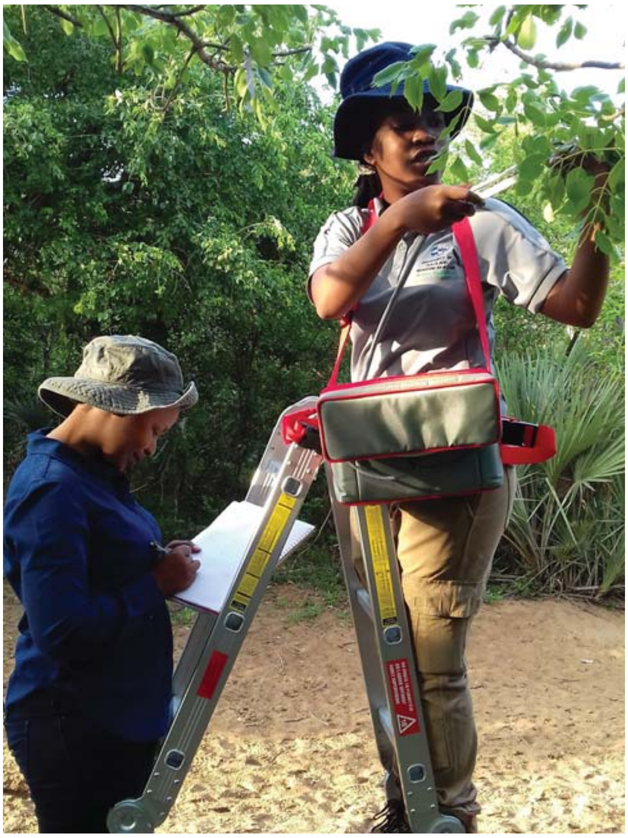
A marula orchard at the Agricultural. Research Council's Institute for Tropical and Subtropical Crops in Nelspruit. Marula trees observed in Mpumalanga during the study appeared "much happier" and considerably larger than those in KwaZulu-Natal and experienced less water stress.



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Members of the research team observing leaf growth during the study.

value. The trees needed to be easy to grow and drought and disease tolerant. On the checklist too were ease of harvesting, transportation and storage. Over the course of a day in October 2017, the workshop came up with 10 species. The participants then whittled down the list to five.

In order of priority, these were:

- *Sclerocarya birrea* (marula);
- *Strychnos spinosa* (monkey orange);
- *Vangueria infausta* (wild meddler);
- *Dovyalis caffra* (Kei apple); and
- *Syzygium cordatum* (water-berry).

Dzikiti remarked in August that the list looked a "little controversial" because it excluded "obvious" species, including baobab. "Part of the reason for this was because most of the participants at the stakeholder meeting were from the nursery side of things and had strong opinions on species that can easily be propagated in the nursery situation."

The team gathered data on the different species at Bonamanzi Game Reserve, near Hluhluwe in KwaZulu-Natal; and ARC in Nelspruit and near Hazyview, in Mpumalanga. But for the purposes of this article we will limit ourselves mainly to the work done on marula and monkey orange at Bonamanzi and marula at Hazyview.

Data collection and logging was largely automated, with instruments set up to measure the micro-climate and soil-water content changes as well as sap flow and leaf gas (water and carbon-dioxide) exchange during photosynthesis. In Bonamanzi, fruit was counted while unripe (to beat monkeys and other wildlife to the punch) on a cross-section of branches to estimate yield.

Dendrometers were wired up to record fruit and trunk growth. This was so growth curves could be mapped to see how seasonal and cyclical changes as well as water availability, weather and other variables affected growth. Data was gathered over two years because the team suspected alternate bearing. This is when trees overproduce in one year and underproduce in the next. Recordings from January 2018 to December 2019 let the team average out dips and rises in production.

At Bonamanzi, the research team measured the transpiration of marula and monkey orange trees. Transpiration is when leaves release vapour through pores (known as stomata) during photosynthesis. It accounts for most water-use in mature trees. The heat ratio method was used to measure the sap flow of whole trees, which is numerically equal to transpiration. The method involved sticking sets of temperature probes into individual stems. A central probe delivered a pulse of heat which the other probes in the set detected. The heat acted as a tracer for the flow of sap – water, essentially, on its way to the leaves. The different probe sets were wired to data loggers to record flow in litres an hour.

The leaf area index (the degree to which a tree's canopy shades the ground) was measured. And a leaf porometer was used to detect how much gas and vapour the stomata allowed to pass. These and other plant, soil and micro-climate data provided values which were plugged into the well-known Penman-Monteith equation. In their findings published in the ***South African Journal of Botany***, the authors said they were able to demonstrate that using the equation, transpiration could be accurately modelled for marula and monkey oranges, despite differences in the species.

Summarising a few of their findings, Dzikiti said the monkey orange trees at Bonamanzi consumed much more water than nearby marulas despite being much smaller. "At the peak, the marula consumed just above 15 ℓ per day per tree versus 35 ℓ per tree per day of the ***Strychnos*** (monkey-orange)." He noted that marula tended to have a long dormant, leafless period when it did not transpire; with monkey orange this period was short. "So… if you are in an area where water is a limiting factor… [marula] has water-saving benefits."

On the other hand, the authors suggested monkey orange trees, with its fine, dense roots were better at scavenging water and nutrients – and so more drought-resistant – than marula trees, which have deeper tap roots, but few feeder roots. Climate was found to be the biggest factor in monkey orange transpiration. But with marula, the response of its stomata when water was available, emerged as the "strong driver".

What about yield? The Bonamanzi marula fruit were not only relatively small in size, but the average yield of 4.3 kg a tree compared poorly with the same species in Mpumalanga, where the trees produced on average 44.9 kg in season one and 24.6 kg in season two. The authors pointed out the Bonamanzi trees were smaller and grew in leached, sandy, "extremely nutrient poor" soils, with a low soil-water content of just over 8%.

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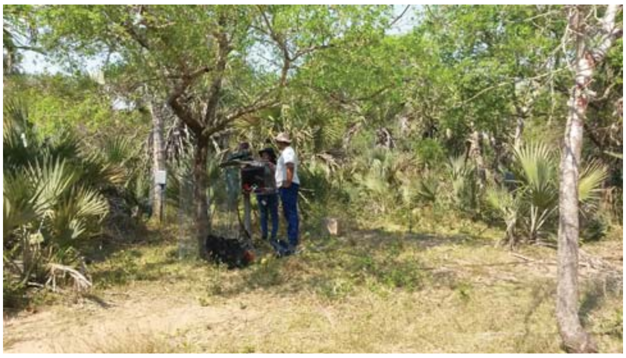

Monkey orange trees in Bonamanzi during their brief leafless period. By contrast marula tended to have a long dormant, leafless period when it did not transpire

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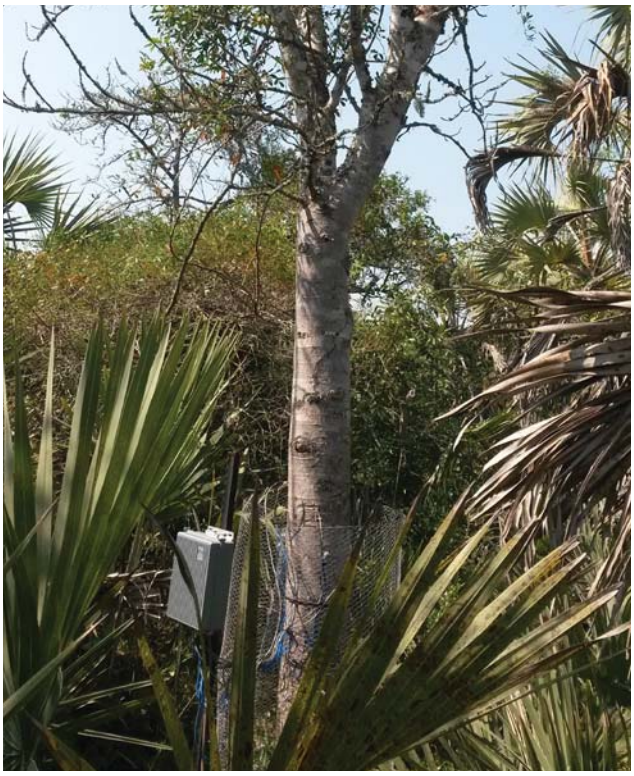

Marulas were instrumented in Bonamanzi to determine their water use.

In contrast, the much bigger Mpumalanga trees appeared "much happier", including those growing in "probably one of the oldest marula orchards in the country" and experiencing less water stress, said Dzikiti. Mpumalanga marula canopies were considerably bigger too, with one particularly large specimen, growing in clayey-loam soils in Hazyview, exceeding 100 ℓ/tree/day.

The authors said the data suggested indigenous fruit trees can use large quantities of water when they can get it. "However, the yield can also be large. For instance, this specific marula tree produced 82 kg of fruit in the 2019/20 season – almost double the yield of a high-performing apple tree."

They noted all the marula trees in the study appeared to be affected by soil-water deficits. The Bonamanzi monkey orange trees produced an average of 15.2 kg. "This suggests you cannot generalise the water use of one species to another," said Dzikiti.

How productive were the trees as water users? The study recorded average yields in Bonamanzi of 2.0 kg of marulas for every cubic metre of transpiration and 2.5 kg/m^3 for monkey orange. "These water productivity values are quite low compared to those of exotic irrigated commercial deciduous fruit under management," the authors said, citing studies which reported water productivity values of 8 to 18 kg/m^3 in Western Cape apple orchards.

This was consistent with the general correlation between transpiration and yield. "Therefore, it is possible the water productivity of the indigenous fruit tree crops could be improved with supplemental irrigation, for high value species like, for example, marula."

They suggested monkey orange, with its greater resilience to drought, might be a productive option for agroforestry where soils are poor or rainfall low. Dzikiti said it was clear that water use varied with conditions and "no one-size fits-all" recommendations could be made.

Further research was needed, "targeting specific species for further development of species into crops". This would include studying how water use efficiency might be improved through tree management. And work would be needed to shorten the time taken to get from a tree's planting to it bearing fruit. Information was lacking on diseases, pollinators and the adaptability of indigenous species to different climates, soils and water availability.

"There are also questions that should be answered on the post-harvest side of things, for instance, the optimal handling techniques of the fruit. How do you store it?" And new indigenous fruit products were needed to add value. "From where we are, we are still a long way to commercialising," said Dzikiti, but he was encouraged by a recent call for tenders from the Industrial Development Corporation for a study to assist in the development of marula orchards and products such as refined marula oil.

To download the report, ***Water use and yield of selected indigenous fruit tree species in South Africa*** (**WRC Report No. 2720/1/22**), Visit: https://bit.ly/3TgscOu

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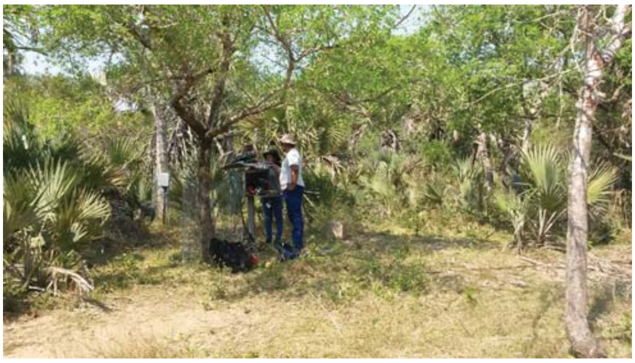

Researchers study data from a monkey orange tree in Bonamanzi during the 2018/19 growing season.