



The macadamia orchard of the future

The South African macadamia industry is entering a new era. Lower nut prices and rising input costs mean that growers can no longer rely on the production systems that have served the industry for years. To remain profitable, orchards will need to produce more high-quality kernel per hectare while requiring fewer inputs. Mechanisation, precision agriculture and improved management practices will all play an important role in reducing production costs. However, these advances alone will not deliver the next leap in productivity. One of the greatest opportunities lies in genetic improvement. This article explores how genetic advances have transformed other tree crop industries, examines the latest research on macadamias, and considers how new cultivars could shape the future of the South African macadamia industry.

Learning from other industries

The evolution of many fruit industries demonstrates the value of combining improved genetics with better orchard design. The apple industry provides an excellent example. In the 1950s, apple orchards were typically planted with fewer than 100 trees per hectare on vigorous seedling rootstocks, producing large, difficult-to-manage trees. Today, modern apple orchards use improved cultivars, dwarfing rootstocks, high-density planting systems and sophisticated training methods. The result has been substantially higher yields, earlier production and significantly improved profitability.

Similar transformations have taken place in citrus, pears, olives and table grapes. While advances in irrigation, nutrition and pruning have all contributed, the greatest gains have come from continuous genetic improvement. Better cultivars have allowed growers to redesign orchards around higher productivity, earlier bearing and greater efficiency. The macadamia industry is now entering the same phase of development.

Genetics: The foundation

For many years, the South African macadamia industry has relied on a relatively small group of proven cultivars. Cultivars such as A4 and 816 have consistently delivered strong commercial performance and will undoubtedly continue to play an important role in orchards for years to come. However, no orchard crop remains static. The most successful fruit industries continually introduce improved genetics, while building on the strengths of existing cultivars. Macadamias are now entering that exciting phase of development.

Several new cultivars are demonstrating the direction in which macadamia breeding is moving.

- MCT1 represents a new generation of high-performing cultivars that combine early bearing, excellent kernel recovery and a naturally compact growth habit, making it well suited to new orchard systems.
- A447, the industry's first dwarfing macadamia cultivar, has the potential to fundamentally change orchard design. Its compact architecture opens opportunities for higher planting densities, easier pruning and harvesting, and greater compatibility with mechanisation.
- A538 can be thought of as a "smaller A4". It offers many of the desirable production characteristics that growers appreciate in A4 but with a more compact tree architecture that is better suited to intensive orchard systems.

These cultivars are examples of the direction in which modern breeding programmes are moving. Future releases from breeding programmes are likely to place increasing emphasis on traits such as higher yield potential, compact growth, precocity, improved kernel quality and suitability for mechanised production. The orchard of the future will therefore not be defined by a single cultivar, but by continual genetic improvement. Growers who adopt superior genetics as they become available will be well positioned to improve productivity and profitability over the lifetime of their orchards.

Designing the modern orchard

While genetics provides the foundation, orchard design determines how effectively that genetic potential is realised. Wilkie (2021) compared different planting densities using the cultivar A203. Five years after planting, orchards planted at higher densities consistently produced higher yields than

conventional systems. Trees planted at 8 × 4 m produced 2.8 t DIS/ha, while reducing spacing to 6 × 3 m increased yields to 3.9 t DIS/ha. At an even higher density of 5 × 2 m, yields reached 4.9 t DIS/ha, and a trellised 5 × 2 m system achieved the highest yield of 5.7 t DIS/ha. These results demonstrate the potential of intensive orchard systems. As more compact cultivars become available, higher-density planting will become increasingly practical, allowing growers to produce more crop per hectare.

Managing tree vigour

One of the greatest challenges of higher-density orchards is controlling tree size. Research has shown several effective tools, including strategic pruning, girdling and plant growth regulators such as paclobutrazol and uniconazole (McFadyen et al. 2013; Yang et al. 2022; Naveena et al. 2023). These techniques can help reduce excessive vegetative growth and improve light penetration throughout the canopy. Ultimately, however, the most sustainable solution lies in genetics. Trees that are naturally less vigorous require less pruning, lower input costs, and are easier to manage throughout their productive life. Rather than continually controlling excessive vigour, future orchards will increasingly be designed around cultivars with a suitable architecture.

Improving nut set

Another opportunity to improve orchard productivity lies in increasing fruit retention. Zeng et al. (2016) found that cytokinin-based plant growth regulators can improve fruit retention, while earlier work by Turnbull et al. (1993) showed additional benefits when these treatments were combined with girdling. Although further research is still required, these techniques may become valuable tools for improving yield consistency. Breeding programmes are also placing greater emphasis on traits such as pollination efficiency, self-compatibility and fruit retention.



▲ MCT1 Nuts

The Orchard of the future

The orchard of the future will combine improved genetics with higher-density planting, precision irrigation and nutrition, mechanisation, effective vigour control and improved crop set management. Together, these advances will enable growers to produce more high-quality kernel per hectare with fewer inputs and lower production costs. Proven cultivars such as A4 and 816 will continue to play an important role, while newer cultivars such as MCT1, A447 and A538 offer new opportunities to improve productivity. The orchard of the future is no longer a distant vision. The genetics to build it are already here.

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▲ Bernhard Jordaan (left) and Dustin Cooper(right) next to an A447 tree in the north coast of Kwa-Zulu Natal.

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