



## Digital Industrial Policy Brief 3

### INDUSTRIAL DEVELOPMENT THINK TANK

<https://www.competition.org.za/idtt/>

## TECHNOLOGICAL DEVELOPMENTS AND THE 'INDUSTRIALISATION OF FRESHNESS' IN FRESH FRUIT SUPPLY

Shingie Chisoro Dube<sup>1</sup> and Reena Das Nair<sup>2</sup>

### Introduction

Strong performance of the South African fruit industry coupled with strong growth in global demand has meant the industry is the central focus for agriculture-led growth. This growth is dependent on applying major advances in technology to underpin sustainable growth of the fruit sector in what can be termed the 'industrialisation of freshness'.

Fruit as a highly perishable product is driving key technological changes in agriculture with respect to: biotechnology; logistics & cold chain systems; and the application of blockchain and the internet of things. These key technological developments improve yields, shelf life and quality, as well as transparency and traceability along the value chain.

Despite South Africa being an established global player in a number of fruit categories it has lagged behind other developing countries such as in South America and failed to maximise the substantial opportunities for export growth given increasing global demand. South Africa's volumes of fruit exports have grown at an average of 3% per annum over the past five years (2012 to 2017). This is much poorer than key competitors such as Mexico and Peru, which grew exports at 8% and 15% per annum respectively over the same period (in volume terms).

In addition, while citrus and apples, which constitute South Africa's main exports, grew at an average of 4% and 1% respectively, there are huge opportunities in berries and avocados. Although berries constitute the fastest growing exports in South Africa's fruit export basket (with a CAGR of 9%), this is from a very low base. Exports of avocados have in fact declined over the five year period, despite global import demand increasing by 87% from 1.1 million tonnes in 2012 to 2.1 million tonnes in 2017.<sup>3</sup>

Adopting and adapting to the advances in technology is critical for a strategy to significantly improve South Africa's performance. Drawing from existing research,<sup>4</sup> and from interviews

<sup>1</sup> Researcher: Center for Competition, Regulation and Economic Development.

<sup>2</sup> Senior Researcher: Center for Competition, Regulation and Economic Development.

<sup>3</sup> ITC TradeMap.

<sup>4</sup> [Structural transformation in agriculture and agro-processing value chains](#) and ongoing research on the Development of technological capabilities for increased market access and participation in global fruit value chains as part of the Industrial Development Think Tank work for the DTI.

with key stakeholders in the fruit sector, this policy brief highlights the key technology disruptions in the global fruit industry and how South Africa is positioned.

## **Disruptive technologies in the fresh fruit industry**

### ***Automated sorting equipment, logistics and cold chain technologies***

The need to preserve the shelf life and quality of the fruit up until the point it reaches the supermarket shelves has been a source of key technological disruptions in the fruit industry. Main technological developments include the use of automated grading technology with high resolution cameras in packhouses, delayed ripening technology, and modular cold chain technologies.

The use of automated grading technology and high resolution cameras taking pictures of fruit and identifying defects has dramatically improved the quality and speed of sorting in packhouses.<sup>5</sup> This has resulted in efficiency improvements in exporting and higher prices. For example, Tru-Cape Fruit Marketing, one of South Africa's largest marketing companies of apples and pears installed a new 10-lane sorting equipment that can process eight fruits per second per lane. This technology is combined with the new iFA light technology to determine any internal irregularities and is installed with camera-scanning equipment.<sup>6</sup>

Modular and controlled atmosphere cold chain technologies using lightweight and expandable smart materials are causing major disruptions in the fruit industry by ensuring longer product shelf life and increased quality. For example, a UK-based firm, InspiraFarms, develops automated, controlled and remotely monitored refrigeration storage units that can be adapted in both size and specific layout to suit the needs of any farmer. Data services, enabled by a remote sensing device and a centralised data management system, support farmers with customised configuration and optimization of their facility. It also enables remote supply chain data aggregation that is supplied to clients to support improved performance and undertake predictive maintenance.<sup>7</sup>

Cold chain technologies coupled with the use of delayed ripening technology, which controls the fruit ripening process means that producers can deliver just-in-time ripened fruits for consumers.<sup>8</sup>

In South Africa, the fruit industry through the Post-Harvest Innovation Programme, a public-private partnership between the Department of Science and Technology (DST) and the Fresh Produce Exporters Forum, is developing a range of technological solutions related to logistics, transport and packaging. These include validation of time and temperature tolerances, cooling efficiency and the maintenance of product quality, modified atmosphere packaging, air freight cold chain management and traceability systems.<sup>9</sup> Similarly, the Citrus Research International

---

<sup>5</sup> Westfalia, Dialogue Presentation, 22 October 2018; <https://www.tru-cape.com/tru-news/new-technologies-keep-tru-cape-and-its-packhouses-in-the-lead/>.

<sup>6</sup> <https://www.tru-cape.com/tru-news/new-technologies-keep-tru-cape-and-its-packhouses-in-the-lead/>; <https://www.tru-cape.com/tru-news/new-grabouw-sorting-line-and-packhouse-uses-the-latest-global-tech-available/>.

<sup>7</sup> <http://www.inspirafarms.com/>. Interview with Inspirafarms.

<sup>8</sup> <http://www.isaaa.org/resources/publications/pocketk/12/default.asp>.

<sup>9</sup> <http://postharvestinnovation.org.za/>.

(CRI) under the Citrus Growers' Association of Southern Africa (CGA) conducts research on cold chain and packaging in order to develop improved handling options in the cold chain.<sup>10</sup>

Although South Africa has been a leader in controlled atmosphere cold storage technologies mainly used in stone fruit, it has since lost its lead position to countries such as Germany and Italy due to limited government funding and lack of private sector investment interest.<sup>11</sup>

### ***Blockchain, internet of things and big data analytics***

Blockchain technology has caused major disruptions in the fruit industry by addressing the core challenges around transparency and traceability along the value chain. Blockchain enables end-to-end data transparency for fresh products allowing all players in the chain to access historical and real-time data linked to the product such as timing (time of harvest, time in transport), location (its origin and the history of its journey from farm to fork) or data on the farming, labour and environmental practices.<sup>12</sup> The internet of things underpins faster connectivity and flow of information across the industry, including real-time tracking of products.

For example, a grower and producer of citrus fruits, Katlego Citrus, is exporting fruits with stickers which have a quick-response barcode. Consumers can scan the barcode with their smartphones, then access video clips about Katlego's production and packaging processes.<sup>13</sup> Such platforms address the historic challenges related to limited data, often of poor quality, difficult to verify and is recorded in different formats at different stages of the value chain resulting in high levels of manual intervention and paperwork.

In response to challenges of manual intervention and paper-based systems, the Department of Agriculture Forestry and Fisheries (DAFF) and Fruit South Africa (FSA) jointly developed a digital data platform called Phytclean for use in the fruit export sector in 2016. Phytclean provides electronic alternative evidence for all the prerequisite steps in the certification process, which can be accessed by all parties in the value chain including importing authorities.<sup>14</sup> However, there is limited success in uptake of the digital platform due to government's slow progress in adopting and implementing electronic systems of capturing industry data.

In the fruit industry, blockchain has drastically reduced the speed with which payments are processed. For example, a company called Traderly uses blockchain to fast-track trade payments by converting the US dollars into cryptocurrency in South Africa. In comparison to the SWIFT payment method, this technology has sped up the payment process from 3-5 days to 15 minutes. This has also reduced costs from 15% to 1% of sales.<sup>15</sup>

---

<sup>10</sup> <http://www.citrusres.com/>.

<sup>11</sup> Interview with the Fresh Produce Exporters' Forum South Africa, 16 October 2018.

<sup>12</sup> Olivier Wyman. (2018). Disruption in fruit and vegetable distribution. Messe Berlin GmbH, Berlin. [https://www.oliverwyman.de/content/dam/oliver-wyman/v2-de/publications/2018/Mai/Fruit\\_Logistica\\_Trend\\_Report\\_2018\\_Part1\\_2\\_3.pdf](https://www.oliverwyman.de/content/dam/oliver-wyman/v2-de/publications/2018/Mai/Fruit_Logistica_Trend_Report_2018_Part1_2_3.pdf).

<sup>13</sup> <http://3b5dca501ee1e6d8cd7b905f4e1bf723.cdn.ilink247.com/ClientFiles/cga/CitrusGrowersAssociation/Company/Documents/Farmers%20Weekly%2014%20October%20-%20Katlego%20Citrus%2C%20Marble%20Hall.pdf>.

<sup>14</sup> <https://www.citrusresourcewarehouse.org.za/home/document-home/news-articles/south-african-fruit-journal-safj/sa-fruit-journal-2016/3748-sa-fruit-journal-aug-sept-2016-cga-phytclean-update/file>.

<sup>15</sup> Interview with the Fresh Produce Exporters' Forum South Africa, 16 October 2018.

With growing sources of collecting data (blockchain, sensors, water and climate monitoring), the ability with which to process and analyse this data is increasingly becoming critical. Big data analytics is a key technology used to analyse large volumes of cloud-based data. For example, retailers and consumer packaged goods companies are using large volumes of consumer data to better analyse and forecast changing demand patterns.<sup>16</sup> These advances represent the next big stepwise changes which are anticipated in the industry.

### ***Production technologies and climate change***

#### *Biotechnology*

The impacts of climate change and weather variability are driving investments in advanced breeding technologies to grow varieties that are adaptable to climate change with improved resistance to diseases and pests (insects, weeds and pathogens). Advances in biotechnology mean that new varieties can be bred according to specific characteristics such as taste, visual appearance, shelf life, seasonality, yield, climatic conditions, soil types and labour requirements.<sup>17</sup> For example, the citrus industry in South Africa has been successful in developing new local varieties of soft citrus such as mandarins. These include branded mandarin variety called ClemenGold, successfully launched into the world markets, and the Tango mandarin variety. The ClemenGold mandarin is being rolled out to other branded citrus products such as the LemonGold, HoneyGold and NavelGold. Tango's Plant Breeders Rights were granted in South Africa in March 2016, confirming that it is now registered as an individual variety in its own right.<sup>18</sup>

Although the South African fruit industry has access to locally bred varieties (through the Agricultural Research Council) and open (typically older) varieties, the industry relies largely on imported varieties.<sup>19</sup> For example, the stone fruit industry has imported more than 4,000 stone fruit varieties since 1994. In 2017, of the planted plum trees, 870,000 trees were 'open' varieties that are freely accessible without conditions, while 915,000 trees were 'protected' varieties with producer limitations and marketing conditions.<sup>20</sup>

Importing new varieties into South Africa takes an extended period of time in quarantine (currently two years) before they can be used for commercial production, causing major delays for growers to plant new varieties. The quarantine process involves laboratory testing to ensure that the imported varieties are free of pests and diseases. The length of time it takes for imported varieties in quarantine could be greatly reduced to improve local growing of new varieties.<sup>21</sup>

In response to the lengthy processes involved in importing new varieties, the Citrus Research International (CRI) under the Citrus Growers' Association of Southern Africa (CGA) conducts

---

<sup>16</sup> Wyman (2018).

<sup>17</sup> The Unlimited Group, Hans Christiaan Muylaert-Gelein, Dialogue presentation, 22 October 2018.

<sup>18</sup> <http://c1e39d912d21c91dce811d6da9929ae8.cdn.ilink247.com/ClientFiles/cga/CitrusGrowersAssociation/Company/Documents/Eurofruit%20-%20Gold%20standard%20for%20Mandarins%20-%20JulyAug%202017.pdf>.

<sup>19</sup> See footnote 18 above.

<sup>20</sup> See footnote 18 above.

<sup>21</sup> See footnote 18 above.

evaluations of new citrus cultivars focusing on cultivar's characteristics, climatic suitability of a cultivar and the commercial potential in the market.<sup>22</sup>

#### *Crop pest and disease technologies*

While biotechnology contributes to producing more pest and disease resistant varieties, technological advances in software can link fruit growers' weather data to actual pest risk.<sup>23</sup> This technology uses weather technology through solar-powered wireless weather stations to gather real-time temperature, humidity, rain, and leaf wetness data which is used to generate stepped risk levels to warn the farmer of when conditions are most susceptible to pest development.<sup>24</sup> For example, Katlego Citrus developed a scouting smartphone app designed to speed up and improve pest and disease identification and treatment. Using the app, a scout can take a photograph of the pest or disease on the tree or plant, then upload the image to a database in real time for immediate identification and treatment.<sup>25</sup>

At an industry level, the Citrus Research International (CRI) and River BioScience, a commercial subsidiary of the Citrus Growers Association (CGA), conduct extensive research on pre- and post-harvest diseases of citrus, crop protection products and pest monitoring products.<sup>26</sup> The association has an integrated pest and disease management division focusing on both indigenous and introduced pests.<sup>27</sup>

#### *Irrigation technologies*

Increased weather variability and water scarcity are driving key disruptions at the growing level through the application of irrigation technologies and precision farming methods. Satellite imagery and high resolution crop sensors are used to inform application of the right amounts of irrigation or fertiliser while optical sensors or drones are used to identify crop health across the field.<sup>28</sup> For example, avocado growing companies such as Westfalia are adopting the use of low-flow drip irrigation technologies in their farming methods, controlled by mobile phones.

The recent droughts in South Africa are increasingly forcing growers to adopt irrigation and precision farming technologies to maintain and improve production. In response to water challenges, the Western Cape Department of Agriculture developed an online application called FruitLook in May 2016 to provide farmers with accurate and reliable information on the water needs of crops.<sup>29</sup> At an industry level, the Citrus Research International (CRI) conducts long-term research on how to improve water use efficacy in citrus orchards. A key part of the research focuses on understanding the basic principles involved in different fruit physiology and irrigation scheduling, which are critical to increase production and fruit quality.<sup>30</sup>

---

<sup>22</sup> <http://www.citrusres.com/>.

<sup>23</sup> <https://www.growingproduce.com/fruits/new-technologies-for-fruit-growers/>.

<sup>24</sup> See footnote 23 above.

<sup>25</sup> <http://3b5dca501ee1e6d8cd7b905f4e1bf723.cdn.ilink247.com/ClientFiles/cga/CitrusGrowersAssociation/Company/Documents/Farmers%20Weekly%2014%20October%20-%20Katlego%20Citrus%2C%20Marble%20Hall.pdf>.

<sup>26</sup> <http://www.citrusres.com/>.

<sup>27</sup> <http://riverbioscience.co.za/>

<sup>28</sup> <https://www.fruitlook.co.za/>

<sup>29</sup> <https://www.fruitlook.co.za/>.

<sup>30</sup> <http://www.citrusres.com/>.

## Implications for South Africa's fruit industry

Disruptive technologies in the fruit industry have huge implications on access to markets for the sustained growth of the fruit industry. If South Africa is to maintain its position as a global leader and take advantage of the growth in global demand, it is imperative that key changes are implemented within the industry in the next five to ten years. As an export-oriented industry worth US\$3 billion and among the most labour-intensive area of agriculture, it is critical that government and private sector understand the impact of technology disruptions on the production systems through the value chains to access world markets.

Innovation in sorting equipment, ripening technology, logistics and cold chain technologies is building faster and more flexible, precise and transparent fruit supply chains. Achieving these step-wise changes in speed, quality and traceability to upgrade the chains requires an integration of the systems by the different participants for an overall systemic shift in efficiency rather than piecemeal adjustments.

Increasing the speed of the supply chain preserves the freshness and quality of the produce enabling access to geographically dispersed and distant markets particularly of sensitive/delicate fruits. For example, products such as berries have a very short shelf life and the slightest reduction in turnover times will increase profits significantly.<sup>31</sup> South Africa has made good progress in some fruits in adopting controlled atmosphere cold storage technologies. Extending these to support broader-based export growth requires increased government and private sector investment, including in terms of research and skills development. This is particularly important for fast growing industries such as berries with a limited product shelf life.

The combined impact of internet of things and blockchain technologies is increasing connectivity, transparency and traceability, and seamless flow of information across the industry. Companies are able to link their systems to relevant government departments, logistics companies and shipping lines allowing better coordination along the value chain. Overall these technologies save costs, reduce paper-based administration processes and increase visibility. Taking advantage of the digital disruptions requires that the industry shifts from paper-based systems to electronic systems within the next five to ten years. Adoption of electronic systems involves significant changes on the part of growers and producers to develop in-house systems of capturing data, for example stock systems and big data systems including the ability to standardize the stored and shared information across the different systems.

Development of new varieties, which are tightly managed by intellectual property rights are starting to become the organising principle of the value chain with owners of protected varieties dictating conditions of production, volumes, marketing and export.<sup>32</sup> South Africa's limited capabilities in developing own varieties coupled with dependence on imported varieties not only raises costs of production through royalties but heightens exclusion of farmers from growing specific varieties.<sup>33</sup>

The growing effects of variable rainfall and increased frequencies of drought conditions on fruit production require that farmers adopt new irrigation technologies and precision farming

---

<sup>31</sup> Wyman (2018).

<sup>32</sup> See footnote 18 above.

<sup>33</sup> See footnote 18 above.

methods within the next five to ten years. These changes are necessary if South Africa is to maintain an upward trend in production subject to water constraints. To maximize production, farmers need to increase plantings of new varieties adaptable to local conditions and this requires that the government implements faster clearing processes of imported varieties in quarantines.

While drip irrigation and automated sorting and grading technologies are resulting in shedding low-skill jobs, these disruptive technologies are creating new high skilled jobs. In addition, the overall growth of the industry creates low-skilled employment in a range of areas such as in fruit picking and logistics.<sup>34</sup> The technologies require different and higher levels of skills which needs to be part of the step-wise changes made.

It is important to note that while market access in itself is not a technological issue, it is closely related and needs to be made a major priority. Different markets require specific phytosanitary standards and certification to be complied with. However, access to some large and growing markets, notably China, require specific negotiations. If South Africa is to double its current growth rate and catch up to competitors such as Mexico, Peru and Chile within the next five to ten years, growers and producers need access to new markets in South and East Asia including China, Vietnam, Thailand, South Korea and India. These are the countries where most of the future growth is likely to come from yet South Africa has been very poor in opening-up access for fruit exports to these markets.<sup>35</sup>

### **Preliminary policy responses**

What is South Africa's policy response to leveraging disruptive technologies? While South Africa is regarded as one of the leading countries adopting new technologies in fruit production methods, logistics and cold chain systems, these efforts have been driven largely by the private sector. For example, the CGA spent approximately R60 to R70 million on research and development from its total annual levies of R90 million in the 2017/18 financial year.<sup>36</sup> The large firms have substantial existing capabilities in research and technology development, and are responding to the global disruptions. However, partnerships and alignment of priorities between government and private sector are necessary to take the industry several leaps forward especially in the context of digital disruptions. It is also very important for the upgrading of smaller producers.

The following issues are important in shaping policy responses to technological changes in the industry:

- Taking advantage of digital disruptions introduced by blockchain and internet of things, requires that government departments and relevant stakeholders urgently shift from paper-based systems to electronic processes of capturing data in the industry.
- Develop systems or platforms to enable linking and sharing of electronic data between producers, relevant government departments, ports, logistics and other industry

---

<sup>34</sup> For example, Westfalia has automated sorting and grading and implemented drip-feed irrigation which reduces the employment previously required in the manual tasks.

<sup>35</sup> Interviews with Citrus Growers Association of Southern Africa, South Africa Avocados Growers Association and Unlimited Group.

<sup>36</sup> Input from the Citrus Growers' Association in the Dialogue held on 22 October 2018.

stakeholders. Currently, there are no systems of linking producers' in-house systems to ports, logistics companies and shipping lines causing congestion at the ports.

- Investments in spectrum and internet infrastructure in production areas (mainly in the rural areas) to enable faster connectivity and flow of information across the industry. Poor access to internet and cell phone connectivity is a major constraint to accessing information.
- Skills development is urgent in partnership with the private sector to meet the demand for different and more advanced skills and to ameliorate losses of low skill jobs in some processes.
- Investment in laboratory equipment and skills to promote local breeding of varieties for greater control over production. This is particularly important for reducing the high mortality rates of imported varieties in quarantines, including the lengthy periods it takes for new varieties to be cleared of pests and diseases
- Market access is critical to realise the gains from technology disruptions. Improved market access requires investment in government's technical skills to negotiate market access and to make effective use of industry research.