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Digital industrialisation of freshness

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1. Introduction

Global markets continue to experience high growth in the demand for high-value agricultural (HVA) products. A case in point is fresh fruit products. In 2020, global fruit exports amounted to US\$99 billion, up from US\$73 billion in 2015 (a 37% per cent growth in value terms).¹ The sustained global growth in the demand for HVA products underpins the strong export-led growth observed in developing countries. This high growth in HVA exports raises questions about the nature of capabilities and investments required in developing countries to gainfully participate, improve competitiveness, and capture value in these markets. This is because the export of high-value fresh fruit - a highly perishable product - for instance, entails constant technology upgrading across the different processes - from inputs through to certification systems. These developments are necessary to keep up and to comply with standards and requirements in export markets; and to develop timely, flexible, and speedy supply chains, in what is termed the 'industrialisation of freshness'.² With advancements in digital technologies, we argue that the 'industrialisation of freshness' hinges on the adoption and application of digital technologies, hereby referred to as the 'digital industrialisation of freshness'.

'Digital industrialisation of freshness' entails the application of different combinations of advanced digital technologies (e.g., computer-managed inventory systems, machine-to-machine communication system, big data, and artificial intelligence) beyond the use of autonomous equipment such as tractors, weeding robots, automated fruit sorting and grading equipment, and cold chain technologies. The application of Internet of things-solutions, for instance, to connect different activities (from production to consumption), to connect different actors in the supply chain, and to enable reporting of information in real time has the potential to improve productivity and decision-making processes in HVA supply chains.

While there is evidence of the application of advanced digital technologies in South Africa's fresh fruit exports (such as satellite imagery and high-resolution crop sensors, irrigation technologies programmed and operated through mobile phones, digitisation of export certification systems)³, this is not happening at the scale and scope required to take full advantage of the strong growth in global demand. Furthermore, there is little research on how to leverage the potential benefits of advanced digital technologies to catapult an HVA-led structural transformation in South Africa.

In this brief, we discuss the prospects for 'digital industrialisation of freshness' in high-value fresh fruit exports in South Africa. Specifically, the brief examines how advanced digital technologies can play a role in addressing key challenges limiting the overall competitiveness of fresh fruit exports in South Africa. The brief concludes by discussing key challenges limiting the adoption of digital technologies in South Africa and the implications

¹ ITC Trade Map, 2022

² Cramer, C. and Sender, J. (2019). 'Oranges are not only fruit: The industrialization of freshness and the quality of growth'. In Kanbur, R., A. Noman, J. Stiglitz (eds) *The Quality of Growth in Africa*. New York: Columbia University Press

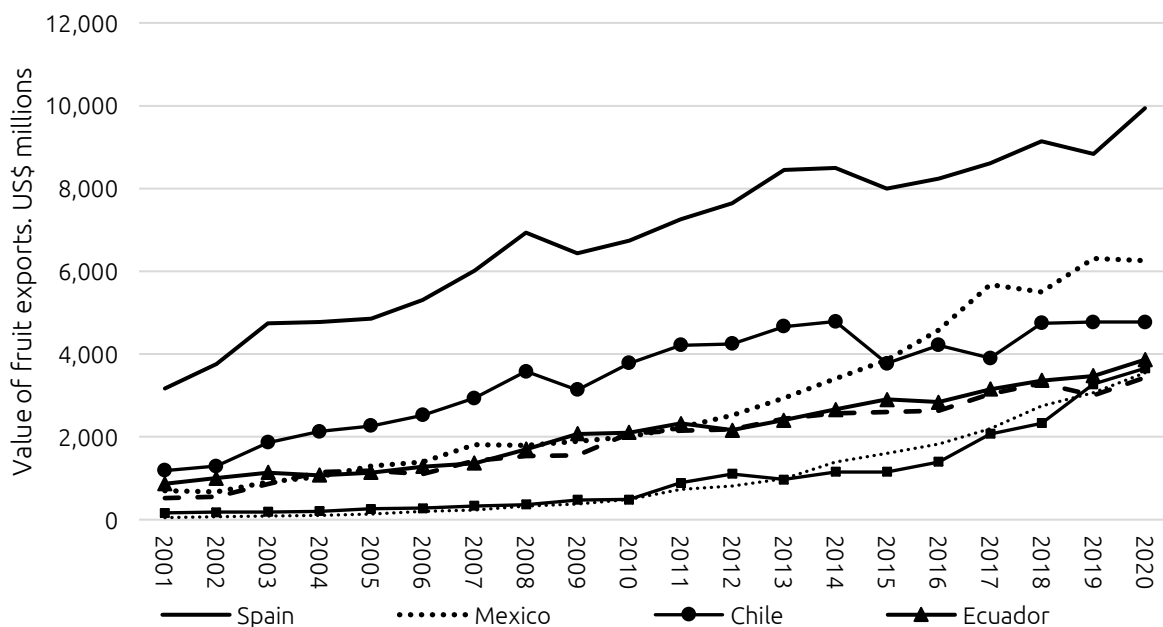
³ Chisoro-Dube, S., Das Nair, R. and Landani, N. (2019). *Technological developments in South Africa's fruit industry and implications for market access and participation*. CCRED Working Paper 2019/5. Johannesburg: CCRED

of digitalisation for participation in global value chains. It builds on insights from several studies undertaken by CCRED and draws on extensive producer and stakeholder interviews.

2. South Africa's performance in global fresh fruit export markets

As noted, there has been growth in global exports of fresh fruit over the last decades since 2001. While South Africa's fresh fruit exports have grown by 32% in value terms between 2015 and 2020, it has lagged key competitor countries such as Mexico, Peru, and Thailand which have grown at faster rates of 63%, 122%, and 217% respectively, over the same period (see Figure 1). However, it is important to note that South Africa is performing well ahead of competitor countries in selected narrow product lines, particularly soft citrus, and lemons and limes.

Figure 1: Evolution of high-value agricultural (HVA) exports in selected countries



Source: ITC Trade Map, 2022

Overall, South Africa has not been as successful as competitor countries in diversifying its fruit products and export markets; and South Africa's share in global markets remains negligible averaging 3.5% in value terms between 2010 and 2021. The observed differences in export performance can, at least, in part, be attributed to the adoption of new advanced digital technologies. For example, Spain although growing slower than most countries at 24% in value terms between 2015 and 2020, has reached a significant share of global trade in fresh fruit, with share oscillating around 10% of world trade. Spain's superior export performance has been built on innovation and digitization which has allowed it to advance and maintain its leadership in terms of competitiveness in international markets, in addition to facing its environmental and social issues challenges.⁴ The Spanish government through

⁴ MAPA and the sector analyse the challenges and opportunities offered by new technologies to the fruit and vegetable sector. Available at <https://www.fepex.es/noticias/detalle/MAPA-sector-desafios-oportunidades-nuevas-tecnologias> published on 17 September 2021

the Ministry of Agriculture, Fisheries, and Food are continuously carrying out different initiatives to provide the sector with instruments that promote knowledge building and transfer, and transparency to know production in real time and in detail, as well as instruments of a predictive nature, which will make it possible for professionals and the government to anticipate decisions in relation to the sector.⁵

The experience of Thailand also illustrates the role of innovation and new advanced technologies to produce higher quality and competitive fresh vegetables and fruits.⁶ For instance, Thailand, from a low base, rapidly grew its exports by 217% in value terms between 2015 and 2020 to surpass South Africa and Peru, and catching up with Ecuador. Thailand's impressive growth is mainly attributed to developing an appropriate package of technologies for improving productivity and quality.⁷ Through investments in R&D by government, farmers, and private sector, Thailand has developed many innovations and new technologies including breeding technologies, production and post-harvest technologies to prolong product shelf life through Hydro-coolers or cool rooms together with various modified atmospheric packaging or controlled atmospheric condition.⁸ In addition to the hardware technology, Thai farmers have also actively embraced modern farm management "software" technologies such as Good Agricultural Practices (GAP) that enables them to adopt traceability systems.⁹

Over the same period, Chile grew its export of fresh fruit by 26% in value terms with favorable results in terms of aggregate export growth as well as market and product diversification.¹⁰ Chile's supportive policy measures have facilitated innovation and rapid transfer of technology across the industry leveraging its strong information technology industry. These include competence and quality of logistics services, ability to track and trace

⁵ MAPA and the sector analyse the challenges and opportunities offered by new technologies to the fruit and vegetable sector. Available at <https://www.fepex.es/noticias/detalle/MAPA-sector-desafios-opportunidades-nuevas-tecnologias> published on 17 September 2021

⁶ United Nations Conference on Trade and Development (UNCTAD). (2021). The commodities and development Report: Escaping from the commodity dependence trap through technology and innovation. United Nations.

⁷ United Nations Conference on Trade and Development (UNCTAD). (2021). The commodities and development Report: Escaping from the commodity dependence trap through technology and innovation. United Nations; Hawaii Tropical Fruit Growers. (2005). Proceedings Fifteenth Annual International Tropical Fruit Conference. Hawaii. Available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.618.996&rep=rep1&type=pdf>.

Poapongsakorn, N. (2011). R&D and performance of the Thai agriculture and food processing industry: The role of government, agribusiness firms, and farmers. *Agricultural development, trade & regional cooperation in developing East Asia*, 401-475.

⁸ Chomchalow, N., Somsri, S. and Na Songkhla, P. (2008). Marketing and export of major tropical fruits in Thailand. *AU J.T.* 11(3), 133-143. Chomchalow, N. and Na Songkhla, P. (2008). Thai Mango Export: A slow-but-sustainable development. *AU J.T.* 12(1), 1-8. Hawaii Tropical Fruit Growers. (2005). Proceedings Fifteenth Annual International Tropical Fruit Conference. Hawaii. Available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.618.996&rep=rep1&type=pdf>;

Poapongsakorn, N. (2011). R&D and performance of the Thai agriculture and food processing industry: The role of government, agribusiness firms, and farmers. *Agricultural development, trade & regional cooperation in developing East Asia*, 401-475.

⁹ Poapongsakorn, N. (2011). R&D and performance of the Thai agriculture and food processing industry: The role of government, agribusiness firms, and farmers. *Agricultural development, trade & regional cooperation in developing East Asia*, 401-475.

¹⁰ Lebdioui, A., Lee, K. and Pietrobelli, C. (2021). Local-foreign technology interface, resource-based development, and industrial policy: how Chile and Malaysia are escaping the middle-income trap. *The Journal of Technology Transfer*, Vol. 46, pp. 660-685.

consignments, and timeliness of shipments.¹¹ One of Chile's success stems from the country's ability to keep pace with technological advances, in particular e-commerce which grew massively in Chile's main market of China.¹²

In the case of South Africa, despite the evidence of dynamism in fruit exports, several factors have been identified to limit the industry's overall competitiveness in global markets. These include the growing impacts of climate change – droughts, limited water availability and phytosanitary requirements – which require ongoing investment in water management, research, and investment in production technologies and systems; and the delays and congestion at the main ports coupled with poor logistics and supply chain communications, among others. These challenges are stifling the production and export of HVA products.¹³

3. Leveraging digital technologies to address key challenges in South Africa's fresh fruit exports

Digitalisation and advanced digital technologies have been identified to enhance the prospects of structural transformation in developing economies. The application of advanced digital technologies is shown to have the potential to reduce communications and transactions costs, thereby enabling the fruit industry to export large volumes, timeously and in line with marketing plans.¹⁴ Digitalisation of logistics chains, for instance, can also help to restructure and set up well-developed logistics systems to provide real-time information that can be used by the industry to make informed decisions and ease congestion and delays at the ports.

In line with these, there are initiatives by the industry and government to develop and adopt advanced digital solutions across different levels of the value chain with major implications for upgrading and access to export markets. Available evidence shows that, at the farming level, farmers are using digital technologies to improve the resilience of the sector to climate change and strengthen their contribution to sustainable development. These include irrigation scheduling, smart water management, modelling disease outbreaks, and use of smart sensors to collect environmental and machine metrics.¹⁵ Through smart

¹¹ Chilean & American Chamber of Commerce of Greater Philadelphia. Why Chile. Available at <https://caccgp.com/why-chile/>

¹² The recipe for Chile's fruit exporting success. Available at <https://www.producereport.com/article/recipe-chiles-fruit-exporting-success>, published on 21 February 2017; Chilean & American Chamber of Commerce of Greater Philadelphia. "Challenges of the Export Industry: Chile's Fresh Fruit Success Story". Available at <https://caccgp.com/challenges-of-the-export-industry-chiles-fresh-fruit-success-story/>; World Bank. (2020). Central Asia's Horticulture Sector Capitalizing on New Export Opportunities in Chinese and Russian Markets. The World Bank Group; Agosin, M.R. and Bravo-Ortega, C. (2009). The Emergence of New Successful Export Activities in Latin America: The Case of Chile. Inter-American Development Bank, New York.

¹³ Cramer, C. and Chisoro-Dube, S., (2021). 'Industrialization of freshness: Structural Transformation in agriculture value chains – case of fruit'. In Structural Transformation in South Africa: Sectors, Politics and Global Challenges, edited by Antonio Andreoni, Pamela Mondliwa, Simon Roberts, and Fiona Tregenna, Oxford: Oxford University Press.

¹⁴ Thukwana, N. (2022). Citrus industry warns of another year constraints at the ports, following a tough 2021. Business Insider SA. Available at <https://www.businessinsider.co.za/south-africas-citrus-industry-expects-port-constraints-at-ports-in-2022-2022-1>

¹⁵ Chisoro-Dube, S. and Roberts, S. (2021). Innovation and inclusion in South Africa's citrus industry. Innovation and Inclusion in Agro-processing Working Paper. Available at: https://iiap.info/wp-content/uploads/2021/11/IIAP_South-Africa-Citrus-Working-Paper_October-2021.pdf

agriculture, farmers are making informed decisions almost in real time and over the whole production cycle. Internet of things-based technologies are allowing farmers to plan production for the monitoring and controlling of their farming systems.¹⁶ Furthermore, the need to measure, monitor, track, and report on growers' carbon footprint to ascertain their impact on the climate is driving the adoption of online carbon-foot-printing platforms as part of South Africa's fruit industry Confronting Climate Change Initiative. This tool enables growers to identify, measure, report and respond to the risks and opportunities associated with carbon emissions. Growers are able to complete a carbon calculator and ascertain their impact on the climate with such initiatives enabling South Africa to gain and maintain market access in key export markets in developed countries.¹⁷

To be competitive in global agricultural trade requires capacity to produce and export high-quality output that meets demanding phytosanitary standards and requirements. As such, the need for improved processes of capturing, storing, and sharing information for compliance with phytosanitary requirements in different export markets, has required that the industry digitalises compliance and certification systems. In South Africa, this has driven the adoption of innovative digital platforms notably Phytclean for issuing export phytosanitary certification. Phytclean digitizes the recording of information and ensures that there is consistency in information for different markets. Phytclean was developed and led by the Citrus Growers Association working with the Department of Agriculture, Land Reform and Rural Development in 2016 and with partial funding from the Department of Science and Technology's Sector-Specific Innovation Fund under Research for Citrus Exports. As of 2016, there were 1,400 registered users of the system in the citrus, table grape, pomegranate, and stone fruit industries.¹⁸

To complement and realize the benefits of the industry's initiative to move to electronic certification and data-sharing systems, individual firms, particularly large producers, are implementing electronic data interchange systems within their supply chains to integrate information in the packhouse and cold chain facilities. This technology allows for the seamless monitoring of supply chain processes as the system syncs the information from the packhouse and cold-storage facility and then produces comprehensive reports and documentation. Tablet devices installed with apps that use cloud storage are used to conduct audits and inspections on the farms that are necessary to acquire accreditation in export markets.¹⁹ Nonetheless, however sophisticated their own operations may be, firms in rural areas often run up against the wall of poor connectivity.²⁰

¹⁶ Chisoro-Dube, S. and Roberts, S. (2021). Innovation and inclusion in South Africa's citrus industry. Innovation and Inclusion in Agro-processing Working Paper. Available at: https://iiap.info/wp-content/uploads/2021/11/IIAP_South-Africa-Citrus-Working-Paper_October-2021.pdf. UNCTAD, 2021

¹⁷ Chisoro-Dube, S. and Roberts, S. (2021). Innovation and inclusion in South Africa's citrus industry. Innovation and Inclusion in Agro-processing Working Paper. Available at: https://iiap.info/wp-content/uploads/2021/11/IIAP_South-Africa-Citrus-Working-Paper_October-2021.pdf

¹⁸ Chisoro-Dube, S. and Roberts, S. (2021). Innovation and inclusion in South Africa's citrus industry. Innovation and Inclusion in Agro-processing Working Paper. Available at: https://iiap.info/wp-content/uploads/2021/11/IIAP_South-Africa-Citrus-Working-Paper_October-2021.pdf

¹⁹ Chisoro-Dube, S., Das Nair, R. and Landani, N. (2019). Technological developments in South Africa's fruit industry and implications for market access and participation. CCRED Working Paper 2019/5. Johannesburg: CCRED.

²⁰ Cramer, C. and Chisoro-Dube, S., (2021). 'Industrialization of freshness: Structural Transformation in agriculture value chains – case of fruit'. In Structural Transformation in South Africa: Sectors, Politics

The use of advanced, smart, and precision-farming technologies to respond to the impacts of droughts and the growing susceptibility of crops to pest and diseases imposed by climate change requires stable internet access and cell-phone connectivity. ICT infrastructure of high-speed, fixed internet connections, such as fibre optic and broadband, or high-speed mobile connections is a core enabler of digitalisation.²¹ Reliable access to the internet is therefore critical to unlocking the possibilities offered by digital technologies. Yet, in many rural areas in South Africa there is poor internet and cell-phone connectivity. Organizations like the Perishable Produce Export Control Board, which conducts audits for export markets and accreditations, have struggled in this context of limited connectivity. Organizations carrying out this kind of activity cannot afford downtime in connectivity because inspections need to be conducted timeously.²²

South Africa's challenges around poor internet and cell-phone connectivity are exacerbated by the country's low levels of broadband penetration and limited access to fixed and mobile infrastructure. The high cost of investments required to roll out fixed and mobile infrastructure, particularly in rural areas, and of leasing space on existing infrastructure sites, has limited broadband penetration.²³

The export-oriented nature of South Africa's fresh fruit industry means that its growth strategy is dependent on efficient ports. High levels of congestion and delays, and poor logistics and communication systems at South Africa's main ports continue to pose the biggest challenges to fresh fruit exports. Machinery breakdowns caused by ageing and worn-out infrastructure coupled with shortage of cranes, traffic bottlenecks, and sluggish logistics communications in the supply chain disrupt operations at the ports.²⁴ Recently in 2021, the industry struggled with a number of challenges including a cyber-attack on rail, port, and pipeline company, Transnet which impacted container terminals at major ports of Durban, Ngqura Gqeberha, and Cape Town.²⁵ The attack caused a logjam at the Durban port prompting growers to halt harvesting and packing fruit in an attempt to ease the congestion, which happens both on the water and landside. Furthermore, the onset of Covid-19 worsened logistical challenges at the ports with shortages of shipping containers due to limited movement and circulation of containers around the world causing shipping

and Global Challenges, edited by Antonio Andreoni, Pamela Mondliwa, Simon Roberts, and Fiona Tregenna, Oxford: Oxford University Press.

²¹ Atiase, V.Y., Agbanyo, S., Ameh, J.K., Sambian, R.M. and Ganza, P. (2022). Creating value for whom? Digitization and governance practices of nontraditional export firms in Africa. *Strategic Change*, (31), 31-44. UNCTAD.

²² Cramer, C. and Chisoro-Dube, S., (2021). 'Industrialization of freshness: Structural Transformation in agriculture value chains – case of fruit'. In *Structural Transformation in South Africa: Sectors, Politics and Global Challenges*, edited by Antonio Andreoni, Pamela Mondliwa, Simon Roberts, and Fiona Tregenna, Oxford: Oxford University Press.

²³ Robb, G. and A. Paelo (2020). 'Competitive dynamics of telecommunications markets in South Africa, Tanzania, Zambia, and Zimbabwe.' WIDER Working Paper 2020/83. Helsinki: UNU-WIDER.

²⁴ Cramer, C. and Chisoro-Dube, S., (2021). 'Industrialization of freshness: Structural Transformation in agriculture value chains – case of fruit'. In *Structural Transformation in South Africa: Sectors, Politics and Global Challenges*, edited by Antonio Andreoni, Pamela Mondliwa, Simon Roberts, and Fiona Tregenna, Oxford: Oxford University Press.

²⁵ Thukwana, N. (2022). Citrus industry warns of another year constraints at the ports, following a tough 2021. *Business Insider SA*. Available at <https://www.businessinsider.co.za/south-africas-citrus-industry-expects-port-constraints-at-ports-in-2022-2022-1>

delays on routes.²⁶ Shipping delays affect cold storage operations²⁷ causing fruit exporters to lose money in unplanned expenditure on additional plug-ins for vessels delayed at the ports. The constraints at the ports make it challenging for producers to connect cost-efficiently with fresh fruit export markets.

In sum, the fresh fruit export industry in South Africa is well-positioned to digitalise given that it is already globalised and are already more exposed to digitalisation. However, the pace of digitalisation (in terms of scale and scope) required to take full advantage of the strong growth in global demand remains slow.

4. Way forward?

Our discussion so far suggests that the application of advanced digital processes can provide a new set of tools and solutions to respond to both existing and new challenges in the production and export of fresh fruit products in South Africa. Despite the prospects and the exposure of the South African fresh fruit export industry to advanced digital technologies, key challenges such as the impacts of climate change, limited water availability and phytosanitary requirements, delays and congestion at South Africa's main ports, and sluggish logistics and supply chain communications remain.

While digitalisation and the application of advanced digital technologies have the potential to create opportunities, it poses new and inadvertent challenges to HVA-led growth in South Africa. For instance, digital industrialisation of freshness has the potential to further entrench the dominance of large lead firms and producers in GVCs. The observed inequality in the adoption of advanced digital technologies also means that digital industrialisation of freshness is likely to benefit large and well-resourced firms and producers more than small and medium-sized producers, an indication that the majority of smaller producers may be left behind due to digital industrialisation of freshness if they do not have adequate support.

These mixed and heterogeneous potential benefits of digital industrialisation of freshness in the HVA fruit industry lays bare the critical role for public intervention to provide opportunities to learn and develop technological capabilities. To support the digital industrialisation of freshness in the HVA fruit industry towards higher value addition and job creation, and to realign the benefits and challenges of digitalisation, a strong role of the government through private-public collaboration is required. Specifically, government and policy makers need to pay attention to the transformative potential of the HVA products through the investment in production technologies and systems, transport, marketing, and trade. Tapping into this potential by creating effective and efficient digital telecommunication networks, and streamlining and digitalising activities at the ports are critical. It is also paramount that the industry and actors in the value chain - from farmers to marketing and distribution - develop digital strategies and capabilities to reap the benefits of digitalisation. The network nature of digital technologies, in which the value of an application's use increases with the number of users, creates incentives for the diffusion of technology from one industry to another. The creation and sustainability of these networks require international collaborations and interactions, and the role of the AfCFTA in offering

²⁶ Interviews with Citrus Growers Association Cultivar Company on 10 May 2022, Boland Wine Cellar on 22 March 2022

alternatives and creating these collaborations at the regional and continental levels cannot be overemphasised. Some of these key policy levers have also been highlighted in several policy documents including the digital industrial policy issues paper²⁸.

²⁸Industrial Development Think Tank (2019). Link: https://www.competition.org.za/s/DPIP_Final.pdf