EMBRACING THE 4TH INDUSTRIAL REVOLUTION: A PROVINCIAL CASE STUDY

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ABSTRACT

The purpose of this paper was to showcase how a sub-national organ of state can embrace developments the 4th IR and empower the Agricultural Sector to capitalise on innovations. A paper on 4th IR technologies, presented at IFMA's 21st Congress, was taken as point of departure and three different strategic processes were followed to design appropriate interventions. In the first 4th IR was placed in context and in the second the implications for the Agricultural Sector of a post Covid-19 future was analysed. As arid areas are often marginalised, the third strategic process exclusively focussed on the future of farming in these areas. It was found that implementation by the Department unwittingly started before the strategic processes was completed and a range of interventions using 4th IR technology were presented. Agricultural drones are playing an important role and the four-pronged approach followed (becoming a legal operator, supporting pilots to become legal, embracing technology and stimulating drone-use by farmers) were discussed. In addition to drones, other initiatives towards the democratisation of 4th IR technologies were also examined.

1. PURPOSE

The future is not what it used to be. Indeed, the Western Cape Department of Agriculture (WCDoA) of South Africa believes that Agriculture will be the most disrupted of all economic sectors by the Fourth Industrial Revolution (4th IR). At the 2017 Congress of the International Farm Management Association (IFMA) a paper was presented illustrating the arguments underpinning this belief (see Troskie, 2017).

In short, a number of drivers (e.g. autonomous vehicles, three dimensional printing, advanced robotics, new materials, digital revolution, the 'internet of things' and biological advances) will be at the core of this disruption. It was also foreseen that 4th IR will manifest in a diverse range

of impacts which includes economic, employment and development whilst it will also change the nature of work, the way we do business, governance and it will lead to new forms of crime and conflict. This paper ended by indicating that the WCDoA has commissioned a research project to investigate the trends underpinning the 4th IR, its impacts and to develop potential interventions which will ensure the best possible outcome for the people of the Western Cape Province (Troskie, 2017).

The purpose of the current paper is to build on the presentation at the 21st IFMA Congress and to report on the research and implementation lessons learned in the intervening period. The next section (Methods) will focus on the strategic context followed Section 3 (Results) which will focus on the lessons learned in the process of moving from strategic intent to operational implementation.

2. METHODS: STRATEG FOCUS

Farming globally, and also in the Western Cape, has been shaped by the fact that farming is a biological production process, it's envelope of 'the possible' is bound by site-specific combinations of geology, climate and soil as well as the fact that it takes place in a spatially dispersed manner. The combined result is that the "family farm" has traditionally been the core unit of agricultural production; and in in the Western Cape Province there are close to 16 500 farms (both commercial and smallholder). However, the underlying structure of farming is fundamentally being disrupted (*inter alia* by the 4th IR), which may result in the family farm going the same way as the traditional corner café being replaced by the convenience store at the filling station. To understand these disruptions and prepare the actors in the Provincial Agricultural Sector to face change, the WCDoA commissioned three strategic research projects.

2.1. Putting the 4th IR in context

During 2017 the WCDoA contracted the Business School of Stellenbosch University to conduct a "diagnostic, impact and design evaluation" of the 4th IR as affecting the Sector. The first section (see USB, 2017) provided context with emphasis on *inter alia* 4th IR, local farming (e.g. realities including unemployment, resources, policy priorities), drivers underpinning 4th IR and potential future scenarios. Demographic and socio-economic drivers are just as

important as technological changes. The second part was the most important and focussed on technologies influencing the Sector and 27 different technologies, were described and contextualised (Figure 1). These technologies could be classified into informatics, automation, manufacture, bioscience, food technology and sustainability. However, it was argued that it is not individual technologies which will be driving disruption, but rather the synergies between the different technologies and how they fit into the socio-economic eco system. In other words, one need to take a systemic view of the technologies (see WCDoA 2017 for the tecnonologies working documents).

These technologies should be interpreted within the local context of the Western Cape Province. I.e., our labour, policy, resource, economic and climate realities must determine priorities, choices and actions. To this end five enablers to be supported by 26 actions were identified and documented. These actions are not "government must" recommendations, but allocate responsibilities to government, academia, scientists, producers, processors, consumers, agribusiness, suppliers, advisors, industry associations, investors and retailers. Hence, if the Western Cape Agricultural Sector wants to achieve the "desired end state" or, embrace the 4th IR to the benefit of all, every section of the agricultural community has a role to play.

The WCDoA firmly believes that a project is only completed once a Management Improvement Plan (MIP) is completed (MIPs were also developed for the other two strategic projects). In this case the Department identified four improvement objectives and for each a number of activities, deliverables, (one) responsible person, due date and budget allocation were identified. The improvement objectives are:

a) Embed agri renaissance in the Western Cape as the desired end state of the 4th Industrial Revolution.
b) Accelerate responsible technology adoption in the Western Cape Agricultural Sector.
c) Develop young people to embrace the 4th IR in support of agricultural development.
d) Reposition perceptions of agriculture in the context of the 4th IR.

2.2. The post Covid-19 future

The period since March 2020 was one of the most disruptive for South Africans. The Covid-19 challenges in food supply ranged from disruptions in value chains (e.g. bottlenecks in ports and limited air cargo space), disrupted markets (ban on wine, tobacco and flower sales; closure

of restaurants), loss of market share, increased cost of compliance (e.g. induced production inefficiencies due to social distancing; cost of personal protection equipment, etc.), changing consumption patterns (domestic and abroad) to a weakening exchange rate. Nevertheless, other than in the case of 'normal' disasters, the agricultural production base was not damaged by Covid-19[1]. If anything, the WCDoA believes that Covid-19 highlighted or accelerated some prevalent and underlying disruptors (e.g. 4th IR; rise of national interests; from trade liberalisation to protectionism, growing chasms in social fabric) which will fundamentally change our world and farming as we know it.

To analyse the long-term future of the Provincial Agricultural Sector, the WCDoA partnered with of Tanja Hichert and Associates to conduct a Diagnostic and Design evaluation to develop a post Covid-19 strategy for the Provincial Agricultural Sector. The Department, together with a diverse set of stakeholders representing multiple perspectives, engaged in a three-month participative strategic foresighting exercise to ultimately identify intervention points that could help lead to a preferred future (30-year time horizon). This preferred future for the Western Cape Agricultural Sector is one that is resilient (to further shocks and disruptors), sustainable and equitable.

As part of this process a set of forty-two 'driving forces shaping the future' of the Sector was identified. Based on extensive desk-top research, covering the STEEP-V domains, (S)ocial, (T)echnological, (E)nvironmental, (E)conomic, (P)olitcal and (V)alues, user-friendly driver cards were developed. From this, five critical themes shaping our future were identified and, following further analysis, a process of scenario development and causality analysis at the hand of twelve 'Causal Loop Diagrams', five intervention points of high leverage were identified:

a) Support Africa as a middleclass market;
b) Deploy and 'democratise' 4th IR (Figure 2);
c) Making large-scale sustainable, 'climate smart' agriculture possible;
d) Successfully conduct agricultural education and knowledge transfer that leads to resilience; and
e) Practice 'Anticipatory Governance' (Hichert, 2020).

[1] During a drought, trees die and the veld deteriorates. A flood washes away orchards, roads and other infrastructure. An outbreak of Avian Influenza leads to the culling of ostriches and chickens. None of which happened during the Covid 19 Pandemic

Hence, the Department's response to the 4th IR will be a key element in the long term post Covid-19 future of the Western Cape Agricultural Sector.

2.3. Future of farming in Arid Areas

Some say that by 2040 most 'meat' will not come from dead animals, but will be grown in bio-reactors (clean meat) or be based on plant-based products (Carrington, 2019). Towards the end of 2020, Singapore became the first country in the world to grant regulatory approval for clean meat (BBC, 2020). At the beginning of 2022 a joint venture between two Israeli companies, Tnuva and Pluristem Therapeutics, announced that they aim to have the first lab-grown beef on the market by 2023 (Ben-David, 2022) and it is reported that a different consortium raised $347 million for the same purpose (Ben-David, 2021). Furthermore, it was recently found that 29,8% of consumers in the USA, 59,3 in China and 48,7 in India were very or extremely likely to purchase 'clean meat' regularly (Bryant et al, 2019).

Where does the rise in supply and demand of 'clean meat' leaves the farmers in arid areas such as South Africa's Karoo (roughly 50% of South Africa's farming area) where the farming system is fundamentally geared towards animal production for meat and fibre? To find an answer to these and similar questions and to give recognition to farming in arid areas[2], the WCDoA commissioned a diagnostic and design evaluation of farming in Arid Areas of the Province.

This project, with a 30-year horizon, followed a similar approach of long-term visioning making use of the three-horizon framework. In addition to being disruptive, 4th IR also has the ability to provide solutions (Figure 3). Included in the recommendations was to establish structures and networks for farmer innovation which could facilitate initiative such as the 'uberisation' of resource use (i.e. use the same resource for multiple purposes) and the necessity to collectively harness the regional (e.g. 'Karoo') brand. The purpose of this intervention is to pre-emptively establish the credentials of products such as 'Karoo Lamb' before 'clean meat' becomes a reality which may be price competitive (Blue North, 2021).

[2] If included in a more encompassing project on farming, the discussion on arid areas is normally limited to a page or two in the project report.

3. RESULTS: IMPLEMENTATION

3.1. Existing initiatives

One of the earliest realisations during this 4th IR journey was that the WCDoA is already embracing 4th IR technology and promoting its use in the Provincial Agricultural Sector. Examples include:

a) Cape Farm Mapper (CFM): A Web-based interface between the Department's Spatial Database and users (comparable to Google Maps with a strong localised focus). In the database is a whole range of spatial datasets from institutions such as the Surveyor General, ArcGIS and the results from the Department's own spatial surveys (conducted in 2013, 2017 and a follow-up planned for 2022). (WCDoA, 2022).

b) Cape Agricultural Mobile Information System (CAMIS): An App enabling the use of CFM on smart phones.

c) Smart Pen linked to smartphones: Technology enabling the Department's extension officers to capture, with handwriting recognition software, all information and advice given during a farm visit. Pictures of the situation (and problems such as diseases) can be taken and, with GPS coordinates, uploaded to a central database for storage and analysis. This allow a record of advice to be developed and, incidentally, the number of farmers claiming that they "never see a Departmental official" declined substantially when we started showing them the electronic reports submitted by extension officers, LandCare officials and Animal Health Technicians visiting them.

d) Tractor Tracker: One of the challenges with land reform is the misuse or alienation of equipment such as tractors. To combat this the WCDoA has installed a tracker (similar as required by short term insurers) in the tractor. In this way the use and whereabout of the equipment can be tracked in-time.

e) Fruitlook: In cooperation with E-Leaf in the Netherlands, satellite images are used to monitor plant stress in all irrigated orchards and vineyards in the Province. The information is available on the Department's website and farmers can register free of charge to get access to their data to manage irrigation scheduling. The WCDoA is currently externally evaluating it and early results indicate that farmers get 30% more 'crop per drop' compared to traditional methods such as tensiometers.

3.2. Drones in Agriculture

The WCDoA's drone programme has taken without any doubt by far the biggest chunk of the time and resources allocated to the Department's 4th IR initiative. In this initiative the Department is striving towards four objectives: To,

a) Be a legal operator of drones.
b) Ensure that officials are legal operators of drones.
c) Introduce the right technology in the Department.
d) Support the Western Cape Agricultural Sector to embrace drone technology.

Becoming a legal operator:

South Africa was one of the first countries in the world to legislate drone-use. As this legislation was based on that for manned aviation, it also turns out to be one of the strictest in the world. Nevertheless, as a civil service organisation, the WCDoA have to set an example and during December 2020 it applied for its Remotely Piloted Aircraft System (RPAS) Operators Certificate (ROC) from the SA Civil Aviation Authority (CAA). The Department is on track to obtain its ROC during the third quarter of 2022, which will make it only the second South African organ of state to obtain an ROC.

This process was definitely not plain sailing and it forced the Department to take a deep and critical look at what it is doing. This included:

a) Develop standard operating procedures and manuals for various aspects such as flight operations and flying in restricted airspace.
b) "Appoint" (actually, designate functions to current officials) certain postholders to comply with the ROC regulations. These postholders include:
    a. Chief Executive Officer; or a person ultimately accountable for drone use
    b. Responsible Person: RPAS
    c. Flight Operations Manager
    d. Safety Manager
    e. Quality Manager
    f. Security Manager
c) Training of some post holders (especially the safety, quality and security managers)
d) Assess medium-term use of drones to apply for the correct category of ROC.

e) Bringing discipline in its operations; after all, we are sharing airspace with manned aircraft.

Ensure that officials are legal operators of drones

The WCDoA has assisted three different groups of officials, students, interns and farmers to obtain their Remote Pilot License (RPL). The course facilitated by the Department consist of seven days (spread over some months) of theoretical lectures covering air law, principles of flight, aircraft technical, human factors in flight, meteorology, radio, navigation and flight planning. As the candidate will be required to respond to all these matters during the final CAA examination, he/she must complete a series of mock examinations. The theoretical part is followed by five days of practical flying after which the formal CAA examination can be attempted. In addition to the CAA examination, the candidate must pass a formal radio examination as well as an air-medical test. The air-medical is the one hurdle which leads to most unsuccessful attempts (colour blindness, diabetes, hypertension, etc. lead to automatic disqualification).

The first group started their training in February 2020 and consisted of students at the Elsenburg Agricultural College as well as interns and officials of the Department. Unfortunately, Covid-19 restrictions severely disrupted the course and the thirteen successful candidates only obtained their RPL during a "wings" ceremony on 25 November 2020. The second group, exclusively Departmental officials, started their course on 16 November and the wings ceremony of the 18 successful candidates was on 5 May 2021. The third group, farmers and farm workers, started on 30 November 2021 and the eleven successful candidates received their wings on 4 April 2022.

Embracing technology in the Department

A different kettle of fish is to make sense out of the data. For instance, when an engineering technician is surveying a dam, he/she would normally be lucky to measure 2 000 points in the space of a week. With a drone, 3 million datapoints can be obtained within half a day and special hardware and software is required to make sense out of the data. Also, a drone is but a platform for a whole range of censors and these same sensors can be installed on static and mobile platforms.

Hence, the WCDoA has started a drone users working group to facilitate the adoption of new technology. This working group make use of own and invited expertise to stimulate growth.

Supporting the Sector to embrace drone technology

Not all farmers need a ROC or RPL to legally operate a drone on their farm but can do so under "hobbyist" rules. For instance, if on his/her own farm, never flying beyond visual line of sight, staying below 50m and not coming closer to 50m of a public road, building or people, a farmer may legally us the drone to patrol fences, inspect water points or to observe livestock. This is one of the first points made at the four workshops on drone use presented by the Department. Close to 200 people registered for the last one which was in preparation for the RPL course for farmers and farm workers.

Despite these events, the flagship activity in this field was the two international Drone Users in Agriculture and Conservation Conferences. Both Conferences took place at Elsenburg (the Head Office of the WCDoA) and was arranged by the Department in close association with the United Nations Development Programme, the Endangered Wildlife Trust and the Global Environment Facility. The first drone conference was attended by 120 individuals and, except for two people specially flown in, all attendees were South Africans. However, the second Conference was physically attended by 150 people and another 100 used the virtual option (many from abroad). More important, eight of the presenters were from abroad and could participate via the virtual facility.

There are currently 27 Schools offering Agricultural Technology in the Western Cape Province and part of the Grade 11 curriculum is a module on drones in agriculture. In the last week of March 2023, the WCDoA will host the teachers from these schools, take them through the themes forming part of the RPL, demonstrate applications (e.g. multi spectral and thermal imaging, mapping and surveying, spraying, etc.) and facilitate supervised flying. In this way the teachers will be empowered to generate interest amongst learners.

3.3. Other interventions

In addition to the above, the WCDoA has also been running a range of other initiatives:

a) Augmented / Virtual Reality (AR/VR): The University of the Western Cape (UWC) is the only South African tertiary institution offering an AR/VR post-graduate course. As this is unchartered terrain, the Department sponsored equipment to the value of R100 000 on condition that the student case-studies should be Agricultural. They developed AR/VR applications on tractor maintenance for Elsenburg College and a VR video for a local wine farm. This demonstrated potential applications and forced students to think of potential applications (and careers?) in agriculture.
b) E-Commerce Module: With the UWC CoLab, an e-Commerce module was developed for smallholder farmers on the trajectory to become commercial farmers. This module was presented to 50 farmers and the extension officers of the WCDoA.
c) E-literacy for farmworkers: South African farmworkers are one of the most vulnerable and isolated sections of society, with the UWC CoLab an e-literacy course was developed and piloted. This course and lecture material is currently being shared with a range of NGOs.
d) Students at Elsenburg Agricultural College and interns: A series of interventions, such as safety on-line and basic coding, was designed and presented for the students and interns.
e) The use of 4th IR technology in traceability: Over the past two years the Wine Industry in South Africa faced regular domestic and international trade restrictions. Rather than closing down the whole Industry, the WCDoA will identify 4th IR technology to determine the exact spot in the value chain where a bottle of wine becomes illegal. Interventions can then be brought to bear on the particular spot.
f) A regular seminar series on particular 4th IR Technologies, and their implication for the Province, will be conducted from 2022 onwards.

4. CONCLUSION

The purpose of this paper was to showcase how a sub-national organ of state can embrace the 4th IR and empower the Agricultural Sector to capitalise on developments. In designing appropriate interventions, three separate strategic processes were followed. The first placed the 4th IR in context and the second analysed the post Covid-19 future of the Agricultural Sector. The third specifically focussed on farming in arid areas. The implementation plan of the Department unwittingly started before the strategic processes was completed. Although the four-pronged approach towards the use of drones in agriculture took up significant resources, other initiatives were also explored towards the democratisation of 4th IR technologies.

Key words:

4th Industrial Revolution, drones in agriculture, government interventions

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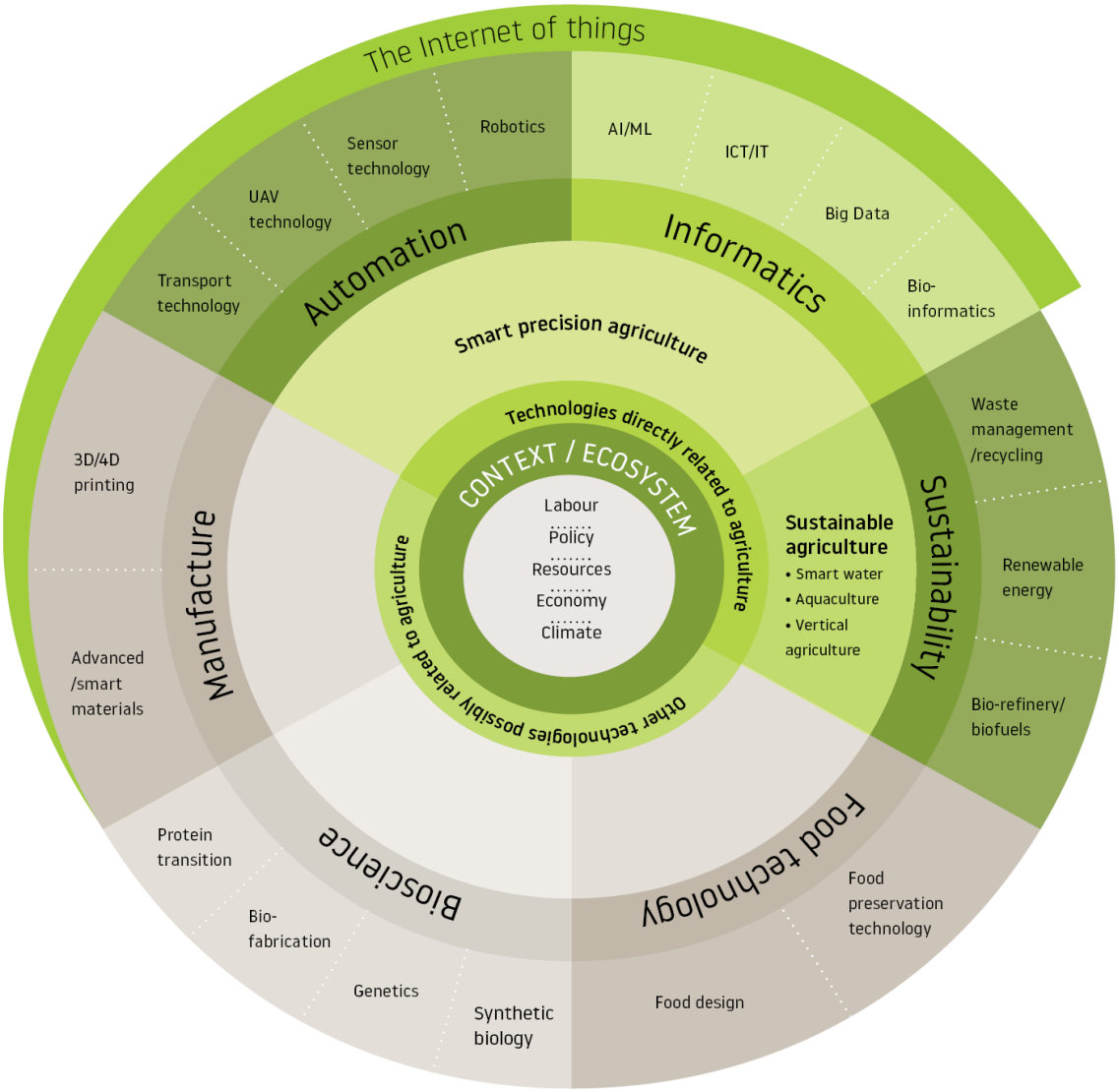

Figure 1: **Technologies, systems and applications**

Source: USB (2017)

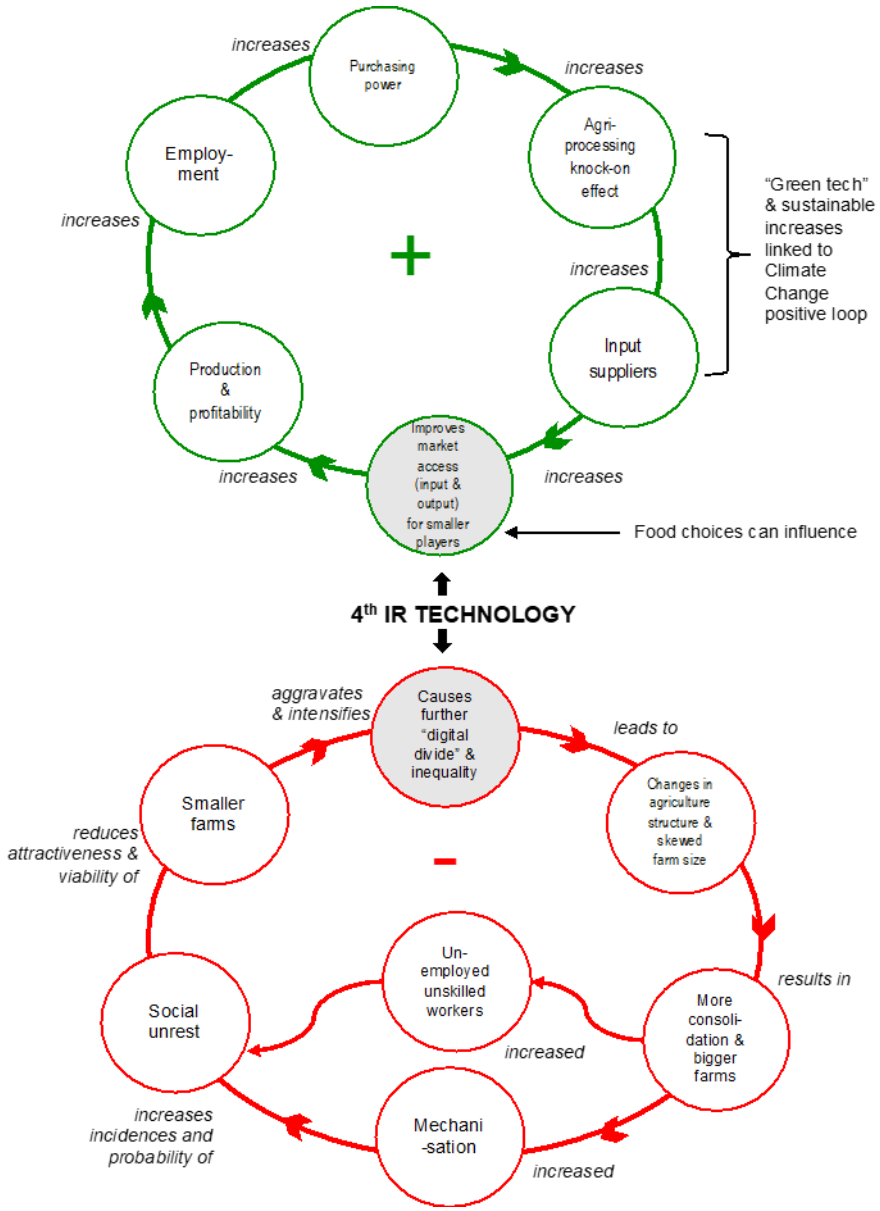

Figure 2: **The 4th IR Technology loop.**

Source: Hichert (2020)

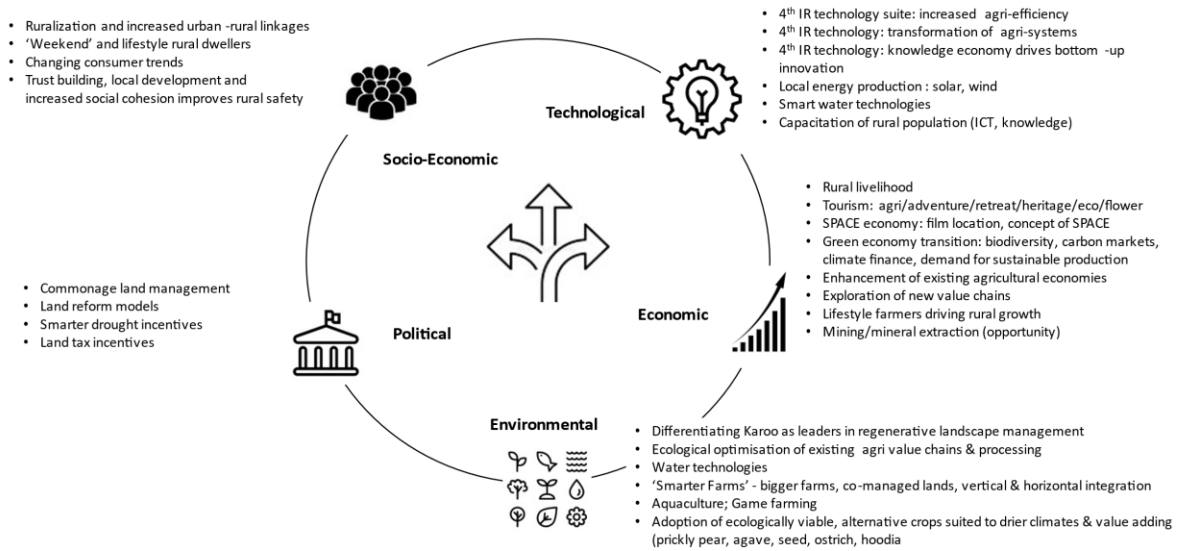

Figure 3: Array of potential future development pathways in arid areas.

Source: Blue North (2021)

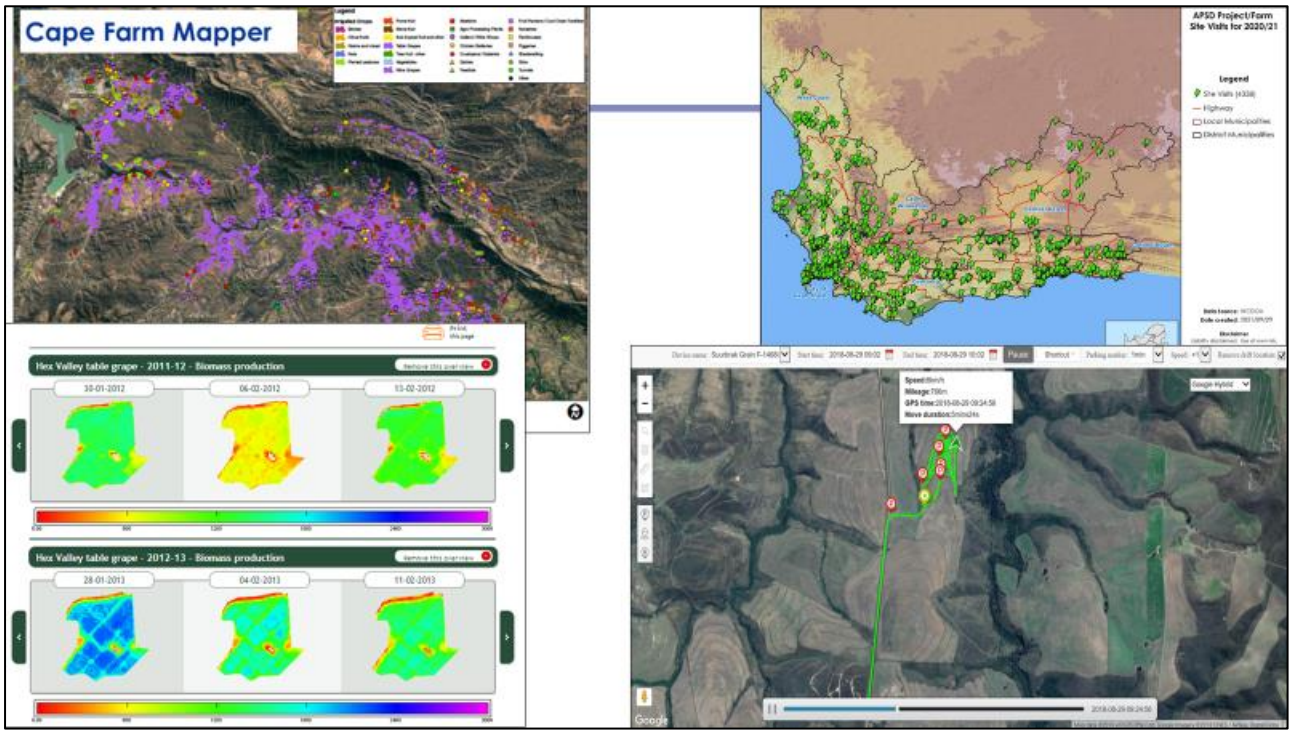

Figure 4: Examples of reports from existing 4th IR technologies in the WDCoA. Clockwise from top-left are: Cape Farm Mapper, Smart Pen, Tractor Tracker and FruitLook.

Source: Troskie (2022)

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