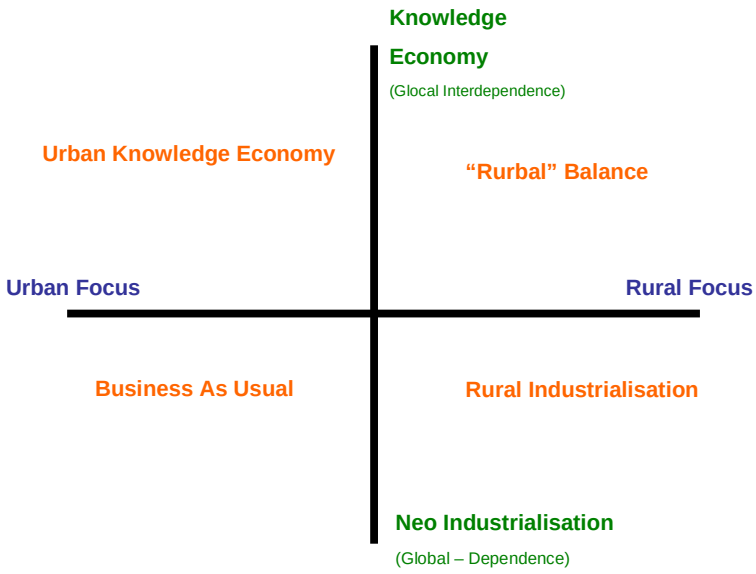
Three Biotechnology-Related Scenarios for the Eastern Cape

24 April 2009

Introduction

From October 2008 to February 2009 the Cooperation Framework on Innovation Systems between Finland and South Africa (COFISA) undertook a Foresight exercise focusing on the biotechnology sector in the Eastern Cape[1].

Two workshops were held as part of this exercise. During the first workshop three proto-scenarios[2] were presented for the E Cape, associated with three of the four quadrants of the diagram to the right. (There was no scenario associated with the bottom-left quadrant "Business as Usual").



The workshop participants then formed three groups which engaged in a process that resulted in biotechnology-related scenario fragments being written by the participants themselves that were relevant to their proto-scenario.

These scenario fragments, together with further inputs solicited by email after the first workshop, were then edited and integrated into their associated proto-scenario, resulting

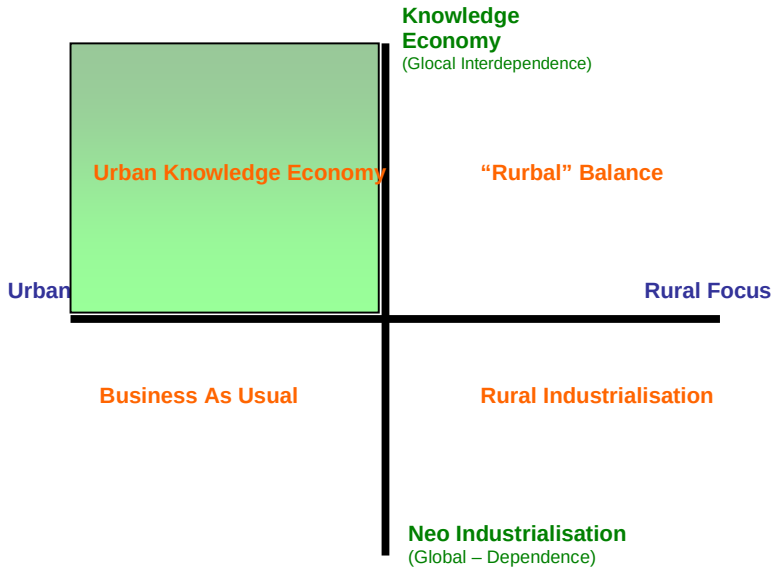
[1] For more information concerning COFISA and the Foresight exercise, see www.cofisa.org.za.

[2] The three proto-scenarios had been derived from COFISA's earlier provincial Foresight exercise.

in three biotechnology-related scenarios for the E Cape, as set out below. For easy reference, the biotechnology-related material is presented with a grey background.

In the case of Scenario 1, the biotechnology material provided as input consisted in the main of lists of items rather than narrative fragments. This is reflected in the format of that scenario below. In the case of Scenario 2, very little input was provided, while for Scenario 3, there is substantial and rich biotechnology-related material.

Scenario 1: Biotechnology in the Context of an Urban Knowledge Economy



The "Boom City State" of East London/Mdantsane

Wiki-Cast, 20th October 2030

Last month's repeat of the unrest that we experienced in the areas of Mdantsane, Ncalukeni and Nqonqweni in 2028 has highlighted the inadequate response of government and the private sector to address the problem, and even more so, it raises the question as to how we turn around the fast-deteriorating security situation in East London. But isn't it time to ask the most fundamental question: What is going wrong with our booming and blooming city?

The years 2009 to 2017

The older segment of our population (those who haven't left for greener pastures) well remember the excitement and energy of the teens, when East London embraced the strategic decision to become a world-class eco-friendly city. This strategy had been

formulated in the late noughties when it was realised across many different sectors and constituencies in East London that a bold plan was required for the development of the city, not only to aim for a brighter future for her citizens, but also to create a major centre for growth in the region.

Making East London the attractive home of high technology and knowledge-intensive enterprises was a core part of the strategy. At the same time, there was a keen understanding that we did not want to fall into the same trap that Gauteng City (Johannesburg, Mid-Rand and Pretoria as it was more commonly known then) and even Cape Town, were falling into: uncontrolled development; traffic congestion; pollution; being perceived as the carbon criminals of SADC. Therefore, through a remarkable process of negotiation and consensus, a set of forward-thinking, technology friendly, green urban policies were adopted that transformed the culture and conditions of East London in five short years.

The policies recognised the need for multiple CBDs so that congestion would be minimised. Six nodes were seeded some 10 km from each other, with ample provision for green leisure areas, and even small-scale agriculture, such as vegetable gardens. Residential areas were planned to be comparatively dense (without being overcrowded) so that services would be available at lower cost and higher efficiency. Energy usage was optimised, both by reducing waste and using renewable energy sources, as was water usage. Throughout, the carbon footprint of the development programme was kept as low as possible. In this respect, some tough regulations were introduced. The use of eco-unfriendly vehicles and engaging in activities that harmed the global environment were severely restricted through taxation and licensing, and urban development along the coast was allowed in only a few selected (and therefore highly sought after) areas.

East London became world-renowned as the leading African city in green development.

As the six CBD nodes developed, the need for facilitating business between them became more important. After a drawn-out but dramatic negotiation, in 2012 East London managed to secure unprecedented funding from central government to subsidise the

deployment of 2 000 km of optical fibre in and around the city. Thus was enabled the low-cost and high-performance connectivity for which East London was famous for many decades.

This assistance package from national government was but one of several that East London negotiated. The negotiations hinged on the huge poverty problem in the Eastern Cape, and the need to address this with urgency. East London was seen as a place that could act as a development node with the required critical mass of infrastructure and expertise. It was also seen as an ideal test-bed for innovative development initiatives. So major concessions were sought and given, enabling East London to become a place of choice for "ideas people" to relocate to. It even began competing with Cape Town in the international arena, as its levels of crime were relatively lower, it offered more reliable services, including ubiquitous wireless internet connectivity at no charge, and better planned housing and road infrastructure, all contributing to an improved quality of life.

Furthermore, East London's growth strategy, with a "green urban plan" at its core, gained considerable international recognition and support for enabling the growth of the city while maintaining and enhancing the quality of life of its citizens. This international profile was reinforced by the substantial involvement of several experts who had contributed to the publication: "*State of World Population 2007: Unleashing the Potential of Urban Growth*", UNFPA. In the wake of this favourable international image, East London began to attract significant amounts of FDI, which further accelerated the establishment of world-class, knowledge-intensive industries.

While the "Green City" plan boasted several components that emphasised the use of various biotechnologies, it also used an innovative approach to create awareness and excitement about the use of technology in achieving its "Green" goals. Thus, tourist services and conference facilities were themed to promote environmental awareness and health technology competencies. A large aquaculture facility was linked to a theme park, emphasising the importance on marine biotechnology.

Underlying the awareness-creation thrust in the plan was a focus on achieving results in

specific areas, and some of these could benefit from the use of biotechnology.

Energy conservation was a core component of the plan, and biotechnology played a key role in achieving the goals set. One of the goals was that by 2030 motor cars would no longer be powered by fossil fuels, but instead would make use of a range of alternative fuels, including biodiesel. In addition, innovative power storing technologies were developed using plants as the storage mechanism.

Another productive area was bionics. A classic example in this area is the development of dirt- and water-repellent paints and coatings based on the extreme water-repellent surface of the lotus flower plant.

Environmentally-friendly products were developed:

- Strong fibres were produced from "fibre milk", with a range of applications including construction materials.
- Sisal was used as a filling in car seats.
- Organic waste was processed and then used to make bricks for construction.
- Genetic modifications were introduced to angora goats resulting in a Mohair with improved qualities (softer and non-scratchy).

There were advances made in food biotechnology:

- Improved food capsules were developed that enable the slow release of nutrients.
- Hydroponics became widespread, using organic, genetically-modified solutions and stress-resistant plants.
- A range of food products were produced, using GMO, for a variety of purposes such as drug delivery, vaccine delivery, improved food preservation, nutritional value, flavour, texture, and appearance.
- Cell cultures were used to produce chocolate-flavoured steak.
- By harvesting viral and fungal pathogens, improved biopesticides were produced.
- Disease-resistant plants and animals were developed using GM techniques.
- GM techniques were also used to produce biofertilisers.

Biotechnologies were applied in the area of conservation, including for:

- Waste and water treatment processes;
- Waste disposal, especially the disposal of organic waste;
- The biodegradation of industrial water, such as tannery waste, and paper and pulp effluent, using enzymes from extreme environments;
- Biodegradable products to replace non-biodegradable materials;
- Accelerated decomposing agents, using e.g. modified microbes;
- Recycling;
- Desalination of sea water into fresh water (which was also linked to harvesting products from the sea);
- Fertilisers from the sea e.g. kelp, algae, plankton;
- Carbon sequestration e.g. planting of spekboom in city gardens and city perimeters;

The health sector also made use of biotechnologies, and in so doing the line between the health and entertainment sectors blurred:

- Bioinformatics played an increasingly important role;
- Brain implants were produced that reduced stress and provided non-addictive stimulation.
- Biokinetic treatment regimes were integrated with virtual environments such as games.

The construction industry began to focus on green building techniques and technologies, focused initially on the largest commercial buildings, but then extending down to the smallest residential buildings. Innovative methods were developed for building affordable housing with a low carbon footprint, but deployment of such houses in the poorer areas ran into interminable bureaucracy and corruption. Thus, while the quality of life within the city rose steadily in the teens and even twenties, the surrounding informal settlements did not experience a similar improvement, and if anything, conditions worsened as more and more people migrated from rural areas, attracted by the “buzz” of East London’s growing success.

So the picture was not all rosy.

Crime was an increasing problem, but it was combated in innovative ways, using the latest technologies. CCTV surveillance became the accepted norm throughout the city, and access to many facilities (e.g. libraries, places of recreation and entertainment) was increasingly controlled, using biometric technologies. So, even into the late teens, East London was able to boast of low levels of crime, and of an ideal environment to develop and test the security technologies and products that were finding ever-growing markets worldwide.

In 2012 the motor industry took a dip as some multinational manufacturers pulled out of the province due to lower labour costs in other parts of the world. However, other multinational manufacturers with installations in the E Cape, who had already begun to focus on green automotive technologies, increased their investment in the East London area, in part because a growing number of their "green" components were designed and built locally, thus reducing their costs. So by 2015 the industry had recovered, and its continued innovation and diversification made it an important component of the city's success over the next two decades.

Further afield, by 2015 the chronic problem of insufficient water in Gauteng had reached crisis proportions, forcing the national government and the mining industry to call on the nation's green engineering expertise, particularly from East London, to help with water management, recycling, leakage and capture, to ameliorate the growing conflict between the water needs of the mining industry and the household use of the growing population. This represented the first clear signal that significant pressures were building within South Africa that would have wide impact, and that cities such as East London would not escape the fallout.

But on the whole, East London's economy experienced very significant growth as a component of the global (rather than the regional) economy in the second decade of this century. Many Knowledge-Intensive Business Services (KIBS) relocated to East London, further stimulating growth. The KIBS had a global reach, and also made heavy inroads

into Africa. The city's population grew dramatically, but planning was adequate, and the city remained a popular first choice for many people from other parts of the world.

The years 2018 to 2029

Towards the end of the teens, East London began to reap the full benefit of the farsighted but costly policy decisions that had been made a decade earlier. This was East London's "Green Boom" period during which there was ongoing, innovative planning and implementation, and the watchwords were "fast, flexible and fun". Increasing numbers of fast-moving, high-flying, innovative people flocked to the city, creating ever more opportunities for innovation. East London was held up internationally as a model green city. A plethora of studies analysed its recipe for achieving this honoured status. One advantage was frequently cited: the city had started late in pursuing development, at a time when it was still small. This allowed carefully planned growth around multiple nodes (rather than one CBD), and the capping of their size.

But planning was not the only characteristic of this period. Stunning technological breakthroughs also raised the profile of East London:

- In 2021 the Water-for-Life research institute (that was renowned for its inputs related to "green" policy) announced that its scientists and engineers, in collaboration with colleagues in Durban, Cape Town and Dubai, had developed a desalination process that held the promise of reducing the cost of desalination by orders of magnitude. Within two years the process was commercialised, and through careful management of intellectual property rights, East London became self-sufficient in producing readily-affordable drinking water, as well as desalinated water for industrial use.
- In another scientific and technological breakthrough, multi-purpose micro-cells (based on frictionless ferro-electric fluids) were used to demonstrate the economic viability of a range of options for power generation (from ocean waves to solar), as well as large-scale carbon dioxide scrubbing.

East London's status was further enhanced when it was announced that the "Green Transport Global Expo" would be held in 2028 in the city. This high profile event was a

major coup for the city. The expo covers a wide range of forms of transport: business, leisure, mass and personal; on land, sea, in the air – and even in space!

However, during this period crime rose dramatically in the peri-urban "grey area" around East London. The relatively low level of policing in these areas (a policing presence was to be found mostly in East London proper, supported by a range of private security service providers), along with the plentiful supply of highly-trained engineers and technicians having world-class ICT skills, made these areas very attractive to cyber criminals. Unbeknownst to almost everyone, bar a few police detectives who were encouraged to focus their efforts within East London itself, a sophisticated criminal network took root under their noses. East London emerged as a key hub in the global network of organised crime, particularly in the areas of cyber gambling, pornography and money laundering.

More visibly, social unrest broke out in the countryside surrounding East London. This took everyone by surprise, but the underlying causes were not hard to uncover: the chronic neglect of East London's rural hinterland had spawned a generation of disaffected young adults who saw no future for themselves, but instead had to watch "foreigners" stream into the city and live out what the TV adverts promised.

Criticism of East London began to mount, coming from both local and global quarters. The lack of attention paid to East London's hinterland now appeared, with the benefit of hindsight, to be foolishly myopic. East London's growth began to falter, and prophets of doom predicted an implosion. Amongst environmentalists, East London started carrying the moniker "Green Bubble". And to add insult to injury, two years before the planned Global Expo of 2028, the international organisers decided to relocate it to Adelaide, Australia.

Meanwhile, in much of the rest of South Africa, there was increasing turmoil and concern. By 2025 in Gauteng, even the significantly improved industrial and household water systems could no longer cope with the growing demand for water by the population of now 12 million people, along with a mining industry that continued to

boom. The populace had become wearily tolerant of water rationing for 2 to 4 months in bad years, but then two full years of drought in 2023 and 2024 led to rationing for a whole year. This proved too much for even the most patient. Public protests took place in various forms, often accompanied by violence from unruly elements.

Permanent water rationing, affecting 12 million people, was introduced in Gauteng in 2028. In 2029 the crisis reached a breaking point. Serious civil strife erupted. The Government was forced to choose between household usage and industrial usage. Out of fear of further civil strife, they placed the most onerous restrictions on the mining industry, which cried foul because of the huge investments that they had made in water systems, at the government's insistence, during the previous 10 years. They argued that the Government had not kept their commitment, made in 2019, to cap the population in Gauteng below 12 million. Repeated legal action ensued, in which the mining industry was usually successful. However the conflict did not abate. It damaged seriously the much-vaunted public-private partnership relationship in South Africa, with severe impact upon FDI, and on South Africa's international image. It has also undermined the credibility and effectiveness of the Government as it has resurfaced at regular intervals, tending to dominate our political discourse.

In 2022 South Africa experienced its first force five hurricane, with East London bearing the brunt of the damage. This proved to be a portent of things to come. The effects of climate change were being felt around the globe, and South Africa was not spared. Hurricanes became, if not frequent, then familiar visitors to our coasts. As ill luck would have it, East London suffered more than other cities. One casualty in particular was the Aqua-World science and leisure park, 1 km out to sea, just to the north of the city. It was due to be completed in 2023, but it was finally opened in 2028, with most of the delay ascribed to two force five hurricanes within 30 months. Their destructive force revealed significant design defects in the under-sea park, and set back construction by at least three years.

The situation in 2030

The year 2030, according to some, is a tipping point, after which East London's decline could prove to be unstoppable. However, most think the situation, though concerning, is not disastrous. After all, East London has risen from very modest beginnings to great heights, so why should today's difficulties be unsolvable.

East London has in the past relied on its own resources and ingenuity. But despite much talk and planning, and even some implementation, the symptoms of East London's discomfort continue to worsen: rampant crime, including horribly violent crime; growing unemployment; and stagnation of public budgets. Many East Londoners appear to be taking a defensive stance, trying to find a way forward using the methods of the past that seem to have worked up until now. But growing numbers are leaving for elsewhere in South Africa, or even the world.

Is East London's mindset that has blossomed in the past two decades, now stagnating? Certainly, there should have been, and must now be serious and sustained engagement with East London's hinterland.

But the national Government has been so focused on, and indeed weakened by, the chronic water crisis in Gauteng that little attention is being paid to what has traditionally been viewed as an unimportant backwater. In addition, the slow collapse of Gauteng's economy – previously the engine room of the national economy – means that funding from the national Government is drying up. With few resources of its own to fall back on, the Eastern Cape government is lurching from one crisis to the next. What may aggravate matters even further is the growing number of Gauteng's urban poor starting to return to their home provinces to escape the ongoing turmoil and unrest associated with the chronic water crisis. This returning population will inevitably put growing pressure on the service infrastructure of Port Elizabeth and East London in particular.

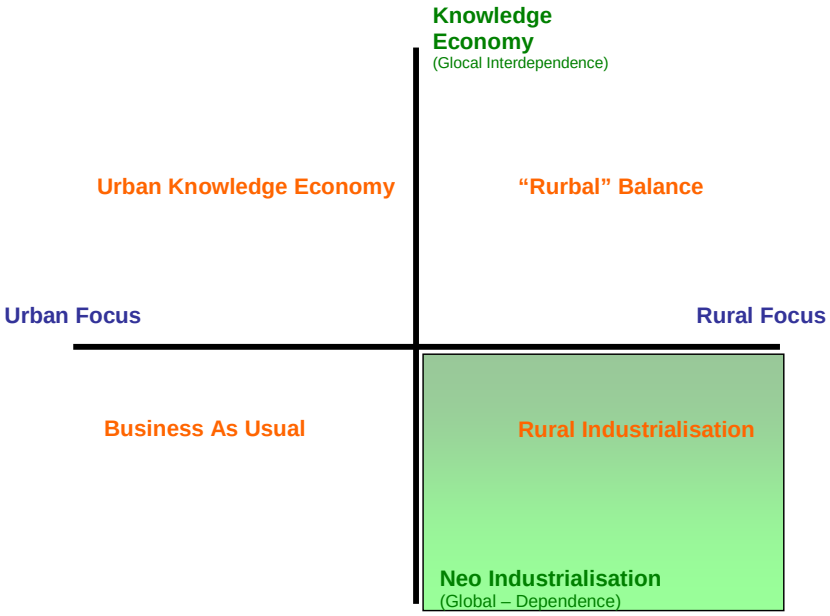
The rising sea level (almost 1 metre between 2010 and 2030) is threatening several areas of East London's prime land, the "Green Bubble" area in particular, most of which has

been reclaimed in the previous two decades. Scientists tell us that the primary cause of this threat is the accelerated partial melting of the Greenland Ice Sheet.

And so we now take stock, remembering with concern who we were just a few years ago: East London's cosmopolitan character is ebbing away. The international knowledge workers are moving on to greener pastures. The slums around the city are becoming breeding grounds of violent forms of extremism. The police are just too stretched (and corrupt) to cope. Old-time East Londoners, many of still considerable means, are trying to cling to their former lifestyles by building a high security enclave (ghetto?). But they appear surrounded by a barely-concealed animosity that is increasingly politicised and organised.

Is the "Green Bubble" bursting, and if so, what is next?

Scenario 2: Biotechnology in the Context of Rural Industrialisation



Editorial in the Daily eDispatch – 20th October 2030

The announcement by Government last night that they are to introduce several "targeted incentive schemes" in the Eastern Cape, prompts a yawn and a sigh. A yawn because this has been tried before, with limited success. What is supposed to make the difference this time? And a sigh, because by putting together such an incentive plan, Government appears to think that they have now discharged their responsibility towards the Eastern Cape for intervening in what is becoming an increasingly intolerable situation. These schemes hardly get to the root of the problems that must be addressed if we are to secure a better future in this region for our children and grandchildren. An understanding of where we have come from is necessary in order to chart a suitable course for our future.

The years 2009 to 2018

Early in the century the strategic importance of agriculture was recognised in South Africa, as indeed it was on the continent as a whole. National Government committed to raising expenditure on agriculture to 10% of GDP, in line with NEPAD's CAADP. This level of expenditure was reached by 2011. As a part of this renewed focus on agriculture, existing agricultural research institutes, such as the one at Middelburg, were upgraded, and three new institutes were established in the Eastern Cape alone, to accelerate the industrialisation of the agricultural sector. Agricultural training colleges received priority funding, both for those already existing, and for the establishment of new colleges. As was to be expected, the numbers of agriculturally-trained graduates increased dramatically.

The vision, at least for the Eastern Cape, was to industrialise agriculture and turn the province, with its high rainfall (in the East) relative to most other South African provinces, into not merely the bread basket of the subcontinent, but to be its "fuel tank". Biofuels were high on the agenda, firstly to achieve national energy independence, and secondly to exploit the growing global demand for biofuels through export. Unfortunately, a preponderance of first generation biofuels was produced, despite warnings that these made a very modest contribution towards reduction in carbon emissions, while also resulting in long-term damage to the soil and to the water table through pollution.

This grand vision was sold on the basis that the rural population of the Eastern Cape would enjoy the benefits of the expected prosperity. A solid rural economy based on "modern" agriculture was to have provided the needed support to thriving urban economies centred on Port Elizabeth and East London. Conservative projections showed that the blight of rural poverty would be largely eradicated by 2020 through migration to the growing urban areas. At the same time, industrialised farming techniques would allow productivity to sky rocket even as the number of farm labourers dropped. Thus the national policy for addressing the matter of rural poverty was to promote urbanisation.

The focus of the development policies was on wealth creation through industrialised agriculture, rather than on sustainable development. In line with the much vaunted public-private partnership, these policies suited well the interests of the multinationals, leading to significant economic growth, measured by the standard indicators, for the next 12 or so years. This economic growth was fuelled first by increases in FDI. International funding institutions recognised and encouraged the Eastern Cape's rural industrialisation initiatives, which resulted in further injections of FDI. On the back of this investment, productivity was much improved as skills were enhanced, which in turn stimulated economic growth. There were those who sounded warnings that the approach being taken was not sustainable in the long term, but the short-term successes being realised served to drown out even those who used solid scientific research, including scientific modelling, to back up their statements of concern.

In short, the land and its potential to bring economic wealth were emphasised, rather than the emphasis being laid upon enhancing rural people and their knowledge.

One sector that began to prosper at this time was the game farming industry (e.g. venison meat production), along with ancillary industries (e.g. taxidermy). Biotechnology-related research was conducted in targeted ways to address some of the issues in the industry. Based on the research results, zero-waste approaches were implemented, with some signs of success. Components of the game, such as the skin and meat, were genetically improved. Biotechnology techniques, such as tissue culture, were employed to ensure the availability of the primary producers (i.e. the plants eaten by the game). In addition, the breeding patterns of the animals were improved through biotechnology-based measures.

Another agricultural sector to experience significant growth was specialised plant farming, particularly in respect of indigenous plants. For example, Aloe Vera and Strelitzia were grown widely, with a view to the market for active ingredients that may be extracted from such plants (Aloe Vera may be used for medicinal purposes, while Strelitzia may be used as a fibre for ropes or seats). Cannabis was genetically modified to be the source of high-quality fibres. The search for new bioactive ingredients in

indigenous plants continued without a pause, spearheaded by researchers in the four universities in the E Cape: University of Fort Hare, Nelson Mandela Metropolitan University, Rhodes University and Walter Sisulu University. A particular goal of this research was to enable the development of new cosmetics.

The E Cape Government tried to encourage the triple helix concept, namely close interactions and cooperation between, the public sector, the private sector and the HEIs. However, the HEIs only paid lip-service to this policy, not unsurprisingly as their performance was measured solely on the basis of numbers of students graduated and numbers of research articles published. They continued to practice minimal, incremental transformation based on institutional interests rather than on national or regional realities. Some universities invested in schools of agricultural engineering, and also of environmental engineering, and these drew students from across the country and also the continent. However, the underlying approach of these schools was founded on the industrial society model, rather than a knowledge society model. Overall, the HEIs as well as the local and provincial governments were not transforming in line with the global knowledge economy and as a consequence, many of the Eastern Cape's brightest and best left the region for more attractive destinations in South Africa and elsewhere.

In the 2000s, a mainstay of the Eastern Cape's economy was the motor manufacturing sector. Over the years several multinationals had invested heavily and the Eastern Cape exported around the globe. The high dependence on multi-national interests in this sector, with the associated risk, was recognised but only marginally addressed. There was some refocusing of the industry on production of industrial agricultural equipment for local consumption, in line with national policy. But almost all of the sector was targeting the lucrative international markets.

Then, between 2011 and 2015, to the dismay of many, most of the motor industry pulled out of the Eastern Cape. Labour costs had risen to the extent that East Africa and South America offered a much cheaper environment, thus cutting the cost of manufacture. By 2016 only 20% remained of the capacity of the motor industry at its zenith in 2010.

There were attempts to rejuvenate it, targeting the manufacture of agricultural equipment, and with substantial funding from national Government to create local expertise that would be relevant to both national and global markets. But this was a case of too little, too late. There was only partial success, and only for agricultural equipment.

In the turmoil of these years, and the desperation of recovering an economic base that had been lost, Port Elizabeth backed the resurgence of the motor industry as they had known it. They tried to go head-to-head with their competitors in East Africa and South America by offering huge incentives to locate new production lines in the vicinity. But all their efforts came to nought. Severe recession in Port Elizabeth set in from 2016 onwards. And as a side effect of this collapse, Coega became a major embarrassment for the national Government, and levels of FDI in the region suffered. Port Elizabeth was caught up in this maelstrom and the future looked bleak.

East London, on the other hand, refocused their efforts on agricultural equipment. This proved to be a wise choice as they enjoyed relatively good prosperity in this sector for two decades, although the volumes and profit margins of the years in the noughties were never experienced again.

The years 2019 to 2029

Industrialised agriculture became a major economic success story for the Eastern Cape. Productivity reached world-class levels as farms were consolidated and automated processes were introduced. Rainfall, although variable as always, tended to be higher than in the past, which also boosted productivity. However, increasing numbers of manual farm labourers were entering the ranks of the unemployed, having been displaced by machines. What had been ignored for a decade was now becoming visible for all to see: a mature, highly-industrialised agricultural sector needs only a comparatively small, well-educated elite to run it. During the early stages of the development of such a sector, large numbers of unskilled labourers are required, but this requirement diminishes over time.

Even independent small-holders were being pushed off their land by forced acquisitions, or insufficient water, as the demand for water by the large agro-companies was prioritised.

The unemployed labourers migrated to the slums around Port Elizabeth and East London, and also further afield to Cape Town and Gauteng. By 2025 the Eastern Cape's peri-urban poor outnumbered the urban "haves" by 4 to 1. They lacked education (many were illiterate), and had almost no skills relevant to an urban context. Conditions in the slum areas, particularly those around Port Elizabeth, matched those found in the worst African cities, such as Nairobi and Lagos.

Most of the small rural towns died. The exceptions were those involved in agro-processing and refining industries.

Less than 15% of the Eastern Cape's population remained living in rural areas, from 70% in 2005, and almost none of these were small-holder farmers. This precipitous drop in the rural population had a devastating impact on the rural communities that remained, dominated by the very old and the very young. Social life and culture faded away, and the loss of indigenous knowledge was irretrievable.

Meanwhile, around the urban areas, human squalor and crime escalated. Human trafficking and the drug trade mushroomed, especially around Port Elizabeth. Local leaders in both the public and private sectors either turned a blind eye to this, or were themselves actively but covertly involved. Many basic services were disrupted due to the bankrupt municipality being unable to maintain the infrastructure or pay their suppliers. The disruptions were aggravated by sabotage of the infrastructure by an increasingly angry populace. Outbreaks of typhoid and dysentery became commonplace, and poverty-related deaths began to rise, added to by an escalating murder rate. (Port Elizabeth overtook Johannesburg as the murder and rape capital of South Africa in 2023).

The situation was ripe for conflict and strife. Despite warnings from many quarters, the authorities took little or no action to address root causes. Civil unrest broke out around

Port Elizabeth first in 2026 and spread to other areas. The police were able to clamp down in most areas, but around Port Elizabeth there developed no-go areas where even the police avoided entry. The National Government sent a token military detachment to indicate support, but this failed to achieve anything. In fact, the national Government had been severely weakened the previous year because of their inability to resolve the ongoing water crisis in Gauteng.

This crisis had been smouldering for several years, driven largely by migrants seeking prosperity in the "place of gold". By 2025 the industrial and household water systems in Gauteng could no longer cope with the growing demand for water by the population of now 12 million people, along with a mining industry that continued to boom. Although the populace had grown accustomed to water rationing for two to four months in bad years, the year-round rationing enforced by the two full years of drought in 2023 and 2024 proved too much for even the most patient.

Unrest in the poorer areas of Gauteng became a familiar pattern, fuelled by dissatisfaction and disillusionment. Many of those in the unrest-prone areas decided to return to their home provinces, worn out by the ongoing water shortages and the incessant strife. However, they returned not to their rural home villages, but to the urban squalor surrounding the cities. Both Port Elizabeth and East London were pushed to the brink as they tried to cope with burgeoning informal settlements beyond what they had previously experienced.

The Eastern Cape provincial authorities, out of desperation, initiated yet another poorly conceived scheme to "reverse urbanisation", but once again it had little impact.

Meanwhile, at a global level, the signs of global warming persisted unabated. International efforts at reducing carbon emissions continued, but without the necessary commitment that dramatic success required. The national Government became a major supporter of the global carbon trading mechanisms favoured particularly by Russia and China. This financial proxy system allowed the emerging economies to continue to exploit fossil fuels as long as they grew more forests and produced biofuels to offset CO2

emissions. But this distorted economic mechanism failed to accurately reflect the real GHG impact, or to stimulate effective mitigation, so global warming continued to accelerate.

The situation in 2030

By 2030 Port Elizabeth is showing signs of becoming a ghost city. The quality of life for its middle and upper-middle classes is deteriorating alarmingly, so that many have taken the decision to leave. In East London some early signs of deterioration are appearing as the biofuels industry starts to come under pressure. In several of the areas being farmed by agro-industrial enterprises, the soil has been exhausted, and water quality has dropped severely due to poor conservation and management. In addition, the unpredictable weather due to climate change is aggravating matters. Although more efficient 3rd and 4th generation biofuels and other renewable energies are being pursued in other parts of the world, the industry in the Eastern Cape still declines to make the necessary capital investments to meet this challenge. The gloomy predictions that the biofuels industry will soon lose its economic viability, with dire consequences for East London, are becoming ever more frequent.

There are signs of a population exodus not only from Port Elizabeth, but throughout the Eastern Cape. Very few of those leaving are moving to Gauteng because the water crisis there has permanently stunted economic and population growth. Instead, many are moving to the Western Cape, which has become the most successful economy in South Africa. But even more are moving to the East and Central African Economic Community, which now has an annual growth of 10% (indications are that it is receiving much of the FDI that had previously been channelled to South Africa).

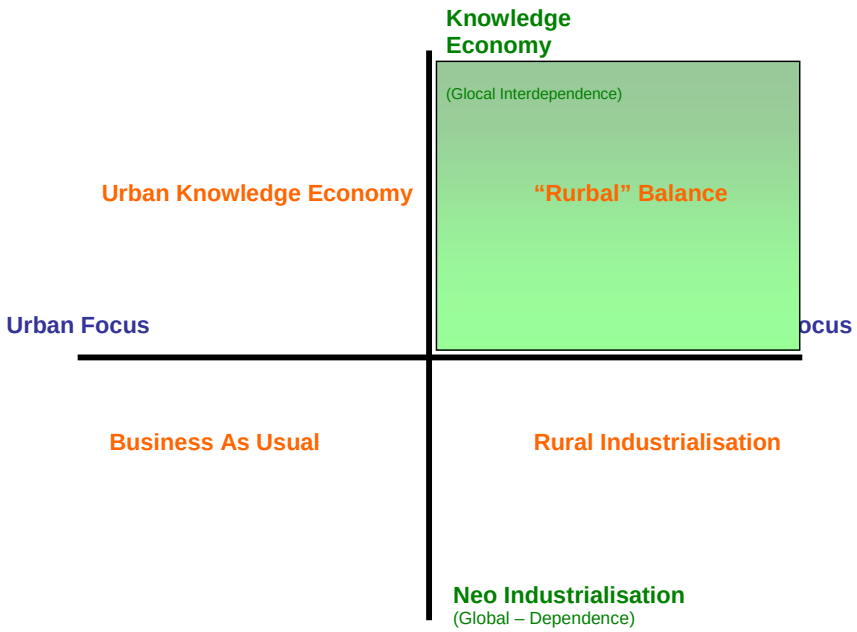
The decline of the agro-industrial sector has placed into question the continued role of the seven agricultural research institutes that were founded some 20 years ago. Their earlier success had drawn much attention, even internationally. The question in the minds of many policy-makers was whether this success could be repeated so that the sector could be rejuvenated. A thorough review was initiated of the role of the institutes

over their lifetime. The review, published earlier this year, returned an unexpected result: over the 20 year period, fully 70% of the expertise and resources of the institutes were used to justify, often based on quite inadequate science, the agricultural mega-projects being promoted by the national Government or the multi-nationals. As a result, funding for these projects was much higher than it would have been had rigorous and open research been pursued. Thus the unhappy conclusion of the study was that no easy turnaround of the sector could be expected.

What next?

There are no easy lessons that emerge from this account of the past twenty years. Clearly, well-meaning (but scientifically flawed) policies have not produced the sustained prosperity for all that was promised. Where will we stand and what will be our perspective at the end of the next twenty years?

Scenario 3: Biotechnology in the Context of "Rurbal" Balance



From The Digital Herald – 14 March 2030

The appointment last month of Bongi Cele as South Africa's first Minister of Rural Development came as no surprise to those of us who have worked with him in the stimulating and sometimes frustrating environment of rural development in the Eastern Cape. In this context, there is value in reflecting on the history of this region over the past twenty years and what it took to bring the Eastern Cape to the position it is now in. Bongi's key role in its successes and challenges are now legend, but he is not the only "hero". Without wishing to detract from his own stunning achievement, the following review brings into broader perspective the successes and failures, the highs and lows of the people of the Eastern Cape during the past two decades.

The years 2008 to 2017

The story may be thought to have had many starting points, but perhaps the primary one is the effort to develop an integrated rural policy for the Eastern Cape which was started in 2009. The provincial Government took the lead, encouraged by both the international community and the national Government. For the next three years the policy was drafted using an iterative and interactive process involving a wide range of stakeholders. The successes and failures of rural policies in other countries were closely studied so that the best learning could be brought to the exercise. The Finnish approach to rural policy proved to be one of the more valuable inputs, and much of the final policy bears the mark of the Finnish experience, although modified substantially to adapt to local conditions.

The point of departure of the policy was articulated as follows:

> *"The requirement of sustainable development will have an ever greater impact on our future choices. As well as being ecologically sustainable, our decisions and solutions have to be economically viable, socially just and culturally valuable."*

During the drafting process it became clear that the notion of 'Information Society' served as an integrating concept for the various threads in the policy, which led to the founding in 2011 of the *Integrated Rural Information Society* (IRIS). IRIS is a national organisation, but at that initial stage it focused on pilot projects in the Eastern Cape. Its goals were:

- To improve the quality of rural life.
- To ensure smallholders have secure sources of energy, food and water.
- To reduce dependence on imported fossil fuels.
- To enhance smallholder productivity (food security first, export second).
- To reduce urban migration.
- To transform urban planning: recognising urban-rural interdependence

This initiative was supported by the national Government and by the EU, the latter seeing it as a potential model for use in the rest of Africa.

Two initiatives flowed immediately out of these efforts:

- Virtual centres of excellence were established to focus on a range of rural issues (that is, networks of smaller research groups, geographically dispersed, that undertake intense information sharing and collaboration).
- The establishment of new forms of "horizontal" community associations were stimulated (modelled on the Village Associations in Europe).

The community associations identified a wide range of local development priorities, and then pursued these, such as community-based infrastructure development initiatives (e.g. building local roads and water systems), as well as ICT-enhanced government services, education (particularly skills development), health, and local entrepreneurship. By 2012 some fifty community associations had been set up, along with district-level and provincial-level forums.

The effectiveness of the community associations was distinctly patchy at this time. The patchiness was related to a wide range of issues, from land ownership to national energy policy:

- Within several communities, issues related to land ownership resulted in gridlock. The bottom-up development processes of the new community associations were sometimes experienced as a threat by the traditional community leadership structures. These structures had ultimate control of the land, and sometimes this power was wielded to inhibit the effectiveness of the community associations.
- A key issue that was pursued was energy independence. This focus stimulated the emergence of private, small-scale energy producers. By 2012 Grahamstown became fully self-sufficient in energy (using an innovative combination of biodiesel, wind and solar), and wanted to feed its surplus green energy into the national grid. However, this was prevented by Eskom who saw such an arrangement as a threat to their continued dominance in the energy sector.
- The matter became a long drawn-out saga, with frequent litigation, which inhibited similar developments in many other market towns across the country.

- Also during this period, industrial farming interests (including multi-nationals) were lobbying for incentives for the industrialisation of 1st generation biofuel production.
- Some incentives were implemented, with early success. Within three years production of home-grown fuel had increased ten-fold, but this put pressure on rural communities to offer up their land for the use of the agro-industrialists.

By 2013 the community association experiment was faltering. Despite the maintained enthusiasm of those directly involved, there was little that could be shown by way of solid progress or success. Calls came from many quarters to cut the funding and have the savings redirected towards initiatives expected to produce results in the short term. At this stage Bongi Cele emerged as an outstanding leader who was recognised as such by the national Government along with the EU and the OECD. Even in his early years, growing up in Ngqeleni, Bongi's leadership skills were obvious. He had graduated from Rhodes University with an unusual degree: majors in Political Science and in the Dramatic Arts (but with a strong multi-media component), before returning to his rural roots, working for several community-based organisations. As the crisis amongst the community associations escalated, Bongi played an increasingly assertive role, until he was prevailed upon to take up the reins at a provincial level. During the next three years he managed to keep thirty of the community associations afloat, despite the increasing pressure to cut budgets due to so little tangible progress being visible after eight years.

By this stage both Nelson Mandela Metro and Buffalo Metro had progressed significantly in stimulating the development of vibrant HEIs connected through broadband technology to schools throughout the province, providing a backbone for communication and for e-learning. This contributed to raising the level of education, provided access to information for many new enquiring minds, and the Metros also launched educational programmes, delivered via the network, that highlighted the importance of the environment.

The universities were active in biotechnology research:

- The University of Fort Hare was central in the development of a proteomics and genomics platform, as well as a Central Analytical Laboratory which assisted in the

development of drought-resistant crops, insect and pathogen resistant crops and wetland crops for bioremediation, as well as providing testing facilities for small rural farmers and industries.

- Rhodes University set up a structural bioinformatics platform which formed part of two Centres of Excellence in bio-nanotechnology and in biomembranes. Several important technologies were developed, including new drug targets, a high-end portable sensor for water pollution/quality measurement, as well as technologies for water purification.
- Nelson Mandela Metropolitan University's algae transformation technology became internationally recognised for bioremediation processes and also as providing alternative sources for the development of health products.

This research, along with the excellent communications infrastructure in the Eastern Cape, resulted in the province becoming a hub for bioinformatics

All three universities were actively involved in the IRIS programme, providing new technologies to the communities, and giving the programme added impetus.

On a different front, the motor manufacturing industry had been through its ups and downs. In 2009, recognising the high dependence of the motor manufacturing industry on multi-nationals, the provincial Government, backed by national Government, agreed to encourage a programme of diversification. The programme focused on a broad range of "green" engineering initiatives for both agricultural and leisure machinery.

In 2011 two multi-nationals did indeed withdraw investment from the Eastern Cape, due to the lower manufacturing costs (cheap labour and highly-attractive tax incentives) that were offered to them by the Thai government. However, there was already an increasing investment on the part of other multi-nationals who were successfully adapting their product range to "green" oriented products. More significantly, these investments were not restricted to the manufacturing phase per se, because more and more products were being locally designed. Thus more highly-skilled knowledge workers were making up an increasing proportion of the motor industry workforce. By 2014 the industry had

recovered its size, back to its 2011 levels, and was growing slightly faster than before. One area experiencing sustained high growth was related to "green and efficient" agricultural machinery aimed at growing both agro-industrial and small-holder markets throughout sub-Saharan Africa.

There was also industrial growth during this period related to an expanding "green" construction industry. Some of this growth was in agricultural buildings, but much of it concerned low-cost rural and urban housing. The "RDP-boxes" that had been churned out at the turn of the century were finally being superseded by affordable but quality housing for the poor (e.g. warm in winter, cool in summer, and easily extended and individualised).

Meanwhile, in 2015 there was a water crisis in Gauteng. Demand exceeded supply for months on end, and severe *ad hoc* water usage restrictions were introduced. In response, the significant "green" engineering expertise that had been established in the Eastern Cape was tapped into by the national and Gauteng governments to help resolve the crisis. After several tense months a short-term solution was implemented, and the groundwork was laid for a long-term systemic solution. In the process, strong links were established between senior leaders in the national Government and local science and technology experts.

The role of GMOs proved to be controversial in the E Cape, with strong proponents on both sides. One of the outcomes of this debate was the creation of a province-wide database of natural seeds and the development of numerous seed banks to maintain biodiversity. During the regional surveys several new drought-resistant strains of maize and sorghum were discovered in secluded communities. These crops were as competitive as some of the GMO seeds, although they were not GM products.

Several researchers at NMMU developed nanotechnology-based portable analytical systems which were able to rapidly determine the presence or absence of critical biomarkers derived from these "old" crops. This led to the development of several small-scale breeding centres across the province which started developing new strains of

pathogen- and insect-resistant crops that were able to provide higher yields in even the semi-arid regions of the province.

A new transformation technology was discovered during this process which was no longer based on the agrobacterium model but instead used aphids and other phloem feeders together with nanobeads for DNA transferrals. This sparked interest in developing the algae industry for alternative health products, food supplements and the expression of industrial enzymes.

The activities of the majority of the rural small-scale farms were either totally organic or based largely on organic methods. The "living soil" concept introduced in 2018 blossomed and rural communities took to the careful composting methods that use slow, low-temperature composting and earthworms to produce microbe-rich composts that are 100 times more active than normal composting methods (2kg per ha instead of 200kg per ha). The "living soil" composting methods made use of optimised composting proportions (brown and green bio-mass, plus manure) along with controlled moisture and temperature, followed by earthworm digestion. (A temperature of 40 to 45C is hot enough to kill weeds but not hot enough to kill off beneficial microorganisms.) Oxygenation and supplementation of nitrogen and carbohydrates increased the count of beneficial bacteria a million-fold. The "living soil" could be mixed with high surface area biochar (from a novel South African continuous generation process) and mycorhizzia.

Biochar is made from the waste wood from sawmills, and from alien plants that have been cleared. The novel carbonisation technology that was developed in South Africa produced not only excess energy but also a superior biochar that, when added to soil and combined with microbiological mixes, stopped fertiliser leaching, reduced the need for fertiliser and resulted, within the space of a few years, in a solid equivalent to the terra preta found in parts of the Amazon forest.

The one hundred-fold increase in activity of the compost was achieved through the use of genetically engineered micro-organisms that biodegrade biological material faster to produce the required set of nutrients and elements to grow plants, while remedying the

soil. Also, certain enzymes were introduced to catalyse this process.

A spin-off from this compost production process was the medicinal use of the earthworms. Some of the earthworms would be sold to a bio-processing plant in East London where a highly active anti-thrombosis agent was extracted from the earthworm glands using micro-syringes. This labour-intensive process created significant employment.

Another success story was associated with the citrus industry. The expansion in 2011 of the organic citrus juice factory in the valley of Bathurst and Fort Beaufort, and the success of all six of the pectin extraction plants, resulted in the waste output from the citrus industry being reduced to a minimum. The remaining waste was transported to the Coega IDZ where it was liquidised and used as a chelating agent for adding micronutrients for foliar sprays. While this appeared not to be viable as a business enterprise, the rising demand for organic products breathed new life into the business, even though the shortage of raw materials was always a major problem. These biofertilisers were further enhanced by the use of non-tillage cultivation. The micorhizza produced by Mycoroot were also profitably used by large-scale commercial farmers, resulting in a 50% reduction in the amounts spent on fertilizers.

In another initiative involving the use of algae, the PPC cement factory commissioned an algal CO2 sequestration plant that successfully removed 50% of the CO2 from its kiln. The algae were then processed to extract the oil which was then sold to the bio-diesel facility at Coega. The remaining biomass, after extraction of valuable vitamins, was anaerobically digested to produce methane that supplemented the fuel for gas heaters. The capital investment was largely funded by carbon credits.

Small-scale soya farmers were becoming increasingly important in the province. Those that had transitioned to become totally organic found that it was more profitable for them to sell their product to a newly-established factory at Coega that extracted the oil for export to the EU as high-value organic vegetable oil. The soya cake was processed into a highly nutritious meat substitute by adding the required amino-acids and vitamins

(including vitamin B) while maintaining the product's status as an organic foodstuff. Soya beans were also used as raw material for nutritious foods additives such as miso and soy sauce, as well as tofu and tempeh (a chicken-flavoured vegan substitute using a mycelium fungus).

Some of the soya farming communities have established small-scale biodiesel manufacturing facilities where the biodiesel is used captively and substitutes for imported diesel. This has meshed with the drive by many in the Agro-Co-op Biofuels Refineries to decentralise this company into smaller regional-based companies, rather than centralising in the East London region. The crude glycerol is being recycled into animal feed and the potassium sulphate into fertilizer – all used captively.

The pineapple industry in the E Cape grew dramatically after the juicing plant in East London was moved to Bathurst in 2011, followed by the establishment of a R250m plant in 2012, producing bromelain and fibres from the stems. Bromelain is a proteolytic enzyme that is produced from pineapple, and is often used by the pharmaceutical industry for the treatment of muscle injury. The high-quality bromelain found a profitable international market, while the high-quality fibres from the pineapples were needle-punched into high-value mats for use in insulating material, car bodies, and the space industry.

Synthetic fibres made from renewable sources of biomass are environmentally sustainable, and became increasingly economically sustainable. These included novel fibres such as polyglycolic acid and polylactic acid, both of which are made from natural starting materials.

Biotechnology ecotourism boomed in this area, driven mainly by growth in environmentally-friendly agricultural practices and by growth in the production of aromatic and medicinal crops in the province. Rotation cropping between the aromatic and medicinal crops was a successful strategy for making use of marginal lands for this purpose. The number of on-site essential oils outlets, and self-designer perfume boutiques, increased dramatically in the area that spans from Grahamstown northwards

to Graaf Reinet and eastwards to Lusikisiki and then down to East London. These attracted a growing number of tourists from the world over. Communities owned some of the essential oils mini-markets, which, after certification of dilution, were sold to visitors in the form of candles and bath oils.

Water security issues remained a high priority, including recycling and bioremediation techniques. An EBRU bioremediation process was rolled out to the two Metros and all rural towns, providing a solution to the overloading of traditional sewage farms. As a result, clean water was available for irrigation for small-scale farmers, while algae grown on the waste produced biofertilisers which supplied the local biodiesel industry.

By 2017 there were early signs of sustained progress in the Eastern Cape:

- Although urban migration was still a problem, the rate of migration was slowing, in contrast to other provinces in South Africa such as Limpopo and the North West.
- One of the community associations managed to resolve their land ownership issues by designing and prototyping a shared ownership system that interfaced with the established financial system, thus allowing rural small-holders to take out loans using their (often shared) land as security.
- The proportion of learners taking science and mathematics up to matric had increased by a factor of three since 2009. Research showed that the primary reason for this increase was that learners could see the evidence that these subjects opened up a wide range of interesting and rewarding career opportunities. More anecdotally, a large proportion of the bridging people involved with the community associations were engineers, who surely acted as positive role models in this regard.

The years 2018 to 2029

As we moved into the twenties urban life in the Eastern Cape was going fairly well, and by 2025 both East London and Port Elizabeth were posting moderate economic growth year after year. Unfortunately the same still could not yet be said for many rural areas of the province. Once again, pressure from the national Government was building to

terminate IRIS and redirect funds to short-term interventions that could show immediate tangible benefits. The majority public opinion in South Africa and in (urban) Eastern Cape was that the integrated rural development initiatives were white elephants, and that good money was being thrown after bad. It took all the political capital and skill possessed by Bongi Cele and his supporters to persuade the powers-that-be to stay the course and not prematurely pull the plug.

In this endeavour he was aided by unwavering support from several influential players within the EU, and also many of the academics in the research institutes. One welcome boost was the result of an independent research study, undertaken in the period 2012 to 2026, that demonstrated that children who had grown up in one or other of the IRIS villages were five times as likely, compared to other villages, to be well established financially and socially. As a result of this research, several of the villages became frequent destinations of the world media, and some of them won global awards for rural innovation. Unhappily, this attention proved to be lethally disruptive for one of the villages, and its decline can be traced back to this time.

Meanwhile, in much of the rest of South Africa, there was increasing turmoil and concern. In 2022 it was scientists from the Eastern Cape who had demonstrated that Gauteng's water problems were approaching a new level of crisis, and that the only solution was to cap and even decrease the provincial population. Such a step proved too difficult for the politicians. By 2025 the industrial and household water systems in Gauteng could no longer cope with the growing demand for water by the population of now 12 million people, along with a mining industry that continued to boom. Two full years of drought in 2023 and 2024 which led to year-round rationing broke the patience of a population that had long accepted intermittent rationing.

Despite frequent, often violent public protests, the measures taken proved inadequate. Permanent water rationing, affecting 12 million people, was institutionalised in Gauteng in 2028, resulting in escalating civil strife. Government responded by favouring household usage, and placed the most onerous restrictions on the mining industry, despite the huge investments that they had made in water systems, at the government's

insistence, during the previous 10 years. The industry argued that the Government had not kept their commitment, made in 2019, to cap the population in Gauteng below 12 million. Repeated legal action ensued, in which the mining industry was usually successful. However, while this approach failed to resolve the water crisis, it seriously damaged the much-vaunted public-private partnership relationship in South Africa, with severe, long-term impact upon FDI, on South Africa's international image, and on the credibility and effectiveness of the national Government.

Given the stability and improved quality of life in many Eastern Cape rural areas, many of the Gauteng urbanites decided to abandon the chronic troubles in Gauteng and return to their ancestral homes, and this was encouraged at both national and provincial levels. True, the rural areas of the Eastern Cape could in no way be described as being affluent; by Gauteng standards they remained relatively poor. However, the improved quality of life that they now offered on a whole held a major attraction for many. So the province welcomed back their 'lost' generations in their thousands. Many returned bringing with them the skills that they had acquired in the city, from artisan through professional to entrepreneurial. This injection of appropriately-skilled people resulted in a boost to local innovation, so that by 2027 economic growth in the Eastern Cape had risen by another percentage point.

During the decade a high priority had been given to food security. This meant that by 2030 food production in the E Cape had benefited from substantial financial investments from the EU, and from collaborative research projects conducted by the four universities in the region. Cash crops for which the E Cape is a leading producer include pineapple; citrus; soya; maize; sweet sorghum; sugar beet, etc. New biotechnology-based propagation techniques enabled the E Cape to remain ahead of the country in terms of production efficiency and quality. Much effort was put into pest control; some of the resulting products were exported to other parts of the world.

Special breeding programmes focused on disease-resistant strains using special tissue cultures and plant propagation techniques. With water scarcity remaining a major issue, hydroponic farming was widely implemented. A major focus has also been on the use of

environmentally-friendly pesticides and herbicides which have been locally developed.

The biofuels production initiatives in the province have been very dependent on the tissue culture propagation of soya, sugarbeet and triticale by the East London-based *in vitro* propagation company, InvitroPlants. This facility also had to deal with the high demand for biomass crops such as miscanthus and bamboo, which were in high demand by the rural biomass gasification plants that generate power to supply the growing rural industries.

The increasing demand for aromatics and ornamentals has also been a major boost to the industry. The merger of Ndonga Pharmaceuticals and Geraniums Unlimited, forming Africa's first ever Phytomedicinals company to be listed on both the JSE and the NYSE, was advantageous to the company as well as supporting the drive to expand to many parts of the province. This new venture boosted the biotechnology ecotourism industry and also the agriculture sector, with many communities now joining the crop rotation exercise to produce plants for essential oils and for medicinal purposes for this company. The merger was expected to grow demand for these plants in the long term, especially for roses, geraniums and aloes.

In another exciting development, a facility has been established at Coega for the purification of silicon feedstock to make wafers, both for export as well as for local production of solar cells and panels, using organic polymers. There were major advances in biological (organic) solar cells, and much more respectable efficiencies are making these modules economically viable for small-scale applications in the rural regions of the E Cape.

This work points to the benefit that can be gained from biotechnology to create useful nanotechnology structured composites (including those containing silicon) with a multitude of potential applications. This, in turn, required multidisciplinary research projects involving biotechnology and engineering, physics and chemistry, etc., encompassed by the term "biomimetics".

Much benefit has been derived from biomimetics, through conducting research at the intersection of biotechnology and nanotechnology, in the interdisciplinary collaboration that combines the approaches of molecular biology and biotechnology with expertise in materials engineering, physics, chemistry and chemical engineering. The molecular mechanisms governing biomineralisation are becoming better understood, and they were used to develop new strategies for the synthesis of high-performance, nanostructured composite materials for the next wave of advanced optoelectronics, microelectronics, catalysts, sensors and energy transducers. Living organisms synthesize remarkably strong and architecturally controlled mineralised composite materials with a precision of nanoscale fabrication that in many cases exceeds the capabilities of contemporary engineering. Use was made of gene cloning, recombinant DNA and protein analyses, gene- and protein-engineering, site-directed and combinatorial mutagenesis and biomimetic peptide synthesis in conjunction with advanced imaging technologies (including atomic force microscopy, X-ray diffraction, solid-state NMR and laser-confocal immunohistochemistry) to reveal the mechanisms controlling the biosynthesis and supramolecular self-assembly of the high-performance mineralized composites of molluscan shells and pearls, the skeletons of corals, and the silica structures made by marine sponges and diatoms. Previously unanticipated mechanisms responsible for this control (in both calcium-based and silicon-based systems) were revealed, and demonstrated that the unique mechanisms that evolved in biological systems for the control of biomineralisation can be harnessed for the development of environmentally benign new routes to the synthesis of high-performance materials.

The success of the Eastern Cape in contrast to the decline of Gauteng told a powerful story. By 2028 the national Government became convinced that the approach being taken in the Eastern Cape was not only valid but also essential for building a prosperous and secure society. A Cabinet-level decision directed that the integrated rural development policy being followed in the Eastern Cape should be adopted and adapted by all other provinces, with a new national Department of Rural Development being established to oversee the process. This was met with acclaim except in the Western

Cape, where its entrenched but successful industrial agriculture sector (over 300 years old) perceived a threat to its dominating and favoured position.

Also by 2028, four of the most successful IRIS communities had established fully functioning Local Action Groups (LAGs). These higher-level structures began providing invaluable inputs to the national integrated rural development structures, much as their Finnish counterparts had begun to do some 30 years earlier. The broader systemic aspects of the integrated policy were starting to work.

The situation in 2030

Since 2025 the country as a whole has been experiencing hardship and turmoil, characterised by economic stagnation and political crises. Gauteng continues to wrestle with its water problems, with both successes and failures. It is fast losing its reputation as being the engine room of the South African economy. The population of Gauteng has dropped considerably, and is approaching the projected "stabilisation cap" of 8 million, due to the emigrations to the Eastern Cape and other rural areas, driven by the desire for an improved quality of life. The lower population level is already having the welcome effect of reducing demand for water which is bringing some long needed relief. Furthermore, the crisis seems to be purging Gauteng of some "dead wood", including inefficient and ineffective firms and processes, especially in the mining and parastatal sectors. Perhaps economic growth may yet return to Gauteng. Certainly, the recent growth in knowledge-intensive SMMEs is a promising sign.

Encouraging though this possible Gauteng recovery might be, last month's prediction by Eastern Cape researchers that an acceleration in the rise in the sea level might begin within five years due to melting and slippage of both the Greenland and Antartic ice caps is cause for serious concern. Perhaps due to the relationships and trust established during the water crisis, there are signs that the national authorities are taking notice and even considering plans and preparations. Given that the sea has already risen by almost 1 metre since 2010, this may well not be a moment too soon.

Meanwhile, the E Cape's petrochemicals industry is now regarded as one of the major drivers of the economy of the province, alongside agriculture. With two distributors, located in the Coega IDZ and in the East London IDZ, this industry now services close to 25% of all of South Africa's petroleum needs, and exports 20% of its resources to China and India, both of which have been hit by shortages in raw materials after breaking their ties with the USA and the Gulf countries. The petrochemicals industry is sustained by, among other things, the buzzing Agro-Co-op Biofuels Refineries model (ACBRs) that was established under IRIS. This model, which is based on a public-private partnership for the production and processing of feedstock for bioethanol, emphasises the rotation of food crops with industrial crops for biofuels.

Small-scale farmers, in an area that spans from the Seymour valley all the way up to Mt. Frere, are provided with incentives to use their arable land for the production of food items, such as vegetables and legumes, for at least 6 months in each year. The remainder of the year the ACBRs take over the land and plant rotational crops (triticale from Port Elizabeth up to the Seymour valley; sweet stem sorghum from there all the way up to Queenstown; and then grain sorghum from there on northwards). These ACBRs then buy these crops from the communities and process them to produce bioethanol, which is then sold to the biofuels refinery plants located in Cradock, Mthatha and Alicedale.

The ACBR business model is, however, heavily dependent on the uncertainty in the regulations of the government regarding the use of maize as a feedstock. It is expected that the Minister of Renewable Energy is soon going to announce the date for public hearings on this issue. This announcement has been anticipated with great tension, especially by the Non-Green Revolution, an NGO dominated by former shareholders of the then SASOL, which was heavily penalised by the EU and later by the USA and Japan for using fake paraffin ingredients. The belief of the Non-Green Revolution is that this announcement will hinder their return to the industry by placing restrictions on their planned maize biofuels processing plant in Gauteng. They have been lobbying for the bill to include maize as one of the industrial crops, due to the monopolistic nature of the sorghum/triticale industry in the Eastern and Western Cape provinces. The Act restricting the use of maize for biofuels was passed nearly twenty years ago, even before

there was widespread use of GM maize.

In an interview given by Mrs Nokuzola Labuschagne, the CEO of the OR Tambo ACBR, she affirmed that she does not fear competition. She gave three reasons for her position:

- New technology that was to be commissioned on a small scale by NMMU and the ACBR will now be rolled out throughout the province on a much larger scale. This technology is based on the Nobel Prize-winning discovery nine years ago of a β-mannanase enzyme from a yeast strain in the Cango Caves, and the subsequent discovery of endo-xylanase enzymes by the Fort Hare Department of Biochemistry on the coast near Port St Johns. Both of these enzymes have been shown to degrade lignocellulose. A R120bn investment in this technology will be announced by the Minister of Finance in the near future. This will sustain the industry and diversify its feedstock sources.
- The Proteomics Centre of Competence at Walter Sisulu University is involved in breakthroughs in a new technology that converts citrus waste and other organic matter into combustible gases. This GM-based microcell technology is currently being put through trials at the East London refinery, with the support of a TIA grant to the value of R23m a year for three years.
- The shortage of water in the Gauteng region, and the battle between the mining sector and the government, will hamper the competitiveness of Gauteng's efforts.

Mrs. Labuschagne also confirmed that communities in the E Cape are being mobilised to contribute to the public hearings as the outcome will have a direct bearing on their food security concerns. Food security in the E Cape has become an issue recently as many people from the Free State and the Northern Cape have migrated to the E Cape due to food shortages in those provinces, and are now starting to build shacks in the Metro areas.

The chief concern in the E Cape, and of especial concern to the premier, is the recent decommissioning of the multimillion rand biogas plants, which have proven to be economically disastrous. This technology was developed by the UFH over twenty years ago, based on anaerobic digesting microorganisms, most of which were genetically

engineered, but a few of which had been derived from bioprospecting activities. The business model assumed a strong linkage to local sewerage systems. The business worked perfectly well for about ten years, until the same university developed a new technology based on nanotechnological purification of sewage, producing a peckonite which then gets filtered using biomembrane technology developed by the Moses Madiba Biotechnology Institute (the then Walter Sisulu University East London campus). This biomembrane technology converts the peckonite into solid matter that is then convertible into biodegradable plastics with many uses, for example in the motor vehicle industry to make cushioning material. The value of this to the motor industry is higher than the use of biogas for domestic purposes. Sadly, it did not prove economically viable to convert the over one thousand biogas plants, which led to their decommissioning.

It is true that per capita income in the Eastern Cape is still the fourth lowest of all South African provinces, but it is more than three times what it was in 2010. By 2029 unemployment in the province was down to 14%, and yet 48% of the population still lives in rural areas. Some 42% of that rural population works on a wide variety of non-farm activities, much of it knowledge-intensive, supported by cheap and ubiquitous broadband connectivity. Of the 58% of the rural population that is involved in agriculture, including upstream and downstream logistics, 70% are associated with smallholder farming (either as individuals or in cooperatives) and 30% are involved with industrial farming. Most rural communities are showing signs of maturing and are beginning to resemble rural communities in Central Europe (e.g. in Austria, Slovenia and Croatia).

In short, the IRIS model of integrated rural development is starting to look like a sustainable success. It has to be a further encouraging sign that variations of the model are being promoted and even implemented in three other African countries.

As Bongi steps from the 'off-Broadway' stage in the Eastern Cape, and moves to the big lights of his new Department, he and we can be justly proud of the achievements that he has helped secure not only for his home province, but also for the country. Despite many

obstacles there is a real sense of progress towards the much-sought-after 'better life for all'. However, as he leaves, the question remains for us: Do we have the knowledge and commitment that is needed so that in another twenty years we may again look back at the past with satisfaction and to the future with hope?