ATLAS OF EMERGING JOBS

SOUTH AFRICAN FOOD AND BEVERAGES MANUFACTURING SECTOR

RESULTS OF THE SKILLS TECHNOLOGY FORESIGHT WORKSHOPS

JOHANNESBURG - OCTOBER 12-13, 2022

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FOREWORD

“It is now that the present is turning into the future before our eyes.”

Isaac Asimov

THE GAP BETWEEN EDUCATIONAL SYSTEM SUPPLY AND LABOUR MARKET DEMAND LEADS TO SIGNIFICANT IMBALANCES IN THE ECONOMY.

The food and beverage manufacturing sector faces internal and external pressures which include global competitiveness, health and nutrition, technological advancements, climate change and food safety. The most significant challenge is technological change.

These factors, and others such as ongoing loadshedding, the increase in the fuel price skills shortages have forced businesses to change the way they operate. What is evident is that technological advancements mean that the SETA needs to reskill and upskill the workforce in the food and beverage manufacturing sector.

Nokuthula Selamolela, CEO at FoodBev Manufacturing SETA,

"The FoodBev SETA is determined to identify where South Africa is lagging in our industry and where we need to place resources and attention to address these issues."

One of the ways we are preparing for the future world of work is through the partnership with the BRICS Business Council. The partnership supports two projects - the BRICS Future Skills Challenge and The Atlas of Emerging jobs for the sector, that prepare BRICS youth of member countries for future jobs.

The gap between educational system supply and labour market demand leads to significant imbalances in the economy. We are preparing for the future of our sector via the Skills Technology Foresight workshop, which focuses on new professions that didn't or don't exist as well as those that face significant change. This process allows us to identify future skill needs in the context of technological innovation and modernisation. This process has been successfully used in countries like Tunisia, Vietnam, Tanzania, Russia, Kazakhstan and others.

Participants build a shared vision of the sector's future, taking into account technological, political and social changes.

Participants focus on skills to predict how the future will change existing professions and what it means for education and training. After these two days, a report is prepared = The ATLAS of Emerging Jobs - containing key findings that emerged from the workshop and recommendations for education and training processes.

LEVERAGING FUTURE SKILLS TO SUSTAIN COMPETITIVENESS WITHIN THE BRICS ECONOMIES

The BRICS Business Council (BBC) was first launched at the BRICS summit hosted in Durban in 2013. It has since emerged as a significant platform that focuses on business-to-business engagements in the interest of creating tangible inter-trade and investment opportunities between the partner countries. The BRICS Business Council Working Groups in Aviation, Agribusiness, Deregulation, Digital Economy, Energy and Green Economy, Financial Services, Infrastructure, Manufacturing and Skills Development support the BBC's objective of increasing trade and investment.

The mismatch between available skills and required skills is a challenge in many countries, including South Africa. In South Africa and a number of other countries, employers report that they struggle to find workers with the skills required by their businesses, whilst at the same time, many graduates face difficulties in finding employment that match their qualifications.

The shortage of relevant skills in South Africa is believed to have an impact on economic growth, service delivery, social development and productivity. The OECD research paper titled "Getting skills right: South Africa" recognises this problem and proposes interventions that include SETAS understanding the long-term trends in their sectors and employers understanding current and future needs. In response to the challenges posed by the reported skills shortages, government has proposed intervention strategies which feature as two of the Medium-Term Strategic Framework priorities.

Future Skills is defined as the skills required for new, emerging and evolving jobs. The focus of the SA Chapter of the Skills Development Working Group (SDWG) is to identify, initiate and implement projects that contribute to building Future Skills, enabling South African business to build and maintain competitiveness in a global economy.

To identify identify Future Skills projects that will have the most impact it is essential to have a view of future jobs and the skills required.

The ATLAS of Emerging Jobs for the Food and Beverage Manufacturing sector provides such a view. In collaboration with the Russian Chapter of the SDWG and through our partnership with the Food and Beverage Manufacturing Seta, we have developed this ATLAS.

Busi Mabuza, Chairperson at South African BRICS Business Council

This will help drive the development of training programmes for these future jobs. It also forms part of our longer-term vision to create a BRICS Atlas of Emerging Jobs in collaboration with our BRICS partners.

65% OF CHILDREN ENTERING SCHOOL WILL WORK IN JOBS THAT DON'T YET EXIST – IS SA READY?

Sherrie Donaldson, SA BRICS Skills Working Group

South Africa needs to prepare for the future world of work by developing future skills that

will facilitate economic growth to enable businesses to compete in local and international markets. An advanced workforce will also make South Africa an attractive investment destination and allow us to stop importing skills. How do we make this happen?

The world of work is changing super-fast on account of factors like globalisation, digitisation, rise of the consumer and artificial intelligence. Various forecasts of the impact of these estimate that between 50 - 70% of current jobs are being lost to technological advances. Our BRICS partners are moving faster to develop relevant skills for the new economy than we are. Unless we catch up, we will sit with a skills gap.

We need to identify the skills, create the roadmap, and implement programmes to build the skills. It is critical that South Africa implements these skills at the BRICS standard.

Analysing, forecasting, and shaping future skills is a critical component in the rapidly changing world of work. To do this, SA is leveraging several BRICS partnerships. As a major step forward, we are helping to develop the South African Atlas of Emerging Jobs in several sectors so we can meet the demand for these skills.

The purpose of the Atlas is not academic research Our objective is to expose the horizon for parents to choose professions for their children that offer actual prospects and are in demand in the country. We need to create new industries today.

Dmitry Sudakov, ATLAS PROFESORII, Foresight Technology, ATLAS of Emerging Jobs

THE ATLAS OF EMERGING JOBS

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Introduction

In early 2020s the whole world faces significant changes that will profoundly affect almost all spheres of human activity and change manufacturing, logistics, services, ownership, and consumption. These changes significantly influence existing professions: many new jobs emerge that never existed before, some skills and disciplines become outdated, and others face significant changes. The inability of the education & training system to adapt to this pace of changes widens the gap between educational system supply and labour market demand, leading to significant economic disbalances. Nevertheless, there are progressive projects in this field. In South Africa, for example, the 21 Sectoral Education Training Authorities (SETA's) have a mandate to build a pool that meet industry needs. This is achieved by partnering with industry and labour, developing, funding and implementing training programmes at various NQF levels. The SETA's also play a critical role in supporting National priorities such as the Economic Reconstruction and Recovery Plan (ERRP).

This report represents the results of a series of two 2-daysworkshops held for the Food and Beverage Manufacturing SETA. The workshops in took place on 12 and 13 October 2022 at the Emoyeni Estate in Parktown, Johannesburg and on 17 and 18 November 2022 at Cultivar Estate in Stellenbosch. During the workshop, participants, guided by Skills Technology Foresight certified facilitators, discussed the future of the sector. Participants worked on building a shared vision of the sector's future, considering technological, political, and social changes.

Methodology

Research Aim and Objectives

Participants in the workshops were asked to consider the current and future changes in their workplaces, and the impact of these changes on the current jobs, future jobs and the skills required to perform these jobs. The objectives of the workshops were threefold, firstly to forecast potential future jobs and the associated skills required, secondly to identify potential obsolete jobs and lastly to offer insights for the training institutions to prepare for these potential futures.

Qualitative Research Approach

Due to the rapidly changing environment of the Food and Beverage Manufacturing sector, a qualitative method of inquiry was chosen. The changing environment causes discontinuity in the data collection space which can only be managed with qualitative methodologies. Qualitative research is a type of research that aims to gather and analyse non-numerical (descriptive) data in order to gain an understanding of individuals' social reality, including understanding their attitudes, beliefs, and motivation.[1] This type of research typically involves in-depth interviews, focus groups, or observations in order to collect data that is rich in detail and context. Qualitative research is often used to explore complex phenomena or to gain insight into people's experiences and perspectives on a particular topic.[1] It is particularly useful when researchers want to understand the meaning that people attach to their experiences or when they want to uncover the underlying reasons for people's behaviour. Qualitative research methods have been used in sociology, anthropology, political science, psychology, medical research and public health, social work, folklore, educational research and software engineering research.[2] In designing a qualitative research process are the following needs to be considered:

- What methods or tools are being used to collect and analyse data;
- How is sample size and representativity managed;
- The reliability and validity of the qualitative research.

[1] Elizabeth St. Clair, MLIS. "City University of Seattle Library: Research Methods and Design: Qualitative Research Methods". *library.cityu.edu*. Retrieved 2022-12-14.

[2] King, Gary; Keohane, Robert O.; Verba, Sidney (2021-08-17). *Designing Social Inquiry: Scientific Inference in Qualitative Research, New Edition*. Princeton University Press.

Skills Technology Foresight

The workshops were done in accordance with the Skills Technology Foresight (STF) methodology. STF gained international recognition and was used in joint projects with the World Bank and the International Labour Organization (ILO).[3] Foresight as a social technology was introduced over fifty years ago and is widely used in business and public administration. This technology allows participants to jointly forecast the development of an industry, region, or country and, following this forecast, agree on activities to achieve the desired future.

Skills Technology Foresight is a qualitative method, developed in 2016 by the Skolkovo School of Management and is included in the library of methodologies of the International Labour Organization. The method was originally piloted in two countries – Armenia (food processing and precision engineering/ICT) and Vietnam (metal processing industry), with particular attention to building policy recommendations applicable to the contexts of developing countries. In both countries, the results were considered to be of substantial value for governments, industry bodies, employers and labour organisations in their efforts to bridge the gap between the skills demand and supply which results from technological change, among other driving factors.

The methodology bridges together skills anticipation approaches and the methodology of technology foresight. It allows the identification of future skills necessary because of technological innovation or the proliferation of existing technology through modernization. STF is a sector-based approach focused on specific sectoral practice transformation by introducing new technologies.

Sample Size and Representativity

In any research a sample size should be large enough to sufficiently describe the phenomenon of interest and address the research question at hand. But at the same time, a large sample size risks having repetitive data. The goal of qualitative research should thus be the attainment of saturation.[4] Saturation occurs when adding more participants to the study does not result in obtaining additional perspectives or information. There is a point of diminishing return with larger samples, as it leads to more data but doesn't necessarily lead to more information.

The objective of qualitative research is to lessen discovery failure; whilst quantitative research aims to reduce estimation error. As qualitative research works to obtain diverse opinions from a sample

[3] https://www.ilo.org/skills/areas/skills-training-for-poverty-reduction/WCMS_534225/lang--en/index.htm

[4] https://interq-research.com/determining-sample-size-for-qualitative-research-what-is-the-magical-number/

size on a client's product/service/project, saturated data does not serve to do anything. One respondent's opinion is enough to generate a code, part of the analysis framework.

The goal of a qualitative study should be to have a large enough sample size to uncover a variety of opinions, but to limit the sample size at the point of saturation. Research on sample size points to a number between 10 and 30 to be optimal.[4]

The workshops in Johannesburg and Cape Town followed the guidelines for the STF approach[5] and invited participants from the Food and Beverage Manufacturing sector to attain a mix of small, medium and large companies. The participant mix included representatives from educational institutions and service providers or suppliers. The participants were further a mix of operational staff, directors and human resources or trainers. The workshop in Johannesburg had 16 participants and in Cape Town there were 23 participants.

Validity in Qualitative Research

A central issue in qualitative research is trustworthiness (also known as credibility or, in quantitative studies, validity).[6] There are many ways of establishing trustworthiness, including member check, interviewer corroboration, peer debriefing, prolonged engagement, negative case analysis, auditability, confirmability, bracketing, and balance. Data triangulation and eliciting examples of interviewee accounts are two of the most commonly used methods of establishing the trustworthiness of qualitative studies.[7] Transferability of results has also been considered as an indicator of validity.[8]

Reliability in qualitative research refers to the stability of responses to multiple coders of data sets. It can be enhanced by detailed field notes by using recording devices and by transcribing the digital files.

Prior to the workshops a comprehensive desktop study was undertaken to determine the drivers and factors of change in the Food and Beverage Manufacturing sector in an international context. This acted as a guide to the workshop outputs and confirmed the trustworthiness of the data. Triangulation

[5] https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_534225.pdf

[6] Lincoln, Y. & Guba, E. G. (1985) *Naturalistic Inquiry*. Newbury Park, CA:Sage Publications.

[7] Teeter, Preston; Sandberg, Jorgen (2016). "Constraining or Enabling Green Capability Development? How Policy Uncertainty Affects Organizational Responses to Flexible Environmental Regulations" (PDF). British Journal of Management. 28 (4): 649–665

[8] Lichtman, Marilyn (2013). *Qualitative research in education : a user's guide* (3rd ed.). Los Angeles: SAGE Publications.

was also used and the workshop in Cape Town was a month after the Johannesburg workshop with the results correlating and confirming the credibility of the data.

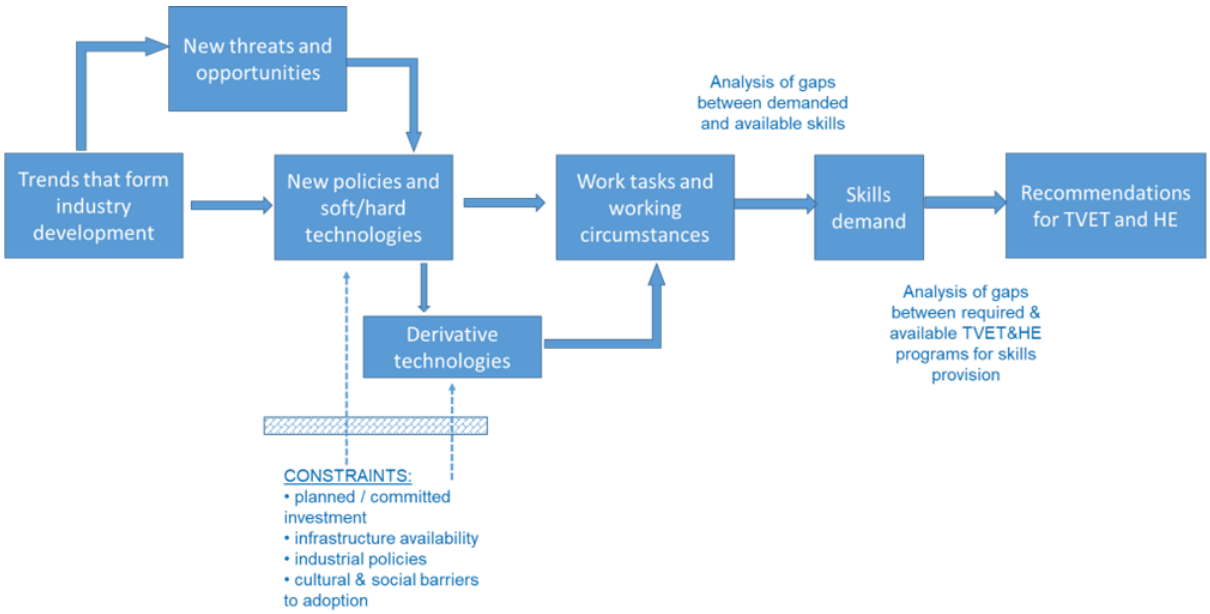
The facilitators at both workshops verified the response coding amongst each other, and also recorded all the sessions using photographs, notes and voice recordings. The research team also cross-validated the results of the workshops with similar research done in Kazakhstan and Armenia amongst others, noting the strong correlation between the outputs with due note being taken to the local context.

Foresight Principles

The basic principles of foresight are as follows.

- The future depends on the efforts made: it can be created.
- The future is variable: it does not simply result from the past but depends on its participants' and stakeholders' decisions.
- Some areas can be predicted, but generally, the future cannot be predicted accurately. We can prepare for the future as we want it, or we can shape it ourselves.

Guided by these principles, content based on foresight reveals the future that will likely emerge with the mutual effort of the leading companies in a chosen industry. This future is based on their development plan: entering new markets, launching new products, applying new technologies, and new ways of working for the organization. STF aims to shape the desired future, as development plans if specialists can only be achieved if experts can implement these plans. As such, STF is a statement about the future that leaders of change in a country, such as development institutions, leading technology companies, and universities, are building together.



Skills technology foresight guide, ILO, 2016

For a long time, the usual educational cycle at school has been 10 to 11 years, and another four to six years are spent in vocational or higher education institutions. That is, a person has about 15 years before they start working. Half a century ago, the realities of social and economic development in the world allowed us to predict the need for personnel for such a distant future. The process cycle was long, and state planning made it possible to schedule an order for necessary specialists for fifteen (15) or even more years ahead. That is why the education system fulfilled its primary function effectively: it trained people so that graduates could easily find jobs.

Today, the world has changed, and the pace of change and the level of uncertainty have increased to such an extent that few companies can predict what specialists they will need even in a decade, let alone a more distant horizon.

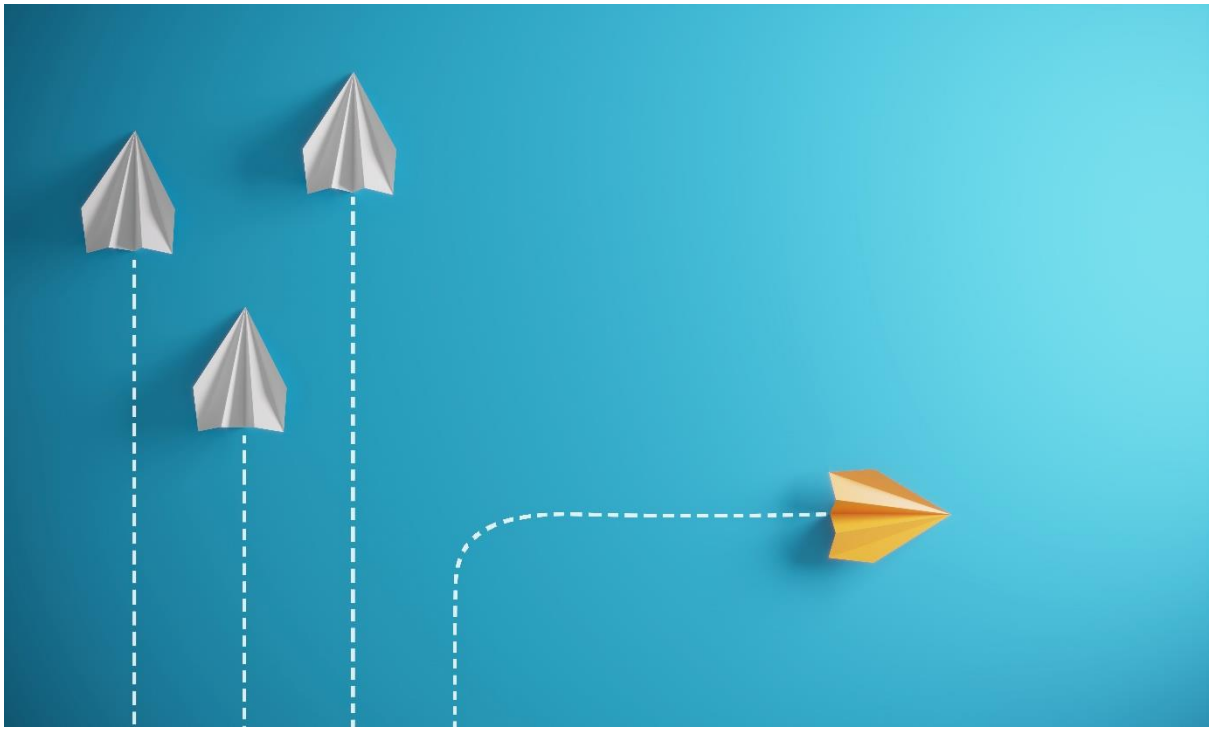
At the same time, specialized expertise is gradually becoming redundant as the technology to which such skills are attached is changing too rapidly. Nowadays, there is a demand for people who have knowledge of several industries and can transfer knowledge and technological solutions from one sector to another. For example, 3D printing approaches, initially designed for quick prototyping, were later shared by professionals in other industries: printing of buildings, medicines, human organs, and food. Today's secondary school students will enter the labour market in five to nine years.

The world will change significantly in that time.

Being expected to become a manager, a lawyer, or even a programmer, a student is oriented towards success in today's realities, but in the future, a different kind of expertise will most likely be required. This uncertainty is illustrated by the frustration of many young people who chose careers based on actual statistics of the current demand for professions. Five or six years later, they realize that they had made a mistake.

Key trends affecting the future of work.

The world of work describes the way we work now and, in the future, and is distinct from jobs of the future which describe the work we will do as opposed to how we will work. To find out how the world of work is changing, one needs to understand the factors that will affect it. This section identifies and discusses the most critical trends affecting changes.



Digitalisation

Digitalisation, i.e., converting all types of information into digital form, permeates every sphere of activity. It changes the approach to managing enterprises, cities, and our daily lives. We are creating a new dimension of reality in which data about the outer and the inner worlds (images, music, heartbeat, itineraries, etc.) are transferred to a uniform format consisting of zeros and ones. We have yet to understand what living in a digital world means fully. It is the digital natives, those who were born and raised in the digital world — who are most likely to teach us this.

Automation

Automation began in the nineteenth century when mechanisms first appeared, but today this process has accelerated dramatically. As estimated by researchers from Oxford Martin School's Program on the Impacts of Future Technology (2011), within the next twenty (20) years, up to 47% of jobs in developed countries may be replaced by robots and computer algorithms.

This does not mean that people will lose their jobs completely — they will do what robots cannot do.

A large part of human work will become creative; therefore, the ability to create will no longer be the destiny of secluded creators but will become a mass phenomenon.

Globalisation

Globalisation has long been part of our reality. In most countries, you can buy world-known brands of clothes or electronics and eat at famous fast-food chain restaurants. Today, it is hard to tell which country has produced which complex product. For example, to make a Nutella jar, you need to deliver African cocoa beans, palm oil from Ecuador and Malaysia, Madagascan vanillin and Turkish hazelnut to the factory that may be located in Poland.

Therefore, employees of the future will have to be able to work in multilingual and multicultural environments, communicating with partners from around the world. In addition to speaking a foreign language, you will need to be able to communicate in international professional languages, i.e., to be aware of the industry requirements, standards, and tools.

To find better place in the world system of labour division, the main players of the South African Food and Beverage Manufacturing Industry (FoodBev) need to fully where their unique competitive advantages lay, and what are the most profitable ways to integrate into global supply chains by building partnerships with other countries.

Growing demand for sustainability

Up to a certain point, ecology was perceived primarily as a restriction on economic activity to maintain a clean environment. "Green" skills were only desired by those who worked in the nature conservation or waste management field. Humanity is witnessing a shift towards a more holistic understanding of the Earth's ecosystem and its role in the biosphere's evolution. Ecological thinking is being integrated into virtually all spheres of life.

The environmental review suggests that we all understand that natural resources are not limitless and that we are responsible for the place we live — be it our home, city, country, or planet.

Therefore, the skills of environmentally responsible behaviour will, in the future, become part of the standard training of any employee and world economy shifts toward “green” values. In the twenty-first century income is driven by investment into such activities, infrastructure and assets that allow to reduce pollution, enhance resource efficiency, and prevent the climate change and the loss of biodiversity.

Development of network organization in societies

The term "network society" was proposed in the 90s by European sociologists Jan van Dijk[9] and Manuel Castells[10]. They predicted that the rise of network communication technologies would radically change the structure of society and the way of life of each individual. In a networked world, there is no longer a need to stay in an office from 9 AM to 5 PM and work for the same company. More people are becoming freelancers. New engineering culture is emerging in the networked world, so makers benefit from new technologies and create amateur projects. More and more people choose to work for themselves and become entrepreneurs, while the internet helps them promote their products or enables them to convert to the digital economy.

Old hierarchical management systems do not thrive in a network society. They are now replaced by new forms of communities and teams, which are more flexible and adaptable, based on personal responsibility for the overall result rather than on work by the book.

This trend is manifested in the corporate sector by adopting new management schemes[11].

[9] https://uk.sagepub.com/en-gb/eur/the-network-society/book268672
[10] https://onlinelibrary.wiley.com/doi/book/10.1002/9781444319514
[11] http://globetrotter.berkeley.edu/people/Castells/castells-con4.html

Accelerating Change

Accelerating technological and social change is a trend that manifests itself in all aspects of our lives[12].

While it took decades to deliver electricity since it was invented, it took a few years to make smartphones widely available in developed countries[13].

Thus, humanity faces the greatest challenge of coping with the increasing speed of change, both technically and psychologically.

[12] https://www.researchgate.net/publication/251496865
[13] https://www.investopedia.com/terms/r/rate-of-adoption.asp

The growing complexity of management systems

The future world of work is complex; it is filled with rapidly changing flexible technological solutions and demands a constant commitment to change. It will require people who can not only navigate the new world of work but also effectively manage projects, teams, and entire organizations.

To meet this challenge, an increasing number of employees will need systems thinking — the ability to understand quickly how complex processes, organizations, and mechanisms operate.

A person can quickly identify and solve a problem through systems thinking, engage in a new area of activity, and communicate ideas to people from other industries or sectors.

Pandemic threats

Mutations of viruses and the growing resistance of microorganisms to antibiotics are becoming a serious security challenge[14], as growing globalisation and connectivity allow the new diseases to spread all around the world very fast.

Security protocols could be duly transformed to prevent new threats, and it is especially important for the Food and Beverage industry worldwide, as it makes a great impact on human health and well-being.

[14] https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

What do the new trends mean for the labour market?

David Autor, an MIT School of Engineering professor[15], has been examining changes in the labour market since the 1990's and discovered the following pattern: Employment has grown in simple and low-paid tasks and, conversely, in complex tasks or jobs requiring unconventional thinking. Employment has been declining in the areas of routine manual or intellectual work, which has always been relatively well-paid.

This pattern appeared, and continues, because it was unprofitable to automate cheap and straightforward work, while it was virtually impossible to automate creative work. However, entrusting the machines with a rather expensive but easily automated intellectual routine was more profitable. What has (and will) happen to the people who have been displaced by technological solutions? In industry, services, and the knowledge economy, there will be two poles: mass standardised products/services (with emphasis on automated solutions) and customized goods and services (with a focus on communication and non-standard tasks).

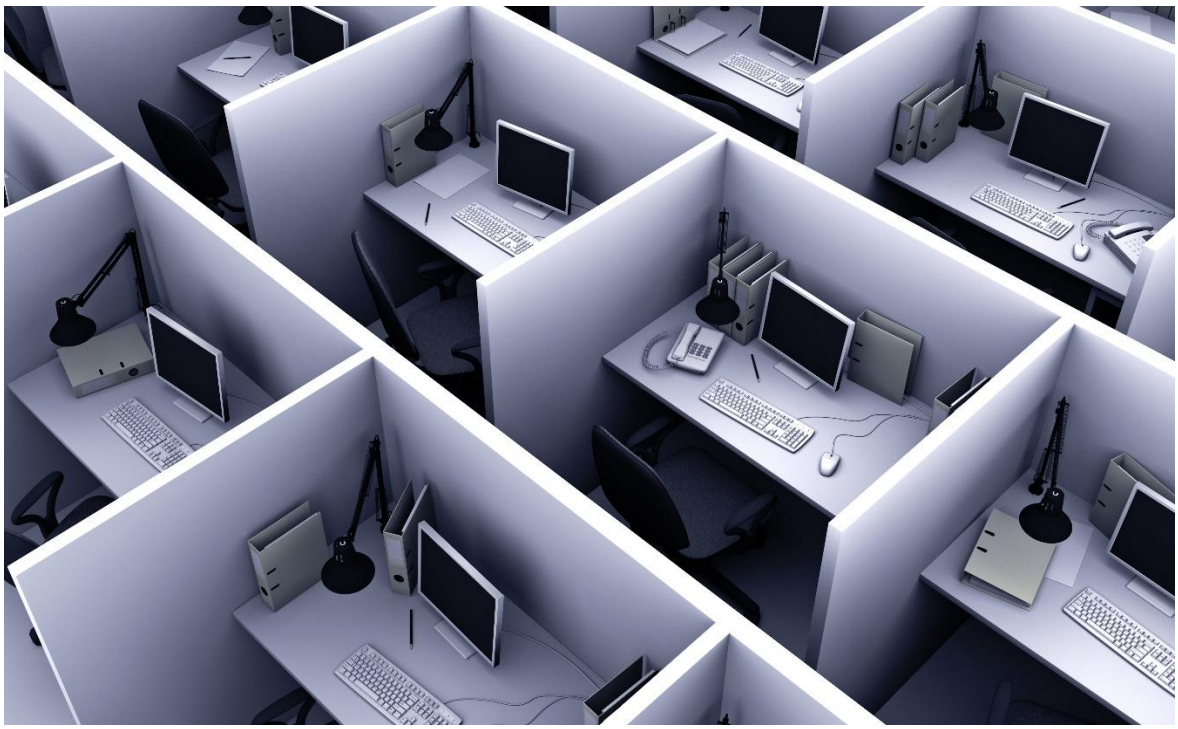
The number of jobs will increase primarily in customized solutions, although some people will continue to develop and maintain automated systems. To stay afloat, one must either build creativity and communication or be proficient in Information Technology (IT). A combined strategy may be used to move in both directions.

[15] https://workofthefuture.mit.edu/team-member/david-autor/

Of course, rapid changes that destroy an entire profession are mostly associated with disruptive technologies (for example, motor vehicles displaced horse drawn cart drivers). Such impacts are usually slower, especially when it comes to changes in mass employment. Firstly, because the technologies spread unevenly they tend to arrive earlier in large cities than in remote regions. Secondly, States have an interest in maintaining social stability. Making a lot of workers redundant can cause significant social upheavals, so the government and employers try to mitigate the risks by preserving jobs.

Yet it is essential to understand that such a safety net will not last forever, and many professions are now, and will be in the future, at significant risk.

The good news is that new professions, markets, and whole employment sectors are emerging, creating new jobs. In addition, people who used to have difficulty integrating into the economic system — for example, creative individuals or those dislike the office environment and flourish in situations of continuous uncertainty — will now have every chance to find themselves in a profitable profession.



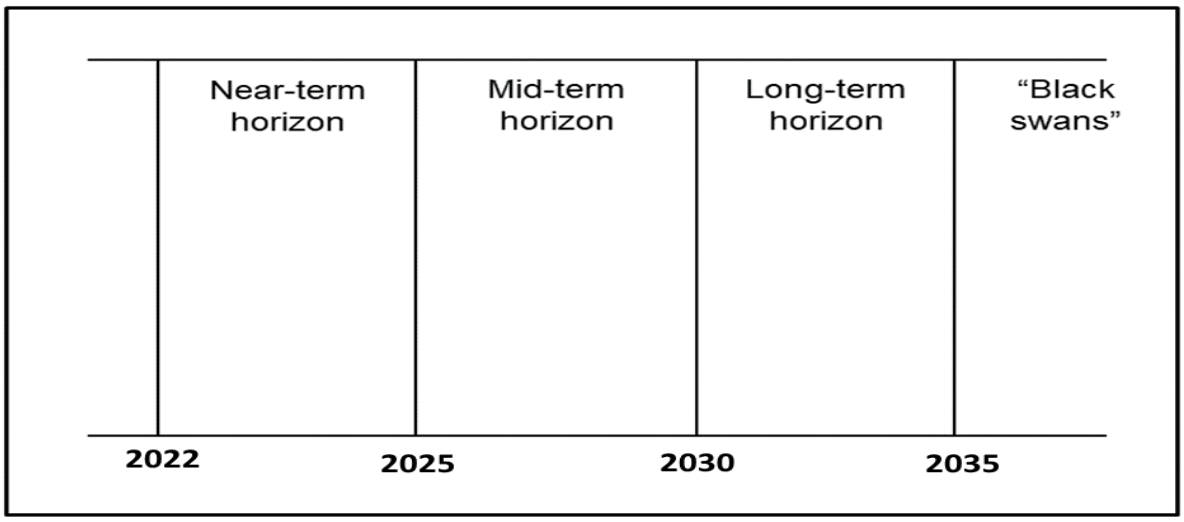
Workshop description

The workshop was organized as a series of two 2-day workshops (2 days in Johannesburg and 2 days in Cape Town) during which participants were guided by facilitators and discussed changes coming to the Food and Beverage Manufacturing sector in South Africa.

Workshop Day 1

The first day of each workshop focused on creating a map of the future for the industry. Participants used blank maps, filling them with trends, challenges, hard and soft technologies, policies, etc. An example of such a blank map is shown below, as well a partially filled-in map where participants recorded the discussions.

Blank map of the future



With the moderator's aid, participants fill in the map with different objects represented by cards stuck to the map. There are 6 basic types of cards: trend, hard technology, soft technology (processes and procedures) , policy, threat, and opportunity. The cards have different colours for clarity. Examples of trends are: 'increase in the proportion of the population over 65 years old', increasing share of small firms', 'miniaturisation of devices around the world'. Trends are directly connected with the foresight subject and occur in a super-system as related to the subject.

Based on the discussion results, the card is placed on the map with an indication of the particular year and, accordingly, in the particular time horizon. The card is placed on the map by the moderator. The group should strive to fill in all three time horizons. In practice, on the majority of maps the long-term horizon is not filled as densely as the short-term horizon. Occasionally, the mid-term and even the long-term horizons may be filled more densely. These features of the group work are diagnostically valuable.

Example of a Cards used

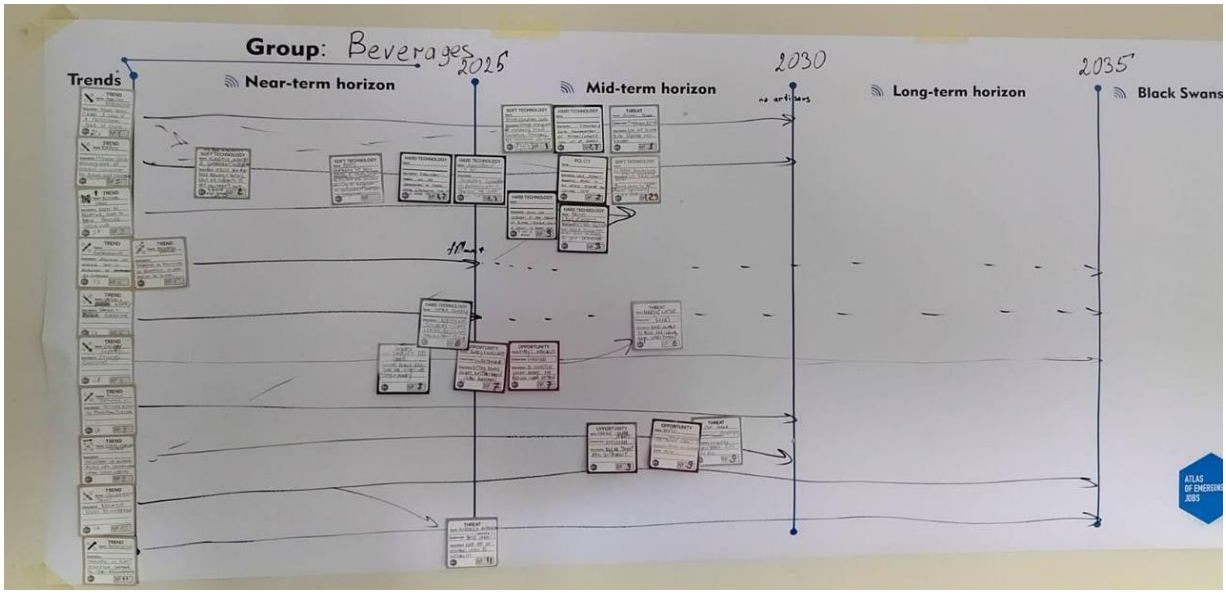
Proposals for cards which are similar in content are located close to one another on the map. Proposals which are inclusive of one another, are closely interconnected, or are special instances of one another should be grouped in one card (pile), with the reference card representing the group proposal in the most complete/precise form on top.

The final product of the group work is the resulting map of the future, which is modified from each step to the next. Throughout the discussions the participants identified key drivers influencing the sector's future and created a shared vision of this based on the map. The identified drivers that emerged from the discussions are:

- Automation of plants
- Digital transformation of supply chain/waste
- Automation of parts of HR and Recruitments
- Mindset change in society, that makes business more socially responsible
- Problems with water and energy supply

- Rise of consumer engagement and activism
- New methods of learning – Virtual Reality/Augmented Reality/Mixed Reality
- Packaging materials technology
- Traceability (digital traces)
- Compact and affordable tech solutions for communities
- Biotech
- Practices of resource economy in communities (like waste-management)
- Skills transfer in communities (Youth being taught in villages by returning workers from the urban areas)
- E-commerce
- Migration
- Global warming and Climate Change
- Proliferation of waste and subsequent waste management
- Biodiversity changes and decline

Partially filled-in map of the future

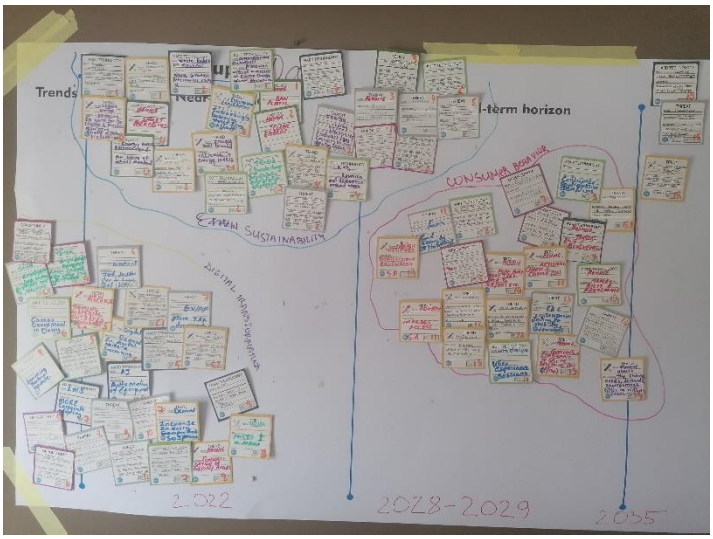


Workshop Day 2

During the second day of the workshop, participants worked with the map of the future, focusing on the skills issue.

Day 2 started with the map of the previous day, and the cards for trends, hard technologies, soft technologies (processes and procedures) , policies, threats and opportunities are grouped into major trends or themes. An example of this is shown below.

Categorising Themes



Using these trends and themes as a guideline the focus moved to which of these trends affected jobs and in which way. The critical questions discussed included:

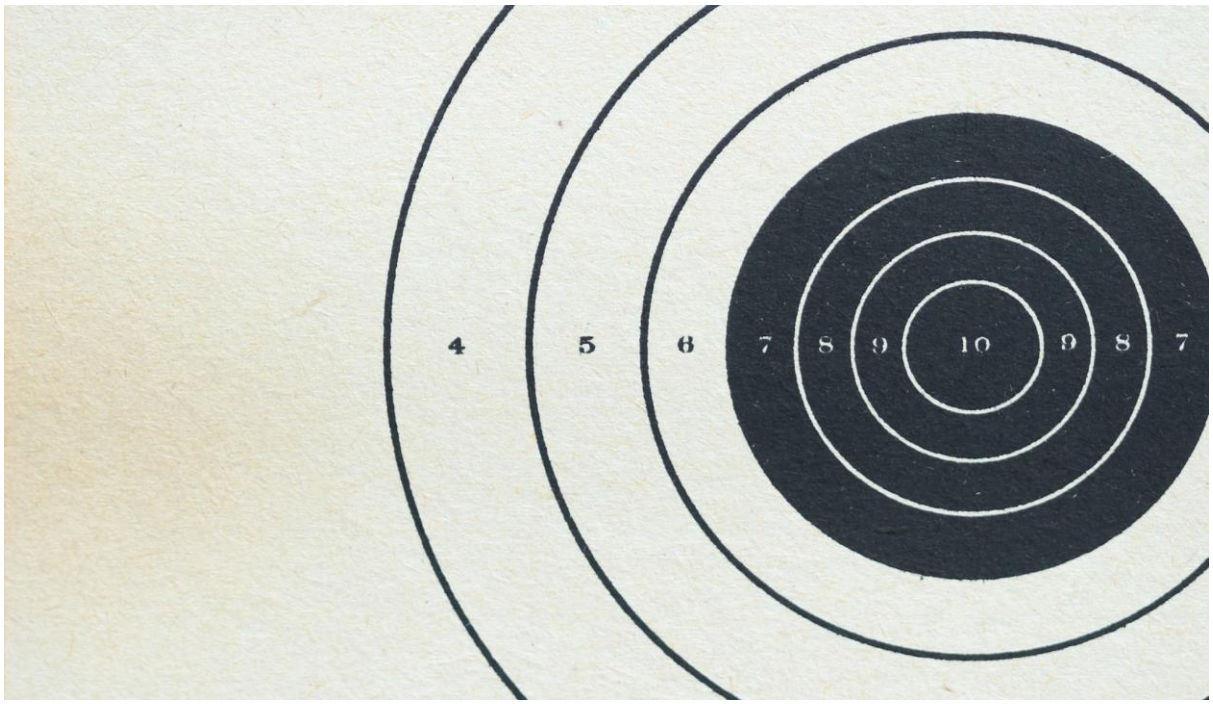
- Key factors influencing sectoral/chamber work-force
- New skills/jobs
- Transforming skills/jobs
- Skills/jobs at risk (for employees: loss of workplaces, obsolete skills, etc.)
- Potential for employment creation in the value chain; and
- Changes that are needed in the education and training process.

Additionally, and as a South African context specific focus, the participants were asked to identify possible opportunities for large scale employment across the value chain.

Skills Technology Foresight for the Food and Beverages sector

Skills Technology Foresight is a collaborative qualitative methodology engaging stakeholders' participation in the knowledge production process.

The main argument for using a qualitative approach instead of a quantitative one is the changing environment of the chosen sector, causing discontinuity in the process and thus making quantitative methodologies less effective.



General vision of the future

In a rapidly changing world the tremendous pace of technological and social advances cannot be ignored. The strict restrictions that were imposed on many countries during the COVID-19 pandemic demonstrated that the world today is truly interconnected. This makes it imperative that business and institutions study and understand local processes and technologies, but also to continually track the global trends and changes and to adapt and change where necessary.

Sector description

The Food and Beverage Manufacturing sector is the most significant contributor to revenue in the manufacturing industry. From 2016 to 2019, the Food and Beverages Manufacturing sector's revenue contribution was steady at approximately 23% but increased to 25.94% in 2020. Considering the impacts of climate change and a growing world population the global food demand is expected to increase anywhere between 60% - 98% by 2050[16]. This presents an opportunity for growth and expansion of the South African Food and Beverage industry.

Employee numbers in the sector increased from 178 335 in 2021 to 188 896 in 2022. The industry has its supply chain linkages ranging from primary producers, through processing and logistics, to the domestic retail sector and exports.

Companies that are registered with the Food and Beverages Manufacturing SETA only include those with activities that fall within the secondary level of the food industry value chain, which is mainly food processing. Food processing includes transforming raw ingredients (input) by physical or chemical means into food or the transformation of food (intermediate goods like sugar) into other forms. Food processing also includes mixing raw food ingredients to produce marketable food products that can be easily prepared by the consumer.

[16] br.org/2016/04/global-demand-for-food-is-rising-can-we-meet-it

Companies operating within the Food and Beverages Manufacturing Sector are categorized as per the Standard Industrial Classification (SIC) codes framework of South Africa, Seventh Edition (2012). The categories or sub-sectors (Chambers), according to the Department of Higher Education and Training, are:

- The production, processing, and preservation of meat, fish, fruit, vegetables, oil, and fats
- Manufacture of dairy products
- Manufacture of breakfast products
- Food preparation products
- Manufacture of beverages.

In the foresight survey, with the sessions in Johannesburg and Cape Town being considered, all five of these categories were represented to varying degrees.

Dairy is the fifth-largest agricultural industry sector and one of the highest-employing sectors in South Africa. Approximately 1.2 million dairy cattle are farmed and the sector employs around 60 000 farmworkers, and provides 40 000 people with direct jobs within the value chain, such as in the milk processing , transporting and marketing industries[17] Based on the production systems currently prevalent in the regions, milk-producing areas in South Africa are divided into six: KwaZulu-Natal, Southern Cape, Western Cape, Central Highveld, Free State, Central-Eastern Cape, and Southern Eastern Cape. Most of the milk and milk products are consumed locally with South Africa contributing only around 0.5% to the world market, with the European Union and New Zealand contributing 31% and 30%, respectively[18].

The beverages sub-sector encompasses alcoholic and non-alcoholic beverages, except for fruit juices, which are classified as fruit and vegetable processing. Between 2008 and 2019, the subsector employed an average of 70 000 people. Employment in the informal sector dominated this subsector, accounting for 18% of the entire beverage labour force in 2019[19]. However, this percentage was significantly lower than the manufacturing average of 25%, implying that informality was lower than the rest of the manufacturing and indicating the dominance of a few players in the iductry. Between 1994 and 2019, beverage production increased by 0.4% per year. As a result, its share of total manufacturing value added has decreased by 3% annually, stabilizing at around 7% in 2019. Beverage exports totalled R19 billion in constant (2020) rands in 2019, accounting for about 1.8% of total South

[17] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7895717/
[18] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7895717/
19 https://tips.org.za/images/Manufacturing_subsectors_beverages_2021.pdf

African exports[20]. Imports were slightly lower at about R17 billion, or 1% of total imports. In 2019, South Africa's beverage exports were led by wine, which accounted for more than half of the total. Soft drinks were the second largest export, accounting for one-seventh of the total in the same year.

South Africa's primary beverage export markets are Namibia, Botswana, Mozambique, Swaziland, Lesotho, Zambia, Zimbabwe, and Angola. Most of these products were alcoholic beverages.

The food processing sector – including food preparation products and breakfast cereals - is significant in its contribution to gross domestic product (GDP), employment and international trade. Moreover, employment in the subsector has demonstrated an upward trajectory and has increasingly become feminised with women representing 51% of the total labour force in food processing by 2020[21]. In 2020, processed food exports amounted to R30 billion or around 3% of total exports. Moreover, between 2002 and 2020, processed food exports have grown relatively faster than total commodity exports. There are an estimated 1 800 food processing companies in South Africa. However, the subsector is characterised by a mix of small informal players and large vertically integrated companies with a significant stake in the various aspects of the food processing chain. Data indicate that by 2019, the top 10 largest food processors accounted for more than 80% of total subsector revenue. In the same year, the income share of the top five food manufacturers was more than 50% in most food processing industries. Similarly, food processors owned 90% of total silos in the subsector in 2019. This would not be problematic in any subsector if linked to large-scale efficiency gains, however, silos and other storage facilities are an extremely significant component of the food processing value chain. This implies that small-scale and informal sector players must be reliant on large players at crucial links in the value chain, which therefore limits both their participation and competitiveness.

Within the FoodBev SETA landscape the Food preparation productions chamber has the largest number of companies (375 in 2022), followed by the Production, processing and preservation of meat, fish, fruit, vegetables, oils, and fats chamber (243 in 2022)

The Food Preparation Products Chamber employs the greatest number of people at Food and Beverages Sector — nearly 90 000 employees.

[20] https://tips.org.za/images/Manufacturing_subsectors_beverages_2021.pdf
[21] https://www.tips.org.za/images/Manufcturing_subsectors_-_Food_processing_2017.pdf

Key factors of change

The key factors that are driving change in the Food and Beverage Manufacturing Sector can be divided into three broad categories. These are Technological advances in the industry and across the value chain, the impact of ecology, climate change and sustainability initiatives and lastly the pressure from social forces and consumers. These are discussed in the section below.

Technological advances

The global market for the development and supply of automation equipment / devices / technology in the food processing industry is expected to reach $29.4 billion by 2027, according to Statista[22]. This is not just hype, but a powerful instrument to supply the world with reduced costs. A Siemens case study reported by *Snack Food & Wholesale Bakery*[23] found that upgrading the old and degraded equipment at a snack manufacturing plant with sensors, drives, and other modern elements led to a 10% production improvement and a 20% savings in maintenance costs and energy usage.

The food production modernisation process is much more complicated than just automation. In what is commonly termed the Fourth Industrial Revolution (4IR), this is the trend towards automation and digitalisation of manufacturing processes, including cyber-physical systems, industrial internet-of-things, cloud computing, and more. According to the World Economic Forum 2020[24], there are numerous combinations of 4IR technologies in the food and beverages industry can address some of the challenges encountered and create more effective production systems. These are discussed below.

[22] https://www.statista.com/statistics/1259903/robotic-process-automation-market-size-worldwide/

[23] https://www.snackandbakery.com/articles/97526-case-study-siemens-drives-snack-food-maker-to-higher-production-energy-savings

24 World Economic Forum, 2020, https://www.weforum.org/focus/fourth-industrial-revolution

Cyber-physical systems.

Cyber-Physical Systems (CPS) opens up new possibilities for food processing automation efforts. The Eindhoven Institute for Research on ICT identified six components of CPS architecture: the physical world, transducers, control components, data analytics elements, computation elements, and communication components[25].

Due to CPS, companies can make a plant "smart" using a complex system of connected sensors, devices, machinery, and data analytics to reduce costs and improve efficiencies, safety, and quality. This leads to increased control over physical and chemical processes. For example, Siemens employs a multi-sensor system in a chocolate spread producing plant as part of the clean-in-place (CIP) system's decision-making.

25 https://linkinghub.elsevier.com/retrieve/pii/S1574119217303127

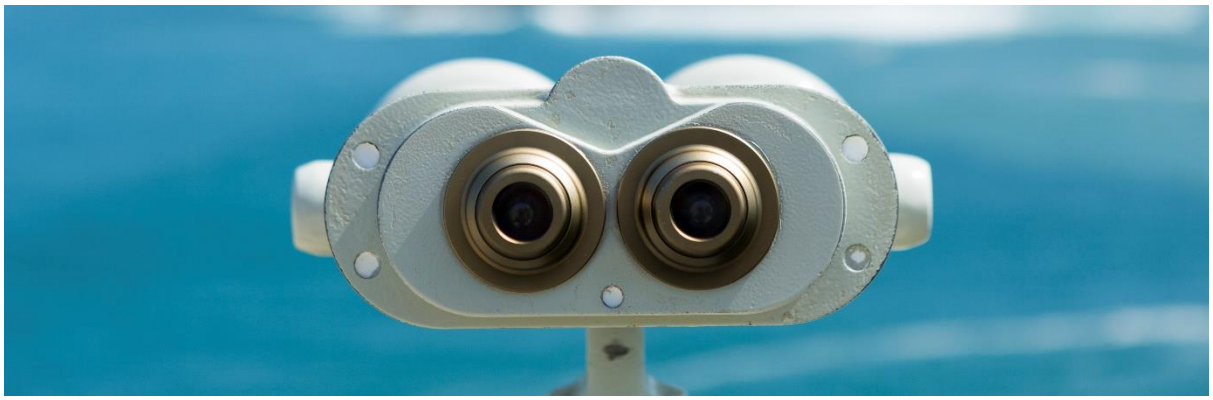
New computing technologies, big data, and advanced analytics.

Big data and data analytics can play an invaluable role in policy decisions and the facilitation of cost accounting that can create a significant impact on consumer consumption[26]. Also, new possibilities emerge for marketers to predict consumer preferences. For example, *Gastrograph AI* by Analytical Flavor Systems[27] uses consumer demographics broken down by age, geographic location, etc. So-called genetic algorithms (a kind of AI) can predict the impact of changes in flavours and tastes on targeted groups thereby reducing development time and R&D resources. Intelligent systems make food processing operations more traceable, making revealing defects and mistakes easier, reducing loss and waste, and gaining consumer trust.

[26] https://www.icaew.com/-/media/corporate/files/technical/technology/thought-leadership/ x
[27] https://www.gastrograph.com/

Artificial intelligence and Machine Learning.

Artificial Intelligence Systems (AI) can assist Food and Beverage Manufacturing in numerous ways, including sorting products by form, colour, and flavour, checking on workplace pollution, enhancing supply chains and aiding decision-making in food processing. For example, AI is used in the coffee business to make coffee bean roasting more accurate, depending on bean variety and other factors. AI can also help with new product development[28]. With computer models, a developer can create a virtual or digital twin of the product and analyse it from different points of view to predict if it will be successful among customers. For example, beer brand IntelligentX has developed a series of premium beers with the help of AI, and it has gained huge success[29].



Although 4IR gives many opportunities, challenges may appear due to the incompatibility of different equipment, digitalization costs, and lack of skilled resources. Industry also needs to develop standards for machine learning and standards for collecting and sharing data.. One of the rare examples of such a development is the OpenAg Food Computer project of the Massachusetts Institute of Technology[30]. The plants in the OpenAg laboratory are grown in shipping containers equipped with sensors and gadgets controlled by artificial intelligence. AI can control the brightness of light, temperature, humidity, and other environmental conditions and calculate the best options in order, for example, to grow the most delicious basil or the most fortified lettuce. The "Climate recipe" is uploaded to the cloud for public consumption, enabling all to use the data.

[28] https://neoteric.eu/blog/ai-in-product-development-examples-and-benefits
[29] https://www.wired.co.uk/article/beer-brewed-by-ai-intelligentx
[30] https://www.media.mit.edu/projects/personal-food-computer/overview/

Automation of Plants

Autonomous and near-autonomous vehicles and advanced smart robotics are changing the face of manufacturing, and the Food and Beverage industry is no exception. The Covid-19 pandemic has been a game-changer in this regard as it was a powerful catalyst to accelerated automation, as robots do not get sick and do not spread infection. Manufacturing or Industrial robots are complex systems composed of multiple components, such as a multi-jointed robot arm or an overhead picking arm called a "delta" robot[31]. Such robots are commonly found in food processing operations. There are also so-called end-effectors, including various manipulation devices specific to the size, shape, and rigidity of the food products that are handled. Computer vision systems can determine a food products' orientation which can then be manipulated enabling bar code reading during the packaging process. In South Africa, there is an increase in the implementation of pick-and-place robots in food manufacturing, especially in the large bakeries[32].

Robotic systems are good at organising food products in boxes for storage and shipment. For example, robotic systems are being used by Sedano's Supermarket (the most significant Hispanic retailer in the USA) to make the process of packaging goods for customers more efficient, enabling rapid filling of online orders with up to 60 items being handled in under five minutes[33].

[31] https://www.smlease.com/entries/automation/delta-robot-working-advantages-applications.
[32] https://www.iol.co.za/technology/gadgets/how-robots-are-revolutionising-south-african-sectors
[33] https://www.sun-sentinel.com/business/fl-bz-robotics-supermarket-sedanos-miami-20190206-story.html

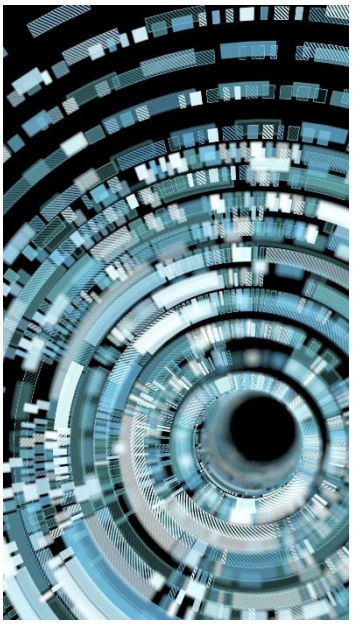
Automation of Delivery.

Many start-ups are experimenting with drone delivery. It is already common in American universities to use automated delivery robots called rovers in their on-campus food service[34]. Whilst these are faster and more affordable than traditional delivery methods, some challenges have been experienced. These include the requirement for specific infrastructure on streets (like unique signs and chargers for robots), but it also means that drones will begin to displace human couriers from their jobs, and those will have to retrain new professions creating societal pressures.

A further complication with automation is the safety of human workers at robotised plants. Safety systems would need to be incorporated which detect if humans or objects come in proximity to moving parts on the robot. Additionally, robotics for the food industry requires food-safe materials, such as stainless steel and food-safe lubricants for moving parts. Lastly, robots need to be controlled by computers securely connected to an internal network to immune to cyber-attacks.

[34] https://www.freightwaves.com/news/delivery-robots-are-coming-to-a-college-dorm-near-you

Blockchain



While supply chains are growing (according to the report of Transparency Market Research, global supply chain logistics will amount to $15 trillion in 2023[35]), sustainability and environmental friendliness are starting to play an increasingly important role in logistics. Blockchain can make supply chains more efficient and ensure their sustainability. In 2020, food safety company Neogen partnered with Ripe Technology to make a blockchain platform that creates a history of the whole production cycle, starting from plant and animal genomics and ending with the sustainability of supply chains[36]. Another emerging tracking technology is intelligent labelling — wireless labels are connected with software applications and cloud platforms.

A consumer can scan such product labels with their Near Field Communication (NFC) enabled smartphone and get much information about its origin, formulation, consumer rating, and more.

[35] https://www.transparencymarketresearch.com/pressrelease/logistics-market.htm
[36] https://www.foodingredientsfirst.com/news/

Virtual and Augmented Reality

According to Statista report, the Augmented Reality (AR) market size is estimated to increase to more than $198 billion by 2025[37]. The Food and Beverage Manufacturing Industry, and the service sector, can use it for multiple purposes.

- To attract and educate and entertain (edutain). In one instance, supermarkets and restaurants can offer consumers a menu that comes to life when scanned with smartphones. Bareburger, an American burger chain, has introduced AR menus, so customers can view menu items using Snapchat[38]. NexTech AR offers an AR tour of the boat showing how fishermen are getting shoppers fresh-caught lobster[39]. Coca-Cola has also launched an AR experience for Christmas series of bottles.
- To improve quality and safety during the working process. AR can provide hints for workers and ensure they do not miss critical steps. As such it can help reduce food product recalls at plants and enhance effectiveness. Virtual Reality (VR) and AR are suitable for training and retraining staff to work with complex equipment.
- To optimize picking in warehouses — for example, to help the operator to identify the picking location quickly.

[37] https://www.statista.com/statistics/897587/world-augmented-reality-market-value/
[38] https://www.youtube.com/watch?v=xF4Ir2U0oDM&ab_channel=AlperGuler
[39] https://www.nextechar.com/

Advances in Biotech

Over the last few years there have been rapid advances in Biotech. These next-generation biotechnologies and genomics include genetically modified plants and technologies used in energy creation, capture, storage, and transmission (for example, sustainable bio-energy made from agri-food by-products turned into gas). Technologies are currently being developed to produce synthetic meat, milk, cheese, and other foods. For example, Impossible Foods makes plausible vegetable burgers by genetically programming the same yeast to produce the protein molecule heme responsible for the colour and taste of meat[40]. Also, the Clara Foods project creates artificial egg white that can be used for baking[41].

Additive Manufacturing and Multidimensional Printing

Three-dimensional (3D) printing is used in food for on-demand production and in making geometrically complicated meals, like exotic cakes or candies. Data-driven recipes allow for customized flavour and nutrition, and printing processes allow to produce unique textures. The South African start-up, Studio H, collected the disformed or disfigured (less appealing looking) fruits and vegetables rejected by supermarkets, made a puree, and 3D printed it into more appealing shapes[42].

[40] https://www.theguardian.com/sustainable-business/2016/oct/23/
[41] https://www.foodnavigator.com/Article/2021/02/09/
[42] https://www.zestfruit.co.za/3d-printer-gets-rid-of-ugly-fruit/

Advanced materials and nanotechnologies

Various alternative packaging materials are being launched on the market to keep the food fresh, prevent contamination, and leave less trace — like active packaging, edible film, bioplastics, and nanocoating.

Intelligent and Active Packaging.

Packaging helps maintain a product's quality and freshness by interacting with food biomass via sensors, nanocoating, and other intelligent elements and can inform customers about the properties of food[43]. For example, packaging that can change its colour when the expiration date is coming to an end.

Edible Film

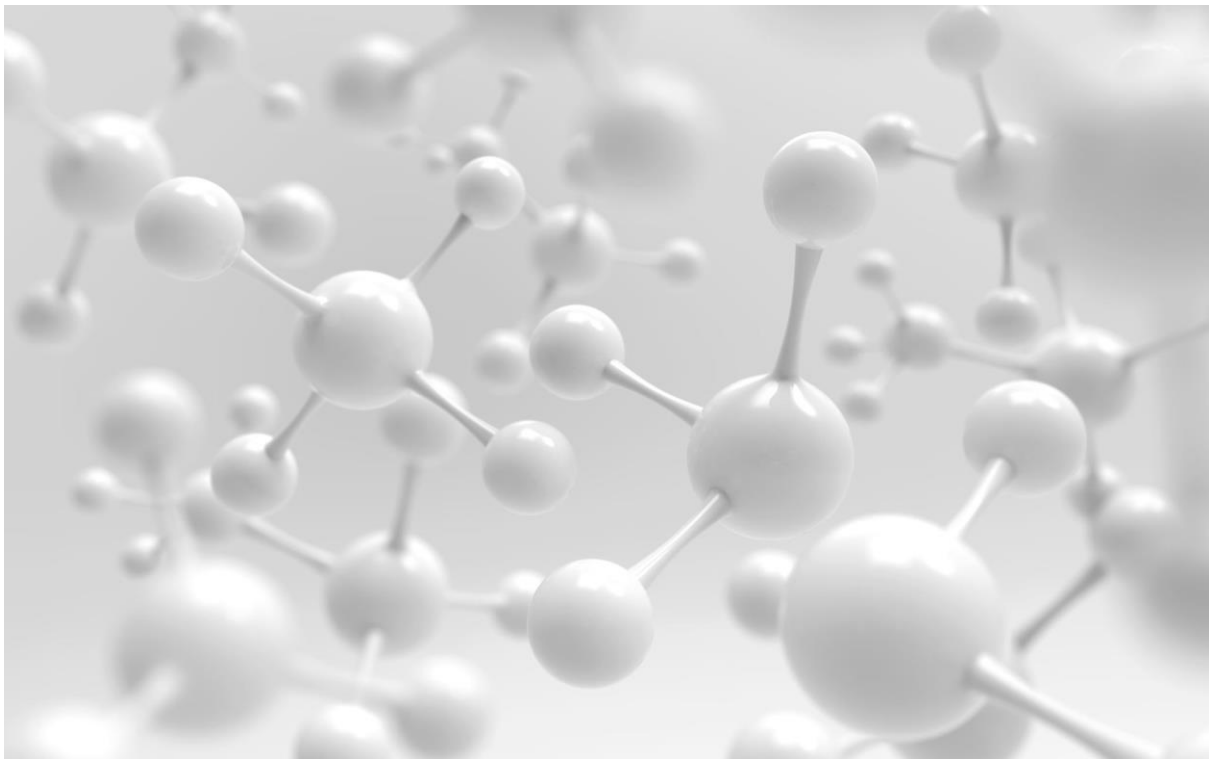
Edible film is made from an edible polymer (like gelatin or wheat gluten) and creates a thin layer that coats fruits, and vegetables, delaying their decomposition[44]. Bioplastic - an alternative non-polluting material to plastic - is a 100% biodegradable natural polymer made of biomass sources such as vegetable fats and oils, corn starch, recycled food waste, etc. For example, the Wyss Institute of Harvard University developed Shrink, a 100% biodegradable and compostable food film derived from chitosan[45]. It is derived from chitin, combined with a silk protein called fibroin. Another example is a kind of polyethylene that has been produced from the fermentation of sugarcane.[46]

[43] https://www.sciencedirect.com/science/article/pii/B9780128161845000124
[44] https://www.sciencedirect.com/topics/food-science/edible-film
[45] https://wyss.harvard.edu/technology/bioplastic/
[46] https://ccea.org.uk/downloads/docs/Support/

Nanomaterials

Nanomaterials are tiny particles ranging from 1 to 100 nm in size used in medicine, agriculture, food, and other industries. Nanoparticles of various substances, such as silver, gold, zinc oxide, carbon, etc., can help to prevent microbial contamination and food spoilage[47]. Nano-biosensors are also implemented to detect carcinogenic pathogens in the preparation of high-quality food. Edible nano-coatings can be used as gas and moisture barriers in meat, fruits, vegetables, cheese, and bakery goods. [48]

The interaction of nanoparticles with food raises concerns about human and animal health. So far, no standard regulatory laws regarding their use in food and Agri-sectors have been introduced. Therefore, practical guidelines and policies are required for the safer use and utilization of nanoparticles in the food industry.



[47] https://link.springer.com/article/10.1007/s40820-020-0383-9#ref-CR4
[48] https://www.hilarispublisher.com/open-access/

Connectivity Technologies

Social networks, peer-to-peer networks, and online e-commerce could enable the tracking of consumption patterns and increase access to nutritional food alternatives. This will require connectivities among industry actors and new ways to communicate with customers.

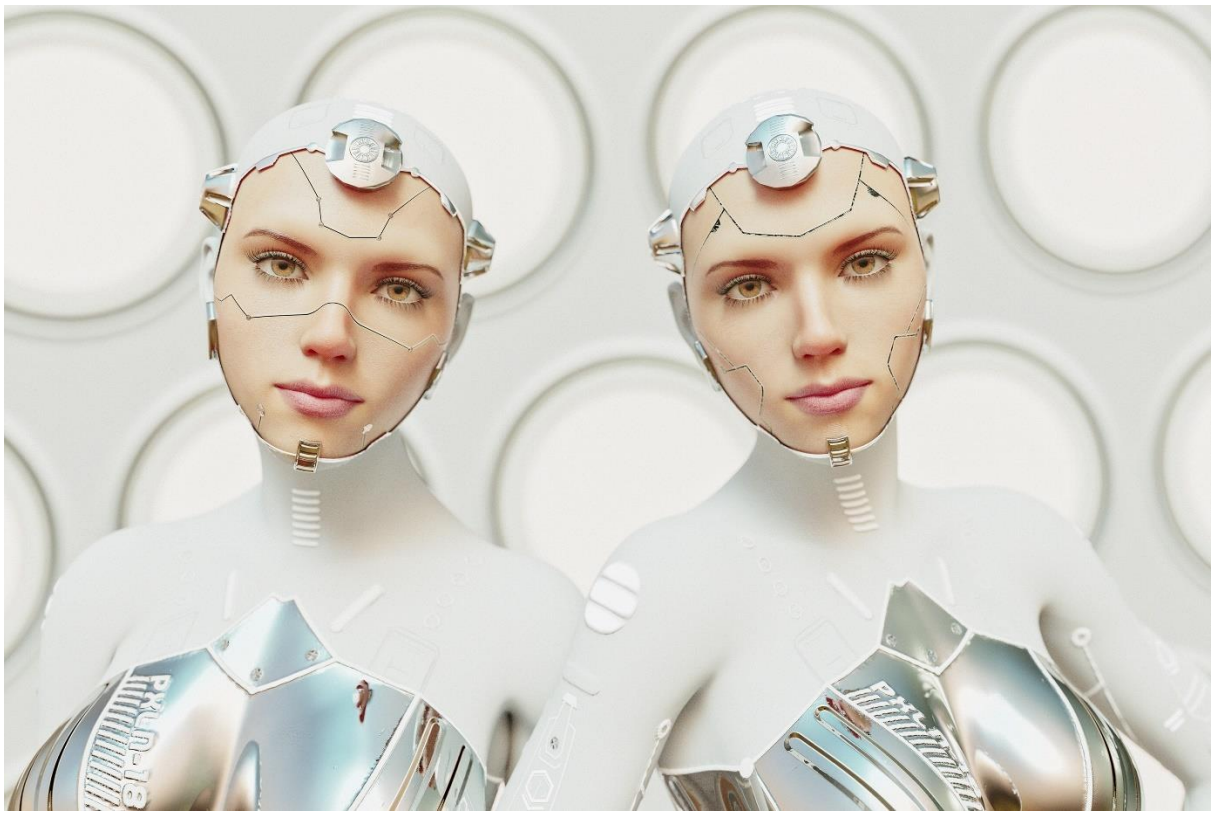
Communication in and between industries is crucial. With connectivity, all participants in the value creation stream will have a significant influence on food preparation, supply issues brought on by political and ecological factors, disruption of established business practices, and increased financial pressure on businesses and consumers. With the current trend towards consumer activism,[49] community members will be able to participate actively in such a supply chain as cooperative individuals or independent business owners. The renegotiation of conditions of service and boundaries of influence will therefore start to affect the entire food business. The business response needs to be one of listening, responding and bringing communities and consumers into the value chain as valuable actors, thereby benefiting business productivity.

[49] https://www.ecommercetimes.com/story/consumer-activism-will-steer-brand-focus-in-2022-87381.html

Digital Twins

Connectivity amongst industry actors will result in a digitally connected and accessible supply chain ecosystem. To remain both agile and multi-agent focussed, the Food and Beverage Manufacturing industry would require coordination mechanisms that will assist. This will take the form of a digital interface between different levels and stages of the value creation chain, a transparency of operations and interactions between agents, and the development of digital twins of the most complex parts of the processing and production process.

A digital twin is a digital[50] representation of an intended or actual real-world physical product, system, or process that serves as the effectively indistinguishable digital counterpart of it for practical purposes, such as simulation, integration, testing, monitoring, and maintenance. Funding for this may be challenging, but these investments can start from something relatively small and tangible, leading to the vision of the future — the digital transformation of the industry.



[50] https://www.ibm.com/topics/what-is-a-digital-twin

Ecology, climate change, and sustainability

With around eight billion people in the world needing food, the agriculture sector all around the world works hard to feed humankind. Moreover, it still remains the world's single largest employer by providing jobs for approximately 40% of today's global population[51]. A recent study by Sarah et al (2021) indicated that about 80% of the world's food is produced by more than 600 million farms, 84% of which are small[52].

In Southern Africa, more than 70% of the rural population depends on agriculture for their livelihoods[53]. Southern Africa is one of the biggest exporters of fruits and nuts ($4.5 billion in 2021), oil seeds, citrus, wine, and most vegetables in the world. However, due to the distinct possibility of poor performance in agriculture where productivity may be affected by the combined effect of climate change and the reduction in irrigated water availability[54], regional economic growth may be constrained[55].

The current **power crisis** in the Southern African region, when combined with the effects of potential **climate change** and **water shortages**, could have a dramatic effect on the **sustainability** of the food and beverage sector.

International Trends in the Agricultural Sector

- An increase private investment in agriculture.
- Government policies being developed to support growth in the farming sector.
- Highly qualified specialists being trained in environmental sciences.
- The localisation of the agricultural sector and promotion of local products.
- Modernisation of farming equipment to increase efficiency and reduce costs.

[51] https://blog.aghires.com/30-ways-agriculture-feeds-world/
[52] https://doi.org/10.1016/j.worlddev.2021.105455
[53] https://www.usaid.gov/southern-africa-regional/agriculture-and-food-security
[54] https://doi.org/10.1016/b978-0-12-820200-5.00006-3
[55] https://www.usaid.gov/southern-africa-regional/agriculture-and-food-security

Climate change and soil depletion

Climate change has the potential of making a significant impact on agriculture all over the world, and South Africa is not an exception. A report released in 2021, but referencing reports from 2015, by the Centre for Environmental Rights, part of the Global Change Institute of the University of Witwatersrand and authored by Professor Robert Scholes Francois Engelbrecht, posited that temperatures in South Africa could be expected to rise by 2-3 degrees Celsius by 2050 and up to 4 degrees Celsius by the end of the century. This scenario would mean that rainfall patterns change and water evaporation accelerates, with an increased risk of extreme storms, droughts, and the loss of biodiversity. Freshwater availability would be impacted causing significant damage to the agri-food business. The report concludes that climate change could cost South Africa up to 11% of GDP per capita by the end of the century.[56]

A separate report[57] from the same research period projects temperature increases of up to 1 degree Celsius by 2050, and up to 2 degrees Celsius by the end of the century. Whilst the two reports differ dramatically in their projections, it is commonly thought that temperatures are on an upward trend, with the corresponding negative impacts on the region.

South Africa receives less than half of the annual global average precipitation[58], albeit with large variabilities between the eastern and western parts of the country, resulting in range-, crop-, and forestlands being very prone to degradation. This dry climate and a very old and stable landscape formed unique combinations of soil and vegetation. The major land use is therefore extensive grazing (83%), with only 14% arable land, and 1% forestry[59]. About 2% of this land is severely affected by wind erosion, whilst water erosion varies from <1 to 60 Mg ha^{-1} $year^{-1}$. Natural acidification occurs on 16×10^6 ha, acidification due to farming practices occurs on 12.9×10^6 ha cultivated land. Extensive irrigation also has the negative consequence of creating saline soil, which currently is on about 1.4×10^6 ha in South Africa. . Water pollution occurs in some rivers in South Africa, with agriculture being responsible for 20% of the nitrogen pollution and 53% of the phosphorus pollution. The remainder originates from human effluent and industry. Soil degradation is of greatest concern in the KwaZulu-Natal, Northern, and Eastern Cape Provinces, whilst vegetation degradation is of greatest concern in the Northern, KwaZulu-Natal, and Northern Cape Provinces. Land tenure, inappropriate land use, and management practices within the unique ecosystems emerged as primary drivers of

[56] https://cer.org.za/wp-content/uploads/2021/09/Climate-impacts-in-South-Africa_
[57] https://www.climatelinks.org/sites/default/files/asset/document/Southern%20Africa%20Climate%
[58] dctanks.co.za/page-12.html
[59] Du Preez CC, Kotzé E, Van Huyssteen CW (2019) Soil, agriculture and food.

agricultural land degradation[60]. This degradation does seem to be restricted to certain geographical areas. Focused management practices for either prevention or improvement could therefore be developed.[61]

As noted above, a pressing environmental concern is soil degradation. Soil formation is a relatively slow process[62], so it becomes a limited resource. Natural soil erosion is enhanced by irresponsible farming practices, such as clearing vegetation, over-grazing, or soil tillage. In addition there are also chemical changes that occur— like acidification of soil in eastern parts of South Africa and salinization in western regions. Overuse of pesticides also has a bad influence on soil quality.

What is being considered around the world to mitigate these issues

- Crop rotation
- Adding more carbon to agricultural soils by planting certain kinds of crops as it minimizes the effect of drought on agriculture
- Preventing planting and over-grazing
- Implementing agricultural sensor systems
- Ecological education and training of ecologically conscious practices for farmers
- Reducing pesticide usage
- Bio-remediation of soil
- Regenerative agricultural practices

[60] Department of Agriculture, Land Reform & Rural Development (2020) Abstract of agricultural statistics
[61] https://link.springer.com/chapter/10.1007/698_2022_922
[62] https://www.qld.gov.au/environment/land/management/soil/soil-explained/forms

Water Crisis

A rapidly growing populace increases the demand for food. The long-term changes in climate which affect rainfall patterns, combined with the seemingly endless prevalence of drought and flood cycles is affecting the agricultural sector, water, and food security of the citizens[63]. In 2018, brought on by three consecutive years of anaemic rainfall, the City of Cape Town narrowly avoided "Day Zero," the day when the piped water supply would have had to be shut off in most areas, and everyone would have had to queue for water[64].

Whilst avoiding “Day Zero” was a collective effort on many fronts in the City, one of the key moments was when the national government throttled allocation of water in the region earmarked for agriculture, allowing more to flow to urban residents[65]. The same month, farmers also agreed to divert additional water stored for agricultural purposes to the city. Whilst being a short-term life-saver for the City, this intervention can have serious long-term consequences for food security in the region and in the country, and actions are required to improve sustainability and prevent these interventions.
Climate experts warn that these kinds of droughts are highly likely to become more frequent, might last longer, or become more severe[66]. It is therefore vital that options be investigated to prevent water for agricultural purposes being diverted to urban areas.
This crisis also showed that a new relationship with water usage needs to be built, with one of the options being to consider the oceans as an abundant water supply[67]. Currently, desalination (the process that removes salt and other minerals from saltwater) is getting more attention from investors and decision-makers in South Africa, as many hope it is poised to solve the scarcity of freshwater in urban areas. Reverse osmosis (RO), which is the leading process for desalination due to its capacity, is a highly recognisable and accepted process of water filtration all around the world as it can remove many types of dissolved and suspended chemical species as well as biological ones like bacteria from water[68].

Another common type of desalination is classical distillation, which means separating the components from a liquid mixture by using boiling and condensation[69]. This process is energy intensive, however, the long-term outlook for desalination as a cost-effective strategy for South Africa’s water security has

[63] https://doi.org/10.1016/b978-0-12-820200-5.00006-3
64 https://resource.capetown.gov.za/documentcentre/Documents/
[65] https://www.bloomberg.com/news/articles/2019-04-12/ o
[66] https://www.sciencedirect.com/science/article/pii/S0048969721045794
67 https://sassda.co.za/news-home/stainless-steel-magazine/march-2018/desalination-plants/
68 https://www.health.state.mn.us/communities/environment/hazardous/topics/gac.html
69 https://www.health.state.mn.us/communities/environment/hazardous/topics/gac.html

improved in recent years as renewable energy has become more efficient. New desalination pumps, membranes, and energy-recovery technology have dropped power requirements to a quarter of what they were just a few decades ago[70].

Another new alternative method of increasing the water supply in South Africa is via phytoremediation[71], or "the use of algae to treat wastes or wastewater". Algae benefits wastewater treatment by producing oxygen allowing aerobic bacteria to break down organic contaminants in the water and take up excess nitrogen and phosphorus in the process. It is also a sustainable and affordable alternative to current wastewater treatment practices[72] and is currently being utilised in the Zaalklapspruit wetland system in Mpumalanga province.

[70] luencecorp.com/is-desalination-key-to-water-future-of-africa/
71 https://doi.org/10.1016/j.envpol.2021.117989
72 https://en.wikipedia.org/wiki/Desalination

Activated carbon filtration is also being used widely in industry. It is a filter with granular activated carbon, a proven alternative to removing certain organic chemicals from water. It also can be used to release chemicals that give objectionable odours or tastes to water, such as chlorine[73].

While trying to reduce the time, energy, and cost of the water recycling processes, circular economy principles could be applied. An example is the waste water (used in the manufacturing process) of one company being sold to another company (which may find the previous company's wastewater useful with minimum or no recycling/filtration).

In water scarce such as South Africa a culture of water being used many times over needs to be cultivated: water can be filtered using RO or distillation and disinfected to the point of being drinking water (high-end use) or for low-end use, which is non-potable, but safe enough for cleaning equipment like vehicles, etc[74].

What is currently being investigated and implemented globally

- Phytoremediation which can be applied to more water systems
- Policies and additional controls to prevent illegal disposal of industrial garbage in rivers, lakes, and oceans
- Policies and incentives which encourage the installation of energy-efficient desalination plants, especially Reverse Osmosis systems powered by biogas.
- The improvement of water irrigation systems by automation which has the potential to save agricultural water requirements
- Companion planting and regenerative practices in agriculture which can reduce water requirements

73 https`://www.alternative-energy-tutorials.com/biomass/biogas-energy.html

74 https://www.manufacturingtomorrow.com/article/2019/10/should-manufacturers-use-water-reuse-practices/14227/

Power crisis

It is no secret that the current unplanned and unpredictable power supply and outages in South Africa is having a devastating effect on both the quality of life of citizens and the economy[75]. While South Africa has been experiencing on-off power outages for years, since September 2022 scheduled blackouts have become routine, affecting every part of South African society.

The impact of loadshedding on the agriculture sector is evident at all levels of operation, including logistics and cold-chain management, which necessitates urgent responses from farmers and government, lest food security and export sales are put at risk.

A report by Nova Economics estimates that agriculture lost about 4.38% of its contribution to gross domestic product in 2018/19 and that the cost of loadshedding for agriculture amounts to R4.01 per kWh in terms of 2020 values[76].

Loadshedding has escalated in its frequency and severity since 2019 and 2020, with a record 5 761 GWh of outages recorded in 2022, from January to September, which is more than double the figure for 2021. In the nine months ended September 30, 2022, the agriculture sector reportedly lost R23-billion, owing to crop failure and a decrease in productivity because of loadshedding.

Loadshedding's impact is ubiquitous, from irrigation, the conveyer belt movement of produce or livestock products, and alarm systems for security to keep livestock contained to cold storage facilities at farms and at ports, as well as railway lines. Industries such as dairy come to a complete standstill during power outages, owing to the need for electricity for milking, processing and storage purposes.

Business owners are actively shifting toward using their own energy source, arguing that every minute they are without power costs them money[77]. South Africa is a coal-based economy and is heavily dependent on fossil fuels rather than renewable energy sources such as solar and wind power. Even though South Africa produces the most solar and wind energy by terawatt-hours (TWh) in Africa, there is ample scope for the proportion of solar (2%) and wind (3%) in their energy mix to be greatly increased[78].

[75] https://edition.cnn.com/2023/01/31/africa/south-africa-power-blackouts-intl-cmd/index.html

[76] https://www.engineeringnews.co.za/article/farmers-seek-new-deal-as-loadshedding-threatens-industry-and-food-security-2023-02-03-1/rep_id:4136

77 https://www.gov.za/speeches/remarks-honourable-minister%C2%A0%C2%A0mineral-resources-and-energy%C2%A0mr-samson-gwede-mantashe%C2%A0-solar

[78] heoutlier.co.za/news/82781/sa-is-the-biggest-wind-and-solar-producer-in-africa-but-most-of-our-energy-still-comes-from-coal

Solar holds the most potential of all South African renewable energy sources Most areas in South Africa average more than 2 500 hours of sunshine per year, and average solar-radiation levels range between 4.5 and 6.5kWh/m2 in one day[79].

The southern African region, and in fact the whole of Africa, has sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m2 for South Africa, compared with about 150 W/m2 for parts of the USA, and about 100 W/m2 for Europe and the United Kingdom. The use of solar energy is the most readily accessible resource in South Africa. It lends itself to a number of potential uses and the country's solar-equipment industry is developing. Annual photovoltaic (PV) panel-assembly capacity totals 5MW, and a number of companies in South Africa manufacture solar water-heaters.

79

https://www.energy.gov.za/files/esources/renewables/r_solar.html#:~:text=The%20annual%2024%2Dhour%20global,the%20highest%20in%20the%20world.

Other sources of renewable energy that are gaining momentum are wind power and biogas. In 2021, SA generated 8 TWh of electricity from wind[80], whilst biogas has the potential to displace 2,500MW of grid electricity[81]. Biogas is relatively new in South Africa, but the National Waste Management Strategy of 2020 has the objective of achieving 40% biogas from organic waste by 2025. A bright example of using biogas to the maximum in the industry is the Rolland Sustana Group based in Jerome in the USA, a large paper manufacturing company that is 93% powered by biogas energy [82].

The current energy crisis in South Africa is having a debilitating effect on the Food and Beverage Industry, from farming through to manufacturing. While load shedding cannot be fixed overnight, there are critical short-term measures that can be put in place to mitigate its impact on food security[83].

What is being done globally to ensure energy security for food

- Companies being encouraged to use biogas from food waste as an energy source.
- Policies and incentives being put in place for companies to produce and use their own renewable energy via installing solar panels and wind turbines.
- The potential of biogas energy in the industry that uses and reduces food waste at the same time is being encouraged.
- Energy storage systems are being developed where companies can sell or buy extra energy.
- Bylaws and laws being put in place which encourage citizens to sort garbage, new programs being developed to encourage the local populace to change their attitudes towards renewable energy sources
- Development of localised mini power plants which only serve the local communities
- Development of mechanisms to sell excess own-generated energy back to the grid

[80] https://ember-climate.org/insights/research/global-electricity-review-2022/

[81] https://www.esi-africa.com/industry-sectors/future-energy/is-there-renewed-hope-for-biogas-projects-in-south-africa/

[82] https://www.rollandinc.com/sustainability/biogas-energy/

[83] https://www.iol.co.za/business-report/economy/government-failure-to-deal-with-load-shedding-could-lead-to-higher-food-prices-and-shortages-agri-sa-a1948455-de1f-4cbb-996d-cdcd6d0f42ff

Sustainability

Increasing concerns internationally around climate change – and in South Africa the **power** and **water** crises - are putting pressure on businesses to improve sustainability. For the Food and Beverage industry globally, the Covid-19 pandemic elevated the stakes. When the supply chain disintegrated, it threw the need for a more sustainable and resilient supply chain into sharp focus. The industry in South Africa was similarly affected.

Sustainability is often interpreted as relating solely to the company's environmental footprint, but the issues involved include:

- Reducing waste
- Cutting pollution and emissions
- Minimizing impact on the environment
- Improving employee safety and health
- Lowering energy and water consumption
- Advancing diversity in hiring
- Promoting a greater range of healthy products

All of this could be thought of as passive sustainability, or "do no harm" as it was termed by The Nature Conservancy[84]. But sustainability goes beyond all of that to include "regenerative agriculture," which strives to actively improve the ecosystem. As a case in point, over the next 5 years, Food and Beverage giant Nestlé will invest $1.3 billion, to support and speed up the implementation of a regenerative food system across its global supply chain[85]. In South Africa, sustainability remains the number one topic across the packaging value chain, so corporations set ambitious targets to improve their performance[86].

Understandably, all of this requires more transparency towards consumers and more commitment to researching supply chain partners upstream and downstream. For the moment, the majority of companies are concentrating on four main concerns: reducing their impact on the planet; improving sustainable food sourcing; lowering food waste; and expanding their product range[87].

[84] https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_COVIDGuidingPrinciplesEconomicRecovery_100920.pdf
[85] https://www.nestle.com/media/pressreleases/allpressreleases/support-transition-regenerative-food-system
[86] https://www.foodbusinessafrica.com/south-africa-advocates-for-environmentally-sustainable-packaging-that-ensure-longevity-safety-of-food/
[87] https://www.precog.co/blog/sustainability-food-and-beverage-manufacturing

Reducing their impact on the planet, or "shrinking their environmental footprint" consist of the following actions:

- Limiting use of plastics and reducing packaging in general
- Controlling energy and water consumption
- Lowering carbon emissions during transportation and distribution
- Ending harmful farming practices
- Measuring and reducing air and water pollution

Sustainable food sourcing includes shifting to use more organic and/or locally grown and raised produce in Food and Beverage Manufacturing plants and ties in with a number of goals for shrinking the environmental impact.

Reducing food waste at every step of the supply chain is a key factor for sustainability. The UN's Environment Programme estimates that every year, roughly one-third of the food produced for human consumption[88] is lost or wasted.

Food and Beverage Manufacturing companies are taking consumer product demands seriously. They are working on **expanding their range of products** to cover a larger range of healthy and diet-specific items, such as gluten-free, vegan foods, plant-based proteins, not from concentrate (NFC), and food with fewer chemicals and preservatives[89].

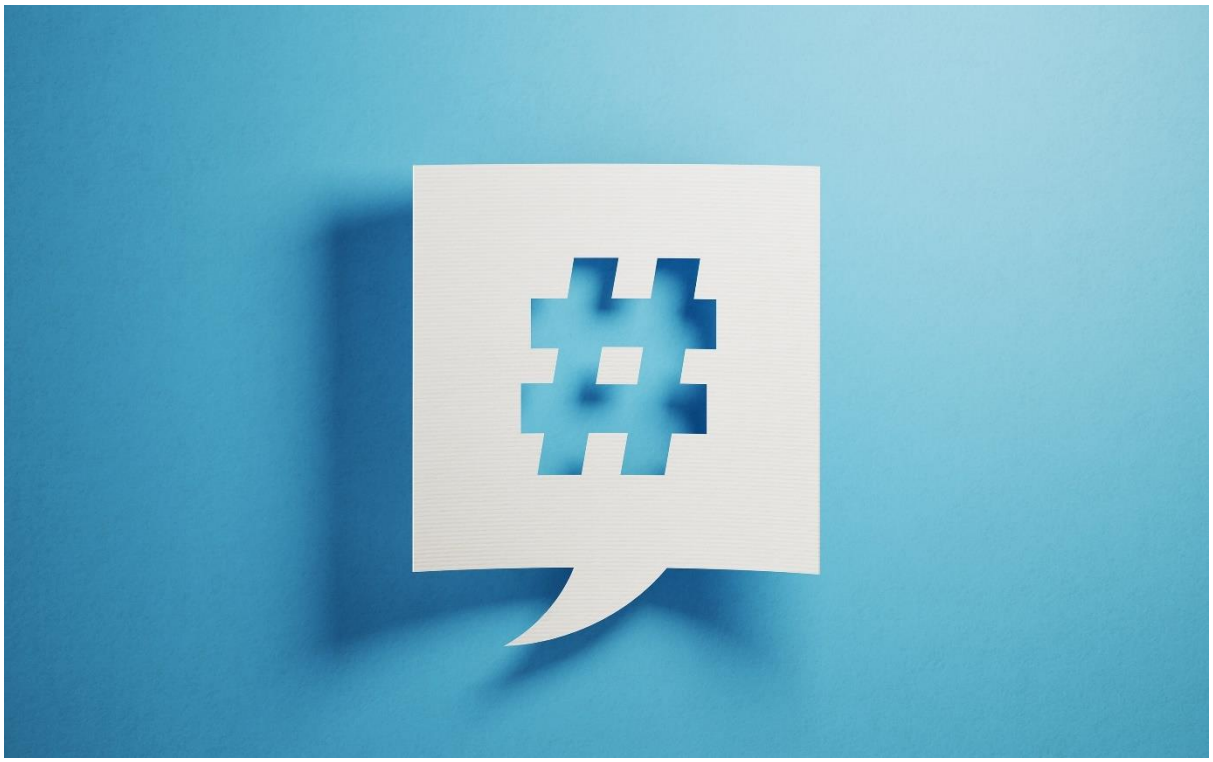
[88] https://www.un.org/en/chronicle/article/feeding-world-sustainably#:~:text=The%20truth%20is%20that%20the,%2D%2D%20is%20lost%20or%20wasted.

[89] https://www.foodprocessing.com/food-safety/environmental/article/11293306/how-food-companies-meet-demands-for-sustainability

Social Pressures

Many consumers are passionate about the quality of their food, the health implications, and the environmental footprint made by food manufacturers[90].

To meet these shifting social expectations, food and beverage manufacturers are speeding up product introductions and developing new offerings which reflect the changing views on what is fresh, healthy, and mindful.



[90] https://www.foodmanufacturing.com/home/article/13249191/consumers-increase-pressure-on-food-and-beverage-manufacturers-to-speed-product-innovations

Mindful consumerism.

Today's green consumers, especially millennials and Gen Z buyers, want to feel good about what they eat, not guilty. "People are waking up to the connection between our food system and the health of the environment."[91] The population's growing awareness of product ingredients and their nutritional benefits makes industries quickly adapt to new realities of the food and beverage market. Conscious consumerism leads people to choose healthier and safer food with accessible information regarding food components.

Alongside the still nascent movement of consumers away from traditional animal-derived products to alternatives like soy meat, coconut milk, etc., local and regional products are also gaining in popularity. The consumer view of sustainable products has some unexpected effect on Food and Beverage decision-making. For example, the beverage industry is seeing a move to more craft beers, which are seen as more sustainable than mass-produced lagers.[92]

[91] https://www.precog.co/blog/sustainability-food-and-beverage-manufacturing
[92] Sustainability 2021, 13, 186. https://dx.doi.org/10.3390/su13010186

Pressure doesn't just come from individual buyers, but also from trade customers like restaurants and grocery stores. The McDonald's Supplier Code of Conduct holds that "suppliers are responsible for managing, measuring and minimizing the environmental impact of their facilities," including regarding air and greenhouse gas (GHG) emissions, waste management, and water consumption.
With around two million smallholders in SA[93] there are opportunities to raise public awareness of local farms and their products, which can assist in boosting productivity and allow these smallholders to become better integrated into the country's agricultural economy.

Food safety is concerned with recognising and controlling risks and hazards associated with food production and consumption, which may result from chemical or microbiological contamination (FAO, 2020)[94]. Today, it is still the most fundamental compliance issue that continues to pose a challenge for the industry. Hazards associated with food include microbiological pathogens, naturally occurring toxins, allergens, intentional and unintentional needs to strictly comply with the water, microbiological, and technical standards and requirements for product labelling, management, and storage. Transparency towards consumers in terms of product sourcing, food safety, quality controls and the complete supply chain is a growing trend that cannot be ignored.

93 https://sustainability-innovation.asu.edu/news/archive/11515-2/
[94] https://www.who.int/news-room/fact-sheets/detail/food-safety

Lean Manufacturing

Lean manufacturing is a philosophy that aims to eliminate waste in all aspects of production activities. Created by the Toyota official Taiichi Ohno[95], it had the goal of creating a smoothly-functioning, high-quality system that can produce, without waste, the finished products of the quality that customers demand. However, lean manufacturing has yet to be fully implemented in the food manufacturing industry[96]. This strange anomaly could possibly be attributed to the disproportionate focus on lean tools and techniques at the expense of the human factor.

According to Carmichael, Mullen, and Mante, 2009,[97] a fundamental tool in Lean manufacturing that can help any business is the '5S' approach.

The 5Ss approach stands for sort, set in order, shine, standardize, and sustain, and it is a structuring technique to get rid of clutter and waste. Cleanliness and having a set place for everything are essential.

A 5S environment has "a place for everything and everything in its place," with all the required resources ready where and when they are needed[98].

[95] https://www.leansixsigmadefinition.com/glossary/taiichi-ohno/
[96] http://vital.seals.ac.za:8080/vital/access/manager/PdfViewer/vital:42218/
[97] Carmichael, C., Mullen, S. and Mante, E., n.d. Banking Industry Leverages Lean Principles to Eliminate Waste Lean Thinking in Financial Services. 1st ed.

98 https://www.techtarget.com/iotagenda/definition/smart-farming

How can Lean Manufacturing be applied to the Food and Beverage Manufacturing Industry

- Use nanotechnologies (nanobots) in packaging to ID products and to preserve the life span of the product.
- Legally ban single-use plastics, and plastic bags, reduce plastic leakage into the environment, and develop and implement control mechanisms
- Avoid food and other organic waste being sent to landfills.
- Change packaging materials nationwide to be more bio-based and environmentally friendly.
- Advocate for a "pull" system in the lean manufacturing process, i.e., instead of forecasting the market demand, incentivize companies to manufacture products 'as needed'
- Provide a methodology for organising, cleaning, developing, and sustaining a productive work environment for food and beverage companies.
- Help local farms to export products such as milk to countries where they have less production
- Legally integrate and advocate for sustainable packaging initiatives that collect or recycle bottles, cans, etc., such as Coca-Cola's World Without Waste strategy.
- Broadcast and educate the notion of "sustainability" nationwide.
- Develop a campaign for plant-based food and packaging
- Assign independent food quality controllers who ensure the companies follow food production standards, correct labeling, management, and storage requirements.

Shared Values and Up-To-Date Technologies

From a customer's perspective, shared values means that they feel a connection to the companies they do business with. It starts with a customer seeing the value in the products or services a company sells but it goes beyond that. It also includes a company's respect for the consumer and the community we share. In many ways, consumers believe the brands they choose are a reflection of who they are[99]. Companies therefore work hard to create a competitive product and also build a good rapport with their customers to share these values. A "modern-day" customer is a person who understands how food is produced and supports "good businesses" in terms of human rights, equity, equality and fair trade. It is a person who cares about how people are treated and to what extent all people from minority groups are included (people with disabilities and mental illnesses, people from rural communities, and other indigenous groups) in the food production processes. Consequently, companies need to shift their paradigm from "People vs. Profit" to "People and Profit," i.e. to become more customer-focused than product-focused to thrive in the market.

This shift to shared values and People and Profit is seen today in the drive towards an Environment, Social and Governance framework for companies, commonly referred to as ESG. This is a is a framework which is designed to be embedded into an organisation's strategy that considers the needs and ways in which to generate value for all of organisational stakeholders (such as employees, customers and suppliers and financiers)[100].

[99] https://www.icf.com/insights/engagement/creating-shared-value
[100] https://en.wikipedia.org/wiki/Environmental,_social,_and_corporate_governance

A shift from only a “people vs. profit” business to a people-oriented type and the embrace of an ESG demanded a change in the technologies used. As a result, soft technologies (the evolution of the business models[101]) proliferated and the amount and quality of IT platforms and mobile apps increased rapidly. Digital channels of communication and data processing technologies allow customized communication, tracking and reacting to each piece of feedback. People-driven is a principle that is facilitated by a set of tools and technologies with the extensive use of data[102].

How is the shift towards a value driven approach incorporated into business

- Analyse and measure all companies using Environmental, Social, and Governance (ESG) metrics
- Make known and advertise "food sharing" among the public by making individuals and businesses (utilizing mobile apps) identify products that are unused and can be donated
- Support marketing programs to increase populations’ awareness of local farms and their products
- Create consumer participation platforms to engage customers in the product design process (makes the customers feel like they are involved in making the product);
- Utilise blockchain technologies and traceable logistics to verify product quality and maintain company reputation.
- Implement waste restrictions on machines (waste conversion, alternative energies).

[101] https://smallbusiness.chron.com/evolution-business-models-77617.html
[102] https://www.oracle.com/za/big-data/what-is-big-data/

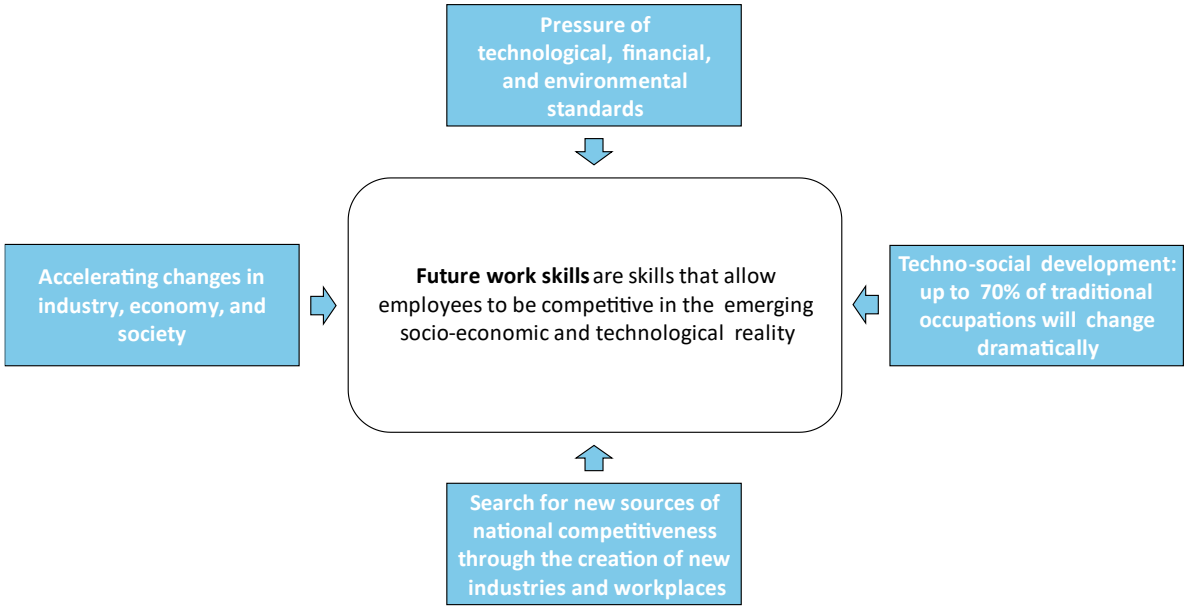
Vision of the Future

The Food and Beverage Sector of the future is a socially responsible sector and will be driven by the increasing power of consumers. These consumers are socially aware and health and wellness considerations are a key part of their life. They will therefore demand information about the provenance of the food they are consuming. As consumer power increases product research and development will become more important to maintain and grow market share. The sector will be continually educating consumers in entertaining and effective ways to assist with informed decision making, utilising technology as an enabler. The focus on education and skills will also be extended to employees (current and future) and suppliers and will incorporate hard and soft skills.

Whilst technology such as automation and robotics will probably impact employment numbers this will be done in a socially responsible way with upskilling, reskilling, and career guidance initiatives as well as provision of support for affected employees. The positive impact of technology will be that consumers will benefit from reduced prices driven by greater efficiencies. Other technologies such as big data and data analytics will facilitate improved offerings to consumers.

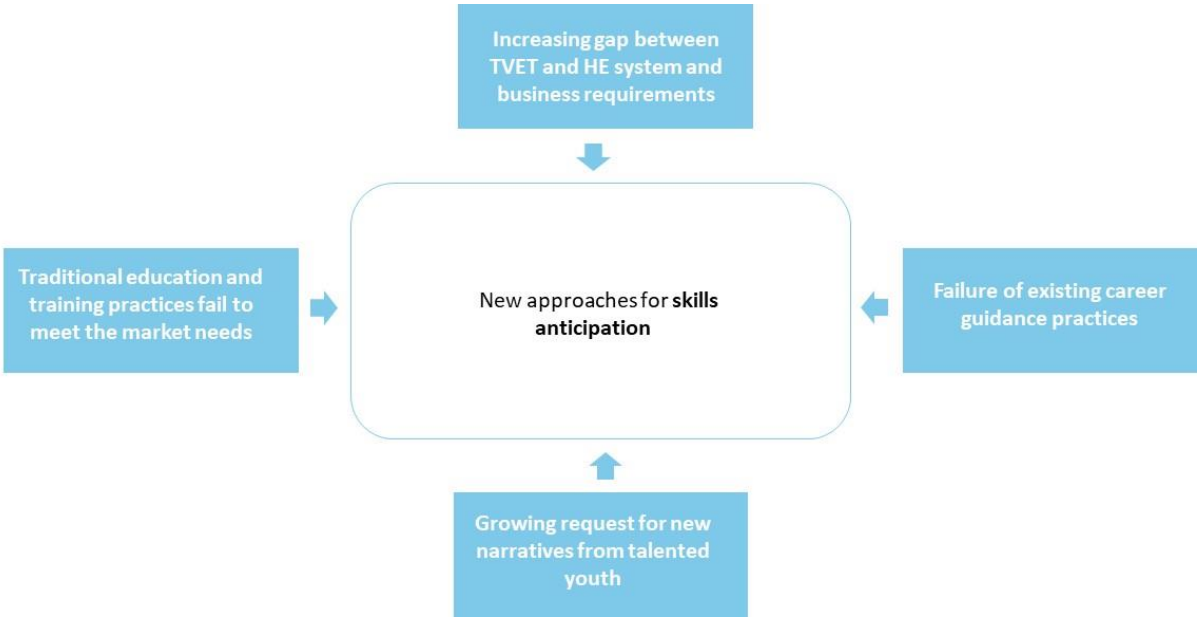
In this socially responsible sector sustainability will be influenced by climate change and environmental concerns. Food, water, power and waste management will grow in importance and will encourage the development of new products and business in the circular economy. No industry can be socially responsible without good governance and new technologies will contribute to managing the sector thereby supporting this need.

In this future vision of the industry, the search for the new sources of competitiveness inevitably raises the question of the skills that are required to navigate the business environment.



Skills technology foresight guide, ILO, 2016

Similarly, the approach to the education and training approaches as well the anticipation for new skills needs to be reconsidered. The pressures are shown in the graphic below.



Skills technology foresight guide, ILO, 2016

New, transforming, and at-risk professions in the food industry

New technologies will require trained professionals who understand the entire value chain of the food manufacturing industry and current technological advancements.

As operations became more automated and digitalized, the critical focus area of personnel will be on analysing data. Elementary workers would need to transition to technical and digital work.

Participants in the Foresight Workshops created a vision of the future and then developed, through dialogue and the sharing of ideas, a forecast of emerging and transforming jobs and professions. In this process the potential jobs that would be lost or become obsolete were also identified, and as mitigation the potential large scale employment opportunities across the value chain were also identified.

The following sections identify possible new professions, transforming professions, professions at risk and large-scale opportunities.

New professions

Hard Skills Guide

Soft Skills Guide

Job Title	Description	Hard Skills	Soft skills
Environmental practitioner	Assesses, improves, and gives advice to companies on environmental strategies. Measures the carbon footprint being left by logistics and processes in the FoodBev Manufacturing industry and advises efficient practices that will reduce impact and contribute to a circular economy	Environmental engineering, geography, meteorology	Negotiation, teamwork, multicultural

Energy Catcher	A professional who advises on how to capture and use the energy from alternative sources (solar, wind, hydro, kinetic, etc.) effectively	Mechanical and Electrical engineering	Lean manufacturing, strategic, analytical, and system thinking

Water Manager	A specialist that looks for ways to use water efficiently (involves research, development, and recycling)	Engineering science, physics, chemistry, ecology.	Lean manufacturing, strategic and system thinking

Digital Twin Ecosystem architect	An IT professional who creates a digital twin for food processing and manufacturing facilities	IT, engineering, design	System thinking, cross-disciplinary thinking, project-management

Digital Twin Ecosystem manager	A specialist whose responsibility is to manage the digital twin of food plant to optimize the production process	Software design, AutoCAD 3D, digital twin operation, management in food manufacturing	System thinking and process thinking Critical thinking and cross-disciplinary thinking

Sustainable packaging technologist	A professional who creates ecology-friendly packaging materials, mostly based on organic substances	Biology, chemistry, ecology, food logistics, environmental science	Project-management, teamwork, cross-disciplinary thinking, analytical thinking

Supply safety consultant	A professional who helps food and beverage manufacturing companies source raw materials that allow for safe and high-quality products	Microbiology, biochemistry, food safety, risk management	Communication, analytical thinking, critical thinking

Circular economy designer	Elaborates a strategy for full production cycle management, helps managers to implement it, and provides consulting support.	Engineering, recycling technologies	System thinking, communication, lean manufacturing, project-management, teamwork

Food manufacturing cybersecurity specialist	Evaluates cybersecurity risks concerning the safety of production of food products and leakage of information about patented technologies, new product development as well as data breaches around consumers and customers	IT, cybersecurity, knowledge of manufacturing processes, risk management	System thinking, critical thinking Communication, project management, team work

Food logistics specialist	A professional who optimizes food logistics in terms of timing, quality control, supply transparency, and environmental impact. Finds new ways to build supply chains in a sustainable way	Logistics, data science, new technologies in transportation, understanding of geographical features and specifics of food storage in specific climatic conditions	System thinking, critical thinking, communication, teamwork

Food waste recycling specialist	A professional who comes up with how to extract useful organic compounds from food waste that are suitable for reuse	Biochemistry, food production technology, recycling technologies	Lean manufacturing, analytical thinking, system thinking, teamwork

Blockchain Platform Architect for the food and beverage manufacturing industry	A specialist who creates blockchain platforms under the requests of the food and beverages industry to make the processes of creating and logistics of food and beverage products more transparent for consumers. And also to prove their high quality	Software design, blockchain, understanding how local supply chains work	System thinking, cross-disciplinary thinking, project-management

System modernization engineer	A specialist who consults the FoodBev Manufacturing companies about available new technologies that will help improve work processes in factories and offices and helps to implement necessary equipment and technologies	Engineering, mechanics, robotics, software expertise	Novelty seeking, creativity, communication, lean manufacturing, system thinking

Robotic systems designer	An IT specialist who designs industrial robots and cyber-physical systems for food and beverage plants and warehouses to optimize the process of production and logistics	Engineering, mechanics, robotics, physics, chemistry, hardware design, software expertise, logistics	System thinking, cross-disciplinary thinking, lean manufacturing, project-management

Climate change data analyst	A professional, who compiles, analyzes and clarifies data regarding environmental management and climate change that could influence the FoodBev Manufacturing industry. Improves decision-making, including 3D and geospatial visualization, simulation models, system dynamics, and computer-assisted tools for collecting data from different sources, including global data	Ecology, geography, digital modeling, data science	Decision-making, analytical thinking

Environmental evangelist	A professional who promotes ecological responsibility on behalf of the FoodBev Manufacturing companies and encourages collaboration between the different stakeholders (including the government) Analyzes existing climate or environmental management legislation, regulations, policies, and practices to determine actual and potential environmental impacts. Communicates research findings to legislators, regulatory agencies, or other stakeholders and recommends new or adapted social and business initiatives, laws, and policies.	Ecology, law, local specifics of FoodBev manufacturing business	Communication, negotiation, leadership, analytical thinking, understanding regulations and policies

Carbon cost accounting manager	A professional who develops cost standards for materials and labour, etc., designs and implements cost accounting systems, analyzes production costs and recommends changes, and oversees annual physical inventory with a focus on the carbon footprint measurement and reduction.	Economics, Accounting, Maths, Coaching, IT	Analytical thinking, critical thinking, lean manufacturing

Food Supply sustainability analyst	A professional who analyses data to determine which crops and cattle breeds are most suitable for different areas based on climate and soil conditions using artificial intelligence (AI). Conducts research to improve crop production and breeding methods and develop new varieties and creates plans for farming operations. Analyses movement of fish using AI to optimise catching activities.	IT, Agriculture, Ecology	Lean production, system thinking, critical thinking, cross-disciplinary thinking

Food biochemist	Plans and conducts complex projects in basic and applied research of organic substances used for food and beverage preparation, manages laboratory teams and monitors the quality of their work, and presents new solutions and products to food technologists and management.	Biology, Biochemistry, food technology, safety, management	Project-management, critical thinking, cross-disciplinary thinking, teamwork

AI Systems Risk Analyst	Conducts risk assessments, collecting and analying documentation, statistics, reports, and market trends using AI. Recommends and implements risk management solutions such as insurance, safety, and security policies. Reviews and analyzes various metrics and employee activity that could uncover fraudulent behavior.	Risk Management, IT, data science, security, documentation in FoodBev Manufacturing	Analytical thinking, system thinking, communication

ESG Specialist	Develops ESG strategies across the organisation to encompass environmental, social and corporate governance elements with specific measurables in all facets of the business. Develops reporting standards and requirements, gathers data and monitors implementation of strategies	Environmental science, accounting, engineering, IT systems	Negotiation, systems thinking, communication,

Transforming professions

Transforming job title	What is changing and why?	New skills needed
Operator + Artisan >> Equipment Operational specialist	Automation is efficient and economically reasonable because it helps reduce production costs. An artisan has no need to do manual labour but has to learn how to work with robots and digital systems	Artisan gets upskilled with digital capability skills

Food scientist +Nutritionist >> Bio-nutritionist	A better understanding of consumer needs, improved technology skills, a better understanding of nutrition and use of biotechnology in food production	Biotechnical knowledge, Data Analysis, nanotech

Marketing manager >> Customer insight manager	Businesses need to become more aware of customers and their needs and develop a better understanding of customer behavior and analyse the trends to be able to provide insights into R&D, production, logistics and marketing activities	Empathy, Emotional IQ, data analytics

E-commerce designer >> Integration software engineer	Systemic integration of multiple parties is required to develop effective digital platforms for e-commerce and improved customer experiences	Multiple software technologies

Farmworker >> farm technician	Farms have become more automated, which provides possibilities to make production much more effective, but it requires increasing IT skills.	Computer skills, digital skills, analytics. Using apps and software, data interpretation, decision making

Logistics planner >> personalized logistician	Personalisation of food preferences for consumers	Knowledge of diverse food, knowing the local community, road safety skills, communication, drone operating skills

R&D manager >> R&D specialist	Additional requirements because of new technologies, consumers' demand and the drive towards sustainable behaviour	Additional technical skills, biotechnology, nano technology

Professions at risk

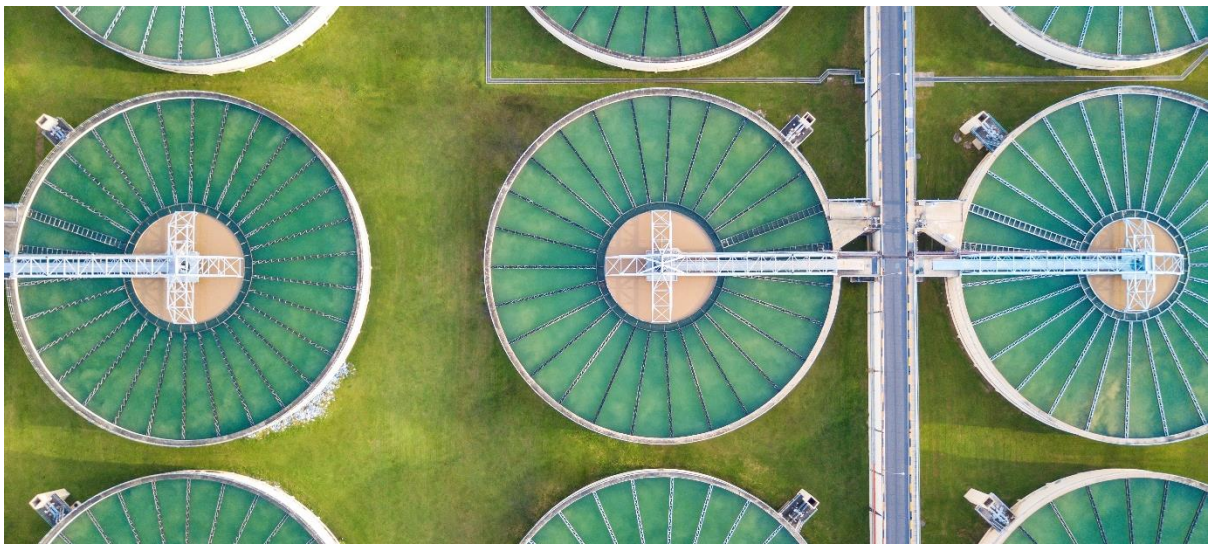
Job title	**The rationale behind the decrease**
Operations Supervisor	Optimization of the workflow and automation
Learning and Development (L&D) Facilitators	Online Learning Management Systems, technologies replacing facilitators
Warehouse Pickers	Automation
Stock-takers	Digital analytical systems monitoring stock and predicting stock levels
Production Planner/buyer	Digital analytical systems will help in procurement planning, so the number of staff members can be reduced.
Couriers	Drones and self-driving cars
Maintenance staff	Self-correcting technology and self-repairing materials
Supply chain professionals	Replacing mediators utilising Uber-like platforms

Professions that can create employment in the Food and Beverage value chain.

Workshop participants were asked to consider jobs and professions that can be used to replace potentially obsolete jobs and to give special consideration to those can create large numbers of jobs.

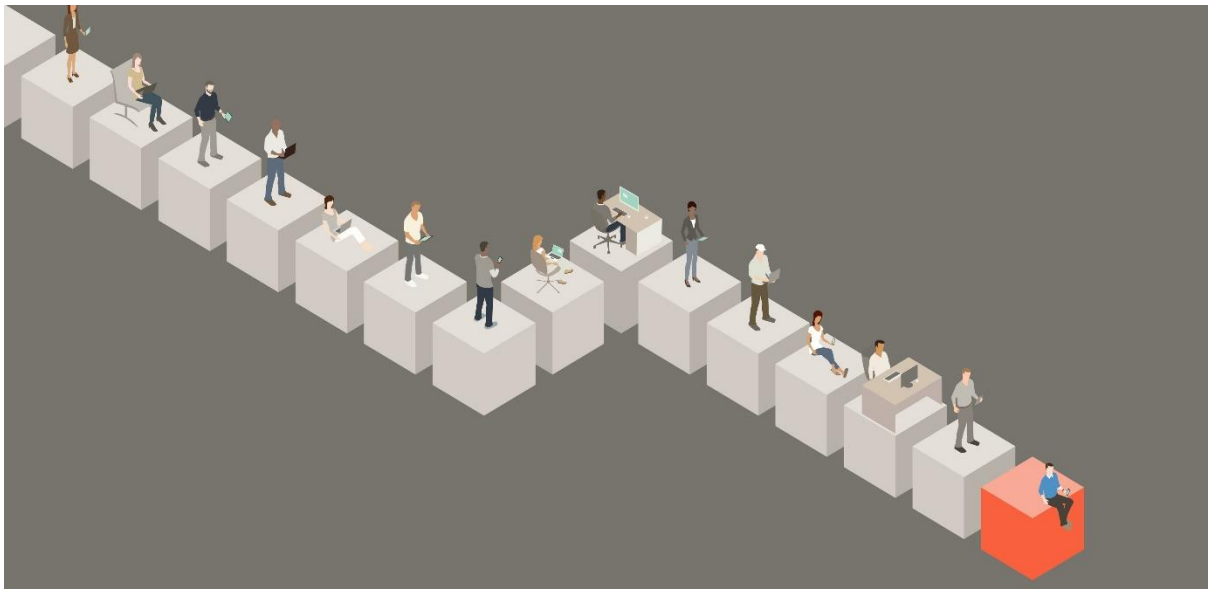
The resulting list is detailed below:

Sector	Job Title	Description	Skills required
Water and infrastructure	Plumbers	Management of scarce water resources and contributing to water savings	Artisan qualifications, customer service, problem solving
	Water saving / water agents	Identifying and reporting water issues and fixing basic plumbing issues without requiring formal plumbing qualifications	Technical plumbing skills, customer service, problem solving, communication
	Pothole repairers	Identifying, reporting and repairing potholes to relevant authority standards	Technical road building skills, communication
	Construction and building assistants	Construction and building specialist to support with the Governmental infrastructure recovery plan	Technical construction skills from entry level to artisan



Sector	Job Title	Description	Skills required
Agriculture	Farming assistants	Assist farmers in traditional and new farming methods Setting up and managing community small holdings	Agriculture technical skills
	Fish farming	Farming and processing of fish products as part of supply chain	Agriculture technical skills, specialist fish farming, environment sciences, engineering
Waste management/ circular economy	Recyclers	Ensuring no recyclable materials end in land fills	
	Food waste management specialists	Ensuring food waste is recycled and turned into other food or nutraceutical products	Problem solving, food sciences, chef
	Recycling vendors	Entrepreneurs that leverage the circular economy to purchase waste from 1 production system and sell to another	Procurement, sales and negotiation, administrative

Sector	Job Title	Description	Skills required
Digital and data management	Data analysts	Analyzing data collected from numerous data sets to contribute to improved decision making	Data science, digital, analytical thinking, statistics
	Data storage specialists	Specialists in data storage ensuring most efficient use of space, data security and compliant removal of data from systems	Cybersecurity, database management, technical IT skills, problem solving
	Blockchain entrepreneurs	Selling and implementing blockchain solutions for start-up businesses and SMMES	Blockchain, digital, analytical, sales
	Data capturers	Capture existing manual data to digitize records in businesses and government	Administration, digital skills
	Digital data administrators	Managing data on behalf of SMMES, businesses and startups, performing data validations	Digital, administrative, accuracy
Food production	Artificial food chefs	Creating food products from artificial foods as part of new product development	Chef, food science, analytical thinking



Education for new professionals

In todays' environment the skills requirements in the food and beverage manufacturing industry in South Africa marks the transition from an operator to a technician or a technically competent professional.

The new professional is expected to possess a wide range of abilities, including leadership and technical competencies (for example in ICT) to perform comprehensive and intricate data analysis and communicate at various levels of industry.

However, business reports that the skills gap being faced are increasing. Solving this requires collaborative initiatives by employers from the sector, educational institutions, as well as labour to effectively address the challenges of the industry.

Requirements in the Industry

Artisans

There is an increasing need for skilled artisan professionals. As workers are expected to handle more difficult jobs that require higher-order cognitive abilities (including creativity, critical thinking, teamwork, problem-solving, decision-making) lifelong learning, will become increasingly important[103], [104]. In addition, technical skills, especially at entry level occupations levels, such as food safety and cleanliness, are among the critical skills predicted to be required for many years after the pandemic period. Whilst the FoodBev Manufacturing SETA supports a number of artisan training programmes, changes could be beneficial. Firstly, the number of training institutions could be increased, for example there is only one centre for butter makers but numerous agricultural training institutions have closed down. Secondly, the training programs need to adapt to meet the current and, perhaps more importantly, future needs of the industry. An example is that electricians would need to be upskilled to meet the requirements for on-site renewable energy installations, and be able to accommodate new technology such as smart meters, internet-of-things etc.

[103] https://www.mckinsey.com/about-us/new-at-mckinsey-blog/our-top-10-insights-of-2017
[104] https://www.mdpi.com/2304-8158/9/4/492

Digital Skills

The need for digital skills is also increasing. As technology changes and the adoption of new technologies increase, workplaces evolve, and some roles become redundant due to automation or other breakthroughs like artificial intelligence that can perform routine jobs. Drones and bots are being used to monitor manufacturing sites, lessening the demand for manual labour. Such increased use of automated procedures will result in job losses. This pattern will last through 2035 and beyond.

The Situation in the Industry

The South African business sector contributes to Skills Development via payment of Skills Development Levies and Broad Based Black Economic Empowerment (BBBEEE) scorecard. This improves advancement opportunities for employees. Skilling and upskilling employees will contribute to people morale and to BBBEE scorecards.

Generational skills gaps exist in many businesses where older employees are skills in operations and have institutional knowledge, whilst newer and younger employees may have theoretical knowledge but may lack practical experience. Industry can address this by conducting on the job training for all employees that covers hard and soft skills. This on-the-job training can enable quick transition from education to industry. With the shortage of opportunities for work experience in South Africa the education sector could consider new technologies that create real life simulations.

Companies are often eager to contribute to TVET and Higher Education curricula as a means of reducing skills gaps and this trend could further enabled and supported as it will result in graduates that have a greater chance of employment.

The role of the SETA is important in addressing the historic inequality issues. South African laws provide opportunities for individuals who were previously discriminated (such as females, people with disabilities etc.) to become a potential new source of talented employees. Greater inclusion can increase idea generation[105] and give job seekers more opportunities.

It is important to note that business is paying greater attention to gender inclusion in the workplace. Gender balance can be improved in the industry with the current and potentially greater focus from the SETA's.

Businesses face increasing challenges in their work and will most likely prioritise digital transformation and communication development. The industry needs facilitation systems to be both agile and multiagent. Use of digital twins of the most complicated processing and production steps, developing transparent operations and agent interactions will increase. Digital interfaces between various levels and stages of the value creation chain will be required.

[105] https://www.forbes.com/sites/biancamillercole/2020/09/15/8-reasons-why-diversity-and-inclusion-are-essential-to-business-success/

Implications for policy and practice

There is a need for the public and private sectors to work on the issues of continuing skills gaps in South Africa. Some possible solutions are (1) the government could make it mandatory for new training institutions to include cutting-edge technology for example using Virtual Reality/Augmented Reality/online to create new courses and to update learning management systems and learning materials, (2) utilisation of modern training techniques, such as Virtual Reality/Augmented Reality /mobile learning, smart learning, and simulations for work experience could have a substantial impact on South Africa's ability to educate at scale, (3) industry professionals could begin teaching students part-time in universities and colleges, which will allow the students to get the latest skills used in the industry.

Several new skills could be considered for the FoodBev Manufacturing SETA programs for all (or most) new specialisations. These are cybersecurity, big data, insights-to-action[106], cloud computing and coding, machine learning (ML), consumer knowledge, media, e-platforms knowledge, maintenance and robotics, and Artificial Intelligence (AI). Soft skills are also believed to be important for new specialisations in the FoodBev Manufacturing Industry. These are critical thinking, troubleshooting, problem-solving, system thinking, learning agility global citizen mindset, and leadership.

Education programs that are oriented on the full production cycle are expected to be developed as future specialists need to understand or be responsible for the full production chain. As production becomes more automated procedures would be under the control of such specialists working with the whole process.

The FoodBev Manufacturing SETA could offer career guidance activities — communicating with school students, telling stories about industry careers on TV and in influencers' blogs, and promoting the industry's sector and future. It is also important for the industry to promote artisanal work and improve the public perception of vocational skills.

[106] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/human-capital/us-insights-to-action-journey-2021.pdf

The Food and Beverage Manufacturing Seta could support and leverage community centres to impart knowledge on how communities can participate in sector value chains and facilitate support. These centres could also be leveraged to run future skills training and business incubation programmes

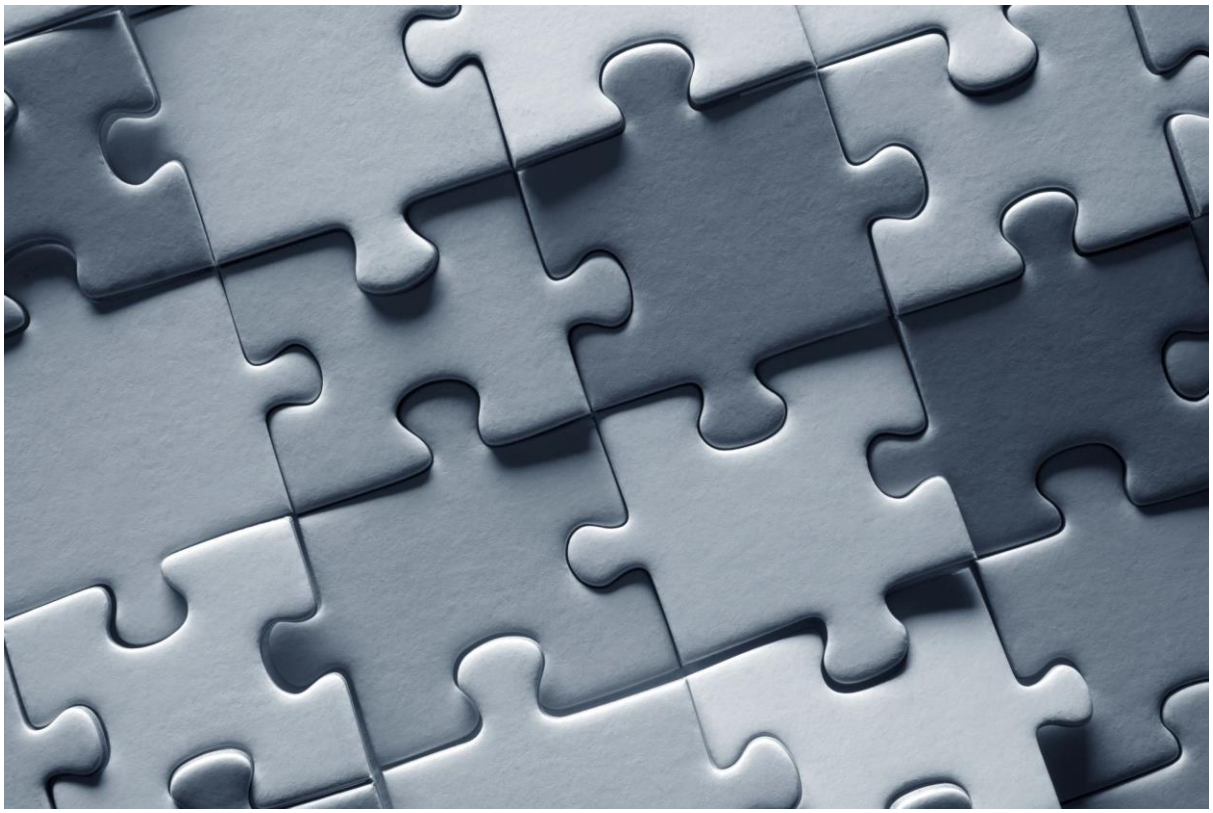
Programmes to upskill and reskill employees into new and emerging jobs could be implemented by the Seta. Additionally implementation of career guidance programmes is essential in encouraging young people to consider future jobs when deciding on career pathways and to assist them in gaining skills that will enable them to thrive in the new world of work. Platforms such as http://yakhifuture.org.za and http://bricsfutureskills.co.za provide examples of how this can be achieved.

Most importantly communication between the education sector and industry must enable rapid responses to changing environments and transforming business needs

Conclusion and Summary

All five sub sectors were represented to various degrees across the two workshops in Johannesburg and Cape Town.

The section below summarises the vigorous discussions that were held between participants and identifies possible futures that could be faced due to the current industry pressures and drivers.



Manufacture of Dairy

There is a trend of growing automation and digitalisation at dairy farms and factories — from robotic milking systems and biofeedback for cows to machine learning systems helping workers to make optimal decisions. For example, at an American cheese manufacturer, machine learning correlation models were trained with six months of historical data on 29 different processing variables, including the amount of starter culture, mixing times, and raw milk composition, to classify impacts on the final moisture content[107].

Climate change makes it harder for dairy cows to produce quality milk because heat stress influences their heart rate, metabolism, and fertility[108].

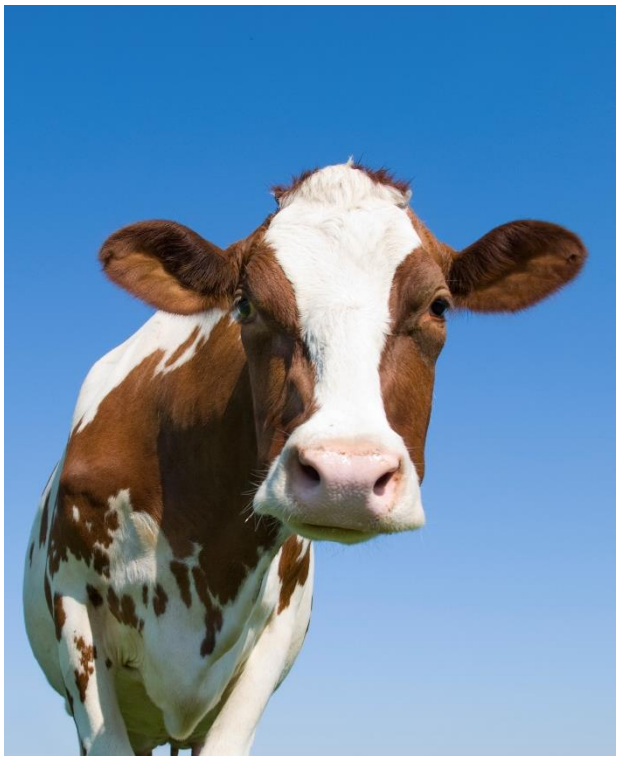
Cows also drink more, eat less, and become more susceptible to disease. So farmers need to implement new practices to keep the cows comfortable, like changing the diet (it's recommended to choose cooler hours of the day for feeding and using a high-fat diet), equipping buildings with good ventilation, and planting trees for shade. Farming equipment could also be heat-proofed. So farmers need to know how heat stress influences the cow's health, be able to implement new practices and technologies (like biofeedback wearable devices for cattle, micro-climate trackers, new ventilation systems etc.), and understand how to upgrade farms due to the new requirements. For this, they could develop system and cross-disciplinary thinking, considering a farm as a complex system where climatic, biological, technological, and other factors interact.

Dairy farms in West Africa are some of the most prominent examples of poor dairy cow health caused by climate change, as the number of days of severe heat is expected to grow significantly. As a result, West Africa's milk production could decrease by around 50-100 gallons every year by the second half of the century[109]. One of the possible solutions is smarter breeding. For example, in Kenya, a breed that could better tolerate warmer temperatures was created, and also researchers found a special

107 https://www.ift.org/news-and-publications/food-technology-magazine/issues/2021/july/columns/processing-food-processing-industry
108 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7067922/
109 https://farmersreviewafrica.com/the-dairy-industry-at-risk-from-rising-temperatures/

gene in the DNA of cattle that can make them disease tolerant.[110] So potentially, it is possible to edit this gene to make cows less susceptible.

A rapidly growing trend is the move from traditional to alternative "dairy" products (like soy or oat milk), so marketing specialists have to work harder on the advertisement and look for new markets in the countries where their population tends to consume more traditional milk. Concurrent with this in the twenty-first century will be a lab-created dairy. The California-based startup Perfect Day Inc. has already developed a special genetically modified microflora that could produce the proteins found in cow's milk[111].



Like in the food and beverages industry in general, dairy customers want to be sure that products are safe for the environment and human health and are made in ethical labour conditions. The manufacturing process could become more transparent, and verification by blockchain technology is one of the possible solutions, as customer participation platforms, where consumers can feel like they are involved somehow in making the product. It is also important to inform customers about small local farms making high-quality dairy products, so it will be reasonable to create an e-commerce platform where such products can be bought.

110 https://www.ilri.org/news/genetics-breakthrough-disease-resistant-native-east-african-cattle-breed%E2%80%94-economist

111 https://perfectday.com/animal-free-milk-protein/

Manufacture of Beverages

One of the main issues facing the alcoholic beverage industry in South Africa is one of individual over consumption. According to the survey conducted by researchers from Boston University School of Public Health and a few South African universities in 2018, 53% of the sample (713 adults) were heavy drinkers[112].

Studies have shown a wide range of problems associated with drinking. Chronic alcohol abuse can result in cirrhosis of the liver and other organs getting damaged. According to the World Health Organisation (WHO), South Africa tops the list of drunk-driving related deaths in the world. And, according to the latest Global Status report on Road Safety for 2015, 58% of deaths are alcohol related[113]. Excessive alcohol consumption also raises the risk of committing crimes and engaging in unsafe sexual practices, leading to the spread of STD's. South Africa also has one of the world's highest rates of foetal alcohol spectrum disorder[114].

As business is moving towards social responsibility, profit need not be prioritised over the wellbeing of the population and balanced strategies would need to be developed.

Conscious strategies of sales and marketing in this respect can also increase customer loyalty.

To solve this problem, beverage producers could collaborate with the government to find a mind-changing approach. Banning alcohol is an ineffective strategy, so that messaging needs to aim at the cultural values and habits, like promoting role models of responsible drinking and using IT technologies. Gamification apps and wearable gadgets are seen to be the new frontier to help citizens control addictions including alcohol consumption[115].

[112] https://substanceabusepolicy.biomedcentral.com/articles/10.1186/s13011-018-0182-1
[113] https://www.news24.com/life/motoring/news/guides_and_lists/watch-had-too-many-drinks-heres-what-its-like-to-drive-under-the-influence-20181220
[114] https://health-policy-systems.biomedcentral.com/articles/10.1186/s12961-019-0447-9
[115] https://medicalfuturist.com/alcohol-smoking-drugs-can-digital-health-technologies-give-a-helping-hand-to-the-addicted/

As driving accidents involving drunk people become problematic, a possible solution would be to promote drinking at home. For example, there are apps that keeps track of the user's stock of alcohol. When the stock is running low, it helps to order the preferred beverage, so there's no need to go out. It means that beverage companies could hire specialists who have skills of social advertising, content-making, gamification, and app development.

Considering the environmental impact and water crisis in South Africa, the beverage industry would need to focus on the economic use of water. There are some inspirational examples of conscious water management in the South Africa, an example being the Heineken Sedibeng brewery's commitment to limiting its environmental footprint. Water recovery technology is being used there — it includes filtration, UF filtration, reverse osmosis, and disinfection. With the new water recovery plant, each month, up to 45.000 m^3 potable water (the equivalent of 18 Olympic swimming pools)[116] can be retrieved from the brewery wastewater. It means that ecological thinking and the knowledge of emerging lean manufacturing technologies is crucial for workers at beverage plants.

[116] https://www.waterleau.com/en/cases/sustainable-beer-production-in-south-africa

Manufacture of Food Preparation Products, Breakfast Cereals and Food Processing

The disruption in global markets during the response to the Covid epidemic emphasised the need to be locally stable in production to meet the population requirements. Producers need to meet these changing demands, and production speed and agility can be improved by implementing new manufacturing and management technologies. South Africa's failing infrastructure has a detrimental effect on the supply chains which makes it difficult to manage businesses optimally and successfully. In this scenario it becomes feasible and reasonable to invest in alternative logistic solutions.

Growing consumer awareness and the increased interest in healthy living is driving change in the industry and new safety technologies, like AI-based models checking potential risks, could be implemented. For example, Remark Holdings, a global technology company, developed a face- and object-recognition technology to track operator actions[117] thereby preventing operator errors thereby improving safety levels. Computers also help to detect pesticides, microbes, toxins, and allergens in the manufacturing environments[118].

The gig economy (the economy of part-time work or free earnings) has seen rapid development in recent time, making it profitable for companies to hire employees for single projects thereby rationalising the workforce and only pay for specific outputs. Similarly, workers can be involved in several projects at once, with different employees, increasing their earnings potential.

The rise of such an economy brings flexibility to traditional working ways.

It allows certain employees within the food production and processing industries to work from any desired location, which can lead to increased efficiency[119]. However, a great amount of traditional supervision and onsite work in the production and processing environment cannot easily be phased out or performed remotely. Plant operators, for example, do need to be physically present but R&D could be done remotely.

117 https://www.prnewswire.com/news-releases/remark-ai-finishes-in-top-5-in-recent-nist-computer-vision-test-301343181.html

118 https://onlinelibrary.wiley.com/doi/10.1002/adma.201806739

119 https://www.forbes.com/sites/glebtsipursky/2022/11/03/workers-are-less-productive-working-remotely-at-least-thats-what-their-bosses-think/?sh=42947db4286a

A key way to increase the speed and agility of food production and preparation to meet demand, and also contribute to affordability for consumers, is to create a digitally connected, accessible supply chain ecosystem. This has the potential to develop a farm to fork capability, minimising wastage. Rapidly creating skilled operators for a changing environment could start directly from the training facilities where the curriculum could adapt quicker with greater collaboration and feedback from business to training facilities. This could benefit both production and distribution and increase agility. To stay both agile and multiagent, the industry needs new coordination mechanisms — the digital interface between different levels and stages of the value creation chain, transparency of operations, and interactions between the various agents in the ecosystem. Cooperative and useful technology sharing could become key as all actors can benefit from the industry's development and improvement.

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