Not many people associate a glass of milk with advanced technology, but in reality there is an extraordinary amount of cutting-edge technology at play to get that glass from the farm to our tables.

For example, UK-based tech company DairyMaster produces MooMonitor, which is a device that connects cows to the internet.

Dairy cows are extremely sensitive creatures, and the slightest illness or excitement can stress them out and adversely affect their milk yield, requiring farmers to monitor them 24 hours a day. This is fine when you have a handful of cows, but how do you monitor hundreds of cows simultaneously?

This is where the **MooMonitor** device implant comes in. It is a tiny implant that constantly monitors each cow, keeping a close watch on its health, movements and stress levels. It uploads vital health data to a server with specialised artificial intelligence software that looks for irregularities in the cow's health and behaviour. The instant it detects something amiss, like an irregular heart rate or a cow moving sluggishly, it alerts the farmer and pinpoints the cow's exact location. The implant also tracks the amount of milk each cow produces over its lifespan, because a slight drop could point to a health issue.

MooMonitor is just one example of what is known the "internet of things", commonly abbreviated as IoT, which is a phenomenon where things besides computers and smartphones are connected to the internet.

Machinery, furniture, clothing, vehicles, kitchen appliances – and now cows – are now connected.

Computer chip manufacturer Intel describes IoT as "a robust network of devices, all embedded with electronics, software, and sensors that enable them to exchange and

analyse data".

In other words, these devices are able to talk to one another and exchange valuable data which is then used to make real-world decisions.

An example of IoT is the "smart home", which will be able to adjust itself for your optimum comfort. As you drive home after work, your cellphone will determine your mood by analysing a number of things like your calendar, your heart rate and even the way you drive. It will then communicate this data to your smart home, which will use this and other data to prepare itself for you.

Let's say it has been a warm day and you've had a rough day at the office. You are totally exhausted and somewhat stressed. Your smart home will kick into action: your air-conditioning system will adjust itself to an optimum temperature, your home entertainment system will play a soothing track and your espresso machine will mix you a delicious "pick-me-up".

At your front door an artificially intelligent facial-recognition camera system will recognise you and disable the home security system and unlock it.

The concept may be a vision of the future, but there are aspects of it that are already in existence, and have been for some time. For example, most security and camera systems allow us to monitor our properties from anywhere in the world with nothing more than a smartphone with a browser. These are IoT devices.

IoT has been around for nearly two decades and has gained incredible momentum in the past few years, thanks to smaller, more powerful computers and faster internet.

But despite its phenomenal growth and huge impact, IoT it is still considered an "emerging" technology whose full potential we are far from tapping. IoT is big, and getting bigger.

And it has some incredible economic ramifications. The International Data Corporation predicts a total worldwide spend on IoT of $772.5 billion (R11.3 trillion) this year alone, and expects a sustained worldwide spending growth rate of 14% until total spending peaks at $1 trillion by 2021. This is huge by any standards.

But not only that, IoT is also a major driver of the Fourth Industrial Revolution. IoT, and by extension the Fourth Industrial Revolution, presents tremendous potential for economic growth.

The question is, will South Africa position itself to tap this potential? Will we ride the wave of the Fourth Industrial Revolution, or as in the previous industrial revolution, will we largely miss out?

No one really knows the answers, but there are certain indicators. We can start with a few questions like: do our schools teach kids computer science skills? Do our kids learn about coding, robotics and IoT?

Do our universities produce software developers and engineers who are ready for the Fourth Industrial Revolution? Are our graduates ready to compete in a global arena? Is there a thriving start-up community focused on IoT?

If our answers are in the negative, then we are in serious trouble

What are the five technologies that are going to fundamentally reshape business and society in the next five years?

Some of IBM's leading researchers shared their thoughts on this at IBM's annual Think conference, which was held in San Francisco this month.

A key part of the annual Think conferences is IBM's "5 in 5" technology predictions, where the tech giant showcases some of the biggest breakthroughs coming out of their research facilities around the world, presented by the people working at those research centres.

This year's predictions are all related to challenges presented by the world's ever-growing population, with the global population expected to cross the 8 billion mark within five years.

According to Arvind Krishna, IBM's senior vice-president for cloud and cognitive software, "to meet the demands of this crowded future, IBM researchers are exploring new technologies and devices, scientific breakthroughs and new ways of thinking about food safety and security".

He sums up these new innovations as going "from seed to harvest to shelf, table and recycling."

The breakthrough technologies include an artificial intelligence system that will help small farmers around the world to optimise farmland usage, thereby increasing production.

Internet of Things devices will prevent food waste, while big data systems will protect us from bad bacteria. Sensors will enable us to detect bacteria in food using our cellphones and new plastic recycling technology will save the oceans.

Kenyan computer scientist Juliet Mutahi, the daughter of a coffee plantation owner, said one of the challenges faced by small co-operative farmers like her father was that they lacked the scientific and technological resources to acquire vital data about their farms that would enable them to make informed decisions about how to use their land optimally.

A start-up called Hello Tractor is fixing this by developing a device fitted with a number of sensors that constantly gather important data about the farm.

The device is mounted on tractors and as the farmers go about their normal day-to-day activities, the sensors gather information on the weather, dimensions and elevation of the farm, then uploads the data to a blockchain.

A separate device is used to get information about the soil and the water table. The farmer simply takes soil samples and places them onto the device, which is about the size of a business card.

The device tests the soil sample and submits the data to the blockchain alongside the data from the tractors. The two are combined to produce a "digital twin" of the farm, which is basically a digital representation.

Data from thousands of farms around the world can be gathered in this way, and the collective data is then processed by artificial intelligence software to make recommendations on optimal land usage.

The system is also able to make accurate predictions on future crop yields based on the region, land size, elevation, soil health and other data.

Optimal farmland usage might raise food production, but how much of this food will end up on tables around the world?

Sriram Raghavan, vice-president of IBM Research in India, said almost half of all the fruit and vegetables produced in the world was wasted because of inefficient and chaotic distribution systems.

The result was that too much food was delivered to some areas while others were left out. The excess food was not consumed by anyone and so went bad, leading to large-scale wastage and millions of dollars in lost revenue.

With timely and accurate data on hand, the excess could have been diverted to areas where it was needed, possibly even to places where there was a food shortage or hunger.

In the next five years, this problem will become a thing of the past. Devices will track the movements of fresh produce along every step in the supply chain from source to table, gathering all kinds of data like temperature, ripening and how close the food is to spoiling.

The data will be stored in the blockchain and processed by AI programmes which will, over time, develop high-level models of the movement of food through the supply chain.

These models will then be used to make more accurate and effective recommendations for food produce logistics, minimising over-supply and wastage.

Between these two breakthroughs, there is hope that the world's food supply problems can be solved. Although it is still too soon to tell, there is even a possibility that such technologies could provide the solution for world hunger.

We are living in some of the most exciting times in history.

Not only are we seeing science and technology advancing in unprecedented ways, but it is possible that, in the near future, we are also going to see many of the problems that have plagued us for centuries, such as food-borne diseases, world hunger and pollution, completely disappear off the face of the Earth.

At this year's IBM Think conference, researchers from the tech giant's research facilities around the world described five technologies they are working on which they predict are going to radically transform our world in the next five years, bringing us a step closer to what we might have once considered to be a science-fiction future.

Among the technologies they described are an artificial intelligence (AI) system that will help small farmers around the world optimise farmland usage, thereby increasing production;

Internet of Things devices that will prevent food waste, big data systems that will protect us from bad bacteria, sensors that will be enable us to detect bacteria in food using our cellphones, and finally, new plastic recycling technology that will save the oceans.

In the previous article in the series I discussed the first two technologies. In this article we will take a closer look at the next two, both of which relate to food-borne diseases.

Big data will protect us from bad bacteria. Every year, around 600 million people, many of them infants, fall ill after consuming spoiled or contaminated food.

Unfortunately, we have no way to prevent this. Lab testing of food is time-consuming, expensive and error-prone, and we typically only do it after a food poisoning incident has occurred. There is no way to test food on the spot.

What we need is a food testing system that is a lot more accurate and effective than current methods, and is so accessible that it can be used by anyone, anywhere.

Incredibly, this is going to become a reality within the next five years, thanks to two independent teams of researchers at IBM.

The first team, headed by Geraud Dubois, has figured out a way to "spy" on the bacteria living in the food, gathering data about them. Using this data, they are able to make extremely accurate predictions about the state of the food. Like our bodies, the food we eat is full of bacteria, some good for us and some dangerous.

Different food types contain different types of bacteria, while a single food item might have different types of bacteria at different stages in its life cycle.

For example, chicken has a set of microbes living on it, while pork has a completely different set. Under normal circumstances, we should not find pork microbes living on chicken, or vice versa. If we do, then that is a strong indication that cross-contamination has occurred.

Similarly, fresh bread might be populated by certain bacteria, while stale bread might host completely different species. These bacteria number in the millions, and there may be tens of thousands of different species on a single food item. The challenge is to identify the different species, know the good from the bad and, very importantly, to understand what the presence of certain bacteria might mean in a food type.

Once we can overcome this challenge, it will be possible to determine if a certain food is good to eat or not.

Geraud and his team have been sequencing the DNA and RNA of microbes on food and, using big data analysis, were able to a create a massive database of all the microbes produced in the world in the last 10 years.

AI will enable home bacteria detection. While it is great having a comprehensive database of microbes, that information will be useless to us unless there is some way to actually detect the types of microbes living on our food. The second team of researchers at IBM is solving this problem by developing sensors that can detect bacteria on food items using nothing more than a cellphone.

The sensors, which will be capable of detecting bacteria as small as 1micron (75 times smaller than the width of a human hair), will scan the food item for bacteria, cross-reference these against the microbe database developed by Geraud's team and provide information within seconds.

Within a few years, the sensors will be small and cheap enough to be present everywhere: in our fridges, on kitchen tops and even on cutting boards, as well as on supermarket shelves and fridges. All we will have to do is hold a sensor up to a food item, and within seconds it will tell us if the food is fresh or not.

Between these two technologies, the world's food industry will be completely transformed.

Not only that, but we will also be able to live much healthier lives because, for the first time in history, we will have the ability to accurately detect if a food item is good for us, or not