

# The Future of the Food Industry

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## The appliance of agricultural science

Businesses are pushing futuristic schemes to help feed the world, says *Scheherazade Daneshkhu*

The cows on the Kimotsuki Daichi farm in Kagoshima on the southern tip of Japan look unremarkable, save for their ankles. Attached to the slender limbs, just above the foot, are bright orange devices. As they wander around, these pedometers measure the number of steps taken and feed the rate of activity into a data system, which analyses it every hour.

Unlike human fitbits, the purpose of this device is not to monitor bovine endurance or agility – instead its aim is to let the farmer know, via mobile phone, when the cow is ready to breed.

The system, developed by Fujitsu, the Japanese IT equipment and services company, is known informally as the Connected Cow project.

Fujitsu says when a cow is on heat – or begins oestrus – it walks on average six times more than usual. The optimal period for insemination only lasts 12-18 hours every 21 days. But two-thirds of the time oestrus begins at night, when the farmer is asleep. Missing this window can result in a low pregnancy rate and another 21-day wait before the next cycle, adding to farmers' costs.

The system is just one example of how the deployment of technology is boosting farmers' output and profits.

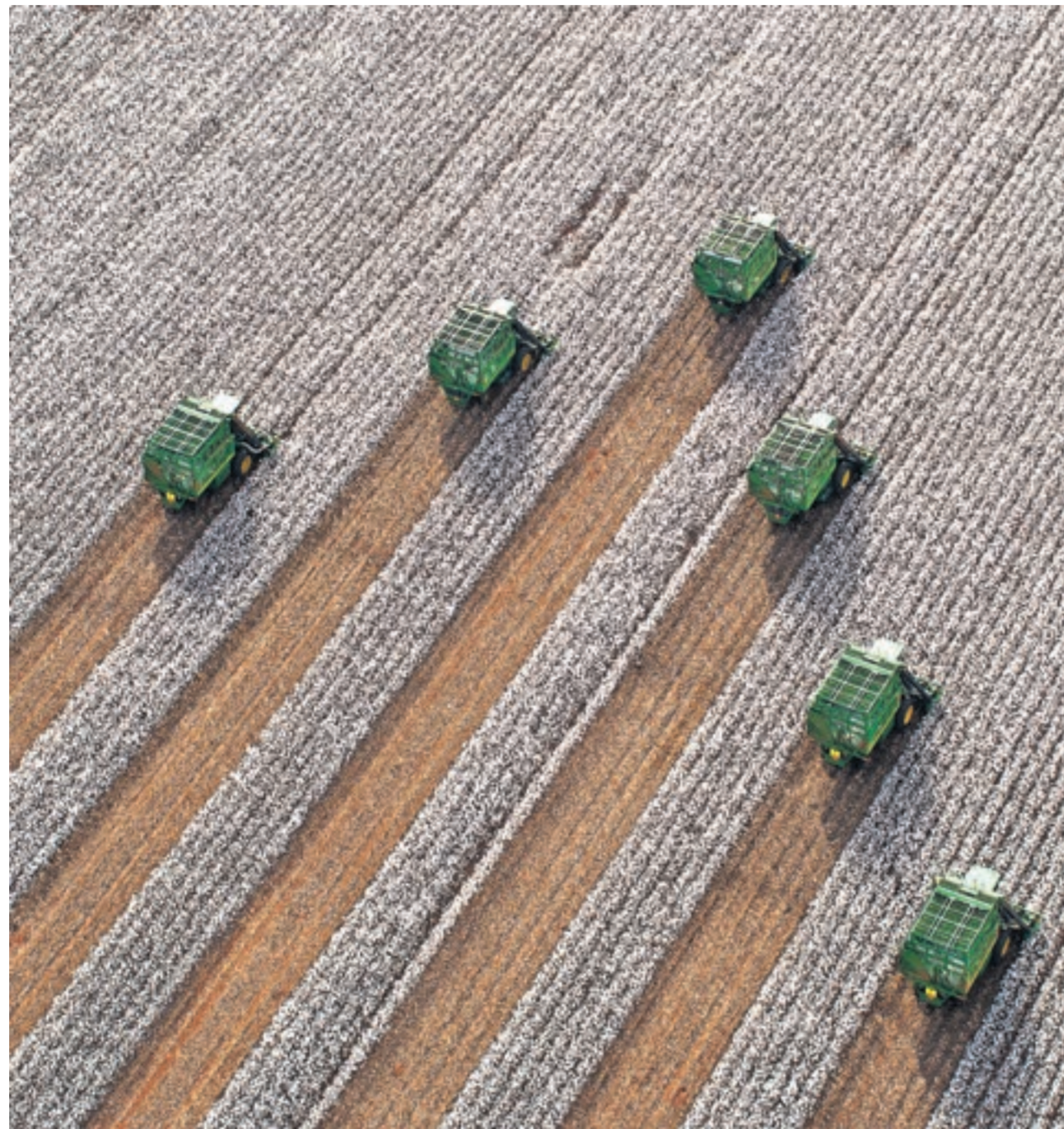
Karl Verhulst, head of internet-of-things solutions in Fujitsu's digital technology services business, says: "This is quite groundbreaking because our algorithms are quite precise. It's accurate and we are also able to influence the gender of the calf."

So far, 5,000 cows are using the Fujitsu Connected Cow service in Japan, Turkey and Poland. The company has embarked on a "proof of concept" trial with the University of Reading to encourage its uptake in the UK.

The leap from millennia of dairy farmers observing their cows for signs of oestrus to using cloud computing and wearable technology is pronounced and relatively sudden.

Such advances in technology will be needed to drive efficiency and yields in order to meet the growing demand for food over the next decade.

The world's population is projected to rise from 7.4bn currently to 8.1bn in 2025, according to the UN's Food and Agriculture Organization. Agriculture already accounts for 40 per cent of the



Harvest for the world: new technologies will be required to boost yields to meet future demand — Fernando Bueno/Getty Images

world's total land area. The FAO says there is some scope to increase land for agriculture in parts of sub-Saharan Africa and Latin America. But it expects demand for food to be met overwhelmingly by productivity gains.

The UN food agency's latest annual agricultural outlook, produced alongside the OECD, forecast that 80 per cent of the increase in crop output would come from yield improvements.

Such technological advances do not come cheap. But the agricultural sector is suffering from a shortfall in investment. The FAO estimates that \$83bn of additional investment is needed to meet the goals for 2050. That is equivalent to an annual rise of 50 per cent from current levels. Farmers are

already by far the biggest investors – their capital exceeds that from governments and domestic corporations by a ratio of more than three to one, says the FAO.

But to encourage commercial investment, reliable statistics are needed to evaluate, monitor and measure farming activities, believes Sara Menker, founder and chief executive of Gro Intelligence, an agricultural data company.

Ms Menker became interested in agriculture in her former job as a commodities trader at Morgan Stanley.

"Agriculture is a very fragmented industry and information about it has been captured in a fragmented, disorganised way," she says. "There's a lot of inefficiencies in markets today that I

think can be eliminated once people have a much better understanding of them."

She quit managing her multibillion-dollar options trading portfolio to establish her venture, which aims to provide that information, with backing from some former colleagues at the bank.

Gro Intelligence has developed a subscription-service software called Clews, which acts as a type of search engine to provide data analytics across a broad range of agricultural data. These include environmental data based on satellite imagery, crop production, trade flows and demographics.

The target audience is not so much the farmer as potential investors, insurers and policymakers.

"It is the ecosystem around the farmer that is not as well-informed as people think," she says. "If you don't get policymakers, investors, corporates, the non-profit sector, all to use the same classification system in a common language, you will not solve some of these fundamental problems around food security," Ms Menker says.

New technologies and better analytic tools can help attract the investment needed to boost global agricultural supplies. Achieving behavioural change is another way of securing food security.

Reducing waste is one aspect of much-needed change, given that up to one-third of food either spoils or is thrown away, according to the FAO.

Another is to eat less meat. Looking to 2025, the FAO says this is when demand will be greatest for meat, fish and dairy products, which in turn will lead to additional demand for animal feed, including coarse grains and protein meals.

Proagrica, the farming informatics business of Relx group (the former Reed Elsevier), says that protein intake has risen by 43 per cent in the daily diet, from an average of 355 calories a day in 1965 to 507 in 2014.

Keeping up that rate of growth will put enormous pressure on natural resources. A aside from the amount of feed and land use involved, livestock produces 14.5 per cent of all greenhouse gas emissions, according to the UN.

This has encouraged investment in plant-based alternatives as a way of reducing demand for animals as food.

Perhaps the most eye-catching and radical approach is that taken by Soylent, the nutritional meal replacement drink that became a Silicon Valley hit after its 20-something inventor Rob Rhinehart wrote a blog entitled "How I Stopped Eating Food" (see page 3)

However, widespread embrace of functional food is some way off. More promising, for the time being, are meat alternatives that seek to emulate the look, texture, sizzle and taste of meat. They are aimed not so much at vegetarians, but at keeping carnivores satisfied enough to cut back on meat in their diet.

So far, high-profile names, including Bill Gates, the former Microsoft chief, and Sergey Brin, Google co-founder, have invested in the sector.

But more recently, Tyson Foods, one of the world's largest meat processors, took a 5 per cent stake in Beyond Meat, a California-based meat substitute company, saying its investment "underscores the growing market for plant protein".

"Beef" burgers without cows would also be one way of resolving bovine breeding problems.

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## Farming needs the best of old and new to avoid disaster

### OPINION

Rosie Boycott

What does a sustainable food system look like? One that could guarantee that everyone on the planet has reliable physical, social and economic access to sufficient safe and nutritious food and that meets their dietary needs for an active and healthy life?

The challenge of delivering food security is one of the largest dilemmas facing the modern world.

Agribusinesses tell us they have the answers: more efficiency, more technology, even greater yields, modified crops. In contrast, the agro-ecological movement argues that only their approach can deliver the necessary calories and nutrition for the world's population, while also nourishing ecosystems and the people who live within them.

There is room for both. To believe that one system will exist without the other is naive. But how will they coexist?

In setting an agenda for both, we need to recognise that seeing food security simply as a challenge of production volumes misses many key problems.

The focus of policy is too often just on tonnages and calories. We have enough calorific output to feed the world but

there is too little attention is given to the problems such as food quality, distribution, impact of production on the wider environment, and waste.

We do not currently have a problem of scarcity: more than 50 per cent of all the world's grain goes to feed animals, who in turn feed us, rather than feeding humans directly. This is a grossly inefficient use of resources: cattle, for instance, can require 15kg of crops for every 1kg of meat. The scale at which we are farming animals means that animal agriculture accounts for 14.5 per cent of all greenhouse gas emissions, which is more than the transportation sector.

We should not be blind to role science can play in ameliorating such impacts. In the near future, it is possible that animal products including meat could be grown in laboratories, via cellular agriculture, a scientific step that could undermine industrial-scale animal farming and its myriad threats to food security. This model system would require 90 per cent less land and produce 75 per cent less greenhouse gases than current meat production – and not require the use of antibiotics.

Would such advances be desirable? Personally, I would welcome a world without millions of animals kept on dusty feed lots in Arizona, eking out short, miserable lives between birth and the abattoir.

Ecological campaigns also need to understand that the corporations are not going away. The world will always have huge players in the food sector

whose goal is to make a profit. Our food world is dominated by a few big names, which enable us to enjoy food from the other side of the world and bread that lasts for weeks. But such apparent consumer gains that flow from commercial endeavour have wider costs. The quest for gains in yield demands we use more chemicals each year, with adverse effects on the nutritional content of food and the health of the land. Meanwhile, food-related illness is on the rise and, while hunger persists in parts of the world, over 30 per cent of food grown is wasted.

Our current food system continues to be disastrous for the planet's health. In the UK, soil depletion means that East Anglia now has an estimated 40 harvests left, while farm land is losing 1-3cm of topsoil a year. The rainforests of Brazil and Indonesia release thousands of tons of CO2 into the atmosphere as they are burnt to provide land for palm oil and grains. The nutrient value of food across the globe is declining as our overworked soil can no longer supply the nourishment fruit, vegetables and grain demand. The Chinese are resorting to hand pollinating fruit trees with paint

Hunger persists in parts of the world, yet more than 30% of food is wasted



Scorched earth policy: rainforest clearances are part of disastrous food system — Chaldeer Mahyuddin/AFP/Getty Images

brushes as their flagrant use of chemicals has all but eliminated vital pollinators.

Sustainable food production also has to encompass health. One in three people globally has some form of malnutrition and those with obesity now outnumber those with too little. In China, 120m people now have diabetes – an astonishing figure caused in the past 25 years by the adoption of western-style diets high in fats, sugars and salts. How do we promote healthy and nutritious food in an environment where a frozen pizza is cheaper than a butternut squash?

With market power comes responsibility. There is massive consolidation of the food industry: in the US, 75 per cent of meat produced is controlled by four companies and in the UK the "Big Five" supermarkets have a 70 per cent market share. Such market structures are considered by some as necessary to drive the provision of cheap food for everyone, but it has

served to remove us from a connection with real food. According to a report by the Food Foundation, typical British children get about two-thirds of their calories from ultra-processed foods. We have a food system that shapes consumer demand rather than vice versa, and supply chains which are so opaque that it is easy for adulterants such as horse meat to find their way in.

At the moment we are moving towards yet greater homogenisation of diets as western fast-food takes over the world. Scarily, today we generate 75 per cent of all the world's food from just 12 plants and five animal species. Yet we need diversity of production and supply chains to withstand shocks – political, economic and climatic – as well as unwelcome effects on health.

To restore balance, we need to give organic, smaller-scale and diverse farming a proper role within the food system, through subsidies which support high quality of produce and recognise positive environmental

impacts. We need to steer the world away from our over-reliance on certain foods such as meat.

Mixed farming, an essentially old practice, can thrive given sufficient backing. Denmark, for example, has the world's highest share of organic produce, coexisting with intensive, and unpleasant, animal production. In 2014, France introduced a law to shorten supply chains, making clear that seasonal produce and organic are vital for health and security. Some governments are finally recognising that ecologically minded farming has an essential role in delivering food security and that it can live alongside modified industrial systems.

Let us do more. Unless we want a future where almost everything we eat is grown in a Petri dish, we have to act now.

Rosie Boycott is a writer, chair of the London Food Board and adviser to the Mayor of London



The Future of the Food Industry

# Silicon Valley makes room for new nourishment

**Fast food** Start-ups hope to wean us off meat by turning gloop into gold, writes Tim Bradshaw

After phones, cameras and taxis, Silicon Valley is looking to disrupt a rather more mundane American mainstay: fast food.

Start-ups are trying to revolutionise the food industry and have received hundreds of millions of dollars in funding from venture capitalists to do so.

Many are motivated by a desire to wean humanity off meat and other foods that have big environmental and social impacts, whether in the methane emissions and land use of cattle herds or additives in typical processed food.

“The traditional food system is broken in every way,” says Seth Bannon, founding partner at Fifty Years, an early stage venture fund in San Francisco that has invested in food technology companies. “It’s terrible for the environment, it’s economically unfavourable and it’s not great for human health.”

The best-known of these would-be disrupters is also the most extreme in its approach. Soylent was founded in 2013 by a group of Silicon Valley engineers trying to cut the time and money they spent buying and preparing food. The company has expanded from producing a powder that was mixed with water to ready-made drinks and nutritional “food bar” snacks.

The company takes its name from a 1966 Harry Harrison science-fiction novel *Make Room! Make Room!*, which explores the impact massive population

growth could have on world resources. In the book, “soylent” is made of soy and lentils and is used to feed the world. A film version in 1973, *Soylent Green*, took this theme further by portraying the main global food stuff as dead human beings being sold as biscuits.

The Soylent company, now based in Los Angeles, says its “intelligently designed” food offers “affordable, complete nutrition”. A serving of its deliberately tasteless gloop costs as little as \$2.

“It’s not surprising to me that Soylent has become the darling of Silicon Valley and computer programmers,” says Amy Bentley, a professor of food studies at New York University. For one thing, she says, it does away with the social interaction that food often involves but tech nerds are not renowned for. “You don’t have to talk to people, you can just fuel.”

However, Soylent has also illustrated some of the hazards of pioneering new food. Two months after they first went on sale, Soylent halted sales of its food bars after some customers said they had caused episodes of violent vomiting, and in October removed its powder drink from sale for the same reason.

Soylent said that while its tests had come back “negative for food pathogens, toxins or outside contamination”, one ingredient, derived from algae, may have triggered intolerance. A new formulation will be released next year, sooner if possible.

“We are just beginning to learn about



**Where’s the beef?: Possible Foods and others are targeting traditional staples**

what our bodies need,” says Ms Bentley. “Turns out when we try to engineer stuff, we figure out nature did it pretty well in the beginning.” She adds: “Humans need variety.”

Rivals have also emerged, including Ambronite, a nutritional drink, and 100%Food, whose maker, Space Nutrients Station, invites customers to “stop cooking — eat like astronauts!”

“The idea is that Ambronite can be any meal, says its co-founder Simo Suoheimo, “but the idea is not to replace every meal.”

Ambronite has received \$600,000 from backers, including a co-founder of YouTube, Jawed Karim, and Lifeline Ventures, while Soylent has raised more than \$20m. But other food technology companies have been more ambitious. Investors have poured more than \$180m into Impossible Foods, which is trying to replace meat with something that tastes and smells similar but is made from plants.

Ingredients such as potatoes and coconuts are fermented then combined

with the “magic ingredient” of heme, a yeast extract with similar culinary properties to blood.

“You can’t get people to stop eating meat,” says Pat Brown, Impossible Foods’ founder and chief executive.

“We turn plants into meat more efficiently and sustainably” than animals, he says.

However, copying nature has proven tougher than Mr Brown may have anticipated. Impossible’s burgers have already been five years in the making, and only now are starting to be offered in selected, expensive restaurants.

A commercial-scale manufacturing facility will not open until next year. In the meantime, a pilot facility is producing 1,200lb a week. Over the past two years, Impossible has reformulated its burgers’ ingredients and reduced costs.

“A cow is pretty much as mature a technology as it will ever be,” Mr Brown says. “One of the huge advantages we have over cows when it comes to making meat is we have the capability of improving every aspect of it.”

Another start-up disrupting nature is Memphis Meats. The Bay Area-based company is taking a different approach — growing meats in a lab, cultivating them from real animal cells.

“We identify cells that have the capability to renew themselves,” says Uma Valeti, Memphis’ co-founder and chief executive. “We breed those cells that are the most effective and growing — just like a farmer would do with animals.” Eventually, he hopes to remove animals from the equation altogether.

Previous efforts to cultivate meat in this way have produced burgers that cost thousands of dollars. Memphis Meats hopes to drive down the price of its meatballs from a projected \$40 a gramme in the lab-scale to a few cents per gramme by the end of the decade.

Mr Bannon, of Fifty Years, who has invested in Memphis Meats, calls its approach the “second domestication”. “Traditionally we have domesticated animals to harvest their cells for food or drink,” he says. “Now we are starting to domesticate cells themselves.”

‘A cow is pretty much as mature a technology as it will ever be’

# Africa must tackle dependency and profit from feeding the world

COMMENT

Karim Lotfi Senhadji

By 2050, the world will need to feed 9bn people, 2bn more than we feed today. In order to meet this demand, global food production must increase by an estimated 70 per cent in the next 30 years. Africa — which contains 65 per cent of the world’s unexploited arable land — has a key future role in delivering global food security.

Yet less than a third of Africa’s arable land is under cultivation, resulting in African food imports that total \$35bn a year. To meet future demand, this equation must be reversed.

Supporting farmers and their local ecosystem is critical to unlocking the full potential of African agriculture.

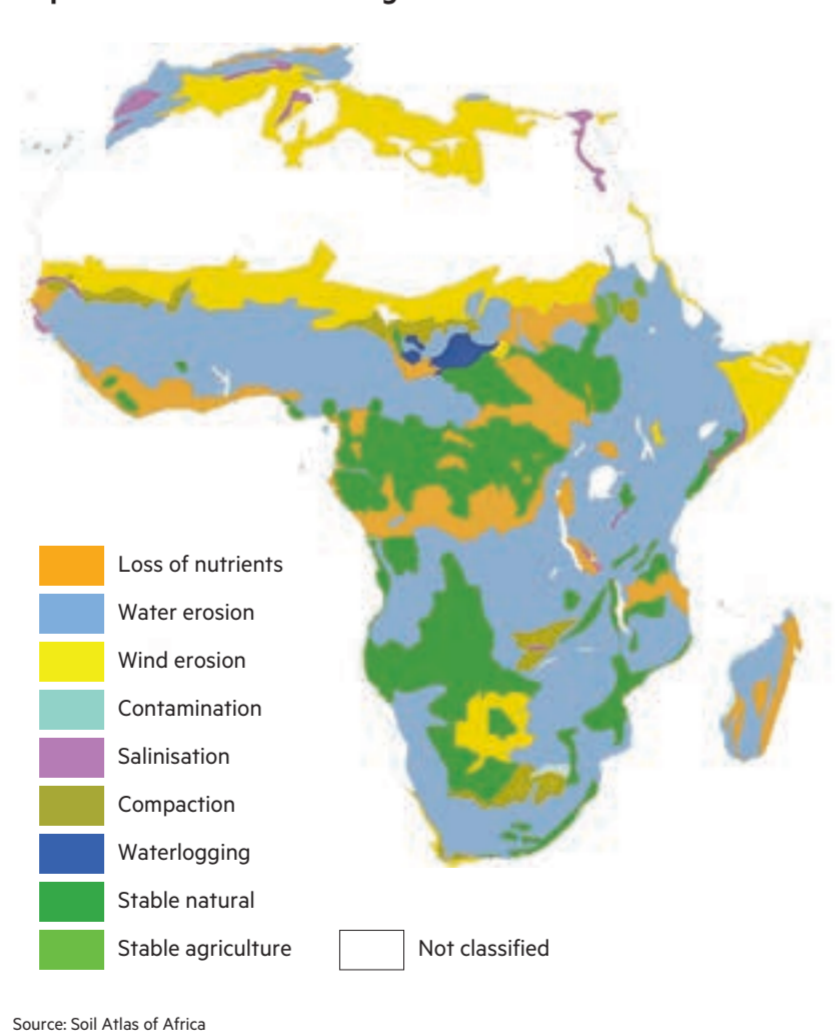
To be successful, African farmers need a reliable supply of agricultural products that increase the efficiency of their land. They also need better education and training to boost soil fertility and access to financing to provide stability for their operations. Transport and storage infrastructure is also essential to allow access to markets and support any increased agricultural output, whether its destination is local, regional or international.

However, Africa’s fragile arable lands are at risk of further depletion in the next decade, a threat that is exacerbated by the effects of climate change. Achieving the goal of securing our global food supply must be achieved in a way that protects our continent’s most precious resource, our land.

A challenge is the lack of a secure and affordable supply of fertiliser that meets the needs of local soils and crops. Africa currently has the lowest fertiliser consumption rate in the world — representing only 2 per cent of global consumption despite holding 20 per cent of the world’s population by some estimates. When African farmers do use fertiliser, they pay two to six times more than the average world price.

OCP Africa is backed by OCP, our parent company and phosphate supplier. We are committed to programmes aimed at tackling soil degradation. The solution starts with soil mapping, which enables farmers to know which nutrients their specific soil

Map of main causes of soil degradation in Africa



Source: Soil Atlas of Africa

needs, and then requires the application of correct and affordable supplements to boost crop yields. However, boosting soil quality is just one challenge tackled by the Initiative for the Adaptation of African Agriculture to Climate Change, one of the priorities of the Moroccan presidency of the COP 22 round of talks and actions on the global threat.

Water scarcity is the most important challenge facing agriculture in Africa. Roughly two-thirds of African lands are

Fragile arable lands are at risk of further depletion in the next decade

located in arid or semi-arid areas made even more vulnerable by climate change, while lands endowed with water often lack storage and delivery systems to effectively irrigate.

If solutions can be found to reduce water waste and improve supply, Africa could massively increase the agricultural potential of its land.

Investment in logistics and good governance is also required to ensure supplies and produce flow easily and surplus production is stored efficiently. Private and public institutions around the world need to join efforts to provide resources and expertise, help with technology transfer and capacity building, and share best practice.

Smarter approaches to agriculture could increase the annual value of the continent’s production from \$280bn to \$880bn by 2030, helping boost global food supply, creating new jobs and improving other economic sectors. This challenge of delivering investment and good governance required is immense, but it is a prize worth chasing.

Karim Lotfi Senhadji is chief executive of OCP Africa

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