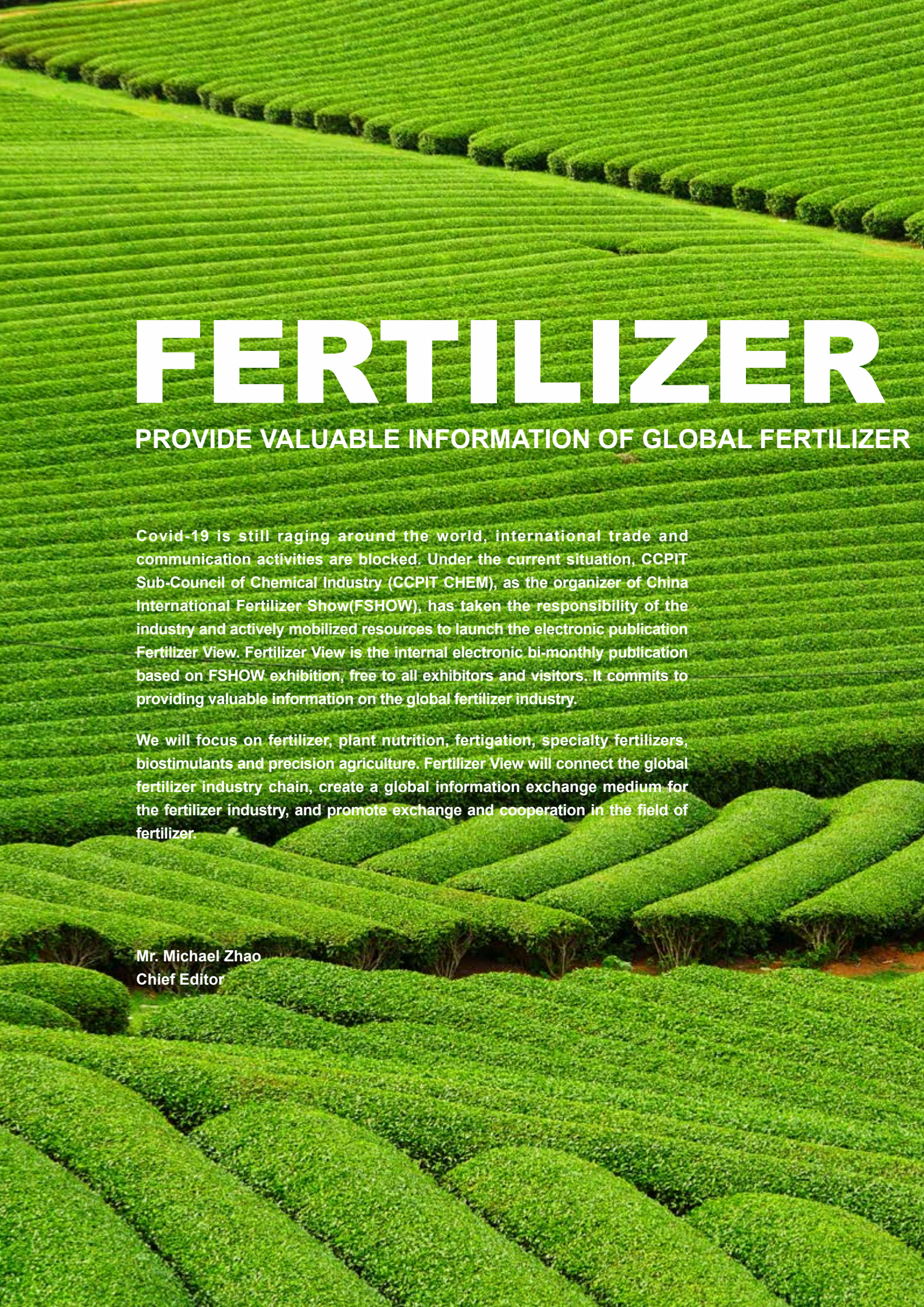
Jul/Aug 2020

Fertilizer View

PROVIDE VALUABLE INFORMATION OF GLOBAL FERTILIZER INDUSTRY

FSHOW
The Leading Fertilizer Platform



FERTILIZER

PROVIDE VALUABLE INFORMATION OF GLOBAL FERTILIZER

Covid-19 is still raging around the world, international trade and communication activities are blocked. Under the current situation, CCPIT Sub-Council of Chemical Industry (CCPIT CHEM), as the organizer of China International Fertilizer Show(FSHOW), has taken the responsibility of the industry and actively mobilized resources to launch the electronic publication Fertilizer View. Fertilizer View is the internal electronic bi-monthly publication based on FSHOW exhibition, free to all exhibitors and visitors. It commits to providing valuable information on the global fertilizer industry.

We will focus on fertilizer, plant nutrition, fertigation, specialty fertilizers, biostimulants and precision agriculture. Fertilizer View will connect the global fertilizer industry chain, create a global information exchange medium for the fertilizer industry, and promote exchange and cooperation in the field of fertilizer.

Mr. Michael Zhao
Chief Editor


VIEW
INDUSTRY

FSHOW 2021 | China International Fertilizer Show

CCPIT Sub-Council of Chemical Industry
E-mail: julie@fshow.org
Tel: +86-10-84255960
Web: en.fshow.org

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Chief Editor
Michael Zhao
E-mail: michael@fshow.org

Deputy Editor
Terry Zhao
E-mail: terry@fshow.org

Julie Zheng
E-mail: julie@fshow.org

Managing Editor
Ethan Cui
E-mail: ethan@fshow.org

Editor
Albert Chen
E-mail: albert@fshow.org

Han Xinrong
E-mail: hanxr@fshow.org

Susan Wu
E-mail: susan@fshow.org

Wang Haiying
E-mail: wanghaiying@fshow.org

Li Rong
E-mail: lirong@fshow.org

Qu Xiufen
E-mail: quxiufen@fshow.org

Communication & Subscription
Tel: +86-10-84292984
E-mail: fshow@vip.163.com

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News in Brief

Fertilizer Import and Export Data of China From January to June 2020

According to the statistics of China Customs, from January to June 2020, China's total export of various fertilizers was 11.93 million tons, a year-on-year decrease of 5.3%; the cumulative export amount was 2.652 billion US dollars, a year-on-year decrease of 24.5%.

Among them, the export of urea was 1.72 million tons, with decrease of 2.6%; the export of ammonium sulfate was 3.58 million tons, with increase of 8.6%; the export of DAP was 2.03 million tons, with decrease of 26.1%; the export of MAP was 1.24 million tons, down 10.5% year-on-year, and a year-on-year decrease of 26.1%.

From January to June 2020, China has imported 4.87 million tons of various fertilizers, decrease of 26.0%; a total of 3.86 million tons of potassium chloride, a year-on-year decrease of 29.0%; a cumulative import of 720,000 tons of nitrogen, phosphorus and potassium compound fertilizer, a year-on-year decrease of 9.4%. ***(Source: FOHOTA)***

K+S to Sell Americas Salt Business to Slash Debt

Opened in 2017, Bethune is the first greenfield potash mine in Canada's Saskatchewan province in more than 40 years. (Image Courtesy of K+S Potash Canada.)

German fertilizer producer K+S AG said it was on track to sell its salt business in North and South America by the end of the year, a move that seeks to slash debt and allow the company to focus on potash fertilizer products.

The sale of Morton Salt comes a decade after K+S acquired it for $1.7 billion. It was triggered by a drop in potash prices, which undermined the debt-financing of the company's new potash mine in Canada — Bethune.

K+S, the world's largest salt producer, expects to complete the transaction and receive payment after 2021. That's why is also implementing other measures to reduce debt, which should strengthen its balance sheet by more than 2 billion euros ($2.3 billion) by that time, Chief Executive Burkhard Lohr said.

Potash stockpiles are at a record high, which means it will be months before demand for fresh supply picks up, CRU senior potash analyst, Humphrey Knight said. ***(Source: Mining.com)***

Syngenta and Mosaic Sign Strategic Agreement

On July 16, 2020, Syngenta China Crop Nutrition Business Unit Sinofert Co., Ltd. and Mosaic Agricultural Materials (Beijing) Co., Ltd. signed the agreement for 2020-2024 strategic cooperation agreement.

Mosaic is the world's largest producer of high-concentration phosphate fertilizers, and one of the four largest potash fertilizer manufacturers. Mosaic Agricultural Materials (Beijing) Co., Ltd. is China regional headquarters of Mosaic. The newly established Syngenta China includes four business units: plant protection, seed, crop nutrition & MAP, and digital agriculture. It is China's largest supplier of agricultural inputs and a leading modern agricultural integrated service platform operator.

Feng Mingwei, Vice President of Syngenta China and Co-President of Syngenta Crop Nutrition, said: The signing of the strategic cooperation agreement signifies that the two parties will further strengthen cooperation on ensuring the supply of domestic crop nutrition products, promoting balanced fertilization, and high-end functional fertilizer distribution, thereby helping MAP development, to ensure a stable supply of domestic crop nutrition, increase fertilizer utilization, improve soil fertility structure, and ultimately help farmers increase production and income, promote the sustainable development of China's agriculture, and ensure China's food security. *(Source www.nzdb.com.cn)*

BeiDou Adopted in Unmanned Farm Machines in Xinjiang

A model of the Beidou Navigation Satellite System exhibited in Zhuhai. [Photo/Xinhua]

URUMQI -- The BeiDou Navigation Satellite System (BDS) has been adopted in more than 10,000 unmanned farm tractors and spraying drones in northwest China's Xinjiang Uygur Autonomous Region, according to the regional agriculture and husbandry machinery administration.

Xinjiang has been promoting tractors, harvesters and other agricultural machinery equipped with BDS in recent years, and techniques such as precision sowing, fertilization, and pesticide spraying, based on the system to improve the working quality of the machines.

The region currently has over 5,000 spraying drones using BDS with a total operation area exceeding 1.33 million hectares. The navigation system has greatly raised the working efficiency of the drones, the administration said.

China completed the deployment of the BDS with the recent launch of its last satellite, the 55th in the BeiDou family, in late June. ***(Source: Xinhua.net)***

Nutrien Ag Solutions Acquires Wireless Data Transfer Company Agbridge

Nutrien Ag Solutions continues to build out its digital agriculture portfolio with the recent acquisition of Agbridge, a hardware company focused on wireless data-sharing.

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The acquisition helps serve Nutrien Ag Solutions' goal of making "hard things easier," says Sol Goldfarb, head of digital at Nutrien Ag Solutions, who notes this is the first hardware acquisition during his tenure at the company focused on digital agronomy.

The Agbridge technology will be used on Nutrien Ag Solutions application equipment. One unique aspect of its product is that data can be transferred via Wi-Fi or cellular connections, and if a connection isn't present, the data is stored until a connection is available to complete the transfer.

"We were looking for a solution for our own application fleet which includes equipment from many companies. The Agbridge technology works on a variety of farm equipment brands, which is important, and having it for our branches the Agbridge devices installed on equipment across our application fleet will allow for consistency in training and troubleshooting," Goldfarb says.

The acquisition will also streamline how Nutrien Ag Solutions crop advisers receive and send data. "It's up to folks like us to make data usable for the grower," he says. "We have to be equipped to help growers keep track of all the activity on their farm with high fidelity and be able to take data and turn it into actionable insights."

Digital agriculture has been a focus at Nutrien, particularly in the past three years after CEO Chuck Magro announced the company would spend $100 million every year on development. ***(By Margy Eckelkamp)***

Lentera and MCFI ink Deal to Provide Satellite Based Crop Analysis for Mauritian Farmers

Mauritius Chemical and Fertilizer Industry (MCFI), one of Africa's oldest fertilizer manufacturer and Lentera Africa an AgriTech company have signed a partnership that will see Lentera provide satellite-based crop health analysis and crop modelling services for Mauritian customers of MCFI. The farmers will get access to weekly crop health satellite images, soil moisture analysis and on demand hyper-localized weather forecast service that will be delivered via a mobile application. The collaboration will start with sugar cane and cereals growers in Mauritius before scaling up to more customers in Eastern and Southern Africa.

"This is an exciting collaboration for us. We believe in working with upcoming and talented African enterprises like Lentera Africa to transform agriculture in our home country and in Africa and deliver real value to farmers through satellite and mobile technology." said Dheer Roy, Business Development Manager, MCFI.

"This is a great milestone for us. As a Pan African company, it is an honor for us to serve Mauritian farmers working with MCFI and we look forward to expanding the partnership to other African countries". said Moses Kimani, Founder and CEO of Lentera Africa.

Launched in 1975, a few years after Mauritius attained its independence, The Mauritius Chemical & Fertilizer Industry (MCFI) was founded by a local executive who considered it vital for Mauritius to stop depending on external suppliers for its fertilisers: Mr. Antoine Harel set up the country's own fertiliser plant to serve the booming local agricultural sector.

Lentera Africa is an agriculture technology company that enables farmers to increase their yield through precision agriculture - satellite based crop health analysis, hyper localized weather updates and climate smart inputs. Lentera has received various accolades and recognition for its technology including - Afric'up Tunisia tech startup of the year, Innov8 Dubai Agritech winner, Airbus Bizlab Finalist, and WWF Pandalabs hackathon winner for technology enabling sustainable agriculture. *(source: feedit.agfunder.com, by Mkimani)*

Bayer: Increase the Layout of Digital Agriculture in China

As a global agribusiness giant, Bayer has made great achievements in digital agriculture. The FieldView digital agriculture platform under Bayer Climate Corporation, since its commercialization in 2015, has over 540 million mu of paid-for use worldwide.

In recent years, China has attached great importance to the development of digital agriculture, taking digital villages as an important aspect of the construction of digital China.

Bayer believes that China's agriculture is currently undergoing a major agricultural integration period of industrial transformation and upgrading, and cross-industry and cross-field connections are becoming increasingly obvious. Bayer looks forward to working with partners to build an ecosystem including agricultural materials, agriculture, agricultural finance, agricultural technology, etc., so that farming is no longer difficult.

In September 2019, Bayer and Ant Chain (a blockchain subsidiary of Alibaba) reached a strategic cooperation.

Bayer will provide crop science superior technology and product resources. Ant Chain is responsible for providing blockchain technology, traceability technology and related resources such as marketing, logistics, and finance. Together with Bayer, it will build a "new dual chain" in agriculture—a new ecology of blockchain and value chain. *(Source: Economic Daily)*

INDUSTRY OBSERVATION

Phosphate Fertiliser Crisis

Threatens World Food Supply

The world faces an "imminent crisis" in the supply of phosphate, a critical fertiliser that underpins the world's food supply, scientists have warned.

Phosphate is an essential mineral for all life on Earth and is added to farmers' fields in huge quantities. But rock phosphate is a finite resource and the biggest supplies are mined in politically unstable places, posing risks to the many countries that have little or no reserves.

Use of essential rock phosphate has soared, but scientists fear it could run out within a few decades

Phosphate use has quadrupled in the last 50 years as the global population has grown and the date when it is estimated to run out gets closer with each new analysis of demand, with some scientists projecting that moment could come as soon as a few decades' time.

Researchers say humanity could only produce half the food it does without phosphate and nitrogen, though the latter is essentially limitless as it makes up almost 80% of the atmosphere.

"Phosphate supply is potentially a very big problem," said Martin Blackwell, at Rothamsted Research, an agricultural research centre in the UK, and lead author of a new study. "The population is growing and we are going to need more food."

At current rates of use, a lot of countries are set to run out of their domestic supply in the next generation, including the US, China and India, he said. Morocco and the Moroccan-occupied territory of Western Sahara host by far the largest reserve, with China, Algeria and Syria the next biggest, together representing more than 80% of global rock phosphate.

"In a few years' time, it could be a political issue with some countries effectively controlling the production of food by having control of rock phosphate supplies," Blackwell said. "There should be a lot more effort being put in so we are ready to deal with it. It is time to wake up. It is one of the most important issues in the world today."

Prof Martin van Ittersum, at Wageningen University in the Netherlands, said problems would begin before the mineral is exhausted: "Well before we run out of phosphate, the resource may become much more expensive."

Potential solutions include recycling phosphate from human sewage, manure and abattoir waste, new plant breeds that can draw the mineral from the soil more effectively and better soil tests to help end the over-application of the fertiliser.

Excessive use of phosphate is not only running down supplies but is also causing widespread pollution that leads to dead zones in rivers and seas. In 2015, research

published in the journal Science cited phosphorus pollution as one of the most serious problems the planet faces, ahead of climate change.

The new study, published in the journal Frontiers of Agricultural Science and Engineering, states: “The continued supply of phosphate fertilisers that underpin global food production is an imminent crisis.”

It notes that an estimate of the remaining years of rock phosphate supply fell from 300 to 259 in just the last three years, as demand rose. “If the estimated remaining number of years supply continues to decline at this rate, it could be argued that all supplies will be exhausted by 2040,” the scientists wrote.

“While this scenario is unlikely, it does highlight that imminent, fundamental changes in the global phosphorus trade, use and recycling efforts will be necessary,” they said. “This is especially pertinent in China, India and the US, the three countries with largest populations on the planet, which rely on rock phosphate to feed their people.”

The European Commission declared phosphate a “critical raw material” in 2014, ie an essential resource with significant risk to supply. Only Finland has any reserves in the EU and most is imported to the bloc from Morocco, Algeria, Russia, Israel and Jordan. “The EU is highly dependent on regions currently subject to political crisis,” according to an EC position paper.

Commercial phosphate fertiliser was invented at Rothamsted in 1842 by dissolving animal bones in sulphuric acid. Blackwell and his colleagues have returned to this source to investigate an alternative supply of phosphate.

They have turned bones, horns, blood and other abattoir waste into phosphate fertiliser and in new research found it worked as well or better than conventional fertiliser.

Blackwell said it could potentially provide 15-25% of the UK's needs. Another potential source is recovering phosphate from human sewage; Thames Water opened a plant doing this in 2013.

Van Ittersum said recycling phosphate from animal and human waste is vital, but that this will take time to implement as new technology and regulation will be needed to ensure contamination and infection of food crops does not occur.

Reducing use is also key, said Blackwell. The soil tests available to farmers at the moment are not very advanced, he said, so farmers add extra phosphate to be sure. This means excess phosphate in most agricultural soils, estimated as representing a century's supply.

But most of this soil phosphate is bound up in organic molecules and inaccessible to plants. Some plants produce acids and enzymes that can break these down, and scientists are using genetic modification to create new plant varieties that can access this phosphate. Van Ittersum said such research was urgent as it will take a lot of time to develop more efficient crops.

Phosphate expert Marissa de Boer said the public lack of awareness means the issue is the "unknown" environmental crisis: "We really depend on phosphate but we take it for granted."

De Boer ran a five-year European Commission project on technologies to recycle phosphate and now runs SusPhos, a company looking to commercialise ways of extracting phosphate from human waste, food waste and industrial waste. She said recycled phosphate could meet the Netherlands' needs if the technology proves successful: "As long as people have got to go to the toilet, and wastewater treatment is centralised, we can use our own phosphate." ***(Source: TheGuardian, by Damian Carrington)***

▲ *Granules of monoammonium phosphate (MAP) moved into a storage warehouse in Cherepovets, Russia. Photograph: Andrey Rudakov/Bloomberg/Getty Images*

◄ *Untreated phosphate in Western Sahara. Photograph: AFP/Getty Images*

Organic Farming

Matters – Just Not In the Way You Think

Is organic agriculture the solution to our global food system challenges? That's been the premise and promise of the organic movement since its origins in the 1920s: farming that's healthy, ecological, and socially just.

Many people – from consumers and farmers to scientists and international organisations – believe that organic agriculture can produce enough nutritious food to feed the world without destroying the environment, while being more resilient to climate change and improving the livelihoods of farmers.

But as with many important issues of our time, there are more passionate opinions about organic agriculture than there is scientific evidence to support them. And there's nothing black or white about organic agriculture.

For a paper published today in the journal Science Advances, we systematically and rigorously evaluated the performance of organic versus conventional agriculture on three key fronts – environmental impact, producer and consumer benefits. As much as possible, we based our review on previous quantitative synthesis of the scientific literature – so-called meta-analyses. We also examined whether those studies agree or disagree in their verdicts.

We discovered that organic farming does matter – just not in the way most people think.

Environmental impacts

Compared to a neighbouring conventional farm, an organic farm at first appears to be better for the environment. But that's not the whole story. Here's how it breaks down.

What's good: Organic farms provide higher biodiversity, hosting more bees, birds and butterflies. They also have higher soil and water quality and emit fewer greenhouse gases.

What's not-so-good: Organic farming typically yields less product – about 19-25% less. Once we account for that efficiency difference and examine environmental performance per amount of food produced, the organic advantage becomes less certain (few studies have examined this question). Indeed, on some variables, such as water quality and greenhouse gas emissions, organic farms may perform worse than conventional farms, because lower yields per hectare can translate into more environmentally damaging land-clearing.

Organic farms have more biodiversity than their conventional neighbours. Mike Blake/Reuters

Consumer benefits

The jury's still out on whether the comsumer is better off, too.

What's good: For consumers in countries with weak pesticide regulations, like India, organic food reduces pesticide exposure. Organic ingredients also most likely have slightly higher levels of some vitamins and secondary metabolites.

What's not-so-good: Scientists can't confirm whether these minor micronutrient differences actually matter for our health. Because the nutritional value of organic and conventional food is so small, you'd do better just eating an extra apple every day, whether it's organic or not. Organic food is also more expensive than conventional food at present and therefore inaccessible to poor consumers.

Pricy organic ingredients don't fall within many consumers' budgets. Phil Roeder/flickr,

Producer benefits

Organic methods bring certain benefits for farmers, some costs and many unknowns.

What's good: Organic agriculture is typically more profitable – up to 35% more, according to a meta-analysis of studies across North America, Europe and India – than conventional farming. Organic also provides more rural employment opportunities because organic management is more labour-intensive than conventional practices. For workers, though, the biggest advantage is that organic decreases their exposure to toxic agrochemicals.

What's not-so-good: We still don't know whether organic farms pay higher wages or offer better working conditions than conventional farms. Organic farm workers are most likely exploited in similar ways as those tilling the fields on conventional farms.

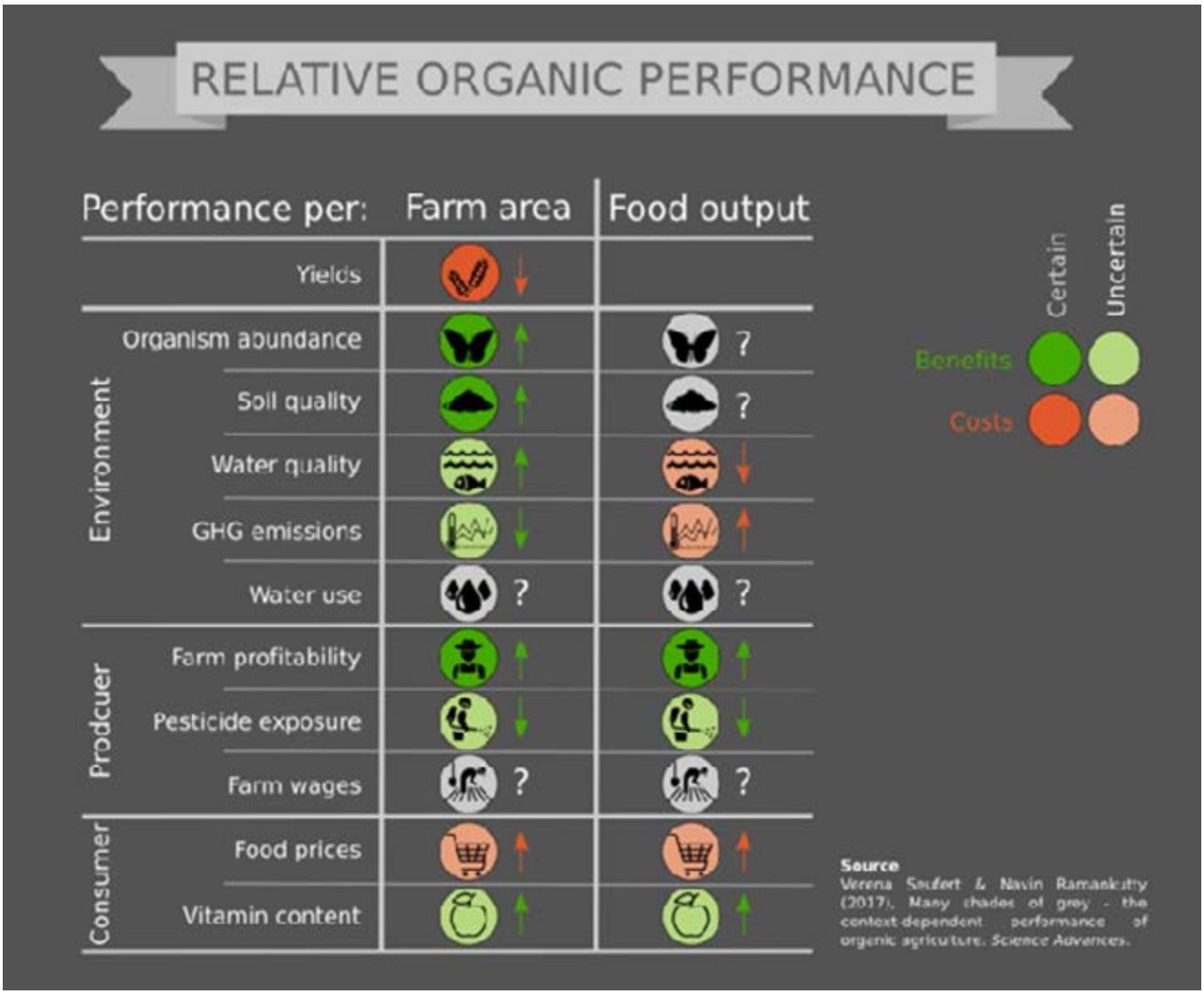
We still don't know whether organic farms offer better labour conditions. Mike Blake/Reuters

The takeaway

We cannot determine yet whether organic agriculture could feed the world and reduce the environmental footprint of agriculture while providing decent jobs and giving consumers affordable, nutritious food.

It's a lot to ask of one industry, and there are still just too many unanswered questions. Some of these questions relate to agriculture, such as whether organic farms can eventually close the yield gap with conventional farms and whether there are enough organic fertilisers to produce all the world's food organically.

But some questions are also about humanity's collective future. Can people in the rich world learn to change our



diet and reduce food waste to avoid having to increase food production as the global population grows? And are enough people willing to work in agriculture to meet the needs of labour-intensive organic farms?

A more useful question is whether we should continue to eat organic food and expand investment in organic farming. Here the answer is a definitive yes.

Organic agriculture shows significant promises in many areas. We would be foolish not to consider it an important tool in developing more sustainable global agriculture.

Only 1% of agricultural land is organically farmed worldwide. If organic land continues to expand at the same rate that it has over the past decade, it will take another century for all agriculture to be organic.

But organic farming's influence goes far beyond that 1% acreage. Over the past 50 years, organic farms have provided conventional agriculture with examples of new ways to farm and acted as a testing ground for a different set of management practices, from diversifying crop rotations and composting to using cover crops and conservation tillage. Conventional agriculture has neglected these sustainable practices for too long.

So yes, you should identify and support those organic farms that are doing a great job of producing environmentally friendly, economically viable, and socially just food. Conscientious consumers can also push to improve organic farming where it is not doing so well – for example on yields and worker rights.

As scientists, we must close some of the critical knowledge gaps about this farming system to better understand its achievements and help address its challenges.

But in the meantime, everyone can learn from successful organic farms and help improve the other 99% of agriculture that's feeding the world today. ***(by Verena Seufert and Navin Ramankutty)***

China's Phosphate

Fertilizer "14th Five-Year Plan" Transformation Development Goal Is Clear

The first forum of the 27th National Phosphate and Compound Fertilizer Industry Annual Conference hosted by China Phosphate & Compound Fertilizer Industry Association -Phosphate Fertilizer Industry Development Forum was held online recently.

The forum focused on the transformation and development direction of the industry during the "14th Five-Year Plan" period, analyzed the situation of my country's phosphate fertilizer industry, and put forward the industry's "14th Five-Year Plan" development goals and technical policy guarantee advices.

Gao Yongfeng, deputy secretary-general of China Phosphate & Compound Fertilizer Industry Association, said that since the "13th Five-Year Plan", China's phosphate and compound fertilizer industry has achieved fruitful performance and is also facing unprecedented challenges.

In 2019, the national phosphate fertilizer production capacity was 22.4 million tons, the production volume was 16.1 million tons, and the apparent consumption volume was 10.97 million tons, both of which have fallen for 7 years. Throughout the "13th Plan" period, the national phosphate fertilizer production capacity dropped by 5%, output dropped by 12%, and apparent consumption dropped by 12%. The domestic phosphate fertilizer supply rate has been maintained at 140%~144%, and the overcapacity is still serious.

The industry should focus on the issues of phosphorus pollution and resource sustainability caused by the huge industrial scale and single product structure during the "14th Plan" period.

Gao Yongfeng introduced the development goals of the phosphate compound fertilizer industry during the 14th Five-Year Plan. By 2025, the phosphate fertilizer production capacity will be controlled below 20 million tons of P2O5 per year. Among them, the production capacity of ammonium phosphate does not exceed 15 million tons/year P2O5; the external dependence of sulfur resources decreases by 10%; the selected grade of phosphate rock decreases by 2%; the proportion of new phosphate fertilizers increases by 10%; the phosphorus yield of phosphoric acid production increases by 1%; the comprehensive energy consumption of phosphate fertilizer production decreased by 5% to 10%; the emission intensity of major pollutants decreased by 30%; R&D investment accounted for more than 3% of revenue; the comprehensive utilization rate of phosphogypsum increased by 20%.

Gao Yongfeng emphasized that China's phosphate fertilizer industry urgently needs to carry out in-depth industrial structure adjustment and optimization, gradually reduce the overall scale, and maintain the sustainability of resources, environment, industry, and markets. Therefore, the industry's "14th Plan" development strategy will mainly include the following aspects:

• Improve the overall technical equipment level through technological innovation, realize energy saving,

consumption reduction, and emission reduction;

• Optimize the industrial structure, upgrade the product structure, develop high-end products;

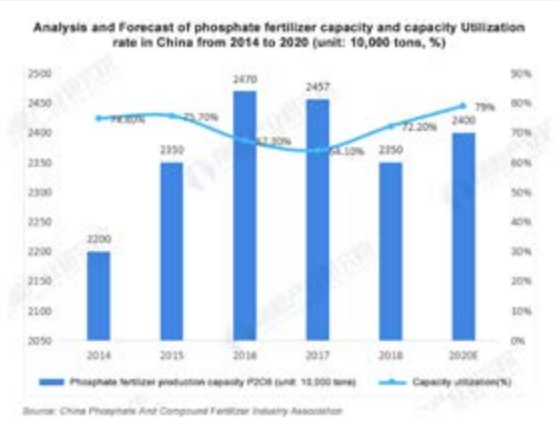
• Improve the high-end level of resource utilization;

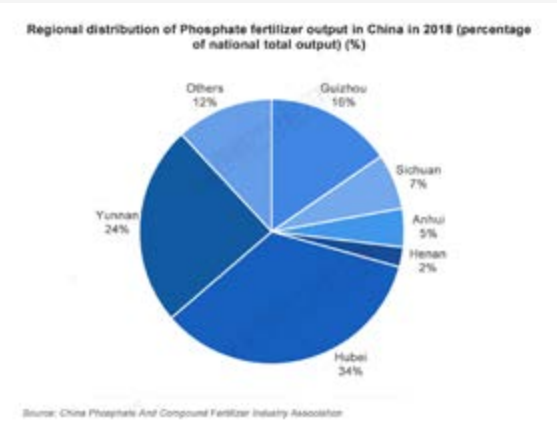
• Cultivate large-scale enterprise groups, and realize innovations in management systems, corporate systems, employment mechanisms, and marketing methods.

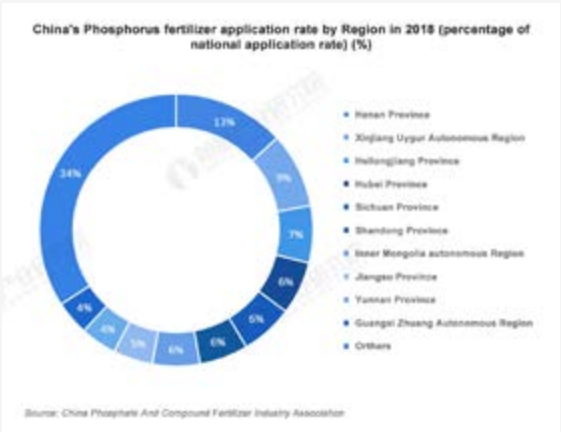
In addition, the industry must strengthen policy support, including increasing support for scientific research innovation, technological transformation, and resource utilization of phosphogypsum.

At the forum, Professor Wang Xinlong of Sichuan University introduced the application technology of low and medium-grade phosphate rock and the technology of new phosphate fertilizer for modern ecological agriculture. He believes that new phosphate fertilizers is to solve the cooperative relationship between phosphorus and middle and micro elements. Li Zhigang, deputy chief engineer of China Wuhuan Engineering Co., Ltd., proposed to build a diversified industrial structure, develop fine phosphorus chemical industry, new energy electrode materials, and improve economic efficiency and comprehensive utilization of resources. *(Source: www.ccin.com.cn)*

Analysis on the current situation of **supply and demand** in China's phosphate fertilizer industry in 2019 - **The industry is in the state of overcapacity for a long time**







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INTERNATIONAL VIEW

The Netherlands:

This Tiny Country Feeds the World

> ***The Netherlands has become an agricultural giant by showing what the future of farming could look like.***

In a potato field near the Netherlands' border with Belgium, Dutch farmer Jacob van den Borne is seated in the cabin of an immense harvester before an instrument panel worthy of the starship Enterprise.

From his perch 10 feet above the ground, he's monitoring two drones—a driverless tractor roaming the fields and a quadcopter in the air—that provide detailed readings on soil chemistry, water content, nutrients, and growth, measuring the progress of every plant down to the individual potato. Van den Borne's production numbers testify to the power of this "precision farming," as it's known. The global average yield of potatoes per acre is about nine tons. Van den Borne's fields reliably produce more than 20.

That copious output is made all the more remarkable by the other side of the balance sheet: inputs. Almost two decades ago, the Dutch made a national commitment to sustainable agriculture under the rallying cry "Twice as much food using half as many resources." Since 2000, van den Borne and many of his fellow farmers have reduced dependence on water for key crops by as much as 90 percent. They've almost completely eliminated the use of chemical pesticides on plants in greenhouses, and since 2009 Dutch poultry and livestock producers have cut their use of antibiotics by as much as 60 percent.

One more reason to marvel:

The Netherlands is a small, densely populated country, with more than 1,300 inhabitants per square mile. It's bereft of almost every resource long thought to be necessary for large-scale agriculture. Yet it's the globe's number two exporter of food as measured by value, second only to the United States, which has 270 times its landmass. How on Earth have the Dutch done it?

Seen from the air, the Netherlands resembles no other major food producer—a fragmented patchwork of intensely cultivated fields, most of them tiny by agribusiness standards, punctuated by bustling cities and suburbs. In the country's principal farming regions, there's almost no potato patch, no greenhouse, no hog barn that's out of sight of skyscrapers, manufacturing plants, or urban sprawl. More than half the nation's land area is used for agriculture and horticulture.

Banks of what appear to be gargantuan mirrors stretch across the countryside, glinting when the sun shines and glowing with eerie interior light when night falls. They are Holland's extraordinary greenhouse complexes, some of them covering 175 acres.

These climate-controlled farms enable a country located a scant thousand miles from the Arctic Circle to be a global leader in exports of a fair-weather fruit: the tomato. The Dutch are also the world's top exporter of potatoes and onions and the second largest exporter of vegetables overall in terms of value. More than a third of all global trade in vegetable seeds originates in the Netherlands.

A sea of greenhouses surrounds a farmer's home in the Westland region of the Netherlands. The Dutch have become world leaders in agricultural innovation, pioneering new paths to fight hunger.

Furrows of artificial light lend an otherworldly aura to Westland, the greenhouse capital of the Netherlands. Climate-controlled farms such as these grow crops around the clock and in every kind of weather.
This photo was originally published in "This Tiny Country Feeds the World" in September 2017.

The brain trust behind these astounding numbers is centered at Wageningen University & Research (WUR), located 50 miles southeast of Amsterdam. Widely regarded as the world's top agricultural research institution, WUR is the nodal point of Food Valley, an expansive cluster of agricultural technology start-ups and experimental farms. The name is a deliberate allusion to California's Silicon Valley, with Wageningen emulating the role of Stanford University in its celebrated merger of academia and entrepreneurship.

Ernst van den Ende, managing director of WUR's Plant Sciences Group, embodies Food Valley's blended approach. A renowned scholar with the casual manner of a barista at a hip café, van den Ende is a world authority on plant pathology. But, he says, "I'm not simply a college dean. Half of me runs Plant Sciences, but the other half oversees nine separate business units involved in commercial contract research." Only that mix, "the science-driven in tandem with the market-driven," he maintains, "can meet the challenge that lies ahead."

With demand for chicken increasing, Dutch firms are developing technology to maximize poultry production while ensuring humane conditions. This high-tech broiler house holds up to 150,000 birds, from hatching to harvesting.

The challenge? Put in bluntly apocalyptic terms, he says, the planet must produce “more food in the next four decades than all farmers in history have harvested over the past 8,000 years.”

That’s because by 2050, the Earth will be home to as many as 10 billion people, up from today’s 7.5 billion. If massive increases in agricultural yield are not achieved, matched by massive decreases in the use of water and fossil fuels, a billion or more people may face starvation.

Hunger could be the 21st century’s most urgent problem, and the visionaries working in Food Valley believe they have found innovative solutions.

The wherewithal to stave off catastrophic famine is within reach, van den Ende insists. His optimism rests on feedback from more than a thousand WUR projects in more than 140 countries and on its formal pacts with governments and universities on six continents to share advances and implement them.

A conversation with van den Ende is a white-knuckle ride on a torrent of brainstorms, statistics, and predictions. African drought? “Water isn’t the fundamental problem. It’s poor soil,” he says. “The absence of nutrients can be offset by cultivating plants that act in symbiosis with certain bacteria to produce their own fertilizer.” The soaring cost of grain to feed animals? “Feed them grasshoppers instead,” he says. One hectare of land yields one metric ton of soy protein, a common livestock feed, a year. The same amount of land can produce 150 tons of insect protein.

The conversation rushes on to the use of LED lighting to permit 24-hour cultivation in precisely climate-controlled greenhouses. It then detours to a misconception that sustainable agriculture means minimal human intervention in nature.

“Look at the island of Bali!” he exclaims. For at least a thousand years, its farmers have raised ducks and fish within the same flooded paddies where rice is cultivated. It’s an entirely self-contained food system, irrigated by intricate canal systems along mountain terraces sculpted by human hands.

Do tomatoes grow best when bathed in LED light from above, beside, or some combination? Plant scientist Henk Kalkman is seeking the answer at the Delphy Improvement Centre in Bleiswijk. Collaboration between academics and entrepreneurs is a key driver of Dutch innovation.

"There's your model of sustainability," van den Ende says.

At the Duijvestijns' 36-acre greenhouse complex near the old city of Delft, visitors stroll among ranks of deep green tomato vines, 20 feet tall. Rooted not in soil but in fibers spun from basalt and chalk, the plants are heavy with tomatoes—15 varieties in all—to suit the taste of the most demanding palate. In 2015 an international jury of horticultural experts named the Duijvestijns the world's most innovative tomato growers.

Since relocating and restructuring their 70-year-old farm in 2004, the Duijvestijns have declared resource independence on every front. The farm produces almost all of its own energy and fertilizer and even some of the packaging materials necessary for the crop's distribution and sale. The growing environment is kept at optimal temperatures year-round by heat generated from geothermal aquifers that simmer under at least half of the Netherlands.

The only irrigation source is rainwater, says Ted, who manages the cultivation program. Each kilogram of tomatoes from his fiber-rooted plants requires less than four gallons of water, compared with 16 gallons for plants in open fields. Once each year the entire crop is regrown from seeds, and the old vines are processed to make packaging crates. The few pests that manage to enter the Duijvestijn greenhouses are greeted by a ravenous army of defenders such as the fierce Phytoseiulus persimilis, a predatory mite that shows no interest in tomatoes but gorges itself on hundreds of destructive spider mites.

A few days before I visited the Duijvestijns' operation, Ted had attended a meeting of farmers and researchers at Wageningen. "This is how we come up with innovative ways to move ahead, to keep improving," he told me. "People from all over Holland get together to discuss different perspectives and common goals. No one knows all the answers on their own."

Nowhere is the Netherlands' agricultural technology more cutting-edge than in the embryonic organism in which most food is literally rooted: seeds. And nowhere are the controversies that surround the future of agriculture more heated. Chief among them is the development of genetically modified organisms to produce larger and more pest-resistant crops. To their critics, GMOs conjure up a Frankenstein scenario, fraught with uncertainty about the consequences of radical experimentation with living entities.

Dutch firms are among the world leaders in the seed business, with close to $1.7 billion worth of exports in 2016. Yet they market no GMO products. A new seed variety in Europe's heavily regulated GMO arena can cost a hundred million dollars and require 12 to 14 years of research and development, according to KeyGene's Arjen van Tunen. By contrast, the latest achievements in the venerable science of molecular breeding—which introduces no foreign genes—can deliver remarkable gains in five to 10 years, with development costs as low as $100,000 and seldom more than a million dollars. It is a direct descendant of methods employed by farmers in the Fertile Crescent 10,000 years ago.

The sales catalog of Rijk Zwaan, another Dutch breeder, offers high-yield seeds in more than 25 broad groups of vegetables, many that defend themselves naturally against major pests. Heleen Bos is responsible for the company's organic accounts and international development projects. She might be expected to dwell on the fact that a single high-tech Rijk Zwaan greenhouse tomato seed, priced below $0.50, has been known to produce a mind-boggling 150 pounds of tomatoes. Instead she talks about the hundreds of millions of people, most of them women and children, who lack sufficient food.

Like many of the entrepreneurs at Food Valley firms, Bos has worked in the fields and cities of the world's poorest nations. With lengthy postings to Mozambique, Nicaragua, and Bangladesh over the past 30 years, she knows that hunger and devastating famine are not abstract threats.

"Of course, we can't immediately implement the kind of ultrahigh-tech agriculture over there that you see in the Netherlands," she says. "But we are well into introducing medium-tech solutions that can make a huge difference." She cites the proliferation of relatively inexpensive plastic greenhouses that have tripled some crop yields compared with those of open fields, where crops are more subject to pests and drought.

Since 2008 Rijk Zwaan has supported a breeding program in Tanzania at a 50-acre trial field in the shadow of Mount Kilimanjaro. Its seeds are sent to Holland for quality control tests on germination rates, purity, and resistance to pests and diseases. Collaborative projects are under

way in Kenya, Peru, and Guatemala. “We try to develop seeds for their specific conditions,” Bos says. But the starting point, she adds emphatically, cannot be the sort of top-down approach that has doomed many well-meaning foreign aid projects.

“We have constant, tremendously important conversations with the small growers themselves—on their needs, on the weather and soil conditions they face, on costs,” she says.

For some Dutch researchers, concern for people threatened by hunger stems in part from a national trauma: The Netherlands was the last Western country to suffer a serious famine. Decades later, WUR’s Rudy Rabbinge, professor emeritus of sustainable development and food security, took up the cause when he helped devise extensive changes in the faculty, student body, and curriculum that transformed the institution into what he calls “a university for the world, and not simply for the Dutch.” Today a hefty share of the academic and research activities at WUR are focused on problems facing poor nations.

Some 45 percent of its graduate students—including nearly two-thirds of all Ph.D. candidates—are recruited abroad, representing more than a hundred nations. Asians, led by Chinese and Indonesians, outnumber almost all non-Dutch Europeans combined. WUR alumni are found in the highest echelons of agricultural ministries across Africa, Asia, and Latin America.

“I met a Wageningen alumna when I was an undergrad in Uganda,” Leah Nandudu tells me when I ask how she wound up here. “She was an expert on phenotyping,” the advanced studies that paint a detailed portrait of a plant’s traits and potential. “It inspired me to discover that an African could do these things. She was the future; she was where we need to go.”

The meeting eventually led Nandudu to a WUR scholarship. Her father farms three acres, split between coffee and bananas. Her mother teaches English in a primary school and helps in the field. “We have all the problems farmers face everywhere today, only much worse, especially due to the consequences of climate change.”

Pragya Shrestha was raised in the Nepali countryside, some parts of which have been wracked by years of reliance on pesticides and fertilizers. Sounder, sustainable methods have made few inroads so far.

“It’s a political problem,” she says. New cultivation methods can’t be implemented because of a shortage of public funding. “It’s also a population problem, the fragmentation of the land into smaller and smaller parcels, suitable only for the use of inefficient human labor and generating very little income.”

In 1944-45 a lethal famine struck the island of Java, where Bandung is located, killing some 2.4 million people. Devastating regional crop failures have haunted Indonesia as recently as 2005. Food supplies periodically run out in rural Nepal because of drought and high prices on essential imports. In 2011 a famine in the Horn of Africa affected 13 million people, and in 2017 1.6 million Ugandans face starvation without rapid assistance from abroad. All these events were unimaginable at the time, yet they pale in comparison to what could lie ahead. The number of people menaced by famine in just three African nations and across the Red Sea in Yemen exceeds 20 million today and is rising inexorably, according to the United Nations. “We are facing the largest humanitarian crisis since the creation of the UN,” the organization’s emergency relief coordinator, Stephen O’Brien, warned in March.

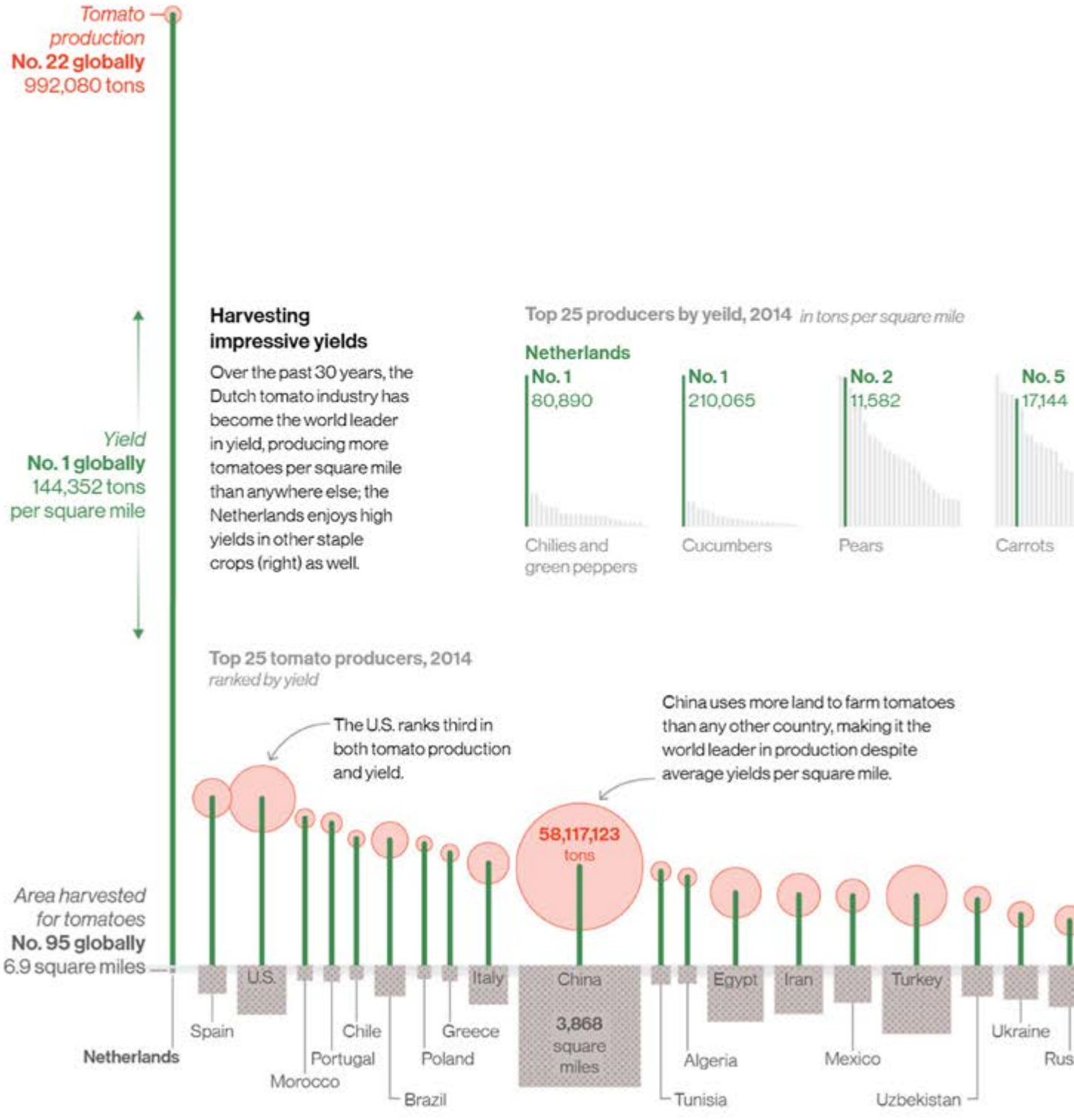
Some 4,000 miles south of Wageningen, in a family-owned bean field in Africa’s Eastern Rift Valley, a team from SoilCares, a Dutch agricultural technology firm, explains the functions of a small handheld device. In conjunction with a cell phone app, the device analyzes the soil’s pH, organic matter, and other properties, then uploads the results to a database in the Netherlands and returns a detailed report on optimal fertilizer use and nutrient needs—all in less than 10 minutes. At a cost of a few dollars, the report provides input that can help reduce crop losses by enormous margins to farmers who have never had access to soil sampling of any kind.

Less than 5 percent of the world’s estimated 570 million farms have access to a soil lab. That’s the kind of number the Dutch see as a challenge.

“What does our work mean for developing countries? That question is always raised here,” says Martin Scholten, who directs WUR’s Animal Sciences Group. “It’s part of every conversation.” ***(Source: National Geographic, By Frank Viviano, Photographs by Luca Locatelli)***

Punching above its weight

The tiny Netherlands has become an agricultural powerhouse-the second largest global exporter of food by dollar value after the U.S.—with only a fraction of the land available to other countries. How has it achieved this? By using the world's most efficient agricultural technologies.

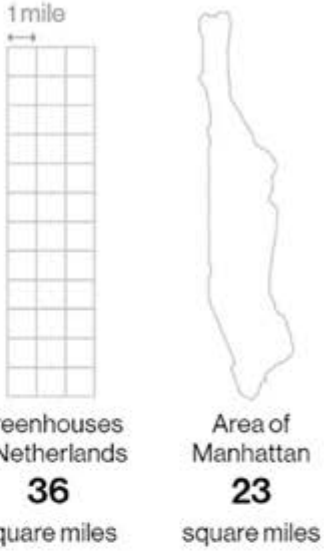


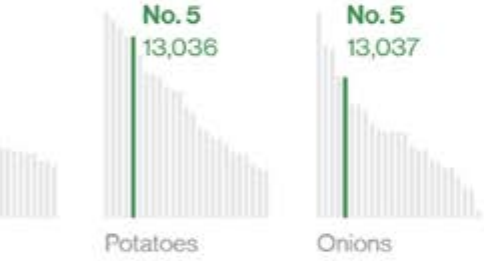
Growing under glass

Dutch horticulture relies heavily on greenhouses, allowing farmers to closely control growing conditions and use fewer resources like water and fertilizer.

Change from 2003-2014

Vegetable production	▲ 28%
Energy used*	▼ 6%
Pesticides	▼ 9%
Fertilizer	▼ 29%

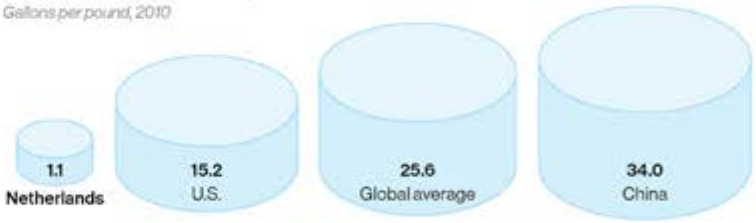




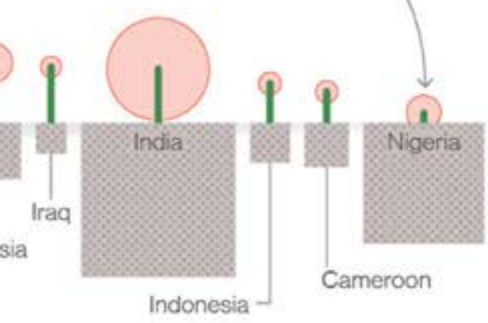
Doing more with less

Utilizing innovations on a large scale, like hydroponic farming—growing plants without soil in nutrient-rich solutions—reduces runoff, saving both water and money.

Total water footprint of tomato production
Gallons per pound, 2010



Nigeria has the third largest area harvested for tomatoes, but the lowest yield among the top 25 producers.



Organic Fertilizer

Market Analysis in Indonesia

Indonesia is the most extensive area in Southeast Asia, which has the largest population in this region. Because of comfortable tropical climate and advantageous geographic location, it is rich in oil, minerals, timber and agricultural products. Agriculture has always occupied a very important position in the economic structure in Indonesia. It accounted for 45% of gross domestic product 30 years ago. The agricultural output accounts for about 15% of GDP at present. Due to the small size of farms, agricultural production is labor-intensive. Since it has large proportion of economy, people pay more attention to increase yield of crops and decrease cost of production. Farmers can use inorganic fertilizer and organic fertilizer for crop growth. It has shown the advantages of organic fertilizer in recent years. The use of organic fertilizer has become a trend, which is in a strong market potential.

Abundance of Organic Materials

In general, organic fertilizer mainly comes from animals and plants, such as livestock manure and crop residues. In Indonesia, crop farming is in rapid development, accounting for 90% in the whole farming industry, while animal farming is 10%. Because of tropical climate and tropical monsoon climate, it provides good condition for tropical cash crop growth. In Indonesia, the main cash crops are rubber, coconut, palm, cocoa, coffee and spice crops. They are all with large yield every year in Indonesia. Taking rice for example, Indonesia was the third rice producer in 2018, reached for 84,000,000 metric tons. Rice production in Indonesia plays an important role in gross domestic product. The production increases year by year. Rice cultivated area is around 10 million hectares in the whole archipelago. Besides rice, Cardamom production accounts for 75% of the world, which makes Indonesia the world's largest cardamom producing country. Because Indonesia is a large agricultural country, there are plenty of raw materials to manufacture organic fertilizers here.

Crop straw

Crops stalks are economic organic materials for organic fertilizer production, which is widely used by organic fertilizer manufacturer. Based on broad planting, the crop waste can be collected easily. Indonesia has about 67 million tons of rice straw every year. In 2013, corn ending stocks amounted to 2.6 million tons, slightly higher than the 2.5 million tons of the previous year. But the crops straw utilization is low.

Palm oil waste

In the past decades, palm oil production in Indonesia has increased nearly threefold. What's more, The area of palm plantation is expanding and the yield is increasing, which has growth potential.

However, we can make better use of the waste. As a matter of fact, it is a better and wiser choice for Indonesia government and farmers to seek the best way to process palm oil waste, such as pelletizing them into fuel pellets, or sufficiently fermenting them into powder organic fertilizers. Whatever methods that can "Turn Waste into Money" should be adopted.

Coconut shell

Indonesia is abound in coconut, which is the largest producer of coconut. Crop residues, such as coconut shell, usually have low nitrogen content, but fairly high potassium and silica content, and a high C/N ratio, which makes them better organic raw materials. It not only helps farmers solve the problems, but also makes full use of the resources to effectively use coconut shell. Furthermore, it provides a way to create profit for manufacturers.

Animal waste

In recent years, Indonesia aims to develop livestock and poultry industry. Cattle population increases from 6.5 million to 11.6 million. Pigs increase from 3.23 million to 8.72 million. The number of chicken is 640 million. With the increasing of livestock quantity, the amount of livestock waste skyrockets. As we all know, animal waste contains many nutrients which is beneficial for the healthy and quickly growth of plants. However, if not being well managed, animal waste will be potential threat to the environment and human health. And if not being completely composted, they won't do favor in crops, even kill them. Above all, it is feasible and necessary to make full use of livestock manure in Indonesia.

From the above summary, we can see that, farming is the strong support of Indonesia's national economy. Therefore, both organic fertilizer and chemical fertilizer plays important role in improving the quality and quantity of crops. Huge quantities of crops stalks produce every year, which, in return, provides rich raw materials for organic fertilizer manufacturing. While organic fertilizer manufacturer seems to be not that easy.

organic fertilizer raw materials

Difficulties Faced by Organic Fertilizer Producers in Indonesia

Small market share

Chemical fertilizer accounts for a large market share in Indonesia. In 2014, the total consumption of fertilizer in Indonesia is approximately 9.55 million metric tons, including 1.00 million metric tons of organic fertilizer. It is one tenth of the whole consumption. As for organic fertilizer manufacturers, to enlarge the market share is the top priority. Therefore, it is necessary to work out the marketing strategy and change the awareness of farmers.

Paying attention to customer and market is the basis for the strategy. Fertilizer companies should meet the needs of customers as much as possible. The companies are supposed to be resourceful according to the change of market the strategy.

Location of industry

Owing to local topography, there are many islands in the country. Indonesia has about the 17,508 islands, of which 6,000 are inhabited. The larger islands are Java, Sumatra, Borneo (some areas belong to Malaysia and Brunei), New Guinea (some areas of the island belongs to Papua New Guinea) and Sulawesi. It depends on the areas of crops, which is relatively scattered. Fertilizer manufacturers should choose a good location for production. It leads to the difficulties in collecting raw materials. What's more, it is related to the economic return of fertilizer companies.

Backward production technology

It takes work to produce organic fertilizer by adopting traditional production technology. It is dirty and tired, which does not meet the needs of the current labor efficiency. The higher labor value is, the more abandon by farmers is. In poor areas, although labor value is low, farmers are willing to engage in this kind of work. Because of smallholders, most of farmers lack of organic fertilizer machinery. It is difficult to transport and use the enormous weight and volume of organic raw materials, including traditional farmyard manure, compost fertilizer and biogas waste fertilizer.

The only way to improve the condition is to introduce advanced production technology. The business manager should be aware that it is important to buy suitable organic fertilizer equipment, from raw materials composting equipment to finished products packaging machine. It provides guarantee for total organic fertilizer production. Moreover, it is the economic base for the company. Therefore, to use organic fertilizer machinery with high quality and low price is the best choice for the investor in Indonesia.

Organic Fertilizer Development in Indonesia

Organic Fertilizer is still in the start stage, so total

production quantity of organic fertilizer is low in Indonesia. Plenty of agricultural residues are not fully utilized and well managed. The main reason is that most farmers are smallholders of the field. Besides that, organic fertilizers are needed in the same acre lands, compared with chemical fertilizer.

Production of organic fertilizer

Production of organic fertilizer is very limited in Indonesia. However, Indonesia Government is increasing its subsidy in organic fertilizer, such as in Bali. The Bali administration is determined to continue transforming the island into an "organic" province, where local farmers embrace healthier and greener organic farming. Bali Governor Made Mangku Pastika declared his administration would increase the subsidy provided for organic fertilizer to encourage local farmers to make the transition from chemical to organic fertilizer. Another key strategy is phasing out the chemical fertilizer subsidy while increasing the organic fertilizer subsidy. The administration completely stopped subsidizing chemical fertilizer in 2012, forcing farmers to pay a higher price for chemical fertilizer.

Previously in 2008, the administration allocated Rp 4 billion for the fertilizer subsidy, all of which went to chemical fertilizer. In 2009, Bali allocated Rp 3 billion to subsidize chemical fertilizer, with Rp 1 billion for organic fertilizer. In 2010, the administration reduced the allocation for synthetic fertilizer subsidies to Rp 2 billion and allocated the remaining Rp 2 billion to organic fertilizers. In the near future, no doubt, organic fertilizer sector will get more subsidy injection.

Utilization and price of organic fertilizer

Indonesia fertilizer use condition compared with Euro-American countries, farmers in Indonesia and many other Asia countries, are not willing to invest organic fertilizers. They are carried away by quick-effectiveness and high subsidies of chemical fertilizer. Meanwhile, they are suffering from the serious problems lead by inorganic fertilizers, such as soil hardening. The disadvantages of chemical fertilizer are increasingly apparent. Considering this, farmers are more likely to apply fertilizers rationally. In areas lacking government subsidy, farmers are interested in applying organic fertilizer. Agricultural income is a big part for smallholders. They are concerned about the cost of fertilizer and high yield of crops. Organic fertilizer is the best choice for the issues. In 2014, the proposal of fertilizer use if estimated around 9.55 million mt, which consist of 4,10 millions mt of Urea, 850 thousand mt of SP-36, 1.05 million mt of ZA, 2.55 millions mt of NPK, and 1.00 million mt of Organic fertilizer. The reference retail prices of those fertilizers are: US$0.15/kg for Urea, US$0.17/kg for SP-36,US$0.12/kg for ZA, US$0.19/kg for NPK, and US$0.04/kg for organic fertilizer.

Use of Fertilizer by Cropping Farms

Cropping Farms	No Fertilizer	Chemical Fertilizer	Organic Fertilizer	Chemical+ Organic	Total
Rice					
Farm Households	1,225,700	10,155,465	94,112	3,516,860	14,992,137
Percentage (%)	8.18	67.74	0.63	23.46	100.00
Maize					
Farm Households	1,010,330	2,472,889	134,648	3,096,828	6,714,695
Percentage (%)	15.05	36.83	2.01	46.12	100.00
Soybean					
Farm Households	215,717	492,888	85,173	370,699	1,164,477
Percentage (%)	18.52	42.33	7.31	31.83	100.00
Sugarcane					
Farm Households	2,819	131,633	4,324	56,683	195,459
Percentage (%)	1.44	67.35	2.21	29.00	100.00

No matter what situation Indonesia organic fertilizer market is facing, the most important thing is that: The preference of consumers directly influences the investment of manufacturers. though organic fertilizer production industry are not that prosperous in Indonesia, for many investors in Indonesia, the earlier you set about, the more profit you will earn. The "cake" is limited, after all. Although there are lots of difficulties impeding the growing of organic fertilizer, there are still opportunities for investors to seek.

Indonesia Government Subsidies to Organic Fertilizer

To encourage farmers to apply adequate amount of fertilizer, Indonesia government has provided subsidies as one of the main policy instruments. The implementation of fertilizer subsidy is motivated by the fact that most Indonesia farmers are smallholders with limited capital. The subsidized fertilizer consist of Urea(nitrogen), ZA(nitrogen), SP-36(phosphate), NPK(compound fertilizer) and organic fertilizers.

Nowadays, farmers and government have realized the advantages of organic fertilizer. It is not only cheap, but also improve the condition of soil. Government advocates the development of organic fertilizer.

Market and subsidized price of fertilizer in Indonesia

Fertilizer	Market price (US$/kg)	Subsidized price (US$/kg)	Percentage of subsidy
Urea	0.3	0.15	50
NPK	0.48	0.19	60
Organic	0.16	0.04	75

From the table, we can see that the government places emphasis on organic fertilizer. Obviously, percentage of subsidy of organic fertilizer is the highest. Organic fertilizer has an advantage in price. The subsidy of fertilizer in Indonesia started from 1971. Moreover, the subsidy is increasing all the time. The subsidy is concentrated on smallholders in the near future.

Huge Potential Organic Fertilizer Market

In 2019, the market of chemical fertilizers and bio-fertilizer market in Asia-Pacific was $ 93.48 billion. It is expected to have a CAGR of 3.8% in 2020 ~ 2025. The main driving factors contributed to changes in the fertilizer market in Asia Pacific are related to the following aspects.

Enormous fertilizer consumption

The first is the rising crop prices. In the Indonesia, oil palm and rubber trees are the main cash crops. Over the past few years, the price of these crops has almost doubled, prompting farmers to actively cultivate these crops and increase output. With the rising price of crops, fertilizer consumption in the forecast period will grow rapidly.

Small competitiveness

Organic fertilizer production is not in large quantity. The number of organic fertilizer companies are small as well. As for investors, it is good for put into the production of organic fertilizer. It is important for a company to seize the opportunity in the early stage. The smaller competitiveness is, the bigger potential is in the market.

Sustainability and cost efficiency

Sustainability and cost efficiency are the decisive factors hen farmers buy fertilizer. The negative impact of chemical fertilizers on the environment makes organic fertilizer becomes the optimal choice. By contrast, organic fertilizer can increase soil microbial communities and absorption of nutrients in the growth of plants. A more important fact is that the price is less than half of chemical fertilizers.

Improvement of utilization rate of materials

Low utilization rate of raw materials is the ongoing problem in Indonesia.

It is badly in need of organic fertilizer manufacturers to produce organic fertilizer, which meets the need of farmers. It not only helps farmers solve the problems of waste issues, but also increases the utilization of raw materials.

Organic fertilizer market analysis in Indonesia

Organic fertilizer is cheap as you point out, put nutrient density is also much lower. So you should calculate nutrients per kg to assess the real price of it as fertilizer. This is not so easy as it is not a standardized product. But if you do not treat it as a fertilizer per se you could get around this completely.

I think the question should not be whether to use organic or chemical fertilizer but which to use for what. Organic fertilizer can improve physical aspects of the soil like soil structure, soil organic matter as well as water and nutrient retention capacity, while it on top provides some plant nutrients. Chemical fertilizers are plant nutrients but when applied to degraded soils their use is limited. But when organic and chemical fertilizer application are combined they might actually lead to the most efficient results.

Organic fertilizers (OFs) need to be applied in relatively large amounts to show maximum effect, which makes them labour intensive if mechanisation is not available on-farm. This is an important reason for farmers not to buy them. If a service could be offered to bring OFs directly to the field and spread them there, this might increase their attractiveness. But in Indonesia's more remote and rugged areas this might be difficult.

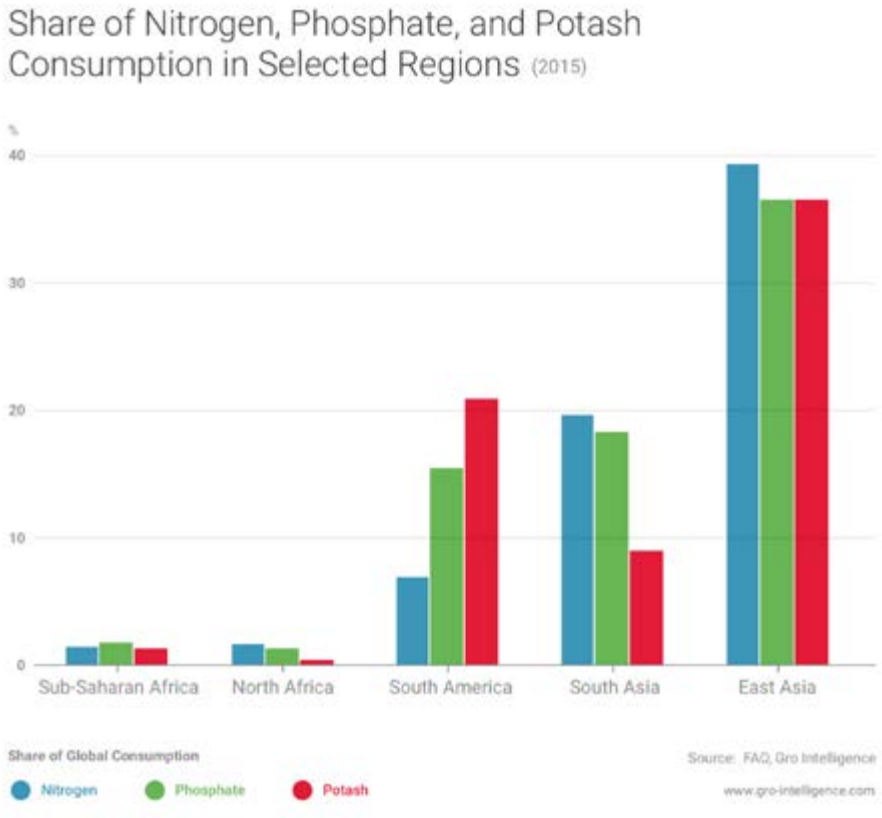
So, as much as I agree with you that this is a great opportunity, I also think that it is one that faces a couple of additional challenges to chemical fertilizers, as the product, despite the same name it was given, is essentially quite different. I think it will require a shift in agricultural practices, with all the learning and infrastructure required for this. If this can be addressed by the private sector alone, I am not sure, but in environments like Bali it might. Let's wish for the best. *(Source: fertilizer-machinery.com)*

The World's Most Expensive

Fertilizer Market: Sub-Saharan Africa

Large scale investments in fertilizer production are a rarity in sub-Saharan Africa. As such, the African agriculture sector watched with great interest when, in November 2016, Morocco's OCP Group, the world's leading phosphate exporter, signed a US$3.7 billion deal with Ethiopia's state-owned Chemicals Industries Corporation (CIC) to build a fertilizer plant in Ethiopia. The country, currently a net importer of fertilizers, would be home to one of the largest fertilizer complexes in the world, which is projected to satisfy the entirety of the local demand with enough left for export to regional markets.

Increased regional production could help address the issue of high fertilizer prices in sub-Saharan Africa, which uses significantly less fertilizer per hectare than the world average. Globally, across all crops, farmers apply 135 kg of fertilizers per hectare of arable land, while in sub-Saharan Africa that figure is closer to 17 kg.



Smallholder farmers make up 70 percent of the population in sub-Saharan Africa, and their productivity is held back, in part, by high fertilizer prices. Although fertilizer usage in the region has grown in recent years, a variety of factors keeps application rates in Africa low—in particular logistics costs and limited domestic production. That is why efforts to reduce the costs of shipping fertilizers in Africa, as well as greater investment in production, should be welcome news for the continent.

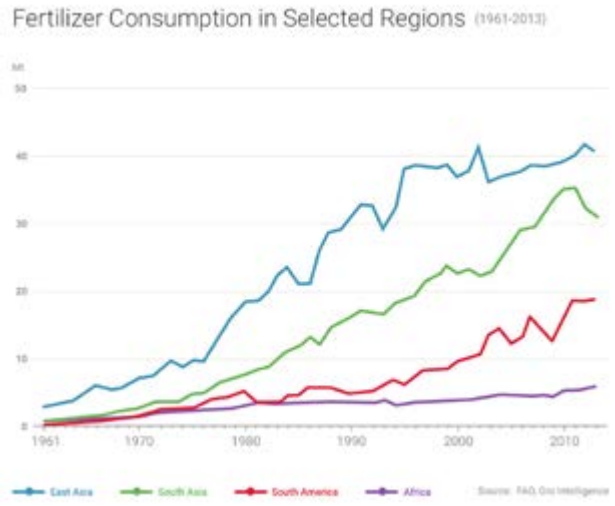
Background

Fertilizers come in different compounds and blends. Compounds are chemically processed to have all the

specified units in one granule, while blends are a physical mixture of different minerals and nutrients in customized proportions. Blends tend to be cheaper but less consistent in quality.

Producers in sub-Saharan Africa use more urea than any other type of fertilizer because it is one of the cheapest sources of nitrogen. The region consumes nearly 3 million tonnes of urea annually, and it makes up more than 40 percent of its total fertilizer consumption. The second-most popularly consumed fertilizer in Africa is NPK, a term applied to a wide variety of fertilizer blends and compounds that are composed of a combination of nitrogen, phosphate, and potassium.

Fertilizer application rates in sub-Saharan Africa are low relative to the rest of the world. In 2006, average fertilizer use in Africa was about 8 kg per hectare—a tenth of the global average. In that same year, African Union member states met in Abuja, Nigeria and adopted the "Abuja Declaration on Fertilizer for the African Green Revolution," pledging to increase fertilizer use to 50 kg per hectare by 2015. Over the last few decades, policymakers linking low fertilizer use to low yields, have attempted numerous interventions to promote fertilizer use across the continent. Yet in spite of the Abuja Declaration and its lofty aspirations, the average fertilizer application rate in Africa today still languishes between 13 and 20 kg per hectare.



Due in large part to low fertilizer use, crop yields in sub-Saharan Africa are significantly below that of other regions. As an example, average maize (corn) yields in Kenya are about a sixth of US yields. Although sub-Saharan Africa dedicates nearly as much land to growing corn as the US, it produces a sixth of US output.

High transport costs hold back fertilizer usage

The high cost of fertilizers in sub-Saharan Africa restricts how widely they can be used. A 2011 study found that fertilizer costs in sub-Saharan Africa were at least four times more expensive than they were in Europe. Even more troubling, studies have shown that while global fertilizer prices have fallen in real terms, that trend hasn't been reflected in sub-Saharan Africa. Country-by-country data shows widely divergent fertilizer use rates. One World Bank study found that imported fertilizer inputs in Zambia cost 30 to 40 percent more than in Thailand. Another report found that a bag of fertilizer in Uganda could cost local farmers double the sum paid for by farmers in the United States or Europe.

Among other challenges, the cost of transport is a major factor that makes fertilizer prices high. As Grace Chilande of the International Fertilizer Development Center (IFDC) tells Gro Intelligence: "Fertilizer is a logistics game." Because domestic production of both fertilizer compounds and blends are very limited, most of these nutrient inputs need to be transported across great distances.

There are two major transportation costs involved in getting fertilizer to sub-Saharan African countries: ocean shipping costs and inland trucking and rail costs. Both are higher than in other regions of the world.

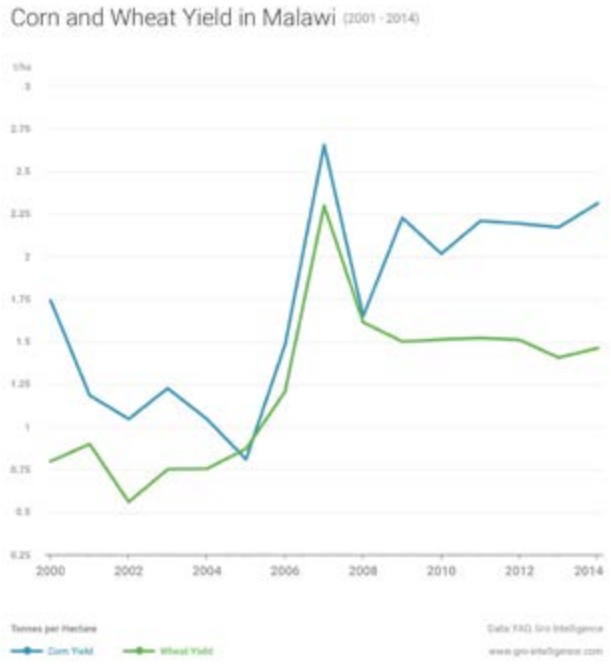
On the ocean side, limited port capacity means that importers must use smaller vessels, which increases the landed costs per container or tonne. At the port, poor infrastructure slows the rates of discharge, which increases congestion and raises the risks of demurrage costs on shippers. Limited numbers of warehouses, aged cranes, and other port issues prevent the swift discharge of goods.

On land, limited rail infrastructure and poorly-maintained roads make it difficult for goods to reach inland countries. Almost as important, governments impose a considerable number of checkpoints on trucking, so that truckers must pay many fees and bribes. A 2011 study found that the retail cost of fertilizers increases proportionately with distance; urea was significantly more expensive in western Kenya than the port city of Mombasa, and almost twice as expensive in landlocked Malawi. Although regional agreements have reduced the costs of some cross-border fees, they haven't been abolished completely, and in many places they're still very high.

Fertilizer production on the continent has also been difficult because, importation of raw materials is costly. Production is also governed by strict regulations. Tanzania, for example, requires three years of trials with the Tanzania Fertilizer Regulatory Authority before a firm can begin production. While trial periods are less in other parts of sub-Saharan Africa, they are usually substantial enough to limit production.

The costs of fertilizer production on the continent are also high because nitrogen fertilizers in particular require a great deal of energy to produce. Nitrogen fertilizer production alone accounted for 2 percent of global energy demand in 2014. In a region where electricity is expensive and not always reliable, energy is a limiting factor for domestic fertilizer production.

A study found that in Nigeria, fertilizers were so expensive



that the benefits of using them were outweighed by their cost. Governments have responded by creating subsidy programs, but their effectiveness has been mixed. Fertilizer programs that were popular in the 1980s had been mostly phased out by the 1990s.

Malawi is a country that has gone especially far in extending fertilizer subsidies. The country spent massively on its fertilizer subsidy program starting in 2005, with the program taking up 13.5 percent of the national budget by 2009. In those five years, fertilizer use in the country nearly doubled; among other increases, it more than doubled the yield of corn. However, as the country tightened its budget, the government substantially cut fertilizer subsidies. While Malawian corn yields held steady for a few years, they've fallen nearly 40 percent since 2014, due to a mix of reasons, including El Nino and fertilizer cuts.

Nigeria is another country that cut back its fertilizer subsidy programs. In 2012, its agriculture minister estimated that as little as 11 percent of subsidized fertilizer was actually passed through to smallholder farmers at the prescribed price. Instead, much of the fertilizer had gone to middlemen, who resold it at market rates. While subsidy programs have had success in increasing yields, they have often been too expensive or poorly managed to help farmers on a sustained basis.

Improving production and lowering costs on the continent

Although subsidies can help reduce the costs of fertilizers, they can also discourage the formation of a vibrant domestic fertilizer industry. Instead, countries may do better by targeting transportation costs, which would ensure better distribution to more farmers. In a study

focused on Nigeria, the World Bank found that reducing transportation costs by 50 percent would increase the number of plots with profitable fertilizer use by 40 percent; if costs fell by 75 percent, then the number of plots could increase by 60 percent.

In addition to lowering the costs of transportation, the region is looking at different ways to improve production. Current sub-Saharan African fertilizer plants tend to be small, and thus they can't easily reach the same economies of scale that larger overseas plants enjoy. They also tend to have to import raw materials at higher costs than other parts of the world. By reducing the costs of sourcing raw materials, countries may be able to raise the levels of domestic production.

Local companies are starting to find more success in sourcing raw materials from within the continent. Businesses have been acquiring urea from natural gas reserves in Nigeria, Egypt, and more recently, Gabon. They are mining phosphate in Mali, Senegal, Togo, and soon Uganda. And they are manufacturing nitrates from ammonia sources in South Africa and Zimbabwe. These raw materials are making it possible to produce custom blends and compounds on the continent.

The OCP-CIC fertilizer joint venture in Ethiopia is a prominent example, and a hopeful sign that the region will produce more fertilizer. The OCP Group claims that the plant is expected to produce around 3.5 million tonnes of fertilizer a year when it reaches peak production in 2025. That's considerably more than the 0.7 million tonnes Ethiopia is currently consuming per year and the 1.2 million tonnes that the International Fertilizer Development Center has suggested the country should be applying to maintain optimal soil conditions.

In addition, there are several other examples of investments in fertilizer production on the continent. Toyota Tsusho has built a large new fertilizer plant in Eldoret, Kenya; it will focus on producing fertilizers that are customized for regional soil types and local crops. Like Ethiopia, Kenya currently imports nearly all of the fertilizer it consumes, around 600,000 tonnes a year. The Toyota Tsusho plant is expected to reduce the country's imports by up to 25 percent.

Conclusion

Africa wants to usher in its own Green Revolution, and raising fertilizer application rates will be one of the main drivers. To increase fertilizer consumption, the costs of fertilizers, among other factors, needs to come down substantially. The region is expected to significantly increase demand for fertilizers over the next decade. The FAO's World Fertilizer Outlook report projected that of all world regions, sub-Saharan Africa will see the fastest growth in fertilizer demand at 4.7 percent, this rate is much higher than the world average of 1.8 percent.

To increase fertilizer use to the levels of aspired to by the Abuja Declaration, there will have to be a meaningful increase in regional production and lower transportation costs. There are hopeful signs on the production front. In addition to greater investments from major producers (like the OCP Group and Toyota Tsusho), governments and NGOs are also promising capital. At a meeting of the Alliance for a Green Revolution in Africa organization, various groups pledged over $30 billion to transform agriculture over the next decade. These funds are directed towards significant efforts to modernize production efforts and to bring more fertilizers to farmers. ***(Source: Gro Intelligence)***

Yara's Incubator

Farms Demonstrate Ongoing Quest for Knowledge

Yara is a global crop nutrition company that has been selling products and solutions since 1905 and employs more than 17,000 workers worldwide. The company places a heavy focus on increasing knowledge in crop nutrition and environmental solutions. One way it does that is by investing to find real-world solutions to crop nutrition needs.

To support this mission, the company established the Yara Incubator Farms in Auburn, Alabama; Modesto, California; and Saskatoon, Saskatchewan, as a place to explore, evolve, refine and share knowledge. Field-scale soil fertility and crop nutrient management research will be done at the combined 240-acre farms in collaboration with partners, customers, and various technology providers.

The incubator farms enable Yara and its partners to gather data and intimate knowledge of every aspect of the cropping system over the years. The Auburn farm, established in partnership with Auburn University, is currently growing corn, cotton, and soybeans on 80 acres, 60 of which are irrigated. The Modesto farm has 40 acres of fertigated and established almonds, and 40 acres of irrigated and established walnuts. The 80-acre Saskatoon farm will be established in 2020 near the Ag In Motion site and focus on the common rotational dryland crops wheat,

canola, and pulses.

Toby Goodroad, market development director for Yara North America, says that Yara's investment in incubator farms and supporting research demonstrates the commitment Yara has to growers and dealer customers.

"These farms are used to generate new knowledge, to try to understand the cropping system as a whole and provide our commercial teams agronomic arguments to try to change things or benefit the industry," Goodroad said. "We have a little over 800 agronomists on the ground globally working with farmers, working with dealers, trying to provide solutions."

Goodroad added that their agronomists are always hungry for information and to be trained on the latest science as they are the technical expert of Yara's fertilizer products. Their collective knowledge helps Yara create trust in the marketplace and bring proper solutions for farmers around the globe.

"I think knowledge is key. We want to sell the right products because at the end of the day, farmers and dealers expect results," said Goodroad.

The research done on these fields aim to improve nutrient and water use efficiency. Using 4R Nutrient Stewardship principles combined with cultural practices and proper water management, Yara intends to find areas where improvements can be made.

"How can we continuously feed fertility through the season, versus big shots only a few times a year?" Goodroad asked, referring to their research. "How do we keep nutrients and water in the root zone where the crop can access it?" Regarding fertigation he said, "That all comes back to water again, but it also comes back to your ability to manage the fertility going into the irrigation system."

Goodroad says "Yara wants to help improve the sustainability of the farmer. And the incubator farms can provide some clear answers on how to advise farmers to do things in the most sustainable way."

"We're a small voice at the end of the day, but we need to work together and build trust. It's not all about sales, but it's all about being here for the next several centuries."
(Source:TFI, By Jennifer Martin)

MARKET SCOPE

An Interview with Shan Junwei

General Manager of Seawin Biotech Group

1. After a long-term unremitting development, Seawin Biotech Group has reached the leading enterprise of China's seaweed fertilizer, what is your philosophy?

Seawin Biotech Group adheres to the enterprise tenet of "talent-oriented, technological leadership, innovative development, and serve the society", follows the enterprise spirit of "broad, ambitious, innovative, and beyond", and strives to make contribution for the development of China's blue ocean economy.

2 How does Seawin Biotech Group insist on technological innovation and drive high-quality development of enterprises?

Seawin Biotech Group originated from China's most influential institution in marine research---China Ocean University, and has always maintained close cooperation with professional research institutes such as China Ocean University and the Institute of Oceanology, Chinese Academy of Sciences.

The company also has a R&D team of more than 100 people, dedicated to technological innovation and product development, and strictly controls the production process and product quality.

Seawin Biotech Group has invested heavily in the construction of a modernly managed production workshop in recent years, and all the supporting equipment uses products from internationally renowned manufacturers.

These software and hardware provide guarantee for the quality of Seawin Biotech Group products.

3 . Seawin Biotech Group actively explores the international market, how is your international market, and how does it work?

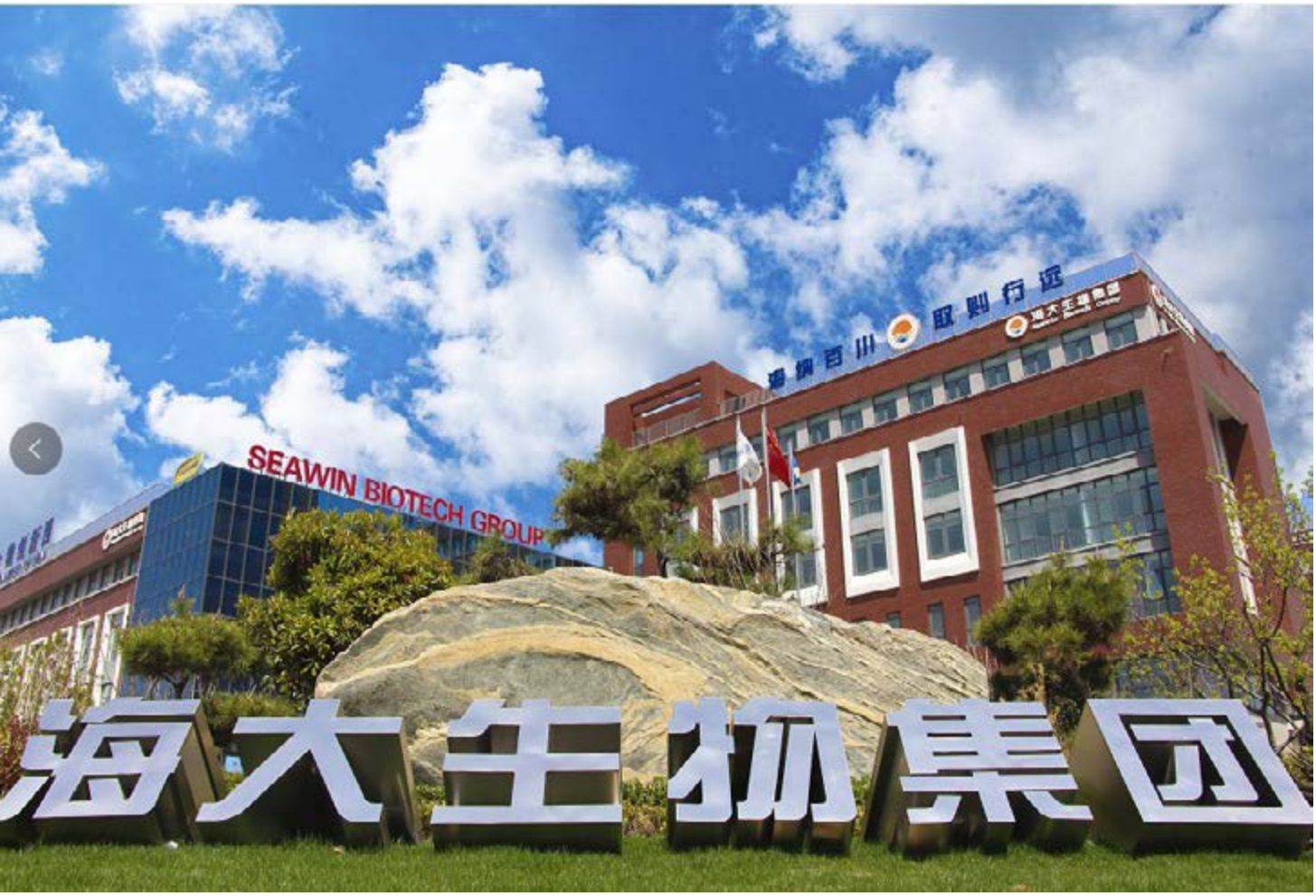
Seawin Biotech Group has entered the international market since 2004.

The products currently sold to overseas markets are mainly high-value-added seaweed extract products and liquid water-soluble fertilizers rich in seaweed active substances.

Organic fertilizers produced with seaweed as raw materials have been widely used in Europe, North America and other regions as early as a few decades ago. Although the seaweed fertilizer industry has only been rising in China for more than a decade, and the domestic market is still in a stage of slow acceptance, there is a lot of room for such products in the international market.

At present, the overseas markets of Seawin Biotech Group 's seaweed fertilizer products are mainly concentrated in Europe, Asia, Middle East, North Africa, Southeast Asia, America and other regions.

The current global economy continues to be sluggish, and the agricultural market is suffering from climate and economic conditions. In the first quarter, China's total import and export values continued to decline, and bilateral trade with major trading partners such as the European Union, the United States, and ASEAN declined.



▲ *Production base in Jiaozhou*

▲ *Production base in Rushan, Weihai*

▲ *Production base in Rongcheng, Weihai*

However, under the severe environment of the overall foreign trade situation, there are still some outstanding enterprises in various industries that maintain a strong development trend and continue to grow sales.

Chinese companies used to compete in the international market in the past, mainly relying on the low cost advantages of manpower and raw materials, and winning by price and quantity. Most of them do not pay attention to product quality, and the planning and long-term development of the company's own brand.

Under the ever-evolving and changing global economy, now Chinese companies want to survive and establish a corporate brand in the international market, they must rely on excellent quality and continuous innovation to achieve long-term development planning. Otherwise, sooner or later, you will be out of the development of the industry.

In the 20 years since its establishment, Seawin Biotech Group has always adhered to quality first, technological development, cherished the reputation of enterprises and brands, and has always maintained good cooperative relations with domestic and foreign customers.

Seawin's products are closely related to agricultural cultivation. The quality of the product is not simply reflected in the effect. The choice of product and the method of use may affect the final effect, and even the local soil and climate conditions will be the influencing factors.

How to combine local crops and planting conditions, and truly provide farmers with appropriate fertilizer recommendations to be economical and efficient is the key to developing international markets. In the international market, we will also combine technical support with agrochemical services and sales to carry out

targeted product promotion and sales. While improving the efficiency of the enterprise, it also brings tangible benefits to local farmers.

4. What is the layout of Seawin Biotech's Production and R&D base?

Since its establishment, Seawin Biotech has focused on the marine biological industry, and has formed four major business sections: "new marine biological fertilizers, functional marine biological products, marine environmental protection services, and marine health food supply chain."

In 2006, a production base for seaweed bio-fertilizer and marine biological products was built in Qingdao Jiaozhou Economic Development Zone, and in 2009, the only domestic high-value utilization base of green algae resources was built in the Jiaozhou production base, and two vessels with a total displacement of 1 A 10,000-ton marine environmental protection service platform, in 2014, built an oyster resource utilization and fish protein production and processing base in the Rushan Binhai New Area of Weihai, and established a marine health food supply chain processing base using kelp as the main raw material in Rongcheng Lidao in 2017.

In 2020, construction of functional marine biological product industrial bases such as "marine tool enzymes, biostimulants derived from double algae, marine biocides, non-anti-feed additives, marine protein peptides" will be started in Qingdao High-tech Zone.

The industrial base located in the Jiaodong Peninsula Economic Circle covers a total area of 520,000 square meters, which provides strong support and guarantee for the industrial upgrading of enterprises and the conversion of old and new kinetic energy.

5. Seawin Biotech attaches great importance to the research on the mechanism of algae polysaccharides and algae oligosaccharides, talk about the progress in this area.

"We have opened a new era of biological seaweed fertilizers. All products use fresh seaweed, using microbial fermentation and biological enzyme degradation to obtain the seaweed polysaccharides and seaweed oligosaccharides needed for plant growth. These two high-purity substances are natural biostimulant has strong biological activity and efficiency. It has a good promotion effect on plant growth!" Seawin Biotech makes full use of the rich brown algae and green algae resources in Jiaodong Peninsula, and according to the different and special characteristics of the two algae nutrients , use special large-scale equipment and special technological process to start a new model of double-algae linkage degradation, and each of the two seaweeds contains special nutrients to form a synergistic and complementary advantage, while enhancing fertilizer efficiency and improving crop disease and stress resistance. Greatly improve the quality of agricultural products, achieve the effect of increasing production and income, and the benefit per mu can be increased by more than 30%!

6. Briefly talk about your understanding and suggestions for the current Chinese seaweed fertilizer industry.

At present, seaweed fertilizer has formed a vigorous development trend in the domestic market. The formation of this good situation has a lot to do with the promotion of several major seaweed fertilizer companies. Seaweed fertilizer has high efficiency and high cost performance, and is a reliable and stable new fertilizer. At present, the development opportunities of seaweed fertilizer are very good, which is of great significance to the realization of the goal of "soil weight loss and zero growth of chemical fertilizer" in my country.

Based on the “Zero Fertilizer Zero Growth” policy proposed by the state and the current situation of rural land in my country in urgent need of improvement and the impact of market conditions, I believe that the development space for new fertilizers will become larger and larger, and it can even be said that the future is “unmatchable”. However, at this stage, we must soberly see that the research and development and promotion of new types of fertilizers in China are still in their infancy, and the products are mixed. If Chinese agricultural enterprises really want to change the status quo in rural areas, they must take scientific and technological research and development as the premise. Only by going all out to control the quality of good products can we really benefit the Chinese land, the Chinese farmers and the Chinese agriculture!

SEAWEED

Laminaria Enteromorpha

- Pure Extract
- Biostimulant
- Chelated Trace Elements
- Functional Fertilizer

SEAWIN BIOTECH GROUP

海大生物集团

Rising Uncertainties

From Covid-19 Cloud Medium-term Agricultural Prospects

The fight against the global COVID-19 pandemic is causing unprecedented uncertainties in global food supply chains, with potential bottlenecks in labour markets, input industries, agriculture production, food processing, transport and logistics, as well as shifts in demand for food and food services. In the short term, the economic and social impacts of the pandemic interrupt the generally positive medium-term outlook for global agricultural production and food consumption. Governments face the challenge to create balanced policies that address immediate needs, such as labour shortages and create durable conditions for the agricultural sector to 'build back better,' according to a new report presented today by OECD Secretary-General Angel Gurría and UN Food and Agriculture Organisation (FAO) Director-General QU Dongyu.

The joint OECD-FAO Agricultural Outlook 2020-2029 report finds that over the next ten years supply growth is going to outpace demand growth, causing real prices of most commodities to remain at or below their current levels. Fluctuations in the driving factors of supply and demand could lead to strong price variations around this general path. At the same time, a decrease in disposable incomes in low-income countries and households caused by COVID-19 is expected to depress demand in the early years of this outlook and could further undermine food security.

An expanding global population remains the main driver of demand growth, although the consumption patterns and projected trends vary across countries in line with their level of income and development. Average per capita food availability is projected to reach about 3,000 kcal and 85 g of protein per day by 2029. Due to the ongoing transition in global diets towards higher consumption of animal products, fats and other foods, the share of staples in the food basket is projected to decline by 2029 for all income groups. In particular, consumers in middle-income countries are expected to use their additional income to shift their diets away from staples towards higher value products. Meanwhile, environmental and health concerns in high-income countries are expected to support a transition from animal-based protein towards alternative sources of protein.

Open and transparent international markets will be increasingly important for food security, especially in countries where imports account for a large share of their total calorie and protein consumption. "A well-functioning, predictable international trade system can help ensure global food security and allow producers in exporting countries to thrive," Mr Gurría said. "Experience has shown that trade restrictions are no recipe for food security."

FAO Director-General Qu said: "We need better policies,

more innovation, increased investments and greater inclusiveness to build dynamic, productive and resilient agricultural and food sectors."

About 85 percent of global crop output growth over the next decade is expected to come from yield improvements resulting from higher input use, investments in production technology and better cultivation practices. Multiple harvests per year will account for another 10 percent of crop output growth, leaving only 5 percent to cropland expansion. By 2024, aquaculture production is projected to overtake capture fisheries as the most important source of fish worldwide. Global livestock production is expected to expand by 14 percent, faster than the projected increase in animal numbers. Feed use will expand in line with aquaculture and livestock production as feed efficiency improvements will be counterbalanced by an increase in feed intensity due to reduced backyard farming.

The Outlook underscores the continuing need to invest in building productive, resilient and sustainable food systems in the face of uncertainties. Beyond COVID-19, current challenges include the locust invasion in East Africa and Asia, the continued spread of African swine fever, more frequent extreme climatic events, and trade tensions among major trading powers. The food system will also need to adapt to evolving diets and consumer preferences and take advantage of digital innovations in agro-food supply chains. Innovation will remain critical in improving the resilience of food systems in the face of multiple challenges.

Assuming the continuation of current policies and technologies, agricultural greenhouse gas emissions are projected to grow by 0.5 percent annually, indicating a reduction in agriculture's carbon intensity. Livestock will account for 80 percent of this global increase. Nevertheless, without additional efforts, this slowdown will still fall short of what the agricultural sector could and should do to contribute to the Paris Agreement targets for fighting climate change. ***(Source: modern diplomacy)***

Focus on the Trend

and Build the World Wide Leading Microbial Fertilizer Factory

An Interview With Mr. Guo Xinglong, Chairman of Hebei Monband Water Soluble Fertilizer Co., LTD.

"Rational use of microbial fertilizers is benefit at less application of pesticides and fertilizer and reducing pollution at the same time."

HEBEI MONBAND WATER SOLUBLE FERTILIZER CO., LTD. was founded in 2009, which is a water soluble fertilizer factory specialized in fertilizer R&D, production, marketing and Agricultural services. The factory is running 6 production lines for macro elements fertilizer, 2 production lines for secondary elements fertilizer, 3 lines for liquid fertilizer filling, fertilizer filling line for bucket, high shear micro granulation line, In-situ reaction coating line (polyurethane coating), tablet pressing line and so on. The annual production capacity is 200,000mt. Monband was listed on New OTC (Over the Counter) Market in 2017. Stock name shorted as: MONBAND, stock code: 872623.

MONBAND is high-tech enterprise and IFA (International Fertilizer Association) member, recommended supplier by CAC. Monband obtains 5 national invention patents, and other 5 products registers REACH certificate. The trade mark "MONBAND ®" is registered at more than Madrid Agreement, EUIPO, South Africa, India, Japan, Korea, New Zealand, and Brazil.

1. Could you please update the company's recent activities?

With the government policy announcement of agrochemical reducing and income increasing, MONBAND aims at long term development and begin to change its products structure. In the process of communicating with European customers, we all reach an agreement on the mainstream product of the future is microbiological fertilizer. Rational use of microbial fertilizers is benefit at less application of pesticides and fertilizer and reducing pollution at the same time. So we invest in bacillus fertilizer.

In recent years, we contribute a lot of resource on the project of silica solubilizing bacillus (Bacillus Aryabhattai). Base on this bacillus, we work on its theoretical research, production R&D and field application trails.

The project was began in 2017. In 2018 MONBAND cooperated with American Chinese Dr. Yaowei Kang the world-renowned microbiologist, and built R&D team specialized in silica solubilizing bacillus. The team devoted to project of selecting one or a class of bacillus strain, which should be unique, versatile and solubilized silica strongly. We collected 34 soil samples from 16 counties in 10 provinces in China. From samples we obtained more than 20,000 bacillus strains, there found 34 new generas and selected 206 bacillus strains with method of Enrichment Plate High-Throughput (So far, MONBAND has the world's largest library of silica solubilizing microbial strains). After confirmation, most of the stains were never reported before on its silica solubilizing ability. Instantly our team do a lot of safty experiments on 206 bacillus strains, like high temperature resistance, salt resistance, acid and

alkali resistance, hemolysis safety, and testing like survival rate after mixing with the popular crop protection products, sporulation rate, stimulation of crop root growth and so on. Finally there came out one outstanding strain No. MB35-5, which we named as Bacillus Aryabhattai and will be marketed as a series of fertilizer product.

In October, 2019 Bacillus Aryabhattai was registered as Agrobacterials with a biomarker system, traceable.

In beginning of 2020, our outstanding discoveries was reported by a lot of national media like Xinhua News Agency, Peoples Daily, Science and Technology Daily and so on. Dated 20th March, 2020 the Seminar on Agricultural Applications of Silica Solubilization Bacillus was hold by China Agricultural Media and Monband Company.

Above is our study achievement.

2. Microbial fertilizer is still quite new among Chinese planters, then how will you launch the market?

So far we already developed 4 kinds of Bacillus Aryabhattai. The application data on crops is accumulated through 115 field trails on 18 kinds of crop. The data suggests that after application of Bacillus Aryabhattai the thickness of the leaves is increased. That will benefit at photosynthesis and yield.

In 2020 we enhance field trails through synergy work among Crop Technology Dep., Marketing Dep., and Sales Dep. There will be 550 field trails on 22 other kinds of crops finished this year to study and discover the most efficient application technique on main crops. At the same time with the accumulation of trail data, the record is updated and new benefit is discovered. Seeing is believing, field trail is always the most direct way of marketing. In China large quantity of planters already learned the effect of Bacillus Aryabhattai.

Nowadays the domestic market of microbial fertilizer has taken shape initially, but the share is still very low. That means there is very large market space we can develop. The Bacillus Aryabhattai is recorded in biomarker system. It is traceable and with plenty of data and theory supported. Bacillus Aryabhattai is not a ambiguous product.

3. With such a new potential product, did you have any new plan on the company next development?

We always keep development base on industry trend. In the first ten years, we keep high lever investment on R&D project. Every year 3% of total income is put into R&D department and get some fruit. In the following years, MONBAND will underline its strength on professional R&D team, advanced technology and processing capacity. The business develop in 4 fields: branding MONABND trademark internationally, expanding OEM and ODM service oh high level, cooperating with plantation and designing fertilizer package, and expanding supply chain trade. Build the world's leading microbial fertilizer factory.

MONBAND®

CAC 2021

BOOTH NO.: N4C05
3-5 Mar., 2021

COMPANY INTEODUCTION

- 6 production lines for macro elements powder water soluble fertilizer. Annual output is 60,000 mt.
- 2 production lines for secondary elements granular fertilizer. Annual output is 20,000 mt.
- 3 production lines for liquid fertilizer. Production capacity: 5000bottles/hour for 100ml-1000ml package, 1000-3000buckets/hour for 1000-5000ml package, 240-360buckets/hour for 10-25 liter package.
- In-situ reaction coating line.
- High shear granulation line.
- Granular full airtight production line.

PRODUCT SERIES

Powder type water soluble NPK

(NPK+TE, NPK+Ca+Mg, NPK+HA,NPK+AA, NPK+seaweed)

NPK+TE , NPK+Ca+Mg

NPK+AA , NPK+seaweed

Liquid fertilizer+Bio-stimulant

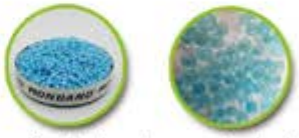
Clear liquid fertilizer
Amino acid liquid fertilizer

HA liquid fertilizer,
Seaweed liquid fertilizer

Granular type secondary element water soluble fertilizer

Optional TE, Bio-stimulant, low nitrogen magnesium kind

Coated Fertilizer



Polyurethane coating technology, control released fertilizer.

Straight water soluble fertilizer

Crystal powder and Granular

MAP, MKP, SOP, AS, Calcium Nitrate, Potassium Nitrate, Urea Phosphate, Magnesium sulfate, Magnesium nitrate, high purity, 100% water solubility. Widely used as straight fertilizers, NPK raw materials.

High-shear mico-granulation processed soluble fertilizers.

Foliar fertilizer, Lignin ch-elated trace elements
Single trace element fertilizer
Multi-trace elements fertilizer

Hebei Monband Water Soluble Fertilizer Co.,Ltd
ADD: 68 Crown Road, Xinzhaidian Industrial Zone, Shijiazhuang, Hebei, China
TEL: 0311-85370180
WEB: www.monband.com
EMAIL: info@jitainy.com

FRONTIER OF SCIENCE & TECHNOLOGY

Safeguarding Human and Planetary

Health Demands a Fertilizer Sector Transformation

Societal Impact Statement:

Fertilizer nutrients are essential for food and nutrition security, but a large proportion of nutrients applied to soil are lost because they are unavailable to plants. The extent of these nutrient losses exceeds safe and sustainable limits. Societal awareness of this is limited because it can take many seasons for nutrient-loss impacts to become visible. We propose that Innovative Fertilizers and Application Technologies (IFAT) could help reduce nutrient losses and thus reduce pressure on resources, and provide important micronutrients for human health.

Summary:

Strategies for delivering sustainable food systems require significant reduction in yield gaps and food system inefficiencies. Mineral fertilizers will play a critical role in achieving both of these aims. However, reduction in nutrient losses from mineral fertilizer use to levels that are considered sustainable has not been achieved and has been estimated to be unachievable, even with optimized practices for current products. We argue that Innovative Fertilizers and Application Technologies (IFAT) are needed to address the daunting and interlinked food, agricultural, and environmental challenges facing humanity and the planet. We define IFAT as a set of fertilizer products and technologies that are designed by taking the physiological needs of plants (such as nutrient uptake, redistribution, and utilization) as the entry point in the fertilizer development process, rather than starting first with chemistry. This approach aims for the timely and targeted delivery of nutrients in balanced quantities. We propose that this can result in multiple food, agricultural, and environmental benefits, including increased yield, improvements in nutritional quality, enhanced crop resilience, and reduced emission of greenhouse gases (GHG), and leaching losses. However, the benefits of IFAT for human and environmental health have remained elusive. The major challenge for optimal use of IFAT is a transformation of the vast fertilizer sector by means of government policy interventions, societal responses, and significant investment in public and private research and development.

Key Words:

Fertilizer Sector, Human Nutrition, Innovative Fertilizers, Nanotechnology, Plant Health

1 | INTRODUCTION

Global hunger and malnutrition are epidemic intergenerational phenomena affecting billions of people. Among our greatest challenges is resolving this dire situation within the limits of our planetary boundaries.

Mineral nitrogen (N) and phosphorus (P) fertilizers are essential for food production and are among the major drivers of global change. Decades of breeding for high-yielding crop varieties that respond to intensive N, P, and K (potassium) fertilization have increased crop yields. Higher yields have limited the need to expand the amount of arable land and have helped spare pristine ecosystems from being converted into land used for agriculture. However, nutrients not taken up by plants from the fertilizers are lost as ammonia and nitrous oxide to the air and as nitrate or phosphate to water bodies contribute to climate change, eutrophication, and biodiversity decline in coastal zones.

"We argue that Innovative Fertilizers and Application Technologies (IFAT) are needed to address the daunting and interlinked food, agricultural, and environmental challenges facing humanity and the planet. We define IFAT as a set of fertilizer products and technologies that are designed by taking the physiological needs of plants (such as nutrient uptake, redistribution, and utilization) as the entry point in the fertilizer development process, rather than starting first with chemistry."

To reduce nutrient losses, the fertilizer industry proposed the 4R nutrient stewardship (right source, rate, time, and place; IPNI, 2012). However, fertilizer use efficiencies remain low, at about 40% worldwide, ranging from less than 30% up to 70%. Indeed, these nutrient losses are likely to exceed the planetary boundaries even with optimized agronomy combined with nutrient recycling, global redistribution (e.g., using less fertilizer in high-income nations and using more in low-income nations), and dietary measures (e.g., consuming more plant-based diets).

Decades of continuous cropping of improved crop varieties using only NPK fertilizers has risked the depletion of soil micronutrients that are essential for plant growth, as reported in India. Jones et al. (2013) reported a consistent reduction in soil Cu, Zn, and Mn content over the past four decades in the relatively young soils of England, UK. These researchers also noted how the recommendation to treat only visible micronutrient deficiency symptoms results in the build-up of 'hidden or subclinical deficiencies' that may be limiting crop yields or livestock health, even without visible symptoms occurring. Therefore, yield increases along with reducing micronutrients through breeding and chronic micronutrient undersupply of crops have reduced the levels of secondary and micronutrients found in crops. For example, the levels of nutrients Ca, Mg, Zn, Fe, and Cu found in cereals, fruits, and vegetables have decreased, sometimes by more than half, which in turn impacts human nutrition.

This current article explores Innovative Fertilizer products and Application Technologies (IFAT); defined as a set of fertilizer products and technologies that are designed by considering the physiological needs of plants, such as nutrient uptake, redistribution, and utilization, rather than chemistry as a starting point in the fertilizer development process. The aim of this is to ensure the timely and targeted delivery of nutrients in balanced quantities. A better synchrony between plants and fertilizer–nutrients ensures that IFAT encompasses the reduction in nutrient inefficiencies and losses; however, IFAT goes beyond nutrient management.

It redefines the concept of fertilizer by advancing balanced-nutrient fertilization as an integrated system that responds to specific plant physiological challenges, individually or simultaneously. In addition to improving production (yields) and reducing the negative environmental footprint of fertilizers, the IFAT approach is designed to improve both the nutritional quality of edible agricultural produce and plant tolerance to both biotic and abiotic stresses. These responses are due to the enhancement of total uptake by plants of the multiple nutrients in balanced fertilizers. Taken together, these responses can result in numerous food, agricultural and environmental benefits, including

enhanced crop resilience to challenging environments, facilitated plant development, increased yield and human/animal nutritional quality, and reduced greenhouse gases (GHG) emissions, leaching losses and eutrophication.

2 | INNOVATIVE FERTILIZERS AND APPLICATION TECHNOLOGIES

Biological fixation of atmospheric nitrogen and soil weathering supplies plants with essential nutrients for their growth and reproduction. In addition, green manuring or cover cropping, and introduction of composted biomaterials contribute nutrients as well. However, these natural processes are insufficient to meet the global demands of food production without significant expansion of the amount of land devoted to the cultivation of crops. The majority of commercial fertilizers have been optimized for largescale physicochemical processing, ease of logistics, and soil application for bulk NPK products. This creates a mismatch between the intended function of fertilizers for optimizing plant nutrition and their actual effectiveness. Combined with improved understanding of nutrient requirements, detection of nutrient deficiencies, and 4R nutrient stewardship, IFAT has the potential to improve the high inefficiencies associated with nutrient use by plants from current fertilizers.

However, despite the low efficacy and environmental problems associated with the majority of fertilizer use, private sector investments in fertilizer R&D is ≈0.2% of total product value, which compares poorly with the over 10% R&D investment seen in the seed and life sciences sectors. Several drivers maintain the status quo of the industry, such as a secured growth in the fertilizer market due to increasing demand for food, market concentration, geographically concentrated production, and recovery of high sunken costs in mining and production facilities. Importantly, nutrient losses are dispersed over land, water, and air, with a long lag time to reveal the adverse environmental impact. This causes a lack of societal awareness that is necessary to demand for change.

To address the mismatch between nutrient supply in fertilizer products and plant requirements, Bindraban et al. (2015) called for a paradigm shift in fertilizer design and delivery to plants by taking contemporary understanding of the plant physiological processes underlying nutrient uptake, redistribution, and utilization as a starting point rather than looking first at the chemistry. Similar ‘‘frontend’’ bio-based strategies for fertilizer design and delivery have also been discussed by Monreal et al., (2015). Indeed, on-going work by these researchers describe a root exudate-activated system for N delivery, the design of which is based on specific plant root exudates that serve as temporal signals for the plants need for N. Figure 1 depicts the proposed reversal of the fertilizer design and development process. Fine-, bio-, and nanochemistry and advanced materials must be central to developing novel fertilizer products that supply balanced amounts of nutrients with temporal and spatial specificity to optimize plant utilization. Thoughtful formulations of multiple micronutrients can effectively increase both crop yield and nutrient content by exploiting synergism among nutrients.

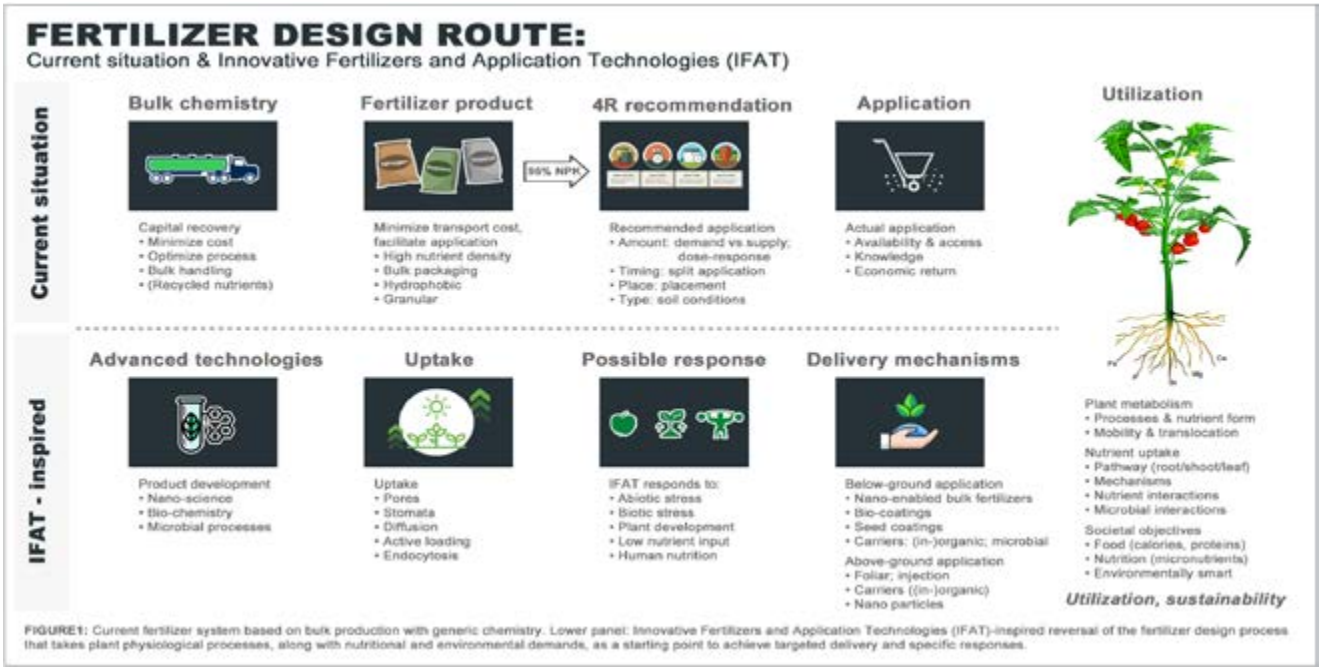


FIGURE1: Current fertilizer system based on bulk production with generic chemistry. Lower panel: Innovative Fertilizers and Application Technologies (IFAT)-inspired reversal of the fertilizer design process that takes plant physiological processes, along with nutritional and environmental demands, as a starting point to achieve targeted delivery and specific responses.

Novel fertilizer products and application technologies should also focus on nutrient uptake via above-ground organs, including leaves, seed dressing, and injection into the stem for crops with succulent and water-filled stems, such as bananas. These alternative application routes can reduce inefficiencies associated with leaching or volatilization, and fixation of nutrients in soil. Foliar application of micronutrients, such as Fe, Cu, Zn, and Mn, is already practiced, but their uptake can be enhanced when chelated with organic molecules, such as humic acid, or delivered as nanoparticles, for instance, with 60% higher uptake of Fe as compared with nonchelated Fe in soybean. Bacteriosiderophore chelated Fe applied to foliage resulted in enhanced grain Fe concentration by 1.7- and 2.0-fold in soybean and wheat, respectively.

Nutrients can be chelated by substances that respond to biological signals, such as root exudates, rather than to physicochemical soil conditions. Depending upon the needs of the plant, such signals will trigger the release of nutrients for uptake by the crop. Soil amendments such as sorbents or beneficial microorganisms may enhance and synchronize nutrient availability to plant demand. Some micronutrients that are not essential for plants, like selenium (Se), are essential for humans and livestock, and increased contents of these micronutrients in crops benefit public health. IFAT approaches may prevent overdosing, such as by chelating or selecting the right formulations to prevent leaf burn, or coating of NPK fertilizers with micronutrients for soil application rather than bulk blending.

An example of the need for IFAT is the formulation of urea–N with micronutrients, which can reduce N transformation via ammonia volatilization and nitrous oxide emission by 20%–35%. Comparable results are reported for coating with neem, nanorock phosphate, and nano-ZnO. Reduced N losses as ammonia and/or nitrous/nitric oxide enhances crop uptake of N, which under a variety of production systems, including drought and low NPK inputs, have been recorded at between 8% and 53%. The mechanism underlying micronutrients' influence on N uptake is related to their potential for modulating microbial ammonification or nitrification rates via influencing urease,

dehydrogenase, and nitrification enzyme activities. Such an outcome could permit significant reduction in N application rates. Invariably, the addition of micronutrient in fertilization corresponds with increasing total plant content of specific micronutrients (e.g., Zn from 85% to 500%), as well as helping to mitigate drought-induced reductions in plant development and productivity. Such effects of a balanced nutrient approach rooted in IFAT can improve environmental and human health, and the resilience of production systems under adverse environmental conditions such as drought. A second example elaborated by Bindraban et al. (2019) relates to the conversion of finite phosphate rock into water-soluble P fertilizers and also highlights the need for IFAT. These most common water-soluble P fertilizers readily bind to soil particles, restricting availability to plants. Excessive P fertilizer applications compensate such inefficiencies but often far exceed plant P demand for maximal growth and yield, suppressing uptake of Zn. Grains store excess P as phytate, which has human health benefits but also inhibits the bioavailability of Zn, Fe, and Ca. This could exacerbate nutrient deficiencies in people with unbalanced diets. Hence, improving the nutritional value of staple crops through reduced phytate and increased Zn and Fe contents could drive P-based IFAT development. Low phytate content in Zn- and Fe-enriched crops would provide critical micronutrients in the low meat–intake, plant-based planetary diet proposed by the EAT-Lancet commission; currently, meat is the major source of these nutrients. Advanced material synthesis and formulation pathways could generate innovative products, such as P complexed to nanoscale Fe particles or microbial beneficiation of phosphate rock (PR) to release plant usable P. Microbial beneficiation of PR has been a subject of study for more than three decades. However, findings from evaluations under field conditions have been rather inconsistent. This is largely due to in vitro misidentification and misselection of true phosphate-solubilizing bacteria based on the use of tricalcium phosphate, as opposed to using multiple metal-P compounds in tandem with tricalcium phosphate to reflect the entire gamut of P sources that microbes encounter in nature. In terms of P product development, the possibility of formulating microbes truly capable of solubilizing PR together with ground PR and carbon sources for microbial growth could be explored, considering optimum environmental conditions for microbial survival in the formulation and the product shelf life.

3 | SUSTAINABLE , RESILIENT, AND NUTRITION SENSITIVE AGRICULTURE

Meeting the nutritional demands of plants under prevailing soil, climatic, and cropping conditions through IFAT could yield multiple direct and indirect benefits to human and ecological health. Crops nourished with balanced macro- and micro nutrients are more resilient to environmental stresses including drought, parasitic weed infestation, and pests and diseases. The application of micronutrients enhances the uptake efficiency of N and K, and mobilizes P in P-limited soils. Improved plant nutrition enhances the cell wall structures of crop produce, which extends shelf life and subsequently reduces food waste. IFAT-assisted closure of the yield gap could prevent ongoing expansion of agricultural land, contributing to the “zero-expansion aim” outlined by Willett et al. (2019). Preventing the clearing of natural ecosystems for agricultural land will avoid the accompanying 80%–90% decline in soil organic matter and associated CO2 emissions. The additional biomass generated from better plant nutrition can partially be incorporated into the soil for negative GHG emissions through carbon sequestration that comes with the cosequestration of N, P, and S. IFAT as a cofactor for driving yield helps to increase crop water-use efficiency by four- to fivefold with a yield increase in cereals from 1 to 5 tons per hectare. These gains are crucial where considerable yield gaps exist, such as in sub-Saharan Africa.

The potential contribution of IFAT toward alleviating human malnutrition is not well investigated. Of relevance is the analogy with multimillion-dollar investments in genetic biofortification, the increase in micronutrient content of crops through plant selection and breeding, with the promise of increasing micronutrient uptake by humans that is yet to be delivered. Based on published studies, a specific emphasis on micronutrients in IFAT can simultaneously increase crop yields by 30%–70% or more; micronutrient content up to two- to threefold across crops and soil types; and crop tolerance to diseases by 30%–50%. To attain the highest efficacy, IFAT interventions should be tuned to location-specific soil–crop conditions. In addition, IFAT can increase, multiple, rather than single, nutrients in plant and animal products. Micronutrient fertilization can mitigate 30%–50% of yield losses and maintain nutritional quality under drought, enhancing the

resilience of the production system. Along the chain of agriculture and food processing, these nutrients enrich hundreds of downstream products. For instance, blending Se into fertilizers, as required by the Finnish government since the early 1980s, has increased Se content in more than 125 food items, including wheat, meat, and dairy products, with human intake increasing from 25 µg/day in 1975 to 124 µg/day in 1989. This meets the recommended dietary allowance for Se, while remaining well below the safe upper limit of 400 µg/day.

Joy et al. (2014) calculated the potential contribution of genetically biofortified crop cultivars (rice, wheat, maize, millet, beans, cassava, and sweet potatoes) with 30%–80% higher Zn content to human Zn intake. Replacing current crop cultivars would reduce the number of people with insufficient Zn intake from 12 million to below 1 million in Burkina Faso, Ghana, Niger, and Togo combined. We anticipate that similar impacts could be achieved with an IFAT-driven 50%–100% increase in Zn content of staple crops. Synergism between IFAT and the genetic biofortification of crops may generate even greater benefits to human diets and health.

4 | TRANSFORMING THE FERTILIZER SECTOR

IFAT is an innovative and comprehensive approach that enhances the production and nutrient use capacity of food systems, with immediate outcomes and long-term sustained impacts. By default, IFAT is not confined to a single crop or cropping system but extends to different cropping systems and numerous products and segments within the food chain, thereby enhancing overall ecosystem health, and providing benefits across multiple sectors of society. Rather than being an end-of-process solution to remediate and recapture widely dispersed nutrients, IFAT is a front-end solution that prevents inappropriate use and uncontrolled loss of nutrients. When coordinated with advanced nutrient detection in soils or plants, agronomic efficiency measures, recycling, and global redistribution, IFAT has the potential to confine N and P losses within the safe operating spaces outlined by Rockström et al. (2009), while simultaneously reducing pressure on water, land, and biotic resources and providing critical micronutrients in the plant-based and low meat diet proposed by the EAT-Lancet Commission. IFAT approaches are emerging that have proven to be effective under controlled conditions, with initial evidence for efficacy in field situations; however, widespread practical efficacy is yet to be demonstrated and implemented at scale.

To date, government policy interventions, Non-Governmental Organization (NGO) involvement, societal responses, and R&D investments have been insufficient to transform the fertilizer sector. Polemic debates over "excessive chemical inputs" have created a blind spot that has inhibited a well-informed dialogue among the actors to drive transformation. In analogy with the transformation of the pesticide sector, a multistakeholder, society-wide process arising from environmental and human health concerns compelled by NGOs, strong government regulations and support for public research, and consequent significant private sector R&D investments should transform the sector. In addition, rather than being considered as a generic bulk industrial commodity with large external costs, fertilizer sector transformation should be catalyzed through public–private initiatives to fully unlock the multifaceted benefits of IFAT to contribute to several of the United Nations Sustainable Development Goals, including goals 2, 3, 13, 14, and 15 (United Nations, 2015). Ultimately for IFAT to succeed, a concerted global effort at both local and national scales is required to validate and upscale the IFAT-based approach.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

AUTHORS' CONTRIBUTIONS

P.S. Bindraban: main editor of overall paper and concept; C.O. Dimkpa: overall editing, reflections, and contributions on nanofertilizers; J.C. White: overall editing, reflections, and contributions on micronutrients for pest & disease resistance; F.A. Franklin: overall editing, reflections, and contributions on health relevance; A. Melse-Boonstra: reflections and contributions on human nutrition and health; N. Koele: reflections and contributions on microorganisms; R. Pandey: reflections and contributions on foliar applications; J. Rodenburg: reflections and contributions on sustainable agriculture; K. Senthilkumar: reflections and contributions on sustainable agriculture under field applications; P. Demokritou: reflections and contributions on material sciences; S. Schmidt: overall editing, reflections, and contributions on concept.

Vertical Farming:

How Plant Factories Stack Up Against Field Agriculture

With the world's population expected to reach nine billion by 2050, estimations project that food production must increase by 70 percent to keep up with worldwide demand. This means farmers will be required to grow more foodstuff in the next 35 to 40 years than the last 10,000 years combined.

There is presently not enough farmable terrain to meet this constraint, and due to the negative environmental impacts of global deforestation (including desertification and flooding), clearing more forest for cultivation is not a sustainable option.

Vertical farming, with its potential benefits, may play a major role in addressing the growing food demand while minimizing environmental impact.

VERTICAL FARMING DEFINED

Controlled Environment Agriculture (CEA), commonly known as vertical farming, is a growing system designed to weather- and climate-proof the production of food crops. CEA grows crops indoors in stacked, or standing, layers using growing systems such as hydroponics, aeroponics or aquaponics, all of which use a method of nutritious liquid delivery with minimal soil. CEA uses enclosed growing practices, controlling the environment's temperature, illumination, gases and humidity with the goal of maximizing crop output in limited space.

CEA has become an attractive alternative to traditional farming in areas where arable land is inaccessible or scarce, including metropolitan areas where citizens wish to bring food production nearer to home. Rather than growing crops on a single level, such as in the ground or a greenhouse, CEA produces crops in vertically stacked layers, which can frequently be incorporated into other constructions like high-rise buildings, intermodal (shipping/ Conex) containers or repurposed industrial space.

ENVIRONMENTAL CONCERNS

NASA reports that the majority of the world's freshwater supplies are draining faster than they are being replenished with freshwater demand set to increase by 55 percent by 2050. Currently, agriculture is responsible for 92 percent of the global freshwater usage, creating a challenge for even developed countries such as the

United States, China and Australia.

A 2017 report found that more than 75 percent of Earth's land areas have suffered from erosion and water degradation. The continual plowing of fields, combined with heavy use of fertilizers, has degraded soils across the world with erosion occurring at a rate 100 times greater than soil formation. This results in 33 percent of the world's adequate or high-quality food-producing land being lost at a rate that far outstrips the pace of natural processes to replace diminished soil.

Collectively, this means arable land is decreasing, and poor soil health is contributing to less healthy agriculture, while water demands continue to rise.

COMMON GROUND

Approximately 1.3 billion tons of food destined for human consumption gets lost or wasted each year globally, discarded anywhere along the supply chain, from farmland to supermarkets, restaurants and home consumers. But crops for human consumption only accounts for 55 percent of all crops grown. Nine percent are used for biofuel and 36 percent used as livestock feed. Feed crops, such as hay and soy, are land and water-intensive to grow and the animals that consume them require high levels of water to thrive. Additionally, many types of livestock occupy the grazing land, which constitutes 70 percent of all agricultural land, which is not arable.

BENEFITS OF VERTICAL FARMING

Some of the obvious benefits of vertical farming for is year-round crop production for both human and livestock consumption, consistent quality, and predictable output. CEA holds other environmental benefits, requiring less fertilizer being applied to plants, reducing water usage up to 95 percent and, through weather-proofing, eliminating the need for chemical pesticides. CEA technology allows for faster growth cycles and quicker harvests, meaning more food can be grown every year, in a much smaller space than on a conventional farm. One of the highest-yielding farms grows over 350 times more food per square yard than a conventional farm.

In urban settings vertical farms utilize a farm-to-table order-based system, drastically cutting down on food waste, packaging and the fuel consumption used to transport food—known as food miles—as well. However, the carbon savings are relatively minor even with these novel approaches as at least 80 percent of the emissions for agriculture happens on the farm—not in the processing, not in the transportation. Urban gardening and vertical systems have many benefits, but it doesn't presently have the scale that's needed to meet human food demand or reduce environmental impact on a massive scale.

CHALLENGES OF VERTICAL FARMING

Economics is a major obstacle for the broad implementation of CEA practices. Plant factories are currently not the solution to feeding the world's increasing population as competition with crops grown in traditional systems will not be economically viable in the coming years. Plants – not just growers – will need to adapt to CEA growing conditions. Meaning, new crop genetics

will need to be designed specifically for vertical farm production that addresses five traits of interest: easy and uniform fruiting; rapid biomass and multi-harvest capable crops; photoinduced quality; auto-harvest friendly traits; and dwarf plants with yield efficiency. It remains to be seen if created, the genetically modified plants would be attractive to an end consumer given the movement of non-GMO products.

CEA approaches require huge capital to launch, as they're high-risk businesses given the cost of production can be quite high per pound of product. Vertical farms are more feasible because of LEDs, but they are still energy-intensive. Proponents of vertical farms often say that they can offset the enormous sums of electricity they use, by powering them with renewable energy —, especially solar panels — to make the whole thing carbon neutral. But just stop and think about this for a second. These indoor "farms" would use solar panels to harvest naturally occurring sunlight, and convert it into electricity so that they can power…artificial sunlight? In other words, they're trying to use the sun to replace the sun. With current technology, it makes no sense to grow food staples, such as wheat, indoors. A Cornell professor calculated that if you grew wheat indoors, just the electricity cost per loaf of bread made from that wheat would be $11.

Even if a vertical farm boom were to ensue, the output would only be a small percentage of the vegetables and fruits grown on traditional farms and none of the wheat, corn, soy, or rice, at least not in the foreseeable future. Nor will vertical farms raise livestock or grow oil palms, which are mainly what people are clearing hardwood forests to make room for.

THE FUTURE OF FIELD AGRICULTURE

The contribution of vertical farms to overall food production and environmental concerns is to be determined. The greatest potential impact is the implementation of technology in agriculture, partly due to new possibilities with data analysis. Vertical farms have a multitude of sensors measuring many parameters (from, temperature, to nutrient levels). The plants are analyzed with cameras and sensors, which monitor plant health in real-time. As a result, vertical farms are hiring data engineers and sensor specialists as a significant percentage of their workforce. Artificial Intelligence already plays a key role in many vertical farm operations. As sensors continue to get cheaper and more capable, the opportunities for field farms increases considerably.

Farmers will solve agricultural problems — like developing new methods for drip irrigation, better grazing systems that lock up soil carbon, and ways of recycling on-farm nutrients. Organic farming and high-precision agriculture are doing promising things, like the use of artificial intelligence for detecting disease, sensor-activated irrigation systems, and GPS-controlled self-driving tractors.

From the plummeting cost of robotics to the new frontiers of bioinformatics, the future landscape of farming may well look very different, indeed. While this isn't going to happen immediately, growth in the sector will accelerate as technological improvements drive down investment and operational costs.

THE BOTTOM LINE

While civilization wouldn't be where it is today without agriculture, it's a big factor in a number of society's greatest challenges. If farming practices continue unabated, the likely outcome is having to cut down more remaining forests for acreage, destroying even more land and freshwater habitats in the process. Current projections make a global water crisis almost certain.

In light of these challenges, AEM members are looking at every way to reduce the negative impact of current agricultural methods and existing equipment technology. Manufacturers are becoming technology balanced and interdisciplinary, utilizing designers, engineers, horticulturalists, and sustainability managers. AEM members can provide service from concept development to feasibility studies to education and workshops.

IoT devices are guiding precision farming to increase yields. Advanced machine communication is allowing the implementation to control the tractor for optimum efficiency. And manufacturers are developing many alternative power sources, such as advanced battery technology, cable-powered machines, and tractors powered by methane gas. Some concept machines are small enough to fit between rows, using lasers to destroy pests one by one. That is precision farming. If constraints are the catalyst for innovation, then AEM and its member companies are already rising to meet the challenge. ***(By Jeff Jurgens, AEM Director of Product)***

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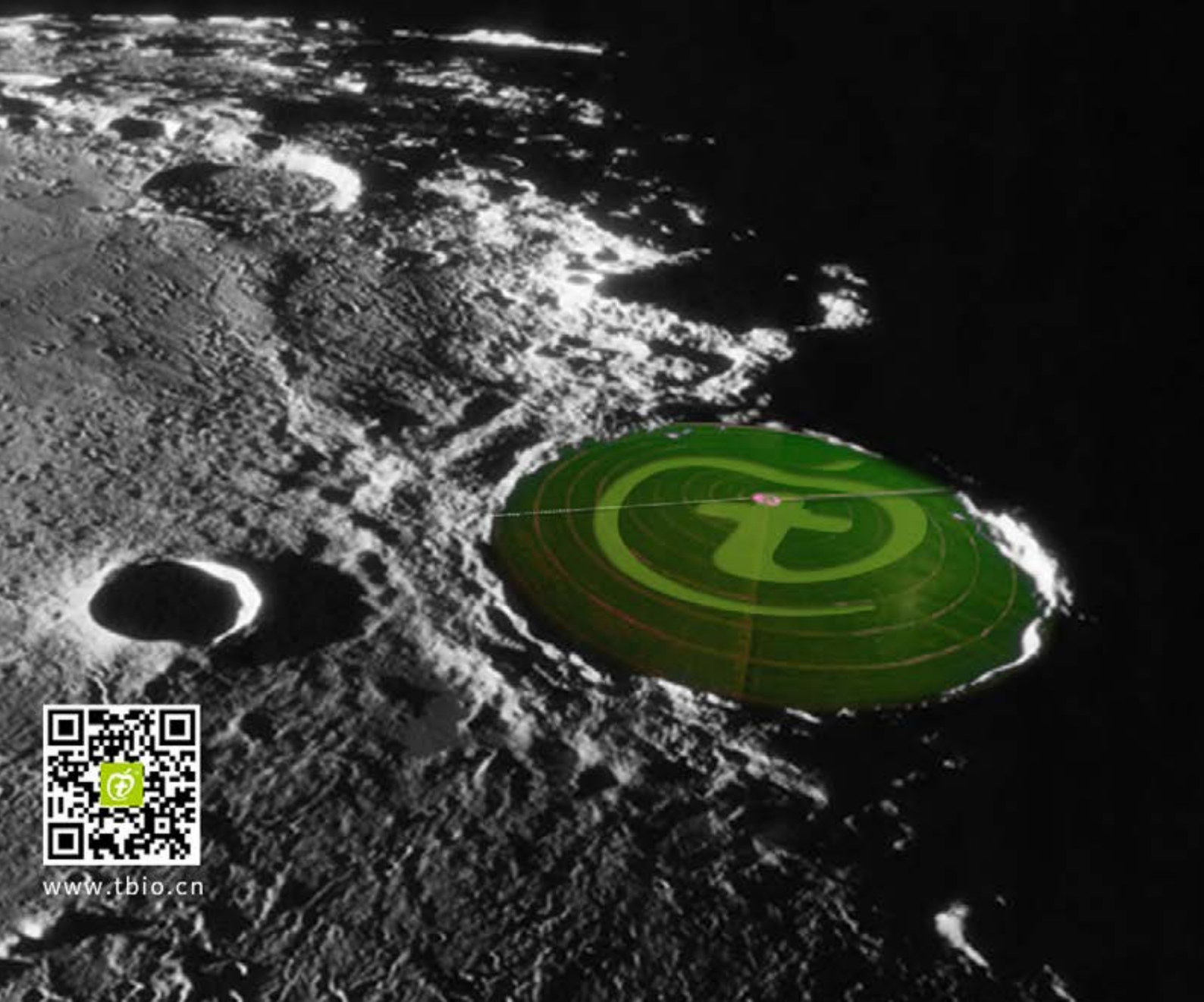

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