HIGH LEVEL FORUM
on sustainable plant nutrition

TOWARD A NEW PARADIGM FOR SUSTAINABLE PLANT NUTRITION

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> "The food systems that have improved things so much in the last few decades are now being asked to transform so they can contribute to a more sustainable world. Plant nutrition has a massive role in getting the repairs in place."
>
> — **David Nabarro,** 2018 World Food Prize Laureate, Conference Chair of the 2019 High Level Forum on Sustainable Plant Nutrition

PREFACE

Acting with a Sense of Purpose

by Mostafa Terrab, Chairperson of IFA and the OCP Group

In 2018, IFA developed a series of scenarios, dubbed "IFA2030", that describe alternate futures for the industry. The scenarios captured seven trends likely to impact the future of the industry, among them:

- the necessity of innovation;
- the likelihood of increased industry regulations;
- shifts in fertilizer demand between regions, in part driven by shifting diets;
- recognition that optimal plant nutrition is site- and crop-specific, requiring the industry to work more closely with farmers;
- and the need for the industry to protect its license to operate and its reputation.

As one outcome of the IFA2030 strategic exercise, IFA reframed its activities around key principles: science-driven actions; promoting sound stewardship; inclusivity in thinking and action; and embracing transparency. The High Level Forum was initiated and carried out in that spirit.

By hosting this High Level Forum on Sustainable Plant Nutrition, IFA is signaling its desire to enter into a more concerted and ongoing dialogue with our key stakeholders. And we are most grateful to **Dr. David Nabarro** for chairing this important dialogue.

This report presents the outcomes of the Forum's deliberations, drawn from the discussions and presentations of the many distinguished participants (from 43 countries) at the event that captured the many ways the industry is already moving toward more sustainable approaches and how it must continue to evolve. The report frames the context for these changes within the **five major challenges confronting agricultural systems globally** (producing more with less, while improving nutritional quality; balancing high productivity with environmental impacts; achieving climate-smart agriculture on a global scale; equipping all farmers with the knowledge, capacity and authority to practice sustainable plant nutrition; and minimizing and reversing degradation of our natural resources). All parts of the food system, including the fertilizer industry, must ultimately collaborate to achieve such a transformation within the context of the Sustainable Development Goals.

The improved yields driven by fertilizer applications account for roughly half of all food produced today. Fertilizers will continue to be vitally important—along with improved soil health, water management and crop genetics—for feeding a rapidly growing global population. Much of that growth is concentrated in sub-Saharan Africa, where the population could increase from 1.3 billion to 4.3 billion by the end of the century, and where nutrient-depleted soils are a major problem. As the fertilizer industry transforms, it can provide for more nutritious food and contribute solutions to climate change and serious environmental problems, while supporting improved farm production that is critical to ending rural poverty and hunger.

The report also identifies ways in which the industry is addressing those challenges and options for making greater progress. And it makes **five major recommendations to guide industry development and growth** (develop business models that build on new opportunities; build innovative partnerships across the value chain, from farmers to consumers; create a core operating system for better data and digital tools; accelerate technology innovation; and advance policy reform).

We are in the midst of far-ranging change. Our approach to markets needs to evolve from product-centric, commodity and volume-based to one that provides solutions to farmers. To manage the complexity ahead, we must think in terms of broad food systems that place the farmer and the consumer in the center.

Business as usual is clearly no longer an option for the fertilizer industry. I invite our members to work together and, in partnership with our many stakeholders, to address these challenges and turn them into opportunities to provide vital support to the world's farmers.

INTRODUCTION

As a world buffeted by climate change hurtles toward a population of 10 billion people by 2050, global agricultural systems must rapidly transform to ensure a sustainable future.

To assess the path forward for the fertilizer industry and its role in this transformation, the International Fertilizer Association (IFA) convened a High Level Forum on Sustainable Plant Nutrition in November 2019 in Versailles, France.

For two days, fertilizer company representatives from around the globe, of varying sizes and product ranges, engaged with global experts on agriculture, food and nutritional security, climate change and the environment.

Opening the Forum, World Food Prize Laureate Dr. David Nabarro noted that for the past 50 years the world's food systems have provided an increasing population with the food it needs to be well nourished and prosper. The Green Revolution launched in the 1960s led to a tripling of crop productivity and saved millions of people from starvation.

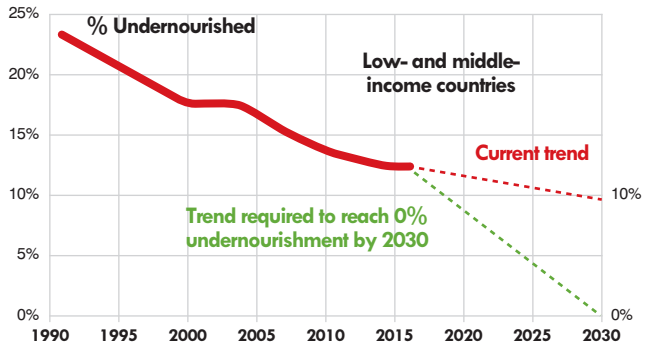
But the benefits have not been universal. More than 820 million people remain chronically hungry, and two billion people suffer from micronutrient deficiencies. For hundreds of millions of smallholder farmers and their families in Africa and South Asia, farming remains synonymous with poverty.

There have also been unintended consequences: agriculture has become a driver of deforestation, biodiversity loss, pollution and damage to ecosystems. It is a major contributor to the greenhouse gas (GHG) emissions that fuel climate change.

These are today's agricultural challenges. And while they cannot be overstated, neither can the potential of agriculture to transform poverty to wealth, to improve health and well-being, to restore depleted soil, to capture carbon and to restore balance to ecological systems.

In all of this, sustainable plant nutrition plays a significant role. It must, because plant nutrition drives the level of crop productivity and crop quality essential for feeding a healthy global population and supporting a healthy planet. Therefore, sustainable plant nutrition—the use of mineral and organic fertilizers, delivered in the context of an integrated approach to soil health management—is essential to achieving sustainable global food systems.

ENDING HUNGER



Source: Kharas et al., 2015 Brookings Institution Courtesy of Bruce Campbell, Director, CCAFS

Today's sustainable plant nutrition solutions

Of course, the fertilizer industry cannot do this alone.

"We need many partners," said **Mostafa Terrab,** Chairperson of IFA and the OCP Group. "This is a team sport, dealing with complex problems, interactions and trade-offs, and it requires multiple perspectives. As a priority, we must engage farmers, and also policy makers and the food industry."

Developing solutions will require innovations in many areas: business models, manufacturing processes, products and partnerships, all supported by a firm foundation of enabling policies. Among other things, policies must stop rewarding excessive fertilizer use, and instead incentivize industry innovation and encourage farmers to adopt new resource-efficient products and practices.

Two essential elements of progress are higher Nutrient Use Efficiency (the fraction of fertilizers taken up by the plant) and lower nutrient losses to the environment. A suite of farming practices known as the "4Rs"—use of the right fertilizer product, at the right rate, at the right time, in the right place—form the basis of sustainable intensification of food production. But due to a number of challenges, including poor access to proper inputs and a lack of technical support, these practices are not followed by the vast majority of the world's 500 million smallholder farmers.

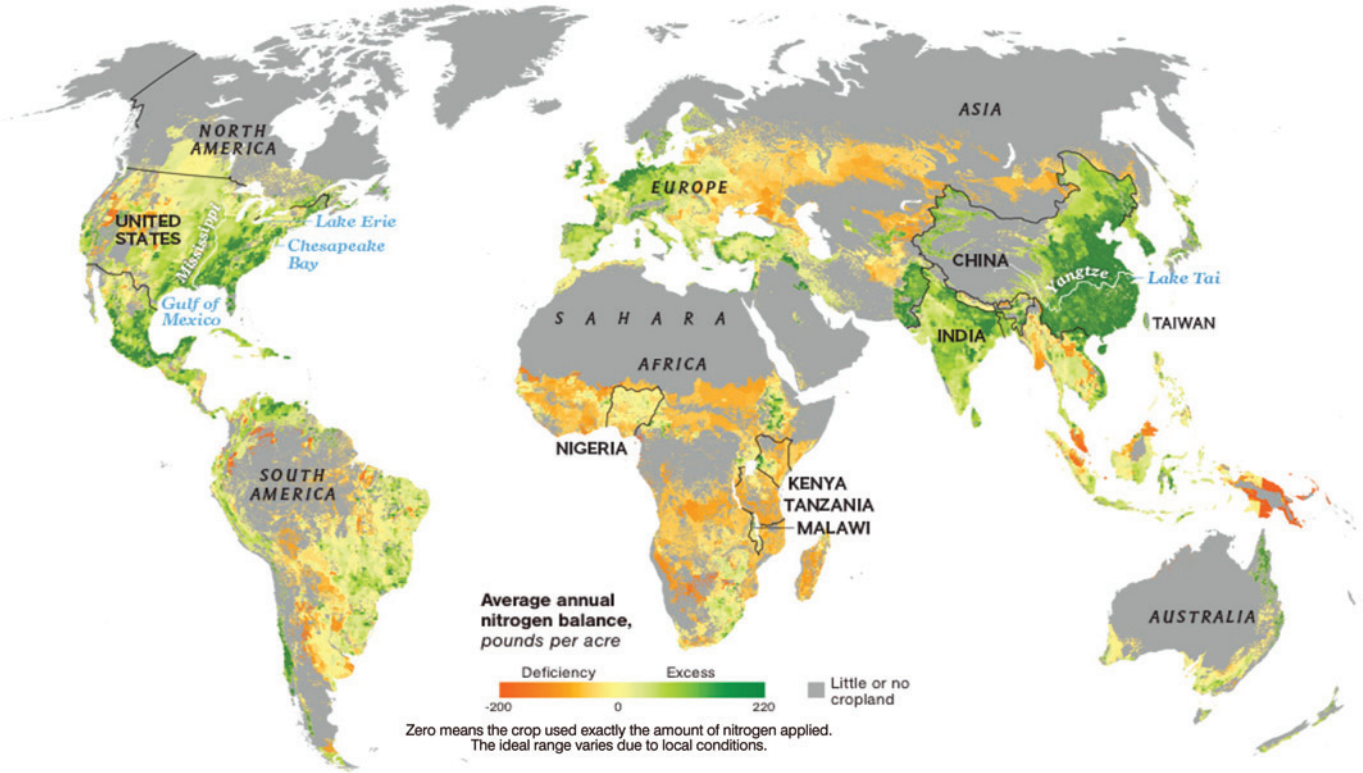
This dilemma is particularly evident in Africa, where smallholder farmers—growers who typically tend a mix of crops and livestock on holdings of a couple of hectares or less—produce the majority of the food consumed across the continent. Poor plant nutrition is a major cause of chronically low yields in Africa that drive widespread poverty and hunger.

His Excellency Hailemariam Desalegn, former Prime Minister of Ethiopia, and now Board Chair of AGRA (the Alliance for a Green Revolution in Africa), noted that feeding Africa's rapidly rising population requires transforming food production to sustainably increase the quantity and nutritional quality of farm output.

> "All efforts to improve crop yield and nutrition should be science-driven and environmentally sustainable."
>
> — **His Excellency Hailemariam Desalegn,** former Prime Minister of Ethiopia, now Board Chair of AGRA (the Alliance for a Green Revolution in Africa)

Hailemariam said African policymakers and farmers can learn from the experiences and, in many cases, the mistakes, of other regions. Ethiopia itself has set a positive example for the continent, transforming many aspects of its agricultural system—work that has included a substantial effort around soil mapping, plant nutrition and proper fertilizer usage.

GLOBAL NUTRIENT IMBALANCE



Feast or Famine

Nearly half the people on the planet wouldn't be alive if not for the abundant food made possible by nitrogen fertilizer. Yet its benefits have not reached everyone. In sub-Saharan Africa, where 239 million people go hungry in a year, crops fail as soil is stripped of nutrients, and farmers can't afford to buy fertilizer. Elsewhere overuse pollutes waterways and releases greenhouse gases.

Jerome N. Cookson and Lawson Parker, NGM Staff
Source: Paul C. West, Institute on the Environment, University of Minnesota Courtesy of Achim Dobermann, IFA Chief Scientist

CHALLENGES FOR GLOBAL AGRICULTURE AND SOLUTIONS BASED ON SUSTAINABLE PLANT NUTRITION

Although each challenge on its own—let alone taken as a whole—is significant, each also presents opportunities for change towards a sustainable, more just and efficient agricultural system—with improved plant nutrition playing a prominent role.

ONE: Producing more with less, while improving nutritional quality

> "If you want healthier foods, you start with healthier soil."
>
> **— Theo de Jager,** President, World Farmers' Organisation

Agriculture needs to produce at least 50 to 60 percent more food to meet the demands of a global population expected to reach almost 10 billion people by 2050. Rising income levels, increased urbanization and shifts in dietary preferences will all impact food demand. At the same time, the nutritional value of food must be improved to combat rising rates of malnutrition.

FACTS:

- After a prolonged decline, world hunger increased for three years straight (2016-19), and now affects 821 million people.
- Two billion people suffer micronutrient malnutrition, which can impair physical and brain development and weaken the immune system.
- Dietary preferences are shifting. In some communities, overconsumption of animal protein is harming health and consumers are pursuing alternatives to meat protein. In other communities, consumption of livestock products is below the levels needed to ensure human well-being, as dietary alternatives to milk, meat or eggs are limited or unavailable.

What is sustainable plant nutrition?

"Sustainable plant nutrition must be based on scientific research findings, and requires greater innovation and supportive policy frameworks. And, most importantly, it requires a farmer-centric focus," said **Mostafa Terrab,** Chairperson of IFA and the OCP Group.

Strictly speaking, plant nutrition involves the interaction between nutrients in the soil and mechanisms within the plant that control how they are absorbed and metabolized. Sustainable plant nutrition broadens the lens to incorporate connections with economic, environmental and social dimensions of agriculture. As explained by **Tom Bruulsema,** Chief Scientist, IPNI Canada, it involves more than ensuring sustainable uses in the field. Sustainability also considers impacts associated with manufacturing and transporting nutrient inputs to the farm and with the ultimate fate of the farm products in the market.

Sustainable plant nutrition can utilize both organic and mineral fertilizers[1], which can be applied as needed to supplement natural soil nutrients and to maintain or revitalize a healthy soil structure. When plants take up these nutrients, harvests increase and crops become more nutritious food sources for people and livestock. Efficiency is a crucial element of sustainable plant nutrition—ensuring that plants absorb a greater proportion of applied nutrients to minimize environmental impacts.

[1] Mineral fertilizers are fertilizers based on products found in nature (nitrogen from the air, potassium and potash from mined ore) that are chemically or physically processed to make the nutrients available to plants. Mineral fertilizers also can include secondary and micronutrients such as boron, selenium, copper, iron, manganese and zinc.

SUSTAINABLE PLANT NUTRITION SOLUTIONS:

Fertilizers and sustainable plant nutrition are crucial to increasing the quantity and quality of foods.

- **Mineral fertilizers are estimated to account for half of the global food supply.** They will continue to be vital in feeding the world's growing population, along with improved soil health management, improved crop genetics and other agronomic practices.
- **Increasing farmers' access to fertilizers and knowledge of their efficient use is key to creating sustainable agricultural systems and growing more nutritious food, particularly in Africa and other regions where soils are being mined of nutrients and organic matter.**
- **Micronutrient-enriched fertilization, which involves using a specific nutrient that plants can accumulate in small quantities and that also boosts human health, is considered one of the most promising ways to fight malnutrition and alleviate nutrient deficiencies worldwide.** It can be especially useful for addressing zinc, selenium and iodine deficiencies. Plants take up the micronutrients, which are applied as formulations that can be sprayed directly

on the plants or added directly to the soil. They then accumulate in the edible parts of the plant and enter the food chain.

- The proper use of nitrogen fertilizers increases the protein content of grains and helps raise the density of iron and zinc—two vital micronutrients—inducing them to migrate from the plant's leaves into the grain.
- Grounding itself in science, the fertilizer industry and its partners can contribute to a deeper understanding of the scientific evidence linking plant nutrition to better human health, which can help consumers understand the role of plant nutrition in providing a wide range of dietary options.

CASE STUDY: Micronutrient fertilization combats malnutrition

Micronutrient deficiencies increasingly impact human health. Zinc deficiency is responsible for the deaths of about 450,000 children under five years old every year. It occurs mostly in regions where cultivated soils are low in zinc and cereal-based foods are the major source of calories. It is not restricted to developing economies. Zinc deficiency is a growing problem in developing and developed countries, including the USA, UK and Australia.

World Food Prize Laureate **Howarth Bouis,** Founding Director of HarvestPlus, reported that micronutrient fertilizers containing zinc raise zinc levels in plants, providing healthier foods for people and livestock. Field trials have shown that when women and children eat wheat with improved zinc levels there is less sickness and disease. Selenium deficiency in Finland was greatly reduced by adding selenium-enriched fertilizers to the soil as was zinc deficiency in Turkey by adding zinc-containing fertilizers.

EFFECT OF HIGH ZINC WHEAT INTERVENTION ON MORBIDITY INDICATORS

Indicator	High Zinc Wheat Subjects	Low Zinc Wheat Subjects	Days of Sickness Averted for ~ 1300 Subjects Over 180 Days	Difference Significant at 5% Level of Confidence?
Children 4-6 Years				
Days with Pneumonia	203	244	41	YES
Days with Vomiting	60	99	39	YES
Women 15-49 Years				
Days with Fever	999	1092	93	YES

Source: Sazawal S, et al. Nutr J. 2018 17(1) Courtesy of Howarth Bouis, CEO, HarvestPlus

TWO: Balancing high productivity with environmental impacts

> "While sustainable intensification is a goal, the historical reality is that unsustainable intensification has been more common."
>
> **— David Cleary,** Global Agriculture Director, The Nature Conservancy

Agriculture must meet the increased demand for food while minimizing environmental risks and contributing to solutions. A prolonged one-sided focus on high productivity growth has created pervasive environmental problems that must now be redressed.

In the 1960s, as hundreds of millions of people faced starvation, a Green Revolution was launched with the goal of dramatically increasing crop productivity and keeping food prices low. High-yielding seeds and the widespread use of fertilizer were two keys to success in averting mass famine.

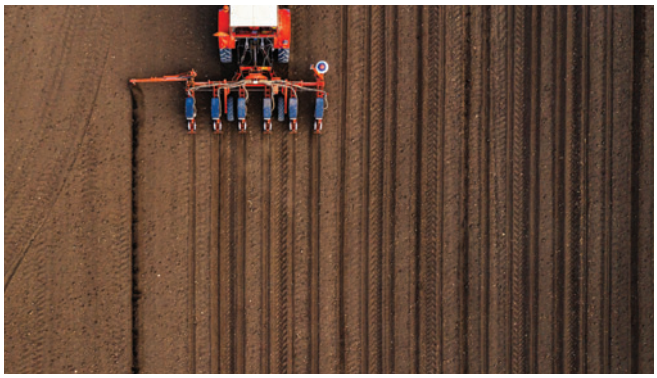
But a one-sided focus on high productivity growth, incentivized by government policies, has arguably disregarded environmental impacts, including excessive fertilizer use impacting air, soil and water quality; the overuse and pollution of water; and biodiversity changes or loss in the surrounding ecosystem.

FACTS:

- Since 1961, food supply per capita has increased more than 30 percent. Over the past 50 years in the developing world, although populations more than doubled, the production of cereal crops tripled.
- Between 2000 and 2010, agriculture drove 80 percent of deforestation worldwide.
- The run-off of nutrients into coastal and freshwater (including from fertilizers applied to farms, livestock manure applications, wastewater systems and other sources), has produced more than 400 hypoxic zones that can pose risks to aquatic ecosystems.
- Land clearing continues to exacerbate a biodiversity crisis that now threatens one-quarter of animal and plant groups with anticipated extinction within decades.

SUSTAINABLE PLANT NUTRITION SOLUTIONS:

- **Best fertilizer management practices minimize nutrient losses to the environment,** protect watersheds, limit harmful emissions from nitrogen products and maintain soil quality. These practices begin with the 4Rs: using the right source of nutrients, at the right rate, at the right time and in the right place. The 4Rs improve Nutrient Use Efficiency (NUE)—the proportion of nutrients taken up by the plant—and other nutrient management performance metrics. Globally, nitrogen use efficency averages about 45-55 percent, whereas optimal nitrogen use efficiency is considered to be in the range of 60-90 percent.
- **Other models for sustainable intensification** include an integrated soil fertility management (ISFM) approach, which combines the use of mineral and organic nutrient sources alongside good soil management practices and the choice of suitable crop varieties. For example, in Europe, fertilization practices typically begin with use of organic fertilizers, and are followed by mineral fertilizers to supplement nutrients as needed to achieve the farmer's yield goal. The ISFM approach can increase productivity while building soil organic matter, sequestering carbon and reducing negative impacts, including runoff and soil degradation.



- **Innovative products, also referred to as "special products", are part of the 4R toolbox available to farmers to reduce nutrient losses to the environment,** such as nitrate losses to groundwater. A recent IFA market assessment shows that such fertilizers (including stabilized, slow- and controlled-release fertilizers and water-soluble fertilizers) account for almost 10 percent of the fertilizer industry's sales revenue. As such products reach more farmers, they can have a much bigger impact.
- **Fertilizer companies, retailers and farm advisers should redirect fertilizer use from a blanket "one-size-fits-all" approach to a science-based, tailored approach that considers the different nutrient needs of specific crop varieties and local soils. Government policies should also support crop- and site-specific fertilization.** Encouraging a more nuanced process for providing plant nutrition could significantly reduce environmental impacts while more effectively raising crop productivity and quality. (See case study below)
- **As fertilizers increase productivity on land already in production, they can forestall deforestation.** It is estimated that agricultural intensification that includes fertilizer use preserved one billion hectares of land from conversion to agriculture between 1961 and 2005 (Burney et al., 2010). In this way, fertilizer use helps to protect biodiversity, but it can do so most effectively when deforestation regulations are effectively implemented.

CASE STUDY: Stemming large impacts from small losses in Lake Erie

Improving nutrient use efficiency is an important first step, but it is not always enough to reduce nutrient losses, explained **Tom Bruulsema,** Chief Scientist, IPNI Canada. And that is the case in the Lake Erie watershed, where two million hectares of corn and soybean fields drain into the water basin—and where losses of less than a kilogram of dissolved phosphate per hectare can stimulate harmful algal blooms.

From 1987 to 2014, although input use decreased and phosphorus use efficiency doubled, algal blooms continued to plague the lake. Then, agronomists discovered that half of phosphate fertilizers was being applied to the surface of the soil, rather than incorporated into it, and five percent was highly susceptible to loss from the first rainfall. But they also soon found that, without additional incentives, farmers were unwilling to invest the time and energy needed to adopt practices that would mitigate phosphorus loss.

"Farmers need ways to derive value from loss prevention," Bruulsema said. In this case, that value was a social value. It came from establishing a 4R Nutrient Stewardship Certification Program, initiated by four local inputs dealers. Wearing the logo became a sign of pride and a matter of respect in a community that knows and loves Lake Erie.

COLLABORATIVE PARTICIPATORY EXTENSION

Courtesy of Tom Bruulsema, Chief Scientist, IPNI Canada

THREE: Achieving climate-smart agriculture on a global scale

> It is fantastic to see the fertilizer industry getting ahead of the game in reducing greenhouse gas emissions.
>
> — **Bruce Campbell,** CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Climate change is challenging agriculture as never before. Agriculture is part of both the problem and the solution and must both adapt to and help mitigate climate change. Sustainable plant nutrition provides essential paths forward.

The impacts of climate change on agriculture are highly variable and may even lead to increased production in certain areas. But the key issue of concern is that, in many regions, climate change linked to anthropogenic emissions is increasing water stress, degrading soils, lowering crop yields, limiting arable land, driving deforestation, increasing food prices and intensifying poverty and hunger. Farmers have both a mega-adaptation challenge and an opportunity to greatly mitigate GHG emissions, said **Bruce Campbell,** CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Perhaps the biggest challenge is equipping the world's 500 million smallholder farmers with climate-smart farming technology that allows them to adapt to shifting and often more challenging growing conditions while limiting their contribution to climate change.

FACTS:

- About 25 to 30 percent of total GHG emissions come from agriculture: 10 to 12 percent from crop and livestock activities on farms; 8 to 10 percent from land use; and 5 to 10 percent from the supply chain. Fertilizer production, distribution and use are responsible for only 2.5 percent of global GHG emissions.
- With just the 1°C warming of today, monthly temperature extremes are already five times more common globally, and dry record-breaking events in sub-Saharan Africa have increased by up to 50 percent.
- In a 4°C warmer world, farming as we know it will not be feasible in many places, with some areas seeing more than one-fifth of their arable land rendered unsuitable for supporting crop production.
- Since the industrial revolution, land use change and agricultural cultivation have generated a loss of soil carbon equivalent to about 22 times the carbon emissions from fossil fuels in 2014.
- Fertilizers applied to crops and pastures (both mineral fertilizers and manure) were responsible for estimated emissions of 1.3 Gt CO_2 in 2010. Nearly all these emissions result from the manufacture, transportation and application of nitrogen.

SUSTAINABLE PLANT NUTRITION SOLUTIONS:

- **Working with and empowering farmers.** The World Farmers' Organization (WFO) has developed a Farmers Driven Climate Change Agenda that promotes a bottom-up approach, where farmers gain a leading role in the global political processes on climate change and agriculture. It is based on the best practices that farmers are already implementing as practical solutions to climate change mitigation and adaptation. It is intended to be farmers-driven, science-based and results-oriented. Efficient use of fertilizers is essential to their success.
- **Achieving an ambitious global average NUE of 71 percent by 2050** (vs 46 percent in 2010) would reduce emissions by 600 million tonnes, keeping nitrogen emissions close to their 2010 levels (WRI, 2019).
- **Embracing climate-smart farming practices.** The smart use of properly formulated mineral fertilizers combined with organic fertilizers is the best method for maximizing plant yields, minimizing nutrient losses, protecting soil health and increasing soil carbon sequestration on farmland. Applying the 4Rs of best fertilizer management practices also contributes to adaptation by enhancing plant growth, crop resilience and water use efficiency. Proper incentives to reward farmers for ecosystem services need to be considered.
- **Use of products and practices that limit the release of nitrous oxides (N_2O).** Mineral and organic fertilizers are a major source of N_2O, a greenhouse gas with a global warming potential roughly 300 times greater than CO_2. It is crucial to apply the 4Rs in crop- and site-specific ways to limit nutrient losses. The rate of application must match the crops' needs, since the N_2O emission rate increases in a non-linear manner with the N surplus. Improving N use efficiency is not sufficient in itself as N_2O emissions are only a small fraction of N losses. Specific practices reducing N_2O emissions should be encouraged. For instance, a "right source" solution, such as adding a nitrification inhibitor, could cut losses by at least a third.

- **Carbon storage in soils.** Soils are the largest terrestrial pool of carbon and could store up to 1.85 gigatonnes of carbon each year, equivalent to the amount produced by all of global transport. Best practices in fertilizer management can help build soil organic matter since it increases plant growth, allowing greater amounts of non-harvested carbon-rich roots and stems to return to the ground. By one estimate, 90 percent of agriculture's future mitigation potential would be based on greater soil carbon sequestration.
- **Emission reductions through changes in diet and production methods.** The carbon footprint of different foods varies, with nuts and vegetables having among the lowest, and red meat having the highest. There is even a ten-fold difference in the carbon intensity of red meat depending on how it is produced. Balanced diets that emphasize plant-based foods—and for many, lower portions of animal products from sustainably produced livestock, or animals, like poultry or seafood that produce less emissions (though it must also be noted that many people in developing countries eat insufficient protein foods and need to increase their consumption)—offer a major opportunity for mitigation of and adaptation to climate change.

FOUR: Equipping all farmers with the knowledge, capacity and authority to practice sustainable plant nutrition

> "There is only one way to destroy poverty: create wealth. Agriculture can do that. But it's not going to happen with compost and last year's left-over seeds and a hand hoe, but through commercialization, balanced fertilization, mechanization and well-established value chains."
>
> **— Theo de Jager,** President, World Farmers' Organisation

Farmers are being asked to play a significant role in providing a sustainable future for all of humanity. Yet they make up the majority of the world's extreme poor. They lack access to inputs and information and remain at the periphery of crucial deliberations on sustainable food production.

Farmers need to be full partners in the decision-making process on agriculture at local, national and international levels. They also need access to the full range of modern and emerging technologies to transform their farms into thriving businesses. Yet, of the world's 500 million smallholder farmers, few are intensifying agricultural production (purchasing inputs, investing in agricultural assets, changing practices) to raise productivity and incomes. Smallholder farmers would greatly benefit from access to sustainable plant nutrition.

FACTS:

- Nearly half of farmers are women. It is estimated that if women had the same access to productive resources as men, the yields on their farms could increase by 20-30 percent.
- Only 10-15 percent of farmers in East and West Africa are intensifying agricultural production.
- Only 12 percent of farmers in South East Asia and 17 percent in South Asia are intensifying production.

SUSTAINABLE PLANT NUTRITION SOLUTIONS:

Solutions must come from the entire food value chain, and the plant nutrition sector can help lead the way. Moreover, other key stakeholders also have a major contribution to make. That includes the network of international agricultural research centers known as CGIAR and the World Farmers' Organization (WFO). But it also must involve local and national research institutes and extension service providers, local farmer groups and representatives from agricultural input retailers.

Sustainable plant nutrition can restore depleted soil, raising crop productivity and nutritional quality. Across Africa, some 65 percent of agricultural land is degraded. Fertilizer is a key ingredient for restoring soil health and improving crop productivity and quality. The average fertilizer use in sub-Saharan Africa was only 16 kilograms per hectare of cropland in 2017, compared to 140 kilograms worldwide. The fertilizer industry should support farmers to address their plant nutrition challenges in ways that increase productivity, restore soil health and give them a prominent role in developing a more sustainable global food system.

- **The plant nutrition sector has an important role to play in developing partnerships with farmers.** The focus should be on both providing tailored soil health and crop fertilization solutions and training farmers in their efficient use, following the 4Rs in a crop- and site-specific manner. In addition, some companies are partnering with financial institutions—or setting up their own lending facilities—to help smallholder farmers gain access to credit, crop insurance and other financial services on terms aligned with the scale of their farms, the seasonal nature of their income and the lack of conventional collaterals.
- **The plant nutrition sector, along with other branches of the food system, needs to systematically include farmers in pivotal discussions.** That includes planning for adaptation and mitigation to climate change; developing new products and processes that are practical and environmentally sound; and anticipating market needs. Likewise, government agencies and multilateral organizations should include farmers as key players in the development of policies that will impact their livelihoods, or that they will be expected to implement.
- **Plant nutrition solutions designed with an awareness of gender inequities can help bridge the gaps in women's access to fertilizer and other productive resources.** Closing the gender gap in agricultural inputs alone could eliminate hunger for 100-150 million people, while empowering women and improving household nutrition, health and wealth.

FIVE: Minimizing and reversing degradation of our natural resources

> "In the market economy, production capital is overvalued, human capital is undervalued and natural capital not valued."
>
> **— Janez Potočnik,** Co-Chair, International Resource Panel, UNEP

Across all economic sectors, poor resource management and failure to account for the value of nature drives widespread degradation of water, soil, biodiversity and other crucial natural resources and related ecosystem services.

To ensure a sustainable future and agricultural system, economic growth needs to be decoupled from natural resource use, and agricultural growth decoupled from growth in fertilizer and water use. All economic sectors, including agriculture, contribute to unsustainable resource use, and all must be part of the solution.

FACTS:

- Global resource use by all sectors more than tripled in the past 50 years, and almost doubled on a per capita basis, from 7.4 tonnes to 12.2 tonnes per capita.
- Resource extraction and processing is responsible for 90 percent of biodiversity loss on land, 50 percent of global climate change impacts and one-third of air pollution health impacts.
- The Inclusive Wealth Report from 2018, which covers the 25 years from 1990 to 2014, shows that growth of GDP has come at the cost of natural capital, like freshwater and savannah and forest ecosystems.
- One study by the Food and Land Use Coalition finds that sustainable restructuring of food and land use systems could create new business opportunities worth up to $4.5 trillion a year by 2030.

SUSTAINABLE PLANT NUTRITION SOLUTIONS:

The decoupling of agricultural growth from growth in fertilizer and water use will involve massive changes in industry business models over many years and build on circular economy concepts that design industrial processes to reuse materials and replenish resources.

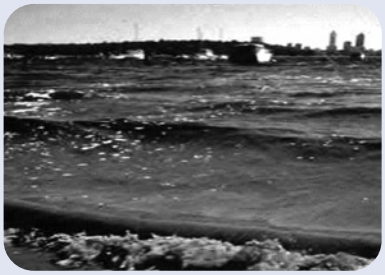
- **In line with the circular economy, fertilizer companies are pursuing opportunities to capture nutrients through waste management.** They are examining their waste streams to determine what is in the waste, and how can it be taken out, made safe and put to use. For example, ICL operates a phosphate recycling unit in Amsterdam. Its goal is to substitute up to 25 percent of phosphate rock with recycled sources, including sewage sludge.
- **The company Elemental Digest Systems has developed Thallo,** a sustainable phosphorous organo-mineral fertilizer made from abattoir waste. Using its approach, small fertilizer factories attached to pig abattoirs could supplement big fertilizer supply chains and increase nutrient use efficiency across the food supply chain.
- **Greatly improved NUE is one key to decoupling** agricultural growth from growth in fertilizer use.

CASE STUDY: Are trade-offs necessary?

Globally, the use of nitrogen would have exceeded a critical threshold for maintaining healthy ecosystems, according to the Planetary Boundaries theory. But the reality varies by geography. **Lena Schulte-Uebbing,** of Wageningen University, the Netherlands, reported on a European Union study examining the trade-offs between food production and water quality objectives to estimate optimal nitrogen inputs.

It found that average nitrogen inputs from all sources (fertilizers, manure, deposition, biological fixation) in Europe is about 145 kilograms per hectare. The critical limit for surface water quality is an average input of 83 kilograms per hectare. Therefore, current practice significantly exceeds this limit. On the other hand, more nitrogen fertilizer is needed to reach 80 percent of the yield potential achievable in the region. To accomplish this, given current rates of Nitrogen Use Efficiency, farmers would need to apply 185 kilograms per hectare—an average increase of about 40 kilos, thus further exceeding the limits for healthy water.

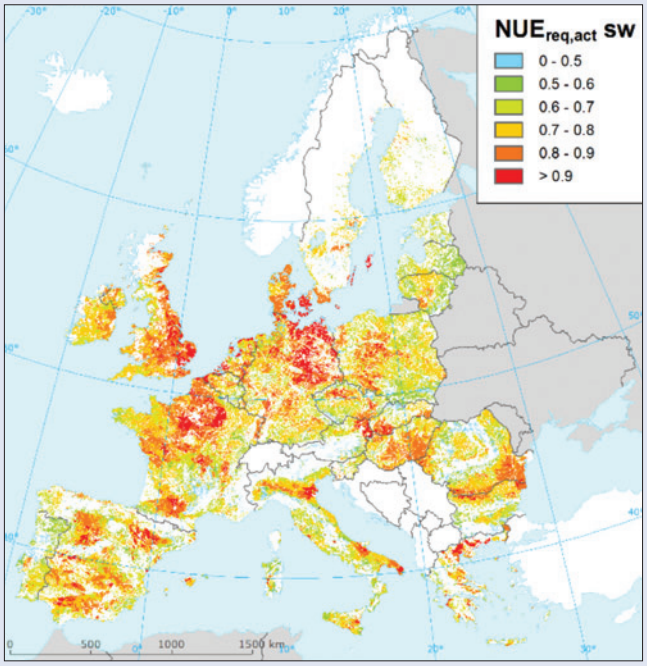
Therefore, the main way to reconcile environmental and food production goals is to increase NUE to about 80 percent on average across the European Union. Because NUE varies across the region, increases would range from 0 to 90 percent, based on the locality. Where it is not possible to reach the target, other changes, such as shifting the location of agriculture, could be needed.



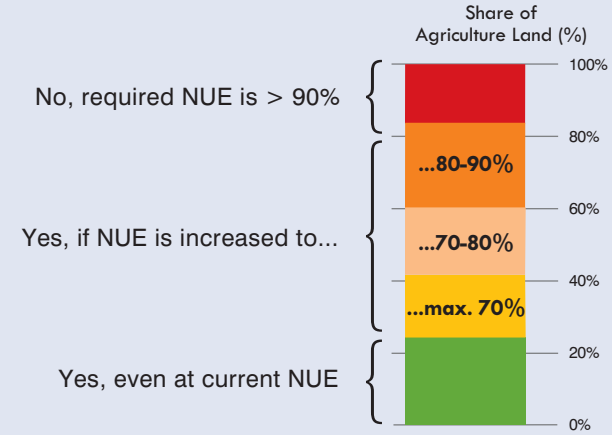
1. Critical N inputs

2. Required N inputs

3. Necessary NUE



CAN CURRENT YIELDS BE RECONCILED WITH CRITICAL RUNOFF BY INCREASING NUE?



Source: Schulte-Uebbing et al. 2019 (in prep)
Courtesy of Lena Schulte-Uebbing, PhD Researcher, Wageningen University

RECOMMENDATIONS FOR THE PLANT NUTRITION SECTOR

Fertilizer companies have already initiated changes—in the development of processes, products, services and partnerships—that are informed by sustainable approaches to plant nutrition. The goal is to encourage the transformation of the global agricultural system into one that enhances Earth's capacity to support healthy life while building profitable enterprises.

Yet, as former IFA Chairperson and current President of GPIC **Dr. Abdulrahman Jawahery** said, "Everybody has good intentions but is working individually." A coherent blueprint for change and shared platforms for execution are needed to direct and accelerate progress.

Underscoring the urgency of accelerating a system-wide transition to sustainable plant nutrition is the sheer increasing scale of fertilizer manufacture. Between 2018 and 2023 the fertilizer industry will invest close to USD $110 billion in constructing 70 new production units, adding 65 Mt products of capacity.

Five major recommendations emerged from the High Level Forum on Sustainable Plant Nutrition. Each one involves changes already underway, with a focus on accelerating these efforts and pursuing more research and evaluation and shared learning.

ONE: Develop business models that build on new opportunities, and do what is right for people and the planet

> "The approach of our business models to markets is beginning to evolve from a product-centric, commodity, volume-based model to one of providing solutions to the farmers."
>
> **— Mostafa Terrab,** Chairperson IFA, Chairman OCP

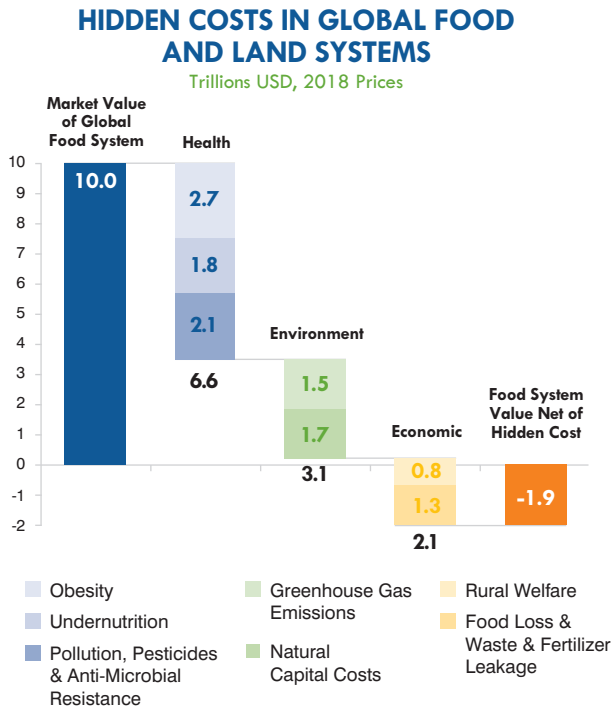
New business models transform fertilizer companies into innovative agricultural solution companies. These are companies that offer tailored, comprehensive solutions to nutrient management informed by substantial knowledge. And they embrace new production technologies and more recycling. At the same time, the industry needs to maintain a focus on regions facing significant yield gaps and huge population growth, where food demand is rising, and fertilizers are crucial for increasing food security.

Elements of the new business models include:

- **Shift from a focus on supply to demand; and from volume to value-added,** with products that generate more output per unit of input. This shift may ultimately decouple agricultural growth from ever expanding fertilizer use. It involves investing more in the research and development of products and services that provide specific solutions required by farmers. Among the products that meet farmers' needs and protect the environment are new formulations and blends, including blends with secondary macronutrients and micronutrients; inhibitors, polymer coatings and other smart technologies that slow the release of nutrients into the soil; and biostimulants and biologicals. Biodegradable polymers and nanofertilizers are also in the research pipeline.
- **Develop novel methods to increase energy efficiency in production and to develop new circular agriculture models.** Applying design principals of the circular economy, the fertilizer industry is looking to the use of renewable energy for the production of ammonia, and also discovering new opportunities in recycling nutrients—from urban, agricultural and industrial waste—into high quality fertilizers. Companies are working with existing and new production processes, and adopting a local approach to resource recovery, processing and distribution.

- **Embed true cost accounting in business** by allowing for better consideration of externalities, such as the cost of negative impacts on ecosystem services. One calculation by the Food and Land Use Coalition finds that every year the food system creates a value of USD $10 trillion. But food and land-use systems could generate "hidden" environmental, health and poverty costs that could amount to an estimated USD $12 trillion a year, so the net would be a negative USD $2 trillion. It also calculates that 10 critical pathways could unlock USD $4.5 trillion in new business opportunities each year by 2030. At the same time, by 2030, this would save USD $5.7 trillion a year in damage to people and the planet, more than 15 times the investment cost of up to USD $350 billion a year.

The "hidden costs" of global food and land use systems sum to **$12 trillion,** compared to a market value of the global food system of $10 trillion



Source: Food and Land Source Coalition, 2019

Courtesy of Janez Potočnik, Co-Chair of the International Resource Panel, UN Environment Program

- **Include young people to help drive business innovation.** Several industry leaders pointed out that young people are less likely to think in terms of a zero-sum game, in which food security and environmental protection are viewed as contradictory goals. Increasingly, young leaders' programs and innovative agriculture start-ups are becoming an integral part of the business development strategy. IFA's Young Leaders Initiative, as well as the Start-up Award 2019, reflect the industry goal of creating new dynamics through an increased involvement of the younger generation.
- **Develop value chain solutions.** New business models must also extend beyond fertilizer companies to other parts of the value chain. For example, in Ethiopia, fertilizer companies now sell directly to farmers rather than going through middlemen, making products more affordable on the farm.

Cultivating a New Generation of Industry Leaders: The OCP Experience

There is widespread agreement that today's rising generation of young leaders is committed to embedding environmental and sustainability goals into the business agenda of major companies. And that's prompting a more intense focus within the fertilizer industry to ensure its workforce includes a healthy number of young people.

OCP is one company that has dramatically increased hiring of a new generation: over the past 10 years, the average age of its 23,000 employees has gone from 47 to 37. At the same time, OCP has embarked on a new social contract with its young employees: to align company growth and their personal growth and sense of purpose. One outcome was the birth of a new university known as UM6P, the Mohammed VI Polytechnic University in Morocco, a hub of education, research, innovation and entrepreneurship for Africa. It now houses the African Plant Nutrition Institute, launched in 2019.

Seeking Sustainable Solutions at ICL and Coromandel

Raviv Zoller, CEO of ICL, described innovations that can lead to a more sustainable business model. Launched 70 years ago as a potash company, today ICL has 44 production sites in 13 countries, and an annual revenue of USD $5.6 billion.

Its sustainability initiatives include:

- Investments that have reduced air emissions of sulphur oxides by 57 percent, and nitrogen oxide by 86 percent since 2008.
- A focus on "specialty products" that include products for fertigation and foliar fertilization that allow growers to optimize their yields, reduce fertilizer use, save irrigation water and reduce leaching and volatilization of nutrients.
- ICL's controlled-release fertilizers can reduce total fertilizer use by 20 to 50 percent; leaching rates by up to 55 percent; denitrification rates by up to 40 percent; and volatilization rates by up to 40 percent.
- Production of polysulphate, a unique multi-nutrient fertilizer containing potassium, calcium, magnesium and sulphur. It requires no chemical processing and creates no waste products, has a low carbon footprint and is approved for organic use.
- Operating a phosphate recycling unit that reclaims phosphates from alternate sources, such as sewage sludge, and uses the recycled minerals for fertilizer production on an industrial scale.

Meanwhile, Coromandel CEO **Sameer Goel** discussed his company's efforts in India to deal with a range of challenges by going well beyond a focus on products to address the many other needs of Indian farmers.

Coromandel is India's largest private sector phosphatic fertilizer company and largest rural retail chain, with 800 retail centers across the country. But alongside fertilizer products it also provides a range of services, including farm mechanization, agricultural insurance, credit, soil testing and extension activities that reach three million farmers annually. The company is now piloting a drone project on paddy and cotton crops that provides crop diagnostics and soil analysis. It also operates e-kiosks for last mile delivery of farm inputs.

"The convergence of products and services makes Coromandel a one-stop shop for agriculture needs," Goel said.

TWO: Build innovative partnerships across the value chain, from farmers to consumers

> "Where we do need a breakthrough is on how to collaborate."
>
> **— Svein Tore Holsether,** CEO, Yara

Partnerships are crucial to achieving sustainable plant nutrition across the global agricultural system.

- **Build partnerships with farmers:** The most important partnership is with farmers because they are the heart of agriculture. Yet hundreds of millions of smallholder farmers remain on the periphery of the market system. They do not yet have access to the wide range of innovations at the heart of sustainable agriculture and sustainable plant nutrition. In addition, because optimal plant nutrition is site- and crop-specific, the industry must work more closely with farmers and advisory services.

  Part of that work involves advocating for policies that support farmers to take up new practices that could be expensive or time-consuming; building collaborative participatory extension programs; lessening the risks of farming through providing financial services; and including farmers in crucial decision-making fora. The use of technology that increases transparency within the supply chain and the traceability of agricultural products can also lead to fairer distributions of the benefits of agriculture.

- **Build partnerships for R&D and funding:** The CGIAR is the largest international agricultural research network and has developed thousands of improved high-yielding varieties of staple food crops. Today it is expanding its focus to scale up agronomic research and solutions. In January 2020, the CGIAR is launching its new **Excellence in Agronomy Initiative.** The Initiative will develop a platform that brings together all agronomy systems within the CGIAR and its partners and develop common standards for the collection and use of data. The CGIAR is now reaching out to the fertilizer industry to discuss potential areas of collaboration.

- **Build partnerships with international and environmental organizations** to conduct research, develop standards and promote the implementation of sustainable agricultural practices. For example, BASF and Rothamsted Research are collaborating to better understand different cropping systems and their capacity to sequester carbon. IFA has also provided inputs to the UN Food and Agriculture Organization (FAO) for developing an International Code of Conduct for the Sustainable Use and Management of Fertilizers (which was presented to the Forum by **Hans Dreyer,** Director of FAO's Plant Production and Protection Division) and to a forthcoming UN Environment report on the environment and health impacts of pesticides and fertilizers (referred to at the Forum by **Jacqueline Alvarez** of UN Environment).
- **Engage consumers.** As consumers understand the role of sustainable plant nutrition, they can become allies in supporting the policies and funding needed to achieve the necessary scale and pace of change. Partnerships with the end-consumers can ultimately help focus social movements around food trends and climate change. Yet, a lack of transparency within the overall food system fuels consumer mistrust. The industry is beginning to apply technologies that allow for greater transparency. Examples include the IBM Food Trust, a blockchain initiative to improve food traceability across supply chains that enables consumers to directly support farmers. Certification labels and the power of trademarks could also communicate sustainable practices to consumers.

THREE: Create a core operating system for better data and digital tools

- **Develop a common, core operating system for curating high-quality data on crop nutrition and soil health that is collectively owned and used and provides a shared basis for conducting research and developing apps.** This core operating system should draw from strong, peer-reviewed scientific findings on plant nutrition, including research related to nutrient management, conservation agriculture, water management and precision-based approaches. It would bring uniformity to research efforts, enable widespread collaboration on a myriad of problems, and end much of the ambiguity around research results. Work has already begun toward developing such a system, including through CGIAR's Big Data platform and FarmStack, an open source digital platform for agricultural extension service supported by the Bill & Melinda Gates Foundation.
- **Become more knowledgeable and precise in data collection and use.** Apply predictive analytics to better serve farmers and fuel the development of disruptive technologies. Needs include a global nutrient modeling system and spatially detailed data to inform farmers' best practices in the 4Rs. Nutrient management decision-making tools powered by artificial intelligence can provide fertilizer recommendations and real-time guidance throughout the life cycle of a crop.

FOUR: Accelerate technology innovation

> "Digital technology and Big Data, precision farming and blockchain are going to change the way we do agriculture forever."
>
> **— Theo de Jager,** President, World Farmers' Organisation

The industry has already made significant breakthroughs in using digital technology for extension and market information; soil analysis and digitalized soil maps; precision farming techniques; and to develop more efficient fertilizer products. But most of these innovations still have limited reach. For example, 20 apps in 20 countries provide expert advice on site-specific nutrient management for rice, maize, wheat and other staples. **Matthew Morell,** the Director General of the International Rice Research Institute (IRRI), reported that the apps have shown benefits of 10-20 percent more yield and profit; 30-50 percent higher NUE; less GHG emissions; less water and air pollution; less pesticide use; and more balanced nutrition.

But, so far, the number of farmers reached by these apps number in the hundreds of thousands, not the hundreds of millions required to deliver meaningful impact. Innovation must therefore also address the reasons behind this limited reach, which often lie in the research process itself.

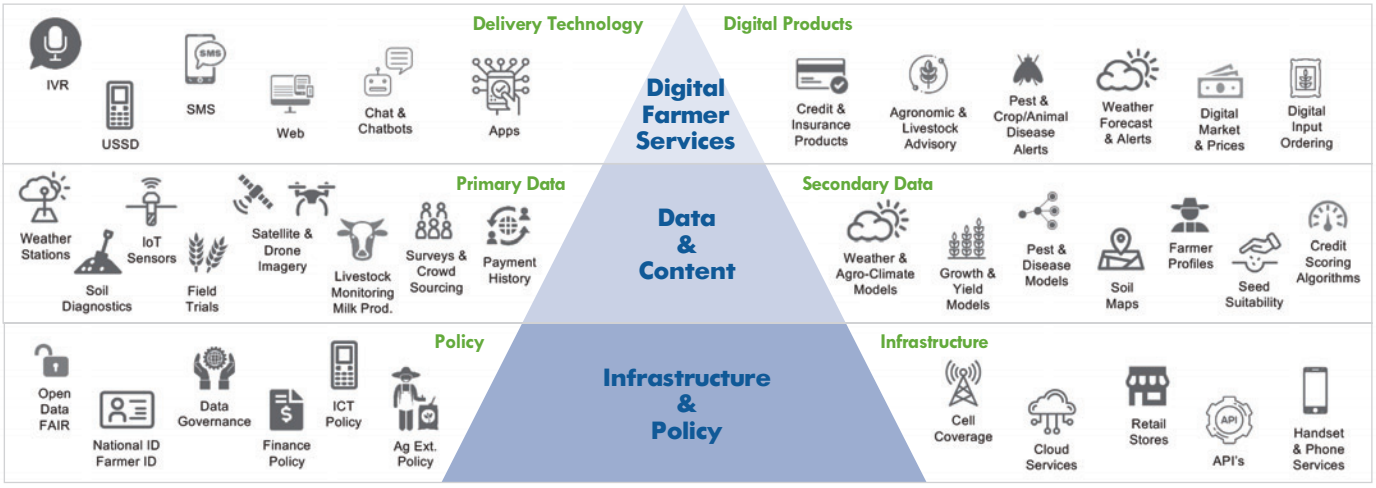
Among the avenues of innovation to pursue are:

- **Development of micronutrient fertilizers to improve human health and create a healthier food system.** Through micronutrient fertilizers—especially zinc, selenium and iodine—the fertilizer industry can have a significant positive impact

on human health. World Food Prize Laureate **Howarth Bouis,** Founding Director of HarvestPlus, noted that it has taken the organization 15 years to develop the range of genetically biofortified crop varieties that are now being grown by ten million farm households. Today, HarvestPlus is embracing micronutrient fertilizer solutions, along with biofortified crop varieties, and pursuing research collaborations with the fertilizer industry. The goal is to reach one billion farm households with innovations that help end malnutrition.

- **Accelerate the development and adoption of products that increase plant nutrient use efficiency; slow nitrification; reduce nutrient losses to the environment; and enhance soil carbon and its stability.** Only through collaboration with farmers will the industry be able to ensure the usefulness and uptake of new products, the reliability of bundled services and a significant return on the farmer's investment.
- **Extend the capabilities of geo-spatial science, satellite imagery and drone technology to inform precision agriculture and to advance agronomic solutions at scale.** Satellites provide a starting point for observation, diagnosis and recommendations for the farmer, said **Charlotte Gabriel-Robez,** Agriculture Portfolio Manager for Airbus. They are most useful for evaluating nitrogen and water management. Airbus has a dedicated program on satellite imagery serving agriculture. Challenges include processing large images, penetrating cloud coverage and translating pixels into vegetation analytics.
- **Innovate the research process.** Including farmers—especially women farmers whose needs are often overlooked—in the technology development process will ensure that products are well-suited to local conditions and will prompt more rapid adoption of new technologies. In addition, an "open innovation" process that assembles cross-disciplinary teams of biologists, computational scientists, chemists and engineers will speed research and lead to more robust solutions.

DIGITAL PLATFORMS AND AG-DATA ECOSYSTEM POWERING DIGITAL AGRICULTURE



Source: Bill & Melinda Gates Foundation
Courtesy of Christian Witt, Sr Program Officer, Soil Health and Lead, Digital Farmer Services, Bill & Melinda Gates Foundation

Company profiles in innovation: Nutrien

"Sustainability will be at the core of everything we do." **Chuck Magro,** CEO, Nutrien

Nutrien, a global provider of crop inputs, services and solutions, is transitioning to be a full-service agricultural solutions provider for the farmer. Magro explained the evolution of their approach, which begins by putting the customer first. "Five years ago, we just wanted the farmer to make more money. We built our products to help their bottom line. But we began to sense that is not enough," he said. Knowing that farmers need to be profitable and more sustainable, Nutrien began asking how it could help reduce farmers' risks and improve resilience.

Today, Nutrien's R&D is focused on data and digital solutions and advancing product technology. It invests USD $100 million annually in digital development. That includes work on an online digital platform where farmers can select seed based on their farm conditions, choose a fertility package based on their soil profile and select a monitoring program (satellite, drone or a new optical technology program). They can then use this package to help secure a loan, either from a conventional financial services provider or a bank within Nutrien.

In the past ten years, the company has also invested USD $1 billion on product technology, including micronutrient liquids. Currently, about 80 projects are in the pipeline, and 4,000 agronomists are working with 500,000 farmers.

FIVE: Advance policy reform

> The situation in China is much different than in Kenya. We need precision policy the same way we need precision agriculture. The system encourages a short-term approach. Until you have industry advocating to government for a long-term approach, it won't happen.
>
> **— David Cleary,** The Nature Conservancy.

The policy environment regarding fertilizer use is stuck in the past, when the goal was to incentivize the bulk use of fertilizer. Today, policies are needed to support the development of new business models, and to incentivize the development, production and use of more efficient and less polluting fertilizers.

Market forces alone cannot stimulate innovation in the industry. To rapidly deliver on the promise of innovation for sustainable plant nutrition, the industry needs an enabling policy environment.

As **Holger Kray,** the World Bank's Practice Manager for Agriculture and Food Security, put it, "The time is now to work with policy makers on the realignment of public investments that amount to half a trillion dollars a year to agriculture."

The Forum considered a number of options:

- **Re-evaluate and end or reform subsidy policies.** Public support should largely be re-directed away from subsidies on commodity fertilizers, which promote imbalanced or inefficient fertilization, and that distort agricultural markets in ways that threaten the long-term viability of agriculture production and of environmental health. Where subsidies continue, many can be made smarter. For example, farmers receiving subsidized fertilizer could be required to have a regular soil analysis, so fertilizer formulations can match the specific nutrient requirements of their soil.
- **Replace direct subsidies with indirect subsidies that build efficient logistics and transport systems.** Such investments could be channeled to developing wholesale markets, road construction, improving ports and extending electrification and broadband coverage. They could also help farmers invest in drip irrigation systems to facilitate transition to fertigation in irrigated areas. Ultimately, indirect subsidies could help lower the cost of fertilizer for farmers, especially those in more remote areas.
- **Promote improved human nutrition as a public policy goal** and incentivize micronutrient fertilization to help meet that goal.
- **Seek policies that incentivize industry innovation in developing sustainable processes and products and incentivize farmers to use suitable fertilizers, embrace the 4Rs and follow the principles of Integrated Soil Fertility Management.** Certify fertilizer quality and prevent sales of fake fertilizers and black-market trading of fertilizer.
- **Advocate for policies that promote carbon sequestration.** This work can include efforts to develop carbon markets, stop deforestation and incentivize farmers to build soil organic matter.
- **Combine market-based instruments with more stringent regulatory measures.** Policies can drive innovations by encouraging the use of more sustainable plant nutrition solutions.
- **Reduce nutrient pollution without placing the regulatory burden on farmers.** Shift the regulatory burden from millions of farmers to other players in the agrifood value chain that can influence farm-level nutrient management, argued **David Kanter,** Vice Chair of the International Nitrogen Initiative. Placing the regulatory burden on farmers is not only unfair, it is also ineffective, he said.

INDIA: A tale of changing subsidies

India exceeded its goal of self-sufficiency in food production during the Green Revolution, and has since multiplied production 3.7 times, while the population has increased 2.5 times, said **Sameer Goel,** Managing Director of Coromandel Ltd, India.

During the Green Revolution, India improved its infrastructure and adopted high-yielding varieties that required large amounts of fertilizer to maximize yield. Although the government began to regulate the sale, pricing and quality of fertilizer in 1957, it wasn't until after the oil crisis in 1973—and the dramatic increase in fertilizer prices—that the subsidy program began.

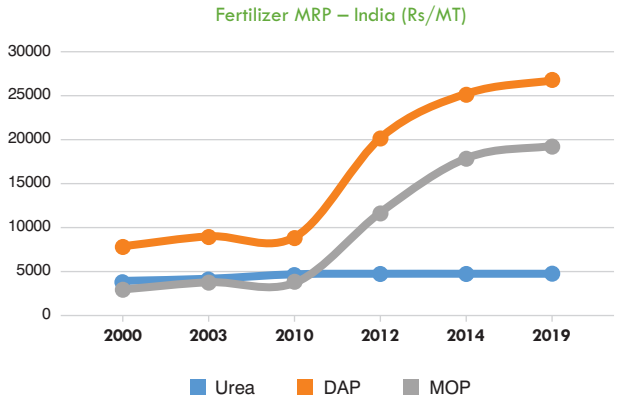
The program quickly grew, becoming a fiscal drain on government resources. Reforms ultimately led to the partial deregulation of DAP (phosphate) and MOP (potassium) but continued to heavily subsidize urea (nitrogen). Consequently, farmers made ample use of urea, but cut back on the now higher-priced DAP and MOP. Over time, this imbalanced use of fertilizer led to declines in soil fertility and yield improvements.

Although fertilizer subsidies persist and today equal one percent of India's GDP, recent policies encourage more efficient and balanced fertilizer use.

In 2015, the government launched a Soil Health Card (SHC) Scheme in an attempt to provide tailored nutrient and crop recommendations to farmers based on local soil health tests every two years. The program serves at least 140 million farmers. The agriculture ministry reported that card use allegedly lowered fertilizer consumption in 2016-17 by eight to ten percent compared to the prior year, while a more balanced use of nutrients increased crop production by 12 percent.

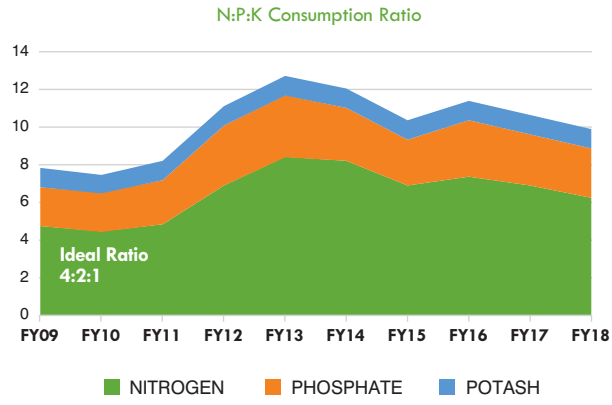
Most recently, the government has linked the SHC to the fertilizer subsidy program. It utilizes India's extensive digital identity system, known as Aadhaar, to link fertilizer sales, land records and SHCs of individual farmers. The process produces a recommended fertilizer mix that is farm-specific. Ultimately, it is intended to directly transfer subsidy payments to farmers' bank accounts.

FERTILIZER PRICE VARIABILITY



Source: Ministry of Fertilizers, GoI

LED TO IMBALANCED NUTRIENT USAGE



Source: FAI

STEPS TO MODERATE 'N' CONSUMPTION

- **Neem coating** Urea – For enabling slow release and preventing diversion
- **Bag size** reduction: From 50kg to 45kg
- DBT 3.0: Contemplating Urea under **NBS (Nutrient based subsidy)** – reducing price distortion

Courtesy of Sameer Goel, Managing Director, Coromandel International Ltd., India

CHINA: How environmental concerns are driving fertilizer reform

Oliver Hatfield, Vice President of Business Development at Argus Media, summarized China's recent and dramatic shifts in fertilizer policy, and the reasons behind them. China's GDP increased from the world's fourth largest in 2006 to second largest in 2014. But its standing in the global environment index fell from 94 to 116 out of 132 countries.

According to the China Environment Report 2013, more than 25 percent of lakes suffered eutrophication, and more than 50 percent of ground water had been polluted. Meanwhile, China's first Soil Pollution Report found highly polluted soil in more than 16 percent of soil test samples.

These conditions had evolved after years of fertilizer incentives that quickly led to overuse. By 2013, China's average wheat yield was about 50 percent of its potential, yet farmers were applying nitrogen fertilizer well above the global average.

"The Chinese government subsequently began to shift its position, from one of growth at all costs to more consideration of environmental impacts of growth," Hatfield said. In 2015, the Ministry of Agriculture established the goal of zero growth in fertilizer consumption by 2020, and more balanced use of fertilizers. The government began pushing to reduce fertilizer consumption and to improve use efficiency through multiple measures.

It began to eliminate incentives that kept the price of fertilizer low, and decreased crop price support. These moves prompted farmers to buy less fertilizer and focus more attention on efficient use. As strict environmental protection forces the closure of polluting factories, and further squeezes the fertilizer supply, demand for urea and phosphate fertilizers is contracting.

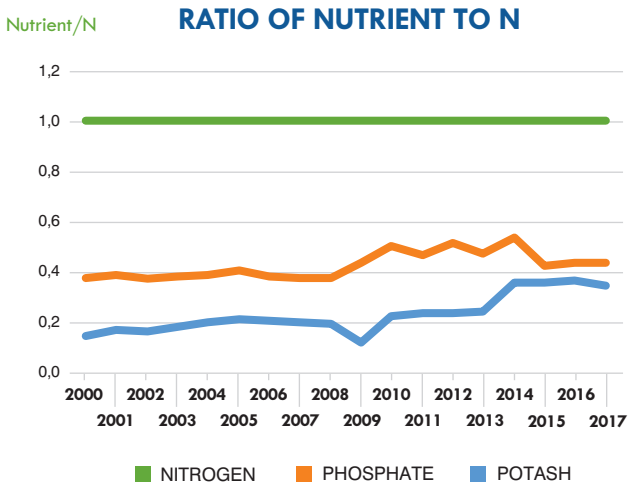
Nonetheless, yields are continuing to improve as farmers increase their NUE. IFA estimates that average national nitrogen use efficiency increased by 7 percentage points in the past 10 years. Farmers are increasing their use of soil testing and micronutrients. They are quickly adopting special products, especially controlled-release and water-soluble fertilizers. In the meantime, a government program that promotes crop rotation and fallow periods is being piloted in nine provinces. The government also encourages greater use of organic fertilizers, especially on fruits, vegetables and tea.

Fertilizer supplier business models in China are also radically changing. Big suppliers like Sinochem are developing and promoting new products and services. There are new education programs for farmers—provided by the government, major suppliers and retailers. Sinochem is cooperating with banks to supply farmers with finance to invest in new, more sustainable inputs.

MORE BALANCED NUTRIENT USE, BETTER PERFORMING PRODUCTS, MICRONUTRIENTS

China is much less reliant on nitrogen

- China has more balanced macronutrient use
- Low analysis products are being substituted for or by high analysis
- More compounds, nitrate-based and SOP-based NPKs where appropriate (and sometimes not!)
- And this extends to greater use of micronutrients
- And importantly, soil testing is being used much more extensively



Courtesy of Oliver Hatfield, VP of Business Development, Argus Media

ETHIOPIA: Pioneering fertilizer policies in sub-Saharan Africa

> Ninety percent of farmers are smallholder farmers. If we want to effectively help farmers intensify their usage of fertilizer, we need to be informed by their behavior.
>
> **— Hailemariam Desalegn,** former Prime Minister of Ethiopia, Chairperson of AGRA

The challenges facing farmers in sub-Saharan Africa are dramatically different from those in other parts of the world. Across the region, soils are highly depleted. In 2017, farmers used an average of only about 16 kilograms of nutrients per hectare of cropland compared to a global average of some 140 kg/ha. This extremely low usage also represents an opportunity, and today sub-Saharan Africa is the fastest growing fertilizer market in the world.

However, to realize this opportunity, and avoid fertilizer misuse, the right policies need to be in place.

His Excellency **Hailemariam Desalegn** described Ethiopia's path toward a more productive and sustainable agricultural system. Desalegn said it started with making agricultural development central to Ethiopia's Growth and Transformation Plan and focusing on farmer needs.

Desalegn noted that 90 percent of farmers in sub-Saharan Africa are smallholders who have high production and price risks and need the confidence and incentives to invest in new technologies, including mineral fertilizers.

"Whatever we want farmers to do, farmers must benefit," he said.

The Africa Fertilizer Summit held in Abuja, Nigeria in 2006, known as the Abuja Summit, produced the Abuja Declaration on Fertilizer for an African Green Revolution. It affirmed commitments by African governments to increase fertilizer use from what was then an average of 8 kilograms per hectare to 50 by 2015. But most countries have yet to meet that goal.

Practical measures that Ethiopia implemented include:

- Mapping of nutrient deficiencies, and widespread soil testing that enabled a shift from blanket products to a variety of formulations tailored to the requirements of specific soils and crops. For many farmers, this change doubled or tripled their yields.
- Government investments in irrigation to protect farmers from erratic rainfall.
- Incentives for the private sector to develop food processing industries, and further ensure markets for farmer output.
- Government investments in a robust extension system to train farmers in the 4Rs of proper fertilizer usage.
- Development of an indirect subsidy program aimed at accelerating rural transformation, through government funding of roads and other infrastructures—including the recent upgrade of the Djibouti-Addis railway.

Desalegn noted that the entire fertilizer value chain, from the port to the farmer, plays a role in the final price paid by the farmer, and each link in that chain must become more efficient. Transport and logistic costs, in particular, add disproportionately to the price farmers pay for fertilizer.

CONCLUSION

Drivers of Change

In the second half of the 20th Century, scientists, policymakers, farmers and the agricultural industry united around a central idea: that addressing the specter of mass starvation required urgent action to increase productivity and keep food prices low. Their efforts resulted in tremendous successes.

In closing remarks, **Charlotte Hebebrand,** Director General of the IFA, noted that a new paradigm for agriculture and plant nutrition has already begun to emerge. But to be useful, it must be better articulated and inform the roles of different players in the agri-food value chain, along with policymakers, international organizations and NGOs. Productivity and food security continue to be essential, but new dimensions must also become priorities. Fertilizers can also make important contributions to nutritional security, poverty alleviation and help to support carbon sequestration in forests and soils. Moreover, more efficient fertilizer use can mitigate key environmental impacts, from climate change to water and air quality to biodiversity loss.

“It is a new paradigm not just for industry, but also for policymakers, farmers, consumers and international organizations. All hands on deck will be required,” she said.

Hebebrand reported on actions at IFA already underway relevant to Forum themes.

IFA Actions to Promote Change

Focus on Product Stewardship

IFA has a long-established set of benchmarks to measure and monitor progress within the industry on safety, environmental emissions, energy efficiency and CO_2 emissions, as well as a product stewardship certification program, entitled Protect & Sustain. It is also providing input to an initiative by the International Energy Agency and the European Bank for Reconstruction and Development to draft a "Nitrogen Roadmap". It is aimed at calculating sector-wide and long-term GHG reduction targets, exploring means to reach them (adoption of BATs, breakthrough technologies) while identifying potential barriers and suggesting ways to jointly overcome them.

Focus on Nutrient Stewardship

IFA also encourages and increasingly expects its members to become champions of industry stewardship in sustainable plant nutrition. IFA members are guided by recently adopted Nutrient Stewardship Commitments, and an Industry Code of Practices for sustainable plant nutrition is under development. Three major upcoming events also underscore this commitment:

- IFA will convene its first Global Stewardship Conference in New York City, 4-7 February.
- IFA will release its first sustainability report in early 2020.
- A second High Level Forum on Sustainable Plant Nutrition is planned for Kigali, Rwanda, in November 2020 to examine the key plant nutrition opportunities and challenges facing sub-Saharan Africa.

Creation of the Position of Chief Scientist, IFA

IFA hired **Achim Dobermann,** Director and Chief Executive of Rothamsted Research, as its first Chief Scientist. IFA already provides the most authoritative data on fertilizer production, trade and demand, and has recently begun to map nutrient use efficiency trends at the national level. With the hiring of a new Chief Scientist, IFA will expand its agronomic data offerings and more deeply engage in best data practices.

Launch of the International Scientific Panel on Responsible Plant Nutrition

Composed of world-renowned experts, this advisory panel will provide guidance to IFA and other stakeholders on options for more effectively promoting sustainable plant nutrition. The panel held its first meeting the day before the Forum. Both Dobermann and the Panel's first Chairperson, **Tom Bruulsema,** participated throughout the Forum, sharing insights and seeking guidance to inform Panel priorities. The Panel will provide synthesized research findings to promote more sustainable plant nutrition and examine how to improve monitoring and measurement of best practices in fertilizer management.

Engagement of a New Generation and Promoting Diversity

IFA actively involves and mentors young professionals, incentivizes their inclusion as company representatives and organizes young leaders sessions specifically designed to inform long-term strategic considerations. IFA has also embarked on a diversity program with the objective to promote and support women throughout the fertilizer value chain.

Strengthening of Partnerships and Dialogue

IFA is deepening its engagement with UN agencies, civil society and the broader food value chain. Looking to the future of IFA, Hebebrand envisioned developing a diverse stakeholder coalition of plant nutrition solution providers and partners committed to more sustainable approaches. She extended an invitation to all organizations present at the Forum to join IFA, from the World Bank to UN Environment to The Nature Conservancy.

FURTHER READING

All High Level Forum on Sustainable Plant Nutrition speaker presentations (as well as supplementary interviews) can be found on the dedicated event website: www.highlevelforum.org

Climate Change, Agriculture and Food Security (CCFAS program of CGIAR), 2019: Transforming food systems under climate change[1]: Local to global policy as a catalyst for change

Intergovernmental Panel on Climate Change (IPCC), 2019: Climate Change and Land[2]: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security and greenhouse gas fluxes in terrestrial ecosystems

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019: Global Assessment Report[3] on Biodiversity and Ecosystem Services

World Business Council for Sustainable Development (wbcsd), 2019: CEO Guide to Food System Transformation[4]

World Resources Institute (WRI) Report, July 2019: Creating a Sustainable Food Future[5], A Menu of Solutions to Feed Nearly 10 Billion People by 2050

Citations:

[1] https://cgspace.cgiar.org/bitstream/handle/10568/101601/CCAFS%20WP%20No.271%20-%20Local%20to%20global%20policy%20as%20a%20catalyst%20for%20change.pdf

[2] https://www.ipcc.ch/srccl/

[3] https://ipbes.net/global-assessment-report-biodiversity-ecosystem-services

[4] https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Resources/CEO-Guide-to-Food-System-Transformation

[5] https://wrr-food.wri.org

ifa INTERNATIONAL FERTILIZER ASSOCIATION

About the International Fertilizer Association

The International Fertilizer Association (IFA) promotes the efficient and responsible production, distribution and use of plant nutrients to enable sustainable agricultural systems that contribute to a world free of hunger and malnutrition. IFA is the only global fertilizer association with a membership of more than 470 entities, encompassing all actors in the fertilizer value chain from producers through traders and distributors, as well as service providers, advisors, research organizations and NGOs.

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