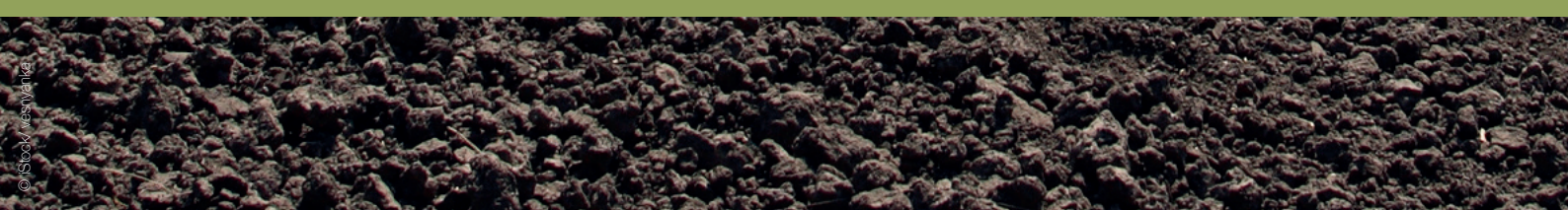
Soil & Fertilizer: Expert Views

In celebration of World Soil Day and the International Year of Soils in 2015, IFA joined hands with experts on the topic of soils and fertilizers to raise public awareness on the relationship between fertilizers and soils.



What is the role of soils in agricultural production, food security and sustainable intensification?

EXPERT'S VIEW

Soils are fundamental to life on Earth and constitute the foundation of agricultural development and ecological sustainability. They are a key enabling resource, central to the creation of a host of goods and services integral to ecosystems and human well-being. Soils are the basis for food, feed, fuel and fiber production and for many critical ecological services. They constitute the largest pool of organic carbon which is vital for climate change adaptation and mitigation. Our soils are responsible for buffering, filtering and moderating the water cycle and for regulating the carbon, oxygen and plant nutrient cycles. In an era of water scarcity, soils are fundamental for appropriate water storage and distribution. Soils host a quarter of the planet's biodiversity. They also serve as a platform and source for construction and raw material. Soils have a role in achieving integrated production systems and helping to address the food, water, and energy nexus.

We commonly say that soils are where the food begins and this is certainly true as around 95 percent of our food is directly and indirectly produced by soils. It is easy to understand how important it is to keep our soils healthy and productive. Today, we have more than 805 million people facing hunger and malnutrition. Population growth will require an increase of approximately 60 percent in food production. Unfortunately, 33 percent of our global soil resources are degraded.

Our challenge today is to produce more and healthier food in a sustainable manner. The promotion of sustainable soil management is essential if humanity's overarching need for food, water, and energy security is to be met.

The achievement of food security and nutrition, climate change adaptation and mitigation and overall sustainable development for all and by all will greatly depend on the condition of soils at local and global level. Healthy soils are needed for a healthy life. All stakeholders need to partner to reverse soil degradation. The Global Soil Partnership is focused on promoting the sustainable management of soils and will use World Soil Day and the International Year of Soils to raise awareness on the importance of our much needed, yet forgotten resource.

THE EXPERT

RONALD VARGAS is a soil scientist from Bolivia who is currently the Secretary of the FAO's Global Soil Partnership. He has 15 years experience on natural resource management with focus on soil assessment and management for food security in Africa, Asia, Latin America and the Near East. He was the promoter of the establishment of the Intergovernmental Technical Panel on Soils and the International Year of Soils 2015.

What is the role of nutrients in soil health management, and how can mineral fertilizer application influence components of soil health such as readily-available nutrient pools, soil organic matter, soil pH?

EXPERT'S VIEW

A healthy agricultural soil supports the production of food and fibre, to a level and with a quality sufficient to meet human requirements, together with continued delivery of other ecosystem services required for maintenance of the quality of life for humans and the conservation of biodiversity. As soil is a very complex multicomponent and multifunctional system, its operating limits and characteristic spatial configuration are altered by agricultural interventions, such as drainage, irrigation, and application of plant nutrients and amendments. Agricultural interventions, particularly those entailing substitution of biological processes with fossil fuel-derived energy or inputs, lead to a highly integrative pattern of interactions within four major soil functions - carbon transformations, nutrient cycles, soil structure maintenance, and regulation of pests and diseases. Although organic carbon is the common currency of the soil system, and its transfer with associated energy flows is the main factor that integrates the major soil functions, nutrient additions and cycling play a vital role in the maintenance of soil health.

Fertilizers applied to the soil following nutrient stewardship based on recommendation of right source, rate, time and place lead to soil health improvements because it meets the practical management objectives of productivity, profitability, cropping system sustainability, and favourable biophysical environment. Not applying nutrients in a balanced proportion leads to soil health deterioration. Over-use of nitrogen (N) fertilizers may result in soil acidification which creates imbalance in nutrient availability – a negative soil health trait. Excessive fertilizer N use may also lead to deposition of N in areas where it is not wanted; chronic N additions lead to increased soil N mineralization. On the other hand, under-use of fertilizers, as is common in many developing nations, means that soil nutrients exported with crops are not being replenished, leading to soil degradation and declining yields. It is a myth that synthetic N undermines soil health by destroying soil organic carbon.

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THE EXPERT

DR. BIJAY SINGH is INSA Senior Scientist at Punjab Agricultural University, Ludhiana, India. His contributions on nitrogen balance in soil-plant systems have led to better understanding for (i) enhancing nitrogen use efficiency in rice-wheat cropping system (ii) fertilizer nitrogen related environmental pollution, and (iii) integrated nutrient management. He is a fellow of the Indian National Science Academy and was one of the ten National Professors in the Indian Council of Agricultural Research during 2006 to 2012.

Is the debate on organic vs. mineral fertilization meaningful? Are integrated approaches -such as ISFM- the only way forward in view of the global sustainability challenges?

THE EXPERT

BERNARD VANLAUWE is based in Kenya as the R4D Director for the International Institute of Tropical Agriculture's (IITA) Central Africa hub and leader of the Natural Resource Management research team. Earlier, he was the leader of the Integrated Soil Fertility Management (ISFM) program of the Tropical Soil Biology and Fertility (TSBF) Institute of the International Center of Tropical Agriculture (CIAT). Dr. Vanlauwe obtained his PhD in 1996 in Applied Biological Sciences from the Catholic University Leuven, Belgium, has published over 140 papers in scientific journals and over 150 other publications, and has (co-) supervised over 35 PhD and 60 MSc students.

EXPERT'S VIEW

The debate between organic vs. mineral fertilization does not recognize that both agro-inputs have a different composition and related functions. While mineral inputs provide high amounts of readily available plant nutrients, organic resources contain organic carbon and usually lower amounts of less readily available nutrients. Crops require soil conditions that favor growth and a wide range of nutrients. Neither mineral nor organic inputs alone can provide both of these.

For these reasons we advocate Integrated Soil Fertility Management (ISFM) which makes the most efficient use of both agro-inputs. Using organic manures and mineral fertilizers together generates synergies: the application of mineral inputs fosters crop production and thus generates more biomass, e.g., for recycling within the plot as crop residues, manure, or compost while the application of organic resources can improve the use efficiency of such mineral inputs.

Agricultural systems are open systems and nutrients removed through crop harvests or carbon lost through decomposition need to be replenished. Only nitrogen can be partially enriched in agricultural systems using organic means through biological nitrogen fixation.

Zooming in on smallholder agricultural systems in sub-Saharan Africa, the same rules apply. Without improving crop productivity through the appropriate use of mineral inputs, it will be hard for smallholder farmers to produce the organic resources needed to boost soil health and optimize crop productivity. Advocating the sole use of organic inputs by smallholders denies them the opportunity to rebuild the fertility of their soils. The core question for smallholder agriculture is: How can we ensure that smallholder farmers have access to mineral inputs and can use them in the most efficient and profitable ways without leaving unacceptable environmental footprints?

Are there still gaps in knowledge on the contribution of nutrients/fertilizers to soil health? What are the areas in this field that deserve greater investments in research?

EXPERT'S VIEW

Fertilizer nutrient uptake by plants is likely to be highest when fertilizers of the right composition and the right amount are applied at the right time and the right place. The infinite combinations and interactions between crop, soil and environmental conditions call for fertilizer recommendations to be extremely precise and location-specific. The gap between current application practice and optimized application is large and leads to low fertilizer efficiency, poor crop yield and quality, and environmental degradation.

The effectiveness and emission of ammonium, urea, and nitrate fertilizers, for instance, depend strongly on soil type. For example, ammonium fertilizers on calcareous soils may deposit as mineral salts. Nitrate fertilizers may leach from wet soils or areas with high rainfall. Production ecological systems approaches using crop-soil models specifically designed to address fertilizer issues can support development of decision rules to tune the allocation of existing fertilizer types to soil and crop types and weather conditions, but these approaches are currently limited to N, P and K.

Field experiments will therefore remain essential, particularly to unravelling the existing knowledge gaps with regard to secondary and micro-nutrients. Secondary and micro-nutrients have been found in recent studies to be essential to further increase yield and product quality. Determining optimal location-specific fertilization for every agro-ecosystem through experimentation would require endless agronomic research capacity and would be prohibitively expensive.

It is proposed, therefore, to geo-spatially integrate generic crop-soil modelling and location-specific experimental statistics using the most recent advances in ICT and analytical methodologies, including big-data approaches, meta-analyses, geo-spatial statistical methodologies, soil mapping, remote sensing and modelling. Spatially explicit fertilizer recommendations will provide consistent information to several chain actors. They will support farmers in operational and tactical decision-making, generate strategic information to optimize networks of agro-dealers and fertilizer blenders and producers for trade logistics and inform policy for geographically targeted fertilizer interventions.

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THE EXPERT

DR. PREM BINDRABAN is Executive Director of the Virtual Fertilizer Research Center (VFRC), Washington D.C., USA. He was Director ISRIC – World Soil Information and Team Leader Natural Resources at Wageningen UR (Netherlands), researcher at IRRI and CIMMYT, and lectured on World Food Security and Crop Modelling at Universities of Wageningen, Amsterdam and São Paulo. He utilizes scientific information to seek practical solutions in agriculture and debates actively in policy circles and society.

What actions (technical, outreach, policy...) are urgently required so that farmers, especially smallholders, manage their soils in a more sustainable manner?

THE EXPERT

DR. AMIT ROY, IFDC's president and CEO, has over 35 years of experience in international agricultural development in more than 100 countries. Roy's leadership has increased IFDC's impact from fertilizer research to agribusiness and economic development. Roy is now expanding IFDC's fertilizer deep placement technology from Bangladesh to sub-Saharan Africa and is guiding the development of next generation fertilizers, having founded the Virtual Fertilizer Research Center in 2010.

EXPERT'S VIEW

Low soil fertility will not sustain food production. In order for smallholder farmers to sustainably manage their soils, they must have access to knowledge and agricultural technologies. Among the technologies, better management of agro-inputs, particularly fertilizers, is vital. In Sub-Saharan Africa (SSA), farmers do not have timely access to fertilizers. When they do access it, the price is three to ten times more than in other parts of the world due to multiple tariffs and poor transportation infrastructure; this results in very low fertilizer use. Moreover, highly variable rainfall and poor water management makes input investments very risky, especially for fertilizers that strongly interact with water. In contrast, Southeast Asian farmers often overuse fertilizer containing primary nutrients while ignoring micronutrients. Both low and unbalanced fertilizer use results in declining soil fertility and consequently low productivity. Recent field trials in SSA show a 50 percent increase in soil productivity when the nutrients are matched to soil characteristics and plant needs. Policies are needed to promote balanced fertilizer use.

Improved policies are only part of the solution. Smallholder farmers must have training in efficient fertilizer use and sustainable agricultural practices. One example is integrated soil fertility management (ISFM). ISFM combines mineral fertilizer, organic matter and improved seeds to sustainably replenish nutrients to the soil, and to better conserve soil water.

Soil conditions vary by location. Researchers must design site-specific solutions. For example, in Mozambique, farmers found that they did not profit from using NPK fertilizer. The soil needed micronutrients. IFDC's Agricultural Input Market Strengthening (AIMS) III project researched the situation and recommended a fertilizer formulation that boosted both yields and income.

Healthy soils equal healthy crops and therefore healthy people. Smallholder farmers feed an ever-growing population. Helping them increase food production and incomes, while improving the resilience of their production systems and mitigating environmental problems, is the cornerstone of IFDC.

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What can the fertilizer industry do to enhance soil health?

EXPERT'S VIEW

Mineral fertilizers make a vital contribution to healthy soils. Nutrients are constantly being removed from the soil and exported in harvested plant and animal products. Erosion and leaching can remove some plant nutrients, others can be lost to the atmosphere, and certain clays and minerals can tie up specific nutrients.

When nutrients are lost from the system, soil fertility declines and plant productivity is decreased. Lower crop yields means less plant residues, which build and maintain soil organic matter. Long-term nitrogen fertilization of agricultural soil increases microbial biomass and soil organic carbon, through higher crop productivity. Nutrient removal without replacement contributes to soil degradation.

Fertilizer manufacturers provide the nutrients needed to replace those that are lost from the ecosystem and those needed to restore the health of degraded soils. Fertilization of nutrient-depleted soils, combined with best agricultural practices and favorable growing conditions, increases plant productivity. High crop yields and more dry matter production, combined with returning adequate crop residues to the soil is critical to conserving soil organic matter.

Aside from providing nutrients essential for plant health, the industry educates retailers and farmers on agronomic practices that can improve soil health, including the adoption of nutrient stewardship programs based on the 4Rs ... application of the right source of nutrient (organic and inorganic), applied at the right rate, right time and right place. 4Rs are a science-based management system that improves nutrient use efficiency and contributes to sustainable intensification through improved yields. This approach can protect the environment and support climate-smart agriculture through lower emissions per unit of yield.

The fertilizer industry supplies the plant nutrients essential for maintaining and improving the health of agricultural soils. The industry is committed to the responsible use of plant nutrients through education and advocacy for good nutrient stewardship.

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THE EXPERT

TERRY L. ROBERTS is President of IPNI and a former President of the Potash & Phosphate Institute (PPI), with 25 years experience as a soil scientist and agronomist working in the global fertilizer industry. A native of Alberta, Canada, he received a B.S.A. in Crop Science (1981) and a Ph.D. in Soil Fertility and Plant Nutrition (1985) from the University of Saskatchewan. Terry was recognized as a Fellow of the American Society of Agronomy (ASA) in 2001 and received ASA's Agronomic Service Award in 2013.

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