Food and Agriculture Organization of the United Nations

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Using Soil Maps to Promote Efficient Use of Fertilizers

Learning from the Ethiopian Experience

Setting the scene

The increase in energy prices was already affecting the price of fertilizers and this was exacerbated by the conflict between Ukraine and Russia which has caused a sudden and sharp reduction in global fertilizer supply given the export restrictions imposed by Russia which is the first exporter of Nitrogen (N), the second of Phosphorus (P) and third of Potassium (K) in the world. While fertilizer use is likely to decline due to price hikes especially in poorer countries, farmers can use fertilizers more efficiently to deal with price changes. Ethiopian producers have successfully used soil maps to identify the best blending of N, P, K fertilizers for their plots, cutting the use of fertilizers while optimizing yields. This approach should be adopted by all countries.

Responding to the crisis

Both Ukraine and Russia are dominant players in the global agricultural market. The current conflict therefore signifies risks for countries that highly depend on imports of agricultural commodities, fertilizers and energy from the two countries. The spike in energy prices is especially concerning. Natural gas plays a pivotal role in the production of N fertilizer. Prices for natural gas increased sharply in 2021, as adverse weather conditions around the world hampered the production of renewable energy and coal, leading to higher gas demand.

Food security could significantly deteriorate in countries that were already in dire situation before the conflict began. Countries must implement evidence-based policies to protect the most vulnerable population and ensure food security. Is in this respect that detailed information on the soil profile and its spatial distribution is essential for promoting sustainable agriculture, with precise inputs in quantity, space, and time. In particular, accurate and updated soil attributes allow for better and more efficient fertility management, benefiting crop productivity and sustainability and at the same time reduce the quantity of fertilizers being used.

The Ethiopian initiative

In Ethiopia, agriculture accounts for 40% of the GDP and employs more than 80% of the population. About 96% of the land is cultivated by smallholder farmers. In the past, fertilizer usage did not promote crop yields in Ethiopia. Unbalanced fertilizer application failed to improve nutrition. Fertilizer consumption was also limited to DAP and Urea, regardless of the soil need, crop types or agroecology. Additionally, fertilizer consumption per unit of land was far below the global average.

This problem led to the establishment of the Ethiopian Soil Information System, also known as EthioSIS, a national initiative using digital soil mapping technologies to generate timely soil information and fertilizer type recommendations. The initiative aimed to support smallholder farmers address problematic soil.

The initiative to build a national soil database lasted from 2012 to 2019, under the aegis of the Agricultural Transformation Agency with a total budget of US$11 million. It involved multiple partners, including the Ministry of Agriculture, Livestock Resources, regional soil laboratories, educational institutions such as Wageningen

University, and research organizations like Yara. The initiative set about to map the fertility status of the agricultural lands and establish a national soil resources database.

The initiative generated detailed sets of soil maps showing various soil characteristics and nutrient levels for Ethiopia. It also produced high-resolution fertilizers recommendation maps. Suffice it to say, this deepened producers' understanding of soil characteristics and nutrient deficiencies, which enabled them to balance fertilizers, instead of blindly using the one-size-fits all mix.

The new soil maps-based fertilizer recommendations provided several formulas for mixing fertilizers to address the deficiency in the soils. It introduced new fertilizer types, following the FAO standards to minimize the risk of contaminants and trace elements buildup. The initiative is contributing to the resilience of smallholders, including adapting to climate change. It has directly supported yield increase and availability of high-quality grains.

Project activities

The proposed initiative looks to establish a self-sustaining, government-managed national soil database to become a public good to be used by public policies, private sector and farmers. The goal is to publish the country's total land mass for which soil information is available. It also aimed to provide accurate soil management information system and advice to smallholder farmers to enhance crops productivity and yields.

To achieve this, the initiative will follow the following steps:

Soil surveying and gathering soil samples
This included conducting various types of field data collection and gathering soil samples. The initiative will use scientifically and technically replicable soil sampling protocol and methodologies using state of the art methods and technology.

Soil processing
The initiative will set up a drying and processing facility to process soil samples.

Lab analysis
This will involve developing a standard operating procedures to analyze soil fertility parameters. The initiative will also introduced multi-nutrient soil chemical analysis methodology.

Soil information database development
Hardware and software component of the system will be procured, including programing languages, storage servers, satellite image processing server, and spatial database development.

Training
Capacity building, as in the case of Ethiopia, will be an integral part of establishing the national soil database. It involved secondments of experts from federal and regional agriculture bureaus and research institutions. The experts will work to transfer knowledge and skills in field surveying, soil processing, laboratory analysis, and output generation. The initiative's ultimate goal is to set up a sustainable soil collection and analysis process.

Risk management
The database had to address inconsistencies of administrative boundaries between and within regions.

Development of digital soil map

Based on the above information a new digital soil map will be developed that will provide access to location-specific information on soil properties for any province, district, municipality or a particular area of interest. The interactive map provides information that will be useful to make new crop- and site-specific fertilizer recommendations for the country.

Monitoring and Evaluation

Studies will be conducted to outline key challenges in the specific country soil sub-sector, including the lack of soil information, which affected fertilizer advisory services for producers. The national soil database will use biophysical approaches of digital soil mapping. These methodologies have standard operating procedures to capture data and keep their quality intact.

Recommendations

Prices for agricultural commodities and inputs are expected to rise even further, adding to food inflationary pressures globally. And yet, farmers can use fertilizer with more flexibility to respond to these price hikes. This is because, unlike in the past, they have tools that can help them manipulate fertilizer use without compromising outputs. Such tools include variable-rate application — which means applying varying rates of inputs in appropriate zones — and precision agriculture. Soil maps are one of those tools. The successful development and adoption of a national soil database will demonstrate that with more information on their soil's condition and needs, farmers can use fertilizers more efficiently with greater impact and lower intensity of use.