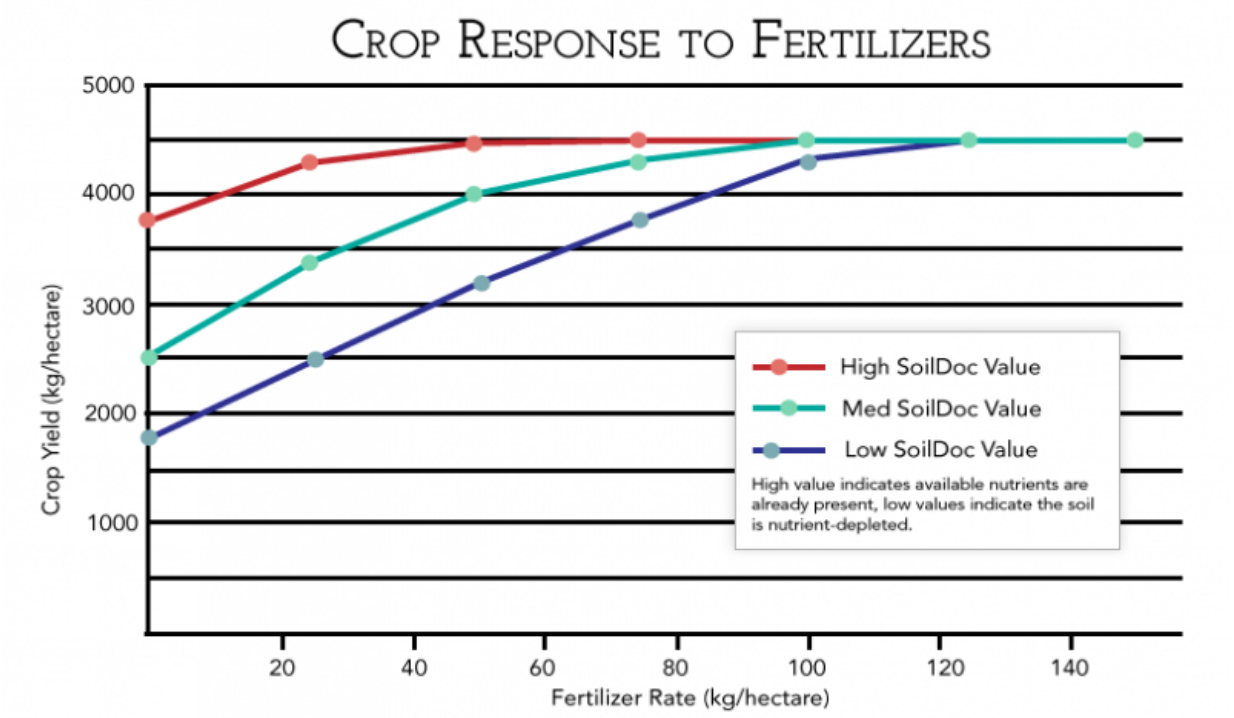
Linking climate forecasts, soil testing for smarter farming

July 13 2016, by Alison Rose



Crop yield based on fertilizer rate is shown for high, medium and low SoilDoc Value. SoilDoc Value represents the nutrient concentration of the soil. A high value indicates a high level of nutrients are already present, a low value indicates the soil is depleted of nutrients and medium value lies in between.

Small-scale farmers in sub-Saharan Africa face many unknowns when making decisions about managing crops and soils. Many of these

unknowns fall into one of two categories: the status of the soil on their farm and the weather in the upcoming cropping season.

Some of their questions are:

- Am I adding the correct fertilizers to my crops? Is the amount I apply sufficient?
- Is the fertilizer recommendation provided by the government appropriate for my farm?
- What will the rainfall season be like on my farm next year?
- When will the rains start?
- Will there be a prolonged dry spell during the growing season?

Having useful climate and soil information is key to increasing yields. Farmers can better plan when to plant, for example, if they have a good estimate for when the rainy season will begin. Soils depleted of nutrients and organic matter are a major contributor to low productivity on smallholder farms in sub-Saharan Africa.

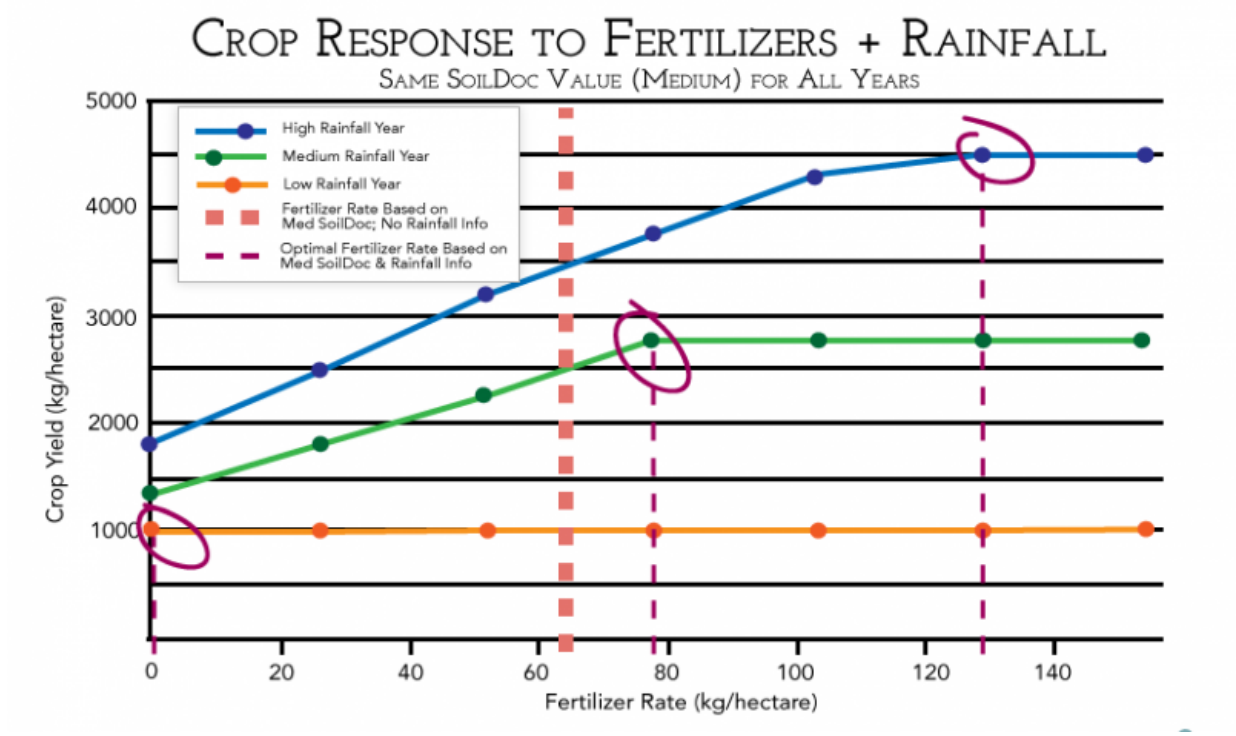
Better information is especially important for small-scale farmers in sub-Saharan Africa who have limited resources to buy inputs such as fertilizer and face higher risks if a harvest fails due to late rains, dry spells, or other unforeseen changes in the weather. Without this information, a farmer can unintentionally apply the wrong fertilizers or the wrong amounts—making fertilizers a risky investment. The combined climate-soil risks contribute to low adoption of income-generating investments and persistence of poverty for smallholder farmers.

Two centers at the Earth Institute have teamed up to help farmers plan more adequately for crop and soil management on their farms. The Agriculture and Food Security Center (AgCenter) developed a tool—SoilDoc—that diagnoses soil issues in farmers' fields and makes

fertilizer recommendations. SoilDoc uses mini-versions of laboratory meters to perform a suite of tests to assess a range of nutrients and soil physical properties. All the instruments are battery powered, use locally available drinking water to enable soil testing and provide tailored results and recommendations on the spot in the most remote locations.

While SoilDoc can help farmers address nutrient limitations, the tool was still missing a key component, namely, short-term (seasonal) climate forecasts. The AgCenter is now working with the International Research Institute for Climate and Society to incorporate climate forecasts into the SoilDoc system to help further reduce risks and maximize investments. The institute will tailor its existing forecast maprooms for SoilDoc over Tanzania, where the SoilDoc+climate tool will first be tested.

The institute has been issuing monthly forecasts globally for the last 15 years. For the most part, however, seasonal forecasts are not adapted in space and time for farming practices. SoilDoc+climate is innovative for its integration of soil and climate information, but the climate information itself is also innovative as it will disaggregate spatially and temporally seasonal forecasts, which will also be directly portable to Androids.

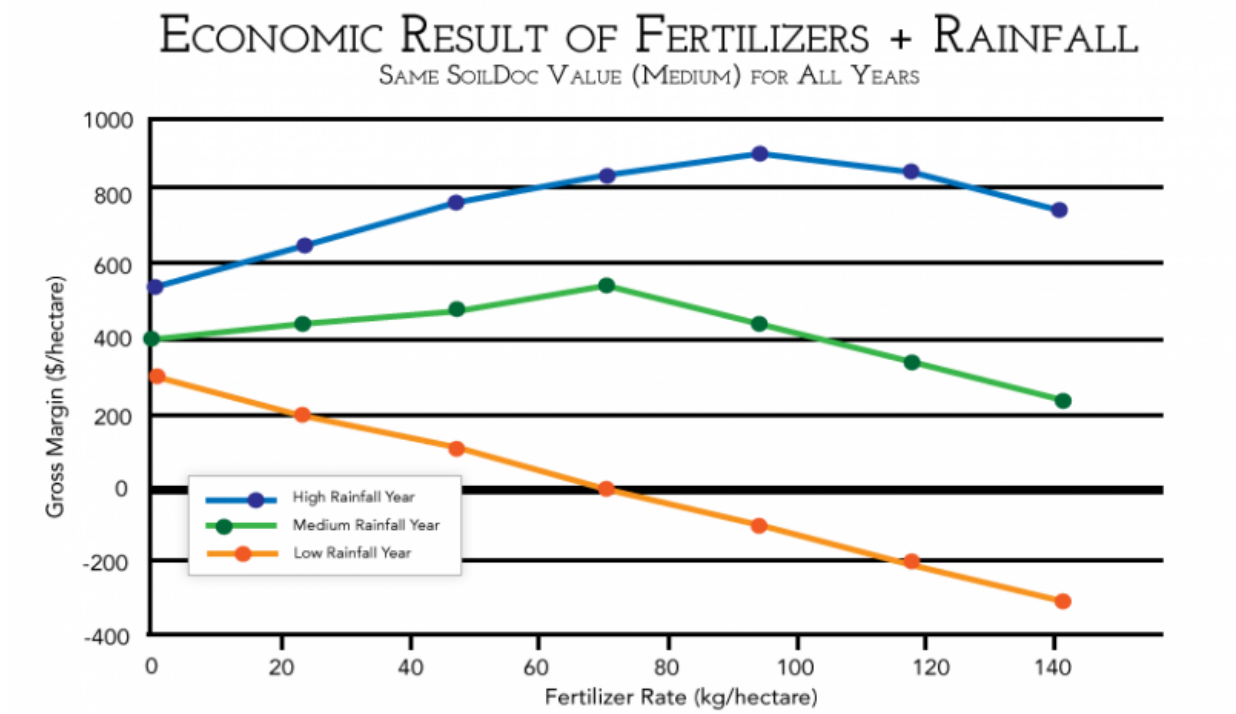


Crop yields based on fertilizer rate for low, medium and high rainfall years, assuming a medium SoilDoc value. The light pink dashed line represents the fertilizer recommendation based on a medium SoilDoc result, but without climate information. The dark pink dashed lines represent fertilizer rates that would result in the highest yields based on a medium SoilDoc value and the year's rainfall.

The figures here illustrate how crops respond to fertilizer from SoilDoc recommendations, how the response is dependent on climate and how fertilizer and climate influence a farmer's profits. If a growing season turns out to be wetter than normal, the crop will respond to a higher rate of fertilizer, and a farmer can achieve higher profits. If the season turns out to be very dry, then the crop will not respond to fertilizers, because the limiting factor for growth is water. In such a year, fertilizer use should be minimal.

A tool like SoilDoc+climate would allow farmers to adjust the recommendation of fertilizer if forecasts indicate that a "wet" year or a "dry" year is likely. Decisions based on site-specific soil conditions and seasonal forecasts will provide cost-effective use of inputs and higher returns on investment. The information can also allow for more surplus production during good growing seasons, leading to income generation that will ultimately enhance food security and resiliency.

"This activity is a great example of the added value of research when two Earth Institute centers work together," said Walter Baethgen, a principal investigator on the project and senior research scientist at the International Research Institute for Climate and Society. "Connecting their knowledge on fertilizer use and on climate risks, the AgCenter and the IRI are adding value to two of their great tools: the AgCenter's SoilDoc and the IRI's seasonal climate forecasts. The result is an enhanced tool that will help Tanzanian farmers to improve the efficiency of fertilizer use for crop production."



Gross margin estimates based on fertilizer rate for low, medium and high rainfall years, assuming a medium SoilDoc value. Because of the cost of fertilizer and diminishing returns on fertilizer rates beyond a certain point, the most profitable choice for fertilizer rate is not necessarily to achieve maximize yield.