Feed the Future Partnering for Innovation Program Launch

Discovering New Tools for Agriculture

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Dr. Ray Weil
University of Maryland

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It's a pleasure to be here. That was a nice little exercise. What I'm going to talk about is a little expansion of what I wrote on my sticky note. I'm going to talk about the first thing that Bob mentioned, the soil fertility limitations and what I think is one of the answers. So smallholder farmers are faced with really a lack of information of what fertilizers they should use. They're usually just given a blanket recommendation for the whole country, sometimes the whole continent almost. And it's a little bit to me like buying shoes for your family. You decide, "Well, I'll take the average show size and just buy six pairs of those." That's about how efficient it is. So what I'm going to talk about is something we're calling Soil Dock. We were happy to see that the website Soil Dock was not yet taken, so we are going to start a website on that.

This is a toolbox full of off the shelf tools, and the thing that makes it unique is that these are inexpensive, rugged, adapted to soils, mostly from hobbies. They're not designed for the purpose that they're used for, and they're digitally connected, so this really changes how it works. So the issue is that they're – and they're particularly focusing on Africa because this is where my experience is, but this could be used around the world. As we said, there are an awful lot of people that don't have enough fluid and are very, very poor, and most farmers have very low production, and really are stuck in a downward spiral that was already described. The key thing here is that smallholder farmers have small amounts of land that they're farming, and this means that there are very many fields, and so the model of soil testing that's used in Europe and the United States and developed countries doesn't work partly for the reason that there's so many small farms rather than a few large ones, but also because there's a total lack of infrastructure to make it work.

So it's been tried, and USAID has certainly been among the agencies that have tried to support this for the past 60 years or so. In fact, it goes back to colonial times. What the farmers are really lacking in the soil fertility area then is information on what would be the most effective type of fertilizer to use. Often, they don't even know what nutrients are limiting. Of course, this goes along with the other half of the equation is if they get this information, they need to have fertilizers available, and in many places, there's very little choice in fertilizers available. Next slide.

This is just a picture I took in an unnamed country of soil test lab. And this is sort of the bottom end of it, but generally, there are lots of soil test labs in Africa, and almost none of them work. They're practically functional. The system doesn't work. Almost none of the samples that are being tested actually are farmer samples that get results back to farmers that farmers can then act upon. Almost all the samples coming through are from the research station that the lab is associated with. So there's a total disconnect between the technology and the end users.

Some of this is due to lack of funding. An agency will build labs. I just saw this recently in Ethiopia where they build about two dozen labs with World Bank funding, buy the equipment, but not train the people, not provide the maintenance, not provide all the things to keep it going, let alone the infrastructure to get the samples taken and back to the lab and all that kind of thing, so the system simply doesn't work. Farmers are pretty much farming blind when it comes to soil fertility. Next slide.

So what we're trying to do is try to fill this void with a completely different approach to the centralized lab and sending samples in. We're intending to send electrons in rather than samples. We're going to send data in. We call this Soil Dock, and it's a system that involves measuring things in the field with the farmer probably with his farm advisor and extension agent. Could be commercial, or it could be a government agent. Possibly you could even train some of the farmers or maybe some master farmers to do this. The technology is pretty simple.

And this is connected with a smart phone, which is fortunately one of the big game changers in Africa, of course, has been cell phone coverage, which is now pretty wide. You can go to some pretty remote places and find cell phone coverage, and even 2 and 3G coverage. Smart phones aren't as wide as regular dumb phones, but they're still pretty wide spread, and with a smart phone, we now have GPS built in. You can download a simple quality control code reader, barcode reader so that we can start to organize these samples done by thousands of people in the field and bring all this data together to organize a regional or national soil fertility map.

So as we get these samples, we're starting to build information for agro dealers. They'll know that, oh, this area has really got a lot of sulfur deficiencies, and this area really needs a lot of phosphorous, and this will all be done in real time. So the data is just punched into forms on the phone. The raw data as you get it off of meters. Sometimes they're in units or just numbers, but they go to computer central where there's a lot of background calculations that transform these into recommendations that come back to the farmer within real time.

So this has a lot of advantages. This is just a picture of me doing this, working on developing this. This is in Rwanda in one of the Millennium Villages in the Millennium Village Project, and working with a couple farmers who were kind enough to bring a little table out for me, which makes it that much easier. You can do it on the ground, but certainly more comfortable with a little table there. And we on the spot, the really nice thing here is the farm advisor can have an interaction with the farmer and say, "Oh, you know, the reason that half of the field never yields, even though you put all the same effort into it, is because it's really low in potassium. And if you boosted that up, you'd make your labor really worthwhile."

You have these kind of situations where the farmers will point out like this field never produces as much as that one, or I have one problem or another. They don't know what's wrong with it. And to hopefully get a recommendation back in weeks, which isn't going to happen, or months or years or never. Just loses that chance to ask the next question that may bring up. Next slide. What we're capable of measuring so far, basically, we're taking instruments. As the quote said, there's all this technology out there. We just have to distribute it and use it, apply it. A lot of these are conventional measurements, although we've tried to simplify it and detoxify it so there's nothing dangerous. The worst thing we use is a little bit of salt solution.

As you can see here, this is a picture of the PH being measured in a village in Tanzania. A very important measurement to take. I think every extension worker out there ought to have one of these little meters with it. This is – you can buy it on Amazon for about $35.00. People measure the PH of their fish tanks with it or their wine making at home. When you're making these for mass consumer hobbyist technology, the price comes way down. A laboratory PH meter is about

$1,000.00. The electrode will be $100.00 or $200.00, just a replaceable electrode. This whole thing includes both. It's exactly the same technology. There are instruments out there that are useless, but this one is not one of those.

We also can measure the electrical conductivity, which is not only important in salty soils, but also is a general indication of fertility in most soils in the tropics, and some of the major nutrients with nitrate, sulfate, phosphorous, and potassium. Next slide. It's pretty reliable results. We can compare this to the results that you get in the lab. I'm not sure which one is better. I'm just comparing the two. This is comparison of some work I did in Western Tanzania in the field versus sending those samples into the lab in Nairobi. Next slide. So I wanted to emphasize that these are off the shelf pieces of equipment. As I said, generally not designed for soil work.

Mostly designed for hobbyists of various kinds. For instance, the balance we use to weigh out the soil sample, is the equivalent of about a $1,000.00 laboratory balance, but if you're selling to jewelers or sportsman that fill their shotgun shells with gun powder and things like that, you can get a balance that weighs to a hundredth of a gram very accurately, usually better than the lab that I go into and compare with the test weight for $15.00. So there's some tremendous economies. I think a few of these could come way down if we have a market. I'm sure that it doesn't cost them anywhere near $350.00 to make that nitrate meter. I'm guessing maybe $35.00 is what their actual cost is, but it's a very small market, and so they have a very high price. The other thing is we – if any of you have worked with laboratories in Africa or third world countries, distilled water is a huge problem.

That's the first thing to go. First of all, it takes a lot of electricity. Secondly, the still breaks in no time. So I've done this with drinking water. I know drinking water is a bad thing environmentally in this country, and I don't use it, but I'm glad it's available all over in the third world where other water is not potable. And the drinking water gives you consistent water that's pretty clean, and you use this in the controls, and therefore, you just go to almost every shop has drinking water, and that's your water supply. Go ahead.

This takes quite a bit of tweaking that we've been working in the lab to make this stuff that's designed for aquaria and beer work for soil, but it doesn't take too much to get it to work, and we also want it to not use some of the more toxic things that are airline unfriendly and difficult to ship. If you've ever tried shipping reagents around the world, as soon as it gets classified as a hazardous reagent, it is just enormously expensive to move them around.

So we've gone to very simple calcium chloride extractions. Go ahead. Oh, that little instrument, by the way that I was showing was the equivalent of about a $2,000.00, $3,000.00 colorimeter. You can buy it on Amazon for about 50. This is just showing the next component of this is the smart phone, and it's really key that this data is not just scribbled down on a pad and sort of lost to this one site, and that the data – that the recommendation is based on good science on the back end. And so the data is geo referenced. You need to set the phone down while you're collecting the sample and get the geo – the geo reference, longitude and latitude for that. That goes into it automatically. Then stickers pulled off and put on the soil sample, and you read the bar sticker. That gives it a unique code.

So now it's in a big data set in the central lab that can start mapping all this out. So every time you work with a farmer, you're getting another point on a map, which pretty soon starts to show your patterns with essentially no extra cost. The other good thing is that you've got the science and the background that tells you okay, if your PH is 4.5, what does that mean? What's your recommendation? Well, it depends where you are, what kind of soil, and what kind of things are available. So that information goes into the algorithms, and then a recommendation comes back. I think the next slide shows the recommendations. This is a system. This is my friend, the late and great Spider ____ from Malawi showing the response to sulfur, an element, by the way, which is almost totally ignored. Not only in the third world, but in developed countries as well, and it's more and more important.

But go ahead to the next slide. So this is sort of the response that we have coming back. Oh, you can also take a picture of the field or of any symptoms, so if there are some questions, an expert at Digital Central could take a look at those symptoms and maybe give you some help with that as well. But you'll get a recommendation back. It might go something like, "Oh, your PH is 4.5. You really should start saving the ashes from your cooking fire and carrying them to the field that's farthest from your house instead of just sweeping them next to your house where the PH is probably seven." And it might tell you that your sulfate is really low, so you probably need a sulfur fortified fertilizer.

It's probably not available, but if enough of this points start showing up on a map, maybe you can get the agro dealers in the area to start carrying it. That's the idea here. Next slide. So we hope that this will be a simple, rugged technology that can be used in the field for real time recommendations to just skip the whole sort of system that hasn't worked for the last 60 years of building central labs that don't – you know, that go run down, and it's no system to get the samples back and forth and get the results to the farmer. Thanks.

[End of Audio]