Keynote: How can 'big data' transform smallholder farmers' lives and livelihoods?

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Abstract

For many years 'big data' has been considered by many as the privilege of the few. Because of its volume, it could only be handled by large corporations, essentially based in the west; because of its complexity, it required high level specialists to manage it, and because of the cost of putting it together, it rested out of reach of the common person's purse. This has changed.

During this lifetime, the world has gone through three consecutive and very fundamental revolutions. The *first* was the Internet connecting the world together. The *second* was the emergence of intelligent devices, starting with mobile phones, bringing knowledge to your fingertips. The *third* revolution is here: *open data*.

Knowledge can now flow across the world with accuracy, at a speed and volume never reached before. The world of agriculture is one of the key beneficiaries of this latest revolution, seeing for the first time the innovative benefits of a true 'cooperative development process' taking place. Governments are opening their data; research is working hand in hand with the private sector; and civil society – consumers and farmers alike – is voicing its needs and triggering innovation tailored to its capacity, situation and choices. As a result, even in the most remote areas today you can see applications using the latest technology – and 'big data' – in the hands of farmers and in a form and shape that makes sense for them. Applications are affordable and manageable, allowing their users to gradually overcome subsistence farming to reach a higher quality of life. Globally this means that continents where agriculture is still the key development engine see their economy improving, hunger decreasing and innovation flourishing. This is what will lead the world to overcome the emerging food security challenges ahead of us, and contribute greatly to allow developing countries to reach their full potential. This presentation describes this process and gives concrete examples of where and how 'big data' is now used by small farmers; and more generally, how open data is changing the face of global agriculture.

Yesterday I was having a talk with someone whose background happened to be in History, and it made me think of a connection between History and the 'big data' we are talking about today. Those who are familiar with Greek mythology know that a long time ago, the mountain in Greece called Mount Olympus (then called Olympus Mountain) was believed to be where the gods lived. The mountain is very high, so of course usually the top is in the clouds. And in the

This paper has been prepared from a transcript and the Powerpoint slides of the presentation.

Mount Olympus: often in cloud and historically out-of-bounds to everyday people.

old days all the gods were there doing their god-business while regular people were down on the ground trying to do other things. Humans were not allowed to go up to the top of Olympus Mountain, of course, because that was a sacred area. The only interaction they had with the gods was that every now and then if one of the gods was not too happy a lightning bolt would come down and toast someone. That's the way it was, so people lived in fear.

But times have changed. Now there's no more fear. Now humans are allowed to go to the cloud. Better, they are allowed to use it – and what do they find? They find that there is a lot of knowledge in the cloud. Our challenge is to get there and make use of it.

I would like now to share with you this [transcript of a] very short video clip:

> *Over seven billion humans inhabit planet Earth. Experts tell us we collectively produce more than enough food to feed everyone. But why do eight hundred million people still go to sleep hungry every night? And why do over three million children die every year due to malnutrition? The causes are many. The problem is global. Solving the problem of global food nutrition security is complex. Perhaps the solution is right before our eyes. If only we could see the entire picture, the solution is breathtakingly simple. The answer to zero hunger lies within existing agriculture and nutrition data. Right now this information is inaccessible to many. This is why we believe in making this data open and available for unrestricted use worldwide, to combat hunger, promote innovation, create economic opportunities, empower farmers and improve the health of everyone. We have the opportunity right now to end world hunger. All you have to do is lend your voice to tell public, private and non-profit organisations to commit to making agriculture and nutrition data open and freely available. Together we can be the generation that takes the most important step to end world hunger by setting agriculture and nutrition data free*.

GODAN: Global open data for agriculture and nutrition

In Sanskrit the word 'godan' means 'gift', a gift of god, or something that everybody should aspire to do in their life. GODAN was created just a few years ago, after discussions at the 2013 G8 International Conference on Open Data for

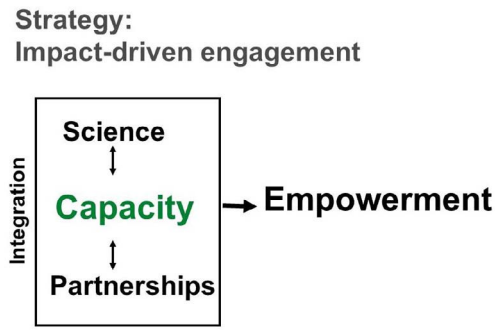
Agriculture. Somebody there said, "Hey, by 2050 there's going to be 50% more people on this planet. So what are we going to do?".

We have to find ways to produce more nutritious food to feed all these people. The Food and Agricultural Organization of the United Nations (FAO) says there will need to be around 60–70% more food than we are making available today. It is quite a challenge. To put it into perspective, the additional food we need to produce this century is equivalent to all the food that humanity has produced in the last 8000 years.

The world is trying to address this need from many very different angles, and there are several complicating factors. One such factor is demographics: it is difficult enough to continue to produce food the way it is produced now, and with 50% more people coming in the next 30 years we shall need to drastically increase production. A second complication is climate change, because it is already difficult just to maintain current production levels: land degradation is prevalent; sea levels are rising; the Earth is warming up. In many places where agriculture used to thrive it is struggling now, for lack of water or simply because the temperatures are too high. What can we do?

We can use technology. Technology is making incredible things possible today. As you may have realised, in our lifetime we have just been through three major world revolutions. They have been quiet revolutions – no noise – but they have transformed humanity. The first revolution was the Internet. Internet has connected the world, enabling people across the world to speak to each other or be able to do so in a fraction of a second. The second revolution was intelligent phones, because it brought the Internet to your hand. Wherever you are – in the car, at home – you can access a wealth of information that may physically be on the other side of the planet. And the third revolution, which is even quieter but much more important, is data, and especially *open* data. Open data is knowledge – if we can shape it and make it available in a form that makes sense to you the user and helps you solve a problem that you have.

GODAN's strategy relies heavily on partnership, and on science and therefore on knowledge and data. We need partnerships because even though people have different specialities – mine may be genomes and yours may be satellites for example – but yet, if we talk long enough we may be able to combine some of the expertise we have to produce *impact*. Impact works by giving knowledge to people, empowering them, as illustrated in the diagram below.



Data leads to knowledge, which in turn allows for empowerment through better choices. With data, a government can make more enlightened decisions, better policies, because it has a better picture of the situations existing in its country. Citizens can make better choices in their requests to government because they have better knowledge of what is available and what can help them. The private sector can make better choices in designing services, applications and products that meet the needs of the population because they know more about them.

GODAN has a presence all over the world (Figure 1), and we are trying to bring together ideas from Latin America, from Asia, from Europe, and see what happens.When we combine them we find innovation: the impossible suddenly becoming possible. That is the kind of outcome we are aiming for.

Examples

Some examples may show how GODAN works at all levels. We are helping governments work out a policy environment that will help data arise and thrive, starting with their own data which you pay for with your taxes, to make it available to you in a way that makes sense. We are also encouraging other sectors to do the same. Some have done it officially. The Dutch recently established a private-sector public-sector data partnership, to see how they can use a common platform to make this wealth of joint information available. In June in Nairobi, GODAN was invited to co-host a very important meeting, at the end of which the Nairobi Declaration involved 15 different African Ministers, agreeing to a roadmap in terms of structuring and implementing open data in agriculture in their respective countries (Figure 2). This is a first for Africa, and maybe for the world, so we are very very happy about that outcome.

Those examples are at the policy level.

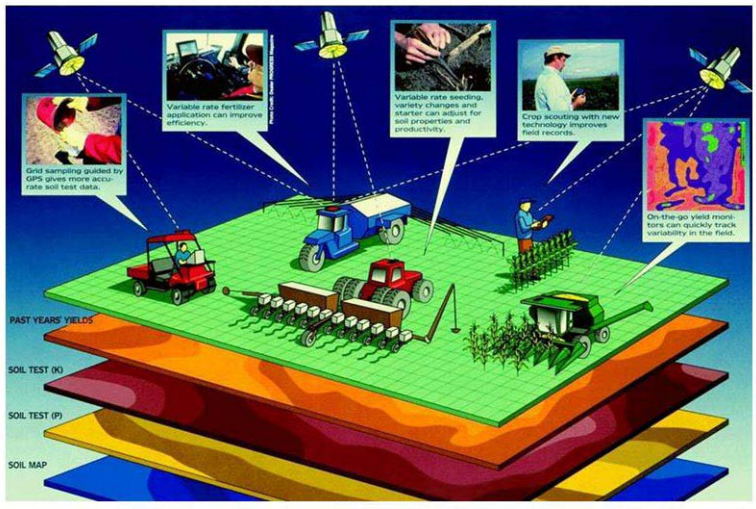
Below policy level, one of the objections we face is that some people ask, "Where is the data? Is there enough data? Where is it?". The answer is that there is a 'massive amount' of data already available out there, and growing fast. To give you an idea, by 2025 the world is going produce somewhere around 180 zettabytes of data (where 1 ZB = 10^{21} bytes). Looking at this another way,

Figure 1. GODAN has over 550 partners worldwide: 10 or more partners in areas with yellow discs; 2–9 partners in areas with green discs.

Figure 2. Summary of Day II, Ministerial Conference on Agriculture & Nutrition Data, June 2017: 1. Strengthening agricultural and statistical data systems in Kenya. 2. South–south dialogue: How data is enabling innovations in agricultural value-chains. 3. Mutual accountability for consolidating gains and delivering actions to achieve.

every day the world generates enough data that if it could all be loaded onto CD ROMs, that daily pile of CDs would be almost the height of the Eiffel Tower.

There is no shortage of data, but what makes its use difficult is that it is not very well structured. We are pushing for data integration, so that data coming from satellites can be combined with data from drones, from FAO, from traditional sources, and so on. We need to combine the data retroactively also, because when you know better what is happening now because you have corrected or improved your data, looking back you are in a much better position to predict what's likely to happen, and therefore to be able to prepare before catastrophes happen or before opportunities occur that you would otherwise miss. That's what the diagram below attempts to represent.



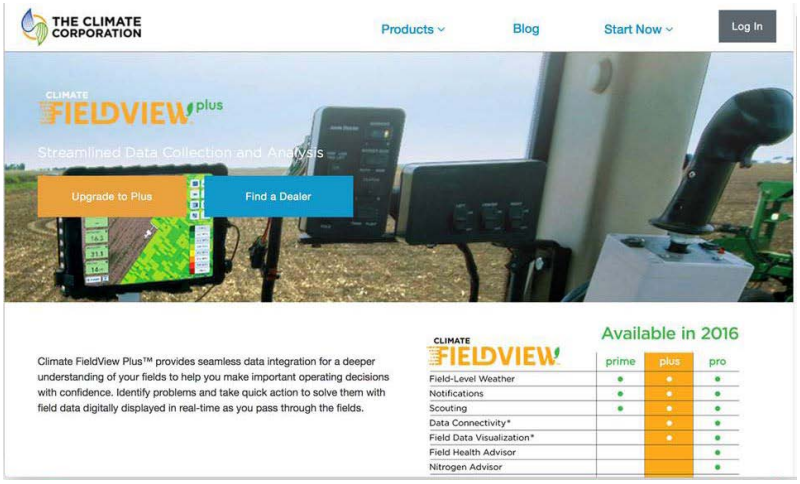


Figure 3. High-tech data loops.
'Climate FieldView Plus™ – seamless data integration for deeper understanding of your fields to help you make important operating decisions ... field data digitally displayed in real time'.

At a different level again, Figure 3 shows the view my neighbour has on his tractor. This software is a product of one of our partners, Climate Corporation. They bring various sources of data to the farmers, and use very sophisticated sensors that help guide with high precision, whether the job is ploughing or fertilising or harvesting. And the little electronic tablet to the left of the view is not just plotting the course and applying fertiliser only where it's needed, thereby saving money, but it also allows the farmer to make simulations. He or she can explore how the crop might respond to a different type of fertiliser, for instance. This capability would have been a miracle five years ago but is now common practice. My friend can hardly use his intelligent phone but he can drive this tractor software ... in fact, he says he doesn't drive it; it drives by itself.

Figure 4 at the top of the next page comes from South Africa, from satellite data. That is the new way to the future. The Sentinel series and others with the latest generation of sensors can give you not just pictures of where the clouds are but also tell you the condition of your soil, whether it needs water, the quality of the biomass and therefore whether you need to fertilise or not, or which part of your land is in trouble and which part is not. This was a small project in South Africa and the same technology is being used in Ethiopia and other places. These services are available to the farmers for a nominal cost through co-operatives or small enterprises because the cost is being shared by a lot of people. The aim in this specific project was to reduce water consumption in this area that you see, by 10%. The end result was that they reduced it by 30% and they more than doubled the land that they were able to irrigate, because of precision irrigation consumption.

Amazing things can be done using technology, and using models that put data in the hands of the farmer.

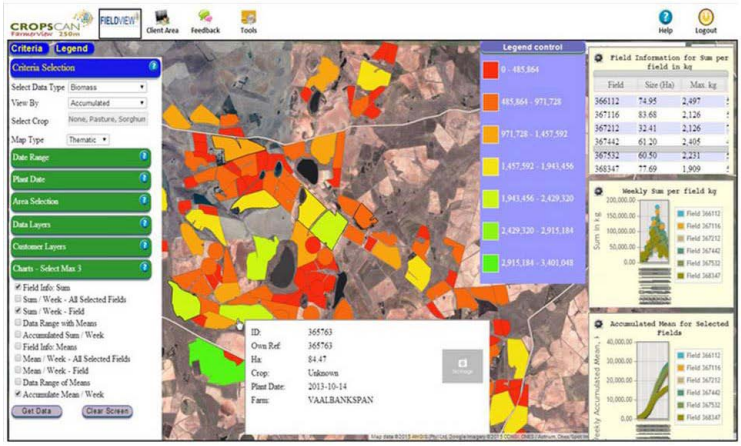


Figure 4. CropScan software showing accumulated biomass on a farm in South Africa.

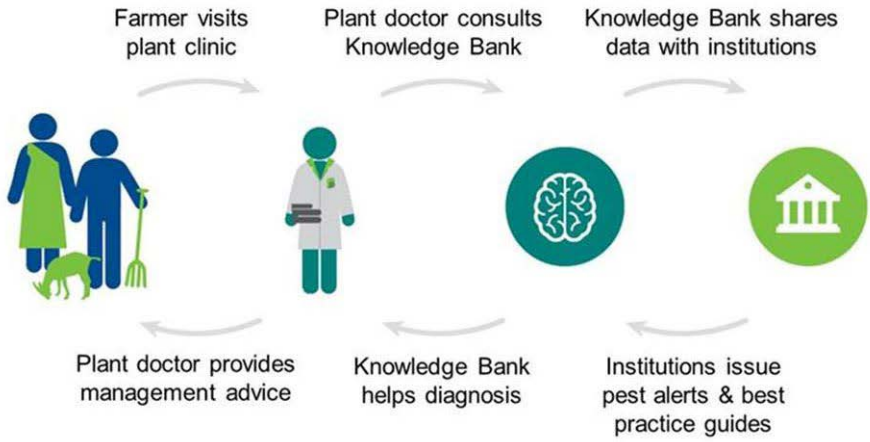


Figure 5. 'Big data': a two-way flow of information through CABI's 'Plantwise' program.

The diagram in Figure 5 depicts the 'Plantwise' system run by CABI, one of the many programs in the GODAN network. The important aspect of this data-sharing is that it is a 'two-way street'. It is not just plant doctors telling farmers what they have to do. Instead this is a win–win situation. The concept is like this: people trained in basic agriculture are available as plant doctors, and if you find your maize or your rice is struggling for some reason and you don't know why, you can call the plant doctor. He or she comes and looks at your crop and tells you what the problem is and offers a remedy. Then the plant doctor goes back and enters this information into a database which, day by day, becomes bigger and more comprehensive. The next time the doctor is called out he or she has more information and is in a better position to give advice. The knowledge base grows and becomes more and more useful to help the farmer. It also helps the

government help the farmers because it can intervene when it sees multiple cases of a certain infestation, say, in one region.

Another aspect of the Plantwise model, illustrated above, has been devised by another GODAN partner, Bayer. They have made it possible for the farmer to take a photo of his affected crop and send that photo to a central database using Artificial Intelligence. In a very short time, even seconds, a response tells the farmer the cause of the problem and the remedy. If for some reason the problem is new to the database, the response message will include contact details for a person who can discuss causes and solutions. As you can see, technology and data are developing fast.

Some people do not have a mobile phone, though that is an uncommon situation. And there can also be language differences. That is why our aim is to be able to provide knowledge and data *in ways that people can understand*. A good example comes from Ethiopia where, acknowledging language differences, they created a hotline for agriculture (Figure 6). If I am a farmer somewhere in northern Ethiopia and my maize is struggling and I don't know why, I can call the hotline and speak to a human being who has access to this database and can give me the information I need. In the first three months of this hotline in Ethiopia, there were half a million calls. Overall, around a million farmers are using this system – another form of sharing open data, sharing knowledge with the farmers.

Summary

In conclusion, we are working towards big data for the 'little guy'. Data should be available to all of us.

Findable: First, we have to be able to find it. So when people publish data, especially research data, they should put it where people can find it.

Figure 6. The range of languages in Ethiopia led to a hotline being set up for agricultural advice: a form of 'big data' that users can understand.

Accessible: Second, the data needs to be accessible without needing three levels of passwords, or membership of a club or something like that.

Makes sense: Third, the data has to make sense. Satellite data is a good example of data that is too complex for me if I am a small farmer. I just need to know why my maize is dying, so the data I access has to be in a format that I understand.

Solving a problem: Fourth, big data needs to solve a problem. As we identify problems and do the research to solve them we must be generating data that is useful, and we must make it available to humans, not just to the gods on the Olympus Mountain.

André Laperrière joined the Global Open Data for Agriculture and Nutrition (GODAN) initiative as its first Executive Director, in September 2015. Before joining GODAN, Mr Laperrière was Deputy Chief Executive Officer at the Global Environment Facility (GEF) in Washington DC. During his career, Mr Laperrière has led or managed numerous projects on behalf of large private corporations and subsequently within the United Nations and the World Bank. In this context, he played a senior role in the design and implementation of major reforms within a number of agencies, such as the International Criminal Court (ICC), the World Health Organization (WHO) and UNICEF. He has extensive work experience in the Americas, Caribbean, Africa, Europe and the Middle East, in particular in developing countries and in conflict and post-conflict environments.