

gODAN

Global Open Data
for Agriculture & Nutrition

Success Stories Issue 2



THE DATA REVOLUTION

Foreword

This second issue of open data success stories demonstrates the importance and the key role that open data plays in supporting innovation in agriculture and nutrition across the globe. As food insecurity continues to threaten many lives, the increased awareness of open data has catalysed a multitude of initiatives designed to improve agricultural productivity at a pace that will allow everyone enough nutritious food for an improved quality of life.

Since our first book of success stories, GODAN has expanded from 250 partners to over 500. We have seen our partner's research data provide new tools for making geospatial data more accessible to all and encourage the flow of best practices from one continent to another. Our partners have stressed the importance of access to reliable nutrition data, which is now seen as an integral part of the global food security agenda.

Open data presents us with huge opportunities. But how do we deliver a responsible data revolution that leaves no one behind? As science-led thinking evolves and more data becomes available, we learn also more about obstacles that make increased agricultural productivity even more challenging than we initially thought.

Success in open data initiatives looks different depending on one's perspective. For some, simply kicking off an open data initiative is a huge success while for others, success is a clear policy outcome or an improvement in human nutrition. Additionally, we also need to be able to articulate where we fail as well as succeed, and most importantly learn and do better next time. Our next compilation will also tell stories of failure. Are you brave enough to share them with us?

The next digital revolution has truly begun. We aim to make it for the benefit of all.

GODAN Executive Director

André Laperriere

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Supporting open data in agriculture and nutrition, with focus on new businesses

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Jean de Dieu Niyibizi, president of the Twihangire Imirimo Cooperative, in Rwanda is clear: open data helped make big improvements for his village and surrounding farms. "In 2006 we were getting just 600 kg of maize per hectare," says Jean. "By 2011 we were getting 4 tons, and we're hoping to get 5 tons by next year," he adds. This picture of progress includes other advances. Homes now have tin roofs, replacing leaking thatch. Dirt roads have been paved. The village now has drying sheds for maize and many farmers get around by motorbike, rather than on foot or by cart. Much of this was made possible as more farmers and their families were linked to digital communications and accessed open data.

"We have discovered new markets, developed new crops and improved our incomes."

The knowledge needed to make changes to their lives comes via the Internet, made available to them by the local business development centre. "We have discovered new markets, developed new crops and improved our incomes," says Jean. "And because we've been able to develop business plans, the banks are more willing to provide us with credit." Paul Barera, at the agency behind the business development centre, points to the impact of the Internet. "They're doing their own research and development and using ICT in a very entrepreneurial way," he says. Not long ago, the main crops were maize and beans. Now, thanks to information from the Web, they are growing tomatoes and developing a small-scale pig industry. They have also learned about new techniques in storage, and disease and pest control.

This small, yet important, example proves that greater access to open data brings tangible results and empowers rural communities

around the world to improve their lifestyles. It can be a real boon for farmers, as illustrated in Rwanda. But the struggle remains: how to fully realise the benefits of burgeoning free data.

For one organisation the key is working with governments to make agricultural and nutritionally relevant data openly available, accessible and usable. The European based Technical Centre for Agricultural and Rural Cooperation, better known as CTA, states that, "Climate change and population growth affect rural communities that are dependent on agriculture. Reliable, up-to-date, easily accessible data is important for making decisions to deal with these challenges."

The organisation is convinced the quantity of relevant data that can support development is steadily increasing. Satellite images and the exponential growth of mobile communications help extend access to open data. CTA Director, Michael Hailu, points to this potential, estimated to be worth trillions of dollars a year. "As a knowledge broker with experience across African, Caribbean and Pacific countries, CTA is uniquely positioned to promote awareness of the benefits of open data based on its knowledge of tangible experiences in various contexts," he says, and adds, "While others have focused on research information, CTA tries to look at a broad range of data that can benefit small-holder farmers and agribusinesses."

"CTA has been like a godfather to us," says Jethro Greene, director of the Caribbean Farmers Network (CaFAN). "It has funded many of our activities since the early days, and we would never have achieved what we have without CTA's support." The network set out to focus on helping small-scale farmers. It was the right place to start according to Jethro, as ninety per cent of farmers in the Caribbean have under five acres. "Improving



marketing is now a key thrust of our work,” he says and is particularly proud of their success improving farmers’ profits from variety of root crops.

Open data on crop care, fertilizer use and market prices provided by the network helped increase smallholder incomes.

A decade ago, farmers were getting much less for their dasheen and banana crops. Then open data on crop care, fertilizer use and market prices provided by the network helped increase smallholder incomes. Jethro is sure access and training on technology and open data sources means farmers’ organisations across the Caribbean are more efficiently managed and better led, helping most farmers to improve productivity and incomes.

Chris Addison, Senior Programme Coordinator Knowledge Management says, “Since the term ‘data revolution’ was first coined in May 2013, CTA has been working to develop open data initiatives that benefit smallholder farmers and agribusinesses. This is because we do believe that open data offers significant potential to benefit rural communities.

This could be done via satellite and meteorological data or nutritional value of crops.”

But the CTA remains realistic about its ongoing mission. While progress has been made, there is still plenty to do in bringing the power of open data to planners and agricultural communities. There are still significant challenges in the countries CTA operates in. Statistical surveys are expensive, capacity is limited, methods and tools are not fully developed, and key agricultural and rural development actors are not yet fully engaged. As a result, data is often inaccurate, outdated, incomplete or inaccessible.

In many cases the enabling factors include improved cataloguing and better communication and access to relevant data resources. Key to enabling access to these resources is the adoption of clear open data policies, platforms and data standards that facilitate sharing and use of information across different contexts and between countries.

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2

FOODIE, GLOBAL

Open geospatial data, arable farming

Farm-Oriented Open Data in Europe, known simply as FOODIE, is an open data initiative based in Europe with ambitions to help agriculture across the globe. It aims to increase efficiency and open new opportunities for all involved in planning, growing and delivering food to the market place.

Making existing agricultural and supply chain data available to as many people as possible is the goal.

Making existing agricultural and supply chain data available to as many people as possible is the goal. In doing this FOODIE aims to change the culture of many large public institutions and government departments, turning them from owners and collectors of data, to organisations that freely share data. This new approach should help to make wiser, more informed decisions, protecting the environment, improving agricultural techniques and driving efficiencies in the food chain. It can be applied across Europe and supports global food production.

FOODIE has funding until 2017 and the team behind the organisation predict that their service will, “facilitate market entry of new companies and the development of innovative services. It will encourage SMEs to seize novel business opportunities offered by the FOODIE platform and develop products.”

Karel Charvet of FOODIE explains its present direction, “We are focusing on arable farming and horticulture, with respect to precision agriculture in the broadest sense. We’re not only interested in site specific farming, but also in logistics, such as machine management and transport needs.”

Agriculture is of strategic importance to Europe and its economy. The sector’s complexity means agro-food operators must manage many different and heterogeneous



sources of information. This involves collection, storage, sharing and analysis of large quantities of spatially and non-spatially referenced data.

These data flows currently present a hurdle to the development of precision agriculture, as the multitude of data models, formats, interfaces and reference systems in use can be incompatible. FOODIE believes that economically and environmentally sound decisions need much better management of all this information.

Whatever an individual user’s interest might be, everyone will need to access a diverse range of data in their planning and decision-making. That means the hub must be interoperable across a wide range of devices, services and facilities. Moreover, the service promises to build an interactive and collaborative network made up of a wide range of food-related businesses and specialists. This is being achieved by integrating existing open datasets relating to agriculture, along with data publication and linking to external agricultural sources, providing specific and high-value applications and services to support those at the planning and decision-making levels in food production.

“Develop open standardized data for precision farming.”

Asked to outline one significant impact of the FOODIE project, Karel Charvet gives a precise answer, “To develop open standardized

data for precision farming.” This has led FOODIE to carefully address the needs of four core groups in the food chain: those in the agriculture sector who are end-users of applications; public sector bodies communicating with farmers about taxation, subsidies and regulation; researchers involved in large scale experimentation who want data; and ICT companies developing new applications for the agriculture and food sector.

The team aims to deliver a range of practical tools and highlights one of their ambitions for the website, “The FOODIE project will enable farmers to provide their own data by easy to use crowdsourcing tools and applications that encapsulate the complexity of the underlying services technology. For instance, this could be a mobile or web application that offers a form with fields for collecting specific information from farms or a wizard application that allows a farmer to configure, with a few “clicks”, the sensor system within his farm to send periodic observations to the FOODIE platform.”

Karel Charvet outlines some of FOODIE’s most recent work, “Open data is not enough on its own without standardisation, so one of our priorities is to define the standardised data model which can be used worldwide, supporting harmonisation of open and, as yet, not open data. We’ve also designed a FOODIE data model for arable precision farming and cooperated on the specification of the SensLog data model. This supports in situ and machinery monitoring.”

“Together with others we have cooperated on the definition of the model for the OpenTransportMap.”

But FOODIE has broader aspirations, since agriculture relies on a complex set of services to get food from field to fork. Charvet explains their involvement with transport, “Together with others we have cooperated on the definition of the model for the OpenTransportMap.” This helps increase efficiency and more timely delivery in the movement of fresh produce from farm to processors and distributors.

Incorporating so much open sourced data helps all types of businesses in the agriculture sector build their own unique services and improve the quality of their products. In short, FOODIE is setting out to increase the viability and profitability of commercial plans, helping to refine proposals that ensure customers get deliveries faster, cheaper and better.

But it is not only business that will benefit from a service spanning Europe and beyond. Anyone involved in environmental protection and agricultural policy will find value in connecting to FOODIE. In the European Union there are currently 28 nations with more than 100 regions; they have their own parliaments and administrations, and each jurisdiction creates its own set of agricultural regulations. The cumulative wisdom and experience gleaned from all these legislative systems and regulations can be exploited for future policies and decision-making.

Worldwide there are around 200 countries, each with their own environmental and agricultural concerns, adding up to a seemingly insurmountable web of rules and regulations. But FOODIE aims to bring all this data under one roof. If you are involved in farming or operating a business in agriculture it is vital to understand the variety of rules and regulations in the international food chain.

Future agriculture knowledge management systems will need to support the profitability of the sector and, more than ever, aid environment protection. But the FOODIE team are keenly aware of an additional need: to link the activities of individuals and organisations across the agro-food industry, aiding effective collaboration across a wide range of interests, representing consumers, public administration and wider stakeholder groups, with focus on those living and working in rural communities.

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AUSGOAL, AUSTRALIA

Public service sharing open data

The advent of open data is undoubtedly playing a pivotal role in delivering agricultural innovations and supporting breakthroughs in nutrition. But an underlying concern persists that may limit the opportunities promised by open data. On the one hand many public officials still want to secure attribution rights, while on the other, researchers and businesses are restricting progress through fear of copyright infringements and loss of potential revenue derived from exploiting primary research.

Baden Appleyard, National Programme Director of AusGOAL, Australia's public sector open data organisation, has been working with the country's states, territories and Commonwealth Government in Canberra. He has seen growing buy-in to the process that supports open data. He says, "Initially it was treated as a structural IT problem, not an information or data management issue."

Initially Australia's public bodies, states and central government shared information through a complex maze of data sharing agreements. But when a crisis struck, such as a large scale forest fire or prolonged drought, the urgency to acquire vital information trumped the need to follow intricate transfer protocols. "We had to move from a need-to-know to a need-to-share basis of operation," explains Appleyard, adding, "Data sharing had to deal effectively and speedily with copyright and liability issues and to deal with these issues it involves the use of Creative Commons licenses."

The USA kick-started the sharing of government data.

Looking across the world Appleyard, an open access lawyer, believes the public sector in Australia was a frontrunner in implementing open data, but recognises that the USA kick-started the sharing of government

data. "Obama galvanized the push for open data and the need to benefit from all the acquired data stored by public institutions and governments. Under Obama's presidency the creation of data.gov, and his administration's encouragement for open government portals inspired the drive for free information and inspired open data," he said.

Public sector data is now more open than ever before, with many countries making available data for research, business and improvements in agriculture.

As a result, argues Appleyard, public sector data is now more open than ever before, with many countries making available data for research, business and improvements in agriculture. Yet, even as AusGOAL and other government open data services employ attribution licensing tools, there remain issues linked to ownership and copyright. "You can't just invite people to share their data without training or simply tell public officers to share departmental or government data. Ownership and liability for data remain important concerns," says Appleyard. But he believes that while there is a legitimate need to address such issues, they should not slow or curtail the flow of open data. He points to Creative Commons and explains it has a range of licences which permit individuals or organisations to re-use data so long as attribution is given.

AusGOAL describes itself as the government and research lead of Creative Commons in Australia. Unsurprisingly, then, it is keen to move public institutions and government away from an 'All Rights Reserved' approach, which invariably leaves information used and in a state of limbo. Users are unsure if data from a public source can be fully incorporated into a new product or

innovation or whether the original owner maintains a stake in their work.

According to the information provided by AusGOAL, implementation of a Creative Commons process doesn't have to be expensive or difficult. In encouraging organisations to consider the licensing process AusGOAL is moving them towards making available as much data as possible. It stresses the need to start the process with "low hanging fruit", in this context, material that does not contain private or confidential information, or material from external contractors. This can form the foundation of an organisation's contribution to open data.

AusGOAL benefits from a policy introduced in 2009 by the Australian government that requires all departments to work on the premise that data should be open and reusable. This is consistent with Freedom of Information legislation, changing the model of government data away from acquisition, towards a default position that assumes all information can be re-published and incorporated into new products or research.

Everything developed and researched on behalf of the department must be open for re-use.

Appleyard enthusiastically endorses the approach adopted by the Commonwealth of Australia's Department of Environment, accepting that everything developed and researched on behalf of the department must be open for re-use, supported by the Creative Commons Attribution licenses. Consequently, data gathered for the department can be easily and quickly interrogated or incorporated into new research or assist innovations.

The ambition is to ensure the highest number of people not only access open data, but benefit from it. AusGOAL promotes the use of blogs and other social media to publicise organisations' information and make it easily available for reuse by the larger community. The AusGOAL website states, "Publicly

funded information (and data) should be made available in open formats. Moreover, it should be made available in formats that can be read by freely available software. Publication in more than one (open) format is recommended."

In 2009, of Australia's official organisations and public bodies that were required to provide their water data for publication by the government, 196 (out of 214) said yes to Creative Commons Attribution. The remainder either did not have data, had no instruments to collect data, or were constitutionally opposed to the fact that the Commonwealth had cast a law to open their data to all. But the vast array of data from the 196 bodies is now being used by farmers, irrigators, and water management organisations to analyse and manage Australian water resources. This important pro open data policy was highlighted and endorsed in a report released in 2016 (links to the report, below).

AusGOAL was also behind the Australian Bureau of Statistics moving to open access. Now all publicly available government statistical data from the Bureau are available as open data and can be seen in its link.

Appleyard argues that open data is at the core of new innovations in agriculture, used to help create proprietary products. This, he insists, should not result in conflicts over copyright and this is why he advocates for the least-restrictive Creative Commons licences, releasing the potential for open data to enable derivatives and bring added value to products and services. Open data says Appleyard, "...is open to all competitors in the market, not just the one that dominates, or even, a government that is behaving like a commercial player."

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4

BOER & BUNDER, THE NETHERLANDS

Open data for farmers and plot development

In The Netherlands a web application has been launched that aims to improve accessibility to open data, unlocking valuable information that can aid the work of farmers and those involved in agriculture and the environment. Its biggest hurdle, however, is not untangling all the available data that is of use to individual farmers, nor is it the design of a time-sensitive and useful format to present the data, but rather getting farmers to see the practical application of the service, although this uncertainty is fast evaporating.

The new web application harnessing the benefits of open data for agriculture is called “Boer and Bunder” (“The farmer and his plot”). It was launched in 2015 and currently visualizes key information on the 1.9 million hectares of agricultural land in The Netherlands.

“We use complex algorithms to create simple-to-understand visualizations, which can be requested through an intuitive user interface.”

Boer and Bunder provides easy access to relevant information linked to farmland. “We use complex algorithms to create simple-to-understand visualizations, which can be requested through an intuitive user interface,” explains Anne Bruinsma, who heads the service that brings together tech-savvy data experts with farmers and the agriculture-business.

At the heart of the application is a smart search function combined with user-generated data. This enables farmers to share all kinds of details about their farm through Boer and Bunder. In turn, all participants can see what is working on other farms and adapt their own farming practices, or they can find information of value for their soil type and topography.



Building on the web application, new content and services are being added, responding to user feedback. This will require focus on technical optimization, adding new data sets and the development of smart filters. The web application is adding further water usage and water quality information to the service.

“Currently we have about a 1,000 to 1,500 daily users.”

Bruinsma says, “Since the launch of the application we’ve had over 160,000 visits, 350,000 page views, generated by almost 50,000 users. Currently we have about a 1,000 to 1,500 daily users.” So it is clear plenty of farmers see the value of the service, despite some concerns.

A small number of farmers, explains Bruinsma, feel open data might have the potential to check on their farming methods. Yet this is a minor issue and the Boer and Bunder team are seeing a growing interest in the positive service it brings to the agricultural sector. They are confident they can build a case that will get farmers comfortable using open data, and look to the growing number of enthusiastic users on the site. It is clear, with greater buy-in by farmers, agriculture and the environment in Holland will benefit.

The Boer and Bunder team has embarked on fostering community debate and enhancing communication about the value of open data in agriculture. Given the potential benefits of sharing high-quality information about the country's farmland, the team feel they have a good case to make and are winning over sceptics.

Bruinsma is optimistic and says most farmers want to embrace the benefits offered by open data and explains the situation in Holland, "There is so much new technology available that the average farmer needs help understanding what works best for them and meets their needs. Is it drones or sensors? Whatever the device, there are plenty of places where open data can be used to improve agriculture. "

The challenge facing Boer and Bunder is filtering all the existing information and presenting it in ways that can be used and valued by the average busy farmer.

The repositories for all the information gathered by sensors, drones and other systems are often open data portals containing many data sets. The team at Boer and Bunder recognises that it requires considerable knowledge and experience to explore effectively. This means that much of the current use of open data is restricted to a small group of academics and experts. The challenge facing Boer and Bunder is filtering all the existing information and presenting it in ways that can be used and valued by the average busy farmer.

The web application has come about through a partnership between Crop-R, a software company specialised in arable farming, Liters, a creative content agency, and Hackwerk Advies, an agency targeting open data and innovations in agriculture. Financial support has been provided by the Dutch Ministry of Economic Affairs, but Boer and Bunder is expected to become part or fully commercial, as it supplements its free services with more specialised paid-for services.

Sources: <https://boerenbunder.nl/>
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5

DIGITAL GREEN, ASIA AND AFRICA

Community video production, improving agricultural techniques

Handing power to poor rural communities in Asia and Africa is something many agencies and charities are striving to achieve. However, intermittent electricity supplies and unreliable connections to digital communications mean the opportunities offered by open data are still out of reach for many smallholders and rural dwellers.

“Women who have never used a mobile phone are now making video films!”

For one organisation it is challenges like these that inspired a campaign to link small-scale farmers to the potential available from access to agricultural open data sources. Thanks to its work an Indian newspaper recently declared, “Women who have never used a mobile phone are now making video films!” Prabhath Khabar, the Hindi News service, might have been shocked, but for the team at Digital Green it is just another example of the way digital technology and open source data help empower rural people.

Rikin Gandhi, Digital Green’s CEO, says “Open data help lay the foundation of Digital Green’s participatory video approach as we leveraged the national sample survey data to study the effectiveness of peer-to-peer knowledge sharing over the classic training and visit model, and use ICT mediums to train farmers on improved agricultural practices.”

The women, helped by local experts, took agricultural information from open data sources and added it to their video about crop production.

The Prabhath Khabar report describes the quiet digital revolution taking place in Bihar and highlighted the major role women played in creating farm-based information videos. Thanks to Digital Green, the women, helped

by local experts, took agricultural information from open data sources and added it to their video about crop production. This was then uploaded to the Digital Green website to be seen by farmers across the region. Using mini projector systems the films have been shown to audiences in thousands of villages. It is a blend of new digital technology linked to the draw of traditional film-making – all made by rural people for rural people. And it delivers a strong, relevant and change-making formula.

Digital Green has reached more than one million farmers over 12,000 villages in nine states in India, parts of sub-Saharan Africa and Afghanistan.

Gandhi puts this approach into context, “As of April 2016, Digital Green has reached more than one million farmers over 12,000 villages in nine states in India, parts of sub-Saharan Africa and Afghanistan. We have helped facilitate the production and dissemination of more than 4,000 localised videos in 28 languages, which are available on our on-line video library on a Creative Commons non-commercial attribution license. We captured data for every individual at every point they interact with our approach, be it screening attendance or adoption of a new agricultural practice, through an open source data management system, and share relevant data right down to the village level on our publicly available analytics dashboards.”

Explaining its unique service the Digital Green website states, “Our data management software, called Connect Online - Connect Offline (COCO), and Analytics dashboard suite are customized to operate in low-resource settings. They are used to collect and analyse near real-time data on dissemination, adoption, and community interest.”



Taking advantage of open data, the COCO database, through the Analytics suite of dashboards, provides information on field operations, performance targets and other metrics relevant to the daily needs of rural life.

COCO requires no additional software installation or maintenance. With affordable smartphones and tablet devices becoming increasingly common, the latest version of COCO has been developed to function on phones, tablets, laptops and desktops.

Farmerbook is an open-access platform which displays detailed timeline-based activities for each participating farmer, along with their villages, plotted on Google Maps.

Digital Green has a number of services to help farming communities in Africa and Asia. *Farmerbook*, for example, is an open-access platform which displays detailed timeline-based activities for each participating farmer, along with their villages, plotted on Google Maps. The application illustrates the practices

that individual farmers adopt on their fields, as well as stimulating healthy competition among participants, village leaders and communities through the sharing of performance data and community feedback.

It is not only limited to facts and figures. On its website Digital Green describes a new service for rural visitors. “To see how our core work in the field can connect with external audiences who could learn and engage in issues related to rural development, we have created a social game, *Wonder Village*, which is hosted on Facebook.”

Through *Wonder Village*, players set up a simulated village economy and have opportunities to relate with actual farmers. Players are placed in a resource-constrained setting and pursue quests, such as setting up small maize farms and supplying raw materials to farmers’ markets. The game follows a “freemium” model, which allows users to play for free and then purchase virtual currency to advance more quickly.

“*Wonder Village* has the potential to be an effective awareness-building and fundraising tool for the development sector,” states Digital Green.

Gandhi is convinced that open data is at the heart of Digital Green’s work, “Our strong belief in open data has driven the creation of publicly available analytic dashboards and the video library, benefitting social organisations and rural communities worldwide.”

Digital Green has attracted support from the Bill & Melinda Gates Foundation and received funding from ministries and international development agencies. It continues to build engagement with rural communities in the production of participatory and local videos. Open data has helped apply important, scientific and researched agricultural innovations, but delivered through the voice of local people - videos of the community, by the community and for the community.

Source: <http://www.digitalgreen.org>

6

ACCESSIBLE DATA ON IRRIGATION, YEMEN

Irrigation, decision-makers data

With scarce water resources – and increasing demand from a growing population – the Republic of Yemen needs to improve food security whilst reducing water consumption. This requires timely and accurate decision-making, made possible by using open data in new irrigation planning. A joint team of irrigation and data specialists has therefore set about delivering an online service to improve water management in Yemen.

This is the first step in setting up an operational remote sensing database for irrigation systems across the country.

The aim is to provide precise information that helps decision-makers and planners deal with water scarcity. This is the first step in setting up an operational remote sensing database for irrigation systems across the country. Remote sensing is especially useful in Yemen which has few ground observations and vast inaccessible areas. With such information accessible to institutions in Yemen it becomes easier to plan for improved irrigation which conserves water and helps increase crop yields.

Annemarie Klaasse, a Dutch member of the team involved in the irrigation sensing project says, “We hope that by facilitating data to all stakeholders there will be more insight and consensus on how problematic the water scarcity is in Yemen and what action should be taken. In the end the smallholder farmers should benefit.”

According to the Food and Agriculture Organization, agriculture is one of the most important sectors of Yemen’s economy. The FAO report on the country notes that agriculture, “...accounts for about 15% of GDP and for more than 50% of the total workforce in the country, at the same time satisfying

a significant part of the population’s food needs and contributing to reduce the incidence of poverty in rural communities.”

Back in 2013 Yemen and Dutch experts met to find ways to improve the country’s agriculture, but realised that the available information on irrigation practices was out of date. Put simply, it would not serve Yemen’s ambitions for more efficient use of water and improved crop yields.

The situation seemed bleak. The team reported that there was not enough water for future irrigation plans, and existing datasets were incomplete or obsolete: for anything worthwhile to be achieved, systematic and consistent databases of crop and water information were wanted. To improve matters in any meaningful way and offer practical help to farmers would need modern digital planning tools.

To improve matters in any meaningful way and offer practical help to farmers would need modern digital planning tools.

Since those dark days progress has been made. Annemarie Klaasse says, “So far the irrigation database has been filled with satellite-derived datasets on irrigation and water. The use of the database is however limited, as we have not yet trained any users on using the data portal.”

The task now is to build up the number of Yemeni water specialists who can work on the irrigation portal. Designed to work in a wide range of environments, from air-conditioned offices to dusty farm sheds, the portal can be accessed through the cloud. It is populated with open data from satellites and other datasets.

The portal has been created by Hydrologic; the organisation states, “We believe that advanced ICT technologies can play a major role in solving the world’s most urgent water problems resulting from urbanisation and climate change.”

This is ground-breaking work for Yemen, helping to provide weekly and quarterly water consumption records, and showing deficits at regional levels, while also able to focus on individual fields.

One of the other partners in this bilateral project is eLEAF, a Dutch-based firm that develops agricultural innovations and supports environmental initiatives using digital data. It has been creating data sets which sit at the heart of the irrigation sensing service and draw on open data to build up the information needed. This is ground-breaking work for Yemen, helping to provide weekly and quarterly water consumption records, and showing deficits at regional levels, while also able to focus on individual fields.

The process benefits from open data, but to be truly effective and relevant it has to be refined to suit the particular demands of the country.

The project involves key consultative stages, where international experts gain essential feedback from local stakeholders, fine-tuning the system to give information specific to the needs of the Yemen team. The process benefits from open data, but to be truly effective and relevant it has to be refined to suit the particular demands of the country. Annemarie Klaasse says, “The irrigation portal has been developed for Yemen, but the technology could be applied in other countries as well. From a technological point of view there is little difference between Yemen or other countries in the Middle East and North Africa region.”

Meanwhile, the project continues to develop the platform delivering remote sensing data and tools for sustainable water resource management in Yemen. Thanks to open data, it provides cost-effective and objective information about agriculture and water use that can be reproduced at regular intervals. The project is a Dutch–Yemen collaboration. The Netherlands Embassy in Yemen has provided support to carry out this work and also supports the Yemini institutions in planning for sustainable water resources.

Sources:
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7

LANSA, ASIA

Open data helps research into nutrition

Across the Koraput and Wardha districts of India new vegetable gardens are springing up, tended by women on a mission. A determination to improve the diet of their children and friends is driving them to tend their own vegetables, adding nutritional greens to their daily meals.

This new wave of 'grow your own' has sprung from the use of open data, inspired by a research programme consortium called Leveraging Agriculture for Nutrition in South Asia. LANSAs is funded by UKAid and linked to the open access policy of the UK Department for International Development (DFID) that aims to share data from most of its programmes worldwide, helping development activities everywhere.

This new wave of 'grow your own' has sprung from the use of open data, inspired by a research programme consortium called Leveraging Agriculture for Nutrition in South Asia.

R.V Bhavani, who works for LANSAs says, "The gardens are managed by groups of ten to twelve women who share the produce. Surplus produce is given to neighbours, relatives or to the village school for inclusion in the midday meal. Household nutrition gardens have been promoted in all the villages." As LANSAs asserts on its website, "We are conducting innovative research to discover how agriculture and food-related policies, programmes and interventions can be better designed to improve nutrition." And the gardens are a prime example of how open data can help realise practical outcomes that make a genuine difference to the lives of women and children in rural India.

Poor nutrition for women has been a persistent problem in the region says Lawrence Haddad, senior researcher at the



International Food Policy Research Institute and associate with LANSAs. To understand the problem, he has been investigating malnutrition levels among women in South Asia and been able to access information using open source data. Tracing data back to the 1990s shows that many women in the region have been underweight. This condition has been, and often still is, higher than in many countries in Africa. Looking at previous research Haddad reports a pattern which suggests the key culprit has been women's low status relative to men and their lack of ability to control decisions about resources, their own bodies, and their children.

The data helps create strategies that improve healthy eating and specifically tackle causes of gender-based malnutrition.

"I was very interested in this issue because of my research on power relationships within the household, in nutrition, and in India. In the late 1990s people were beginning to put the Demographic and Health Surveys national data sets together, realising that the common features of these surveys allowed samples of tens of thousands of children to be constructed across countries." says Haddad. Access to those datasets enabled increased levels of research which has helped organisations like LANSAs translate information into action. It is this use of open data that can counter the ongoing malnutrition rates in women and children in South Asia.

Much of the open data used by LANSA and similar organisations has been in the form of national nutritional surveys, employment records and demographic health reports. Together the data helps create strategies that improve healthy eating and specifically tackle causes of gender-based malnutrition. The empirical evidence provides an authoritative foundation for action, enabling nutritionists, government officials and activists to implement life-changing activities focused on producing results that increase the quality and range of food on offer to rural women.

Health-related data has identified anaemia as one of the main factors linked to the high rate of mortality among women and children in India.

Another example of LANSA's approach to research which influences cultural behaviours while increasing nutrition levels for women, is seen in the organisation's recent national seminar in India, entitled Strategies for Women and Child Survival. Using and combining health-related data has identified anaemia as one of the main factors linked to the high rate of mortality among women and children in India. At a



recent event D.J. Nithya, a LANSA nutritionist, offered evidence on the connection between nutrition and anaemia in women and children. His research demonstrated a link between iron and vitamin A intake and blood haemoglobin levels and anaemia prevalence.

For most agricultural communities increased attention to nutrition was recommended to reduce anaemia.

But, by accessing open data sources, he was also able to point to other vital issues in some Indian regions. The data for these regions revealed that while there was sufficient iron intake in the diet there continued to be a high prevalence of anaemia. Nithya concluded that other factors had to be taken into account before planning a remedy to the problem. He pointed to lack of adequate sanitation and poor levels of hygiene. Malaria was another factor effecting the high prevalence of anaemia. Even so, for most agricultural communities increased attention to nutrition was recommended to reduce anaemia. And as new measures are being put in place, such as enabling women to run community gardens, LANSA is undertaking accompanying study on the gardens initiative which can be input to the growing amount of open data on health issues in India.

Across the border in Pakistan, open data is also helping improve nutritional intake for women. Researchers have been asking the question: does women's work in agriculture help or hinder nutrition in Pakistan? This question has assumed great significance owing to the steady feminisation of the agricultural labour force over the last decade, and the absence of nutritional improvement during the same period.

Researchers Mysbah Balagmwala, Hais Gazdar and Hussain Bux Mallah in their study on women's agricultural work and nutrition in Pakistan address the limitations of relying entirely on open data. "While statistical data sources suggest that there might be an association between women's work, and their own health as well as the

nutrition status of their children, there is need for a more precise understanding of the linkages through which this relationship might operate.” Rightfully, their work returns to original field research. But over the years, their findings will join the growing body of work available through open data which will more precisely and effectively inform methods to improve women’s nutrition.

DFID sees this accumulation of knowledge as an essential resource in fighting poverty and hunger.

DFID sees this accumulation of knowledge as an essential resource in fighting poverty and hunger. It is dedicated to sharing surveys, research and reports through its R4D website, which states: “R4D is a free access online database containing information about research programmes supported by DFID. R4D makes available the latest information about research funded by DFID, including details of current and past research in over 40,000 project and document records.”

To help sift through this mountain of knowledge facilities have been developed to make the datasets held within R4D accessible to other organisations and individuals. The aim is to enable as many as possible to reuse the knowledge funded by DFID and built up by experts around the world. The hope is that that information can play a productive role in building and extending new humanitarian and development projects.

A research-based initiative is helping to improve the nutrition of rural children.

The type of work conducted by LANSa, along with many other regional and country-based expert groups, is contained within open data offered by DFID. And to ensure it can be viewed by all, from different countries and areas of expertise, DFID has invested in making information as accessible as possible. As the website states: “Subject experts assign relevant keywords from controlled vocabularies such as AGROVOC, MeSH

and the CAB Thesaurus. They also categorise and assign themes to each document. All of this data is available via R4D open data services.”

Back in the field LANSa is continuing the accumulation and practical use of open data sources. In its recent ‘Research to Policy’ consultation it brought together a varied group of agricultural-nutrition experts and activists to discuss research provided under its India programme.

Sangeetha Rajeesh and Christy Raja from LANSa illustrate how a research-based initiative is helping to improve the nutrition of rural children. The gathered experts heard about, “...the importance of including millets in the diet to improve nutrition. This came out strongly in discussion with the Director of the Tamil Nadu State Agriculture Department. She spoke of the need to meet the demand for pulses and wanted to understand what ‘shortfalls have been identified to address nutritional requirements’ and asked about cropping pattern changes required to meet protein issues for women and children since the State is experiencing a shortfall in the production of pulses”. In this discussion LANSa shows how officials are not only asking questions about nutritional deficiencies, but also recommending actions and checking what research is available to help make decisions that can improve the lives of women and children.

Open data has not solved the problems of nutrition in South Asia, but has certainly played a pivotal role in educating decision-makers. It is the basis of many practical solutions that can be put in the hands of rural women – enabling and empowering them to improve the health of millions, village by village.

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“WE ARE CONDUCTING INNOVATIVE
RESEARCH TO DISCOVER HOW
AGRICULTURE AND FOOD-RELATED
POLICIES, PROGRAMMES AND
INTERVENTIONS CAN BE BETTER
DESIGNED **TO IMPROVE NUTRITION.**”

R.V. Bhavan, LANSA

8

SUSTAINABLE WORLD, GLOBAL

Training and advice for accessing open data for development

To deliver a game-changing development project aid agencies and support organisations need a thorough grasp of the country, region or issue they seek to support. Local knowledge is essential, but alongside that there needs to be access to a raft of data which forms the foundation to the design or sustainability of interventions and support activities.

The amount of detail required in preparing project proposals or compiling project reports is onerous. Funders want to see context and understand conditions before engaging in new projects or committing to continuing action.

The service provides guidance and practical tutorials on using open source data.

There is a website which provides important help, offering aid and development planners and operational staff a way into national-level open data, mainly produced or curated by international organisations. The service provides guidance and practical tutorials on using open source data. It deals with the realities of discovering and extracting relevant information and pays particular attention to difficulties accessing data or facing the problem of bugs and errors both in the source of the data and the data itself.

Sustainable World.com is the brainchild of Canadian, John Gordon. He has more than 45 years' experience working in and with developing countries, and he has worked at all levels of international technical assistance as a consultant, resident adviser, project manager and head of a non-governmental organisation. In the introduction to Sustainable World.com it says of Gordon, "Since 1984 he has concentrated on the practical application of information technology in developing countries in the field of agriculture, concentrating on food security and

safety, health, cleaner production, water and sanitation, WTO transparency and education."

He has turned his considerable operational experience to helping others design and implement projects for themselves. The site, which first appeared in 1998, is designed to provide access to a selected number of important and free international data-rich sites. It has developed over the subsequent years, but deliberately maintains a simple format that is easily accessible to those working in areas of the world where internet speed is slow and reliability intermittent. The service helps visitors understand and access open data, combined with training on open-source or free software, which can be used to connect to and analyse data. "The site has been developed to be of general interest, but particularly useful to governments, businesses and students in low-bandwidth areas in developing countries," the website states.

Gordon explains that most recently his site has supported, "UN Volunteers who have more than 350,000 registered online volunteers to try to link them effectively to data collecting activities with CGIAR organizations and Humanitarian Open Street Maps." Working with a diverse range of groups and supporting people who have little or no previous experience accessing open data does throw up problems, but the latest activity has effectively established a test project which can help improve analytical skills.

Sustainable World.com is a practical grassroots-based service, offering step-by-step help on open-source computer operating systems and applications which are used to extract and analyse open data.

Sustainable World.com is a practical grassroots-based service, offering step-by-step help on open-source computer operating

systems and applications which are used to extract and analyse open data. The ability to link free operating systems to free information opens up a world of opportunity for many communities and development organisations around the world.

The service points users to other sources and gives confidence to seek out other free on-line data available from international sources.

There are limitations, as Sustainable World.com warns, "It is not possible on this website to track all databases. But information on a number of key databases will be updated regularly. The databases selected will be of particular interest to people working in demographics, agriculture, health and education."

The service points users to other sources and gives confidence to seek out other free on-line data available from international sources. These resources have increased since 2010 when large organisations implemented a policy making more of their data available. For instance, the World Bank which used to charge for its World Development Indicators and other data, now makes them available for downloading free.

Sustainable World.com estimates there are at least 46 free data bases on the World Bank's main data site alone, all available to download free of charge. Similar services are provided by many other international and national organisations, such as the United Nations, the Food and Agriculture Organisation, the European Union and the US Census Bureau.

Sustainable World.com has a specific interest, "Preference will be given to databases which provide data at the country level and have time series data. For population databases, at least three will be included which provide population projections to 2050 or longer." The databases it focuses on are updated regularly.

Naturally, it is not possible for one free website to track all databases. But the objective of Sustainable World.com is to help those learning about open data to discover how to search out and explore authoritative information for themselves.

Source:
<http://www.sustainableworld.com>
<http://www.sustainableworld.com/data/index.html>



Domain, community and database on agricultural open data

The International Information System of Agricultural Science and Technology, better known as AGRIS, claims to be the biggest agricultural domain in the world. Its roots can be traced back to 1974, as an initiative of 180 member countries of the Food and Agriculture Organisation of the United Nations.

AGRIS main objective is to improve access and exchange of information related to agricultural research.

Its main objective is to improve access and exchange of information related to agricultural research. It serves the information needs of developed and developing countries and has created a spirit of partnership as it works with all its users and supports their research needs. This makes AGRIS more than a simple repository of data, it also works as a network. In a collaborative approach it connects more than 150 institutions from 65 countries.

AGRIS provides worldwide coverage, offering users access to an enormous amount of open data and today its statistics are impressive; 400,000 documents from Latin America, 150,000 from Africa, 750,000 from Asia. It provides multilingual content covering 64 languages, with at least 10,000 resources for 26 languages. Despite its development over the last few years, AGRIS continues to have ambition and plans to be a global hub for agricultural research and technology information.

"AGRIS is not only technology and services, but also a community."

Fabrizio Celli from AGRIS says, "AGRIS is not only technology and services, but also a community. There are 150 data providers, many of them constantly active to contribute

to AGRIS from all over the world." As a web portal, it also acts as a web application that links users to web resources using the Linked Open Data methodology.

In the last couple of years it has adopted Linked Open Data technologies which allows AGRIS to create mashup-pages. A mashup page (see more detailed explanation, below) is a web page where an AGRIS resource is displayed together with other relevant knowledge extracted from external sources which is not part of the AGRIS database. "In this way, when a user is looking for a publication in AGRIS, they can have access to a lot of other resources available on the web, related to the same topic, such as other bibliographies, distribution maps, definitions and country information," explains Celli.

As a database it provides a multilingual bibliographic resource for agricultural science. Celli explains, "On the data side, this means also improving comprehensiveness. Behind all this, the most important aspect of AGRIS is the user: AGRIS is a service that wants to help users, it should be the platform that allows its users to do better their job."

AGRIS has also implemented a cross-language search facility, enabling users to look for data in their own language, retrieving results in all available languages. According to Celli this feature has two main advantages. Users can search in every language and retrieve relevant literature in English, a language that provides the widest variety of data. When there are no results in a specific language, users may find relevant results in a wide range of other languages. Celli has written an article explaining this facility (see link—Sources).

In the context of European data, AGRIS has implemented a process that discovers



web resources for agriculture, assigning a semantics that uses the AGROVOC thesaurus, linking back to AGRIS records. This enable the service to intelligently suggest linked activities to specific topics of interest to the end user.

In total it presently offers 1.3 million links in full text and has data from more than 150 partner organisations across the globe.

Returning to AGRIS' impressive service for agriculture, it delivers up to 8 million multi-lingual bibliographic references. It has 31,000 books, can access 286,000 conference papers, provides 5 million journal articles and shows upwards of 62,000 theses. In total it presently offers 1.3 million links in full text and has data from more than 150 partner organisations across the globe. This is a valuable tool for researchers and graduate

students looking for references and bibliographies. Librarians and cataloguers link to AGRIS along with journal publishers and conference organisers. AGRIS also responds to government officers seeking reports on specific agricultural topics.

As to the focus of its bibliographic references, the domain concentrates on agriculture, forestry, animal husbandry, aquatic sciences and fisheries, and human nutrition. Beyond these specialisms, it interlinks to other kinds of information related to its main fields of expertise, such as statistics, maps and country profiles.

Sources:

<http://agris.fao.org/content/about>

<http://agris.fao.org/agris-search/search.do?recordID=QM2008000025> (information on mashup)

<http://aims.fao.org/activity/blog/focus-agris-multiilingual-search> (multilingual search facility)

The Global Yield Gap Atlas has been set up to support efforts to achieve the highest possible crop yields from existing farmland. The Atlas provides a range of information, offering relevant data to policy makers, researchers and industry. This extensive open-data initiative takes a bottom-up approach to data, concentrating on delivering detailed information on weather, cropping systems and soils. It up-scales the locally gathered data so it can be of relevance at national and global levels.

To deliver effective country-based and regional information successfully, it relies on open data sources that accumulate highly localized data linked to weather patterns, soil conditions and cropping methods. This data populates the Atlas with information of value in planning and decision-making.

The designers of the Atlas consider previous yield gap analyses to be “too coarse or too empirical”, and criticise those earlier efforts as lacking transparency with regard to methods, sources of data, and underpinning assumptions, making it hard to validate or improve estimates. “To address these deficiencies, the Atlas utilizes methods that are transparent, reproducible and based on the best available science”, the website’s introduction states.

The current rate of yield increase for major food crops is not fast enough to meet demand on existing farmland.

The website also makes it clear that there is an urgency to improve this kind of data, “The current rate of yield increase for major food crops is not fast enough to meet demand on existing farmland. Given limited land suitable for crop production and population soon to exceed 9 billion, ensuring food security while protecting carbon-rich and biodiverse rainforests, wetlands, and grasslands depends



on achieving highest possible yields on existing farmland.”

In implementing the service, they are concerned that most major crop-producing countries, including data-rich regions such as the USA and Europe, have insufficient reliable data on yield potential or water-limited yield potential. This revealed the need for the Atlas which helps with best available estimates of the exploitable yield gap, defined on the website’s introduction as the difference between current average farm yields and 80% of yield potential and water-limited yield. Water resources to support rain-fed and irrigated agriculture are also limited, which means efficiency in converting water to food (alternatively described as water productivity) is another key food security benchmark included in the Atlas.

“Our approach has a strong agronomic foundation. It gives preference to best available sources of weather, soil, and management data, well validated crop simulation models

The team at the Atlas also state, “Our approach has a strong agronomic foundation. It gives preference to best available sources

of weather, soil, and management data, well validated crop simulation models to estimate potential yield and water productivity, and expert opinion to provide scientifically robust, transparent, and reproducible yield gap assessments. Results are up scaled from location to climate zone and country following a novel bottom-up approach.”

This approach involves access to location-specific data on current cropping systems, soil type, and long-term weather data from selected reference weather stations. This means results can be validated and improved upon in major crop-producing regions worldwide.

The partnership behind the Atlas believe it can help determine the untapped crop production potential and identify the most promising regions for investment in agricultural development and technology. The Atlas can also be used to monitor progress

towards closing yield gaps, quantitatively estimate the impact of R & D investments on yield gap closure over time, and assess the degree to which food self-sufficiency can be achieved through sustainable crop intensification. Furthermore, the Atlas offers a foundation for explaining and mitigating yield gaps and for spatial studies that deal with a wide range of issues such as impact of climate change, land use, environmental footprint of agriculture, and for in-season crop forecasting.

The team managing the Atlas is made up of the Water for Food Institute of the University of Nebraska-Lincoln, Wageningen University, and Alterra, a research, development and consultancy organisation based at Wageningen University.

Source:
<http://www.yieldgap.org/web/guest/methods-overview>
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*Supporting open data in agriculture and nutrition,
with focus on new businesses*

The Open Data Institute aims to connect, equip and inspire people around the world to innovate with data. “We will incubate, nurture and mentor new businesses exploiting open data for economic growth. We will promote innovation driven by the British Government’s Open Data policy,” states the organisation’s Implementation Plan 2012 and Beyond.

ODI’s Alexander Leon says, “As part of our mission to bring open data’s benefits to specific areas of society and industry, we’re currently focusing on six sectors, including the agriculture and nutrition sector.”

As part of its drive to keep at the forefront of open data initiatives the organisation hosts events which aim to expose potential innovations, even if this means dealing with difficult, even controversial issues. In July 2016 it focused on the growing use of food banks in the UK and the scourge of food poverty in a wealthy country. The Trussell Trust Foodbank Network’s statistics show usage at an all-time high, so the ODI asked can open data help us understand the scale of the problem and point the way to solutions or better targeting of resources?

Simon Raper and Andy Hamflett explain how they aligned Trussell Trust clients and food bank location data with a range of open datasets to create the UK’s first dynamic visualisation tool for food poverty. As well as mapping geographical demand, the prototype platform also aligns findings to 2011 census data to predict where additional food banks may be needed. The project, delivered alongside academics from Hull University Business School, presented the Trussell Trust with many new insights and points to much greater potential for a wider community of charities working to counter the UK’s nutrition deficit and poverty.

Founded by Sir Tim Berners-Lee and Sir Nigel Shadbolt, they designed ODI to be an independent, non-profit, non-partisan organisation. Now with global reach, it has hundreds of members, thousands of people trained, dozens of start-ups incubated, and a 5,000 sq ft convening space in London.

“We train, nurture and collaborate with individuals around the world to promote innovation through open data.”

But despite having its base in Britain’s capital and conducting work with the British government the ODI is actively looking at activities beyond their home shores, with the founders asserting, “We train, nurture and collaborate with individuals around the world to promote innovation through open data.”

Leon amplifies the organisation’s worldwide ambitions, “Through applied research, sector-themed events and collaborations with organisations within the sector the ODI is exploring what the challenges are and what our global priorities should be.”

Among the ODI start-ups a number rely on food and environment data.

This has meant meetings with large players who have influence in the farming sector and who interact commercially with food producers. During 2016 it held workshops with organisations such as Syngenta, the supermarket giant, Sainsbury’s and the UK’s Food Standards Agency. The aim was to explore the value in sharing and publishing data to ensure the improved efficiency and transparency of the food supply chain.

Earlier, ODI collaborated with GODAN, says Leon, “We published the discussion paper ‘How can we improve agriculture, food and

nutrition with open data?’ which explored how open data can inform decision making, boost innovation and promote transparency in agriculture and nutrition, from farm to fork.”

Among the ODI start-ups a number rely on food and environment data. One of these businesses is FoodTrade which aims to help small restaurants and caterers create menus with up-to-date allergen information. This supports compliance with the UK’s Food Standards Agency (FSA) regulations.

As a new company FoodTrade attracted coverage in the Financial Times, Wired and the Huffington Post and secured support from companies including Telefonica and British Growers. Amongst its services, FoodTrade provides an on-line market place and says, “This is where anyone can buy, sell, find collaborators, or find a home for surplus produce. Like a real-world market, anyone can talk to anyone, and transactions happen between you. We don’t take a cut of any transaction.”

To date more than 1,600 businesses have enrolled on the platform enabling more than 1,300 connections between them and other users. As a result, FoodTrade can map supply chains and promote transparency within the UK food sector, which has in the main kept most data closed.

FoodTrade was also a winner of the Food Open Data Challenge, supported by ODI, with backing from Nesta. It was one in a series of seven challenge prizes that encourages individuals to develop products or services using open data for public good. ODI reports that, “The Food Challenge, explored over six months, asked participants how open data could be used to help people eat more healthily, eat more sustainably and/or have a more secure food chain.”

ODI’s work with government helps work out the role big data sets can play in helping agriculture and nutrition. The UK’s Department of Environment, Food and Rural Affairs

(Defra) open data plans intend to support innovation with food, environmental and agriculture data. In a significant move in 2015 it announced its intention to release 8,000 datasets as open data and by mid-2016 more than 5,000 had been released. While this must be marked as an important milestone, the ODI report ‘Open Data Means Business’ looked at how 270 companies could benefit from open data as part of their business.

The research included insights into an influential group of companies, with ODI calculating a combined turnover of £92bn between them. Importantly, it documented how several reported concerns about open data’s limitations, especially when it restricted information being published as a ‘one off’. This prevented some companies from relying on available data, reducing its value in the building of sustainable business models. It showed there is still work to be done in the area of ownership and liabilities linked to the use of government based open data.

Leon addressed how ODI is helping to improve agriculture in the UK and points to a series of events entitled ODI Futures, “They’ve been held in collaboration with the Department for Environment, Food & Rural Affairs and sought to bring together experts across the agriculture sector to explore data-driven innovation, with a particular focus area on open data.”

With the consultations only recently concluded, ODI is still collating the information and settling on potential outcomes before presenting initiatives. “These outcomes will frame the rest of the work we do in the sector,” says Leon.

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