SUSTAINABLE ROOTS IN AGRICULTURE

DIGITAL INNOVATIONS IN AN ENDANGERED AGRICULTURAL VALUE CHAIN

Capgemini

CONTENTS

FOREWORD

Let's face it: we have had enough opportunities to change the way we grow our foods, ship our products, pay those in the value chain and so on. However: for every step in getting where we are today, there was (at the time) a valid reason. Be it for economic growth for a few people, better job positions for the lucky few, or to gain an advantage over the competition. In that symbolic walk, we forgot to think about the soil beneath our feet: the planetary boundaries that must be safeguarded. In harsher terms: we have put the sustainability of agriculture and the food system under severe pressure.

In this paper, we would like to give you insights on what needs to be done to give us healthy food, a healthy planet, and healthy people. Agriculture plays a key role in that. Retailers also play a role: as resellers, they have a choice in the food they feel comfortable selling. In a follow up to this first paper, we will take a closer look at the role retailers have to play in promoting sustainability in agriculture.

Since the publication of the groundbreaking book Silent Spring (1962, Rachel Carson), the agriculture sector – and humanity as a whole – have been aware of agriculture's impact on our planet. Ten years later, the report Limits to Growth (1972) by the club of Rome was published – and widely embraced by politics. On November 8th, 1989, British Prime Minister Margaret Thatcher gave an inspiring speech to the UN General Assembly about the environment and climate change. Over the course of her half hour speech, she set out the problems we face and how we could resolve them.

Today, many nations have signed the Paris Agreement (2015). So far, 26 Conferences of the Parties (COP) have been held, with the most recent being hosted by Sharm el-Sheikh (2022). Yet we're still not there. Meanwhile, climate change is ongoing. Just like what was once the granary of the Roman Empire has turned into the Sahara, today's climate change may turn fertile lands in Spain and Italy into barren deserts.

It's time for action. Politics must retake the lead and design new policies that take into account social and ecologic boundaries. The European Union is designing new laws that make businesses accountable for the environmental and social impact of their entire full value chain. Businesses and customers alike must start paying the true price for their goods. (for a good example of this, see https://trueprice.org/nl/).

Our current food system is dependent on all kinds of materials and substances that have an adverse effect on the environment and on the traditional social fabric. Take, for instance, nitrate, which has been used since the end of WWI as agriculture's preeminent growth agent. Later, we started to mechanize and eliminate human efforts on the farms, which has had a negative impact on agricultural communities. To make matters worse, the chemical industry has introduced poisons that are destroying fungi, bacteria, insects, and herbs on an unprecedented scale. These applications may have seen short-term gains on productivity and yields but have had a disastrous impact on the environment – and on the farmers themselves. Parkinson is a disease recognized by the France government because of the pesticides.[1]

For around 60 years now, this industrialized way of farming has been the norm. Yet still, 500 million farmers in the world do not have a tractor and access to scientific information that can improve their daily lives.
A paradigm shift, then, is overdue. In this paper we will share some thoughts and insights on how this paradigm shift can take place. This, the first paper published by our team of sustainability enthusiasts, does not present the long-sought silver bullet solution, but will give some input for introspection and reflection; what we can do in our daily lives and work to fix this broken system?

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1 (https://pubmed.ncbi.nlm.nih.gov/28185034/)

SUSTAINABLE AGRICULTURE UNDER THE PANDEMIC LENS

By Tushar Agarwal

The COVID-19 Pandemic sent shockwaves through every industry. Even today, these waves and their repercussions are being felt in different parts of the world and morphing into newer problems in almost every aspect of agriculture. Production, supply chain and consumer retail, each sector under the umbrella of agriculture is facing a strong current that's pulling the sector apart.

But not all is doom and gloom. These times of experimentation have led to an increased awareness of the need for sustainable agriculture. A report by the Organization for Economic Cooperation and Development presented the pandemic as an opportunity "to not just respond effectively to the current crisis, but to roll back distortive, inefficient and environmentally harmful support, thereby freeing up financial resources for investments in a more productive, sustainable and resilient food system able to meet new challenges".

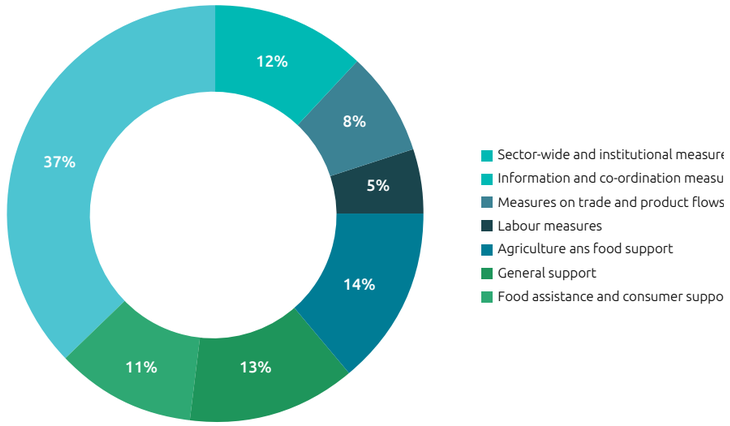
Sustainable farming is becoming a desire, rather than just a compliancy directive. Farmers and associated organizations acknowledge the importance of using technology along with age old knowledge for soil-to-crop benefits, climatic predictions and demand and supply mechanisms. Utilization of more advanced bioorganic fertilizers rather than chemical pesticides has gained momentum during the pandemic. Purchasing organically grown food is now becoming the norm across several high-income countries. This shift in demand has also led to a shift in the ideology of farmers and organizations, moving away from mass-production through chemical fertilizers. Organically produced crops are now certified and sold at a higher markup, and this has been welcomed by both producers, consumers, and distributors across the supply chain. The benefits? Better top-soil quality and lower chemical indulgence in food. Or in the light of the bigger picture: sustainable farming and health benefits.

Technological research has also seen a major push during the pandemic. When the supply chain was disrupted, several major countries turned towards their food storage, distributing the stored foods amongst developing nations, to ease the shocks of disruption. This has led to the need for growing stronger crops, which have a longer shelf life, whilst keeping in mind the need to grow organically. A truly remarkable combination of long lasting, organically grown food.

The pandemic and the subsequent lockdowns and regulatory measures led to multiple adjustments by stakeholders along agriculture and food supply chains. Producers looked for new sources of foods processors and wholesalers adopted new sanitary measures. Retailers adapted to shifts in consumer demand, while food services developed deliveries at home. The Asian and European market saw an increase in the number of startups in the distribution chain. Deliveries in under 15 minutes of organically grown farm fresh food brought producers closer to the doors of the consumers, removing middlemen, and thereby increasing the revenue generated by the supply chain (and farmers in particular).

The mindset was and to this day still is to source quality vegetables and fruits, which has been touched by fewer hands, indirectly resulting in cleaner, more sanitary food brought to the doorstep. This shift in mindset has its pros and cons. On the one hand, consumers helped the farmer directly, whilst on the other hand the supply chain middlemen saw a downfall in revenue generation. Another advantage was the availability of clean food, with higher sanitary throughput, whilst a disadvantage was the increased costs for maintaining such sanitary conditions. All in all, the positives outweighed the negatives in terms of health, safety, and economic relief for farmers in these trying times, and thus in terms of sustainability.

The government led the way in developing relief policies and responses in 2020/2021 towards developing a more stable worldwide solution. Certain countries utilized individual measures, whilst a few countries adopted them all. About 54% of measures undertaken by governments of OECD countries focused on the three categories of financial support (categories 5. Agriculture and food support, 6. General support, and 7. Food assistance and consumer support measures). In contrast, 58% of measures undertaken by emerging economies were in the non-support categories of measures (categories 1. Sector wide and institutional, 2. Information and coordination, 3. Trade and product flows, and 4. Labor measures).



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2 OECD, 2021
3 (Lusk et al., 2020; Wieck et al., 2021
4 Source: OECD (2021[12]).

SUSTAINABLE AGRICHEM INNOVATION THROUGH DATA-DRIVEN R&D

By John Godfree

Making agriculture sustainable depends on new and renovated agrichem products. To meet this challenge, agrichem needs data-driven R&D.

Agriculture feeds the world, but at an enormous cost to people and the planet. It contributes to greenhouse gas emissions through fertilizers, pesticides, and animal waste, some of which also release harmful chemicals into air, water, and soil. Biodiverse lands are cleared to expand farming. The agricultural sector consumes 69 percent of the planet's fresh water, according to MIT[1]. Addressing these challenges represents a big opportunity for the world's agricultural innovators. Transforming agriculture is a big job that spans scientific and technological innovation, policy, and education. One of the biggest opportunities to make agriculture more sustainable is through innovating and renovating agrichem products.

How agrichem innovations will improve sustainability

Agrichem innovation has a broad remit. Genetic tweaking can create more resilient crops, reducing water waste, pesticide use, and maximizing use of land (thus reducing the need to clear more). Dietary supplements for cows could reduce the methane emissions from their waste. Pesticide researchers could replace harmful chemicals with biobased ones, or formulations with a toxicity that is highly specific to one pest.

How Capgemini Engineering can help with agrichem data driven R&D

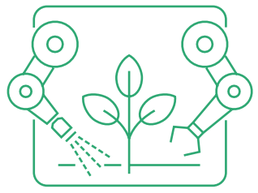
To deliver the value described in this article, you need to capture and understand complex data sets, and build models that support innovation, renovation, and scale up of agrichem products, as well as turning them into science based digital services. Capgemini Engineering can help you deliver on all of these. We are experienced in combining complex scientific data sets, and have done this in agrichem, pharma (e.g. modelling drug efficacy in different populations) and consumer products (how weather affects local demand for ice cream). We setup the systems to ensure the right data is captured, labelled and shared for you to deliver Data Driven R&D. We helped Rothamsted create a platform to share their research data with the world's agricultural researchers cleaning it, making it intelligently searchable, and presenting it in a usable format. Finally, we have experience in the emerging field of 'science-based digital services'. For example, we helped AkzoNobel combine its own product data with oceanographic and sensor data to create apps that lets their shipping customers predict the impact of hull coatings on carbon emissions. Through 40 years of supporting R&D with data driven innovation, we have developed experience of their specific data and scientific challenges, proven methodologies to build and progress portfolios of data projects that deliver quickly, and roadmaps to move any R&D department along its journey to become truly data driven.

Many are inventing whole new approaches. Researchers are investigating RNA interference – using technology like some COVID vaccines to create pesticides that disrupt key biological mechanisms of a specific pest, whilst leaving everything else unharmed[2]. A trial is looking at using genetically engineered mosquitoes to suppress populations of disease-carrying mosquitoes[3] – currently aimed at protecting humans but with implications for pest management. A watchword for all R&D-based industries is personalization.

A true approach to sustainability means developing different solutions optimized for different environments. This may mean developing pesticides with a very specific target, rather than one that kills everything. But it also means solutions designed for different regions, farm sizes and buying powers. Many technologies will need to be 'appropriate' rather than optimal – seeds that offers a 10% greater yield to subsistence farmers may be better than seeds that offer 20% greater yield, if the latter cost twice as much to develop.

The data and skills to do data-driven R&D

Doing any of this well depends upon organizations having sufficient quality data on the product and the environment where it will be deployed. Organizations will need to be able to combine these complex data sets - which may include chemical models, satellite images, weather, and soil data – to deliver results they can trust. Rapid data driven innovation means making this data accessible and findable to anyone who needs it, whether for internal R&D, or collaboration with your value chain. If one team gathers data on a particular environment to study a new pesticide, that data is valuable to other teams wanting to study how their innovation will perform in that same environment. This requires organizations to have good data management processes. To do all this, organizations will need the right mix of skilled people, processes, operations, and technology platforms all working together. This may take time to setup, but getting this right reduces research and manufacturing costs, time to market, and time spent pursuing duds.



Data-driven R&D, an approach pioneered in the life sciences, offers a way forward.

The importance of data-driven R&D for agrichem innovation

The challenge is pressing, and the products which address them will need to be far more numerous and varied than the all-purpose products of the past. Innovating, renovating, and personalizing all of these new products needs to be done at scale and speed if sustainable agrichem is to be competitive. Traditional R&D is not geared up to working at this scale and speed. It is slow and expensive, relying on physical experimentation and manual processes. Data-driven R&D, an approach pioneered in the life sciences, offers a way forward. It leverages AI, data science and data engineering to accelerate R&D processes and dramatically shorten time to market.

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2 https://www.economist.com/science-and-technology/2021/05/20/rna-good-for-vaccines-can-also-be-used-as-a- pesticide
3 https://www.nature.com/articles/d41586-021-01186-6

Three ways data-driven R&D can speed agrichem innovation and create value

Firstly, thanks to data driven R&D product design and testing can often be done in-silico, allowing organizations to quickly work out optimal product formulations for new needs, or understand the impact of replacing chemicals in their existing products with greener alternatives. Such models also help predict how chemical formulations will evolve over time, which will be vital for managing the growing regulatory and safety assessments that come with increased personalization of product lines. Secondly, by combining these models with data on different environments (weather, soil, satellite images, etc.), organizations can predict how new formulations will perform in different settings - from arid smallholdings to well-managed super farms. This allows them to tweak products accordingly, without travelling the world to test them. Finally, models that predict chemical interactions can create wholly new value in a surprising area: customer apps. With some adaptation and an easy-to-use interface, a farmer can feed in local parameters (through a questionnaire or from sensors) and apps can make recommendations for the most sustainable approach for their specific environment. This improves sustainability, creates value added services, upsells sustainable products, and captures data on how products perform in the real world.

ECOSYSTEM COLLABORATION FOR WATER MANAGEMENT

By Luc Baardman

COVID-19 has driven collaboration outside one's own organization. Now that meeting with people from other organizations can be arranged with the click of a button, the chance of silo formation decreases. "Want to share data?" "No problem, just provide us an API and we'll link our data lake". This broadens possibilities of collaborations between organizations. Let's explore a case from the Dutch sector.

Public-private partnership (PPP) is defined as 'More or less sustainable cooperation between public and private actors in which common products and/or services are developed and in which risks, costs, and revenues are shared' (Klijn and Teisman, 2000). However, the promise of PPP goes beyond simple cost-saving and revenue sharing. The aim is to achieve added value that cannot be achieved without cooperation. In the optimal situation, synergy arises: a situation in which the sum of created value is greater than the parts because activities reinforce each other (technically speaking, mutualism). A cliché often used in speeches by board members and government officials and the like. PPP is inspired by ideas from New Public Management (NPM), with the guideline that the public sector should focus on formulating policy and leave innovation to the private sector. This encourages better products or policies for complex social problems, by improving horizontal coordination and removing obstacles to policy implementation or product introduction.

For a while, PPP has had a negative connotation around it. News about delays in large scale - often infrastructural – projects, but also in ICT (Cybersecurity of systems or poor UX-design of systems), regularly made the headlines. If projects go well, we don't hear much about them. However, due to ongoing digitalization, PPP has continued to develop it is increasingly characterized by a broader ecosystem approach. No longer is PPP locked between the government and one party under strict contractual terms. The new mandate is that collaboration is fluid and should be open to new parties. This provides flexibility, so that it can be adjusted at any time in a project.

As a result, mutualism can arise faster. Instead of having to collaborate with a contractually determined consortium, space can be created within the collaboration for the arrival of a new party. This can bring in new knowledge that may be required at any given time.

As in nature, momentum is constantly shifting. Rabbits eat plants, foxes eat rabbits, and fungi process the remains into food for plants. When a disturbance in the balance occurs, for example due to a surplus of foxes, nature will restore balance and hunger will cull the fox population to accommodate the others in the ecosystem. As humans, we strive for the same kind of balance between prosperity for people, the environment, and the economy (People, Planet and Profit, also the 3P model). ICT is the big driver of this type of collaboration. Today, it is easier than ever to find the right people outside your own organization. In recent years, platforms such as LinkedIn have grown enormously, and the amount of publicly available knowledge has increased explosively. Where you used to need serendipity to bump into the right person, in 2022 a connection request on LinkedIn is sufficient and you can virtually speak to each other within minutes, regardless of the distance.

The most beautiful collaborations are those in which organizations that traditionally do not collaborate. An example I have been working on for a year and a half is Grow with the Flow: a collaboration between the Regional Water Authorities Vallei en Veluwe and Aa en Maas, knowledge institutes Deltares and Wageningen University and Research, insurer Achmea-Agro and potato products manufacturer Lamb-Weston Meijer. In 2018, they got together with the idea of optimizing water management for the agricultural Netherlands. The main goal: to increase harvests by combating drought in a changeable climate. At the beginning of 2020, I entered the consortium on behalf of Capgemini to support the collaboration and further realize the design of the application.

Leading in my approach was the Empowering Ecosystems method. This framework consists of four phases, the sum of which increase the chances of successful collaboration if implemented correctly.

The first phase, **framing** the issue, allows the parties within the collaboration to better define the problem and to investigate who should be involved. Commitment is also recorded at this stage, because without an administrative commitment, sufficient time for collaboration can never be unlocked.

Next, one should look at the **focus** of the effort. Characteristic for this second phase is the determination of the order in which activities are included. A strategy and approach are formed, and people and resources are gathered that are necessary to implement change.

It is important to quickly achieve first results in a collaboration. **Implementation** is therefore central to the third phase. A new color or module in an application (the low hanging fruit) goes a long way to ignite energy within the parties involved. This is how I prefer to see collaboration: achieving results quickly and getting closer to the solution step by step. The agile way of working fits perfectly into this, so this idea is often introduced quickly. More importantly, the agile way of working ensures results.

The fourth phase of the model focuses on **sustaining** the collaboration. In addition to making results measurable, we can also safeguard knowledge and continue to remove obstacles during the project period. Sometimes, we may need to revert to an earlier phase, for example to re-establish commitment when a partner joins the consortium, or if there is a major change in the scope of the project.

Grow with the Flow is not the only project we have applied the Empowering Ecosystems to. We also applied the framework in promoting collaboration within the criminal justice chain, within the European Cybersecurity domain and within the realization of Smart City projects in the Netherlands.

The fact that the demand for these types of management methodologies has increased is partly due to COVID-19. A walk to your coffee machine at home will not result in a valuable impromptu meeting, except perhaps one with your pet. And as you have to make more of an effort to meet valuable new people, why not search for collaborations across the boundaries of organizations? But when collaborations are not formally established anywhere and it is not possible to steer on (interim) results, the speed of action can quickly decrease. The energy flows away and what remains is a 'cold case'.

To give these projects new energy, Capgemini can fill the role of a temporary outboard engine. A role in which we support the direction and clearly explain the perspectives of the collaborative partners. A role in which we think about how everyone can get the most out of the collaboration. This describes the new era of ecosystem thinking; achieve more, by getting the right people to work on your problem faster. Achieve more, by sharing knowledge faster and stepping towards strangers earlier than before. And finally, achieve more, by thinking bigger. Technology is no longer the limiting factor.

Box 1: History of collaborations

Collaborations between governments and the private sector have been around for many years. In the 1980s, the coalition agreement for the Lubbers II cabinet already stated that "new forms of public and private cooperation (PPP) are being set up, with the municipal government, local or regional business and, if necessary, the central government, aimed at increasing the volume of investment for urban renewal, among other things". Major social problems could be solved by combining the best of both worlds: vision and policymaking from the government and the speed of innovation in, and perseverance of the business community.

FIVE REASONS WHY VERTICAL FARMS WILL SKYROCKET POST-COVID

By Luc Baardman

The idea of vertical farms has been around for quite a few years. Spurred by technological advancements in construction, agriculture, and technology, it approaches the market adaptation point. But will we see the ubiquitous arrival of food-producing towers on our cities' skylines post- COVID? Here are five reasons the global pandemic may be give birth to mass-adoption of vertical farming.

A brief history. The Hanging Gardens of Babylon were perhaps the first example of vertical farming. Using a unique aquaponic system that relies on the capillary action within plants and trees, Babylonians were able to create a garden towering into the sky, rich in biodiversity and abundantly producing food. The garden fed the entire city of Babylon, which with its population of 200,000, was the equivalent of a modern megacity. Will the megacities of today also seek salvation in modern hanging gardens?

Let's describe a vertical farm. Surely as the name suggests its orientation is vertical, stacked, instead of horizontal. It's also a farm, meaning plants, seeds, nuts, or livestock are the products that are sold at the end of the line. But contrary to traditional farms, vertical farms are sheltered from the elements in controlled indoor environments. The stacked arrangement furthermore blocks direct sunlight to reach all plants, so in vertical farms you will also see LED armatures shining bright pink colors. Why pink? Pink (or red and blue combined) is the part plants use for photosynthesis. They reflect green (hence their colors). Not having to emit green light also decreases the energy usage. In most current vertical farms, only a few crops are harvested. Economic factors limit the set of crops to small crops, crops that are prolific in reproduction or crops that grow quickly. Compatible crops are leafy greens, microgreens, herbs, tomatoes, mushrooms, or strawberries due to their high return per kilogram.

Vertical farms have lots of potential. And we expect they will soon start popping up all over the globe. Below, we present five reasons why we believe the era of the vertical farm has begun.

Vertical farms are typically associated with cities. Cities have limited space, and a higher price per square meter; vertical farms are a perfect fit. Megacities especially could represent an interesting business case, with a huge population that vertical farms could sell their produce to. And the number of megacities across the globe is growing. In 2018, the planet numbered 33 megacities; by 2030, there will be 43[1]. Megacities consume large amounts of fresh water otherwise used by traditional agriculture. This increases the need for smarter farming. Vertical farms provide an answer since they require 70–95% less water.[2] Plus, vertical farms don't require large acreages of soil. The sprawl of megacities, then, is the first reason we will start to see more vertical farms this year.

Advancements in construction and armatures provide a second reason why vertical farms will soon become a reality. As companies start developing more cost-efficient methods to build sustainably, vertical farms will profit from lower startup costs post-COVID. The modular design of many vertical farms means the cost of construction per unit can be low and scaling up or down can be done at lower cost. In contrast to traditional farms, vertical farms are quite mobile; they can be implemented as a temporary function for vacant inner-city buildings. In addition to construction, improvements in smart farming practices allow urban farming at greater efficiency with the development of smart climate. Vertical farms use no soil, little water (compared to traditional agricultural practices), and a combination of natural and artificial lighting. With companies such as Signify and Valoya continuing to develop better lighting solutions, the costs of running a vertical farm will also decrease.

Improvements in IT will also make it possible for vertical farms to start appearing on the landscape. Monitoring crops creates a huge amount of data. For instance, Aero Farms generates 130,000 data points every harvest. With the analysis of this data, harvesting can be optimized, increasing profits for vertical farms, and minimizing fertilizer runoff - a big problem in traditional agriculture. With the rise of 5G connectivity, (vertical) farms can enjoy greater precision of robots with lower latency, resulting in fewer diseases on the fields and in the labs and better-quality yields.[4]

The global pandemic has made us aware of how heavily we depend on international trade. In Western Europe, our climate is not suitable for growing avocados, but with the right indoor conditions, we can grow all year around. Through less import, we minimize the spread of viruses. Growing food on our doorsteps also provides a great opportunity for children to learn how their food grows – systematically eroding the consumerist mindset that's currently implanted at an early age. This is also beneficial for the planet, as we'll see in the final reason.

There's no way around it: we are facing a global climate crisis. Temperature and sea levels are rising, and weather patterns will increasingly display more extremes. The population is constantly growing, meaning more mouths need to be fed. As the agricultural sector grows to meet this rising demand, agricultural emissions are expected to increase by 15-20% in 2050 compared to 2019[5]. And what to think of emissions we could avoid by growing our food locally instead of halfway across the planet? Perishable fruits and vegetables which nowadays are imported by air account for a whopping 11% of carbon emissions[6]. Vertical farms will have the capacity to capture greenhouse gasses as they, in essence, are greenhouses (meaning harmful emissions will remain indoors and can be captured with filtering technologies.[7]

In summary:

Whether it is through a growing market demand in the emergence of new megacities (1), cheaper construction and modular designs (2), greater control and understanding of plant growth through better IT systems (3), becoming less dependent on international trade (4) or for the love of the planet (5); vertical farms may soon be dominating our skylines. This green promise of vertical farms is potentially our only viable alternative, as indoors is the one place where we can control the climate. Almost nine years after the artist's impression on these pages, emerging vertical farms may become a post-COVID reality.

Above: Rotterdam's skyline enriched by a vertical farm, artist impression.

Above: fresh fruit, vegetable and spices for millions of Chinese megacity inhabitants made possible through vertical farming, artist impression.

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WHY IS DATA-DRIVEN INSIGHT IN AQUACULTURE NEEDED TO BUILD TRUST IN CONSUMERS, SHAREHOLDERS AND REGULATORS?

By Gunnulf Rasmussen & Hans de Man

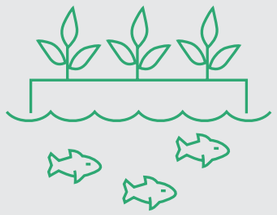
Increased demand for food calls for new, sustainable sources

The world population will increase by two billion to 9,7 billion in 2050. Land based farming will not be sufficient to feed the increased population. The ocean may fill this gap, but overfishing is already a well-known problem. Aquaculture, if regulated effectively and done sustainably, may come to the rescue. The supply of farmed Atlantic salmon has increased by more than 500 % since 1995. According to researchers at Kontali Analyse, the yearly growth rate of 6% for the last decade will shrink to 4% for 2020-2025 due to biological boundaries. The industry needs new technology and new areas of production to accelerate growth. We will see land-based production using recirculating aquaculture systems, RAS, and offshore production of salmon. These are large industrial projects built from scratch that can benefit from Industry 5.0; the use of highly automated systems supported by data capture from sensors, big data, advanced algorithms, and the use of Artificial Intelligence.

According to researchers at Kontali Analyse, the yearly growth rate of 6% for the last decade will shrink to 4% for 2020-2025 due to biological boundaries.

Environmental risk equals investment risk

Investors funding these initiatives will carefully examine the risk position and compare it to the expected financial outcome. For example, Larry Fink, the CEO of Blackrock, stated in his famous letter in January 2020 that environmental risk equals investment risk. Large corporations, professionals in handling investor relations, picked up the message immediately. As a result, they accelerated their existing momentum in sustainability. However, some clouds are on the horizon, despite unrivaled farming metrics regarding feed conversion ratio, historically high profitability, and high returns on investments. For example, intensive aquacultures face trouble with lice and diseases, leading to relatively high mortality. These kinds of challenges threaten both the financial and the sustainable part of the equation



Transparency is the key to consumer trust

During the pandemic, salmon producers successfully extended their market share of the regular dinner table, as the restaurant and catering market plunged. We, as consumers, face the moment of truth when deciding what to choose at the fridge counter in the supermarket. Modern aquaculture faces resistance from ESGactivists (Environmental, Social and Governance). The Netflix documentary-style Seaspiracy movie from 2021 questions the exploitation of the ocean, pushing viewers to avoid animal-based protein and turn to a plant-based diet. The film received a lot of criticism, as some found it speculative. Kate Winslet, the famous actor, produced and narrated “Eating our way to extinction.” The film describes the problem of climate change, urging spectators to move away from fish and animal protein. Increased transparency is the key to trust from investors, consumers and regulators.

Sources:

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Sustainability in aquaculture – and how to describe it

he salmon farmers and their Boards of Directors have over recent years adopted the strong message of sustainability. Sustainability in aquaculture consists of many elements. Among them are:

- Feed origin and food safety
- Environmental issues like carbon footprint, escapes, and pollution of water and seabed
- Fish health and mortality
- The usage of natural resources, like fresh water and electricity

The industry has recently turned to acknowledged institutions for setting up and documenting their effort and progress regarding sustainability. Among them are:

FAIRR, Farm Animal Investment Risk and Return, an investor network to assess the ESG risk before making investments.

The Scientific Based Target initiative, **SBTi**, invites companies to declare their sustainability targets and provide mechanisms to report and audit figures accordingly.

The Global Reporting Initiative, **GRI**, is a sustainability reporting standard supported by the United Nations Environment Program. It is the environmental cousin to financial reporting standards like GAAP and IFRS, harmonizing rules and principles to assess sustainability independent of industries.

Major salmon producers adhere to these third-party verifications to build awareness and keep their management and Board of Directors accountable for the promises made.

Integrated reporting replaces the annual financial report

ntegrated reporting encompasses sustainability/ESG reporting alongside traditional financial reporting. Salmon producers know that strict transparency and adherence to sustainability goals are fundamental to attracting investors and providing peace of mind to sustainability aware consumers. Accurate and verifiable insight is also necessary to gain approval from regulators for the extension of areas of production.

Benchmarking with data to believe in

Key Performance Indicators for sustainability allow for benchmarking between peers. However, these numbers may be hard to deduct from a variety of data sources. Thus, as with any trustworthy creation of insight, data lineage is vital. This central element of data analytics describes where the data comes from, what happens to it, and where it moves over time. Unfortunately, building the data platform used for data-driven insight and decisions can be a challenging task. As an alternative, manual work will be highly time consuming, introduce lag and errors and break the promise of data lineage.

Creating insight from data is the entry point for companies like Capgemini that combine their strong background in ERP with skills in Insight & Data, augmented with data collection through sensors and control systems.

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REGERNATIVE AGRICULTURE FOR FASHION

By Tushar Agarwal

The fashion industry loves to find buzzwords, driven by culturally significant aspects. Just like in politics, where politicians tend to lean towards the favorable ideology from the general masses, fashion industry to seems to follow a similar trend – if it is culturally accepted, it is worn. Sustainable farming for materials has fast become the new culturally hip prospect of the fashion industry – if the cotton was farmed in a regenerative fashion, it is going to be more highly regarded. However, the question remains: "Are we on the right path towards regenerative farming?"

Regenerative Farming

To start, let's first discuss what regenerative farming is. A possible definition could be: "The act of conserving and rehabilitation of nature, after is it has been used towards the growth of crops." As an analogy: regenerative farming is yoga for farms and agriculture. We have learnt over the years that the topsoil of the earth has been eroded of its nutrients through over-utilization, and human-led degenerative practices to grow more and more, to fulfill ever-increasing demand. This has led to unfavorable situations in countries that largely depend on farming as their main source of GDP.

The regenerative practice allows the farmers to rehabilitate their land, thereby increasing the futuristic value of said lands, and reduce global impact on topsoil quality. The idea behind regenerative farming is that farmers let nature decide how it wants to progress, and thus work with nature, instead of trying to control it. Farmers mix different crops, (similar to crop rotation but in this case simultaneously) and thereby nourish the soil, and the microorganisms in the soil, to help maintain a higher level of ecosystem quality. Farms also experiment successfully with chickens, cattle, sheep and pigs, who roam about freely, in an effort to balance the ecosystem even further. Jute, cotton and wool are increasingly used (and grown) as premium materials for the fashion industry, as fabrics for shirts, pants, suits and even for handbags.

Turmoil in the fashion industry

There is an increasing number of books and articles, speakers, and farmers taking a stance against "non-regenerative" acts of farming. These have been primarily focused on the way food crops have been grown thus far. However, over the last couple of years, a new faction has joined the fight: the fashion industry. In 2021, companies such as Merino Wool, Allbirds and Icebreaker joined forces to form a regenerative wool platform. Kering, the holding behind luxury brands such as Gucci and Saint Laurent, cofounded the Regenerative Fund for Nature, to preserve a million hectares of land producing raw materials for fashion from regular farmland[1].

This sounds promising in the light of global warming reduction, and improving our ecosystem, but has regenerative farming for fashion also benefited the farmer? Another question one may ask is, does regenerative farming benefit the fashion industry? Due to the general masses' lack of insight into the quality, durability and looks of regenerative clothing, they mostly tend to stick to traditionally produced clothes. This reduces demand, thereby increasing cost of production, further reducing purchasing power of individuals who really do want to buy a regenerative piece of clothing. This vicious cycle has not favored lesser brands, as regenerative clothing has thus far not been a sound business proposition. Production and marketing of regenerative clothing thus far is dominated by large companies such as Gucci, and Prada. However, another Western European brand has found a market segment where regeneratively grown cotton is fast becoming accepted. They are working on baby-clothing made from regeneratively grown cotton from Bangladesh.

The company, founded by two ladies, was based on the idea that baby clothing (toddlers util the ages of 5) usually do not last very long, and the toddlers outgrow their clothes quickly. By replacing traditional clothing with regenerative clothing, they try to provide an alternative for baby clothing that's a little bit more sustainable. What is special here is that the idea of buying regenerative clothes that will only be worn for a few months has gained traction; regenerative clothes for babies are becoming widely accepted. To conclude: Even though regenerative clothing is not always feasible yet, in some segments the business case is already viable – and these segments benefit the whole sector. But how about the farmers? How do they benefit from the regenerative transformation in the fashion industry?

Benefits for farmers

For starters, the farmers are liberated to grow crops the way they want to. As such, they decide how much raw material can be grown, rather than being told how much raw material they need to deliver. Initiatives and funds from larger brands have created a win-win situation. These financial enablers can help farmers with funds, ensuring capital during tough times such as droughts. In return, such enablers gain certain bragging rights that allow them to show to the world their increasing sustainability. The fashion industry is responsible for 4-7% of all global emissions; a higher percentage than that of the combined economies of France, Germany, and the UK. It is also the second biggest consumer of water.

The UN has started an alliance on sustainable fashion, working with social and environmental non-profits to educate and stimulate farmers to change their practices towards cotton farming and other crops for the fashion industry. In a hypothetical scenario, if all cotton and jute, and wool, and other raw materials could be produced regeneratively, then all of the fashion industry would become a little more sustainable.

Sustainable fashion

We must however keep in mind that such transitions from conventional to regenerative farming are expensive and time consuming[2]. Adaption at the farm level and at the consumer level requires care and attention. Priority needs to be given to a transition model that can solve the sustainability puzzle for the fashion industry. The real question, however, remains: how can regenerative farming, and the concept of "buy better, wear longer", help change consumerism? Will sustainable fashion replace fast fashion?

1 www.nytimes.com/2021/04/20/stule/fashion-regenerative-farming.html
2 IRA report 2020-2021.
3 www.greenbiz.com/article/regenerative-agriculture-wont-solve-fashion-industrys-pollution-problems

QBITS AGAINST HUNGER

Three business cases for the agricultural sector based on further development of quantum technology

By Julian van Velzen and Luc Baardman

Forget drones, dashboards or autonomous machinery you have read about in other articles for a moment. What will really disrupt the industry will be a technology that will give humanity access to unmatched computing power and ultra-precise measuring capabilities: Quantum Technology. By leveraging quantum physics, scientists are designing the tools that can solve problems classical computers would never be able to. In this article, we dive into the quantum realm to demonstrate its potential for solving real world problems that the agricultural value chain faces today. Soon, we'll have unmatched computing power and ultra-precision sensoring at our finger tips; what are some of the practical use cases in the agricultural sector?

A short history of Quantum Technology

Since the early 1900s, physicists such as Max Planck, Albert Einstein and Niels Bohr have explored the behavior of particles at the atomic scale and discovered strange behavior that defied the logic of large-scale physics. Whilst scientists got comfortable with the idea that everything can be expressed in terms of chance rather than absolute zero or one (something either exists or doesn't exist), others invented groundbreaking technology as the transistor, solid state lighting, lasers and GPS technology based on the first scientific insights from the first quantum revolution.

Fast forward to 2023, and we find ourselves at the dawn of a second revolution in quantum technology. IBM and Google, two quantum frontrunners, believe that Quantum Computers will have evolved sufficiently to solve real world problems by 2030[1]. Quantum technologies will likely once again revolutionize sectors and industries. Yet how exactly the developments will unfold is still very much uncertain.

Why the agricultural sector needs a revolution is evident. The earth's population will continue to grow to 10 billion, under increasingly unfavorable conditions. We're witnessing wholesale climate change, potential water supply shortages and a potentially catastrophic loss of biodiversity. Although technological advancements since the first industrial revolution are the very reasons these challenges now exist, technology is at the same time our best bet in solving the challenges ahead. We highlight three of the many business promises for quantum technology in the agricultural sector.

A disclaimer should be made: the second wave quantum technology is at the time of writing not viable for mass adoption and the question is whether humanity will ever progress to this stage. However, numerous recent breakthroughs look promising, and venture capitalists, hyperscalers, and startups seem to be racing to bring a ‘quantum advantage’ (the moment when quantum computers bring value for an industry relevant use case).

Unmatched computing power for complex model calculations

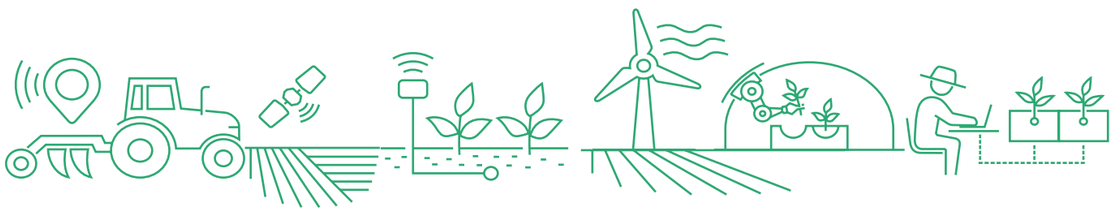
In recent years, classical computers have helped farmers to optimize farmland management through information access, model predictions and dashboards. However, current day computers face a big constraint: the increase in computing power of current day systems has slowed in the past years and is expected to stop entirely. Previous innovation in computing power resulted from the miniaturization of transistors; however, as we reach the physical limits to how small we can make transistors, it is no longer economically feasible to further reduce in size. There’s simply no more space. This ‘end of Moore’s law’ means that compute systems won’t continue to improve at the pace they once did. To compute large stochastic models in the future, with growing complexities, we need new computers with much bigger computing power. In other words, we need a ‘quantum leap that traditional, transistor-based computers won’t be able to provide. To accurately compute farming scenario’s that account for the impact of environmental change on crop health, farmers require quantum computers.

Precision agriculture at the quantum scale

For ages we have been monitoring our fields with sensors that until recently were mostly analogue in nature. The first early day thermometers and barometers sensed temperature and pressure and indicated the changing of weather to farmers. Improvements in sensors would over time further increase the understanding of characteristics of the land. With current day sensors, farmers can already see concentrations of plant stress per square meter or see where fertilizers need to be applied. Future sensors will, however, make it possible to scan each individual plant and determine what the plant needs for optimal growth. Quantum sensing and measurement will furthermore allow the mapping of invisible underground processes, including minuscule differences in soil types and water resources based on differences in observed gravity[2].

Fertilizer production at room temperature

Synthesizing chemicals such as fertilizers at scale will be a promising business case for quantum technology. Currently, producing fertilizers requires huge amounts of energy, often still retrieved from non-renewable sources such as coal, oil and gas. It is estimated that around 1,8% of all energy usage on earth is needed to produce the key ingredient to fertilizers, ammonia. Because of the energy required, this process also emits 500 million metric tons of $CO2^3$ annually (also 1,8% of the global total emissions CO2). With Quantum Technology, scientists are optimistic that it is possible to produce new types of catalysts, inspired by naturally occurring enzymes. Enzymes are natural catalysts that can convert products at room temperature and at outdoor atmospheric pressures. Calculating how to make enzyme structures is a complex challenge as there are many angles in which the long molecules that enzymes are can be formed and folded. To produce nitrogen, scientists are working on the enzyme nitrogenase.



Implications to current value chains

Fresh produce today is travelling around the globe at a high level of efficiency. International trade is growing; while in 1986 only 9% of food produced was traded internationally, that number rose to 13% in 2011[4] . A big defect in this system is its poor route optimization causing 44% of fresh produce never reaching the plate[5]. Due to constraints in computing power, global value chain players often compute an acceptably efficient route, not necessarily the most efficient route. In science, this is called the 'travelling salesman problem' and classical computers have a hard time computing the most optimal routes within a transport system. Once we can assign perishable produce to optimal transport routes, losses can be prevented, and a consistent quality can be provided to customers while minimizing losses and limiting food miles.

A new dawn

There are thousands of business-cases yet to be discovered. Modern-day farming, mostly run by big machinery and a large number of fertilizers, may be replaced by controlled environments in which food is grown with super precision. The modern-day crops we know now may have vastly different shapes, tastes, and nutritional values through more efficient computation of seed breeding. We may no longer have to produce food far from the location it will be consumed.

The second quantum revolution is unfolding worldwide, revolutionizing science, industry, and society. It will create new commercial opportunities addressing global challenges and will find its purpose in the agricultural value chain. We must nurture this technology now and hope that one day, we will be able to reap the benefits from quantum technology for a sustainable future for mankind.

The second quantum revolution is unfolding worldwide, revolutionizing science, industry, and society. society.

1 https://fortune.com/2020/09/15/ibm-quantum-computer-1-million-qubits-by-2030/
2 https://www.livemint.com/technology/tech-news/google-says-it-will-build-a-commercial-quantum-computer-before-2030-11621363226405.html
3 https://www.nfuonline.com/nfu-online/news/the-future-of-food-2040/
4 https://royalsociety.org/-/media/policy/projects/green-ammonia/green-ammonia-policy-briefing.pdf
5 https://www.metabolic.nl/publication/global-food-system-an-analysis/

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Luc works at Capgemini Invent on projects in which he searches for the common denominator in achieving profit for every party in every collaboration. Luc applies Capgemini's method of Empowering Ecosystems in agricultural themes, primarily around the sustainable use of water. Next to that, he leads the business development for Project FARM.

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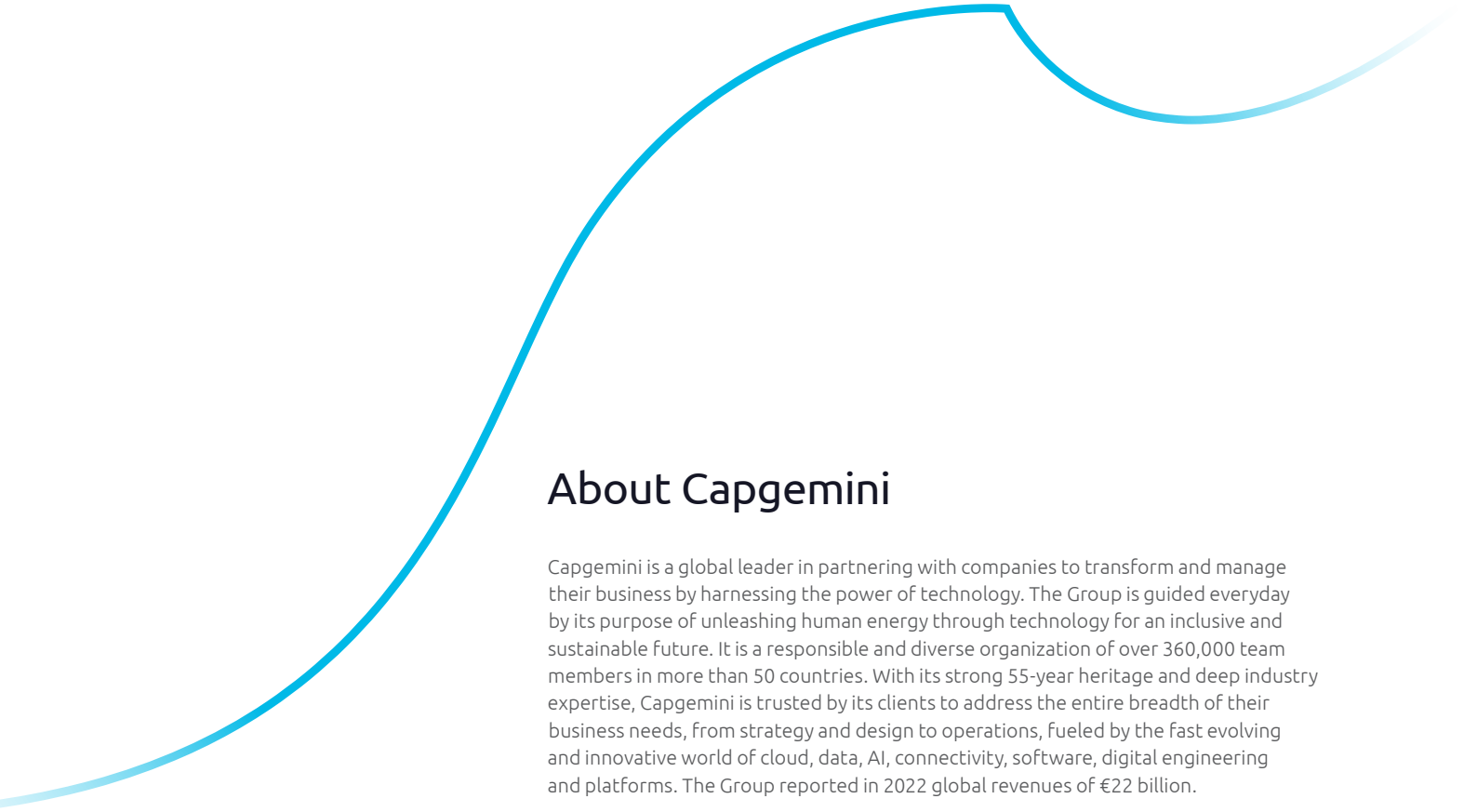
Julian van Velzen is CTIO & Head of Capgemini's Quantum Lab: a global network of quantum experts, partners, and facilities, focused on three key areas: sensing, communication and computing. From this Lab, Capgemini is exploring with its clients how to apply research and build demos to help solve business and societal problems that, up until now, have been seemingly intractable.



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