



Sustainable Land Use





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The extensive demands on natural resources, and the interactions between land use and ecosystems services make the agriculture, food and natural resources sector complex in terms of sustainability. With the impact of climate change, there is a need to build resilience into food and forest supply chains, and, at the same time, drive transparency and traceability. There is a need for a coordinated approach that addresses externalities and efficiency across the value chain.

Climate-KIC's Sustainable Land Use theme supports approaches that decarbonise agriculture, making it more efficient and productive. We foster innovation in the bio-economy that builds resilience into global food and forest value chains. We promote integrated, sustainable land use, coalescing disparate needs through partnerships and collaboration.

Key Activities

- **Forests**

We support monitoring, restoration and management initiatives to prevent deforestation and degradation and to promote biodiversity. We support innovation that embraces the multi-functional role of forests both as carbon sinks and as natural assets in the bio-economy.

- **Agriculture and Food Production**

We promote precision, efficient and low carbon agriculture, and integrated cultivation systems that maximise resources and innovate waste out of the food chain. We work to build resilience in forest and food supply through risk services, diversification tactics, and evidence-based planning and management.

- **Integrated Landscape Management**

From maintaining ecosystems services to balancing the diverse demands on natural resources, we take the approach of integrated landscape management to find common ground between sectors, rights, stakes and objectives through adaptive management and shared learning.

Climate Smart Agriculture Booster

Summary

Climate change threatens agriculture worldwide. It impacts productivity and the stability of food production. CSA Booster brings together researchers, practitioners and experts to foster and accelerate agricultural techniques and approaches that reduce greenhouse gas emissions and support adaptation, while at the same time, enhancing yields.

Key Points

- Agriculture needs to mitigate greenhouse gas emissions, adapt to climate impact and produce more to feed a growing population
- Livestock farming, energy consumption and chemical fertilisers have the most environmental impact
- Climate-smart agriculture is an approach to food production that combines technology, investment, capacity-building and policy to address these challenges
- Climate-KIC's CSA Booster has a mission to mainstream CSA – through supporting policy and frameworks, business development, capacity building and supply chain development
- CSA Booster operates in five test regions: the Netherlands, the UK, Italy, France and Switzerland
- Technologies include risk analysis, smart spatial allocation, specialised water drainage, efficient machinery and feed additives to reduce livestock methane emissions

Project Background and Drivers

Agriculture's role in climate change is two-fold. On one hand, there is an urgent need to reduce greenhouse gas emissions stemming from the sector, yet at the same time, agriculture needs to be able to cope with the impacts of climate change and have contingency plans when disaster strikes. The twinned challenges of mitigation and adaptation are set against a growing global population, exerting increased demand on the food supply. The United Nations Food and Agriculture Organisation (FAO) estimates global food production must increase by 60 percent by 2050 to keep pace.

Intensive livestock farming, grazing and depletion of soil, the disruption of the nitrogen cycle through chemical, fossil-fuel based fertilisers and energy consumption, as well as the pressure to convert wetland or forest to agricultural use, all constitute the agriculture sector's contribution to the production of global greenhouse gases. It's the EU's third-biggest contributor behind transport and energy.

The FAO (2014) estimated that between 2001 and 2010, emissions from crop and livestock added up to the equivalent of five billion metric tonnes of CO₂ annually. Emissions accounted for by deforestation averaged four billion metric tonnes each year over the same period.

Global warming is having an increasing impact on agriculture and the global food supply, too. Agriculture is a highly climate-dependent sector, and the incidence of extreme weather events, such as droughts and floods, is set to increase. Shock and disruption to food supply chains can reverberate well beyond the regions in which they occur. The 2010 heatwave that crippled Russia's wheat output led to a 16 percent rise in the commodity price in Pakistan, which was, in turn, responsible for a 1.6 percent rise in the level of poverty there, according to Oxfam. Increasing temperatures suggest this volatility, which will hurt the incomes of farmers as well as consumers, will only worsen in future.





Climate smart agriculture (CSA) describes an approach to food production that combines technology, investment, capacity-building and policy to address these challenges. It builds resilience into food production systems and reduces the agricultural sector's greenhouse gas emissions, while promoting productivity and output – sustainably. While there are many technologies and approaches that support CSA, mainstreaming it requires awareness-raising, knowledge exchange, implementation frameworks and processes. The successful design and implementation of CSA approaches require integration with disaster risk management strategies and actions, and social safety net programmes.

Programme

Climate-Smart Agriculture Booster, a flagship programme of Climate-KIC's Sustainable Land Use theme, has a mission to accelerate the climate-smart approach to agriculture, developing and promoting CSA technologies across Europe and beyond. It aims to reduce and sequester the equivalent of 10 million metric tonnes of CO₂ annually by 2020, implement 20 CSA systems and grow its network to 200 members.

Much of the CSA work is based around helping identify the needs of particular parts of the sector and matching these with an appropriate solution or investment. Technologies and approaches include risk analysis and risk management, resource management optimisation, smart spatial allocation, multiple constraints mitigation, specialised water drainage, efficient machinery and feed additives to reduce livestock methane emissions.

CSA Booster operates in five test regions: the Netherlands, the UK, Italy, France and Switzerland, working on all aspects of mainstreaming CSA, from impact analysis and verification to policy and frameworks, business development, capacity building and education, and supply chain development. Its main audience includes farmers and cooperatives, large agri-food corporates, technology providers, investors and the public sector.

The Consortium

The programme is driven by leading agricultural and environmental science institutions together with experts in business model development and risk analysis: Wageningen UR (Alterra and Wageningen University) (lead), CNR-IBIMET (Italy), South Pole Group (Switzerland), INRA (France) and the University of Reading (UK).

A wider network of 40 organisations includes major players from the agro-food industry, the agricultural sector, regional authorities, and technology providers. This network helps connects providers and users of CSA solutions to European networks, and provides science-based quality stamps and certification.

"We want to strengthen this knowledge exchange on an operational level," says Tilmann Silber, CSA Booster's finance lead. "Can we find a way to leverage the 5,000-plus experts in our network and get them to work on these projects? That might provide much more value than just a list of solutions."



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The Booster also plans to leverage the expertise of its partners in European policy. The thinking behind this is to identify existing national or regional support for any given project and whether or not there are subsidies available to scale up solutions.

While the programme is based in Europe, it is already working with clients whose operations are global. As the projects on the following pages describe, CSA Booster's impact on climate resilience, sustainable farming practices and emission reduction will be felt far outside Europe's borders.

Climate-KIC Support

The Climate Smart Agriculture Booster flagship programme was officially launched by Climate-KIC in early 2015. The Booster has identified more than 20 technologies and approaches ready to go to market.

What's Next?

CSA Booster's ambition is to develop into an independent and leading network organisation in climate smart agriculture in Europe by 2018, functioning as a broker between the agro-food industry, the policy forming community and CSA technology providers. Such an organisation is currently missing at the European level.

Reducing Emissions in the Dairy Supply Chain – CSA Booster

Summary

Dairy production is a significant contributor to global greenhouse gas emissions. This is a major focus for CSA Booster, which has a number of projects addressing the issue. This year, South Pole Group began a project under Climate-KIC's Climate Smart Agriculture (CSA) Booster Flagship Programme to explore how new technologies and interventions could be used to reduce emissions within the dairy supply chain of a major chocolate producer. The project will work with the firm's suppliers in markets around the world to match and pilot the best-suited technologies and practices in each context: modern feed additives, for example, can reduce methane emissions from cattle by 10 to 30 percent, while increasing milk yield at the same time. Jointly with their suppliers, the company can then scale these approaches throughout its dairy supply chain, while the knowledge gained over the project's lifetime can thereafter be applied elsewhere.

Key Points

- Dairy production is responsible for four percent of global manmade greenhouse gas emissions
- A team led by South Pole Group, funded by Climate-KIC's CSA Booster Flagship Project, is exploring ways to reduce emissions in the dairy supply chain of a major chocolate producer
- Using the CSA Booster's experience and network of experts, the project will identify and pilot technologies and practices in a handful of markets around the world
- Once these approaches are tested and fine-tuned, the company will be able to scale up its investment in emission reduction along its extensive dairy supply chain

Project Background and Drivers

The world's dairy industry accounts for around four percent of manmade greenhouse gas emissions. In 2007, the sector was responsible for emissions equivalent to almost 2 billion metric tonnes of CO₂, 93 percent of which was produced before any dairy products had left the farm gates, according to the FAO.



Even large corporations need support in getting started on projects like these. It can be about knowing where best to start directing resources for maximum impact or identifying the best methodologies.

Methane – produced by cattle's digestive systems – accounts for just over half of the greenhouse gases emitted by dairy production. Nitrogen dioxide (NO₂), a greenhouse gas 300 times more potent than CO₂, released during the application of manure, accounts for around one-third. New technologies and farming methods, including feed additives for cattle and using manure for biogas production can be deployed to bring these numbers down, and corporations with extensive supply chains have the capacity, in theory, to make sizeable dents in this sector's emissions. But those companies often lack the necessary expertise to both identify and source appropriate technologies and interventions, and to embed them in their suppliers' operations.



Project Detail

Earlier this year, global sustainability solutions provider South Pole Group began a project, co-funded by Climate-KIC's CSA Booster flagship programme, to explore methods of reducing the greenhouse gas emissions and how to implement those reductions in the global dairy supply chain of a major chocolate producer.

The company has ambitions to considerably reduce CO2 emissions along its dairy supply chain. While it has plenty of expertise when it comes to cocoa, and has for some years successfully invested resources in making its cocoa supply chain more sustainable, this, however, is relatively new territory.

"For them, climate change mitigation in dairy is a new field," says Tilmann Silber, practice leader sustainability action and water at South Pole Group and finance service lead for the CSA Booster Flagship Programme. "They are at the beginning of their journey. The CSA Booster is a great partner to support them along this journey."

Even large corporations need support in getting started on projects like these. It can be about knowing where best to start directing resources for maximum impact or identifying the best methodologies.

"Our vision is that the further we can help them understand what can be done, what the best solutions are and the impact they can achieve through this, the more investment-ready it will be for them so they can take over the programme and scale it up themselves," says Silber.



The company's dairy supply chain spans the globe, and the project team has initially selected a handful of markets around the globe that it believes are representative of the firm's operations.

Knowledge Sharing

CSA Booster can provide a range of knowledge and expertise to support the company and its suppliers in reducing supply chain emissions. To help reduce methane emissions from cattle, for example, adding lipid supplements made from linseed or cottonseed oils to their feed could be an option; these make the fermentation process within the cow's stomachs more efficient and less gassy, and can boost productivity, too.

Better animal management practices can also help. Improving herd fertility and the productive lifespan of milk cows through dietary changes and breeding techniques mean fewer livestock and less methane. Composting manure, using it for biogas production or even changing the timing of its application to fields can bring down NO2 emissions.

The project team is also looking at reducing CO2 emissions through the use of renewable energy, for example, or more efficient machinery. Deciding on which new approaches to deploy is only half the battle, however. The second, equally crucial challenge is how to integrate these into the suppliers' operations. Large corporations often operate well upstream in the supply chain, Silber explains, some distance from the producers who will have to make these adaptations.

"How should corporations influence and interact with their suppliers and move them forward?" he says. "There are different options, and they have to be customised to the context." There is a broad spectrum of approaches, from signing producers up to a new procurement policy, with conditions built in, to offering financial incentives for reducing emissions.

"And in between those approaches, there are different ways we are exploring. Are there projects that increase productivity in a sustainable way?" Silber asks. "These financial models are coming up and it's an interesting way to engage with the supply chain. It's a big field of questions, and there is a lot to learn and develop in this area."



Climate-KIC's involvement

The financial support and the expertise provided by Climate-KIC and its flagship CSA Booster programme are crucial to get projects like this off the ground. "The funding helps to de-risk the project for the company," says Silber. "We can help them with building their capacity and knowledge and help them realise their ambitions."

The Booster has much more to offer than knowledge on CSA technologies, he adds. It is also a broad network of organisations that includes some of Europe's most important research institutes, which can be leveraged as part of projects like this. "That way we can provide much more value than just a list of solutions."

What's Next?

The project is two months old, and the team is doing some preliminary scoping. "After that we will elect the technologies, engage with the suppliers and start piloting," says Silber. After that, the company should be ready to start implementing and scaling up these interventions in the second half of 2017. But it's not just this chocolate producer that will ultimately benefit from the project's findings.

"The knowledge we are building up on this project is global," says Silber. "This is a good thing for CSA Booster, too – we cannot of course use this company's commercial secrets, but we can use the understanding we are building up here on other projects."

Climate Impacts on Sugar – CSA Booster

Summary

Climate change is increasing the risk of disruption to global food supply chains. A warming climate is likely to increase extreme weather events, such as floods and droughts, according to the Intergovernmental Panel on Climate Change (IPCC). These shocks can be detrimental to supply and price as well as the livelihoods of producers. In a piece of research funded by Climate-KIC's Climate Smart Agriculture (CSA) Booster Flagship Programme, climate fintech firm Carbon Delta and the Potsdam Institute for Climate Impact Research are using crop yield data and weather modelling to quantify the risks posed by climate change to specific parts of the supply chain of a major chocolate producer. This is one of a number of CSA Booster projects addressing issues in the food supply chain.

Key Points

- The risks to food supply chains posed by climate change are increasing
- Their impact can have a knock-on effect
- The Potsdam Institute for Climate Impact Research, together with Carbon Delta, is investigating climate change risks to the sugar and coconut supply chain of a major chocolate producer
- The company plans to use the research to mitigate against these risks in future
- This will benefit more than just the firm's bottom line: it will help ensure the land on which these commodities are grown is farmed more sustainably

Project Background and Drivers

Climate change impacts pose an increasing set of risks to food supply chains. Being able to quantify these risks before they materialise means businesses can take measures to protect themselves and their suppliers rather than simply respond to events. While you can't stop flooding or heatwaves from happening, the best way to mitigate their effects is to literally start from the ground up.

Educating small-scale producers about these risks, and giving them the knowledge and tools with which to better farm their land, plays a large part in this mitigation. That's good news for businesses and good news for the farmers whose incomes depend on the quantities they are able to produce. It can also strengthen food security and reduce pressure on global food production when disaster strikes.

Project Detail

Carbon Delta is a financial technology firm based in Zürich that analyses and evaluates the climate resilience of companies and their assets.

While climate change is acknowledged as a major global risk, most companies and research organisations are still not prepared, even though the capabilities exist to make risk calculations, says David Lunsford, Carbon Delta's head of development and co-founder. "We have developed a quantitative model that helps companies and banks understand what risks they could be confronted with over the next 15 years."





Earlier this year, Carbon Delta together with the Potsdam Institute for Climate Impact Research, began a project to examine parts of the supply chain of one of the world's biggest chocolate producers. "We are examining and calculating the risk that the company has in terms of climate change in their supply of key ingredients like sugar and coconut," Lunsford explains. "The firm understands the risk for cocoa very well, but they recognise there are obviously other risks in their agricultural commodities and they want to establish the full risk picture."

Using Crop Yield Data

The chocolate company has provided the project team with crop yield data from its coconut and sugar producers over the past eight years. "We need to know as much detail as possible," says Lunsford. "The modelling we do is very detailed – a 20km by 20km square matrix – so we need to learn where the farms are located in those countries and how much demand there is in these regions."

That data is currently being integrated into the Potsdam Institute's agricultural climate models. The team hopes to be able to start running its model within the next couple of months, at which point Carbon Delta will begin to identify the most significant climate change risks to these parts of the company's supply chain – from risks to the farms themselves to the greenhouse gas emissions caused by sugar processing plants higher up in the supply chain. The study will also propose ways to mitigate against those risks, from sustainable farming methods to the use of more efficient processing equipment.

Most companies don't respond to climate change risk until after it has had an economic impact, Lunsford says. "If there is a big drought or flood then crops can be wiped out for a season. But if you can predict these events before they happen, it's a whole new perspective on crop-planning and agricultural engagement with farmers," he explains. "Understanding the long-term trend of a country or region being put under pressure by

drought or flooding means you can really understand and manage your supply chain risk rather than simply respond to problems."

These problems can be huge. In the summer of 2010, Russia's wheat crops incurred a loss of 59 percent of its estimated economic value due to a heat wave. A loss of approximately €4.13 billion was incurred by Russian farmers.

A big contributor to mitigating against these risks will involve educating the suppliers. It's a win/win for both the buyer and the grower. The former can smooth out risks and any volatility in its supply chain caused by climate-related factors, while the growers' income is similarly protected.

"If you educate farmers about how to enhance nutrients in their soil, for example, then a small decrease in the water supply may not have such an impact on the growth of crops," says Lunsford. "There are also better tillage methods they can implement, and there are fertilisers you can use to help protect your agriculture."

There is a social benefit here, too. Sugar cane farmers in the developing world live on low incomes, and as such are vulnerable to even small hits to the quantities they are able to sell. Improved land stewardship and better farming practices can help maintain their livelihoods.

Elsewhere in the supply chain, meanwhile, levels of greenhouse gas emissions – for sugar processing plants, for example – pose another climate risk. The study will also look at whether cleaner production processes can be implemented in those regions.



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Climate-KIC Support

Carbon Delta and the Potsdam Institute formulated the project in the first instance and submitted it to Climate-KIC's CSA Booster Flagship programme in response to a call for proposals in August 2016. It's a one-year project, due for completion in summer 2017. Carbon Delta's participation in the programme has brought more benefits than just the funding, Lunsford says.

"One of the really nice things Climate-KIC does, at least for the CSA Booster, is they have meetings every three or six months and you get to sit with other participants and hear about each other's projects," he says. "They do a good job in keeping everyone focused and creating an atmosphere where people doing research on agricultural issues and climate change can learn from each other."

What's Next?

Currently, the team is working the data into the Potsdam Institute's agricultural model. It hopes to have the model up and running within the next couple of months, after which the partners can start to identify risks in the client's sugar and coconut supply chains.

The project will finish around summertime next year, but its implications could be felt for a long time after that. "We are delivering a very valuable piece of research that will inform decision-making and will be the basis for further action in the future," Lunsford says. "We are modelling out to 50 years into future. This would give the company foresight for quite a long time."

Landmapp

Summary

Netherlands-based start-up Landmapp has developed a mobile platform that enables farmers in the developing world to map the boundaries of their smallholding and to obtain legal documentation of their land rights. Landmapp also builds data profiles of each farm, which it can then use to broker targeted services for those smallholders.

Key Points

- Around 70 percent of the world's land is not legally registered
- Secure land tenure mitigates against deforestation, which is a major contributor to greenhouse gas emissions after burning fossil fuels and can help reduce pressure on ecosystems and biodiversity
- Many of the world's 525 million rural smallholders hold no legal rights to the land they farm
- This can leave them unable to access finance with which to improve their productivity
- Landmapp is a Dutch start-up that has developed a mobile app with which rural farmers can map the boundaries of their land and secure legal documentation of their land rights
- The company was part of the 2015 intake into Climate-KIC's Dutch Accelerator programme
- Landmapp is now operational in Ghana, where it has already provided legal land tenure documentation to more than 1,500 farmers

Project Background and Drivers

Deforestation is responsible for 15 percent of global greenhouse gas emissions – the second-largest contributor after burning fossil fuels, according to the World Wildlife Fund. The CGIAR Research Programme on Climate Change, Food and Security has suggested that this issue can be tackled quite literally from the ground up: that providing security of tenure to rural smallholders helps prevent deforestation.

Only around 30 percent of the world's land is legally registered, however, and many of the world's 525 million rural smallholders have no provable legal rights to the land they farm. Security of tenure does more than curb the destruction of forests. A legal document proving land tenure can help protect a smallholder's livelihood. It can also be used as collateral, enabling farmers to access financial and other services and so increasing the productivity of their land. This, in turn, helps alleviate the pressure on ecosystems and biodiversity caused by the growing global demand for food.

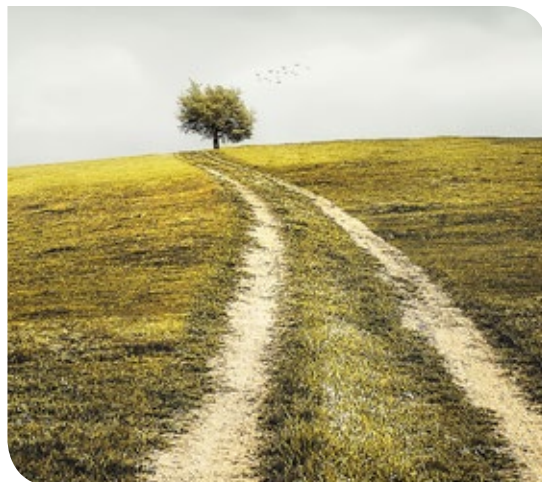
Project Detail

Securing that legal documentation, however, can be a costly and complex process. Landmapp, a start-up based in the Netherlands, has developed a platform that both simplifies the process and vastly reduces the cost to smallholders.

The system is based on a mobile app that enables users to map the boundaries of their farm simply by walking them. This data is then verified by the farmer's neighbours, before Landmapp submits it to the relevant local and government authorities. In Ghana this includes the Ghana Land Commission as well as local chiefs – who then validate and sign the documentation, which Landmapp delivers into the farmers' hands.

"These people have more assets than most of us in the Netherlands – a big piece of land – but because it's not documented it is not possible to collateralise or protect it," says Thomas Vaassen, Landmapp's co-founder and chief technical officer. "It's a big obstacle for them to access services to grow and improve their farms. And it's proven that you can quite easily double or triple yields with quite simple inputs such as fertilisers, improved practices and training. Land tenure plays a big role in un-locking that. Through those improvements, the land area needed for food production would be much less, which means the pressure on ecosystems and deforestation rates would be mitigated."

Earlier this year, Vaassen moved to Ghana to launch the firm's operation there. Already Landmapp's 11-strong team based in the country's capital, Accra, has delivered land rights documentation to 1,500 smallholders in the country's Western, Eastern and Ashanti regions. And, with Ghana's harvest season about to start, the firm hopes to sell its services to thousands more farmers in the coming months.



"The first year has been about proving that these people can pay up to €100 for these documents," Vaassen says. That's a lot of money to the average Ghanaian smallholder – one or two months' income, in many cases – but it's a worthwhile price for what the documents represent. "At least in Ghana, people are really hungry [for this service]," says Vaassen. "It makes a lot of sense to these people; it is an actual risk, so they are willing to pay."

As well as mapping farm boundaries, Landmapp also gathers geographical and agricultural information on each smallholding, creating a complete and accurate data profile of each property. The company plans to use these profiles to broker more efficient, better targeted solar energy, credit or agricultural services to farmers.

"We can work with rural banks in the area, or we can work with agricultural input providers to get them the right amount of fertiliser at the right point in time at the right price," explains Vaassen. "And we could work with solar companies to identify which houses would benefit from a solar panel and what is the repayment based on data we collect, for example."

Climate-KIC Support

Landmapp was part of the Climate-KIC Accelerator programme's December 2014 intake in the Netherlands. As well as seed funding, the Accelerator provides start-ups with business support, mentoring and masterclasses, as well as access to its network of experts and partners.

Vaassen describes the experience of being part of the Accelerator programme positively – as akin to having Landmapp's ideas put through a meat grinder. "It's about structuring and straightening your idea," he says.

"To take it from an idea to a business model, you need to speak to a lot of people and experts in the industry, and you need to test and experiment to find out whether your assumptions hold up.

"In that process, we were really pushed to speak to hundreds of people, to get out there and do a proper pilot with our customers, and to present it well and pitch it every two weeks. In the beginning, maybe you shoot ten holes in your idea; at the end you might shoot two or three holes. You have some answers."

Since completing the Accelerator programme, Vaassen says his mentors have kept in touch, especially to update Landmapp's team on any opportunities that have come up. "Just this week we had the chance to meet with [ex-US vice president] Al Gore in the Netherlands, and that was arranged through Climate-KIC," he says.

What's Next?

In June, Landmapp secured €240,000 in funding from investors, and is currently in what Vaassen describes as the final stages of securing a first round of private investment. The company hopes to conclude the due diligence process and secure backing from a US venture capital provider. The team is now looking beyond Ghana. Following a successful pilot last year in which the plots of 108 cocoa-growing smallholders were mapped and documented, Landmapp is in the process of setting up operations in Indonesia.



A legal document can help prove a smallholder's land tenure and protect their livelihood.





nextProtein

Summary

nextProtein is a producer of proteins and feed commodities, derived from sustainable insect cultivation. This French-Tunisian start-up is developing large scale technology to raise beneficial insects fed on organic waste collected from local food distributors and agricultural residues. The bioconversion process generates valuable components: an insect-based protein meal for use in aquaculture, livestock and pet feed, an oil for the animal feed industry and an organic nitrogen, phosphorous and potassium (NPK) fertiliser.



150m2 of insect farming produces as much protein as 150 ha of soy field.

Key Points

- The global demand for meat, and the resources needed to rear livestock, have enormous environmental impact, placing pressure on land, producing pollution and driving deforestation
- Insects need little to no water, space or energy and produce few greenhouse gas emissions
- 150m2 of insect farming produces as much protein as 150 ha of soy field
- nextProtein rears black soldier flies, producing insect-based protein meal for use in aquaculture and valuable protein components
- Climate-KIC has funded and mentored nextProtein, supporting its IP and R&D, and enhancing credibility with regional and national organisations
- nextProtein is near to closing a round of funding that will enable it to scale up industrially
- Waste recycling infrastructure and institutional frameworks are needed to accelerate this growing innovative industry



Project Background and Drivers

More people than ever across all continents are consuming greater quantities of meat. The Organisation for Economic Development (OECD) predicts that the number of people eating meat will double by 2050, entailing an unprecedented increase of the global animal feed production. This will put significant pressure on natural resources because of the fresh water, feed and land required to rear livestock over its lifetime, and the pollution associated with this farming.

Around 97 percent of global soya crops are consumed by livestock – placing pressure on forests (and ecosystems) to be converted to commodity grain production. Livestock farmers can spend up to 70 percent of their costs on commercial feed, according to the Sustainable Food Trust. The pet food market, growing annually at a compound rate of five percent, compounds matters further.

Insects represent a viable protein alternative to conventional livestock feed, radically reducing the required energy and space, and pollution produced. Crucially, they can be fed on organic waste and agricultural by-products. Interest in the potential of insects as a sustainable source of protein is growing, and research in this area is flourishing. However, the industry is far from established, and concerns about biological implications, health and safety, and the manner in which insects are fed pose the greatest barrier to industry growth.

Project Detail

nextProtein is a producer of proteins and livestock feed, derived from sustainable insect cultivation. This French-Tunisian start-up is developing large-scale technology to raise beneficial insects fed on organic waste collected from local food distributors and agricultural residues. The bioconversion process generates valuable components: an insect based protein meal for use in aquaculture, livestock and pet feed, an oil for the animal feed industry and an organic nitrogen, phosphorous and potassium (NPK) fertiliser.

The firm cultivates non-disease carrying insects including black soldier fly larvae. These multiply rapidly in the relative warmth of the North African region. They feed mainly on food waste, eating up to twice their body weight daily – almost 10 kg per m² of insects per day, according to Mohamed Gastli, nextProtein's co-founder.

"We are in the very beginning of this incredible insect industry," says Gastli. "Insects are a viable source of protein without the intense use of resources. They need little to no water, space or energy. They produce very few greenhouse gas emissions. We discovered that with 150m² of insect farming, we can produce as much protein as 150 ha of a soy field." Critically, insect farming can be done on a more local basis, while soybeans are often imported from countries experiencing deforestation and pressure on land from the protein feed commodity market.

nextProtein, with its R&D, sales and marketing arms located in France, has been developing a subsidiary production plant for cultivation, harvesting and processing the insects based in Tunisia. "The plant has several zones," says Gastli. "Inside, we have a lab, cultivation, processing and logistics. There is a zone called nextFly with cages of flies in various stages of breeding and maturity; there is a zone nextHatch where eggs hatch; and there is an area with trays of larvae eggs – nextLarvae. These feed off the food waste, which is stored in a food container area outside."

Growing the team in the past few months has been critical to getting operations going, adds Gastli. nextProtein has recruited a chemical engineer, a microbiologist, an animal nutrition specialist, two agronomists, a lab technician and waste handlers. The next step is to hire a waste supply chain manager, who will oversee sourcing, logistics and distribution – a particularly crucial role since waste recycling infrastructure in Tunisia is still in its infancy. "We're also looking for a chief industrial officer, processors and business developers."





Funding and Product Development

nextProtein is near to closing its first round of seed funding, and by the end of 2017, will be capable of producing 1 tonne per day of protein meal and oil for the aquaculture and pet food markets. The firm has sent samples to European customers in the fish feed and aquaculture sector with positive feedback, according to Gastli. The product is resonating with customers looking for stable commodity prices, and secure protein feed supplies.

“Currently fishmeal prices range from €1,500 – €2,000 per tonne, which is a worry. Customers are also concerned about fish stocks and sustainability. They want to say we are using more local, natural, organic sources, not from genetically modified soy from Latin America. The whole animal feed industry is waiting for insect start-ups to scale. They need to buy more than 5,000 tonnes a year, which means we have to grow very fast to be a viable commodity supplier. Our next step is to make an industrial pack with our product and start producing the amounts that are needed,” says Gastli.

The potential is immense, but for now, it’s an industry with infrastructure and institutional frameworks that have to be created. Like all animal breeding and food production operations, concerns centre on contamination, health, safety and tractability.

“At the moment Europe is pushing for this new industry, but the legislation and regulations around food production and farming are holding it back. There isn’t the same legislation in Africa or Asia, and that means we can access that market,” says Gastli.

“Of course, we have to address risks such as ensuring contaminants do not enter our feedstocks. A second risk is the length of developing up-to date regulations for the industry. We’re talking about insects reared on organic waste, and this means we are also recycling waste. Legislation currently only authorises specific kinds of waste – plant based waste – from particular sources. We have to really think about the supply chain, going to grocery stores, collecting agricultural waste, coffee pods or even breweries. We need to find all these and sort it. This is challenging when you’re trying to meet 200 tonnes a day in a few years,” says Gastli.



nextProtein will also develop a waste and recycling management infrastructure as there are few to no waste management companies currently in North Africa, and almost all waste goes directly to landfills. “We will have our own fleet and trucks. We can’t count on another company to do it. We have to source organic matter free from contamination or heavy metals. The idea is to create plants close to the source of organic matter, so as we develop sourcing, we will start to scale up,” Gastli explains.

Climate-KIC Support

nextProtein applied to Climate-KIC’s Accelerator programme in 2015, completing the first two phases with grants, masterclasses and mentoring to support its production plant and team development.

“We’ve had great support with the IP and R&D aspects of the business. As the first funder and supporter of this project, Climate-KIC has helped us gain recognition from the Paris regional authorities. We are now closing a new round of funding, which we hope will be close to €1 million,” says Gastli.

What’s Next?

nextProtein will now look at stepping up its production potential to gain a foothold in the pet food and aquaculture markets. The company hopes to build an industrial facility by the end of 2017 with capacity to produce more than 20 tonnes per day of insect larvae by 2020, and 1 tonne of protein and oil a day.

SimGas

Summary

SimGas produces and installs domestic biogas systems that are integrated into farms and rural households in developing countries, using livestock manure as the main input. In a country heavily reliant on wood for fuel, the aim is to make biogas systems an affordable alternative and help prevent deforestation. Slurry, a by-product of biogas production, is a high-quality fertiliser that can be used in crop cultivation.

Key Points

- Demand for wood fuel in East Africa is a major driver of deforestation, contributing to climate change, and weakening adaptation capabilities
- These issues are driving interest in energy alternatives such as biogas production
- By producing biogas from their livestock manure, smallholders can power their houses and fertilise their soil plots
- SimGas's central aim is to accelerate the adoption of biogas systems by focusing on the 10 million-strong smallholder market in rural East Africa
- The company now has 1,500 domestic customers
- Products are manufactured locally and the company employs a Kenyan and Tanzanian team
- The company is expanding with new products including biogas powered rice cookers and milk chillers
- New areas of development include remote sensing to support monitoring of the biogas systems, expanding the system to integrate with human sanitation and offering customers credit

Project Background and Drivers

There are between 5 and 10 million smallholder livestock farmers in East Africa, heavily dependent on wood as their primary energy source. This demand for wood, together with the effects of war, drought and severe climate conditions have exacerbated deforestation and degradation of land in the region. Forests are critical in preventing soil erosion and regulating the water cycle. Forest conservation is vital in preventing further vulnerability in the face of warming and climate change.

These issues are driving interest in energy alternatives such as biogas production – the production of gas from manure sources using anaerobic digestion. This breaks down organic matter into biomethane and a slurry by-product that can be used as fertiliser. By producing biogas from their livestock manure, smallholders can power their houses, fertilise their soil plots, avoid smoke inhalation that causes respiratory illnesses and prevent deforestation. Biogas systems can replace up to five tonnes of wood per person per year in Kenya and Tanzania, according to SimGas. But while this represents significant opportunity to improve sustainability and livelihoods, the high initial investment costs of biogas systems are a barrier to wider adoption.



Biogas systems can replace up to five tonnes of wood per person per year in Kenya and Tanzania.





Project Detail

Dutch company SimGas was founded by brothers Sanne and Mirik Castro in 2009. Its central aim is to accelerate the adoption of biogas systems by focusing on the domestic, smallholding market in rural East Africa.

"The background research for SimGas was that the domestic setting had the most potential," says Sanne Castro, CEO of SimGas. "There was a solid business case in that with the money saved from buying wood, the cost of a digester could be paid back within two to three years. However, despite a viable market and projects from government programmes there were no available products. The biogas plants promoted in national programmes in Tanzania and Kenya tend to be based on a brick and mortar design, meaning farms would become building sites, hindering acceleration of the system. In the end, people want to own a real product with service and guarantees," adds Castro.

The research inspired the creation of a biogas digester developed through industrial design engineering processes. The system, now manufactured locally, comprises piping and a digester, which the farmer feeds daily with manure and water. Inside the diges-

ter, micro-organisms convert the organic matter into biogas and slurry, before it is channelled to the stove, through a connection to the house. The first biogas is produced about two weeks after the manure is fed in – the time taken for the first biological matter to break down.

Castro explains: "The key to the circularity of this system is balancing the inputs and outputs. Gravity does its work with the feed and the water level. There is no pumping mechanism, it's continuous. The manure from five cows can create a lot of fertiliser. The effluent is organic but is as effective as synthetic fertilisers and enhances the carbon mass of the soil."

The latest additions to the end system include biogas powered rice cookers and a milk chiller, providing very efficient cooking and off-grid cooling for milk. He adds: "One cubic metre of biogas can cool up to 10 litres of milk per day. There is a need for storage and cooling since the distribution of milk is limited to certain times of the day (it gets dark at 6pm and roads are bad). The biogas milk chiller means it can be stored, chilled overnight and transported the next day."



Expanding the Customer Base

Setting up an international innovation business from scratch has been a challenge, but SimGas has managed to overcome the hurdles and now supports a growing local economy. Its local biogas system factory can produce up to 10,000 units per year and the workforce, including sales, distribution, installation and finance, is Kenyan and Tanzanian. “We worked really hard to get on board local investors and local banks, private individuals and those willing to invest in East Africa,” adds Castro.

The company now has 1,500 domestic customers. Getting new customers is usually done by collaborating with schools, churches or village elders. They help coordinate community events where the digester is connected to a cooking stove and tea is made. Potential customers can fill out a form of interest. Applications are assessed on the basis of how big the livestock herd is (how much manure they will produce), and how appropriate the site is. The gas stove is installed when the first down payment is made. Householders pay the cost of the digester back through a monthly plan, but they can start making savings from the first day.

Climate-KIC Support

Climate-KIC accepted SimGas to its Accelerator programme in 2012, after a thorough pitch and introduction through Climate-KIC’s partner, Yes!Delft. At the time, the priority was to find a greater level of investment to move the company on from being a start-up. Climate-KIC offered a grant, a move that helped attract major corporate shareholders by demonstrating credibility. “To get letters of recommendation from people who were recognised in industry and who could lend some credibility to a new venture – this informal support was crucial,” says Castro.

Another major line of support was masterclasses. “One in particular was a marketing masterclass, not just about segmentation but about positioning yourself as an entrepreneur to attract investment. It was about understanding where you are in relation to the rest of the innovation landscape and your competitors,” says Castro.



Others included financing. “I really enjoyed the discussion with coaches and those within Climate-KIC. There’s a high level of authority, knowledge and expertise in the field. There was always constructive feedback and sometimes that is the best thing that you can have. It really helps to sharpen your entrepreneurial mind,” says Castro.

One of the greatest lessons that Castro has learned is the unpredictability of the innovation process. “Time and again you have to rethink strategy, products, pricing, or budget. Things always work out differently to how you think they will. In the process of innovation, there are always unknown unknowns, and it’s very hard to budget for these,” says Castro.

The SimGas team has dealt with this by engaging with stakeholders and partners at all stages of the process. Managing the expectations and needs of so many partners is an art of balance. “Many organisations understand that innovation is risky. When things go unexpectedly, this ‘failure’ has to be recognised as part of the process and part of the innovation cycle. If they are involved along the way and know what’s going on, then this can help. It’s about being in touch informally as well as formally – to make them part of the process and to enable comparison to the original project plan,” Castro says.

What’s Next?

SimGas is currently making solid sales. However, a customer credit product would help customers make the initial investment and accelerate take-up. “Generally, Tanzanians spend up to a third of their salary on energy and fuel. The rest is spent on food, so it is difficult for them to make savings, or to invest in their education,” says Castro. “We are currently setting up a financing product for customers and are organising sufficient backing for this. This would be really scaling up – by providing the upfront investment customers need.”

Remote sensing is another area of development. This would enable the company to receive data back from the installed biogas digesters, providing maintenance information, which would support better customer service. “We will be able to detect leaks if they occur or can suggest service visits. It’s also about transparency of performance,” says Castro.

SimGas is also scoping out the parameters of extending the system to include sanitation. Rather than integrating with rural households, fed by livestock manure, this system would integrate with schools and other large public sites, fed by human excrement. It is currently being piloted with five schools. “We’re still assessing the safety of putting the effluent that is produced from human waste on land. This would be a new product with a much bigger system.”



Cycle Farms

Summary

A growing population and the consequent increase in demand for food and protein is putting pressure on agricultural land, which in turn is leading to deforestation. Protein from insects is one possible solution – it's efficient, has a small environmental resource footprint and can be fed with biowaste. French start-up Cycle Farms is developing a biorefinery that converts organic matter into protein-rich black soldier fly larvae, which are then processed into feedstock for aquaculture.

Key Points

- Global food production will have to increase by 70 percent by 2050 to keep pace with a growing population
- The demand for protein is increasing, too, to feed both humans, and the livestock and fish we consume
- These demands put increasing pressure on existing agricultural land and on natural ecosystems that may be cleared for food production
- Insects are a potentially sustainable source of protein that could feed livestock and fish, reducing pressure on existing food production methods
- French company Cycle Farms has developed a biorefinery that converts food waste into insect protein, which is then processed into fish food
- The firm hopes to begin operation in Africa next year, selling food pellets to farmers

Project Background and Drivers

With an estimated 2.3 billion more people on the planet by 2050, global food production will have to increase by 70 percent to keep pace. Demand for livestock and fish is growing too, placing extra pressure on the protein sources needed to raise them. Three quarters of the world's soybeans are used in animal and fish feeds. In South America, the amount of land used to farm soybeans increased from 17 million ha in 1990 to 26 million ha in 2010, largely on land converted from natural ecosystems including rainforests, according to the World Wildlife Fund. Deforestation is estimated to account for around 15 percent of global greenhouse gas emissions.

Our relationship with food is a major contributor to climate change in another way, too. Around one-third of all food produced globally is wasted. The carbon footprint of this uneaten food is an estimated 4.4Gt of CO₂ yearly. If food wastage was a country, it would be the third largest emitter of CO₂ after China and the US.

Project Detail

Over recent years, interest has grown in farming insects as a sustainable way to inject protein into the food chain, while at the same time, reducing pressure on existing food production methods. Not only does insect protein have a much smaller environmental footprint than traditional agriculture – a 150 m² insect farm can produce as much protein as a 150 ha soybean field – insects can be raised on food waste rather than raw materials.



Start-up Cycle Farms has built a 40 cubic metre biorefinery in France that uses black soldier flies, a friendly species that is neither a pest nor a disease vector, to turn food waste into fish food. The flies' protein-rich larvae are miniature waste-processing plants, fattening themselves on leftovers and food industry by-products that would otherwise end up being thrown away. The larvae also produce a rich compost that the firm hopes to sell to farmers or cooperatives.

Cycle Farms' proprietary, self-contained system oversees every stage of the process, from hygiene of the food waste it uses as raw material to processing the insect meal into complete food pellets, which can then be sold to fish farmers. The company has been testing food waste provided by a French supermarket chain to identify the widest range of diet used in producing insect meal.

At present the company is piloting and refining its process in France, but it plans to establish an operation in Africa in 2017, selling food pellets to fish farmers. Currently, African fish farmers spend around 70 percent of their production costs on feed – a figure Cycle Farms intends to bring down significantly with its all-in-one production system. "We would like to help these people," says Cycle Farms' CEO Marc-Antoine Luraschi. "And we need to reduce pressure on soya producers." He also points out that the black soldier fly is perfectly suited to equatorial or tropical climates. "We don't need to use any other source of energy to heat or cool this system."



Climate KIC Support

The company has just been selected to join the Climate-KIC accelerator programme in France, following a six-month stint in Climate-KIC's Greenhouse pre-incubator programme for entrepreneurs. The Greenhouse provided the startup with €5,000 to help develop its first stage experimentation, as well as offering mentoring, workshops and support.

"We worked on developing our business model," says Luraschi. "How can we deal with the innovation we have, how can we market it, and bring it to market? That was the most important work we did [in the Greenhouse]. During that process we decided to form Cycle Farms, and we now employ four people." They include an entomologist and an industrial designer, as well as a business developer and marketing director.

Although Cycle Farms has only just joined the Accelerator programme in 2016, Luraschi says he has already received invitations to meetings and masterclasses. "I think it is a rich programme with many other startups and universities involved. There will be a lot of benefits for us," he says. "We will have contact with investors, with universities, and with private partners. Maybe the Climate-KIC programme will also bring us new ideas, new developments and new perspectives, and link us with other start-up technologies that could be useful for insect production."

What's Next?

The company's first planned venture in Africa will, Luraschi says, produce around 200 tonnes of pellets each year to begin with. But he expects the low cost and scalability of the equipment to enable them to increase this output by a factor of five within three years.

And the system will, he hopes, provide more than just a sustainable supply of environmentally friendly protein: "I want to secure the jobs of the people I employ today," he says. "As a start-up you need to secure the talents you have already recruited for the long-term."



The carbon footprint of this uneaten food is an estimated 4.4Gt of CO₂ yearly. If food wastage was a country, it would be the third largest emitter of CO₂ after China and the US.



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About Climate-KIC

Climate-KIC is the EU's largest public private partnership addressing climate change through innovation to build a zero carbon economy. We address climate change across four priority themes: urban areas, land use, production systems, climate metrics and finance. Education is at the heart of these themes to inspire and empower the next generation of climate leaders. We run programmes for students, start-ups and innovators across Europe via centres in major cities, convening a community of the best people and organisations. Our approach starts with improving the way people live in cities. Our focus on industry creates the products required for a better living environment, and we look to optimise land use to produce the food people need. Climate-KIC is supported by the European Institute of Innovation and Technology (EIT), a body of the European Union.

www.climate-kic.org



Sustainable Land Use

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