



# WATER AND AGRIFOOD

An integrated approach



Agriculture



Horticulture



Aquaculture



Cattle farming





# WATER AND AGRIFOOD

**“Water management is one of the greatest challenges facing farmers and growers all over the world”**

**Foreword** A slice of bread takes 40 litres, a cup of coffee 140 litres and a steak at least 3,000: we might not stop to think about it at every bite or sip, but it takes thousands of litres of water to produce the food we eat. At the same time, clean fresh water is becoming increasingly scarce in some places, making it a precious resource.

Water management is one of the greatest challenges facing farmers and growers all over the world. The global population continues to expand, and emerging countries are becoming steadily more prosperous. Both of these developments are increasing demand for food, and also for water. Climate change, resulting in unpredictable and irregular rainfall, is exacerbating the situation even further. Too much or too little water not only presents an acute threat, it also puts farming at risk, as crops can be washed away or shrivel in the fields. And salinisation makes soil unsuitable for farming.

Yet there is reason for optimism. Farmers and growers are improving their water efficiency by using new technologies, cultivation methods and improved seedstock. Precision irrigation systems can save water and at the same time increase yields. We can even double the productivity of rain-fed and flood-dependent agriculture by using water more wisely. But whatever the challenges of climate and terrain, good water management always takes in an entire river basin rather than the water consumption of individual farmers.

The Netherlands is a natural partner for agricultural water management. Our country has been shaped by our battle against water and by our efforts to make optimum use of our limited land area. Our agricultural sector is one of the most innovative and productive in the world. And the more efficient the production, the lower the water consumption. Worldwide it takes an average of 844 litres of water to add one dollar's worth of value to a product; the average in the Netherlands is around eight litres.

This portfolio shows what is being achieved using the knowledge and skills of the Dutch. For example, satellites, sensors and open data allow information to be gathered on the weather, how much water is in the soil and how crops are faring. The combined data can be used to advise farmers and growers, who can see via an app on their smartphone where they need to irrigate, and how much. This is one of several examples of Dutch technology that can be used in many places and in many ways. I hope you enjoy reading about all the other possibilities for reducing the water footprint of the food on our plates.



**Martijn van Dam**  
Minister for Agriculture





## Infographic Water & Agrifood

Generate maximum impact at all catchment levels using an integrated approach for all water and agrifood related issues.



### 1 High land agriculture

- Erosion
- Re-forestation / contourbunding

### 2 Low land agriculture

- High quality input (seed)
- Moisture sensors
- Controlled drainage
- Irrigation techniques
- Soil improvement
- Hydroponics
- Unique soil analysis
- Aquaculture

### 3 Greenhouses

- Water and nutrient re use
- Emission reduction
- Hydroponics
- High quality input (seed)

### 4 Industry

- Water footprint
- Better quality resources
- Continuity supply resources
- Treatment process water
- Corporate social responsibility

### 5 Urban cities

- Drinking water quality
- Waste water treatment
- Water infrastructure

#### Water conservation hierarchy

- Reduce
- Re use
- Recycle

### General topics (touching all catchment levels, 1, 2, 3, 4 and 5)



- Geo / Meteo information
- Water harvesting
- Water re use
- Integrated Water Resources Management (IWRM)
- Closing the water cycle
- Stakeholder processes
- Salination
- Rural planning
- Flood risk management
- Fresh water supply and distribution
- Phosphorus recycling
- Water recharge



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For more Dutch expertise on Water & Agrifood, check out our website [www.dutchwatersector.com/agrifood](http://www.dutchwatersector.com/agrifood)





# WORLDWIDE PROJECTS

Focus on fungi

Business from waste & water

Precision in water and fertilizers

Efficient landuse by reducing land fragmentation

Half the water, just as many strawberries

Focus on fungi

Growing potatoes in salty soil

Agri Gulf for better crops

Satellite for crops project Bangladesh

Real-time help to locate good grazing lands and water

Focus on fungi

PiMapping® - Making sugarcane monitoring sweeter

Business from waste & water

## Projects in the Netherlands

- Water and fertilizer reuse for horticulture
- Climate proof soil and water management in agriculture
- Growing potatoes in salty soil
- Freshwater storage against salinisation
- Increase of fresh water availability by using subsoil storage
- N, P and K recovery from Agri-biomass streams
- Protection against Harmful Algae Bloom (HAB)

The links between weather and crops

Focus on fungi

Affordable crop insurance based on relative evapotranspiration

PiMapping® - Making sugarcane monitoring sweeter

From field to supermarket

PiMapping® - Making sugarcane monitoring sweeter

Business from waste & water

## Worldwide projects

- Looking underground without digging
- Onions that can stand the heat
- Cross-over between soil and water

 Click on a title to go to the article

For more Dutch projects in Water & Agrifood, check out our website [www.dutchwatersector.com/agrifood](http://www.dutchwatersector.com/agrifood)





# LESS WATER, NEW SOLUTIONS

Worldwide, less and less water per head of the population is going to be available for food production. In 2050 it will be a third of what it was in 1950. This is easy to explain, since in the same period the world's population will have grown from 2.5 billion to 9 billion people. All these mouths need to be fed, people also need drinking water, and the industry needs ever more water. At the same time the supply of natural fertilisers is dwindling; phosphates provide the best known example. The conclusion is that yields per hectare will have to rise, while using less water and fewer nutrients: 'more crop per drop'.

However, saving water starts even earlier, in the sensible management of water flows so that all stakeholders are well served. Not doing so can mean the loss of valuable fresh water that could, for instance, have been used for irrigation. Sustainable water management demands

a coherent, multidisciplinary approach to the river's entire catchment area. This includes effective steering through governance, regulation, enforcement, and financial incentives. This approach demands commitment from government and from the business community, including farmers.







### Taking the entire river basin into account

The approach begins upstream, where mountainside deforestation is often a serious risk. More sustainable arrangements in this area can prevent soil erosion. 'Agroforestry' results in better retention of water and contributes towards the revitalisation of upland areas. Lower in the river's catchment area, land use is generally more intensive, with urban conglomerations taking up part of the space. Water resources are needed not only for irrigation, but also for drinking water and industry. Agriculture and horticulture is practised on a larger scale, and often in more intensive ways. Emission regulations become stricter, fuelling the search for ever-smarter solutions for crops grown under glass or inside buildings. Techniques like biomass re-use, and its processing into organic fertilizer, are opening new perspectives in agriculture and horticulture. These kinds of solutions contribute towards the closure of water and nutrient cycles at regional level.

## Dutch companies and organisations are always keen to bring together available expertise to create strongly goal-oriented partnerships.

The most fertile ground is found lower still, in the river delta. Here, measures are needed to protect against flooding. The active use of pumps and flood-control dams keeps agricultural land as productive as possible. Storing fresh water underground, in aquifers, safeguards irrigation water supplies during dry spells and in those areas where surface water is threatened by salinisation.

### Focus on soil and water

Soil that is physically, biologically and chemically well maintained has a high water-buffering capacity, resists erosion, and lies at the root of an effective water management system. A fertile soil is the best foundation for the development of a healthy plant root system and a vigorous crop, which takes up water and nutrients efficiently.

Measuring soil quality and moisture levels enables farmers to take the right measures. Innovative technologies, such as direct crop monitoring and geo-information, are making it possible to detect changes and respond quickly. That means being able to deliver the right amount of water and of nutrients at just the right moment. The re-use of waste water means that more is available in dry periods. Difficult environmental conditions also demand new crop varieties that are resistant to drought and salinisation. Dutch plant breeding companies are global leaders in the development of the crops of the future.

### Let's work together

Dutch companies and organisations are always keen to bring together available expertise to create strong goal-oriented partnerships, working together with local partners to bring about effective and sustainable solutions to today's issues and to those of the future – with professionalism and decisiveness.

In the Dutch Water & Agrifood network, facilitated by the Netherlands Water Partnership and financed by the Dutch government, the strengths of both the water and the agribusiness sectors are combined. The network gathers the expertise of the business community, knowledge institutes, and public partners, as the basis for identifying complete, practical solutions. A view examples of these solutions can be found in this portfolio.





Scope



Agriculture



Horticulture



Aquaculture



Cattle farming

Click to go to related articles

Themes



Water use efficiency >



Soil quality & nutrients >



Crop variety >



Salinity >



Yield quality & quantity >



Smart information solutions >



Strengthening farmers >

Click to read more about the themes

# INTEGRATED APPROACH ON WATER & AGRIFOOD

Working on sustainable solutions to the problems found where water meets agrifood means ensuring a coherent, mutually balanced combination of suitable soil, not too much and not too little water, the amount of nutrients actually required by the soil, skilled management and an effective governance structure. It means not being satisfied with part-solutions to part-problems but always looking beyond the boundaries of one's own discipline. And improving existing solutions, because we believe that we can always do things better. That is why in this portfolio the broad spectrum of Water & Agrifood is taken into account. The scope of this portfolio comprises: Agriculture, Horticulture, Aquaculture and Cattle farming.

Click to go to related articles







# FROM FIELD TO SUPERMARKET

*“Creating market opportunities for smallholder farmers: that’s the essence of our project. Small maize farmers in Giyani, South Africa, have no access to the commercial market. Maize flour is one of the area’s principal food ingredients, but currently it has to be transported to Giyani from Free State province, more than 500 km away. Working in a consortium led by the local SPAR supermarket, we want to develop the Manombe Cooperative in Giyani into a sustainable, profitable institution. The local production of high-quality maize flour forms the basis of the cooperative’s business case. We tackle the whole chain: a good irrigation system, independent product processing, and a cooperative that works together with a private party interested in investing”, says Jochen Froebrich from Alterra Wageningen UR.*





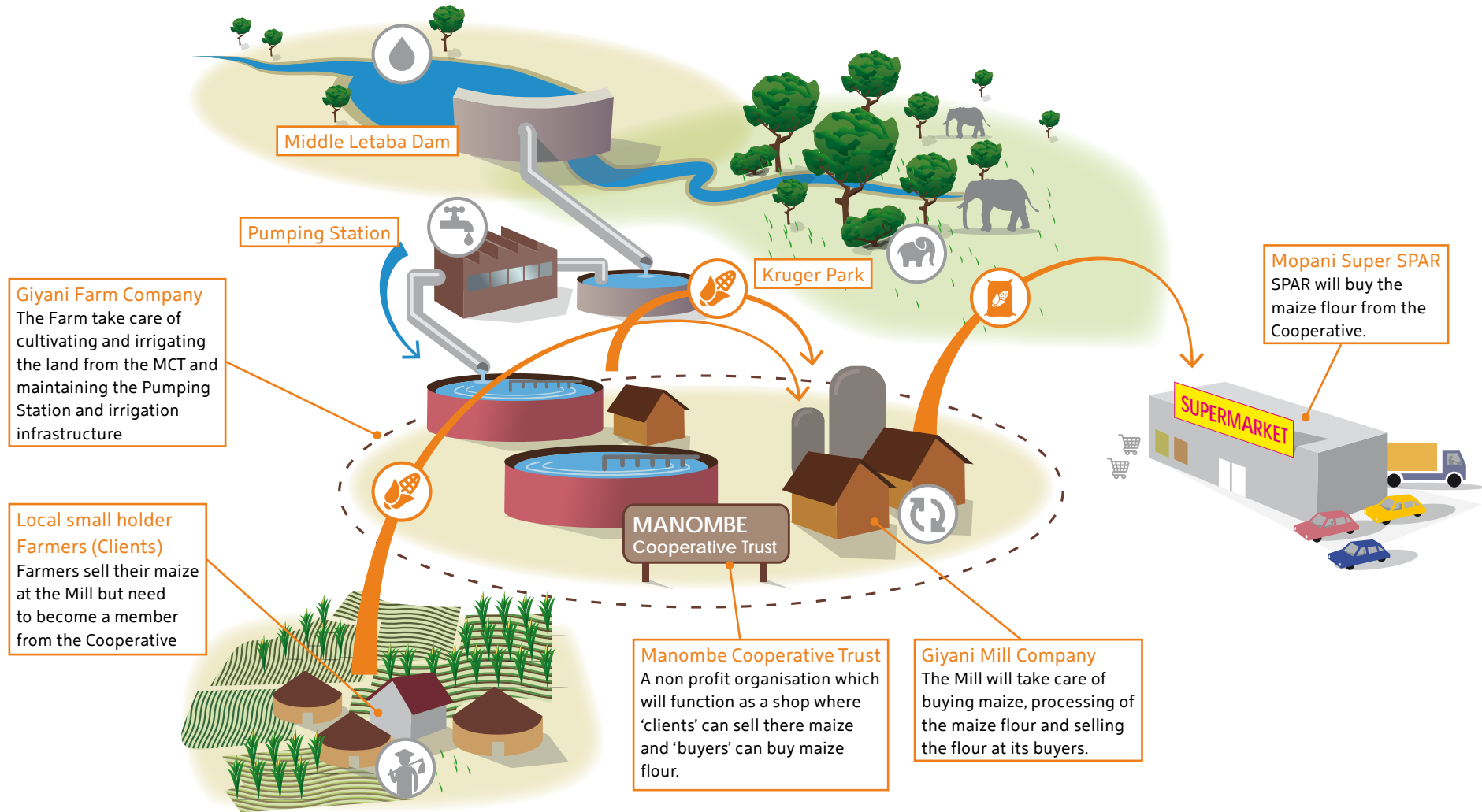
### Stimulus from agribusiness

Small farmers in Giyani have a strong interest in the creation of local market opportunities, reinvestment in capacity building, and agribusiness innovation. The

Public Private Partnership (PPP) project INNO-Giyani has put this into practice with the Manombe Cooperative. Giyani is a town in the South African district of Mopani, in Limpopo province; it has about a quarter of a

million inhabitants. The starting point for the business case is the local production of high-quality maize flour purchased by the local SPAR supermarket. To this end the Public-Private

Partnership (PPP) project INNO-Giyani, with the local SPAR supermarket as a private partner, will rehabilitate 800 hectares of a former irrigation system in Giyani. A new maize mill in Giyani will be used as a





# “We are now setting up a cooperative and a foundation, together with the local SPAR and the chiefs of two local tribes”



cooperative mill. This gives smallholder farmers in the area, who are cut off from a formal market, a chance to sell their maize locally. The mill will also house and maintain the cooperative's machinery. Since an adequate capacity will have to be built up, the project cannot be a commercial venture from the very start.

*excellent partners for this public-private initiative. We are now setting up a cooperative and a foundation, together with the local SPAR and the chiefs of two local tribes. For now the irrigation pivots will be located on their land; later we want to expand, so that more farmers can profit from the project.”*

*“In the SPAR supermarket chain, which is a large concern in South Africa, and Stellenbosch University, we have found*

The cooperative's staff will receive special training on how to safeguard operational and production quality. The project also provides

for ways to take advantage of new business opportunities. An open innovation platform offers creative farmers and entrepreneurs in the area opportunities to identify new niche products; a practical example of this is the growing and drying of tomatoes. Within the project, working partnerships have been set up with Stellenbosch University, DACOM, and the local department of the Ministry of Agriculture.

## Most important crop

Maize, South Africa's most important crop, is a dietary staple, a source of livestock feed, and an export crop. Maize production exceeds 10 million tons in good years. Government programmes have been crucial to the country's self-sufficiency in this enterprise. Maize is grown commercially on large farms and on more than 12,000 small farms. Maize production generates at least 150,000 jobs in years with good rainfall, and uses almost one-half of the inputs of the modern agricultural sector.



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(search for InnoGiyani)

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Mopani Super SPAR

Stellenbosch University

Dacom

ZZ2

Limpopo Dept. of Agriculture

Dutch Ministry of Foreign Affairs



# BUSINESS FROM WASTE & WATER

*“We have developed a process and business plan which allows waste water and organic waste to be employed in a safe, reliable and affordable way to support food production. This can be done right where the demand is and where the waste is produced, close to cities: ‘local for local’, says Aad Wubben on the Aqua-Soil Approach, but also for export purposes.”*

## **Transforming waste and waste water into valuable resources**

The Aqua-Soil Approach, developed by Aqua-Terra Nova, Soil & More, Tuptotec, For elements and Verbos Business Development is a joint approach for water and organic waste recycling concepts as part of the Metropolitan Food Cluster. The combined

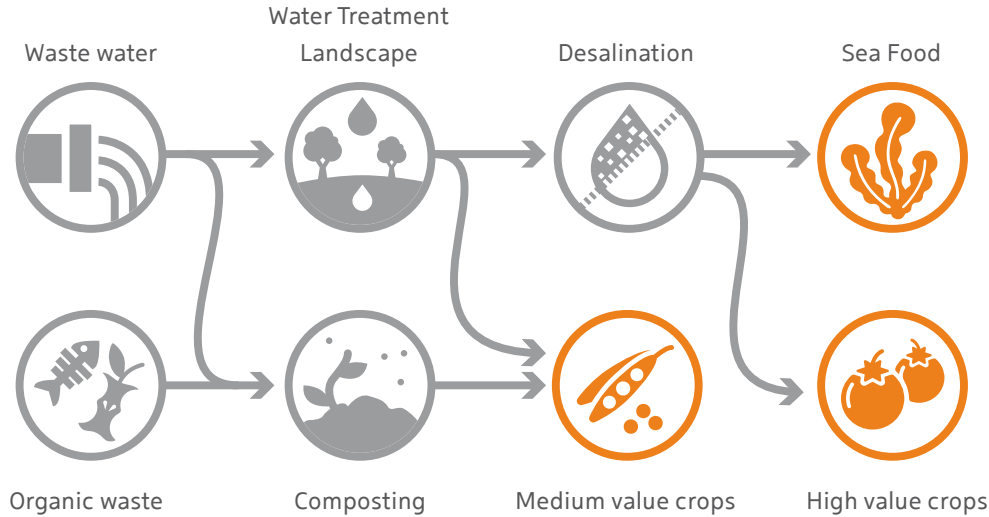
efforts offer a solution for two common problems for waste water treatment facilities, namely the disposal of sludge and the effluent quality. Moreover, the Aqua-Soil Approach offers a cradle-to-cradle business opportunity for sustainable horticulture with a minimal carbon, water- and nutrient footprint.







## The Aqua-Soil Approach



**“The AquaReUse installation for 100 hectares of horticulture in Bleiswijk means that this is now a tried-and-tested concept”**

### How it works

The Aqua-Soil Approach is based on the biological treatment of waste water and composting of organic waste which results in high-quality compost and reliable, clean and nutrient-rich irrigation water for horticultural and agricultural needs. The concept is now being followed with interest by municipalities, water boards and private investors, as it is also highly applicable for more rural areas thanks to its cost efficiency and low investment requirements. The Aqua-Soil Approach is a modular construction and is readily applicable to a wide range of locations.

*“We would like to see our system linked to existing municipal water treatment plants*

*or other water of bad quality, so that we can demonstrate how their existing cost-based model can be transformed into a profit-making model. We have developed a business model that invites developers and government bodies to join in. In South Africa and Ethiopia we are in talks with several market parties, and considerable interest is being shown in Mexico. Even with UNEP a joint proposition is developed which they are promoting”*

### Water and food security

The basic concept can be used in low-cost applications and is aimed at delivering the basic ingredients for the production of medium-value crops. An optional follow-up treatment results in better food quality,

higher yields, and a smaller carbon & water footprint, producing irrigation water for high-value crops or process water for industries, thus generating the ideal solution for urban agriculture, potentially even in industrial areas. We create a ‘Window of Opportunities’!

The concept can be completed with the production of algae for cosmetics or fish farming. The Aqua-Soil approach delivers water security, food security and jobs, increases the value of the food production sector, the amount of nutrient re-use, carbon credits and organic composting, reduces water footprints and is an incentive to better waste management and alien clearing. The business model can give insight of the Capex en Opex.



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[For elements BV](#)

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# AGRI GULF FOR BETTER CROPS

*“In Saudi Arabia we saw enormous variation in date yields, anything from 35kg to 180kg per date palm. Naturally, this has partly to do with the soil type; yields are much lower on sand. Still, it ought to be possible to obtain 100kg yields even on poor soils. With combined expertise we will achieve water savings over 70%, and four times higher yields”, says Mink Vermeer of Delphy on behalf of the consortium “Agri Gulf”.*





# “With combined expertise we will achieve water savings over 70%, and four times higher yields”

The cultivation of dates is crucially important to the economic well-being of countries in the Middle East and North Africa. Saudi Arabia is responsible for 17% of the world’s date production. The country’s plantations cover 157,000 hectares of land and contain over 25 million date palms. They produce 1.1 million tons of dates a year, only 5% of which is actually exported. Innovative and sustainable solutions and optimal use of available water are essential for higher yields and better-quality fruit.

## Smart with less water

On average, a hectare of date palm plantation in the Gulf region consumes about 20,000 cubic metres of water a year. However, a combination of water availability, monitoring (moisture, weather), knowledge of soil quality, smart irrigation techniques, and crop advice can reduce this figure by 70%.

This is a five-step process.

- 1 Determine groundwater availability for long-term sustainable approach
- 2 Soil knowledge: insight into the moisture-buffering capacity of the soil prevents excessive water consumption and leaching of nutrients.
- 3 Sensors measure soil moisture. An automatic signal sent to a mobile phone or computer keeps the farm manager updated 24/7 and warns when irrigation is needed.
- 4 Smart water-controlling-irrigation systems, improved distribution of water around the tree, and regulated discharge of water can prevent evaporation losses into deeper soil layers beyond reach of the roots. Permanent flow meters indicate the efficiency of the system.
- 5 Crop advice to train and assist the management in the best practises including production plan, fertilizer plan and crop protection plan.

On large plantations, the irrigation valves in each section are opened and closed by hand. The producers would like to automate this process so that the right amount of water can be delivered to the right section at the right moment from a central location, together with the delivery of fertilizers. And they want to monitor this process using sensors.

## Combined expertise for coherent measures

This combined expertise forms the basis for a custom-made, coherent, overall solution to water, fertilisation, crop protection and other cultivation measures. For instance, optimising water dosage is of little benefit in the absence of soil improvement action. Our complete solution leads to improved production, in both qualitative and quantitative terms. Our smart complete solution in palms & dates also aims at improving the sustainability of this national cultivation.

The Dutch experts in Agri Gulf are committed to provide solutions that countries and regions can use themselves. They believe it is essential to train local management, so training also forms an integral part of their approach.

*“We possess an excellent combination of the expertise needed to grow dates: measurement, knowledge, organisation and management. We measure not only the soil moisture, including fossil groundwater reserves, but we also know how long any*

*given soil can retain moisture and nutrients, and we can supplement this knowledge with meteorological data.”*

## Cooperation with Saudi Arabia

The Ministry of Agriculture in Saudi Arabia is interested in the prospect of collaboration; for instance, a long-term monitoring programme for date companies is currently being considered. As Agri Gulf consortium we have presented an offer to implement our complete solution at 48 farms across seven regions. Each of them will be fitted with a smart irrigation system, mixing tank, soil moisture sensors, weather station (each region), crop advice, and soil sampling.



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[Acacia Water](#)







# CLIMATE PROOF SOIL AND WATER MANAGEMENT IN AGRICULTURE

*“Our organic cattle farm at Wapserveen, in the eastern part of the Netherlands, has 70 cows, 20 yearlings and 30 calves. In the last few years many of our peat plots have been subsiding. We expect more extreme weather situations to occur in the future, and we want to be ready for them. By taking part in the ‘Landbouw op Peil’ project we are gaining insight into the kind of investments these preparations should involve. We are reassessing everything, and devising a new water management system that prepares us for the consequences of climate change and helps us to respond adequately to it.”* These are the words of Ton Spijkerman, Wapserveen farmer and part of the agricultural enterprises cooperating in the ‘Landbouw op Peil’ project.





## Changing climate, changing agriculture

Our climate is changing and this has consequences for the management of groundwater and surface water. That, in turn, has consequences for agriculture. The eastern part of the Netherlands is made out of higher, free-draining sandy soils. This area will increasingly become subject to both extremely dry and very wet periods. The 'Landbouw op Peil' project aims at improving water management, whilst maintaining a vigorous agricultural sector in the future. Climate change means that water boards will need to store more water during wet periods so that these reserves can be drawn on during periods of scarce rainfall. Improved water storage is also needed to prevent problems downstream.

*"The new drainage system will ensure ideal water levels as well as water removal. Drainage will be installed with an ideal balance of spacing and depth to give the best possible results. We will dig a new drainage ditch to collect water; in dry periods we will be able to use this water to supplement normal supplies. We will also be able to deal flexibly with the groundwater table, by opening and shutting existing dams and culverts.*

*Working with the district water board, we will raise or lower the groundwater table according to the weather conditions. So in wet periods we will drain off water more quickly, and in dry periods we will use the water of the drainage ditch to keep up soil moisture levels. We will also be spreading*

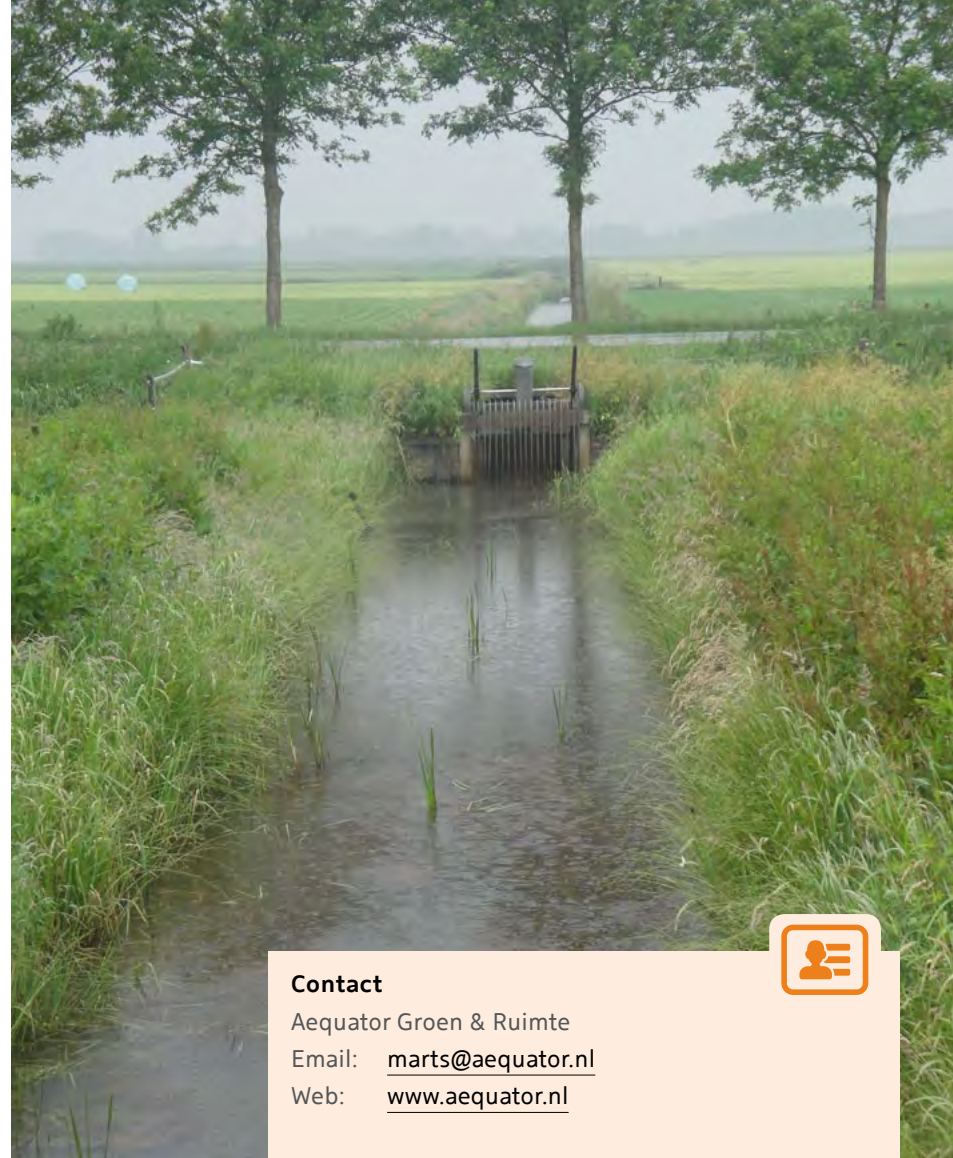
*extra compost on higher ground; ensuring higher humus levels, the advantage being that humus-rich soils retain water longer."*

## Broad cooperation

In the 'Landbouw op Peil' project five water boards, three provinces, the Ministry of Economic Affairs and the agricultural sector joined forces to find out which practical measures could be employed to make the water system climate-proof. This practical research was carried out together with 15 agricultural enterprises which made their land available for research and experiments in water recycling, cropping, soil and operational management.

The project brought forward important information for farmers, water boards and the provinces about the links between agricultural and water management measures and their practical applicability.

The 'Landbouw op Peil' project is financially supported by the European Union. Freely translated, the project name stands for 'Agriculture and water management up to standard'.



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[De Bakelse Stroom](#)

[District water board Vechtstromen](#)

[District water board Rijn en IJssel](#)

[District water board Drents Overijsselse Delta](#)

[Province of Overijssel](#)

[LTO Noord](#)

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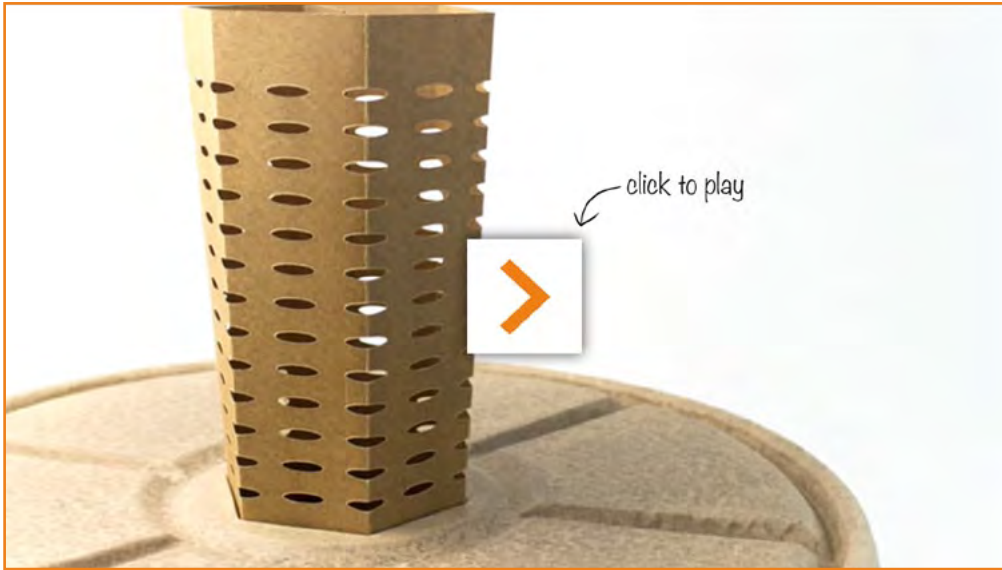




# FUNGI AND SOIL QUALITY TO IMPROVE WATER UPTAKE

*“Periods of serious drought and flooding are becoming more prevalent, and the sector needs to respond to this. Drought-resistant agriculture needs soil with adequate absorption capacity, and with the biological characteristics that enable it to make water and minerals available to the plant at the right moments. Until recently we assumed that a plant’s roots were responsible for the uptake of water and minerals. But in modern agriculture we overlooked the vital role played by root fungi”, says Pius Floris of Plant Health Care.*





# “Mycorrhizal fungi colonise plant roots, creating an invisible network of fungal filaments”

made out of paper pulp, crop residuals and grasses. The reservoir itself is waterproof due to the use of natural wax. The centre has a hollow tube for the tree seedling. When a tree is planted the reservoir is filled with water, keeping the plant alive for 12 to 18 months. Since no water pipelines are needed, the system can be used almost anywhere in the world.

*“In April 2014 several hundred moringa and acacia trees were planted via the Cocoon technology in a large date palm plantation in Saudi Arabia. A year later, 70% of the moringa trees and over 80% of the acacia trees had survived. The trees had strong, healthy roots, enabling them to draw enough water and nutrients from the soil, despite the arid area they were growing in.”*

The ‘Cocoon’ technology, a patented product of Land Life Company, demonstrates what can be achieved with this knowledge. Planted out in biodegradable cardboard boxes, each seedling is provided with the right (amount of) fungi, bacteria, and water. This gives the young tree at least a year’s worth of independent healthy development. The fungal filaments attached to the roots quickly reach subsurface levels where the sun no longer affects soil temperature, and where water is always available in capillary form. The roots cannot reach this depth, but the fungal filaments, which are no more than 3 microns wide, can. Further irrigation is simply not needed.

*filaments – one to three kilometres per cubic centimetre of soil. These can penetrate into the smallest micropores of substrate to absorb water and release minerals. The activities that we had always attributed to roots is in fact done by these fungi, and there is as yet no agricultural system that takes full account of this fact.”*

### The less water the better

The adequate availability of water is a growing challenge for agriculture and horticulture all over the world. So the less water is needed and used, the better. Land Life Company’s biodegradable water reservoir, the Cocoon, allows trees and plants to grow and thrive in arid climates without irrigation. The underground water reservoir in the Cocoon is filled with water and

### Less ploughing, less artificial fertilizer

Constant ploughing and the unceasing use of artificial fertilizers and slurry has impoverished soil biology. As a result, water and minerals are poorly retained and are therefore inadequately available at the desired moment. Soil cultivation should therefore ideally go no deeper than 15cm, so that the underlying soil biology can gradually recover. Crop residues are then broken down more quickly, and real humus can be formed. Artificial fertilizers should be applied in only very limited amounts. The productivity might appear to be lower at first, but so are the costs. Thereafter productivity will rise from year to year, and the disease burden will also be much lower.

*“Mycorrhizal fungi colonise plant roots, creating an invisible network of fungal*



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### Partner

[Land Life Company](#)







# PRECISION AGRICULTURE IN NORTHWEST EUROPE

*"Horticulture under glass is all about intensivity: getting high yields of high-quality produce from a small area of land. Even under strict regulations on emissions, for instance. Farmers want their plants to grow without stress, so the yield and quality does not suffer. Drip irrigation and fertigation make a big difference. You can deliver exactly what is needed, much closer to the roots and using less of it than with other techniques. Now we're transferring this approach to intensive arable farming and vegetable cropping in the open field." Jacob Dogterom of Delphy speaks about his drip irrigation/fertigation techniques, developed with international partners.*







### Looking for answers

Tests have already shown that 15 – 30% savings on water and fertilizers can be reached. At the same time yields can grow by 10 to 30%, whilst quality improves. Produce can be better sorted, in ways that meet the demands of specific buyers. We've already seen this in leek, potato and bulb crops, for

instance. We've succeeded in improving storage times; the plants are sturdier, and their shelf life has gone from five days to seven days. That makes a big difference to buyers.

Farmers are enthusiastic about this system, but there are still questions to answer.

For example, how can this system be implemented in existing crops? How should watering and fertilizing be managed? What is the optimal application method, and are there ways to influence the quality and quantity of (seed) potatoes, leek, onions, etc.? There are also many questions related to plant physiology. Delphy and international

partners are collaborating to address these issues.

### Drip irrigation and fertigation

Delphy has recently started farm-level pilots testing drip irrigation/fertigation in the Netherlands. This system is well known in warm and dry climates and in fruit crops







“These techniques make it possible to use a very intensive form of agriculture on a relatively small area of land”

in the Netherlands, but not in annual, arable crops under Northwest European circumstances. Farmers in the Netherlands face the effects of salinisation, as climate change makes fresh sweet water scarcer. Our intention is to store the water that is abundant at certain periods during the year and to use this water in the dry periods more efficiently and more effectively. This water can originate from a variety of sources. Farmers can then optimise the supply of water, minerals and chemicals. It's a form of precision farming, like in greenhouses, but in the open air.

### Results

Drip irrigation/fertigation offers farmers under different circumstances:

- A new formula for sustainable and integrated crop production
- Sufficient fresh water, originating from different sources
- Efficient irrigation and mineral supplements using drip lines
- Drip lines that can be situated on the surface or subsurface, depending on the farming system and crops
- The efficient use of minerals (10 – 30% less)

- The efficient use of water (15- 30% less)
- Higher yields (10 – 30%)
- More possibilities for influencing product quality

*“These techniques make it possible to use a very intensive form of agriculture on a relatively small area of land, in the open air. In our climate zone, here in north-west Europe, this is becoming increasingly interesting. The switch to a more intensive agriculture – within the constraints of sustainable, ecologically responsible cultivation – needs to be made.”*



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RMA

Broere Beregening

Smits Veldhoven

Vos Capelle

Netafim

Yara







# THE LINK BETWEEN WEATHER DATA AND CROP MANAGEMENT

CropMon project Kenya

The objective of the CropMon project, which started on 1 September 2015, is to develop an affordable crop monitoring service that provides smallholder and medium-sized farmers in Kenya with location-specific and real time information about the actual status of their crops using satellite, weather, soil and farm data. Possible causes for yield depressions are given, and corrective measures to overcome this are proposed.







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[Springg](#)

[NEO, Netherlands Geomatics & Earth Observation](#)



# “If you have better information about the course of a rainy season, you can sow and harvest your crop at just the right moment”

Of the total land area in Kenya, only 9% is used for crop cultivation. The agriculture sector, with primary exports of tea, horticultural products and coffee, represents more than 20% of GDP. About 75% of Kenya’s labour force is dedicated to agriculture.

Management Services. It is up to the advisors in these organisations to translate the project data into information for the farmers and their corporations. The project also looks at commercial feasibility and financial sustainability, in which microfinance also plays a part.

Gerrit Hiemstra of Weather Impact: “We look at the links between weather and crop quality and quantity. When we visited Kenya we found that the locals had very little access to meteorological information. They had to work with a monthly overview and a seasonal forecast. And they watched the sky and the wind. We want to improve on that, for instance with the ‘plume’ forecast: the longer-range the forecast, the greater the uncertainty and the wider the plume. This can be applied to ordinary weather forecasts as well as extreme weather situations. Our ultimate aim is to develop a mobile app.”

“The trick is to bring all these components together into a single, integrated approach. Here’s a simple example: if you have better information about the course of a rainy season, you can sow and harvest your crop at just the right moment.”



Target group:

# 150,000 farmers



Input data:



satellite imagery



weather data



soil analysis data



farmer information

Cash flow:



pay per SMS



positive cash flow after 5 years



financially viable after 10 years

The project entails 150,000 farmers growing coffee, cereals and fodder. An important role is played by the Cereal Growers Association and the comparable organisation Coffee

### Crop Monitoring Kenya

Crop Monitoring Kenya is a project financially supported by Geodata for Agriculture and Water (G4AW). [G4AW](#) improves food security in developing countries by using satellite data. The Netherlands Space Office (NSO) is implementing this programme, which was commissioned by the Dutch Ministry of Foreign Affairs.







# HALF THE WATER, JUST AS MANY STRAWBERRIES

*“The Huelva region in southwest Spain produces as many strawberries and blackberries as in the Netherlands altogether. In our RESFOOD project we demonstrated that they could use the same cultivation methods with easily only half the water. It had no adverse effect on the crops at all. It was a simple case of overdosing, overlooking how much water the crop actually needed”, says Wilfred Appelman of TNO, a Dutch leading knowledge institute.*







The increasing demand for healthy and nutritious food requires an efficient use of the natural resources needed for food production and processing. The EU-funded project RESFOOD develops technologies and tools to overcome the barriers to a resource-efficient food chain, leading to a reduction of water and energy use of 25-80% and the recovery of valuable materials.

*“It’s hard to persuade the growers to adopt our tools. If one crop fails, a lot of money is lost. The project aims at demonstrating new techniques, but we also have to demonstrate the economic profitability to convince the growers. To do that, we want to work together with the business community.”*

#### Focus on entire food production chain

The RESFOOD programme is directed towards the entire food production chain, and examines every link in that chain to see what opportunities exist to make production more sustainable. For soil-based crops the aim is to enhance water use efficiency by using fertigation for cultivation while maintaining the required fruit yield and quality. For soil-less cultivation, new water treatment concepts are developed to recover and reuse water and nutrients.

Field trials have been conducted in the experimental plot of the ADESVA technological centre located in Lepe, Huelva, Spain. The crops studied were strawberry and blackberry, representing two of the most significant crops of the Huelva region. Using three different irrigation tapes with

different flows (2.5, 3.8 and 5l/h) whilst keeping the amount of fertiliser constant, the influence of the amount of water applied on the production and quality of the fruit was studied. No significant statistical differences were found between the three irrigation tapes in any of the analysed quality parameters during the season of strawberry and blackberry cultivation.

#### Reduction of water and nutrient use

This means that water and nutrient use can be reduced by 34% and 50% respectively. This will also lead to reduction of water use and nutrient losses from leaching, considerably minimising the environmental impact of cultivation with regard to water/nutrient use and preventing soil and ground/surface water contamination.

*“The next step in the RESFOOD project would be the transition from open fields to cultivation channels. Our estimate is that only a quarter of the water is needed, in comparison to what is being used now. It is already a closed system, which re-uses drain water. However, this gets more and more concentrated and therefore more saline. Sodium then becomes a particular problem, because it inhibits plant growth. At present the drain water is eventually discharged. In the Netherlands we have done tests to desalinate drain water using electro dialysis. The technology is not yet being used in horticulture, but we expect it to become more commercially interesting. The tests being done in Dutch horticulture should demonstrate that.”*

**“Our estimate is that only a quarter of the water is needed”**



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[Centro Tecnológico ADESVA](#)  
[La Canastita](#)





# WATER AND FERTILIZER REUSE FOR HORTICULTURE

A growing world population and rising prosperity has made the preservation of resources a major concern. Fossil fuels and essential plant nutrients, such as phosphorus, are running out. In addition, we only have a limited supply of fresh water for agriculture and horticulture, and there are no viable alternatives. In horticulture, large quantities of fertilizers and fresh water are unnecessarily wasted. This is due to the fact that plants do not absorb all the applied irrigation water at once; a certain percentage runs off. Recycling this drain water saves enormous amounts of fertilizers and water.







Recycling drain water requires a technology that eliminates harmful pathogens without affecting the dissolved fertilizers. *“Intensive collaboration between HortiMaX and Van Remmen UV Techniek has resulted in a sustainable solution for the reuse of water and fertilizers. Our specially-developed UV systems for horticulture under glass mean that up to a quarter of the irrigation water and up to half of the fertilizers can be reused. This is unprecedented in the field of glasshouse horticulture”*, says Ton van Remmen of Remmen UV Techniek.

### Effective disinfection

Only a verified UV-C disinfection system can ensure the reliability of the recycling process. The use of ultraviolet light (UV)

at a wavelength of 254 nm is an effective method of disinfecting water. The process destroys over 99.9% of all pathogens present in the water. UV disinfection can be used on all types of water. It is not only cost-effective for the grower, but also beneficial to the environment. The custom-designed UV-C disinfection system has been microbiologically tested to ensure the required performance.

*“In horticulture under glass, UV-C disinfection has long been employed in ‘ebb and flow systems’. Naturally, this requires a disinfection technology that actually works. Designing and developing a system is just one aspect; testing to ascertain whether predicted results are actually achieved in*

*practice is another matter. Our UV systems have been demonstrated to actually do what they claim to do: they have been tested and validated at the microbiological level. The test, which we developed jointly with the Eurofins KBBL knowledge centre, is derived from the European standards for validating UV technology.”*

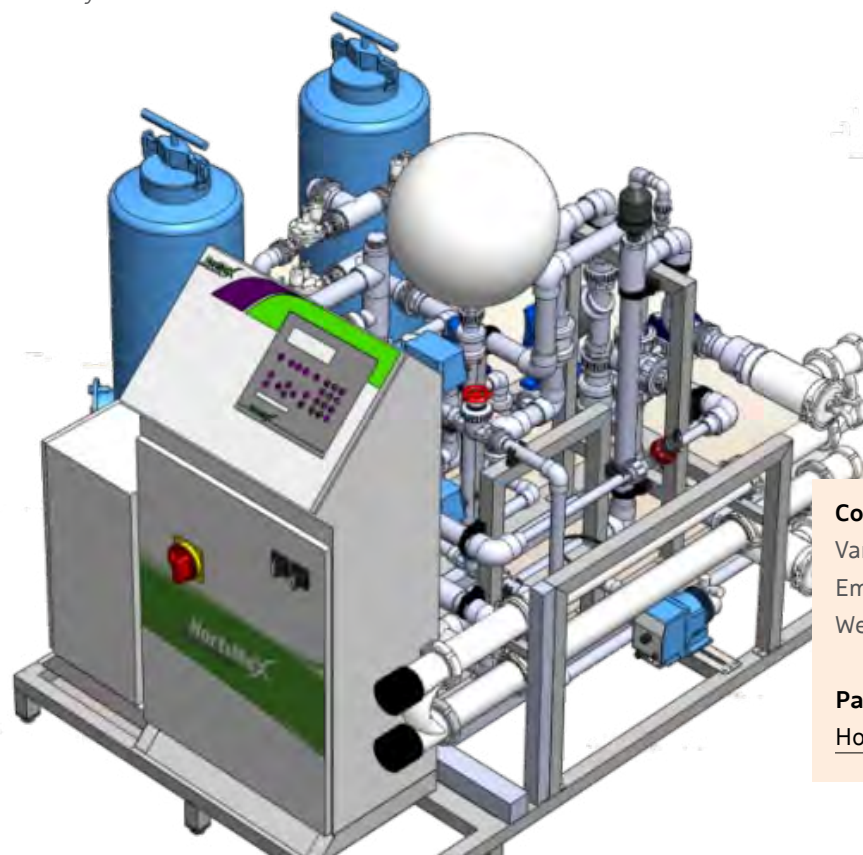
### Total Cost of Ownership (TCO)

Growers who focus on the Total Cost of Ownership (TCO) find that the maintenance costs of our UV system are low. The investment for the UV system soon repays itself, since the UV system generates substantial energy savings for the same amount of reused water and fertilizer.

### Results

A grower can reuse up to 25% of the applied irrigation water and 30 to 50% of the applied fertilizers. A major benefit is that there are no chemicals added to the irrigation water and that there is no risk of crop damage or residues on the harvested product.

**“The UV system is flexible; it is easy to scale up to higher capacities”**



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# LOOKING UNDERGROUND WITHOUT DIGGING

*“People often water their crops too much, assuming too much water is better than too little’. If you use a sensor to measure soil moisture, you know exactly how much is needed. This alone can save a lot of water”, says Jan Hadders of Dacom.*

*“With sensors you can look underground without having to dig a hole.”*







*“The sensor sends an electrical signal in the soil. The amount of moisture in the soil determines the degree to which the signal is reflected back. The resulting data, which can be read remotely, is used to support the decision whether or not to irrigate. The next big challenge is to measure nutrients, such as nitrates, by combining satellite images with field measurements. We must make sure that these different technologies don’t just exist side by side, but that they work together. That’s the future: linking all these options, connecting the data dots, to create a single, continuous film.”*

**Not too little, not too much**

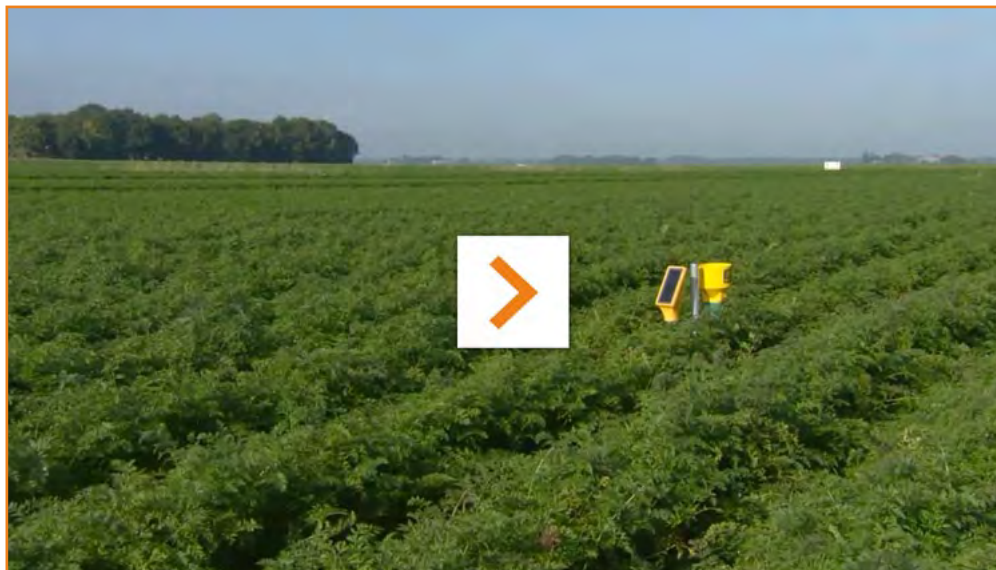
Interest is growing in simple and affordable solutions allowing a more efficient dosage of water and fertilizers in soil-based agriculture and horticulture (‘More crop per drop’). Such techniques ensure the improved and more cost-effective use of water and fertilizers, but are also an effective response to ever-stricter regulations governing the run-off of fertilizers and crop protection chemicals into surface water and groundwater. Measuring means better products, higher yields, diesel fuel savings, reduced water and fertilizer requirements, reduced environmental impact – and, naturally, often a combination.

*“In the next few years this sensor technology may become much cheaper. The sensors currently use a conventional GPRS SIM card to communicate data, but a new, simpler communication channel is on the way. It is called LoRa, which stands for*

*‘Long Range Low Power’. This technology can exchange small amounts of data and requires very little power; a penlight battery powering a LoRa device can last for years. This means that the sensor costs break even within a year.”*

**New data every hour**

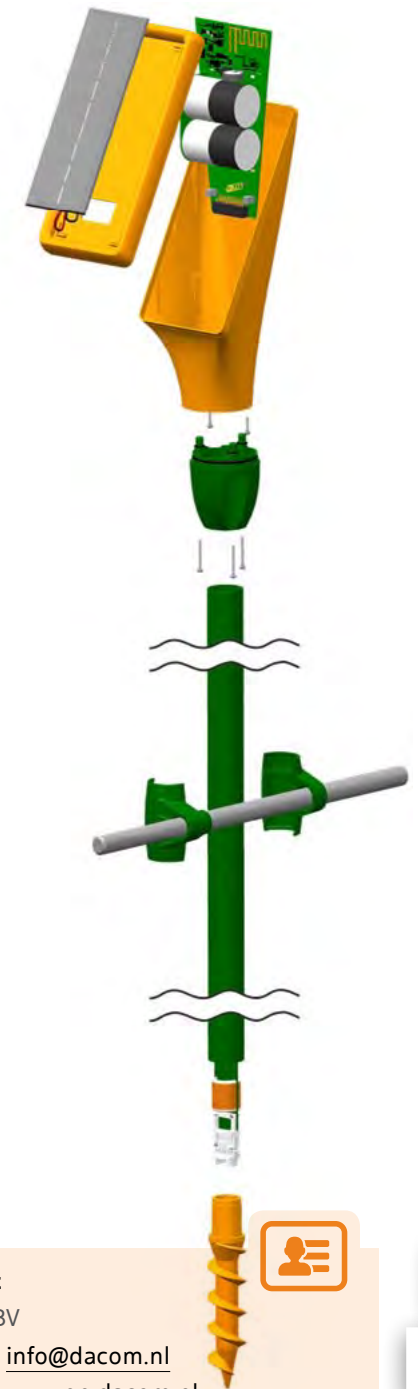
The wireless system used by the Dacom sensors is ideal. Every hour, new data is sent via the mobile phone network to the Dacom database. When combined with soil data, it is turned into specific recommendations and sent to the farmer’s or grower’s smartphone. The farmers and growers then know how much water is still in the ground, and how much should be added. In Saudi Arabia, for instance, these sensors have been used for several years, and have enabled 30% to 70% reductions in water use.



**More Crop per Drop**

Water is one of the most important factors in crop growth. This occasionally necessitates the irrigation of crops during the growing season. The key is to irrigate the right volume at the right moment. By installing a soil moisture sensor in the grower’s field it will show what the daily water consumption of the crop has been throughout the different soil layers.

This data can be used to determine the optimum time for irrigation. This prevents both damage due to drought stress and excessive watering. Soil moisture sensors can be used in all crops cultivated in the soil.



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# ONIONS THAT CAN STAND THE HEAT

*“We supply seeds for onion producers worldwide. Living standards rise in countries in Central Asia, Africa and elsewhere, as does the demand for a more professional approach to onion cultivation. This market is going to grow strongly in the years to come”, says Jasper Pennings from Bejo Zaden, leading in vegetable seeds.*





**“The seed costs are relatively low, especially when you consider the qualitative and quantitative increases in crop yield that can be obtained”**



Different markets want different product attributes such as taste, size, shape and shelf life, but also drought resistance, crop yield reliability, and resistance to bolting. When improving stock, Bejo Zaden works on new varieties that combine two properties: long day length and an extra strong root system. In onion cultivation, day length in the summertime plays an important role. The varieties best suited to this, found in the northern regions of western Europe, were bred way back when summer climates were milder. Their root systems are therefore naturally less developed than they are in the southern, drier areas. This can lead to problems if plants can't be given enough water.

can be harvested, thanks to new onion varieties that can cope with less water. That's a considerable improvement. Developing new varieties is a step-by-step process that takes a long time, but considering the market interest it is worth the effort. The seed costs are relatively low, especially when you consider the qualitative and quantitative increases in crop yield that can be obtained.

*“We're working today on improvements that will lead to new varieties in ten or twenty years. Developing a new hybrid variety often takes fifteen to twenty years, so what we're bringing to the market now are varieties we started working on a very long time ago. It's a continuous process.”*

#### **80 tons per hectare**

Under ideal conditions yields of 80 tons per hectare can be obtained, but in dry years the yield reduces to 20–25 tons. Bejo Zaden has now got to the point at which even in dry weather an extra 5 to 10 tons per hectare

#### **1.3 billion kilos per year**

The onion is the world's largest vegetable crop: total global production amounts to about 52 million tons of onions per year. China is the most important onion-producing country in the world, with India in second place. The Netherlands, which produces about 1.3 billion kilos a year – about 2% of the world's total – falls just outside the top ten. But the Netherlands is the largest producer in Europe, with almost 23,000 hectares given to onion cultivation.

The Netherlands exports about 90% of this production; in other countries this figure is 10% at most. With a 20% share in global exports, the Netherlands is, together with India, the largest onion exporter in the world, thanks to a combination of very high per-hectare yields and low growing, processing and transportation costs. In the area of professional seeds, those with excellent germinative power and strong genetic traits, the Netherlands is also market leader.

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# CROSS-OVER BETWEEN SOIL AND WATER; NEAR INFRA RED

*“In the past, soil fertility was seen simply as the soil’s capacity to retain nutrients. However, it is just as important that soil is able to take up water, retain it, and release it. In today’s agriculture and horticulture sectors, soil and water are increasingly regarded as being inextricably linked. Soil fertility is the nutrient and water supplying and retaining capacity of the soil. With the Near Infra Red (NIR) device we are able to measure over 20 soil indicators within 20 seconds, including the pH value, soil structure indicators and texture indicators. These indicators can then be used to determine a plot’s potential yield, for instance, but they also provide information on the soil’s water retention capacity, for irrigation purposes”, says Arjan Reijneveld, Eurofins Agro.*







### 100,000 samples per year

A simple example: if a soil contains insufficient nutrients, a crop's root system cannot develop fully, and can therefore not respond efficiently to irrigation. Water and nutrients are not two separate worlds, this insight is growing rapidly. Near Infra Red (NIR) helps to collect the right data and provide insight into soil and crop health, fertilisation, feed value and food safety.

*"The soil goes into a small glass pot, which is then scanned with near-infrared light using a field-portable NIR device. We assess the NIR data and report what the actual soil fertility is. So you don't have to set up the usual laboratory. That saves a lot of time and money; manual analysis often takes weeks."*

Eurofins Agro analyses over 100,000 soil samples per year. In every sample, more than 20 soil characteristics are measured. Innovative analyses lead to clear, case-specific advice, also for the level of

irrigation. It is also possible to take the soil characteristics as the basis for an indication of the potential yield, and to describe the steps needed to bring that goal within reach.

*"Naturally, everything rests on the interpretation of the data. We have done a great deal of research into this, and our recommendations are backed up by literally thousands of analyses. But just supplying the figures is not enough. It's all about the story behind the figures – how everything fits together. We always try to work with locally active information providers and advisors."*

*Our own advice is a guideline – it gets you 90% of the way: how much phosphate, how much potassium, how much organic material, and how much water a plot or a crop needs. It is up to the farmer or advisor to add the last 10% by translating this advice into practical action. Worldwide there are now thirty locations using our apparatus."*

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# GROWING POTATOES IN SALTY SOIL

*“Our farm is right next to the Wadden Sea, an intertidal zone in the southeastern part of the North Sea, so we know all about salinisation. Salinity is a growing problem in the Netherlands and other parts of the world. As a specialist company in potato breeding it’s only logical that we work on salt-tolerant varieties”, says Peter Keizer from Fobek.*



The open-air laboratory of Salt Farm Texel. Here, fresh water and seawater are mixed into 7 different salt concentrations to determine the salt tolerance of many different crops. Results can be used directly at locations in different areas.







Water-scarce areas (such as the Middle East, North Africa, Asia, and the Americas) frequently have to deal with soil salinity and brackish water conditions. The UN estimates that at least 1 billion hectares of land are currently affected by salinity, and the world loses at least three hectares of arable land every minute due to salinisation. Farmers are frequently forced to use brackish groundwater to water their crops, which reduces the overall yields and quality of

crops such as potatoes. Due to these problems, food self-sufficiency is at risk in many of these countries. A logical choice for governments and farmers would therefore be to focus on food crops that have a low water footprint and are salt-tolerant.

*“It’s pretty difficult to test new varieties in the field, under identical circumstances so that the data is reliable; after all, one heavy rainstorm can leach out all the salt.*

*Fortunately, the Salt Farm in Texel, a state-of-the-art research facility, offered the solution.”*

Potato is the champion salt tolerant staple crop with a high nutritional value and a low water footprint. It would therefore be an excellent crop to grow under water-scarce conditions. At the Salt Farm in Texel, different varieties of conventional crops have been screened during the past years, under highly controlled saline field conditions, to select the most salt-tolerant varieties. The Salt Farm facilitates this research in collaboration with Dutch breeders, such as Fobek.

Fobek breeds new potato varieties to ensure durable, safe and local food production in affected regions around the globe. A continuous drive to improve potato varieties for salt tolerance has led to amazing results; this is now being implemented in the Netherlands and Pakistan, where 6 million hectares of land is affected by salinisation. Cultivating salt tolerant crops in saline soils is an opportunity to increase agricultural production in many salt-affected areas of the world.

*“Several regions in Pakistan have been affected so badly by salinisation that the resulting salt crust has stopped people from growing anything. Within the framework of the ‘Securing Water For Food’ initiative, salt-tolerant potatoes were cultivated on this salty soil for a three-year period. Salty potatoes were successfully harvested in the first year.*

*In the second year, scaling up was the central goal. At the same time, the first four salt-tolerant potato varieties have been put forward for Pakistan’s official list of potato varieties. In the Netherlands we get yields averaging 50 tons per hectare. This won’t be the case in Pakistan. But if you can grow 10 tons where nothing grew before, then in social terms that’s still a big step forward. Worldwide, 60% of all seed potatoes come from the Netherlands. If we can succeed in including salt-tolerant varieties, we will have contributed to improving the world’s food situation.”*

The seed potato is an important pillar of Dutch agribusiness. The global market share of Dutch potato breeders is almost 10%, whereas 60% of all commercial seed potatoes worldwide are grown in the Netherlands.



Growing the salt tolerant potato in Pakistan. The first results show that the yield of the salt tolerant potato can even reach 40 tons per hectare under saline conditions.



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D. Biemond BV

Newstyle Potato







# FRESHWATER STORAGE AGAINST SALINISATION

*"We are keen to be part of the Spaarwater project, because as far as we're concerned the need for innovation is clear: we can't spray with ditch water because of brown rot, and we can't dig a well because of the salty water. In the future, salinisation could be a problem here too, as our farmland is so close to the sea", says Pieter Noordam. Mr. Noordam is a farmer on one of the Wadden islands, a group of small islands surrounded by the Wadden sea in the northern part of the Netherlands.*





# “This is a permanent system; the irrigation pipes aren’t taken away after the harvest. That is what makes this system so unique”

## Expanding freshwater availability

Spaarwater (‘save water’) is a project to decentralise water storage in the north of the Netherlands. The principle purpose of the project is to expand freshwater availability by making efficient use of the available water on site. Combining groundwater infiltration with subsurface drip irrigation achieves the highest possible use efficiency of local precipitation. The north of the Netherlands is of high agricultural value. Due to climate change this region, like the rest of the country, will suffer from freshwater shortages in the summer, with crop damage as a result.

*“The aim of the Spaarwater project is to combat salinisation. We are now in the third year of the freshwater storage test. Rainwater is captured using drains and*

*stored in a silo, then filtered through sand beds, and from there we pump it into the ground, creating an underground freshwater lens. We use the water we stored for our irrigation needs during dry periods. This is a permanent system; the irrigation pipes aren’t taken away after the harvest. That is what makes this system so unique.”*

## Countering the threat of salinisation

The growers taking part in the Spaarwater project have enough water to cover a dry period, as in the spring of 2015. By capturing rainwater on their plots in autumn and winter and storing it deep underground, they can irrigate using water from their own wells, thereby reducing the risk of crop loss. The project focusses on the Wadden Sea area at first because here reduced fresh water availability and salinisation threaten

the economic well-being of the agricultural sector. Drip irrigation can reduce water use by up to 50% compared to conventional spraying. In principle a closed, and therefore sustainable, water cycle is created.

*“In the first year the potatoes didn’t grow as well as we’d expected. It turned out that the water storage method meant the water didn’t have enough oxygen, so we modified it. In the warm, dry spring of 2015 we benefited a lot from the drip irrigation system. During this dry spell the soil stayed nice and moist, so the seed potatoes could grow well. The tuber structure looks good, so does the foliage, and there’s no sign of damage. So in a dry year this system is particularly interesting. That’s when you see the benefits, especially in more intensive farming.”*



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[Broere Beregening](#)

[BE-de-Lier](#)

[Netafim](#)

[Vrije Universiteit Amsterdam](#)

[Combidrain](#)

[Yara](#)

## Robust and efficient

Spaarwater contributes to robust and efficient agricultural activities:

- Recharge of drain water from agricultural land
- Retention of fresh drain water in a salt groundwater environment
- Self-sustainability for fresh water
- Sufficiency of fresh water originating from local sources
- Avoidance of drought damage
- Avoidance of salt damage
- Efficient irrigation with the use of drip lines
- Efficient use of fertilizer with the use of fertigation
- Extra yield of up to 17% due to drip irrigation





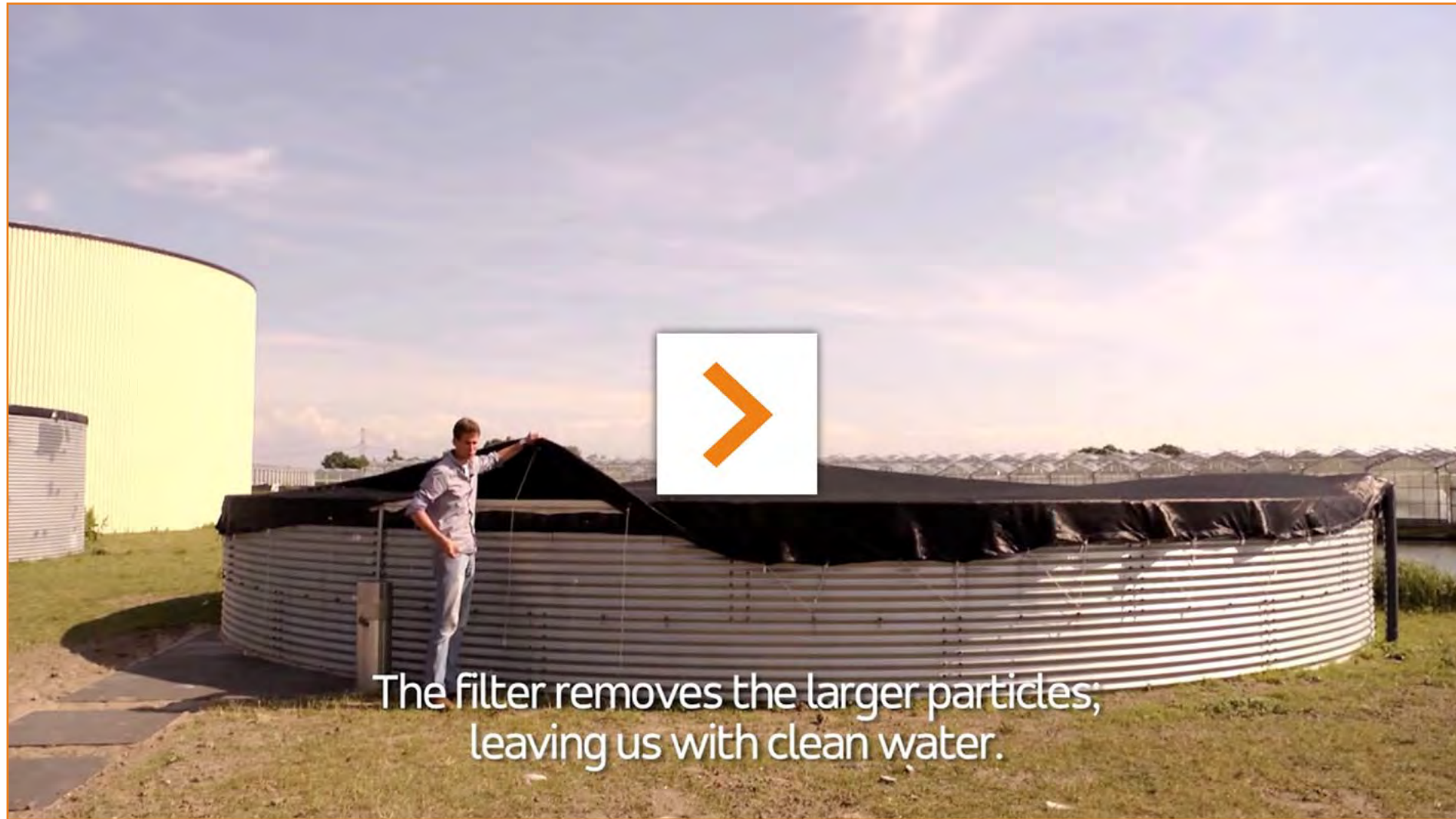


# INCREASE OF FRESH WATER AVAILABILITY BY USING SUBSOIL STORAGE

In the south-west delta of the Netherlands, in the province of Zeeland, the agricultural sector is confronted with the increasing impact of water shortage and salinization.







The filter removes the larger particles; leaving us with clean water.

*“In the Netherlands we have a yearly precipitation surplus. Traditionally, we’ve always focussed on draining the excess water into the sea as soon as possible, risking water shortages in some periods of the year. And that’s too bad, because with a more proactive resource management system*

*we could match supply and demand better throughout the year.”* These are the words of Carl Paauwe of the Waterbuffer Foundation.

*“In the province of Zeeland within a project called GO-FRESH a test is being carried out at a fruit-growing company to increase*

*freshwater availability. It is making use of a so-called ‘Freshmaker’, a technique by which fresh water is infiltrated via a drain at a depth of about 7 metres below surface, while at the same time saline groundwater is removed via a deeper-lying drain at 14 metres below surface. The existing, shallow*

*freshwater lens from which the farmer takes its irrigation water is thereby made thicker. This technique could be applied in coastal areas with shallow aquifers. Main condition is the availability of sufficient freshwater to infiltrate. With a larger freshwater supply a fruit farmer can, for instance, carry out*





preventative spraying if there is frost in early spring. When the irrigation water freezes, it releases energy in its immediate vicinity preventing the buds to freeze. .

Another test within the project GO-FRESH makes use of creek ridges– ancient, sandy creek beds and river beds which form raised ridges in the landscape after the surrounding clay and peat soils subsided as a result of poldering and draining. Here, freshwater is infiltrated in order to raise groundwater levels while depressing the underlying saline groundwater, thereby creating a larger freshwater supply. In this test, after one year the freshwater-saltwater boundary had been lowered by two metres. This simple technique is an interesting option in places all over the world; creek ridges are quite common.”

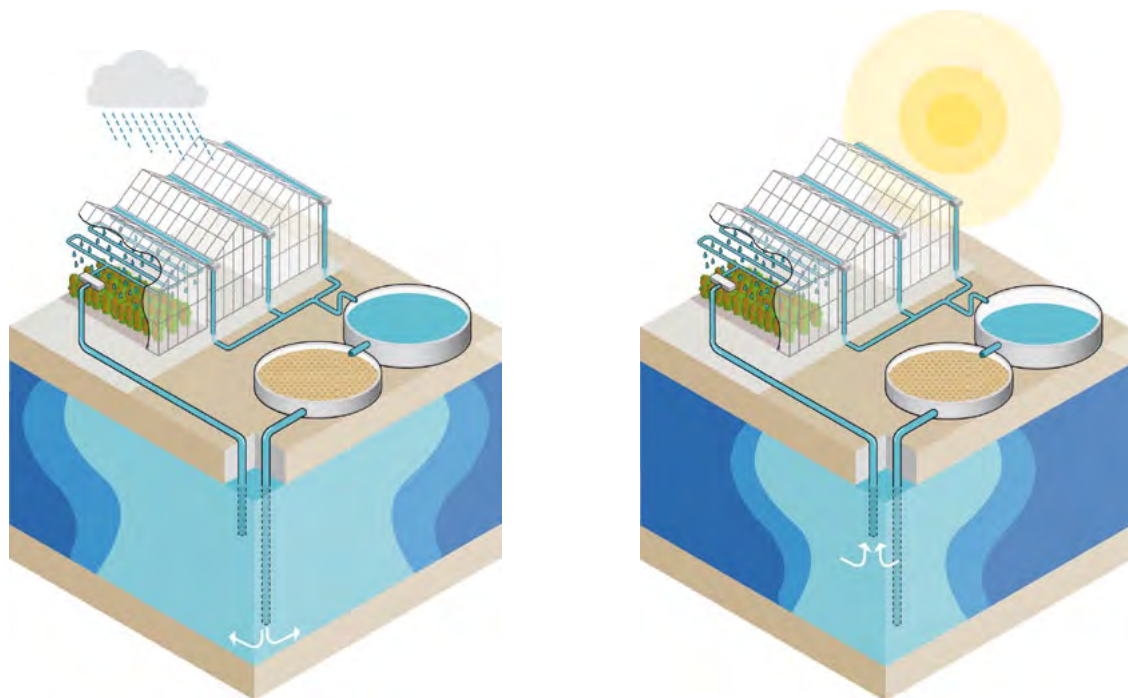
### Growing impact

A reliable freshwater supply is considered one of the key issues for future development and sustainable growth. Improving the use of existing fresh groundwater resources and using different methods to create new freshwater reserves is quite innovative and could be promising in other deltas in the world, where fresh water is becoming scarce (e.g. the Nile, the Mekong, and vulnerable islands). The main goal of the GO-FRESH project, of which the ‘Freshmaker’ is one of the initiatives, is to improve the use of existing fresh groundwater resources and to create new freshwater reserves, thereby increasing regional self-sufficiency and reducing dependency on external freshwater supplies. Research is already taking place on the theoretical feasibility of possible measures. Building on this knowledge, the

research goals are to investigate which measures actually work in practice and to analyse whether such measures are economically feasible.

### Promising technologies

- Pilot: ‘The Freshmaker’, aquifer storage and recovery (through horizontal directional drilled wells)
- Pilot: ‘ASR-Coastal’, aquifer storage and recovery (through vertical multiple partially penetrating wells)
- Pilot: ‘Creek Ridge Infiltration Test’, infiltration via drainage utilising the potential of sandy creek ridges for water storage
- Pilot: ‘Drains2Buffer’, optimising freshwater volume in shallow rainwater lenses



In 2012 the Waterbuffer Foundation ([www.waterbuffer.net/english](http://www.waterbuffer.net/english)) was founded to promote the application of underground water buffering and to increase and share knowledge of the different techniques. Agriculture and horticulture depend on high-quality fresh water. It is important to use the available fresh water supplies efficient and effective.



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Deltares

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Acacia Water

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Waterbuffer Foundation

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[Alterra Wageningen](http://www.alterra.wageningenur.nl)





# RELIABLE HYDROPONICS

Land-based cultivation techniques are exhausting the soil and cause the discharge of unwanted substances to underground and surface waters. Moreover, clean water is becoming scarce all over the world. When introducing new cultivation systems, it is therefore necessary to strongly confine emissions and to achieve water use reductions. On top of this, work efficiency, better product quality, and new market opportunities are of importance. Hydroponics offers a solution to this challenge.







Hydroponics means growing plants with nutrients and water but no soil. When used in greenhouses, hydroponics is technology and capital intensive. It is also highly productive, conserves water and land, and protects the environment. Hydroponic culture requires high agricultural skills.

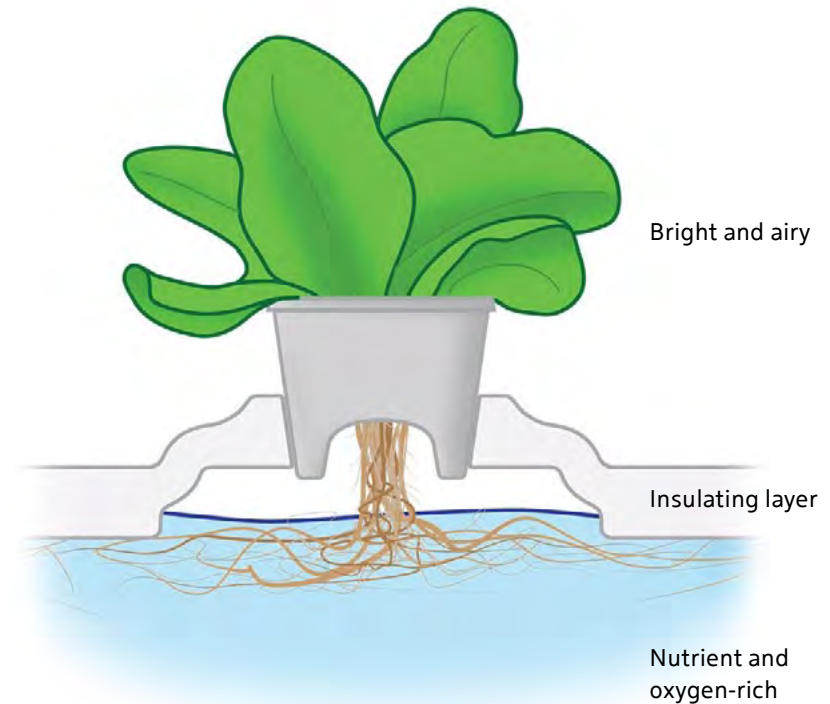
*“The unique thing about Dry Hydroponics® is that in saving water and raising productivity we didn’t necessarily want to sacrifice production quality. Many cultivation systems use too much water. We’ve worked very hard to create a situation which genuinely benefits the plant”, says Maurice van der Knaap of Dry Hydroponics®.*

**Stronger and sturdier plants**

There are many ways to deliver water to the plant root zone. For container-grown plants, each individual plant is provided with

an emitter for water from a drip irrigation system. Water may also be channelled to a continuous row of plants within a trough, as in the ‘nutrient film technique’ system. A large tray of plants may be watered from below by filling the entire tray with water and then draining all excess water. This is called ‘ebb and flood irrigation’.

*“We make sure that part, but not all, of the roots are in water. This makes the plant grow towards the water, so to speak; it has to make roots in order to reach the water. If the roots are all standing in water already, then the plant doesn’t have to make roots anymore and it gets lazy. With our technique, plants get stronger and sturdier. The dry matter content of lettuce rises to 5%, for instance, while in other systems it’s about 4%. This has a considerable effect on the taste and shelf life.”*



**“We have stripped our technique down to the most basic system that is consistent with functional efficiency and stability. To put it simply: when we deliver a system, it has to be so good that we’re never called back because something’s not working”**



**Contact**

Dry Hydroponics

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# PIMAPPING® MAKING SUGARCANE MONITORING SWEETER

eLEAF's PiMapping® technology transforms meteorological and remote sensing based data into quantified parameters relevant to crop production. *“Based on satellite information, we can estimate crop growth and water consumption. This is what makes eLEAFs PiMapping® Technology so unique. We go beyond vegetation indices that indicate whether a plant is healthy or not. We provide quantified information on real-time biomass production (in kg/ha) and actual crop water consumption (in mm)”*, says Maurits Voogt, Managing Director of eLEAF.







eLEAF applies its PiMapping® technology to a wide variety of crops worldwide, with a focus on sugarcane in Southern Africa. Commercial sugar companies manage large production estates in several geographical areas. Monitoring production on all these sites can be challenging. Additionally, sugarcane is grown in densely planted fields which obstructs physical crop inspection after the initial growing stage, so being able to monitor the crop by satellites is a welcome solution.

### Sugarcane monitoring in South Africa

In South Africa, about 22,500 registered sugarcane growers produce an average of 19 million tons of sugarcane per year from 14 mill supply areas. About 21,110 of them are small-scale growers, only producing 9% of the total crop. There are about 1383 large-

scale growers responsible for 83% of total sugarcane production. Milling companies with their own sugarcane estates produce 8% of the crop.

PiMapping® based crop monitoring helps farm managers to locate areas that are performing below potential and to prioritise fields that need immediate attention. An example at field level is shown in the figure below, where areas with lower biomass production are clearly identified in red, indicating possible pests, diseases or other potential threats. In this South African example, farm managers were able to take mitigating action which increased production with 1000 kg/ha within one month. The image shows how the biomass production deficit in low performing areas was reduced from 2000 kg/ha to 1000 kg/ha

between the 10th of November and the 7th of December 2014.

*“Being able to pinpoint problem areas quickly and accurately allows farmers to take action and limit damage to the minimum. This has an immediate effect on yield quality and quantity leading to direct financial gain for the producer”* says Maurits Voogt.

In similar manner the crop water needs can be mapped in real-time, supporting farmers to irrigate the right amount, at the right location at the right time. This way water can be saved while maintaining optimum production levels. At estate management level tracking biomass production provides a dynamic overview of production at any time. This streamlines production management, agronomy services, post-harvest planning,

and logistics management practices from field to mill, leading to reduced associated costs all along the value chain.

eLEAF’s PiMapping® algorithms are the result of over 20 years of extensive research and validation. For sugarcane specifically, PiMapping® data has been demonstrated and validated in the SugarcaneLook project in South Africa. The success of this project resulted in the current use of PiMapping® data in the day to day management of several commercial parties. Currently eLEAF is monitoring sugarcane in South Africa, Malawi and India.



#### Contact

eLEAF

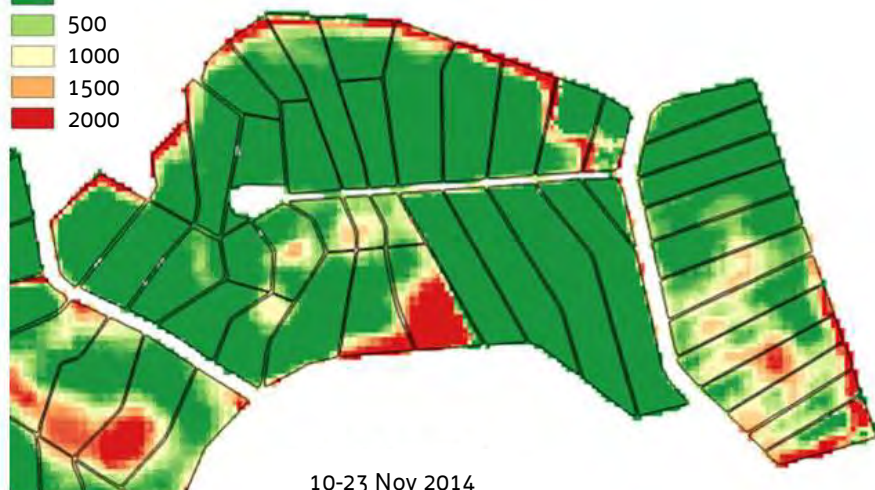
Email: [info@eleaf.com](mailto:info@eleaf.com)

Web: [www.eleaf.com](http://www.eleaf.com)

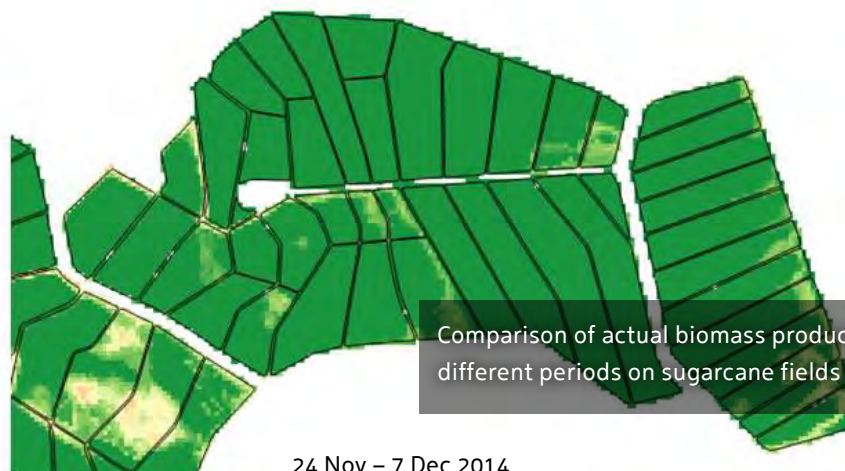
#### Legend

Biomass production deficit (kg/ha/biweekly)

- 0
- 500
- 1000
- 1500
- 2000



10-23 Nov 2014



24 Nov – 7 Dec 2014

Comparison of actual biomass production deficit for two different periods on sugarcane fields in South Africa.







# SATELLITE FOR CROPS BANGLADESH

**Agricultural monitoring and information services for farmers and decision makers.**

To strengthen the agricultural sector and fortify food security in Bangladesh, BRAC (Bangladesh Rural Advancement Committee) and the Center for Environmental and Geographical Information Services (CEGIS) use remote sensing technology. Satellites provide unbiased and consistently collected data of large areas, which if properly processed are the basis for agricultural monitoring and information services for farmers and decision makers. BRAC and CEGIS have commissioned the Dutch consortium of SarVision, eLEAF, Deltares and Nelen & Schuurmans to demonstrate that reliable information based on satellite data can be provided year round and under various weather conditions.





BRAC and CEGIS need reliable information on agricultural development under various weather conditions, with special attention to the (pre-)monsoon period when it is cloudy. This information can be obtained year-round from the processing of radar and optical satellite data combined. The satellite-based data products resulting from this project will be made available through an Open Data Portal for interested stakeholders and the development of applications.

### Project objectives

The usefulness of the data obtained will be demonstrated in two pilot areas. The satellite data and other (basic) data are available through a Data Portal in order to make the data directly accessible for direct users and other stakeholders as well as for the development of diverse applications. The project also looks at business opportunities for satellite data based services for BRAC and other potential users in the public and the private sector.

### Satellite data

For this project a combination of optical and radar satellite data is used to produce crop information. Optical satellites provide a wide range of information about crops, including biomass increase and water use efficiency. Nevertheless, given the frequent cloudy and foggy circumstances in Bangladesh, radar satellites are needed to 'look through' the clouds. The combined satellite data products include parameters like crop type, crop growth stage and biomass (production) and for clear periods also evapotranspiration and

water stress. Every two weeks new data is collected and processed. The consistent time-series of satellite data provide year round field information, which could be used to get information about cropping patterns, relative performance of a field compared to similar fields, areas affected by floods, storm surges, cyclones, etc.

In this project data is collected and processed for two pilot areas in the Western part of Bangladesh, one in Bogra and one in Magura. The processed satellite data will be validated with field data, to get a clear image of the actual accuracy. Based on data of the pilot areas a match will be made with actual use-cases within BRAC and other potential users. Also BRAC and CEGIS will receive training in using the data.

### Open Data Portal

The Data Portal, called Lizard (developed in the Netherlands), will be used to make the data accessible to the end-users. In a Google Maps like web-interface the user can navigate and use the data immediately for his area. The Data Portal will also be used to demonstrate the satellite data and to give access to people interested in the data.



### Contact

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### Partners

[SarVision](#)

[eLEAF](#)

[Deltares](#)







# N, P AND K RECOVERY FROM AGRI-BIOMASS STREAMS

*“Phosphorus (P), nitrogen (N) and potassium (K) can be recovered from sugar beets, potatoes, chicory roots and other biomass streams. These nutrients can then be used as plant based fertilisers in agriculture and therefore close the cycle for nutrients and residual-organic matter”, says Johan Raap from Royal Cosun.*







“This approach is not only beneficial to the environment, but also to satisfy society’s need for responsible products and production processes”

Agri-industrial group Royal Cosun consists of several companies that fabricate products and ingredients for nutrition from soil based agricultural raw materials. These products and ingredients are used in the food and retail industry. The Royal Cosun group consists of the following companies: Aviko, Duynie, Sensus, Suiker Unie and SVZ. Well-known brand names are Suiker Unie, Van Gilse and Aviko.

Royal Cosun has the ambition to use the raw materials as much as possible. This approach is not only beneficial to the environment, but also to satisfy society’s need for responsible products and production processes. The products are used in the human food sector,

but also in the animal feed sector and renewable chemicals as replacement for petroleum based products. The remaining by-products are used for production of renewable energy (biomethane).

Biomass digesters produce bio-methane and digestate from the byproduct-streams of, amongst others, sugar production. The digestate is separated in a dry and wet fraction. Especially the dry fraction is used as an organic fertiliser in agriculture. At this moment research is done on the recovery of N, P and K from the liquid fraction. The research also focuses on how to make these recovered nutrients suitable for the use as a fertiliser in agriculture. A good nutrient

balance contributes to a better retention of water in the soil, resulting in a higher yield. Apart from the digestate also struvite (magnesium ammonium phosphate) is recovered from the potato process water. Struvite recovery from chicory roots processing will be in operation in the near future.

Royal Cosun is a frontrunner in the food industry to reuse phosphor at the processing of agro raw materials. For instance, Betacal, a lime fertilizer in the agriculture sector, is used already for many of years. Betacal contains next to Calcium and other minerals, also phosphor.



#### Contact

Royal Cosun group

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#### Royal Cosun group consists of

[Aviko](#)

[Duynie](#)

[Sensus](#)

[Suiker Unie](#)

[SVZ](#)



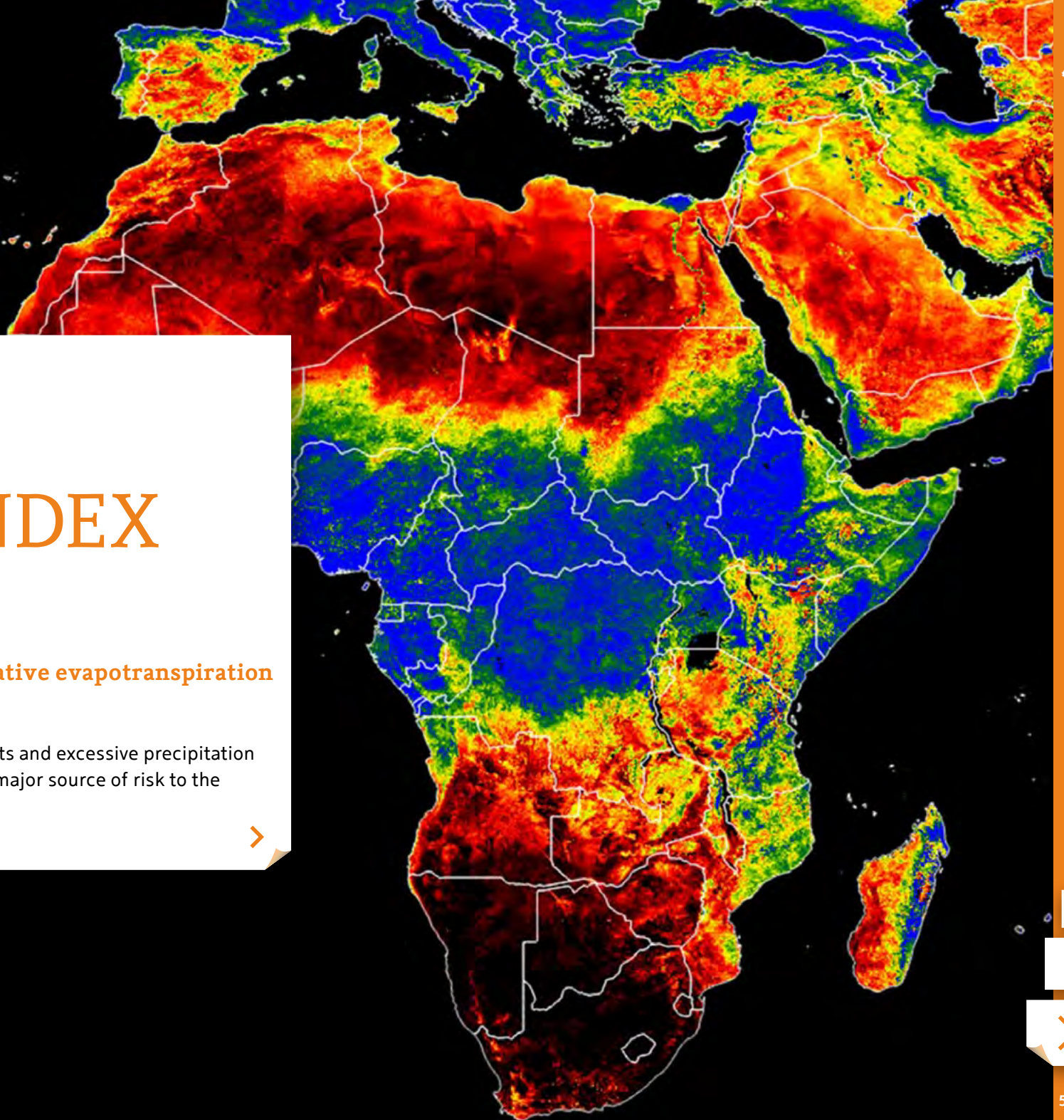




# METEOSAT DROUGHT INDEX INSURANCE

**Affordable crop insurance based on relative evapotranspiration**

Increasing extreme weather events such as droughts and excessive precipitation are main causes of crop loss in Africa. They pose a major source of risk to the welfare of rural households.







Crop insurance can increase financial resilience and unlock credit, allowing African smallholder farmers to invest in high-quality inputs, reach higher production and improve food security and income. The main challenges that crop insurance in Africa face are related to scale and costs. Low costs are considered mandatory and would be enabled by using index insurance. But throughout Africa index insurance has been frustrated by lack of data.

EARS drought index insurance is based on innovative satellite technology and provides an affordable alternative to expensive traditional loss based crop insurance. Using 33 years of Meteosat data and near real-time data reception we develop evapotranspiration-based drought insurance

indices. EARS continuously monitors drought across the entire African continent at 3 km resolution.

Evapotranspiration is the best indicator of crop water availability and has a linear correlation with crop yield (Doorenbos & Kassam 1979, "Yield response to water", FAO irrigation and drainage paper 33.). It is therefore a much more suitable indicator of agricultural drought than rainfall.

Based on these data, EARS designs index insurance solutions for any location in Africa. Using its Meteosat receiving system, the company will also monitor the insurance index during the growing season and calculates and reports pay-out to the insurance stakeholders.

Working together with local insurers in an increasing number of countries, our

technology can provide affordable insurance for farmers everywhere in Africa.

### Results

Drought insurance products have been developed or are currently on the market in a range of countries across Europe, the middle east and Africa. These products can be tailored to various specific crops but they can also offer more generic coverage against drought.

### Impact

Both commercial and smallholder farmers, cooperatives, or any value-chain stakeholders can insure themselves or their members against drought related yield losses, thereby improving resilience and opening up access to financial services.

**“Using 33 years of Meteosat data and near real-time data reception we develop evapotranspiration-based drought insurance indices and continuously monitor drought across the entire African continent”**



#### Contact

EARS Earth Environment Monitoring BV

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# REAL-TIME HELP TO LOCATE GOOD GRAZING LANDS AND WATER

**Direct and objective assistance for livestock farmers using satellites in Mali, Ethiopia and Tanzania**

Climate change hits the dry areas of Africa hard. Areas that were once green are no longer. Some water points dried up and others emerge. Traditionally farmers rely on information of other farmers, scouts and family to find good grazing grounds. There is a clear need for additional sources of information.





## Using various high and low resolution satellites, a real-time mapping service is set up for specific areas.

Using various high and low resolution satellites, a real-time mapping service is set up for specific areas. This information is updated every 10 days. Through a community mapping exercise, farmers have been asked where their grazing grounds are and how their migration routes run. Please see [www.hoefsloot.com/saparm](http://www.hoefsloot.com/saparm)

### Results

Farmers tell us they like our maps beyond expectation.

### Impact

Investigation revealed that we have changed migration routes in Afar, Ethiopia.

### Spin off

We started in Afar, Ethiopia. Now we also do Oromia, and parts of Tanzania and Mali.



### Contact

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### Partners

[SNV](#)

[PCI](#)

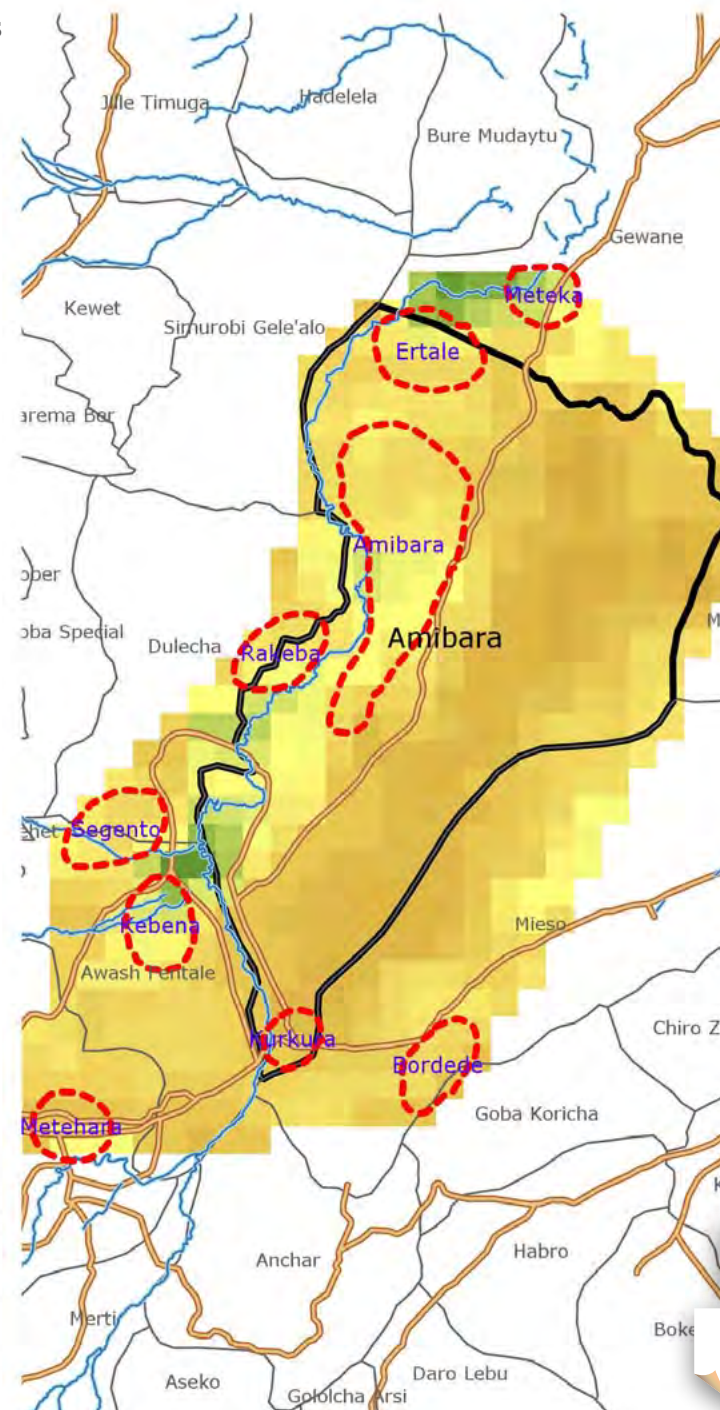
[ACF](#)

## Grazing Conditions April 20, 2016

### Legend

- Kulihina-ana
- Wali-ena-ana
- Endidi

- Roads
- Woredas
- Grazing Areas
- Rivers



### Satellite Assisted Pastoral Resource Management (SAPARM)

Created with LEAP software and disseminated every 10 days. Based on METEOSAT NDVI combined with information on grazing areas provided by local livestock farmers







# FISH FARM MONITORING

## Protection against Harmful Algae Bloom (HAB)

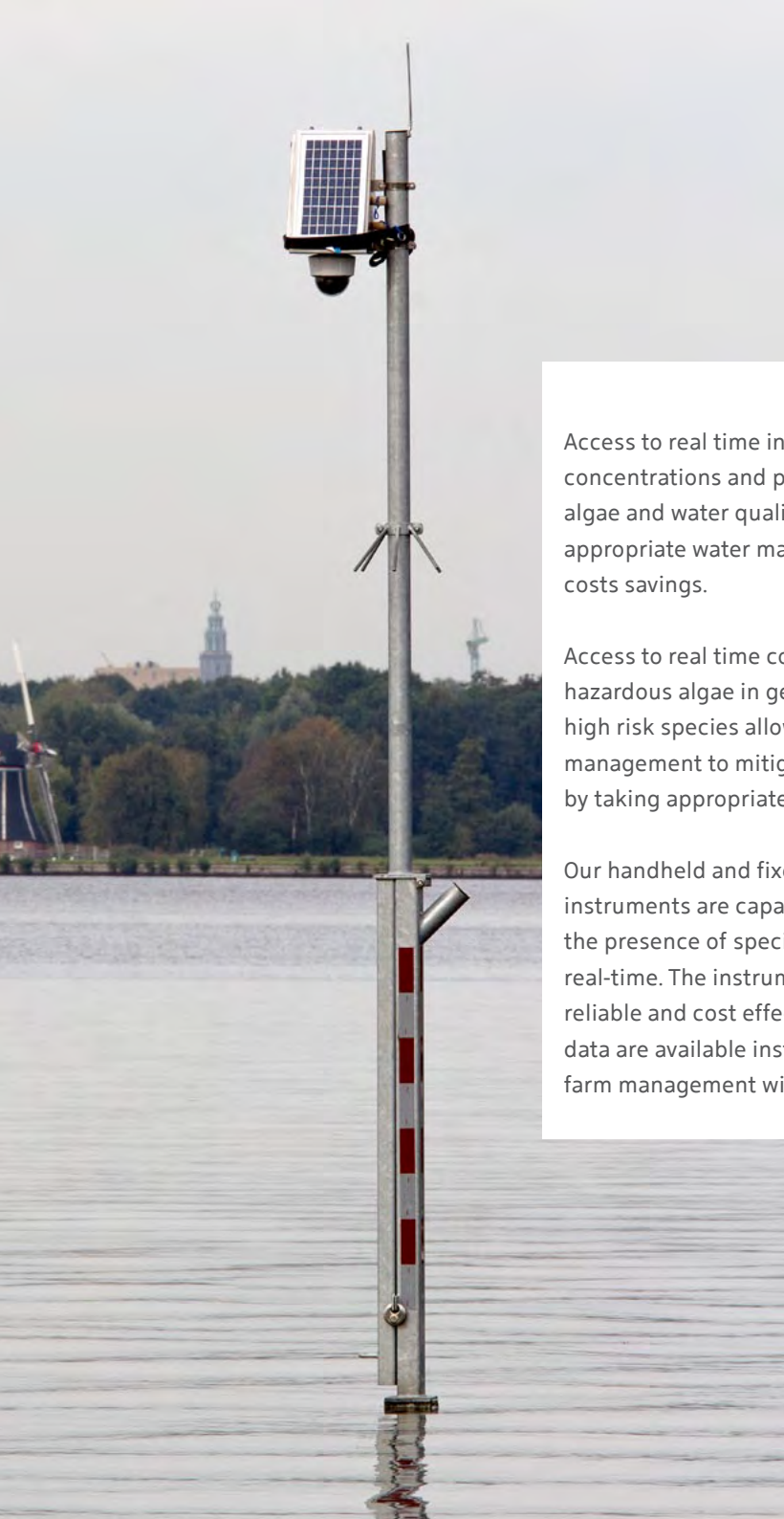
Surface water quality is a global concern for both salt and fresh water aquaculture. Fish suffer mortality due to the presence of harmful algae blooms around the farms. Specific algae species may cause 100% mortality in a matter of days. The global aquaculture market is desperately seeking for options to mitigate this risk.







## “Our handheld and fixed position field instruments are capable of detecting the presence of specific harmful algae in real-time”



Access to real time information on the concentrations and presence of harmful algae and water quality parameters enables appropriate water management and major costs savings.

Access to real time concentrations of hazardous algae in general and particular high risk species allows the fish farm management to mitigate risks of mortality by taking appropriate actions.

Our handheld and fixed position field instruments are capable of detecting the presence of specific harmful algae in real-time. The instruments are easy to use, reliable and cost effective. Water quality data are available instantaneously and hence farm management will not lose time to take

decisions. With our instruments mortality rates will be reduced and higher production volumes will be reached.

### Results

We are closely collaborating with Marine Harvest to set up dedicated services fit for farm management purposes. Field trials are ongoing at the Vancouver Island (Canada) Quatsino Sound fish farm facilities. Further activities around aquaculture monitoring are projected in Chile.

### Impact

Harmful algae blooms are envisaged as the number one risk factor in aquaculture in open waters. Huge economic losses are reported year after year. Both the aquaculture businesses and the insurers

are very focused on reducing risks and increasing profits in food production. A dedicated monitoring system which will help farm management to increase production and reduce mortality will make a real difference.

### Spin off

The services may be used for both fresh and salt surface water monitoring. The aquaculture business is a multibillion dollar business and harmful algae are reported as the main risk factor in this business.

Global introduction of monitoring services in aquaculture will become imminent to secure the business.



### Contact

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### Partners

[Water Insight](#)



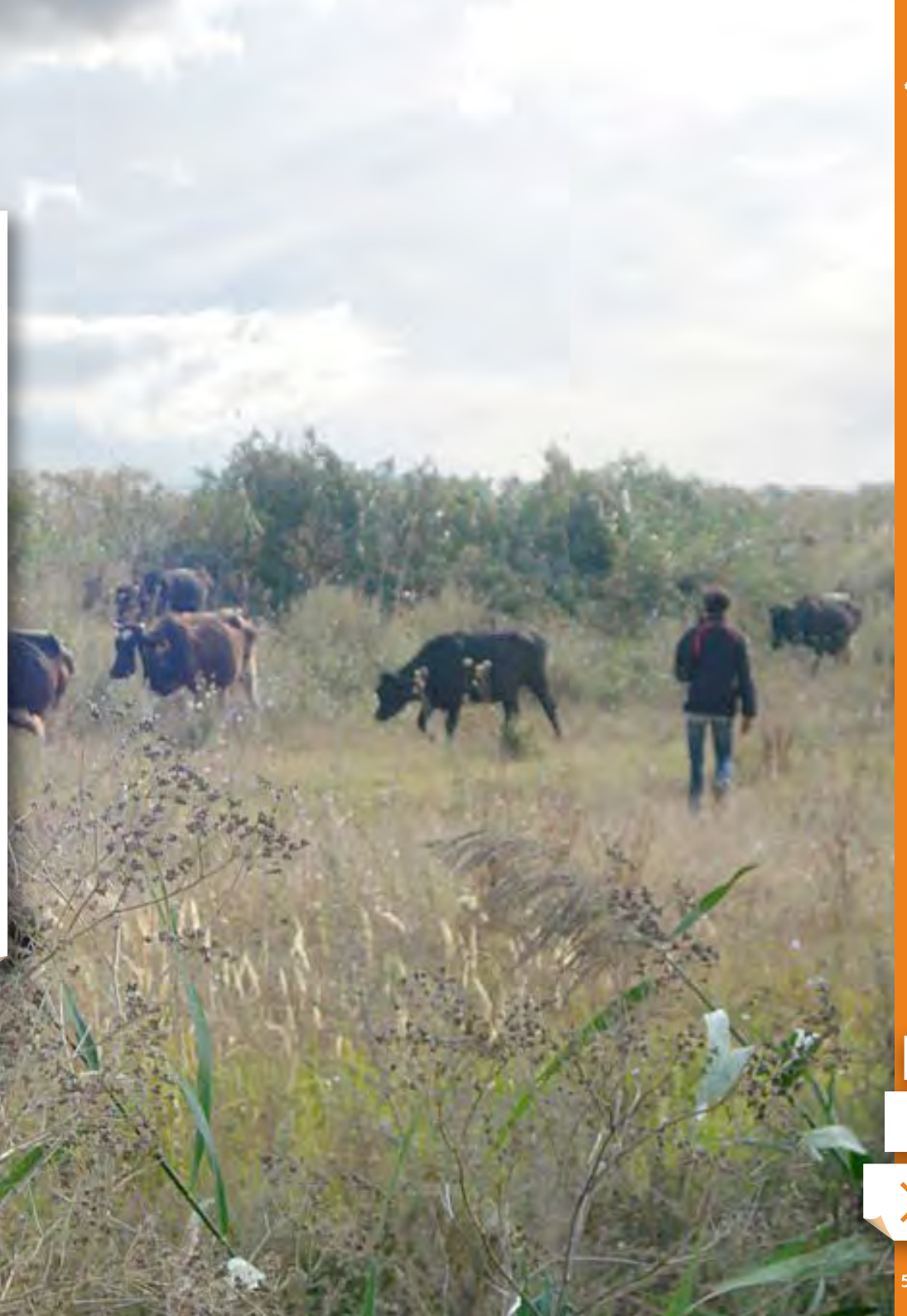




# EFFICIENT LAND USE BY REDUCING LAND FRAGMENTATION

**Better agricultural conditions by improving land management in Romania**

In Romania huge agricultural potential is unused, mainly due to the lack of up-to-date land administration in combination with fragmentation of land. Registration of rights combined with re-dividing of ownership and re-assignment of land use create or improve conditions for sustainable urban and rural development.







Land consolidation and voluntary re-allotment are effective instruments for creating farm enlargement, increasing natural values of areas but also to help achieve realization of retention areas.

### Benefits

- Possibility of multi-purpose approach: integrating improvements of the farming-structure, nature, infrastructure or water retention;
- Process of exchanging land is often cheaper than buying and selling or expropriate land;
- Efficient agricultural production (contiguous plots).

### Results

- Reviewed methods to reduce land fragmentation and enlargements of farms by applying land consolidation techniques in the pilot area(s);
- Improved cooperation between all stakeholders within the agro-chain (focus on improvement);
- Best practice working methods and organization are documented and presented to all key stakeholders in Romania during the final seminar (2012);
- An action plan to rollout the pilot project for land consolidation in Romania is developed and shared with all key stakeholders in the agro-sector;
- A study is executed and presented at Universities in Romania.

### Impact

The project pilot established six voluntary parcel exchanges showing that, no matter the circumstances, improvements in agrarian structure can be achieved.

# “Land consolidation and voluntary re-allotment are effective instruments for creating farm expansion”



### Contact

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### Partners

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Pro Frizon SRL ([j.houtsma@davincifinance.nl](mailto:j.houtsma@davincifinance.nl))





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P/a Netherlands Water Partnership

Mr. Peter Prins

Special adviser More Crop per Drop

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For more Dutch expertise on Water & Agrifood,  
check out our website

[www.dutchwatersector.com/agrifood](http://www.dutchwatersector.com/agrifood)



This publication was supported by the Partners for Water programme and realized in close cooperation with the Dutch Ministry of Economic Affairs and the Netherlands Enterprise Agency.

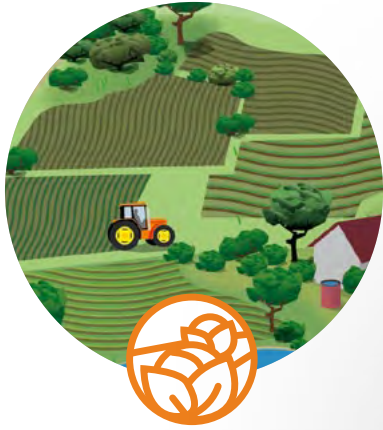






Click to go to related articles

Scope



Agriculture



Horticulture



Aquaculture



Cattle farming

Themes



Water use efficiency >



Soil quality & nutrients >



Crop variety >



### Water use efficiency

Water is essential for the agrifood sector, but it is getting scarcer and countries face serious challenges due to climate change. The available water therefore must be used efficiently. New techniques offer all kinds of sustainable, efficient en cost-effective solutions that enable farmers to use their water wisely.



Quality & quantity >



Smart information solutions >



Strengthening farmers >

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# INTEGRATED APPROACH ON WATER & AGRIFOOD

little water, the amount of nutrients actually required by the soil, skilled management and an effective governance structure. It means not being satisfied with part-solutions to part-problems but always looking beyond the boundaries of one's own discipline. And improving existing solutions, because we believe that we can always do things better. That is why in this portfolio the broad spectrum of Water & Agrifood is taken into account. The scope of this portfolio comprises: Agriculture, Horticulture, Aquaculture and Cattle farming.







Click to go to related articles

Scope



Agriculture



Horticulture



Aquaculture



Cattle farming

Themes



Water use efficiency >



Soil quality & nutrients >



Crop varieties >



Soil quality & nutrients

Poor soil structure due to intensive use causes runoff and reduces the water storage capacity of the soil. Full understanding of the soil condition is therefore essential for making the right decisions on irrigation and fertilization. A soil that is well maintained forms the basis of effective water management.



Crop quality & quantity >



Smart information solutions >



Strengthening farmers >

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Water use efficiency >



Soil quality & nutrients >



Crop variety >

**Crop variety**

Difficult environmental conditions demand new crop varieties that are resistant to drought and salinisation. It brings crop yield reliability, but also different product attributes such as taste, size, shape and shelf life, depending on the different markets and customer preference.



Quality & quantity >



Smart information solutions >



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Scope



Agriculture



Horticulture



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Cattle farming

Themes



Water use efficiency >



Soil quality & nutrients >



Crop varieties >



Salinity

Climate change (sealevel rise) and evaporation brings the problem of salinisation which makes agricultural areas less suitable for traditional crops. Fortunately, more and more salt-tolerant crops are available today. Also, storing fresh water underground safeguards irrigation water supplies in areas where surface water is threatened by salinisation.



Quality & quantity >



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Scope



Agriculture



Horticulture



Aquaculture



Cattle farming

Themes



Water use efficiency >



Soil quality & nutrients >



Crop varieties >

### Yield quality & quantity

Long periods without rain can ruin crops, lower crop yields and have a negative effect on the quality. Effective water storage solutions and less nutrient run-off can increase the yield quality and quantity. With more mouths to feed in the coming decades farmers have to make the best use of the arable land.



Yield quality & quantity >



Smart information solutions >



Strengthening farmers >

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Scope



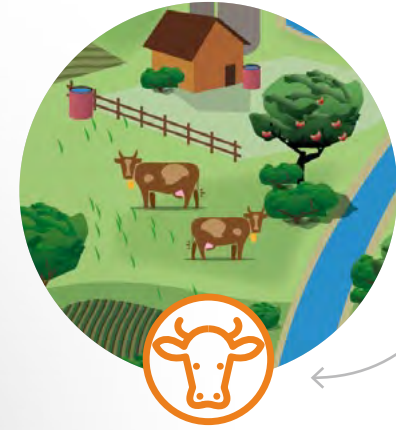
Agriculture



Horticulture



Aquaculture



Cattle farming

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Themes



Water use efficiency >



Soil quality & nutrients >



Crop varieties >



**Smart information solutions**

An important pre-condition for successfully coping with water related events is access to reliable and accurate data that can be translated into smart information solutions. These solutions can provide water managers and farmers with better insight in amongst others their water resources. This is essential for decision-making and operational management.



Quality & quantity >



Smart information solutions >



Strengthening farmers >

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Scope



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Water use efficiency >



Soil quality & nutrients >



Crop varieties >



### Strengthening farmers

Creating sustainable agribusiness is not only dependent on creating the right conditions for crops and cattle. It is also about strengthening the position of farmers through cooperation, land ownership and distribution and finding the right market for your produce, for instance. By combining these two, we ensure meeting the rising demand for food.



Quality & quantity >



Smart information solutions >



Strengthening farmers >

Click to read more about the themes

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# AGRICULTURE



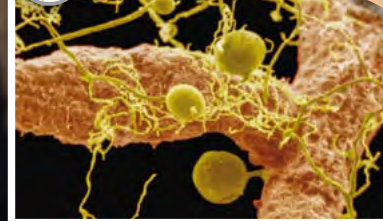
FROM FIELD TO SUPERMARKET >



AGRI GULF FOR BETTER CROPS >



CLIMATE PROOF SOIL AND WATER MANAGEMENT IN... >



FUBGI AND SOIL QUALITY TO IMPROVE WATER UPTAKE >



PRECISION AGRICULTURE IN NORTHWEST EUROPE >



THE LINK BETWEEN WEATHER DATA AND CROP ... >



LOOKING UNDERGROUND WITHOUT DIGGING >



ONIONS THAT CAN STAND THE HEAT >



CROSS-OVER BETWEEN SOIL AND WATER; NEAR INFRA RED >

8 more







# AGRICULTURE



GROWING POTATOES IN SALTY SOIL >



FRESHWATER STORAGE AGAINST SALINISATION >



INCREASE OF FRESH WATER AVAILABILITY BY USING ... >



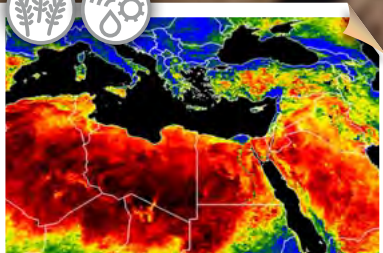
PIMAPPING® - MAKING SUGARCANE MONITORING ... >



SATELLITE FOR CROPS BANGLADESH >



N, P AND K RECOVERY FROM AGRI-BIOMASS STREAMS >



METEOSAT DROUGHT INDEX INSURANCE >



EFFICIENT LANDUSE BY REDUCING LAND ... >



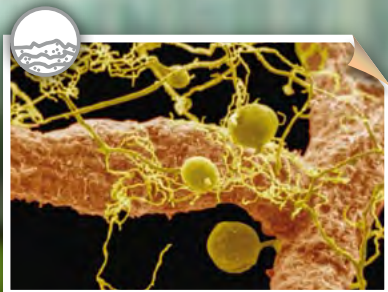




# HORTICULTURE



BUSINESS FROM WASTE & WATER >



FUNGI AND SOIL QUALITY TO IMPROVE WATER UPTAKE >



PRECISION AGRO CULTURE IN NORTHWEST EUROPE >



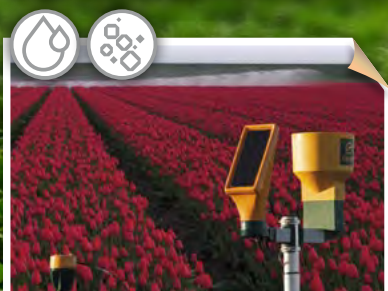
THE LINK BETWEEN WEATHER DATA AND CROP... >



HALF THE WATER JUST AS MANY STRAWBERRIES >



WATER AND FERTILIZER REUSE FOR HORTICULTURE >



LOOKING UNDERGROUND WITHOUT DIGGING >



CROSS-OVER BETWEEN SOIL AND WATER; NEAR INFRA RED >



INCREASE OF FRESH WATER AVAILABILITY BY USING ... >

3 more



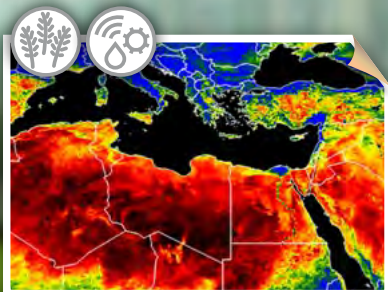




# HORTICULTURE



RELIABLE HYDROPONICS >



METEOSAT DROUGHT INDEX  
INSURANCE >



EFFICIENT LANDUSE BY  
REDUCING LAND ... >







# AQUACULTURE



RELIABLE HYDROPONICS >



FISH FARM MONITORING >







# CATTLE FARMING



THE LINK BETWEEN WEATHER  
DATA AND CROP... >



REAL-TIME HELP TO LOCATE  
GOOD GRAZING LANDS ... >



EFFICIENT LANDUSE BY  
REDUCING LAND ... >







# WATER USE EFFICIENCY



FROM FIELD TO SUPERMARKET



BUSINESS FROM WASTE & WATER



AGRI GULF FOR BETTER CROPS



CLIMATE PROOF SOIL AND WATER MANAGEMENT IN...



PRECISION AGRICULTURE IN NORTHWEST EUROPE



HALF THE WATER JUST AS MANY STRAWBERRIES



WATER AND FERTILIZER REUSE FOR HORTICULTURE



LOOKING UNDERGROUND WITHOUT DIGGING



ONIONS THAT CAN STAND THE HEAT



7 more



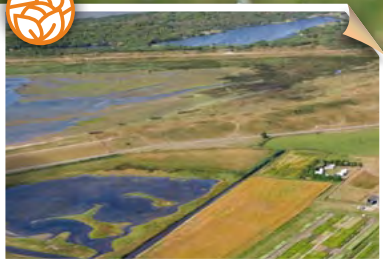




# WATER USE EFFICIENCY



CROSS-OVER BETWEEN SOIL AND WATER; NEAR INFRA RED >



GROWING POTATOES IN SALTY SOIL >



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RELIABLE HYDROPONICS >



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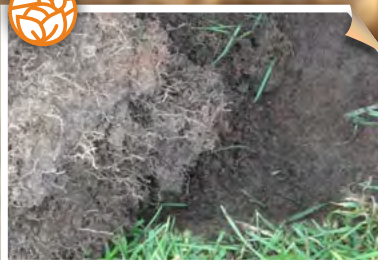
# SOIL QUALITY & NUTRIENTS



BUSINESS FROM  
WASTE & WATER



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CROPS



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RELIABLE HYDROPONICS



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N, P AND K RECOVERY FROM  
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# CROP VARIETY



ONIONS THAT CAN STAND  
THE HEAT







# SALINITY



HALF THE WATER JUST AS MANY STRAWBERRIES >



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INCREASE OF FRESH WATER AVAILABILITY BY USING ... >







# YIELD QUALITY & QUANTITY



FROM FIELD TO SUPERMARKET



BUSINESS FROM WASTE & WATER



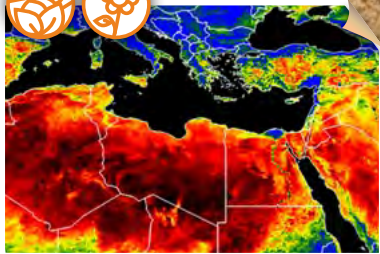
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FISH FARM MONITORING







# SMART INFORMATION SOLUTIONS



AGRI GULF FOR BETTER CROPS



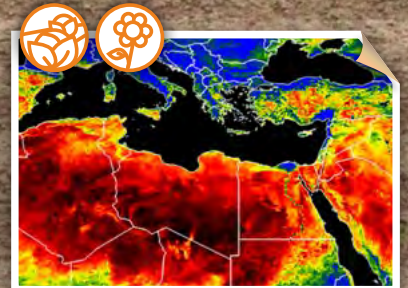
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REAL-TIME HELP TO LOCATE GOOD GRAZING LANDS ...



FISH FARM MONITORING







# STRENGTHENING FARMERS



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SUPERMARKET >



REAL-TIME HELP TO LOCATE  
GOOD GRAZING LANDS ... >



EFFICIENT LANDUSE BY  
REDUCING LAND ... >

