Knowledge grows

November 2015

Climate Smart Agriculture

Making agriculture part of the food and climate solution

half a trillion tons of CO_2 emissions avoided
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more crop per drop:
adapting fruit production to arid conditions
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◂
Slash-and-burn farming contributes to deforestation and major CO_2 emissions.

◂▾
Freshwater withdrawal from agriculture will reach unsustainable levels if efficiency is not improved.

▸
Food security, climate change and resource scarcity are interlocked issues.

▸▾
Improving both profits and the environment can be done according to a four-year scientific project.

▾
With a sustainability conscious approach, European farmers have made major progress.

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Inside back cover page has additional info on company facts and performance. Yara delivers solutions for sustainable agriculture, the environment and safe and efficient industry operations.
Founded in Norway in 1905, Yara has a worldwide presence with sales to 150 countries.

Published by Yara 2015 This magazine has been published by Yara International ASA (Yara) with the intended purpose of highlighting some important aspects of Climate Smart Agriculture (CSA). It is however not a full representation of the topic, or of Yara's knowledge, positions and solutions to CSA and related practices.

We need smarter farming

CEO Svein Tore Holsether argues the case for smarter farming: what is needed to drive development towards more Climate Smart Agriculture (CSA)

Q: Svein Tore Holsether, CEO of Yara – what is Climate Smart Agriculture?

A: There are three key elements: We must continue to raise productivity and yields. We must adapt to the coming climate changes. And we must work smarter to drive down emissions. All at once!

Q: Can you explain how increased productivity and yields play a role?

A: To grow more food we must either achieve higher yields – or expand farmland. Farmland expansion causes deforestation, which again releases massive amounts of CO_2. Deforestation is a major source of emissions caused by agriculture.

Q: Many see intensive agriculture as a major environmental issue. Do you disagree?

A: Both farming and fertilizer production cause emissions. We need to limit these to a minimum – also by reducing food waste. But the key is to achieve higher yields through smarter farming: Reducing deforestation as well as other environmental impacts of intensive farming.

Q: Work smarter – how can we do that?

A: We need to partner with the farming community to optimize resource use – more crop per drop of water, acre of land and kilo of fertilizer. At the policy level, there is a strong need to consider agriculture as a system – including the effects on land use change.

Q: What strategies are emerging to handle these issues?

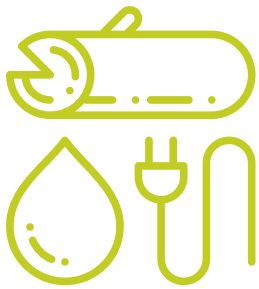
A: I see a need to strengthen international leadership and coherence. In September 2014, Yara had the pleasure of joining the new Global Alliance on Climate Smart Agriculture. As an open platform across sectors, this has a potential to really make a difference. Also, an important next step is to firmly integrate the link to global warming into agricultural development.

Q: How will Yara contribute?

A: We have halved our own greenhouse gas (GHG) emissions, and we are driving the development of carbon footprint methodologies in our industry. Now, we are actively searching for collaboration and partnerships to put CSA into practice, promoting climate smart solutions through the value chain of food. Our crop nutrition solutions can contribute to location-specific CSA strategies and target yields.

Q: Can we feed the future in a world of global warming?

A: I firmly believe that is possible. But I am also convinced that global leaders need a wakeup-call. We need to address these entangled issues in parallel, and we need to do it together.



Climate as a driver for food security strategies

The global food system has overcome great challenges before. But in the coming 50 years, we need to grow as much food as over the past 10,000 years combined. Eliminating hunger is possible, but successful transformation requires consensus, collaboration, innovation and capacity investments by all stakeholders – at an unprecedented scale.

Food, resources, fresh water, energy and climate change are entangled issues which must be understood in the context of one another.

Food

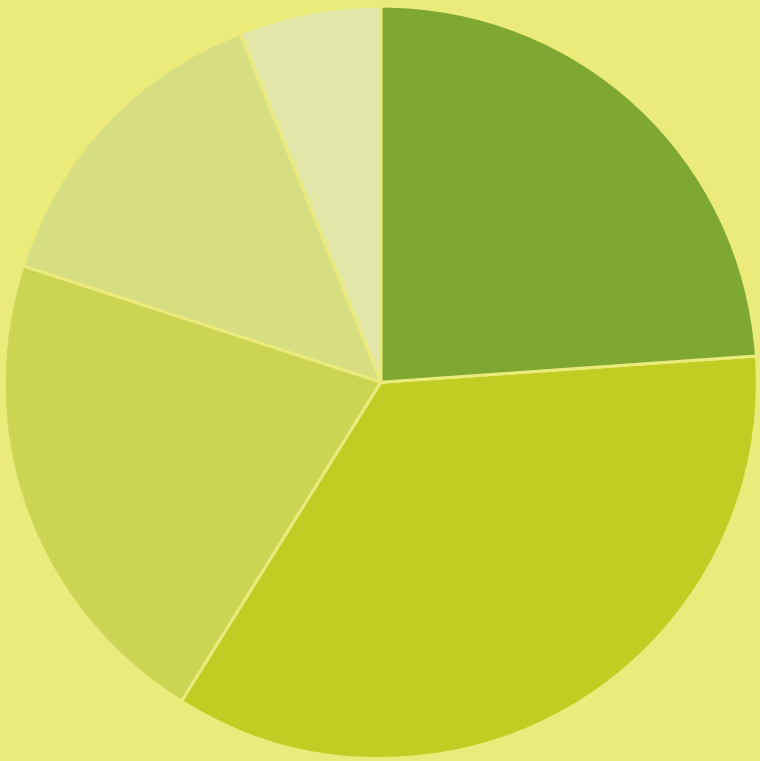
Underpinned by the megatrends of population growth and increased prosperity, the need for food is growing. With a global population expected to exceed 9 billion in 2050, and dietary changes, food production is required to increase by 60% from a 2005/07 baseline. Even achieving this target would still leave more than 300 million hungry, with major regional imbalances, e.g. in Sub-Saharan Africa. This should further drive policy debates on options to aim for zero hunger.

Resources

The fresh water withdrawal from agriculture will, in a business as usual scenario, exceed the global limits of what is sustainably available by 2030. Also, productive farmland in areas close to the market is in scarce supply, and land degradation is an important issue.

Global GHG emissions

About one fifth of all emissions comes from agricultural activities – with land use change as the most important part.



Agricultural activities 24%

Emission sources by order of magnitude:
- Land use and land use change
- Livestock
- Manure
- Mineral fertilizer
- Rice
- Other

Energy 35%

Industry 21%

Transport 14%

Buildings 6%

Over the past decades, the development of high-yielding farming systems has been key to feeding a growing global population. Being energy and input intensive, high yielding farming increases the greenhouse gas (GHG) emissions per hectare.

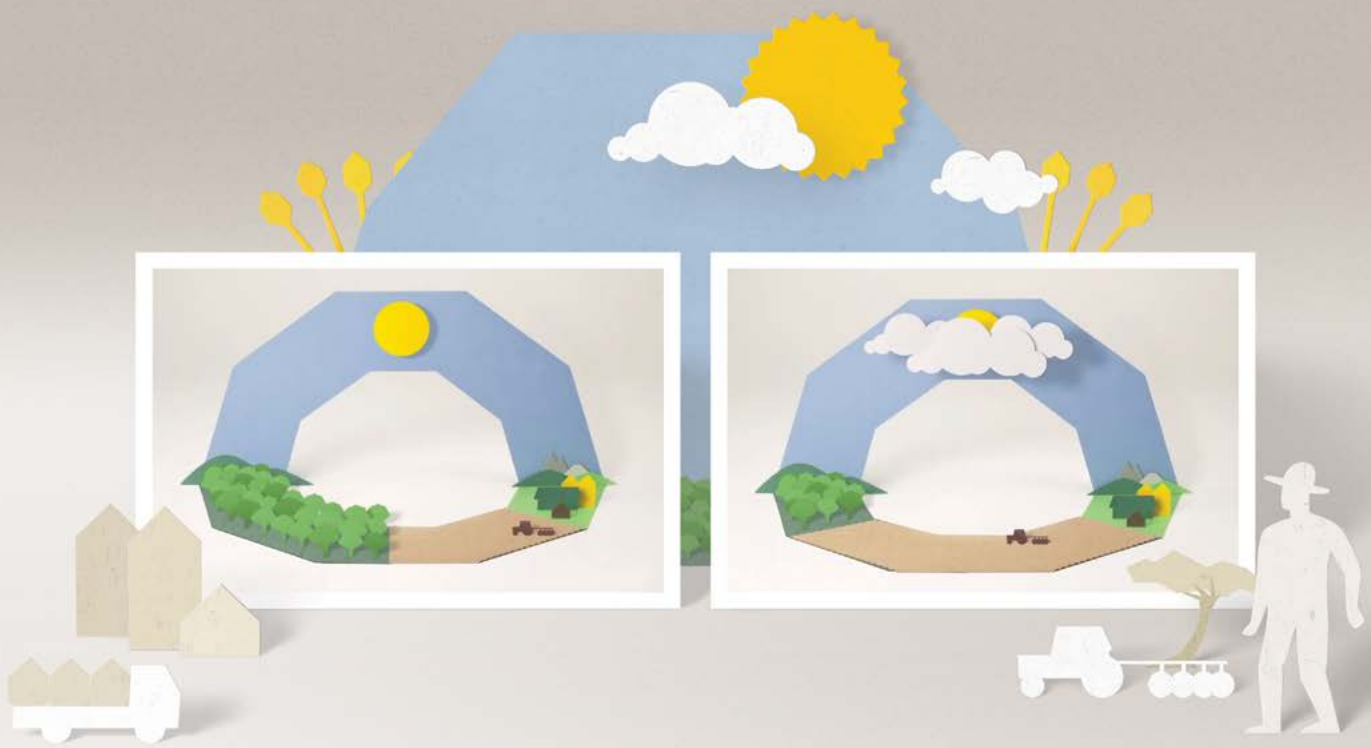
However, deforestation and draining of wetlands is today the single largest source of GHG emissions related to agricultural production. The alternative of growing food by low-input farming with lower yields will lead to land use change and even higher GHG emissions. The net effect of higher yields has been lower GHG emissions than in a low-yield scenario.

Climate change

According to the 2014 IPCC report, global warming may have a net negative impact on agricultural productivity. Yields may be reduced by 2% per decade, which in itself will be a driver for farmland expansion – again driving GHG emissions. The food price volatility seen over the past years, to a large extent caused by weather extremes, is forecast to become an increasing issue.

Responses

As about half the global hungry are themselves subsistence farmers, inclusive growth models for agricultural development are key to create smooth transitions to a food secure future. The current low input farming



▲ Need more food:
To increase food supply, we must either gain higher yields or expand the farmland.

▲ Deforestation: Apart from the loss of biodiversity and ecosystem services, expansion of farmland into forests release more CO_2 than modernized, high-yielding farming.

9 billion

people
By 2050 the global population grows to an estimated 9 bn. – driving food demand

+60%

increased food production
Increased demand for more diverse diets adds to food demand, but +60% still leaves 300 million hungry.

-2%

risk of yields reduction
Global warming puts yields at risk, making agricultural adaptation to climate change a priority

systems have proved themselves to be insufficient in eliminating hunger and bringing the rural poor into the formal economy. At the global level, however, smart use of the resource base for high-yield farming is a necessity for long term sustainable food supply.

Balanced approaches

Innovation as well as massive interventions on locally and regionally adapted levels are all needed to gain the momentum needed. While a precision farming future is an ultimate goal, the here and now also calls for more educational methods, requiring widespread knowledge sharing, infrastructure development and inducement of enabling environments for functional value chains in the agricultural sector in large parts of the world.

A call to action

With FAO, the World Bank, CGIAR and a range of governments endorsing the agenda of Climate Smart Agriculture, the starting point is promising. It should however be remembered that in spite of a strong global commitment, the millennium goal of decreasing hunger has not been met. Collaborative action is needed and time is of the essence. From the private sector, we are ready to participate. But there is yet a lack of global patrons yielding the strength to combine the so far segregated agendas of climate change, resource scarcity and food security. ■

Growing cocoa yields – benefiting the new generation

Mrs. Elizabeth Sarfo has increased her cocoa yield levels fivefold. Successes such as hers demonstrate how Ghana has increased its cocoa deliveries – and reduced deforestation rates.

Mrs. Elizabeth Sarfo runs a cocoa farm in Ghana. Increasing yields and income allows the family toprovide education for the kids.

Before I started using fertilizer on my land, I only harvested one bag of cocoa per acre, but after I started applying fertilizer, I now harvest five bags of cocoa from the same area," says Elizabeth Sarfo (51), a cocoa farmer with 26 years of experience from Ajumako, in the Bosu District in Ghana.

Higher cocoa yields have changed the life of her family. "My husband and I have five children, but in addition to our own kids we take care of my sister's four children after she died some years ago," Elizabeth tells us. "We also house some of my husband's relatives, and that is another five people." This adds up to quite a numerous household.

By employing modern farming techniques Elizabeth Sarfo and her family now gain more money from what they harvest. "We are now building a new house with the money we have earned from our farm," she says.

But it is not only her family who have seen recent changes due to increased yields. Elizabeth has seen the local society change over recent years. "By applying fertilizer the farmers got more money and they send their children to school, like we now can afford to do," she says. "And now that the cocoa business is growing, some come back and work with farming, as well."

Modernizing

Sander Muilerman, working at the International Institute of Tropical Agriculture (IITA), has co-authored a scientific paper describing the cocoa sector's sustainable intensification.

"In the 90s, the acreage of cocoa farming in the forests of Ghana's western region expanded rapidly without increased deliveries. The situation was turning negative," explains Muilerman. There was a need to turn cocoa production logic around.

Safeguarding rainforests

"The Ghana Cocoa Board decided around the millennium that they simply could not allow the area to expand, substituting the need for land with fertilizers," says Muilerman. "They put 60,000 people on the ground, sprayed to prevent pests and brought in subsidized fertilizers. They have demonstrated that a sustainable intensification program is feasible, resulting in much less pressure on land," says Muilerman. Mean cocoa yields increased from 200 kilos per hectare in 2001 to more than 500 kilos per hectare in 2011.

200

KILOS PER HECTARE (2001)
Pre-intensification program cocoa yields were extremely low

500

KILOS PER HECTARE (2011)
Ghana managed to substantially increase yields over a decade, but there is still room for improvement.

The carbon question

"Deforestation is much lower. We looked at a benchmark area with 47% mature cocoa coverage and a forest reserve. Achieving the 2010 cocoa production using the old technology would have taken the 402 km^2 forest reserve plus another 316 km^2 elsewhere," explains Muilerman. The safeguarded forest of 402 km^2 represents major carbon storage and a global natural asset. In the paper of Muilerman et al, the mitigated emissions of CO_2 are estimated at 17.6 million tons.

Remaining challenges

Globally, Ghana's yield levels are still relatively low and, according to Muilerman, 1,000 kilos per hectare is a realistic goal for a smallholder farmer. Current fertilization rates are still well below recommended levels, but this is far from the only remaining challenge.

"For larger farms, access to labor is the limiting factor, especially during harvesting. Improved plant varieties are available, but take a lot of work and resources.

Access to finance, training and availability of inputs are issues, and markets need to become more effective – not least for real estate," says Muilerman.

"IITA would also like to see fertilizer formulations specific to the crop and agro-ecological zones. Nutritional and micronutrient deficiencies differ widely between areas," he explains.

Improving markets

Back in the village of Ajumako, we meet Elizabeth Sarfo again and she tells us that other farmers in the local community have been watching her. "Some of them are seeing that I have got money to buy fertilizer, and some of them are trying to buy fertilizer themselves. They say if they can get the money they will buy fertilizer to apply on their fields," she says.

The global cocoa supply is under pressure and prices are rising. Yara is developing a dedicated program to improve its deliveries to cocoa growers, farmers such as Elizabeth Sarfo. ■

"The potential of climate mitigation through improved yields is very high and this is a relatively cheap strategy with clear food security co-benefits"

Jennifer Burney, assistant professor at UC San Diego

1/2 a trillion tons of CO_2 emissions avoided

While many believe agricultural intensification to be harmful for the environment, Stanford scientists found that high yield agriculture has prevented CO_2 emissions of up to 590 billion tons in the period 1961 to 2005.

An area larger than Russia would have been needed to meet current demand at 1961 yield levels (1,761 million hectares)

We started out asking ourselves, what would have happened if this massive push in intensification didn't take place? The answer is that, clearly, intensification saved a lot of greenhouse gas emissions. We would have been worse off, from a climate perspective, without the yield increase," says Jennifer Burney, assistant professor at UC San Diego and previously post-doc researcher at Stanford.

Land conversion avoided

Together with Assistant Professor Steven Davis at UC Irvine, and Associate Professor David Lobell at Stanford, she wanted to look at the period of the so-called green revolution, when a combination of fertilizers, improved seeds and access to irrigation and mechanization led to significant yield increases in agriculture.

These yield improvements in turn have reduced the need to convert natural carbon banks such as forests and grassland to farmland, which generates carbon dioxide and other greenhouse gases.

The conclusion, published in their paper "Greenhouse gas mitigation by agricultural intensification" in Proceedings of the National Academy of Sciences in 2010, was that high-yield agriculture in the period 1961–2005 prevented the equivalent of up to 590 billion metric tons of carbon dioxide gases from entering the atmosphere.

"Our results dispel the notion that modern intensive agriculture is inherently worse for the climate than a more 'old-fashioned' way of doing things," says Burney.

Cost effective method

Burney and her colleagues also calculated that for every dollar spent on agricultural research and development since 1961, emissions of the three principal greenhouse gases – methane, nitrous oxide and carbon dioxide – were reduced by the equivalent of about a quarter of a ton of carbon dioxide. That is a very high rate of financial return compared to other approaches to reducing the gases.

"The potential of climate mitigation through improved yields is very high, and this is a relatively cheap strategy with clear food security co-benefits. However, this assumes that high yields spare land from conversion. We need to be aware that, for example, high crop prices are also an incentive for the farmer to expand into the nearby forest," Jennifer Burney explains.
Her research has been well received. However, she feels the agricultural sector can do more regarding adaptation to climate change, but there is concern within the climate community that adaptation efforts can distract attention from mitigation.

Farmers: Good scientists and good economists

"I think one of the nice things about agriculture and climate mitigation is that the incentives are potentially very much aligned at the individual level. The farmers want to maximize profits and continue to live off the land. To me, farmers are both good scientists and good economists, which means there are some nice climate co-benefits to be realized from smart agriculture," says Burney.

She is currently involved in several research projects on land use change, as well as looking at climate adaptation on the ground with smallholders.

"I've been very heartened by efforts in the private sector to improve yields via input efficiency," says Burney. ■

Deforestation is a major source of emissions caused by agriculture

About Climate Smart Agriculture (CSA)

What is CSA?

CSA has three major aims (FAO 2013):

- sustainably increasing agricultural productivity and incomes
- adapting and building resilience to climate change
- reducing and/or removing greenhouse gas emissions

CSA strives to meet all three objectives at scales from farms to landscapes and short and long time horizons.

CSA is a holistic approach

- CSA is an integrated approach that considers the social, economic and environmental context specific to the location
- CSA requires close cooperation between agricultural and business sectors, policy makers, institutions and financial supporters
- CSA takes into account all dimensions of food security (availability, access, utilization and stability)

Yara's contribution to CSA

- Yara can make an important contribution to realizing CSA through improved crop nutrition solutions
- Yara is engaged in case studies on mitigation, adaptation and increasing productivity
- Improved crop nutrition does not comprise a holistic CSA approach, but Yara aims to work with partners who address the other relevant issues
- Yara's solutions and offers are important elements of an integrated concept to create climate smart systems, addressing both increased productivity, adaptation and mitigation opportunities.

Degradation, Rehabilitation and Restoration of agricultural soils

1. Agricultural soil is a precious resource

- Suitable soils for agricultural production are only a fraction of the land.
- Today, every hectare of arable land feeds 5.2 people – in 2050, 6.9 people, if forests shall be safeguarded.
- 500 million hectares of degraded farmland has been abandoned.

2. Soil degradation is a challenge

- 25% of usable land is degraded, causing an estimated economic loss of US$ 40 billion per year.
- 12 million hectares are degraded annually by human activities — an area half the size of the UK.
- Farmland expansion is the main cause of deforestation and other land use change – causing about 1/10th of the global GHG emissions.

3. Rehabilitation can be done

- By rehabilitating 12 million hectares annually, up to 1Gt of CO_2 emissions can be sequestered.
- Over two decades, mobilizing USD 50 bn can rehabilitate 300 million hectares, avoiding or sequestering 20 Gt of CO_2 emissions.
- Yara sees balanced crop nutrition as part of the solution for rehabilitating or restoring degraded land.

Sources: FAOSTAT, UN, WBCSD, UNCCD, Yara.

Closing the big gap

If yield levels don't continue growing, an area the size of most of Western Europe will have to be converted to farmland – releasing massive amounts of greenhouse gases (GHG).

▼ **EXPANSION OR NOT**
Future food security is a challenge: balancing the growing of food, sustainability and climate change.

▼ **GROWING YIELDS**
Sustainable intensification can reduce pressure for deforestation. This is the climate smart solution.

▼ **DEFORESTATION**
If forests are turned into cropland, huge amounts of carbon from trees and the soil is released as CO_2.

The soaring food prices since 2007–08 confirmed a basic challenge for the agricultural sector: to match strong growth in demand with increased productivity. Future volatility, not least due to increases in severe weather conditions, is predicted to be a new norm, adding to this challenge.

"Food, climate, energy, resources – not least that of fresh water – are entangled issues. Global leaders must integrate all these elements when resolving future food security," says Svein Tore Holsether, CEO and President of Yara International ASA.

Reports such as the UK Government's "The Future of Food and Farming" describe the unprecedented confluence of pressures put on the global food system over the next 40 years. The conclusion: decisive action must be taken now.

Clear options

The agricultural sector is itself a major emitter of greenhouse gases (GHG), with livestock and deforestation caused by farmland expansion as the main sources. Land conversion releases large amounts of GHG from biomass both above ground and in the soil. This plus biodiversity issues are the key reasons why the "The Future of Food and Farming" report concludes against land conversion: "there will hardly ever be a case to convert forests, especially tropical rainforests, to food production."

"In the case of high and low yielding farming systems, the options are very clear. Agriculture is the main driver for deforestation. This is a major part of the GHG emissions caused by agriculture and should be avoided," says Joachim Lammel, Yara's VP in Research and Development.

Yields in the balance

Yara has reviewed the yield levels of five key global crops; wheat, rice, maize, soy bean and barley. Combined, these crops cover about 50% of current cropland. By 2050 the demand for these crops will increase by 30%. This is based on a 2010–12 baseline, using the FAO 2050 crop demand scenario, which will still leave 320 million people hungry.

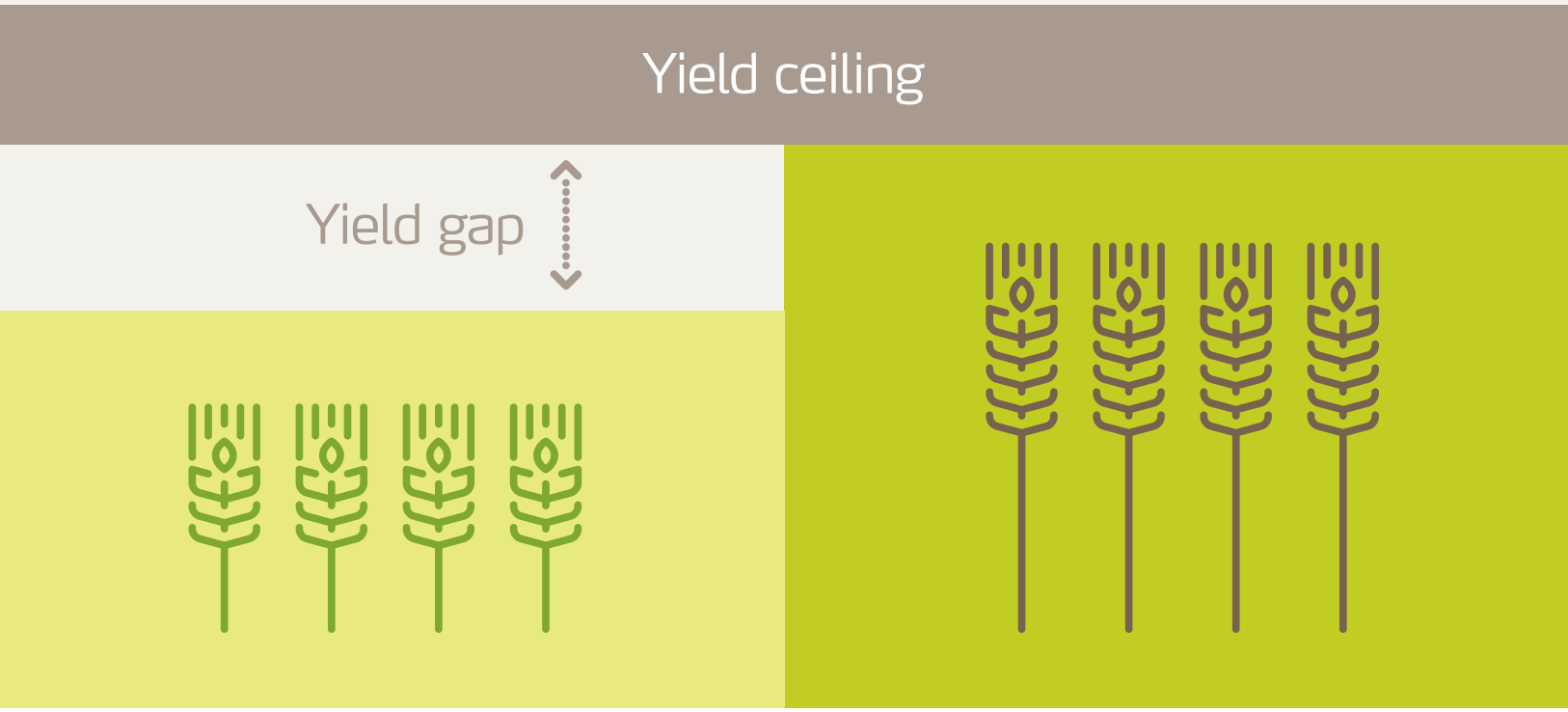
"Without any yield level increase, covering the additional demand would take an added acreage of 220 million hectares. This is the size of most of Western Europe; Germany, Netherlands, Belgium, UK, Ireland, France, Italy, Spain and Portugal combined," explains Lammel.

Converting natural land into arable land at this magnitude would trigger devastating amounts of GHG emissions, not to mention the local climate and biodiversity effects.

"While this is of course not a likely scenario, it illustrates the importance of continuous efforts to lift yield levels," says Lammel.

Forest smart farming

In an alternative scenario, Yara has calculated the required annual growth rates in crop yield that



Annual yield growth rates:

Crop	Zero deforestation scenario	FAO prediction
Barley	0.93%	0.20%
Maize	0.78%	0.47%
Rice	0.37%	0.48%
Soy bean	1.08%	0.66%
Wheat	0.63%	0.53%

are needed to meet the demand based on existing agricultural land without triggering deforestation.

"In such a scenario yields must increase substantially, but still within what has been historically achievable. The highest growth rates are at 1.08% for soy bean, down to 0.37% for rice," says Lammel.

In the FAO prediction, a total of 58 million hectares of additional farmland is needed for these five crops alone – and for all crops combined, more than 100 million hectares. The FAO prediction sees lower annual growth rates than in a zero deforestation scenario. Closing this gap would substantially reduce the GHG emissions caused by agriculture.

"The yield growth rates predicted by the FAO are below the current growth trend. We agree there are foreseeable challenges to maintain growth. However, this illustrates that a substantial reduction of deforestation rates should be within reach if a global consensus is reached to dedicate resources to sustainably increase yields," says Lammel.

Reduced deforestation

Over the past decades deforestation due to farmland expansion has slowed down. Compared to the 1990s, the deforestation emissions caused by agriculture in 2011 were reduced by about 17%. At the same time the agricultural system has increased deliveries substantially.

"This is truly encouraging, and it demonstrates that the higher-yields option can be achieved. Halting deforestation would be a major win in the fight against global warming," says Lammel. ■

Yield ceilings and gaps

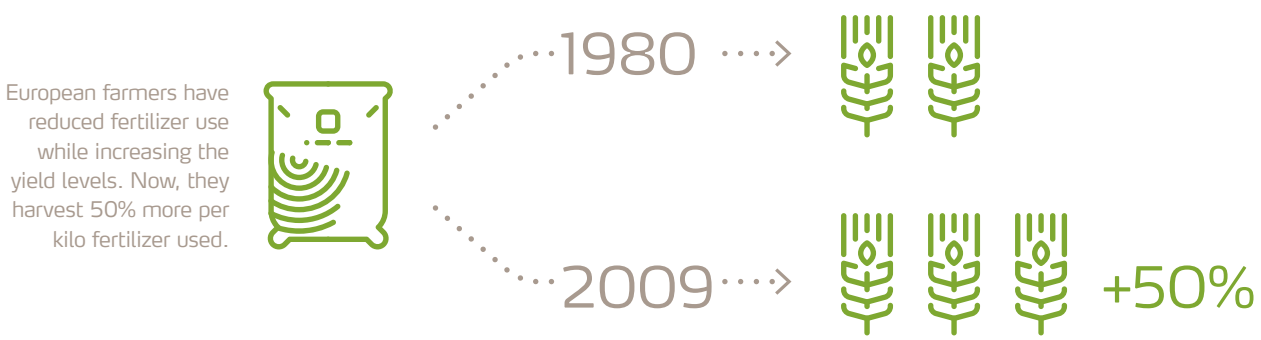
Data show that over time crop yields in developed agriculture countries are reaching a ceiling level, and the annual growth rates in crop productivity are on the decline.

"It should be anticipated that the law of diminishing returns also holds true for crop productivity in agriculture. There are data supporting the idea of a yield ceiling due to abiotic factors, of which limited water supply by rain is most important," says Lammel.

While yields are at high levels through most developed countries, significant observable yield gaps still exist, in particular in South-East Asia and Africa, but also partly in Latin America as well as FSU countries.

"As a consequence, the greatest return on investment into higher yields should be anticipated in developing economies. As in Tanzania, for example, we have conducted field trials demonstrating that it is fairly easy to gain substantial yield increase provided growers have access to farm inputs and the right knowledge," says Lammel.

Transforming trial results into country-level farming practices is not a straightforward task, and the challenge should not be underestimated. According to Joachim Lammel, Africa could become a future breadbasket, but we do not yet see sufficient growth in productivity to make that a reality.



Resource smarter farming

"Business as usual in our globally interconnected food system will not bring us food security and environmental sustainability," concludes the renowned scientific institution CGIAR in a report.

Yara supports the idea that a global commitment towards business as unusual is needed: "Gaining higher yields is essential to alleviate pressure on deforestation. But agriculture must also become more resource efficient. Farmers must achieve bigger harvests from every kilo of fertilizer, every drop of water and every hectare of land," says Yara CEO Svein Tore Holsether.

The experience from Europe over the past three decades illustrates that there is strong potential for smarter farming: European farmers have substantially increased the efficiency of fertilizer use. For every kilo of mineral nitrogen fertilizer applied today, they achieve about 50% higher yields compared to 1980.

"This means far less nutrients are lost to the environment, as well as a significantly reduced carbon footprint. Considering that this improvement comes from management of natural biological processes, it is an impressive deed," says Lammel.

Population:
45 million (now)
138 million (2050)

Maize production:
4.65 million tons p.a. (now)
18.6 million tons p.a. 2050

9 million hectares
Additional land needed for maize if yield levels are flat.

Feeding Tanzania's future population

Tanzania has a thriving economy, expanding by more than 6% annually. Alongside the economy, the population growth rate is also strong, which will challenge domestic food supplies.

Mainland Tanzania covers more than 940,000 km2, making it larger than all European countries but Russia. Factoring in its favorable climate conditions, Tanzania is seen as having a huge potential for agriculture. Yet, strong efforts are needed to increase productivity: At current yield levels, maize acreage must quadruple by 2050 to supply the growing population.

Growing maize consumption

Up to 80% of Tanzanians depend on subsistence farming. Though the economy booms and poverty rates gradually decline, making growth reach the poorest remains a challenge.

Several initiatives are ongoing to alleviate low productivity levels, such as the Southern Agricultural Growth Corridor of Tanzania (SAGCOT). This Public-Private Partnership aims to lift 2 million people out of poverty through collaborative action and investments.

Lack of food security is endemic, and triggering forceful action is vital: The population is predicted to grow from 45 to 138 million by 2050. At the current per capita maize consumption level, the supply of maize alone must increase from 4.65 to about 18.6 million tons. This can ease existing undernourishment, but assumes no diet change.

Alternatives

Tanzania's maize growing has low productivity, with average yields of 1.55 tons per hectare. If yields don't increase, another 9 million hectares of farmland has to be cultivated. While available space is no apparent issue, sustainable land use is.

Deforestation rates are estimated at 130,000 to 500,000 hectares annually, and agriculture is a main driver. If yields don't increase, the population growth may escalate deforestation, with subsequent large emissions of GHG.

Higher yields are possible

In a private public partnership research program the partners Syngenta, the Sokoine University of Agriculture in Tanzania, the Norwegian University of Life Sciences and Yara have documented how best practice farming methods impact productivity, profitability and the environment (read more on next page).

At the project fields, average maize yields were increased to 5.4 tons per ha under rain-fed conditions. If the average maize yields in Tanzania increase to 6 tons per ha by 2050, the maize demand for the entire population can be met on the existing maize fields – diminishing the need for expanding farmland into forests. ■

Building knowledge: Sustainable agriculture

Modernized farming methods can improve sustainability in African smallholder farming. Fredrick Kaduma, a maize farmer from the Tanzanian village Tagamenda, improved his yields and income when taking part in a research program called ECCAg.

Mr. Kaduma and his family lives in Tagamenda village in Ingongoro ward at Makambako, Tanzania.

"I have had this farm for the last ten years. Since then I built it with my own efforts," says Fredrick Kaduma.

Now we can generate money easily, our income has increased. Through that our children were able to receive better education and our living standard is better," says Kaduma. He grows maize at his smallholder plot in the Njombe Region of the Tanzanian southern highlands.

Mr. Kaduma is one of ten Tanzanian farmers taking part in the partnership research project on Environmental and Climate Compatible Agriculture (ECCAg).The partners consist of the universities of Sokoine (Tanzania) and Life Sciences (Norway) on the academic side, and the companies Syngenta and Yara on the private sector side.

Quantified impact

"The partners have developed a methodology to assess and measure sustainability aspects, including environmental impact, of traditional and modernized farming practice," says Dirk Schroeder, who has headed the ECCAg agronomy work in Yara.

While using modernized inputs is known to e xpand yields, their impact on the environment and farmer economy has long been debated. A main objective of the research is to quantify the impact of high yielding crop production. This was measured in a structured framework, documenting both crop farming activity (including impact on air, soil, water and biodiversity), value chain efficiency (including loss and waste) and land use change.

Professor Ephraim Mtengeti of Sokoine University describes the main outcome: "The improved agricultural practices have increased maize and rice productivity substantially. This improved yield will significantly change smallholder livelihoods in terms of household food and income security, and thus enhance increased conservation of natural resources."

Higher yields

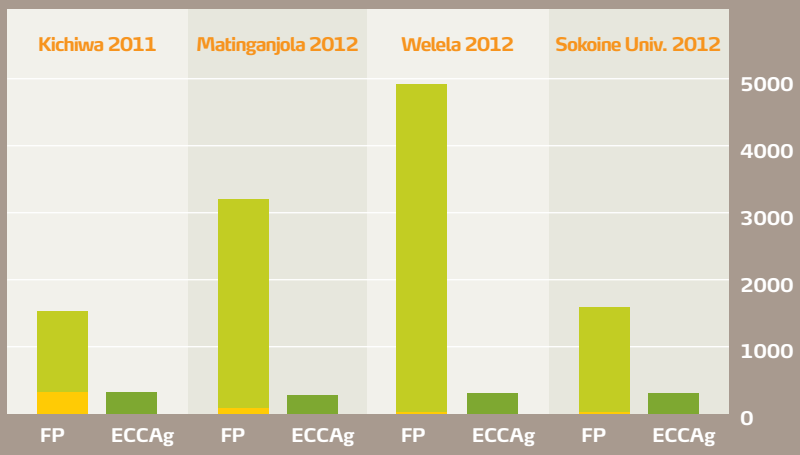
Through the ECCAg project the partners developed an optimized farming practice, tailored for the crops and local conditions. This provided a healthy increase in crop yields for all farmers involved in the trials. While the national average maize yields are 1.3 tons/ha, with optimized practice the average yield was 5.4 tons/ha.

For rice, the trials saw yields at an average of 8.0 tons/ha, compared to a Tanzanian average of 2.1 tons/ha. In a country expected to grow its population from 45 to 138 million by 2050, such an increase is highly relevant.

Reduced GHG

"In plots using traditional farming practices, soil mining led to nutrient depletion. Deficiencies and imbalances of soil nutrients limited yields, and over time soil fertility is impaired," says Frank Brentrup, PhD and Senior Scientist in Yara.

"Using the ECCAg optimized farming practice provided a low, yet positive nutrient balance. Also, using less land for each ton of crop produced offers a huge potential to halt deforestation," says Brentrup. GHG emissions per hectare increased using the optimized farm practice. However, emissions per ton of grain are significantly lower when taking into account the farmland expansion needed



FP = Farmer practice
ECCAg = modern practice

- Emissions from the field, farmer practice. *Average: 111 kg CO_2-eq per ton of maize*
- Emissions from the field, ECCAg practice. *Average: 300 kg CO_2-eq per ton of maize*
- Emissions from land use change if traditional farm practice expands to match yields. *Average: 2 697 kg of CO_2 eq per ton of maize.*

to obtain the same yield. For traditional farming to match the yield that can be achieved with improved inputs, land expansion would be unavoidable.

Biodiversity

Biodiversity was measured both in field and at the level of the whole farm.

"We found fewer species of weeds and insects in-field, but an improved off-field biodiversity. This was primarily due to farmers planting perennial trees when gaining higher income," says Schroeder.

"On average, by using the modernized technology growers needed 50% less acreage per ton of grain. Expanding farmland into natural areas would clearly have a negative impact on biodiversity," says Schroeder.

Farmer income

"First I got education on how to cultivate the farm with real methods from Yara's experts and their fertilizers," explains Kaduma.

"When I used to cultivate by myself, before the researchers came, I was getting three bags of maize from one acre. But now I am getting more than twenty-four bags of maize. This gives me better income."

The ECCAg research found that though purchasing inputs comes at a price, the increased yields more than compensate for the cost. There was an average increase in net income of 50–75%. Farmers mostly used the added income to pay for their children's education, improving homes and purchasing livestock.

Facts-based

The project has produced fact-based evidence that agriculture can simultaneously contribute to food security, economic opportunity and environmental sustainability.

"Using a standardized methodology to measure all impacts will enlighten the debate and clarify the options," says Brentrup.

Modernizing inputs and knowledge to improve farm practices is a viable method of sustainable intensification in African smallholder farming, and would also safeguard forests. Says Professor Mtengeti: "Through better farming practices, including plant nutrition, improved seeds and conservation agriculture measures, the sustainable intensification of smallholder crop production can significantly improve livelihoods and enhance increased conservation of natural resources, hence coping well with effects of climate change."

Availability of findings

Both Syngenta and Yara are founding companies in the World Economic Forum's 'New Vision for Agriculture' (NVA), where a range of global companies have committed to increase agricultural productivity, reduce GHG emissions per ton of produce, and decrease rural poverty. More detailed results about the environmental assessment methodology and the optimized farming practice used will be made available through NVA and in research papers. ■

We're farmers of course we're optimistic

"I think consumers believe that farmers are using far more fertilizers and pesticides than we actually use," says Rickmann.

"People think that farmers are unwise, that we only work with our hands. But that's not true, we work with our brains," says German farmer Thomas Kläber.

The sun is breaking through the clouds and shedding its light on the golden fields. We're in the German region of Brandenburg that surrounds Berlin, and while most people tilt their heads backwards enjoying the warm sun on their faces, farmers Thomas Kläber and Jürgen Rickmann have their attention firmly on the ground.

It's late June and harvest is only one week away, and they have been hoping for more rain. Situated in the community Oder-Spree, southeast of the German capital, Mr. Kläber and Mr. Rickmann are farming under somewhat difficult conditions. The soil in this region is sandy and lack of water poses a real challenge. The difference between a rainy and a dry season can mean the difference between profit and loss.

Precision farming in practice

Nevertheless, the two neighboring farmers love their job and wouldn't have it any other way.

"I love being a farmer. Being outdoors a lot, no days alike. There's a lot you need to know. About markets, animals, soils and crops. People think that farmers are unwise, that we only work with our hands. But that's not true, we work with our brains," says Thomas Kläber.

As part of a cooperative of 46 farmers with approximately 1400 hectares, Kläber is applying both brains and skills to make sure they do their utmost to increase their yields of grain, maize and rapeseed. In the past decade, however, another factor has become crucial to the way they operate: environmental impact.

The key words for both Kläber and Rickmann are 'increased precision', in application of both fertilizers and pesticides.

"We consistently take soil samples to measure the development of nutrient levels," explains Jürgen Rickmann.

For ten years he has also been using the N-Tester, a handheld device that enables him to measure the level of nitrogen in his crops.

Another environmental measure is to grow catch crops in the winter, between autumn and spring, to prevent leakage of nutrients into the rivers.

Environmental pressure – from within

"Why have environmental measures become important to you? Is it because of pressure from consumers, legislative pressure from politicians – or both?"

"Environmental measures are very important for us, and we do this because we ourselves want to. Of course, we also see that consumers and politicians are very much aware of this, but as I see it, it's crucial that we manage our land in a sensible way. It's important to be careful with the input, both because of our economy and because of the environment. You have to remember that we are also thinking about how we hand this over to the next generation," says Thomas Kläber.

Neighbor and colleague Jürgen Rickmann nods, and adds: "We also eat what we are producing on the fields, so of course we want it to be produced in a sustainable way."

Switched from organic to conventional

By being more precise in their application of input, they have managed to increase yields significantly.

"We use approximately the same input as before, but we use it smarter. This way we have increased our yields by up to five percent," says Kläber.

This yield increase comes on top of the already high productivity European farmers have.

"What about organic farming, which seems to have strong support in Germany?"

"Actually, until 2008 we also had an organic field, but we decided to turn it into conventional, and the result was that we doubled the production on it," explains Kläber.

Both he and Rickmann believe that most consumers are unaware of the significant environmental improvements that have been made in European agriculture over the past decades.

"I think consumers believe that farmers are using far more fertilizers and pesticides than we actually do," says Rickmann.

As the son of two farmers he knows first-hand how much more resource efficient he is when operating his 2300-hectare farm compared to his parents' 15-hectare farm, where the single most important thing was to produce enough food.

Open farms – open dialogue

One of the things several farmers in the region are doing to explain to consumers how they operate, is to invite them to an open-day at the farm.

"We do this once a year. Last time we had more than 1000 people visiting. Many are surprised when they learn more about what we do," says Thomas Kläber.

Precision tools help farmers fine-tune the resource use. This Yara N-Tester measures how much fertilizer the crop needs.

Continuously monitoring the crops' status is needed to optimize farming.

Kläber and Rickmann are excited about the future, and they think most don't know farming has made significant progress in Europe.

Both he and Rickmann have experienced that questions from consumers are becoming more and more critical of conventional farming.

"That's why we as farmers have to have more open-farm days, to show and honestly explain what we do," says Kläber.

"But given this skepticism towards agriculture, how do you see your future? Are you optimistic or pessimistic?"

"I see an exciting future. I think organic is just the fashion now. We will continue to develop farming, through better technology, methods and knowledge," says Rickmann.

Thomas Kläber nods and smiles: "I'm a farmer. Of course I'm optimistic! We just have to convince consumers that what we're doing is also right for the environment." ■

Europe: efficient and climate friendly

Agriculture has the potential to become part of the solution," explains Dr. Joachim Lammel, Yara's Vice President Research and Development and a self-declared agri-climate optimist.

Q: The two farmers Thomas Kläber and Jürgen Rickmann are both optimistic on behalf of farmers. Do you share their optimism? A: I am definitely an agri-climate optimist, if you will. To me, agriculture has the potential to become part of the solution in reducing GHG emissions and environmental impact.

Q: How environmentally friendly are European farmers? A: European farmers are highly resource efficient, and therefore also have relatively low environmental impact. Use of nitrogen fertilizers, for example, represents both a substantial part of the energy consumption and the potential environmental impact of farming. For each kilo fertilizer used in Europe, yields have increased by 50% since 1980. This is a fantastic improvement, for the farmers, the climate and the environment.

Q: What kind of measures have they taken to achieve this? A: It's a combination of technology, methods and knowledge. For example, sensor technology can measure the nutrient status of the crops. This enables farmers to add precisely the right amount of fertilizers. European farmers are also using nitrate-based fertilizers. These have less environmental impact, and with clean European production they are also more climate friendly.

Q: In already efficient European farming – how can improvements be achieved? A: There is always room to advance. As an example, over the past years Yara has engaged in the countries around the Baltic Sea. This is one of the world's most polluted seas. One of the key issues is run-off and leakage from agriculture into the sea. The solutions are actually also more climate-friendly.

Q: What then is the way forward for a cleaner Baltic Sea? A: Basically, it's the same logic of using innovative technology and knowledge. Having more farmers use precision farming tools will minimize the environmental impact, but maintain productivity. I also believe in pragmatic solutions developed in public-private partnerships. Yara has been involved in such a partnership in Finland, and the results have been impressive.

Q: What kind of partnership was this? A: The project is called TraP, and it had the objective to find solutions to reduce leakage of phosphorus into the Baltic Sea. A group of partners developed and documented a new solution: using gypsum to trap the phosphorus in the field.

Q: And what was the result? A: The leakage of phosphorus was reduced by 60% on the fields we tested. This is a good example of how agriculture can become part of the solution. ■

A cool climate tool

The mathematician Jon Hillier at the University of Aberdeen is one of the brains behind the innovative Cool Farm Tool – currently a CO_2 calculator, but with plans to include both biodiversity and water usage.

It started out as a model in an Excel spreadsheet back in 2008. In 2014, however, the Cool Farm Tool is an online tool that helps farmers and the food industry to calculate the carbon footprint of crops and livestock products.

"It has moved from an Excel sheet to an online tool, and that's really rewarding to see. As an academic researcher you tend to specialize on your own thing, your own research, but it has been very interesting to link this with the industry knowledge," says Hillier.

With a PhD in Mathematics he joined the University of Aberdeen as a research fellow in 2006, working in the team that does modeling of greenhouse gas (GHG) emissions from soil. The head of the group is Pete Smith, who is also Convening Lead Author for the IPCC (Intergovernmental Panel on Climate Change) on agriculture and the land based sectors for the last two assessment reports (AR4 and AR5).

Creating a new tool

In 2008 Unilever, who needed a tool for their farmers and suppliers that would allow them to identify greenhouse gas mitigation options, contacted the group at Aberdeen University.

"They had been doing their own assessments, and when they did their analysis, they saw that emissions

embedded in agricultural raw materials constituted around a quarter of the carbon footprint of their products," explains Hillier.

From Hillier and his colleagues' point of view the idea was to make a tool that also made sense at an aggregated level, i.e. building a regional and global overview of where the emissions and the potential for reductions are.

Identifying inefficiencies

"One of the things the Cool Farm Tool really does is identify inefficiencies. And for the farmer that's also very useful, since those things that reduce GHG emissions have a tendency to improve profitability as well," says Hillier.

When testing the prototype in 2009 the team at the University of Aberdeen found that many other companies in the food value chain had identified a similar need for such a tool. They then conducted a pilot called Cool Farming Options – led by the Sustainable Food Lab. Being sponsored by some 10 to 20 companies allowed the group to make this a free and open tool. They have now been joined by companies and organizations such as Fertilizers Europe, Heineken, Marks & Spencer, McCain Foods, PepsiCo, and Soil & More, Tesco, Yara.

Water usage and biodiversity

After the launch of the tool online this year, Jon Hillier and his colleagues are looking at ways to expand it. "Water is an obvious add-on. Assessing water usage is critical," says Hillier.

The Helmholtz Zentrum Potsdam have already started a study on water through a studentship funded by Climate-KIC. In addition to this, a project funded by the UK research council NERC (www.nerc.ac.uk) on biodiversity has been established in collaboration with Cambridge University and a Dutch based environmental consultancy CLM – adding the evidence base to an existing biodiversity management tool.

"Our feeling, based on the impact we have had with businesses and

Cool Farm Tool

- A GHG calculator to estimate carbon footprint of crop and livestock products
- Developed by researchers at University of Aberdeen, Unilever and the Sustainable Food Lab in the period 2008–2010
- Launched as an online tool in January 2014
- Cool Farm partners include organizations and companies, such as Fertilizers Europe, Heineken, Marks & Spencer, McCain Foods, PepsiCo, Soil & More, Tesco, and Yara. To learn more, please visit www.coolfarmtool.org

farmers, and the interest from the academic sector of integrating their research in this decision support tool, is that this is only the beginning. Within 5 years the Cool Farm Tool aims to have helped millions of farmers globally make informed decisions – using up-to-date science – to ensure sustainable production and supply of agricultural produce to global businesses," says Jon Hillier.

Weighing the input

Using the CFT, farmers can easily identify how their carbon footprint improves when choosing climate smart inputs. Fertilizers are typically a big portion of the total footprint, but the variability is sizable.

Emission figures for granulated ammonium nitrate fertilizers:

EU	3.57
Russia	8.58
USA	7.58
N-Africa	4.21
China (coal-based production)	11.08
China (gas-based production)	7.67

Figures are kg CO_2-eq emitted per kg nitrogen in the fertilizer product. Values are calculated with the "Fertilizers Europe Carbon Footprint Calculator for Fertilizer Products" (validated by DNV).

Swedish leaders

In Sweden, a climate certification for food has been established. The voluntary standard has been defined by the quality-labeling body Sigill in dialogue with other partners.

To qualify for climate branding of agricultural produce, farmers must comply with defined protocols, including the choice of feed, fertilizer, animal welfare and energy efficiency.

In crop production, farmers must provide a fertilizer plan, account for nutrients applied to the fields and removed through the crops, and use only mineral fertilizers with a low carbon footprint guarantee (Less than 3.6 kg CO_2eq per kg N at factory gate). ■

"Climate change over the 21st century is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions"
IPCC 2014

Using every drop of the water

"If it wasn't for improved water administration, this area would have been a desert," says Spanish farmer Salvador Garre Garcia from the Murcia region. While freshwater availability is a rapidly increasing global issue, farmers in Spain are already experts at adaptation.

Growing fruit in arid conditions implies applying the water where it is needed, when it is needed and in the right amount.

With almost 35 years of experience in agriculture, Garcia, alongside his brothers, has brought about remarkable changes to the family farm. With enormous savings in water and nutrients while at the same time increasing quality and yields, he hails the shift as an agronomic revolution.

Investing to improve

Three brothers run the farming business, and Salvador Garre Garcia is the one responsible for soils, nutrients and more for their citrus, vegetables and fruit production.

"Water has always been a problem, already for my father. We started using subterranean water which was in short supply and of very poor quality," says Garcia. Due to quality issues, cash crops were not an option and the farm economy suffered. Step by step investments have added dams collecting rainwater, sourcing from the nearby river and a desalination unit.

Steep learning curve

With a range of water sources adding to availability and quality, the next step was to manage the resources in a

more cost effective way. An initial step was to advance from flooding to more targeted irrigation, which saved the family at least 20% of their water expenses.

The learning curve was steep, and parts of the first harvest were lost due to overly sparing irrigation.

Unimaginable

Collaborating with Yara, the Garcia family proceeded into fertigation: applying fertilizers dissolved in water. "We started working with liquid fertilizers in 1994. The technology made everything automatic and controllable. Yes, we were truly a part of a small agricultural revolution!" explains Garcia.

The use of technology takes the water and nutrient use efficiency to a new level. They obtain better quality and increased yields while saving both costs and the environment by using less water and nutrients per ton of crop.

"Today, the way we cultivate our huge variety of crops would have been unimaginable for my father," says Garcia.

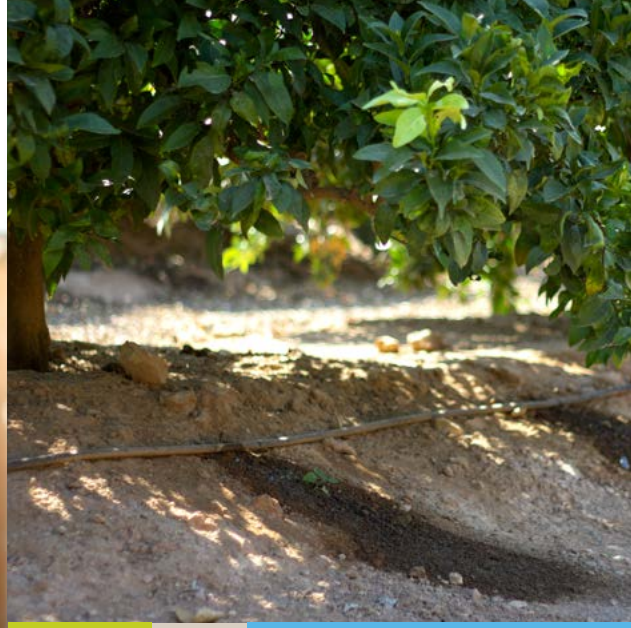
Water, liquid fertilizer and precise control mechanisms help farmer Garcia to utilize the scarce water resource in an optimal way.

For future generations

The farmer's knowledge and genuine interest help make agriculture meaningful and prosperous. Using precision technology allows Garcia to stay on top of farming trends.

"The leading trend is less environmental impact. You either take part and adapt, or soon you're uncompetitive," says Garcia.

Traditionally, water corresponds to 50% of the production costs. Being on top of both farming costs and the environmental trend secures stability for future generations. Year by year Garcia is fine tuning, and money spared on water is re-invested. ■



The way Salvador Garre Garcia cultivates today would have been unimaginable to his father.

Investing into irrigation and fertigation systems has been key to his success.

"I am always striving for perfection and to be at my best."

Quick facts about the water issue

Water stress similar to that on the Garcia farm is predicted to become more widespread as demand grows and global warming changes weather patterns.

Even before considering the predicted effects of climate change, water stress is a major global challenge on the rise. Improving water use efficiency in agriculture is mandatory over the next decades:

Global water:

- 70% of Earth is covered by water
- 97% is salt water

The 3% freshwater resource:

- 69% in glaciers
- 31% in groundwater
- 0.3% in rivers and lakes

Water use:

- Population doubled in the 20th century
- Water use grew 6X
- Agriculture represents 71% of freshwater use

The water gap [1]:

- Sustainably available freshwater: 4,200 billion m^3
- Current use: 4,500 billion m^3
- 2030 demand in agriculture alone: 4,500 billion m^3
- Total demand in 2030: 6,900 billion m^3
- Water gap in 2030: -40%

Water use efficiency of irrigation methods:

- Flooding: 30–40% efficiency
- Furrow: 55–70%
- Sprinkler: 70–85%
- Drip irrigation: 90–95%

[1] «Charting our water future» 2030 Water Resources Group (2009)

"Unless local, national and global communities come together and dramatically improve the way we envision and manage water, there will be many more hungry villages and degraded environments (...)"

HRH The Prince of Orange Willem-Alexander
(Chairman of the United Nations Secretary-General's Advisory Board on Water and Sanitation)

Tackling the coffee challenge in Vietnam

In test trials in Vietnam, coffee farmers have reduced the use of fertilizer by 20%. The result: Yield and profitability are up 10%, while carbon footprint is reduced.

The coffee challenge is three-fold, and follows the same pattern as many other food crops. Firstly there is a growing demand that has to be met. Secondly, consumers are increasingly demanding sustainable production. And thirdly, farmers need to improve their profitability. In a public-private partnership model, solutions are shared through demo farm plots and extension services.

Vietnam is the number one exporter of Robusta in the world, using approximately 550,000 hectares to grow the coffee beans – by and large by smallholders. To generate sufficient income farmers have to increase the yield. This is also important to reduce the pressure on deforestation and biodiversity.

Strong government support

During a regional WEF New Vision for Agriculture meeting in June 2010, the Minister of Agriculture and Rural Development in Vietnam, Cao Duc Phat, requested that participants join forces to help find more sustainable ways to grow coffee. Following this meeting, a group of international companies – from international roasters, and input companies to international coffee traders and NGOs – decided to establish a public-private partnership. With strong governmental support, the ambition was clear from the start: To develop a model that promotes sustainable coffee production, putting the smallholder farmer at the center.

The initiative gained strong support from the Vietnamese government, and Minister Phat launched a coffee task force. The same was done for other strategic crops, such as corn, soybean and tea.

Increased farming precision

Vietnamese farmers are experienced fertilizer users, but the task force identified early on that there was a huge potential for improvements in adjusting their fertilization practice.

"The overall concept when we meet farmers is what we call the 4-right concept. Right fertilizer, right rate, right time and right place," says Huynh Nhat Tan, Chief Agronomist and Crop Expert Manager at Yara Vietnam. This approach ensures a more precise application, which benefits both the farmers and the environment.

The results of the project have been outstanding. By using Yara crop nutrition recommendations, switching to a balanced nutritional program and a more suitable source of nitrogen – mainly nitrate-based – the farmers have reduced fertilizer use by 20%. At the same time yields and farmer profits have increased by 10%. Last, but not least, is the environmental effect. The total carbon footprint per ton of green beans was lower in all Yara plots compared to farmer practice plots.

"What we have seen in Vietnam is the power of a good example, and this is a kind of partnership that we're currently working to develop in 11 countries, in Africa, Asia and Latin America," says Lisa Dreier, Head of Food Security and Development Initiatives at the World Economic Forum USA. ■

WEF coffee partners:

- Ministry of Agriculture and Rural Development (MARD)
- The Sustainable Trade Initiative – IDH
- 4C association
- Utz
- Rainforest Alliance
- International Finance Corporation (IFC)
- Yara
- Nestlé
- EDE (Neumann Coffee Foundation)
- Solidaridad
- ECOM

Coffee farmer Tran Van Cong, from Krong Nang district, Dak Lak province, Vietnam

Meeting 250,000 Asian farmers in one year

With crop clinics and farmer meetings, Yara agronomists are sharing knowledge in Asia with a quarter million farmers a year.

"The most important thing is to make sure we understand the real needs of the farmers and find relevant solutions," explains Seksan Ekkajit, Chief Agronomist of Yara Thailand.

The 22 million farmers of Thailand are faced with the same challenges as farmers in many other Asian countries: How to increase production and earnings when no more arable land is available and the environmental impact has to be reduced?

Crop clinics and diagnosis

In Asia, Yara has found that meeting farmers face-to-face is by far the most efficient way of discussing these issues and finding solutions. In Thailand alone the company's 25 agronomists attend more than 2000 farmer meetings annually. The topics are almost always the same – the crop challenges in the area.

The farmers also have the possibility to bring their problematic plant leaves or fruits and soil samples to so-called crop clinics, to better determine what is needed to boost both yield and quality.

Yara employs more than 300 agronomists across Asia, and farmer meetings like those in Thailand are also used in countries like Vietnam, China and Indonesia. In total Yara organized approximately 6500 farmer meetings in Asia in 2013. With 40–50 farmers attending each meeting this means the company sees more than 250,000 farmers each year in this region.

Balanced fertilization

"Excess and unbalanced fertilization are two key problems in Chinese agriculture. Our agronomists are using Yara knowledge and global experience, combined with local scientific research and experiences, to improve nutrient use management," says Cheng Wu Huang, Chief Agronomist in Yara China.

In addition to increased yields and farmer profitability, he is convinced also about the environmental effects. China is a market dominated by urea and ammonium nitrogen fertilizers. Since the early 1990s Yara has advocated the usage of nitrate-based fertilizers, which are both more efficient and environmentally friendly, and this has contributed to increased production and use of these types of fertilizers.

"Chinese farmers have definitely recognized the benefits of nitrates, and since the early 1990s the production of nitrate-based NPKs in China has increased from 600,000 tons to more than 3,000,000 tons per year. This has reduced greenhouse gas emissions significantly," says Cheng Wu Huang.

Farmer meetings will be one of the most important channels for knowledge transfer also in coming years, as farmers are still facing the need to improve profitability and environmental performance.

"As we see it, good economic farming is good environmental farming," says Seksan Ekkajit of Yara Thailand.

About Yara and Climate Smart Agriculture

We pioneered the manufacturing of nitrogen fertilizers in 1905. Our strong focus on Innovation and R&D has produced tangible results. Yara's innovative technology and recommendation tools help growers apply the right rate of fertilizer and to maximize their return from our products.

Approach to Climate Smart Agriculture:

- Reduce emissions from fertilizer manufacturing
- Increase efficiency, helping farmers maximize yields for every kilo fertilizer applied through knowledge sharing, balanced and crop-specific nutrition and technology
- Optimize productivity on existing farmland, reducing pressure for deforestation
- Adapt to water scarcity through product and technology development

Company strategic response:

- Creating Impact: Yara creates value by delivering profitable business solutions to the human challenges of food, resources and the environment
- Shared value: Yara's mission is to deliver good returns to customers, shareholders and society at large
- By setting industry standards, Yara will be a positive force, developing the industry through performance and growth
- Yara enters innovative partnerships in the value chain and across sectors

Yara technology sensor solutions:

N-Sensor, N-Tester, Image-IT app, ZIM crop water sensor

Yara's N-Sensor technology is reading nitrogen needs and optimizing fertilizer application on fields across Europe, Latin America, North America, Africa and Australia.

ImageIT: Measures nitrogen uptake and generates nitrogen recommendations based on photos of the crop

CheckIT: Photo library allows fast identification of possible nutrient deficiencies

TankMixIT: Provides advice on mixability of YaraVita with other spray materials

With the acquisition of ZIM Plant Technology, Yara can offer water sensor technology that allows for irrigation on demand based on real-time metering of the water status of plants.

1+

million tons harmful NO_X emissions cleansed annually by customers using Yara's environmental solutions

Company overview:

Operations in
51 countries

Annual sales of
35 million tons

Revenues and other income:
USD 15.1 billion

Global leader
in the fertilizer industry

Company performance:

Emissions 2004–2014:
1/2 GHG

Energy use
258 million GJ

2010: Launched Carbon Footprint Guarantee

New goal
-13% GHG
for European plants

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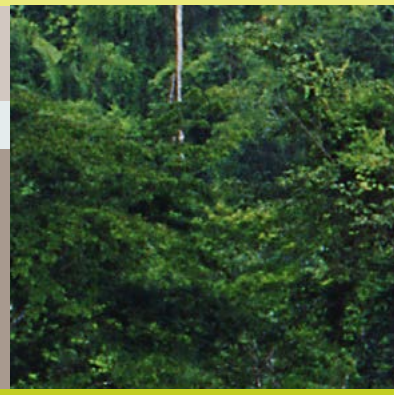

Yara's knowledge, products and solutions grow farmers' and industrial customers' businesses profitably and responsibly, while nurturing and protecting the earth's resources, food and environment.

Our fertilizers, crop nutrition programs and technologies increase yields, improve product quality and reduce the environmental impact of agricultural practices. Our industrial and environmental solutions improve air quality by reducing emissions from industry and transportation, and serve as key ingredients in the production of a wide range of goods. We foster a culture that promotes the safety of our employees, contractors and societies.

Founded in 1905 to solve emerging famine in Europe, today, Yara has a worldwide presence, with more than 12,000 employees and sales to more than 150 countries.

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