What is climate smart in Africa's horticulture ?

A network mapping of drivers for climate action
in Kenya, Tanzania and Zambia

In cooperation with

Verbos
Business Development

Assigned by

Food & Business
Knowledge Platform

Agri
Pro
Focus

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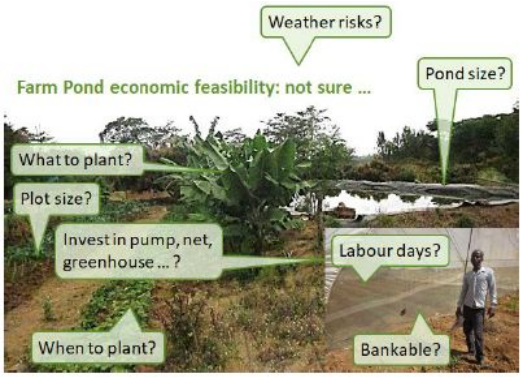


Colophon

With support of the Food & Business Knowledge Platform, AgriProFocus and Verbos Business Development carried out a mapping and review of business drivers for Climate Smart Horticulture in Kenya, Zambia and Tanzania.

December 2018.

Content

Summary

Climate change is and will continue to be a major challenge for East and Southern African horticulture. Its effects on horticulture are lower water availability, lower soil health, higher disease pressure and planning disruptions.
Understanding which solutions work for horticulture entrepreneurs (*and which are not*) will help the Agriprofocus network's know how to adapt and mitigate horticulture to climate change. With support of the Food & Business Knowledge Platform, AgriProFocus and Verbos Business Development carried out a scoping study of business drivers for Climate Smart Horticulture in Kenya, Zambia and Tanzania.

A mapping was done of climate smart agriculture (CSA) solutions currently being adopted by horticultural producers in and around the AgriProFocus networks in these three countries. Most of the 21 practices found related to improved production technology. Inputs for production and for getting it fresh on the market are a good second. The mapping found few services. In 10 out of 21 practices listed, there was a direct link to Dutch horticulture. In Zambia no practice was linked to the Dutch. In Kenya and Tanzania, the "Dutch" practices range from innovative (solar pumps, soil test) to proven elsewhere (water harvesting, breeding, training). The search for specific examples did not aim to produce an exhaustive overview. Rather, the search is meant as inspiration for further network learning and action.

The mapping paid particular attention to business drivers, i.e. to resources or processes vital for the continued success and growth of a company. Business drivers were primarily expected in the CSA pillars a) productivity and b) adaptation as these directly affect revenues and costs. A business driver related to the CSA pillar c) mitigation was identified in the 'Cool Farm Tool', which quantifies carbon emission reductions which may be sold on the market..

Many of the practices identified are options for SME agripreneurs. For them, seeing is believing which means that demo plots, demo farms and demo villages are the best means to get agripreneurs informed and aware. AgriProFocus is to step up the visibility of these efforts for farmer entrepreneurs in our network to enhance further mutual learning.

Members and partners in the network may also want proof of concept, including modelling tools with cash flow projections. It is recommended that AgriProFocus next work sessions (Kenya, Tanzania, Zambia, Netherlands) focus on what members and partners do and need to improve the offer of support in their climate programmes.

The findings of the mapping and two specific practical tools were presented and discussed in an expert session with Dutch horticulture companies and experts at World Horti Centre in the Netherlands in November 2018. Among the recommendations that emerged, was the suggestion to develop a complete and (more) coordinated offer from the Dutch horticulture suppliers to African SME agripreneurs. For this, the sector could learning from the Amiran approach, which combines simple greenhouse, inputs, finance and advice in a package deal. Specific Dutch technologies that could be offered to the horticultural sector partners in Africa, are amongst others: the smart usage of new crop varieties; soil treatment; easy to use irrigation techniques, reduction of postharvest losses; cold chain logistics; more efficient and sustainable production, processing and distribution processes; optimal water usage in production and processing (re-use of waste water and less consumption); optimal usage of residual flows; and in the reduction of and innovations in packaging[1].

[1] *Further findings will be shared via https://agriprofocus.com/climate-smart-horticulture and social media to inspire the APF network, members and partners.*

Introduction

Climate change in relation to horticulture is a less prominent discussion compared to the debate on livestock. Nevertheless, climate change is and will continue to be a big problem in East and Southern African horticulture. The main climate change threats are lower water availability, higher surface temperatures and degraded soils. These threats are not new to horticulture, but the scale and effects are. The challenge today is bringing to scale the solutions that counter these threats.
Understanding which solutions work for horticulture agripreneurs (and which are not) helps decision making on adaptation and mitigation measures in horticultural development. This is why AgriProFocus (APF) and Food and Business Knowledge Platform (F&BKP) engaged in this network mapping exercise.

Scope and methodology of this study

The scope of the study is to map climate smart agriculture (CSA) solutions currently being adopted by horticultural producers, small and medium scale enterprises (SMEs) in and around the APF networks in Zambia, Tanzania and Kenya. The network aims to better understand the business drivers for CSA adoption in horticulture, as well as potential barriers, from the perspective of agricultural SMEs in sub-Saharan Africa.

In this study the FAO definition of CSA[2] was used, which has three pillars:
a) sustainably increasing agricultural productivity and incomes (food security),
b) adapt and build resilience to climate change (adaptation),
c) and the reduction of greenhouse gas emissions (mitigation)

A business driver is a resource or process vital for the continued success and growth of a company. In this mapping, the business drivers are expected in the CSA pillars a) and b) as these directly affect business income and business vulnerability respectively.
The search for specific examples does not aim to produce an exhaustive overview. Rather, the search is for inspiration for network action.

The mapping was organised in three phases:

1. Quick scan in Netherlands

This was aimed at creating an overview of existing knowledge and information and what CSH related initiatives are already happening in and around the APF network. Interviews were held with BoP Inc, SNV, RijkZwaan, CCAFS and a desk review was done.

2. Mapping in Kenya, Tanzania, Zambia

The second phase entailed country desk studies to understand the climate smart initiatives at country level. Also, in each country at least three interviews were conducted with relevant stakeholders. Main questions in this exercise are

- first, how climate change poses threats for horticulture entrepreneurs.
- second, what practices are applied to responds to the threats of climate change.

3. Discussions on findings & communication

In the last phase, expert meetings were planned to share and discuss the mapping outcomes with stakeholders and members. APF staff involved in the mapping participated in the CSA aid summit (May 2018, Nairobi) and used the opportunity to discuss findings. One work session on water was held at the WHC (Netherlands)

Further sharing and learning is planned for 2019, including dedicated meetings on specific topics. Findings will be shared via https://agriprofocus.com/climate-smart-horticulture and social media to inspire the APF network, members and partners.

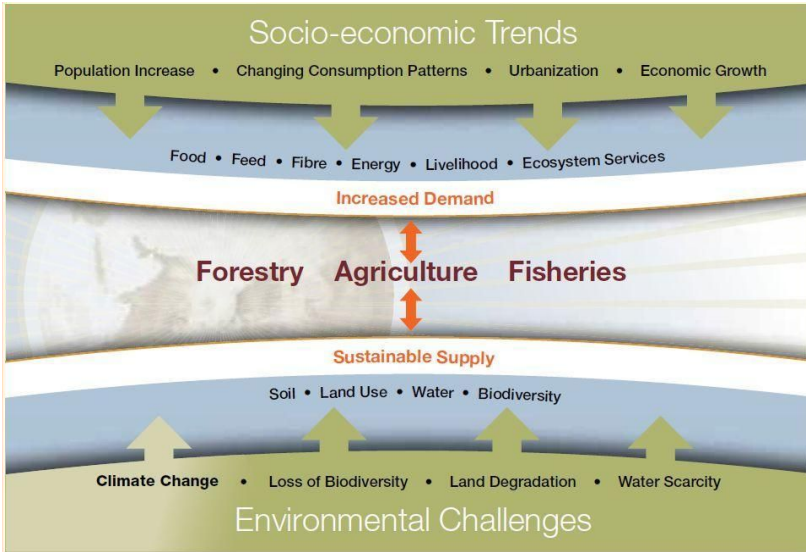
[2] http://www.fao.org/climate-smart-agriculture/en/

1. Climate change, horticulture and the Dutch

1.1. Climate change hazards

Horticulture is an intensive subsector of African agriculture. The use of inputs (water, soil, labour, finance) and the productivity per square meter are higher than in other sectors of agriculture. Also, horticulture's interaction with the national and international market is more intensive. Market gardens[3] supply the cities on a regular basis which means consumer feedback reaches the producer relatively quickly and the income flow is more constant.
The **first main question** is how climate change poses a risk for horticulture entrepreneurs. Risk is the product of hazard exposure and vulnerability. Market horticulture is more vulnerable because more consumers depend on it. The exposure to higher temperatures and irregular rains lead to the following hazards for horticulture:

- Water availability. In some areas, the increased frequency of droughts cause water shortages, while in other areas there is an increased frequency of flooding.
- Soil fertility. Higher surface temperatures decrease the soil organic matter. Organic matter keeps nutrients and water in the soil and releases them later to plants. Lower soil organic matter makes fertilizer less effective. Irregular rains may cause erosion.
- Disease pressure. Higher temperatures favour pest and diseases while water stress may weaken plant defence systems. This leads to lower production against higher costs of plant protection.
- Planning disruptions. In rainfed horticulture, unreliable rains and extreme weather events disrupt the timing of planting, the days for crop growth and timing of harvesting. These disruptions have their effects downstream the supply chain.



This visual from FAO shows that climate change is not the only challenge. Horticulture is like agriculture squeezed between increased demand and the challenges of supply.

source: FAO, 2015

[3] '*Market' gardens are thus framed differently from 'home' gardens primarily for household consumption. Read more on its nutritional importance in the Ethiopian home garden network and the 10.000 Slow Food home gardens.*

1.2 Trends in the horticulture sector

The **second main question** is to find out how horticultural sector responds to the threats of climate change. Horticulture is a highly dynamic sector, it constantly responds to changes in the consumer market.

General trends on the demand for horticulture products from desk study are:

- higher quality requirements
- increased attention for food safety and fair pricing
- higher demand for 'healthy' food
- more transparency in production systems
- higher diversity of crops

On the supply side, general trends are:

- The use of adapted varieties (drought, disease, salt tolerant);
- Tailoring varieties to local circumstances;
- Reduce loss of seedlings during initial production (stronger selection).
- Analyse soil health and 'customize' fertilization advise (lower fertiliser use)
- Increased know-how on climate smart farming
- Access to "real-time" production data via smart apps (transparency)

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There is a vast sea of literature on smallholder agriculture and climate change in Africa. In the desk study, sources from CCAFS and FAO were used. At CCAFS, Thornton (et al, 2018) listed 25 CSA interventions and scored them against 9 considerations for meaningful CSA research. The FAO handbook on gender in CSA (2015) lists 12 CSA practices and scores them against CSA pillars, food security and 6 gender considerations.
Below table combines both sources for a selection of CSA practices (annex a for full tables).

	CSA pillars			Adoption		
Practice	Food Security	Adaptation	Mitigation	Time till benefits	Gender benefits	observations on enablers
drought tolerant crops	+	+	+-	M	L	seed system, extension/education
conservation agriculture	+-	+-	+-	L	L	know-how, machinery, (pesticides?)
supplemental irrigation	+	+	?	Q	L/M	available water, farm power, crop type
farm ponds	+	+	+-	Q	?	know-how, water efficiency
composting	+-	+-	+-	Q	M	labour, tenure
farm trees	-	+	+	S	L	labour, tenure of farm land
home gardens	+	+	+-	Q	H	labour, household level
weather info services	+	+	+-	Q	?	specific, timeliness, extension
soil health cards	+-	+-	+	Q	?	low impact without extension
village water budgeting	+	+	?	Q	?	community power
national climate plan	+	+	-	L	?	finance, coherence
effects: + is positive effect, +- moderate and - no effect.						
Q,M,L = quick <3yrs, medium 10 yrs, long time till benefits						
H,M,L = high, medium, low gender benefits						

A first observation is that no single practice scores positive on all CSA pillars plus all adoption pre-conditions. The best score is for home gardens, but arguably these lack scale.
Every practice from this shortlist contains a trade-off between the CSA pillars. Also, the adoption of CSA practices is a trade-off between speed and likely impact. Successful adoption in smallholder horticulture requires that 'Time till benefits' is short and "Gender benefits' are positive.

CSA Aidforum (Nairobi, 15-16 May 2018)

This event provided an overview of CSA policy and business practice. Comparing the CSA pillars, attention for mitigation was less prominent. Stronger attention was for the need to scale the proven interventions, such as farm trees and water harvesting. "*There are thousands of pilots on CSA in East Africa, but too few efforts to use existing structures and networks to massively scale out what is already proven*". Third, gender in relation to CSA was a prominent topic. See this video report.

1.3 Quick scan of Dutch initiatives related to Africa's horticulture.

Horticulture in the Netherlands remains a key economic sector with global connections. Dutch businesses are involved in horticulture imports, in the export of horticultural products or inputs, and many engage in overseas production locations to have a year-round offer of their produce for the European market. A smaller number of horti businesses aims to produce for the growing African market.

Under the Paris agreement on climate, Dutch horticulture has a target to bring back its CO^2 emissions. These emissions come mostly from fossil energy which is used for heating the greenhouses in winter time. The sector is developing technical and logistical solutions to meet this challenge by using low-grade heat and CO^2 from industrial sectors.

Climate is also a priority in the Dutch international aid and trade policy. The Netherlands is a contributor to the Global Environment Facility (GEF) and the Green Climate Fund (GCF).
In November 2018, the Netherlands launch a € 40 mln/yr fund for climate and development. The emphasis will be on climate adaptation and with special attention paid to the poorest countries and focus regions MENA, Sahel, Horn, Grand Lacs. The aim is to make Dutch knowledge of water security, climate-proof agriculture, sustainable energy and the circular economy more accessible to developing countries. The fund will work with loans, guarantees and equity investments.https://www.government.nl/documents/publications/2018/11/19/grant-application-dfcd

A non-exhaustive list of Dutch initiatives with relevance for horticulture in East and Southern Africa is presented here. In a few cases, the work of the African partners in these initiatives is described as well:

World Horti Center Naaldwijk

- The World Horti Center opened in 2018 as an innovation centre for greenhouse horticulture. The centre hosts a horticultural TVET, a permanent business expo and facilities for production trials.
- WHC hosts the Seed2Feed initiative, which is involved in upscaling an existing horticulture project in Kenya with Rabobank, Rijk Zwaan and Koppert Biological Systems.
- WHC also hosts the Center for Frugal Innovation for Africa, a joint initiative of the universities of Delft, Leiden and Rotterdam. Partners include the South-Eastern University of Kenya, University of Nairobi and REPOA Tanzania.

WUR Greenhouse Horticulture Innovations Bleiswijk

The unit Greenhouse Horticulture in Bleiswijk, is one of the experimental greenhouses of Wageningen University & Research. It consists of approximately 7500 square meters of glass which has been divided into 90 sections. The design of the greenhouse approximates the current standard in horticulture as much as possible (https://bit.ly/2z8s6l7)

SeedNL (The Netherlands)

The SeedNL initiative proposes to coordinate, align and promote seed sector activities within the Dutch international policy for trade and aid. Among the key actors is Plantum, the Dutch association for the plant reproduction material sector which includes key vegetable seed companies (see https://www.plantum.nl/basis-for-the-green-economy)

AgriProFocus

AgriProFocus is a network organisation with presence in 12 countries. Members with relevant activities are listed below.

APF member	Relevant links
BoP Inc	http://www.bopinc.org/our-projects/our-projects/smart-adaptive-sustainable-horticulture
Bejo Seeds	http://www.bejo.com/bejos-support-smallholder-farmers
Heifer NLD	http://www.igungaecovillage.com/project-approach/
Hivos	https://hivos.org/program/kenya-market-led-horticulture-project-hortimpact/
ICCO	https://www.icco-cooperation.org/en/projects/vegetables-for-all-in-tanzania
Oxfam	Interactive data tool for commodity footprint
PUM	https://www.pum.nl/vegetables-and-fruits-green-and-glasshouses
Rabobank	World Vegetable Map
RijkZwaan	https://www.rijkzwaanafrica.com/partnerships-projects
SNV	http://www.snv.org/sector/agriculture/topic/horticulture
Soil & More Impacts	Partner in https://coolfarmtool.org and www.soilandmore.com
Solidaridad	https://www.solidaridadnetwork.org/supply-chains/fruit-vegetables
WUR	http://csabooster.climate-kic.org/ and https://www.wur.nl/en.htm
MVO NLD	https://mvonederland.nl/publicatie/soil-initiative

AgriProFocus network organised a landmark **regional horticulture event** in November 2015 in Kigali, Rwanda. It was a combination of an exhibition (including a Dutch pavilion), a conference and an innovation competition for horticultural entrepreneurs. See this 12m video. Climate was discussed in related topics as soil fertility, greenhouses and post-harvest losses.

On the occasion of this mapping, APF re-contacted the entrepreneurs from Kenya, Tanzania, Zambia that participated in the innovation competition. Some are no longer in business or did not reply. Four companies further developed their agri innovations for market introduction:

- KOFAr (Kenya) is a social enterprise that sells fortified compost and soil conditioners that reverse acidity, boost moisture retention and increase quality food production.

- EAFF (East African Fruit Farms, Tanzania) is in business, with AgDevCo is investing in their cold chain with a refrigerated truck, cold rooms and a processing factory. All activities are powered with solar and bio-diesel. The plan is to set up a solar dryer.
- Zelo Foods (Zambia) is still active as processor of groundnut powder which stay edible for 12 months. Improved packaging reduces the risk of aflatoxin contamination. In 2017, Zelo foods won the GAIA/ AWARD gender inclusive international award. Recently they participated in the 3 month Zambia Agribusiness Bootcamp, which grants them access to the World Bank's MarketConnect programme.
- The overall winner, AfriBanana from Uganda, is still active as an incubator programme for SME entrepreneurs and innovators in the banana value chain.

Delphy Improvement Centre

Delphy is using a modern greenhouse complex called the Delphy Improvement Centre. In the nine compartments of their state of the art greenhouse, cultivation concepts are developed, tested and demonstrated. Knowledge development means knowledge sharing. To achieve this they have set up the training centre called the Horti Experience Centre for students and trainees from all over the world. This facility is integrated inside the Delphy Improvement Centre. (Delphy Improvement Centre)

***Food & Business Knowledge Platform* (The Netherlands)**

The Food & Business Knowledge Platform is one of the knowledge platforms initiated by the Dutch Ministry of Foreign Affairs in 2013. It aims to enhance the coherence and use of knowledge in the field of Food and Nutrition Security, fostering collaboration between business, science, civil society and policy. The Platform facilitated a knowledge trajectory on the food and nutrition security potential of the horticultural sector, collaborates with NWO-WOTRO and CCAFS to enhance future research uptake from eight research consortia exploring scaling of CSA (see overview article) and prepares further work to foster learning on horticulture - vegetables programmes,

***CCAFS (Climate Change, Agriculture and Food Security* - The Netherlands)**

CCAFS is one of the 15 CGIAR research centres based in Wageningen. CCAFS , F&BKP and NWO-WOTRO collaborate to enhance the impact of research consortia participating in the Global Challenge Programme - Call 4[4]. . Relevant research projects (non-exhaustive) are:

- An earlier ARF project focused on smallholder IPM strategies against Tomato leafminer (*Tuta absoluta*) and Fusarium in Kenya. Koppert Biological Systems ran successful IPM trials and demo plots. Farmers are now able to make their own traps for mass trapping of Tuta absoluta.
- A research project on organic soil fertility and marketing of indigenous vegetables in Kenya. These are nutritious, tolerate weather stress and produce with low external inputs.
- A GCP research project in Iringa Tanzania by CARE and WUR will focus on micro finance and 5 value chains (soya, maize, onions, tomatoes, poultry). These are linked through intercropping, animal feeding, composting and nitrogen-fixing in the soil.
- A maize nutrients project in Ethiopia and Tanzania aims to improve the delivery and uptake of nutrient management advisory tools. These tools are made to make more efficient use of nutrients.

[4] See: https://knowledge4food.net/research-projects/global-challenges-programme/ for a full overview of GCP-4 call projects

Horticulture production zones in Kenya, Tanzania and Zambia

(adapted from MatchMakers KE and TZ, 2017 and APF Zambia 2017)

Kenya:

Kenyan Highlands: potatoes, cabbage, garden peas, carrots, snow peas, snap peas,

Nyanza, Western and Central Rift Valley: African leafy vegetables, fruit production

Tanzania:

Northern Highlands: flowers beans, peas, berries, spices, onions

Coastal Zone: mango, orange pineapple, papaya, spices

Lake Zone: Potatoes, banana, cabbages, sweet pepper, kale

Southern Highlands: Tomato, avocado, potato

Zambia:

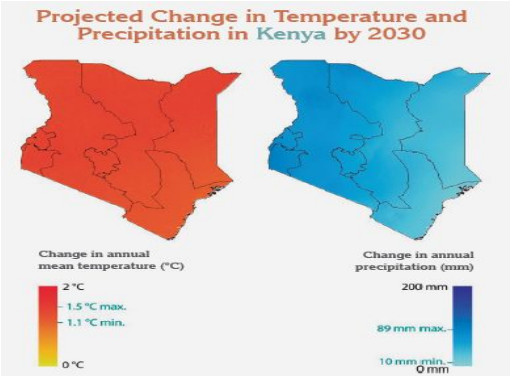
Lake Tanganyika: Cabbages, Onion, Tomatoes, Mangoes

Central and Lusaka Province Tomatoes, Potatoes, Cabbages, Watermelons, Eggplants, Butternut squash

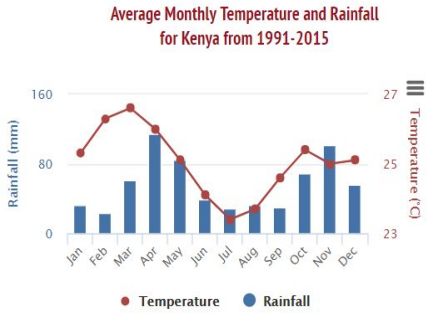
North-Western Province Mangoes, Pineapples, Beans, Cabbages

2. CSA horti in Kenya

The area under horticulture production is well over 700,000 hectares and the sector has a value of over USD 2 million. The export is mainly for cut flowers, European and Asian vegetables and fresh fruit markets. There is also a large domestic market for vegetables, potatoes and bananas. Kenya has a variety of climatic conditions (Rift Valley versus highlands) and fertile soils in the production areas. In Kenya, the use of fertilizer is 40 kg/ha (national average for agriculture).



source: https://ccafs.cgiar.org/publications/csa-country-profiles



source: http://sdwebx.worldbank.org/climateportal/

Research[5] from Wageningen UR indicates that Kenya's production/hectare is dropping due to warming and change in rain patterns. Dry spells are expected to occur more frequently, even though Kenya average rainfall is expected to increase. Rainfall was already unevenly distributed over the country, but that also goes for the distribution over the seasons and years. In April 2018, heavy rain and flooding has caused large scale destruction and displacement in southern Kenya, this happened after months of drought[6]. It is likely that higher annual mean temperatures are also felt mostly in extreme temperature events.

Policy

Kenya has a climate smart agriculture strategy for 2017-2026. In October 2018 it also launched the Kenya CSA Implementation Framework. This framework sets guidelines for implementing CSA approaches, strategies, practices and technologies in the country through:

1. Coordinated governance for climate resilience and low carbon growth in agri;
2. Mainstream CSA to support the transformation of Kenya's agricultural sector
3. Reduce vulnerability of agriculture systems and reduce GHG emissions.
4. Strengthen communication systems on CSA extension and agro-weather issues.

Horticulture is not specifically mentioned in the strategy. The decentralisation in Kenya may result in county level implementation of CSA policies.

Dutch initiatives

In Kenya there are a number of Dutch initiatives with a link of climate smart horticulture. Some of the key programmes are;

I. The Kenya Market Led Horticulture Programme (HortIMPACT) combines private sector expertise with social impact solutions to build sustainable, inclusive, climate resilient, horticulture value chains and markets Kenya that benefit small and

[5] https://www.sciencedirect.com/science/article/pii/S1573521416300057
[6] *Newspapers and 3-monthly overviews at* http://www.environment.go.ke/

medium-sized farmers. The programme is funded by the Dutch Embassy in Nairobi and led by SNV.

II. Smart Water for Agriculture (SWA) aims to save water and energy, and to ensure sustainable resource use by promoting farmer-led and market-based smart water products and services. The interventions also aim at reduction of labour and inputs, mitigate weather related risks, and promote off-season production opportunities.

III. The new CSA EA programme for Kenya, Tanzania and Uganda (SNV, WUR, CCAFS, Agriterra, Rabo Partnerships) aims at climate risk analysis of major food value chains, identification of business opportunities in CSA, access to finance, policy influencing and knowledge sharing between countries and networks.

IV. The Africa Biogas Partnership (SNV, Hivos) is relevant here for the biogas residue bio-slurry use in horticulture sector. The nutrient value of slurry is comparable with the original manure. The bio-slurry from an average biogas installation fertilizes one acre (0.4 ha) of horticulture.

AgriProFocus Kenya

APF Kenya works with HortImpact and SWA to promote learning and scaling of innovative horticultural interventions. Both programmes develop business cases with local companies in order to stimulate horticulture sector development as well as promote innovative smart water technologies.

In this context, APF Kenya organised a horticulture partner day in July 2018. The session most relevant for this mapping was the technology session which focused on how technology can be leveraged to reduce cost of production and increase sector efficiency. There is consensus from this session that technology plays a critical role in horticulture but its success can only be guaranteed by ensuring there is interaction between the providers and users. The additional costs of climate adaptation measures may be balanced with increased efficiency and the guarantee of a continuous supply.

2.1 Selected cases

From interviews held with key stakeholders in the AgriProFocus network, the following practices were derived:

Cabbage in a bucket and vertical farming

Free Kenya develops low-tech solutions that enable the inclusion of vulnerable and marginalized communities in agribusiness. Free Kenya has a Resource Centre in Kisumu.

One solution for smallholders with disease infected soil is growing vegetables in a bucket of clean soil. In the case of cabbage, the plant will sprout multiple times. Conventional planting in the soil would give only one time sprouting. So this means a huge production increase.

A second solution is the home made vertical farming method. Space and water is used very efficiently as different layers of product can be grown at the same time.

(source: FreeKenya, Resource Center, Kisumu, Kenya)

Soil testing and advice

A solution offered by AgroCares in Kenya is for improving poor soil health and fertility through mobile soil testing combined with a specific advice. A handheld scanner monitors the pH, N, P, K level and organic matter in a soil sample. The advice depends on the crop and production target: the report mentions Soil Status; Nutrient Needs; Soil Improvement Plan and Suitable Crops.

The main advantage is the speed, one can get the advice from the database back on a smartphone in 10 minutes after sampling.The cost of such an advice is approximately €9,00 while the benefit is in lower costs for chemicals, higher yield and healthier products

Source: https://agricares.com

Climate Smart Villages

In the Climate Smart Village in Lower Nyando, Kenya, farmers work together. Improved water harvesting technologies enhance crop and livestock production, increasing household income and food security. CGIAR has set up similar CSA Villages in Tanzania (Lushoto).
Researchers and community representatives identify appropriate climate-smart options for the village, such as technologies, information services, local development and adaptation plans and supportive institutions and policies. The decision-making is as participatory and inclusive as possible, encouraging women and more vulnerable groups to participate.
In Kenya, for example, more than 1100 households in the climate-smart villages joined self-help groups established by the project to support the communities, and 70–85% of the active members of the groups are women.

(Rainwater harvesting - source CGIAR, 2016)

Tissue culture and more for a clean start

Growpact

GrowPact has developed a concept to make simplified Dutch horti- and agricultural technology accessible to emerging and developing countries. The most innovative Dutch horti- and agricultural ideas have been combined into a fully manually operated young plant nursery. (**www.growpact.com**)

The already existing GrowPact Hub in **Kitale, Kenya** is fully operational since September 2017. The GrowPact nursery is well known among the local farmer community in West Kenya.
Irrigation systems are part of the **turn-key** approach, as well as training & education, Seed & Plant genetics, fertilizers, greenhouse & equipment, micro finance. (www.growpact.com)

Growpact in Kisisi, Kenya also promotes Tissue culture. This a propagation technology that produces many planting materials that are free from pests and diseases. Examples are young plants of Banana, Strawberry, Cassava, Stevia and Sweet Potato. Growpact is an integrated concept that supplies young plants, irrigation, inputs and microfinance.

Solar pump for irrigation

FuturePumps were developed by Practica Foundation (NL) and tested in Kenya. The pump is solar powered and designed for small scale farmers with parcels ranging from 1 acre to 2 acres. The pumps are wired for remote sensing which allow for the after-sale services including if the pump is working properly, the carbon mileage and the pumps safety.

This system is cheaper in labour compared to the Moneymaker threadle pump. It has big potential in areas that are off the grid.
It has the capacity to measure carbon emission, anticipating the future market in carbon offsets.

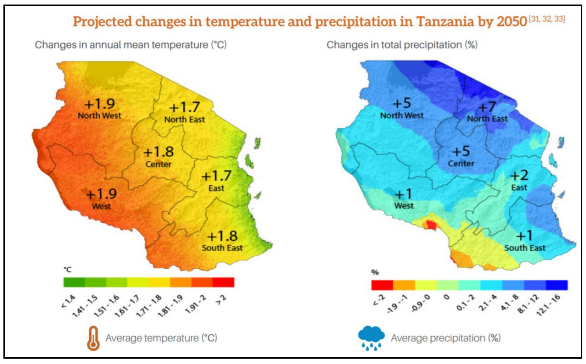
	
Moneymaker costs about € 200	Futurepump GF1 cost about € 408

Dodore

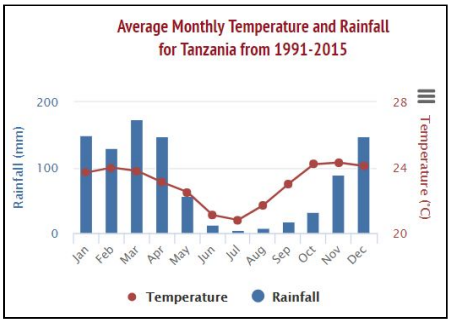
Dodore developed an app called the Agri-Wallet. They work with small farmers to enable and empower them to save, borrow and pay for income generating activities to increase food security and fight poverty. This empowers farmers to finance ***Climate Smart solutions*** to improve their production, increase yields and become more resilient to climate change. **(www.agri-wallet.com)**

3. CSA horti in Tanzania

The key horticulture production areas are indicated on page 3. Horticulture is traditionally concentrated in the Arusha-Moshi area, also home to the WorldVeg Centre and several Dutch horti seed companies. New investments (tomatoes, potatoes) are channelled to the southern highlands between Mbeya and Iringa.
The sector has an export value of USD 545 million (2015), mainly flowers and vegetables to Europe. The information on horticulture in Tanzania is old or incomplete. The area under irrigation is above 330,000 ha. The Tanzania tomato production was 450,000 MT in 2014, which is 12% above Kenya production.
The use of chemical fertilizer is rather low at 4,4 kg/ha (national average for agriculture).



source: https://ccafs.cgiar.org/publications/csa-country-profiles



source: http://sdwebx.worldbank.org/climateportal/

Climate projections indicate higher temperatures and, especially in the north, more rainfall for Tanzania. In between rainy seasons, droughts are expected to be more frequent and severe. In 2017, Tanzania experienced a drought season with extremely high temperatures that affected the country's agriculture production. In 2018 on the other hand, heavy rainfall occurred in different parts of Tanzania mainland and Zanzibar causing floods. The northern region was highly affected by the two incidents.

Policy

The Climate-Smart Agriculture Programme for Tanzania (2015 – 2025) aims to build resilience of agricultural farming systems for enhanced food and nutrition security through six programmatic result areas namely: Improved productivity and incomes; building resilience plus mitigation, value chain integration, research for development and innovation, improving and sustaining agricultural advisory services; and improved institutional coordination.

World Vegetable Centre (AVDRC)

The AVDRC website has no specific mention of climate smart horticulture. In their view, the skills, practices and innovations under CSA are not different from what farmers need in regular horticulture sector development: water efficiency, soil fertility, marketing and business. A new element is in weather forecasting.

Breeding activities do take climate change into account: indigenous vegetables that are easy to grow (amaranth, African nightshade, Ethiopia mustard); disease resistance in tomatoes.
World Veg is also working on pesticide reduction with WUR and affordable greenhouses for the sector. World Veg tests shade nets, greenhouses, screenhouses, polyhouse on the cost and benefit. They also have a training programme for young entrepreneurs in horticulture.

Dutch engagement in Tanzania horticulture

Afrisem in Arusha is a breeding station set up by RijkZwaan. Afrisem breeds hybrid varieties for African eggplants, African kale, Chinese peppers and semi-determinate tomatoes.

The SEVIA programme (RijkZwaan, East West Seeds, WUR) aims to contribute to the development of the vegetable industry in Africa by breeding, testing existing genetic vegetable resources and disseminating adapted technical innovations.

Stawisha Ltd is a non-for-profit company that is the implementer of the Centre for Development of the Potato Industry in Tanzania (CD-PIT) project which is a public-private partnership of the Netherlands Ministry of Agriculture, Nature and Food Quality, The United Republic of Tanzania Ministry of Agriculture and private sector from both countries. These collaborative efforts aim at; developing a robust, competitive sector, with focus on facilitating private sector sustainable development and creation of jobs; building capacity of farmers and companies in Tanzania involved in the value chain for sustainable potatoes production and marketing; creation of added value; enhancing sustainable business relations between Dutch and Tanzanian partners; and improve food security, more safe and healthy food.

AgriProFocus Tanzania

APF Tanzania regularly promotes Afrisem and SEVIA field days. APF also works on horti with other national and international partners in Tanzania:

- Promotion of the horticulture sector at the annual farmers fair (with FERT, Meru Farmers Platform JUWAME). These fairs aim at linking farmer entrepreneurs with input suppliers and financial institutions. The next fair is in November 2018.
- Tomato value chain analysis (with SAGCOT Center and Agriterra, 2017) which is now leading to a tomato sector action plan with key stakeholders.

3.1 Selected cases

Farm ponds

Kiboberry is harvesting rainwater using the 'Gley Method'

Kiboberry grows about 25 ha of export raspberry near Moshi, Tanzania. They grow 'Kweli', a tough variety that resists high temperatures and has a shelf life of 7 to 10 days. Kiboberry uses shade nets for growing raspberry to prevent them from direct sunlight. Raspberry can not grow in greenhouses, only the nurseries are in the greenhouses.

Raspberry needs a lot of water. In the dry season it is usually irrigated 2 to 3 times a day. To store rainwater in a pond, they experimented the 'gley method'. This method is called after gleysol, the impermeable layer in ponds and swamps that are the result of anaerobic decay of organic matter. The gleysol is formed by adding organic materials like grass, leaves, fresh manure and cardboard to create a natural seal which prevents leaking[7].

To prevent erosion and to straighten the pond walls, Vetiver grass has been planted which has strong fibrous root system that penetrates and binds the soil to a depth of up to 3 meters and can withstand the effects of tunnelling and cracking.

Kikoberry is using cocopeat as a substrate for 10% of their raspberries. Using cocopeat leads to higher yields but also higher costs (for the cocopeat, more water). Kikoberry uses cocopeat to grow young shoots of raspberry. These are stored in a cold room to simulate winter. After planting in soil, the warm environment enhances quick growth and production.

Breeding for drought tolerance

Afrisem breeds seed for drought tolerant tomatoes and African vegetables.
RijkZwaan Afrisem sells vegetable seeds all over East Africa. It has a breeding station near Arusha, Tanzania and demo plots in the Southern Corridor horticulture areas.
Afrisem holds farmer field days and train a range of topics: use of the hybrid seeds, nursery trainings, drip irrigation, greenhouse farming, biological control of pests and diseases.

[7] Journal of the New Alchemist, volume 1 p35, 1973

Afrisem breeds vegetable varieties specific for the hot seasons and other for the wet season. It allows year-round production.
The Jarrah Tomato variety is meant for the dry season, as it is vigorous and resistant to drought, diseases and pests. These traits have led to reduced use of pesticides which in the end pollutes the environment and is a climate hazard. In 2017 a total of 1.6 million seeds of Jarrah have been sold.

Jarrah RZ F1 harvest in Mufindi District, February 2018

RijkZwaan also collaborates with other suppliers. Examples are Real IPM who provide trainings on integrated pest management; Solar Simu who promote and distribute solar powered pumps; Irrico Irrigation who distributes different types of drip irrigation and greenhouses solutions; Wade Rain a drip irrigation distributor and , EFTA an agricultural equipment leasing company. Demo sites show the combination of inputs and services.

Rijk Zwaan Afrisem Centre of Excellence Morogoro getting ready for the Nane Nane. Developed with partners.

Alternatives for soil

In the demo plots Afrisem uses cocopeat made from coconut husk that retains water for a long time. This is suitable for dry seasons and areas. However the challenge is that it is cocopeat is only manufactured in Pangani, Tanga and not very easily accessible. Mr. Able from Afrisem mentioned that in areas where the soil has been damaged by pesticides and herbicides then cocopeat is a good alternative to use in the green houses.

SEVIA, Seeds of Expertise for the vegetable sector in Africa

SEVIA is a joint project from RijkZwaan and East West to professionalise the vegetable sector in East Africa. Apart from encourages the use of hybrid seeds. SEVIA has farmer trainings on demo plots for water storage and protected growing.

SEVIA is training farmers about mulching, which is covering the soil with plant material, such as grass. This works well in Dodoma and Mwanza where farms are bigger and material for mulching is easily available. In the Northern part of the country, grass is usually used as feed for livestock.

As greenhouses are too expensive for most farmers, SEVIA is promoting shade nets as these reduce the impact of rain and sunlight on crops. However , the SEVIA demo plots show the different options.

SEVIA also organised participatory costing of irrigation options with farmers in Sanga Sanga and Mlali villages. The calculations and trials showed that it is worth to grow vegetables using drip irrigation system with a water pump especially during dry season.

On average, tomato yield under drip irrigation system is about 44 tons per acre. However, the potential yield of variety Assila under drip irrigation system following good agricultural practices is said to be about 54 tons/acre.

Keeping the vegetables fresh

The Zero-Energy Cool Chamber - Local refrigerator - WorldVeg Centre

With rudimentary means for storing, processing, and transporting crops, farmers and traders throughout sub-Saharan Africa may lose nearly half of their fruits and vegetables between the harvest and the point of consumption or sale, according to the UN's Food and Agriculture Organization. A key technology that farmers lack is refrigeration. The zero-energy cool chamber, or ZECC helps farmers improve the longevity of their produce up to two weeks. The ZECC, which uses evaporation to cool its inner space relative to outside temperatures, offers a low-tech, low-cost version of refrigeration. Keeping the bricks wet is the only real maintenance it requires. The first picture shows the ZECC while the second shows a comparison of vegetables stored outside (right) Vs vegetables stored in a ZECC (left)

Charcoal Cold room

There is a charcoal cooler in the demonstration plots that helps to keep fresh vegetables. It uses the principle of evaporative cooling to maintain a cool interior temperature for refrigeration and food preservation. This has been adapted by many farmers that have visited the station. Funny detail is that this solution was shown as well by a Dutch farmer from Moshi who joined the TV show "'Boer zoekt vrouw'[8]

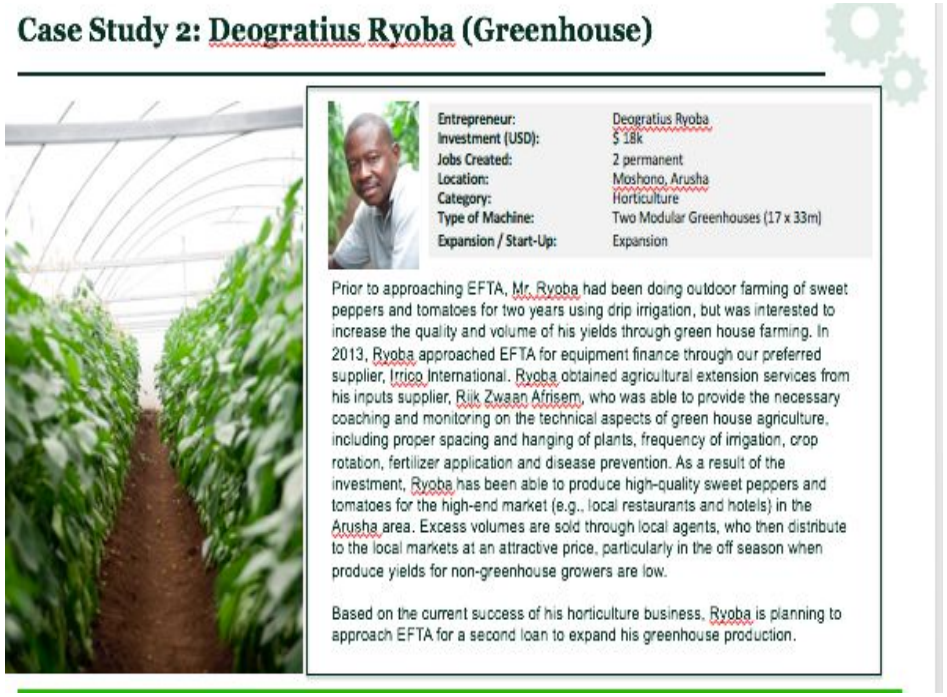
Solar Dryer

Also, the use of solar dryer is encouraged to reduce post-harvest losses of vegetables. However, the market for dried fruits and vegetable is still small in Tanzania hence limiting adoption of this technology.

[8] *http://farmingafrica.net/2015/03/het-wordt-koel-bij-boer-wim-van-boer-zoekt-vrouw/*

Agriculture Financial Leasing

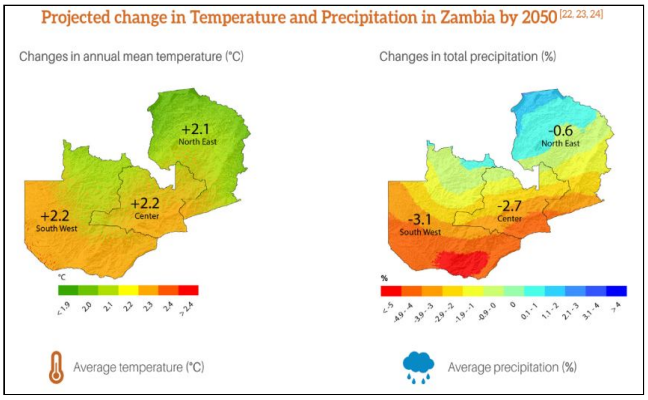
EFTA is a financial leasing company in Tanzania, focused on small enterprises and farmers (55% of the portfolio is in agriculture value chains). They offer unique products such as greenhouses and drip irrigation with the equipment serving as the collateral. With a 10% down payment, 18-36 month payment period with a 2 month grace period,accessible to semi formal enterprises (no business plan or audited accounts required),and a broad range of equipment available for leasing,the model provides farmers and small agri enterprises with a commercially sustainable and scalable solution to limited access to finance.



4. Zambia

Horticulture production in Zambia is concentrated along the line of rail (page 3) with the fastest growing markets being in the mining towns which are dotted in the North Western and Copperbelt regions.
Zambia has a horticulture export history, but currently, it is a net importer. In 2014, Zambia imported vegetables worth USD 412.6 million, mostly coming from South Africa to supply urban supermarkets and mining companies. The Zambia horticulture sector had an export value of USD 16,6 million in 2016. The import of processed tomato products has a value of USD 9.2 million in 2014.

The Zambia tomato production was 25,571 tons in 2016, mostly for the fresh market.
The area under irrigation is 423,000 ha of which only around 56,000 ha is under horticultural production. The use of fertilizer is 36 kg/ha (National average for agriculture).



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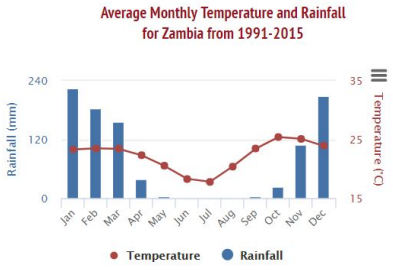


source: http://sdwebx.worldbank.org/climateportal/

Climate change projections in Zambia point to higher temperatures and lower rainfall, especially in the south. Unlike some prolonged dry spells in 2015/2016 agricultural season, the 2016/17 agricultural season was characterised by the La Niña weather event, which meant that most parts of the country received between normal and above normal rainfall.

Policy

The Zambian Government has continuously been developing programmes and conducting policy reviews in an effort to encourage increased adoption of climate smart agricultural practices. While there is currently no specific climate-smart agriculture policy or strategy in place; a number of policy documents recognize CSA as an important priority in both mitigation and adaptation. These include:

- Comprehensive Africa Agriculture Development Programme (CAADP) Framework (2010) at a regional level.
- CSA Development and Investment Plan (Under Development)
- National Agriculture Investment Plan,
- National Agricultural Policy (NAP) which targets a conversion of about 600,000 small scale farmers to Climate Smart agricultural practices under conservation agriculture.

Dutch initiatives in Zambia

In Zambia, member programmes with a climate smart dimension include the Sustainable Land Management Programme under Solidaridad. One of the ways Solidaridad is advancing the landscape management agenda in Zambia is by presenting alternative farming methods including organic farming, through its advocacy and lobby programmes.

In addition, the Netherlands Development Organisation SNV is also implementing the Sustainable Integrated Land Management Solutions (SILMS) which focuses on introducing Climate Smart farming methods to farmers in Lundazi and Katete. Through another project called Energy for Agriculture (E4A) SNV is promoting the use of Bio Slurry in gardening as an added benefit in the installation of Bio Digesters.
As mentioned before, bio slurry can be used as an organic fertilizer for home gardens and this has worked very well as evidenced by one of the SNV beneficiaries Twaambo Bbuku of Monze district who after installing a bio-digester is now using the bio slurry as a by-product to fertilise her vegetable garden which due to the equality of the yield has become most popular for the local market where she sells the vegetables.

Agriprofocus Zambia

APF Zambia has in the past commissioned a horticulture sub-sector study (EKN, AgBIT, 2015) to identify business opportunities (such as input supply, refurbished equipment, see 10m promotion video). One follow-up with EKN was a scoping mission with Agriterra to map horticulture entrepreneurs and producer organisations in the North and North-western provinces. This information was used to develop a training programme in seedling production, greenhouse technology and some other basic CSH practices.

4.1 Selected Cases

Compost and soil management

Kasisi promotes soil management practices.	
KASISI is a training centre in Zambia based on organic principles. They see high adoption rates of compost but low rates of adopting green manure. Farmers with small plots need every square inch for production. Kasisi now recommends to plant nitrogen- fixing crops only in the rainy season, when farmers focus on fields crops rather than vegetable gardens. The poor adoption of raised beds in horticulture had another reason: to farmers it does not match well with crop rotation. Rotation helps to control pests. Farmers till and plant the full plot. Kasisi is promoting rotation of crops per raised bed. Kasisi manages pest prevention by planting hedge rows with resistant crops such as Chilli and Lemon grass and insect repellent crops such as marigold. This is only a partial solution.	 

Organic fertilizer

Lima Fertilizers puts organic fertilizer pellets on the Zambia market.

In February 2018, a new company started to sell organic fertilizers in Zambia. Theirs is 100% Zambian product originating from 200 suppliers of organic waste.
The raw material is a mix of animal manure and vegetable & fruit waste with no chemical supplements.
Lima sell it also in pellets for easy application.

The company developed the formula for the organic fertilizer over the last 2 years, taking into account the soil types and earlier use of synthetic fertilizers. In many exhausted soils, the balance of N, P and K need to be restored.

Linking producers and consumers

Kasisi KATC creating market linkages

Kasisi noted that adoption of new CSH practices remains poor when farmers have limited access to the market.

Kasisi facilitated a profitable market linkages for farmers organised in CHOPPA. Their organic produce supplied large supermarkets in Lusaka, Zambia such as Food Lovers, Pick n Pay and Choppies, Melissa Super Market and to hotels like Cresta Golf View and Fairview.

However, the role of Kasisi relied on a subsidy and a central pivot (fuel-driven) to organize a regular flow of produce.

Female farmers aggregate their produce for the market
source: field visit Chali Nyirenda.

5. Discussion

In this mapping, APF and F&B worked via their networks in Kenya, Tanzania, Zambia and the Netherlands. Guided by a consultant Aart van den Bos, network facilitators described 17 practices in total. Some practices such as canola conservation agriculture were not included, as it was outside the working definition of horticulture. The consultant contributed with 4 more practices from his own network and visits in Kenya.

Most practices found in the mapping related to production technology. Inputs for production and for getting it fresh on the market are a good second. The mapping found few services, while a lot of efforts focus on improving weather information.
In 10 out of 21 practices listed, there was a direct link to Dutch horticulture business or organisations. In Zambia there was no practice linked to the Dutch. In Kenya and Tanzania, the "Dutch" practices range from innovative (solar pumps, soil test) to proven elsewhere (water harvesting, breeding, training).

The **first main question** was about the climate change risks for horticulture: water stress; soil fertility, disease pressure, planning disruptions. Most practices found in the mapping are technical solutions related to the first 3 risks. Only one practice focused on the market link.

Type of risk	Water stress (3)	Soil fertility (4)	Disease (2)	Planning disrupt (3)	Other (4)
practices (examples from this mapping)	farm ponds solar pump mulch	organic fertilizer raised bed rotation soil test	breeding repelling plants	coolers driers market link	leasing agri-wallet CSA village SEVIA

The **second main question** was about the response of the horticultural sector to these climate change risks. The practices correspond roughly with the general supply side trends mentioned in the introduction chapter.
A preliminary discussion of business drivers was held by the mapping team halfway the exercise. It led to a list of conditions for adoption. These were grouped as technical, economic and social conditions.

Technical	Economic	Social
Reliable technology After sales guarantee Sustainable post adoption Proof of concept Farm context	Commercial viability Long term access to land Labour availability Proof of concept Market Access	Knowledge and skills Perceived risk Access to technology Culture,norms, gender Early adopters

The mapping of practices does not include a detailed analysis of the contribution to the three CSA pillars, the time till benefits and the gender dimension. Below, we discuss this for 4 topics: Water, Soil, Greenhouses and integrated approaches.

5.1 Water for horticulture

This topic was discussed in a work session in November 2018 at the World Horti Centre (annex b). In addition to Farm Ponds and Solar Pumps, practices to reduce water consumption such as Mulching, Drip systems and Soil in buckets/on sheets are also important.

Technical issues define the adoption of the solar pump: it works when there is sunshine (during the day), and that is the best time of watering plants (morning, evening).

Solar pumps supply low pressure water, which requires an adapted sprinkler or a storage tank with gravity drip systems.

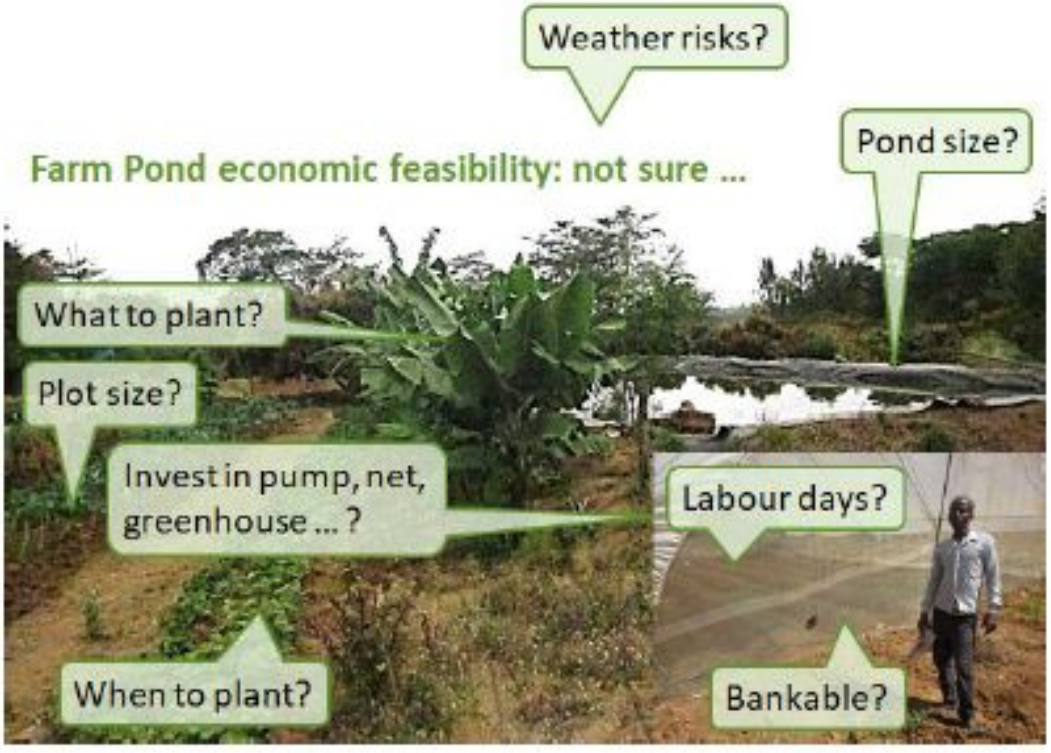
Economic issues concerning farm ponds are another dimension that becomes visible with the Farm Pond Planner tool. The model relates farm pond size to the cash flow of the horticulture business. The model takes into account likely local weather patterns (big data), crop requirements and even seasonality of crop prices.

Some practices, such as drip irrigation are reportedly a challenge as they are too expensive. According to SEVIA, only 1% of farmers trained adopt drip, as it is too expensive.

Social issues were discussed in general terms as the level of skills of producers and farm staff. Innovations require early adopters showing the (quick) results of practices working under farm conditions. Many believe in 'show' above 'tell''. Another way to convince non-adopters may be promoting pay-as-you-go for watering services.

A gender dimension in adopting water practices was not discussed.

CSA pillars. Obviously, water is key for productivity in horticulture. The practices in the mapping are all relevant for climate adaptation, while the solar pump also has a mitigation effect by replacing fossil fuel. The coolfarmtool also assesses the water footprint of horticultural production. Efficiency and low losses are rewarded in this tool.



The Farm Pond Planner supports farm decision making by showing cash flow effects of different measures. For example, a simple measure as putting a plastic sheet under fresh uncontaminated soil for tomato may reduce water and fertilizer leakage with 85%, requiring a much smaller investment in the farm pond.

5.2 Soil for horticulture

The mapping found 6 practices on soil; these include clean soil in buckets or on sheets, coco peat substrate, compost and mulch, organic fertilizer, raised beds and soil testing.

Technical issues: a simple and reliable practice against soil nematodes is getting fresh soil from nature or buy substrate. Improving soils with compost and conservation measures takes more time to show effects.

Economic issues: micro-dosing of fertilizer has the quickest return, also because it reduces fertilizer leakage. Crop rotation (alternating Legumes; Brassica; Root crops; Solanaceae and Leafy crop families) means varying less profitable crops to help conserve the soil fertility.

Social issues: as soil health is a longer term issue, more extension and training are needed to strengthen skills and awareness. Labour constraints, particularly for women, blocked the introduction of permanent beds at Kasisi, as it leads to more weeding work in their organic system. The effects of compost take more time, so landowners are more likely to invest than others.

CSA pillars. The coolfarmtool was designed to measure the carbon footprint at chain level. It allows for paid mitigation when farmers capture carbon in the soil that compensates for carbon emissions further downstream. The tool shows for example that using chemical fertilizer has a high carbon cost (including the fossil fuels used in manufacturing fertilizer).

5.3 Greenhouses and integrated concepts

The mapping listed greenhouses as part of integrated concepts and demo farms in Kenya and Tanzania. These concepts integrate different types of greenhouses and shade-nets with other technology and advise to improve horticultural production management.

In Zambia, Kasisi Centre provided an integrated approach without a greenhouse. It was practicing a market link between organic producers and conventional retail.

Technically, greenhouses range from simple to complex: some of the cheaper greenhouses trap too much heat and were abandoned. The integrated concepts may prove their viability, but have an even bigger technology gap with the average horticulture entrepreneur.

Economically, greenhouses require that finance for investment is in place. For small and medium-sized horti entrepreneurs accessing other protected cultivation measure may be more easy. One vegetable farm in Zambia pointed out another problem: there is no market premium for sustainable production, so they returned to conventional production.

Socially, greenhouses are a trend in some areas, such as central Kenya. The World Veg Centre in Arusha is currently testing different greenhouses and other options for protected cultivation. The challenge is to design a cheap but good enough concept for the African market. The early adopters will also need skills, reliable logistics and quality inputs to make concepts a success. According to SEVIA newsletters, a farmer with a production plan can make money with a greenhouse by being earlier or longer on the market than the average producer.

CSA pillars: integrated concepts with greenhouses may be more productive and nutrient efficient (as evidenced under Dutch conditions). In Africa, they may also help the adaptation to extreme weather. Whether greenhouses have a mitigation effect depends on the context: the plastic has a fossil origin, the higher fertilizer efficiency is a positive thing. Integrated concepts that reduce post harvest losses are positive.

5.4 Further discussions and network action

Many other topics remain for discussion: for example the added value of short local value chains ('eating local'), the particular issues related to seed, the use weather data.

The issues discussed above can be integrated in the further agenda of the APF network in view of accelerating climate smart horticulture in Africa. At the level of members and partners, the network is there to organise linking and learning and leadership on this topic.

The linking is also about working with farmers as business partners instead of beneficiaries. The latter leads to little pro-poor inclusiveness[9] and unsustainable partnerships. Farmers as business partners are more likely to boost adoption rates of climate smart practices in horticulture.

[9] *4P brokering and partnership development (2017, SNV)*

6. Conclusions & Recommendations

6.1 Conclusions

Climate change in Kenya, Tanzania, Zambia poses a growing threat to horticulture. It affects both production and the rest of the value chain. Action is urgently needed to prepare the horticulture for the prospect of extreme weather events: heat waves, dry spells, heavier rains. At the same time, horticulture also needs to reduce its carbon emissions that contribute to climate change. This is a daunting task.

There are many climate smart practices and interventions mentioned in literature and present in the APF network. Most practices found in this mapping are technical and focus on innovative production solutions. For further network exchanges, the focus will gradually shift towards solutions that encompass the whole value chain as well as the relevant enabling environment.

The adoption rates for these climate-smart horticultural practices have not been studied. There are technical, economical and social conditions determining whether or not farmers would integrate these solutions in their practice.
Tools such as the farm pond planner help to analyse / predict the cash flow of different scenarios. Apparently, this is only part of the puzzle.

Climate Smart Horticulture requires:

- Entrepreneurial farmers, eager to learn and invest in business relations.
- Know-how about the technical factors, requiring education and training.
- Demo farms: seeing is believing for farmers in horticulture.
- Tools to measure carbon and water effects of (new) horticultural practice.
- A combined offer from suppliers that is “fit to context’ and with access to finance for farmer entrepreneurs.
- Joint learning on climate smart practices for food security, adaptation and mitigation.
- Multi-stakeholder collaboration in / around horticulture value chains

6.2 Recommendations

As a general recommendations on ‘business drivers’, all stakeholders are reminded that **no solution is *the* only fit** for all problems; business thrives best when a smart farmer (f/m) in a smart food system uses smart farming practices, smart market links and so on.

Many of the practices identified in this mapping are options for SME agripreneurs. For them, **seeing is believing** which means that demo plots, demo farms and demo villages are the best means to get agripreneurs informed and aware.

Members and partners in the network may also want **proof of concept**, including modelling tools with cash flow projections.

Among the recommendations that emerged from the WHC session, was the suggestion to develop a **complete and (more) coordinated offer** from the Dutch horticulture suppliers to African SME agripreneurs. Learning from the Amiran approach which combines simple greenhouse, inputs, finance and advice in a package deal.

Building on this, the AgriProFocus network's further role could be to:

- step up the visibility of climate-smart horticulture efforts of farmer entrepreneurs in the network;
- further identify good CSH practice within the broader value chain;
- clarify with members and network partners what their role could be to support horticultural sector actors, particularly SMEs, in enhancing their business' resilience to climate change;
- identify and connect partners within the network to collaborate and facilitate this
- organise further work sessions (Kenya, Tanzania, Zambia, Netherlands) to facilitate multi-stakeholder connections and learning on the above.

Table 4

Different types of intervention and relation to the prioritisation framework in Fig. 1. Estimates taken from the references cited or authors' assessment. Examples in light blue shading are from Table 3 and are referred to in Section 5.2.; Carter et al., 2014, Chowdary and Theodore, 2016, Grajales et al., 2015, Kaczan et al., 2013, Kumar et al., 2011, Kumar et al., 2016a, Kumar et al., 2016b, Makate et al., 2016, Meinzen-Dick et al., 2017, Ojango et al., 2015, Ombogoh et al., 2018, Pathak et al., 2009, Rao et al., 2016, Saxena, 2018, Seo, 2010, Singh et al., 2007, Swain, 2014, Tabo et al., 2011, Thierfelder et al., 2017, Venkateswarlu et al., 2012, Wajih, 2008

Type of CSA intervention 1 Entry point	3 Spatial & temporal scale		4 Research feasibility	4 CSA metrics			5 Other metrics		6 Outputs to impact	
	Space	Time		Productivity (P)	Adaptation (A)	Mitigation (M)	Environmental (E)	Social (S)	Likely impact	Enablers
Climate smart technologies										
Farm ponds: Constructed on-farm rainwater harvesting structures (RWHS) to capture runoff for reuse for irrigation, stock water, etc. (Kumar et al., 2016a).	Plot, farm	Short	M	+	+	+/-	+	+/-	M	Capacity to determine appropriate size and location of the structures, efficient water use methods for high value crops, RWHS implemented as context specific integrated packages
Supplemental irrigation: addition of small amounts of water to rainfed crops to improve and/or stabilize yields (Owais and Hachum, 2012).	Plot, farm	Short	H	+	+	+	+	+/-	M	Sustainable source of water, energy access (for a pressurized irrigation system), suitable crop/cultivar
Conservation agriculture: retention of crop residues, minimum tillage and rotations including legumes (Kumar et al., 2011; Thierfelder et al., 2017).	Farm, community	Long	L	+/-	+/-	+	+	+/-	H	Local capacity building, cost effective access to appropriate machines and implements
Crop diversification: Using multiple crop types and varieties to increase dietary diversity and resilience (Makate et al., 2016).	Farm, community	Long	L	+/-	+	+/-	+	-	M	Access to inputs (e.g. seed) and market for diversified outputs
Agroforestry: Combination of perennial tree species with cropping (Kaczan et al., 2013).	Farm, community	Long	L	+/-	+	+	+	+/-	M	Assured markets via long term contracts with industry (for commercial perennial tree crops)
Climate-smart breeding: development of new or replacement varieties adapted to future climates (Atlin et al., 2017).	Farm, community	Medium	H	+	+	+/-	+	+/-	H	Effective seed and extension systems
Crop/animal improvement: Breeding for new and improved crops/animals (Jaabe et al., 2013; Ojango et al., 2015).	National	Long	H	+	+	+/-	+/-	+/-	H	Effective research and extension systems, private sector involvement
Drought-tolerant crops: development of new crop varieties that are high-yielding under current drought conditions (Andrade et al., 2017)	Farm, community	Medium	H	+	+	+/-	+	+/-	H	Effective systems capable of providing adequate planting material, and effective extension and education systems
Micro-dosing: Application of small amounts of inorganic fertilizer with / without organic inputs like farm yard manure or compost (Tabo et al., 2011).	Farm	Short	H	+	+	+/-	+	+/-	H	Effective farmer education and extensions systems, effective private sector linkages
In-situ moisture conservation: broad-bed & furrow systems, contour bunds, drainage and intercropping systems (Pathak et al., 2009).	Farm, community	Short	H	+	+	+/-	+	+/-	H	Farm mechanisation options available, farm credit
Integrated farming systems: farming systems with integrated enterprises including livestock, perennials (Seo, 2010; Kumar et al., 2016b).	Farm, community	Long	M	+	+	+	+	+	H	Effecting farmer education and extension systems, farm credit
Bundles of CSA options: managing climate risk in highly variable environments (Kumar et al., 2018)	District	Medium	M	+	+	+/-	+/-	+/-	H	Integration of many different stakeholders' perspectives
Climate information services										
Agro-meteorological information: short-term to seasonal climate forecasts released through radio, climate information centers, contingency plans (Singh et al., 2007).	Community, district	Short	M	+	+	+/-	+/-	+/-	H	Effective farmer and extension education systems, weather information well matched to farmers' needs
Crop insurance: covering yield loss due to weather related calamity (Carter et al., 2014).	Region, state	Medium	H	+/-	+	+	+/-	+/-	M	Reliable and quick estimation of crop losses
CSA packages for cocoa production: Farmer innovation for adapting to new climate risks in cocoa production (Schroth et al., 2016).	Community, district	Medium	H	+	+	+/-	+/-	+/-	M	Options matched to the production risk by ecological zone, appropriate training materials, broad stakeholder engagement
Local level development plans										
Village water budgeting plans: collective action to help govern the use of scarce ground water resources (Meinzen-Dick et al., 2017).	Farm, community	Short	L	+	+	+	+	+	H	Community participation, collaboration based on capacity and trust
Crop planning and monitoring: collective action to manage community resources (Grajales et al., 2015; Ombogoh et al., 2018).	Sub-district, district	Short	M	+	+	+	+/-	+	H	Communal capacity development, access to financial resources and resource maps, mechanisms to spread risk
Local knowledge and institutions										
Village seed banks: establishment and maintenance of village seed banks to deal with seasonal and extreme events (Wajih, 2008).	Village	Medium	L	+/-	+	+	+/-	+/-	L	Effective farmer and extension agent education activities

(continued on next page)

Annex a overview of practices

Table 4 (continued)

Type of CSA intervention 1 Entry point	2 Spatial & temporal scale		3 Research feasibility	4 CSA metrics			5 Other metrics			6 Outputs to impact
	Space	Time		Productivity (P)	Adaptation (A)	Mitigation (M)	Environ-mental (E)	Social (S)	Likely impact	Enablers
Custom Hiring Centre–mechanization: Equipment available for hire to mechanize farm operations (Venkateswarlu et al., 2012)	Village	Short		+	+	u	+/-	+	M	Multiple models: community based, collective business and individual entrepreneurship needed
Farmer producer organizations / village climate risk management committees: Collective action to create and manage climate adaptation and commercialization opportunities (Venkateswarlu et al., 2012)	Community	Medium	M	+	+/-	u	+	+	M	Hand holding and credit support in the initial phases
State / national policy interventions										
Soil Health Cards: provision of soil testing to all farmers for use in fertilizer recommendations (Chowdary and Theodore, 2016).	National	Short	H	+/-	+/-	+	+	+/-	L	Effective extension systems, use of digital tools such as mobile apps to enhance sustainability of use
National Crop Insurance Schemes: covering yield loss due to weather related calamity (Swain, 2014).	Region, state	Medium	H	+/-	+	u	+/-	+	M	Reliable and quick estimation of crop losses and aligning policies to promote climate smart practices
Demand creation & value addition: Enhancing value of climate resilient grains and legumes using novel products (Rao et al., 2016; Saxena, 2018)	Region, state	Medium	H	+/-	+	u	+	+	M	Policy to promote their integration into public distribution system, public awareness building and education
Agricultural system transitions: Shifts in the location of or production from farming systems (Naylk et al., 2014; Weindl et al., 2015).	Global	Long	M	+	+	+/-	+/-	+/-	L	Region-specific understanding of impacts, costs and benefits of transition for different stakeholders
National adaptation and mitigation planning: development and implementation of NDCs, NAPs and NAMAs (Richards et al., 2015).	National	Long	M	+	+	+	+	+/-	M	Finance, policy alignment and convergence

Time: short, 1–3 years; Medium, 3–10 years; Long, > 10 years.
Research feasibility: technical feasibility, cost of technology, inclusivity (smallholder, gender) and synergy with local or national plans and development programs.
Likely impact: the likely impact of the intervention in adapting to climate variability and change, both short-term events (such as individual drought) as well as long-term (a changed climate). L = Low, M = Medium, H = High.
+ positive impact, − negative impact, −/+ context-specific impact; u largely unknown impact.

Table 18.1 Potential Gender Considerations of Various CSA Practices

	Contribution to CSA Goals Relating to			Gender Impact	Requirements for Adoption of Practice					
CSA Options/Practices	Climate Change Adaptation	Mitigation (Reducing GHGs)	Potential Household Food Security and Nutritional Impacts	Women's Control of Income From Practice	Relative Amount of Time until Benefits Are Realized	Potential for Women to Benefit from Increased Productivity	Female and Youth Labor Availability	Female Access to and Control of Land	Female Access to Water for Agriculture	Female Access to Cash and Ability to Spend it
Stress-tolerant varieties	High	Low	High	Low	Low	Medium	Medium	High	Low	High
High-yielding varieties	Low	Low	High	Low	Low	High	Medium	High	High	High
Conservation agriculture	High	Medium	High	Low	High	High	Low–Medium	High	Low	Low
Improved home gardens	High	Medium	High	High	Low	High	High	High	High	High
On-farm tree planting	High	High	Low–Medium	Low	High	Medium	High initially; Low later	High	High	Medium
Composting	Medium	Medium	Medium	Medium	Low	Medium	High	Medium	Low	Low
Small-scale irrigation	High	Low	High	Low–Medium	Low	High	Medium	High	High	Medium
Fodder shrubs	High	Medium–High	High	High	Medium	Medium	High	High	Medium	Low–Medium
Herbaceous legumes	High	Medium	High	High	Medium	High	High	High	Medium	Low–Medium
Improved grasses (for example, Napier)	High	Medium	High	High	Low	High	High	High	Medium	Low
Livestock genetic improvement	High	Medium	Medium–High	Low–High	High	High	Low–High	Low	High	Medium
Restoration of degraded rangeland	High	High	Medium	Low	High	High	Low–High	High	Low	Low

Source: Author, based on a range of expert opinions.
Note: Beuchelt and Badstue (2014: 715) also provide useful guidance on key questions for exploring similar kinds of potential effects on women and men of conservation agriculture practices.

Annex b smart water meeting at WHC

"Exploring business drivers for Africa's Horticulture"

Session Report

Climate Smart Horticulture requires: - Entrepreneurial farmers, eager to learn and invest in business relations. - Know-how about the technical factors, requiring education and training. - Demo farms: seeing is believing for farmers in horticulture. - Tools to measure carbon and water effects for donors and policy makers. - A combined offer from suppliers that is "fit to context' and with access to finance for farmer entrepreneurs. - Joint learning on climate smart practices for food security, adaptation and mitigation.	Work session on water for horti 29 November 2018, 13u30 - 16u00 World Horti Centre, Naaldwijk 

1. Tour de table who is who and works where on what.

The 15 attendees in the work session represent a mix of organisations, companies and consultancies working in horticulture in Africa. The venue, World Horti Centre is a brand new, inspiring location combining vocational training Lentiz, permanent business expo and greenhouse R&D sites for horticulture (www.worldhorticenter.nl).

2. Mapping climate smart practices in horticulture.

Wim Goris presented a) AgriProFocus network and b) the mapping of business drivers for climate smart practices in horticulture, done with Aart van den Bos (Verbos Business Development) and supported by F&BKP. See ppt in annex.

The mapping was done in Kenya, Tanzania and Zambia. A range of practices was found, with a variety of effects on the CSA pillars (production, adaptation and mitigation). Widespread adoption of new practices is more likely when there are quick gains and benefits for women who often do most of the work. No single CSA practice is without a trade-off, so a mix of practices may offer the best way to speed up adoption rates.

There are many different actors in the dynamic horticulture sector, again ranging from offering a single solution to complete 'climate smart villages'. Networks like APF can help linking and learning between actors. For example today: how can tools support decisions of farmers and other entrepreneurs by measuring impacts on cash flow, water use and carbon.

Question:
What is the focus of this mapping in terms of farm size? In the Netherlands, innovations are driven by medium size companies, with the smaller ones adopting. The mapping in ESA looked for innovations independent of farm size.
Background of innovators are African, international and Dutch, business, research and development organisations. Dutch innovators mentioned are big ones like RijkZwaan, SNV and smaller ones like Practica (solar pump, water pan app) and Growpact. Growpact is interested in linking up with other initiatives.

3. Farm Pond Planner (www.farmtreeservices.com)

For an ICRAF / World Vision project called DryDev, Frank van Schoubroeck analysed the cost and benefits of micro irrigation for horticulture producers in Machakos, Kenya. He visited farmers who had built a project-financed Farm Pond. Farmers visited were happy: *"with the farm pond, I can grow crops year round'*. DryDev wondered if Farm Ponds can be promoted commercially. With a pond, farmers' choices have consequences: small ponds lead to water shortage if plot size is too big, or horticulture crops demand too much water. Crops timed well fetch a high price, and vice versa. Frank modelled in Excel a Farm Pond Planner based on data from field visits and soil / 15 yr weather records (from partner www.agrisim.com).
With such a planner, farmers can try out cropping scenarios: changing the pond size impacts on costs (and earn back time) but also on the risk of water shortage. Conclusion was that, if the right choices were made, Farm Pond investments could be repaid in 1-3 years. Such tools can be developed for any system, and made available to farmers through apps etc. Frank works with Agrisim to get such tools online (he also models Agroforestry systems) in the course of 2019. Specialised tools must be ordered. Check out his website or contact him for details.

4. Cool Farm Tool (www.coolfarmtool.org)

Aart van den Bos (as co-founder of Soil & More) presented the cool farm tool, which is a practical tool to make carbon effects visible in *the whole chain*. It was developed with industry in the lead, and science in a supply role because it had to be practical and not too academic. A carbon neutral value chain may compensate the emissions during processing and transport by capturing carbon at farm level. The tool shows that using chemical fertilizer has a high carbon cost (including manufacturing fertilizer). Efficiency and low losses are rewarded in this tool.
The tool also includes measuring the water footprint and a biodiversity footprint. Obviously the more the tools are used, the more feedback is available resulting in continuous improvement. The water footprint within the Cool Farm Tool is partially

based on the work of the Water Footprinting Network (originated in the Netherlands by Prof. Arjen Hoekstra of Twente University). The tool can be downloaded for free on the website. developed an app to easily collect data which will be launched this year in collaboration with the Cool Farm Alliance.

Questions
What are incentives for farmers? Aart has an example from Germany where a group of farmers (2.000 hectares) use the tool to quantify their CO_2 emission reduction and sell these as carbon credits. In this case, climate smart measures are not a cost, but an additional income.

How is the carbon impact of all the industry members in the alliance? Not sure, the members ask their suppliers to use the tool. If this is done consistently it would mean hundreds of thousands, if not millions of farmers.

5. Discussion

Nicole Metz facilitates by summarizing the presentations before the break and also invites people to share their own experiences.

Success depends on ...

- Participants agreed that it helps to be clear about whom you target. Heifer has a focus on small-scale mixed farmers, including subsistence. Other attendees (wish to) work with medium farmers for the market. Size matters, but also look whether farmers are willing to learn, willing to invest and/or join a cooperative with scale. Suggestions to involve traders and processors in the selection of entrepreneurs. And to try things that worked in Netherlands: study clubs for farmer entrepreneurs.

-Technical factors: investing in a farm pond sounds straightforward, but many factors determine the return on investment. For example that a plastic liner with clean (healthy) soil for tomatoes also reduces water usage by 80%, could mean the pond can be much smaller. Quality - also an important factor.

- Reference was made to Amiran[10] Kenya who offers ‘a do it yourself package’ with simple tunnel, drip, seed and tech advice. It is a basic, but integrated concept for medium farmers. Critics note that some of the Amiran tunnels were abandoned due to poor performance. Still, Dutch suppliers often work in a too isolated way and do not adapt their offer to local conditions. They could learn from this and address potential clients in Kenya/Africa with a competitive ‘fit to context’ complete package.

- Recognition and acknowledgement of cultural differences and how to cope with that, requires in depth understanding of each other and permanent communication.

- Demonstration and training: seeing is believing. farmers need to have the opportunity to see, feel, smell and experience ‘sustainable farming’ in real life. So demonstration centers (in combination with training facilities) will showcase best practices.

[10] https://www.hortinews.co.ke/2016/02/01/amirans-1-acre-kit-to-unlock-farmers-potential/

- Joint learning: developing climate smart practices that work in e.g. the East African context is a two-way process in which local and international entrepreneurs and organisations both play their part.

- Access to (pre-)financing.

Scaling requires …

- Sustainability of the business model. Example: farmers think they lower risks with too much water, fertilizer and pesticides. Training them to optimize inputs will immediately reduce their costs for same or higher productivity. Entrepreneurial skills also an important requirement.

- Involving Dutch businesses (as in SWA coalition) requires a business viability at both ends and compatible scales, for example through producer groups / cooperatives.

- Partnerships: Heifer, SNV and Soilcares (new name: Agrocares) were successful in training 10,000 farmers on soil management. The mobile soil and fertilizer lab did not work, but then they developed the handheld soil-tester which is becoming a market success. The tool may not respond to high standards of Dutch horti, but it does the job for the entrepreneurial farmer in East Africa and is a good start.

- Markets. The massive regreening of farm trees in Niger driven by the fuelwood market in nearby Nigeria.

Challenges that remain...

- Skills for horti are a big challenge, related to the educational system. Remarks were made on technical and entrepreneurial skills. Solutions for hands-on training are demonstration farms, centres of excellence; virtual training or e-coaching are an option but struggle with poor internet.

For most participants in this meeting, a mix of Dutch and African staff and experience is the best combination in a business or project. Info: Dutch institution NUFFIC and the 'Borderless Network' are involved in structural collaboration to strengthen African and Asian agricultural education.

- Risk behaviour. Many farmers fall back to their old habits (non-sustainable farming practices) when something new does not work properly.

- Markets: improving production may result in lower prices if this leads to an oversupply. Therefor involvement of market parties (supply chain approach) is a requirement.

Final remarks

- Recommendation was made to develop more collaborative partnerships between NGOs and companies. Focus on the common objectives instead of the differences. There is more overlap and possible synergy then organisations realise.

- An idea could be to offer funding as co-investor to farmers who have an entrepreneurial mindset. It would mean that part of the Dutch approach would be to share risks and ‘get paid’ when success is proven (according to the DBOT method (Design Build Operate Transfer).

- Another idea is to facilitate the knowledge transfer on a semi-permanent basis through a sort of YEP program for experienced middle aged farm managers.

Annex c further reading

Further reading on Kenya

- CSA in Kenya and supplementary materials (22p)
- Matchmaker, Scoping horticultural study Kenya 2017
- CSA programme SNV and others.
- Horticulture validated report 2015-2016

Further reading on Tanzania:

- CSA in Tanzania
- tanzania: tomato report. Kirchner (final version?)
- 2017 Matchmaker Associate horti in Tanzania.
- RVO horti report 2015.
- Onion & Garlic market scan (with TRIAS, Mviwata and TAHA, 2015).
- Study on Assessment of Market Options for Smallholder Horticulture Growers and traders in Tanzania with Moshi Cooperative university

Further reading on Zambia

- CSA in Zambia
- APF Agbit report 2015
- APF Atrade horti business Zambia report
- http://knoema.com/FAOPRDSC2017/production-statistics-crops-crops-processed?tsId=1546280
- www.pidg.org/resource-library/case-studies/pidg-case-study-chiansi.pdf
- www.fao.org/3/a-i4157e.pdf
- http://www.yieldgap.org/zambia
- https://www.researchgate.net/

Further reading on Dutch policy

- https://topsectortu.nl/ (Dutch); Topsector horticulture (Eng)
- www.government.nl/documents/policy-notes/2018/05/18/investing-in-global-prospects
- http://knowledge4food.net/theme/fruits-and-vegetables/

Find research projects via

- http://knowledge4food.net/research-projects/research-projects-locator/
- https://ccafs.cgiar.org/

Earth Overshoot Day *www.overshootday.org*

Earth Overshoot Day marks the date when we (all of humanity) have used more from nature than our planet can renew in the entire year. In 2018 this was August 22.