

Food Security and Valuing Water

WUR Research Programme 2019 – 2022

Core team members:

Eric Arets, Jan Broeze, Dolfi Debrot, Marijke Dijkshoorn-Dekker, Annemarie Groot, Geerten Hengeveld, Huib Hengsdijk, Bas Hetterscheid, Nina de Roo, Katrine Soma, Catharien Terwisscha van Scheltinga

Writing team:

Jakob Asjes, Arjan Budding, Lucia Kaal-Lansbergen, Stijn Reinhard, Joost Snels, Jan Verhagen

Programme Lead:

Ivo Demmers

May 2020



Wageningen University & Research



Change Performance Indicators targeted:

1. Continuous improvement for research excellence
6. Improved entrepreneurial culture and practice in education, research and value creation
10. Expanded connection with society and partners

Strategic Research

Old structure 2015-2018

8 Kennisbasisthema's (WR)

5 Investerings thema's (WU)

11 Additionele programma's
sinds 2018

New structure 2019-2022

5 Kennisbasisthema's (WR)

A. Circulair en Klimaatneutraal

**B. Voedselzekerheid en
de waarde van water**

C. Natuurinclusief en landschap

D. Veilig en Gezond

E. Data-Driven en High-Tech

3 Investerings thema's (WU)

I. Verbonden circulariteit

II. De eiwittransitie

III. Digitale tweelingen

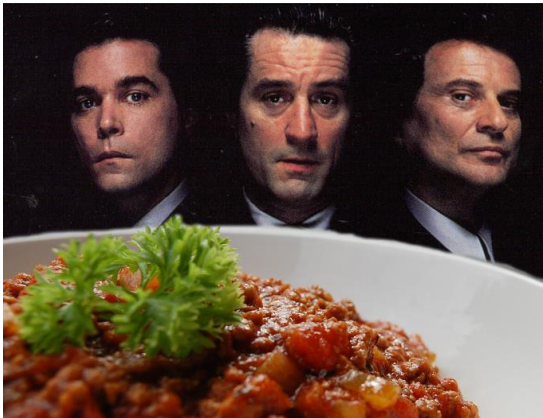
Food is ...



... Life

Roald Amundsen

(1st man @South Pole 1912) declared that " ...the cook's contribution was greater than that of all others in the party..." (BTW the competing British team lost)



... Culture

Martin Scorsese

uses cuisine to define the characters and make us, the audience, understand why they loved being gangsters and what a life like that, despite its obvious risks and drawbacks, promised for them.
Good Fellas (1990)

Food – Arab Spring Tunisia 2010

Water(quality) protest Iraq 2018



11% - 821 million undernourished

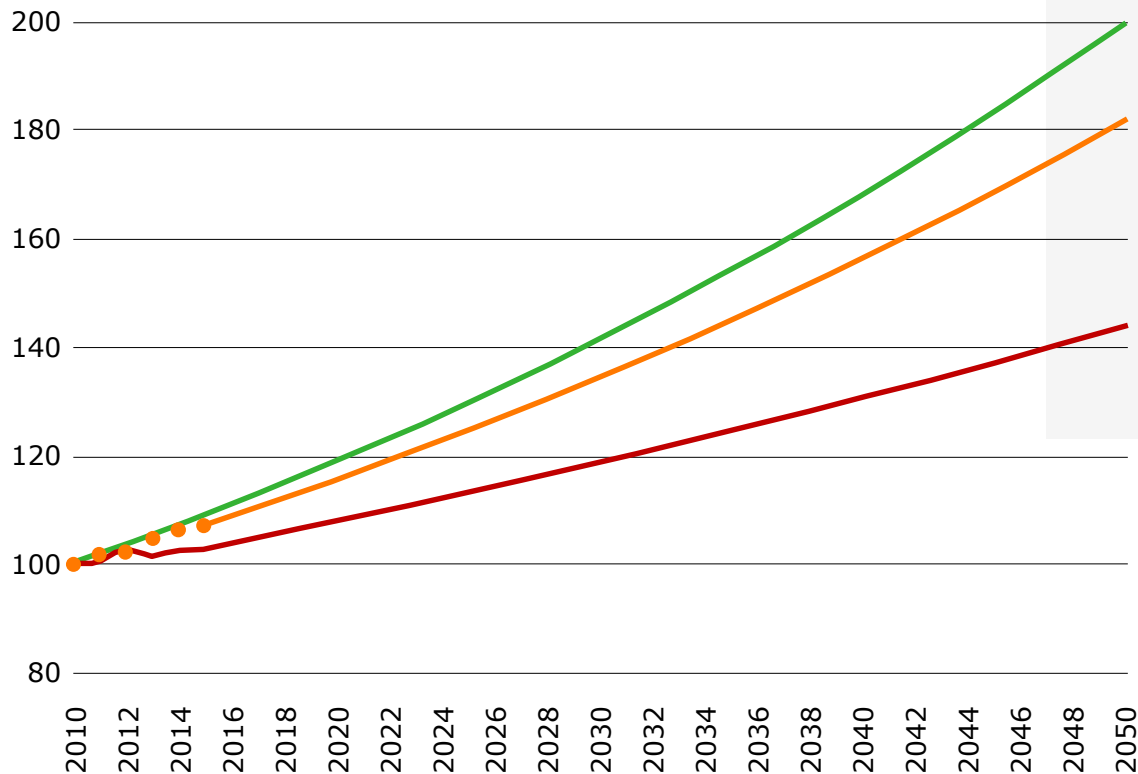


More production by 2050 ...

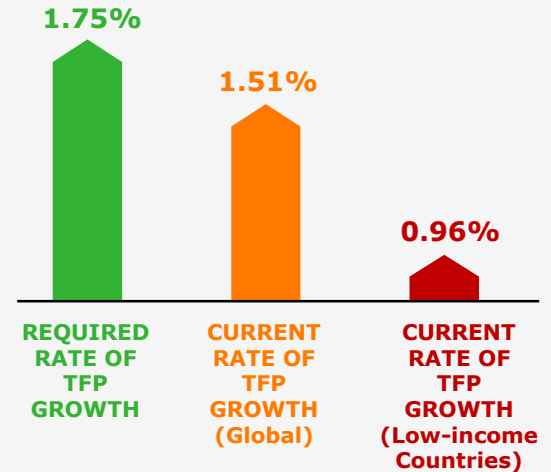


Total Factor Productivity (TFP)

Global agricultural activity increase by 1.75 percent annually to meet the demands of nearly 10 billion people by 2050.
and we're already behind...



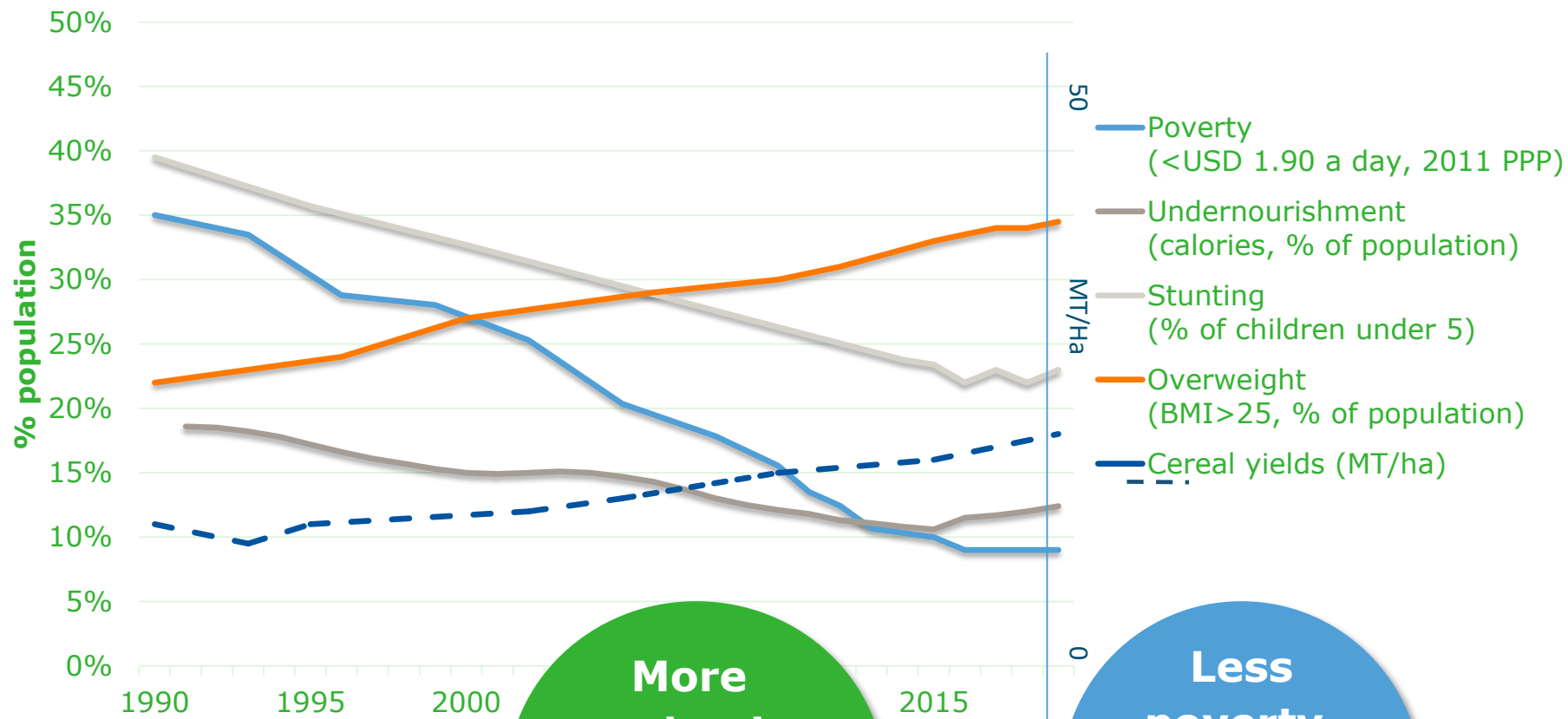
2050



- ● ● Actual TFP
- Required Rate of TFP Growth (Double Output by 2050)
- Projected Rate of TFP Growth (at Current GAP Index Rate)
- Projected Rate of TFP Growth (Low-income Countries)

Source: Food Demand Index is from Global Harvest Initiative (GHI) (2018); Agricultural Output from TFP Growth is from USDA Economic Research Service (2018).

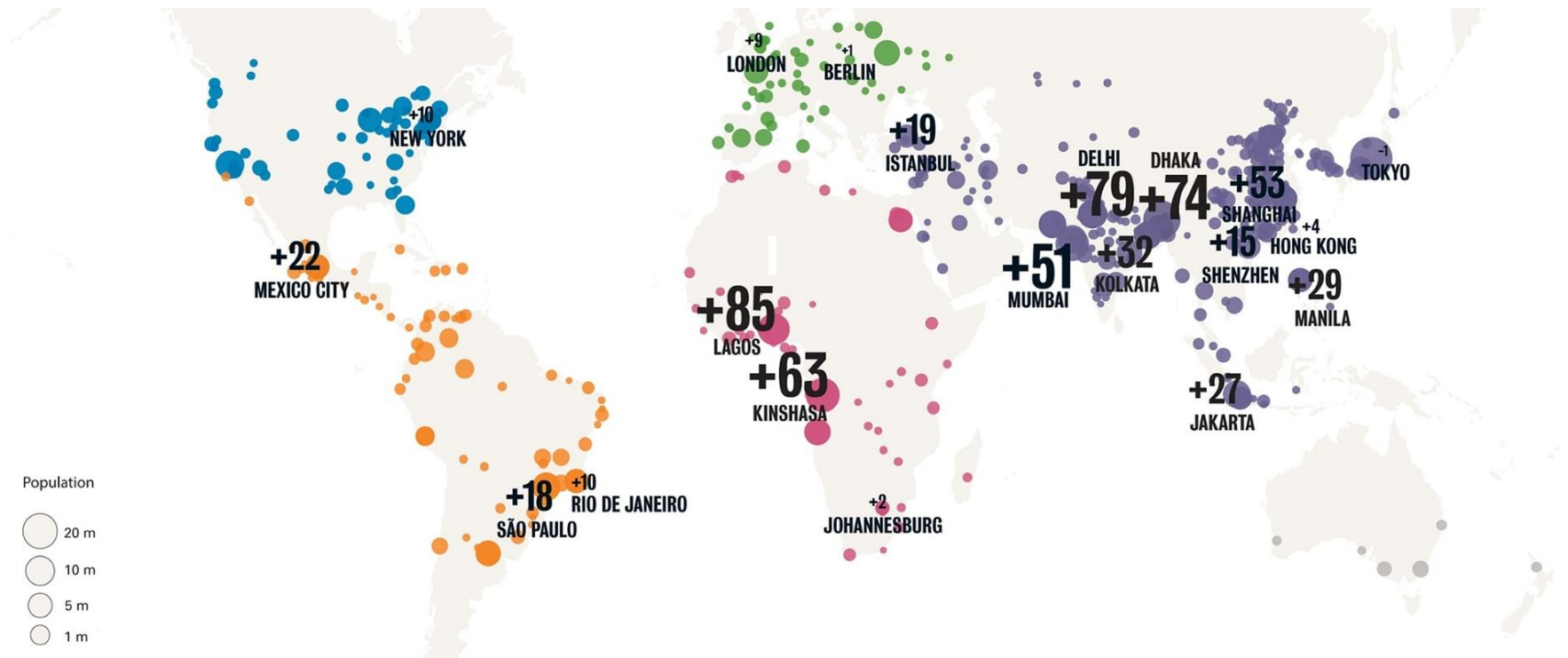
Poverty & Food Security



**More
production
≠
Better
nutrition**

**Less
poverty
≠
Less
hunger**

Urban growth per hour



City populations grow with
1.5 million per week

City populations grow with
65 million every year

By 2050 **2/3 of the global population**
9.7 billion will be urban

Food loss and Food Waste

>500kcal
Food
wasted p.p.

Menu **nrc.nl** Digitale krant

PODCAST VANDAAG Vijftien jaar YouTube FOKKE & SUKKE Hebben inmiddels een traditie AEX 628,70 Puzzels 9°C

Binnenland Buitenland Economie Den Haag Cultuur Wetenschap Opinie Sport Webwinkel

Vandaag Meer →



WAGENINGEN
Consument verspilt veel meer voedsel dan gedacht
Als landen uit de armoede komen, gaan ze meer voedsel verspillen, ontdekten onderzoekers uit Wageningen.

Laatste nieuws

- HOF VOOR MENSENRECHTEN
15:19 Spanje mag hekklimmers collectief en snel terugsturen
- PARIJS
14:52 Burgemeesterskandidaat Parijs trekt zich terug vanwege compromitterende video
- WAGENINGEN
14:33 Consument verspilt veel meer voedsel dan gedacht
- ASTRONOMIE
14:21 Ster Betelgeuze verandert van vorm. Gaat-ie ontploffen?
- DIESELGATE
14:10 'Volkswagen wilde voor 830 miljoen schikken in dieselgate'

Trends in consumption & Nutrition

High food expenditures

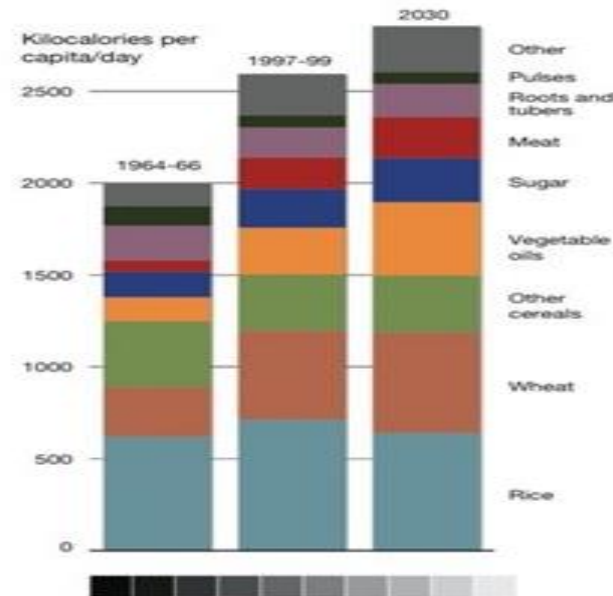
African households spent up to **70-80%** of their income on food. Healthier foods (F&V, eggs, fish, poultry) are 4-5 times **more expensive**.

Rapid Dietary change

Growing incomes lead to changes in diets. Share of staples & starchy food is rapidly decreasing, while processed foods become more important.

Retail revolution

15-30% of food is purchased in supermarkets. Growing out-of-home consumption from street food & fast-food restaurants.



Urban foodprint



1,575 ha. of plants



96 ha. of fruit



126 ha. of vegetables



955 ha. of wheat



102 ha. of potatoes



296 ha. of sugar



223,109 animals



2,220 dairy cows



5,252 beef cows



15,972 pigs



23,947 laying hens



175,718 chickens



4,069 ha. of fodder



735 ha. of wheat and barley



1,556 ha. of corn products



1,175 ha. of grass and clover



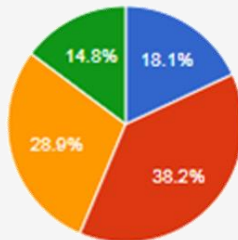
603 ha. of additional produce



another 35-50% from abroad

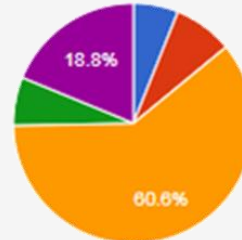
Vegetable products

total of: 1,575 ha.



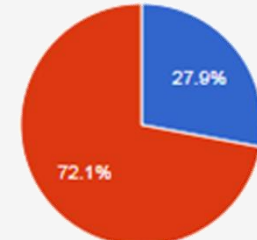
Fodder

total of: 4,069 ha.



Vegetable produce versus fodder

total of: 5,645 ha.



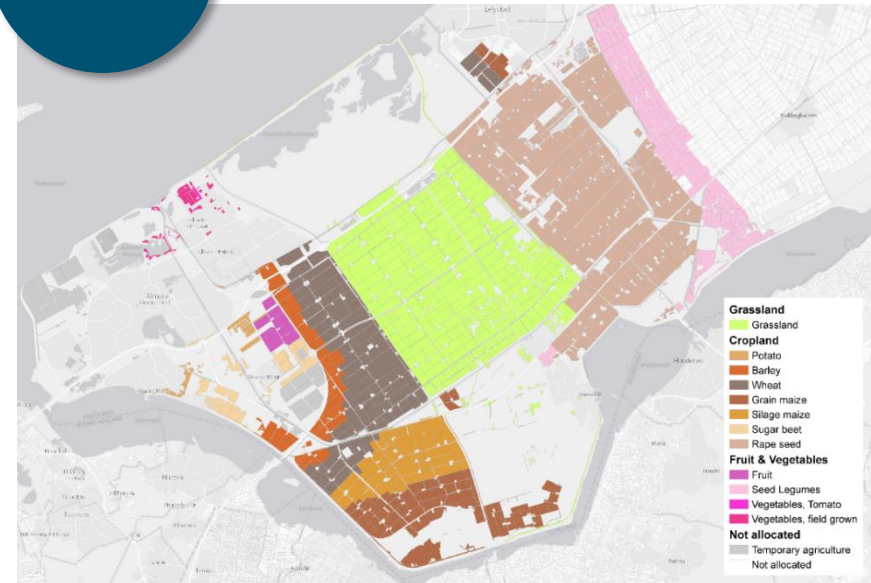
Example: local food production Almere

allocating the area needed for local food production

Current situation



Scenario



Water for Food – climate stress

70%

fresh water
for agriculture

In 22 countries
in Asia and Africa:
waterstress level are

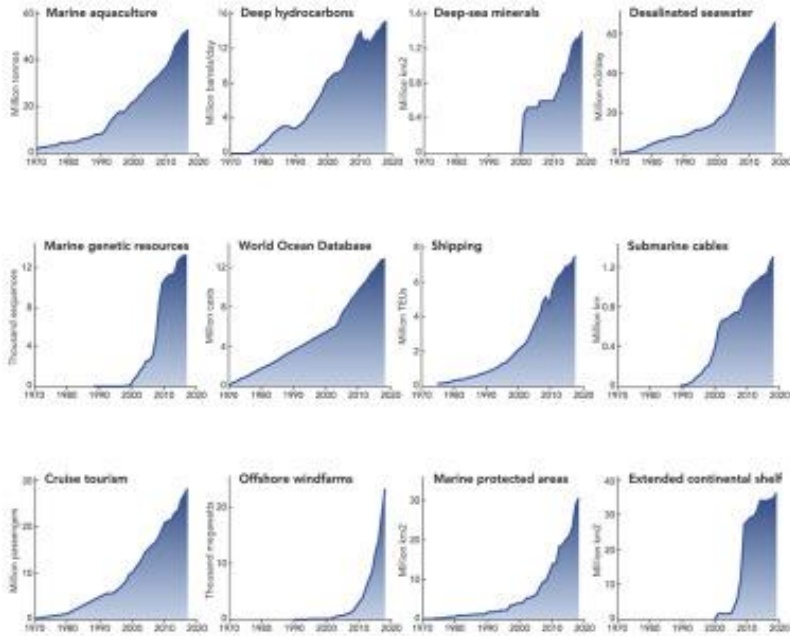
>70%



70% of fresh water is frozen,
29% groundwater

Fish, food and feed

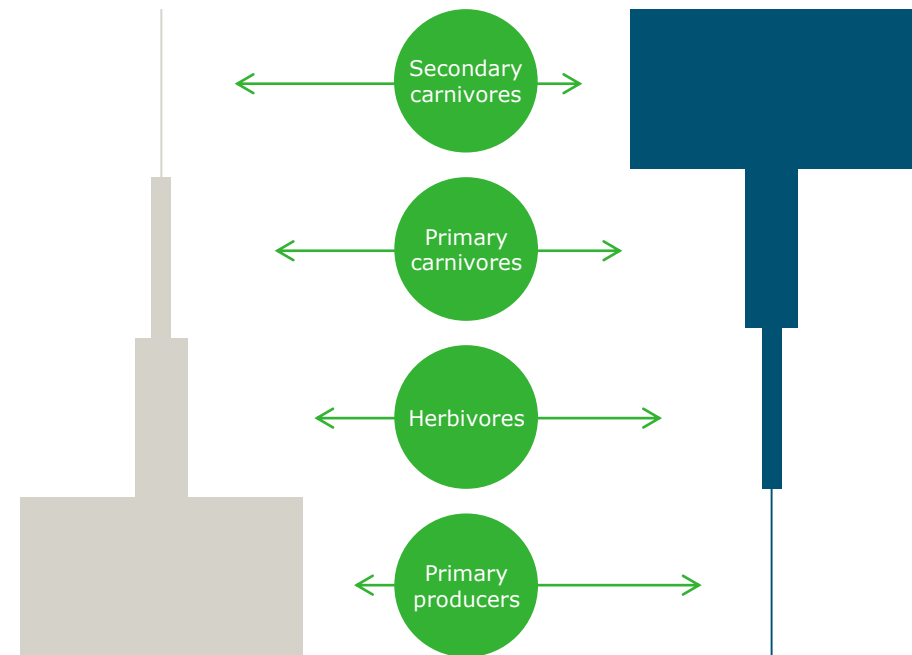
The blue acceleration



Terrestrial ecosystem

Biomass

Aquatic ecosystem



We need a transition in Biodiversity under threat



Multiple Scales: Local and Global

By 2050

**2/3 of the global
population**

9.7 billion

will be urban



Trends in Food Markets & Trade

Local & regional trade

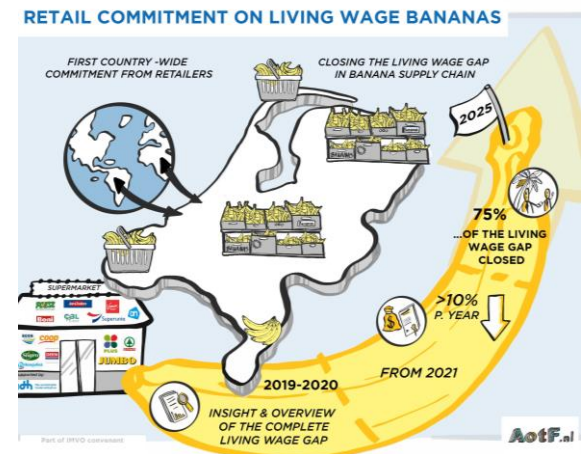
Africa represents only 3% of world agricultural trade. Import caps can be used to enhance local sourcing. Large prospects for AfCFTA.

Hidden Middle

80% of food consumption is sold locally. SMEs like agro-dealers (seed, fertilizers) and traders & processors are critical for agricultural growth.

Value added shares

Farmers only get 5-10% of total value added. Most value added is generated in processing packaging, storage & retail.



We need a transition in our Food System



Food Security and Valuing Water - Mission



Contribute to Food Security by combining our interdisciplinary knowledge in the agri-food and water domains to shape the transitions towards sustainable food systems

Food and SDGs



Nearly **80% of the world's poor** live in rural areas and work mainly in agriculture.



There is enough food produced today to feed the global population yet **around 800 million people are chronically undernourished**.



Malnutrition is the largest contributor to disease in the world. Over 4 billion people are either micronutrient deficient or overweight.



Malnutrition, which affects nearly one in four children under age 5 worldwide, is associated with **reduced school performance, and impaired brain development**.



Women represent 43% of agricultural labour yet have **unequal access to land, technology, markets and other resources**.



Today, food systems account for **70% of freshwater withdrawals**.



Modern food systems consume around **30% of world's available energy** and are heavily dependent on fossil fuels.



Agriculture is the single largest employer in the world, employing around 60% of workers in less developed countries.



Around 900 million people in rural communities, the majority of whom work in agriculture, **don't have access to electricity**.



Seven out of 10 people live in a country that has seen a rise in inequality in the last 30 years. **Inequality shapes who has access to healthy food.**



By 2030, **nearly 60% of the world's population** will live in urban areas, changing the shape of consumer demand and increasing pressure on land and other resources.



Nearly one third of global food production – 1.3 billion tons of food – is lost or wasted.



Food systems are currently **responsible for 20-30% of global greenhouse emissions**. Inversely, climate change threatens to cut crop yields by over 25%.



Fish accounts for 17 percent of the global population's intake of animal proteins. However, over **30% of the world's fish stocks are overexploited**.



Agriculture is the most significant driver of deforestation, contributing to a record global tree cover loss of 30 million hectares in 2016, an increase of 51% from 2015.



Increased food insecurity – 815 million undernourished people, up from 777 million in 2015 – **can be both a cause and consequence of conflict**.



Partnerships are crucial to transforming food systems. Unlocking opportunities in food systems could be worth \$2.3 trillion annually for the private sector by 2030.

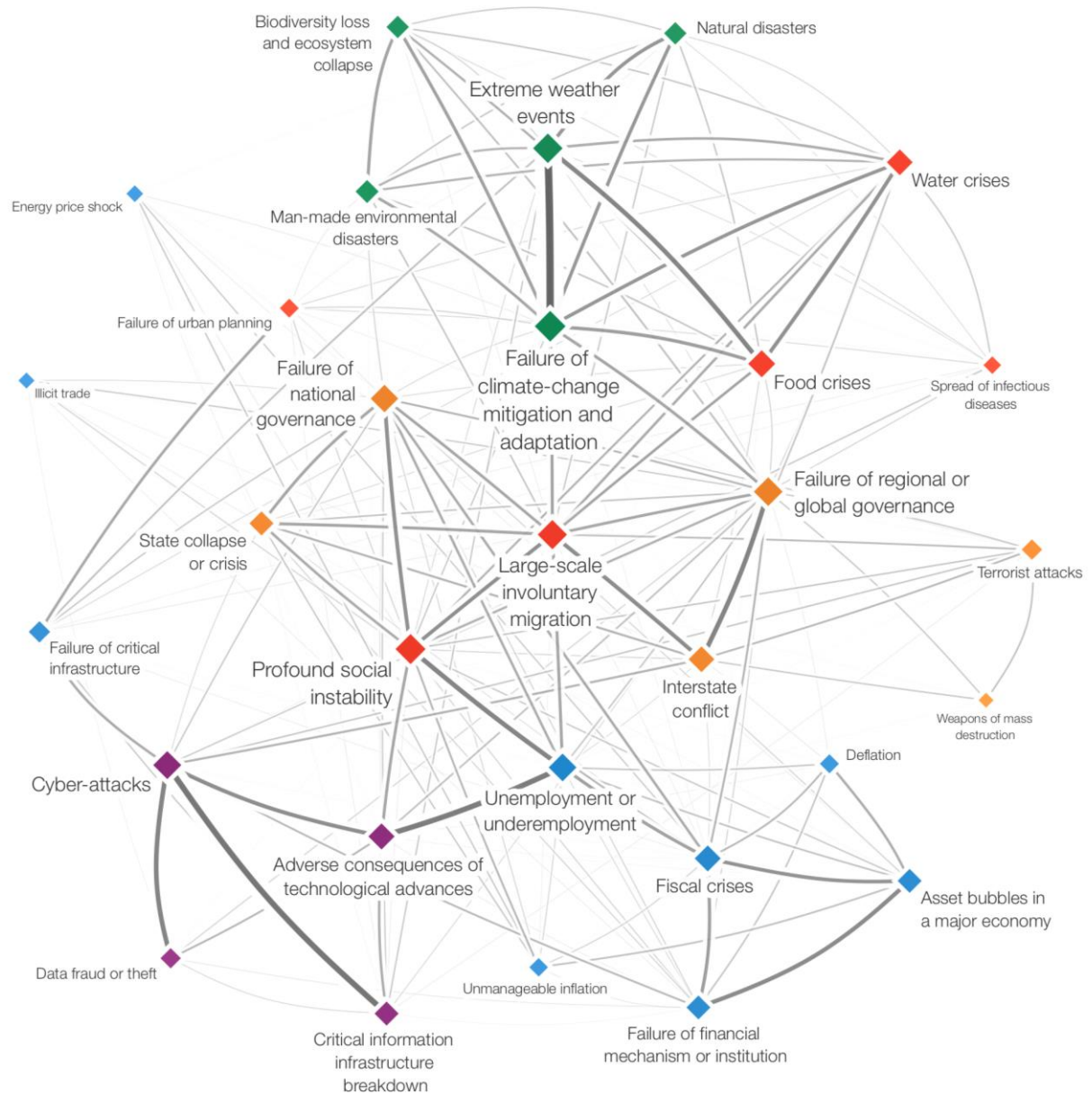
Transition & Vision



Risk Interconnection Map

**"Food is as important
as energy, as security,
as the environment.
Everything is linked
together."**

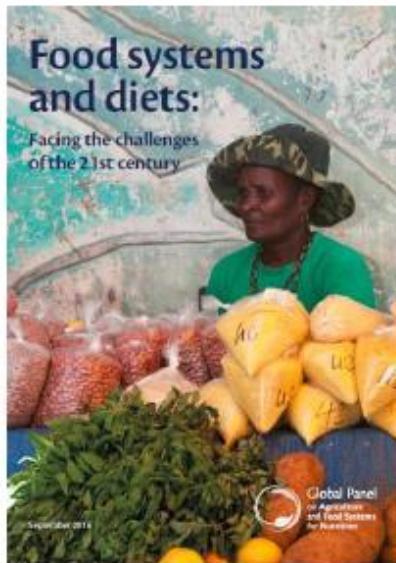
Louise O. Fresco



Food Systems Thinking

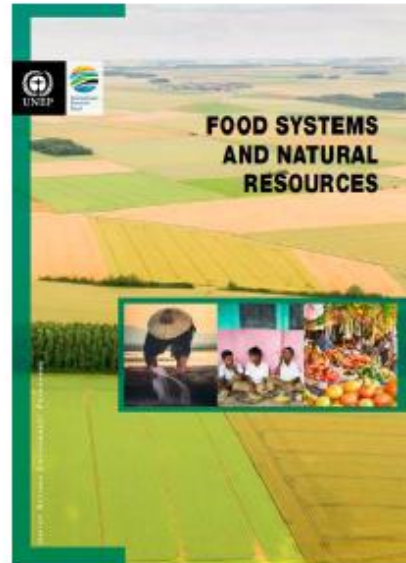
Global Panel (2016)

Food Systems and diets



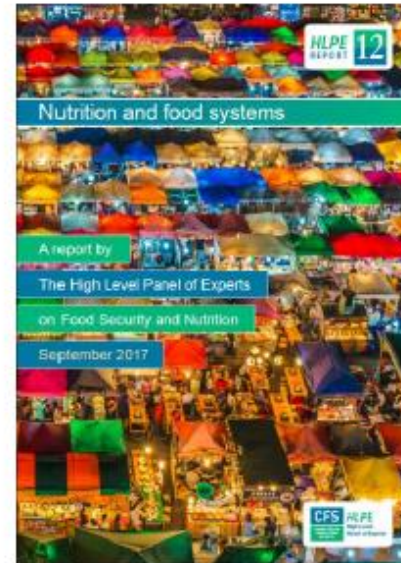
UNEP (2016)

Food Systems and Natural Resources



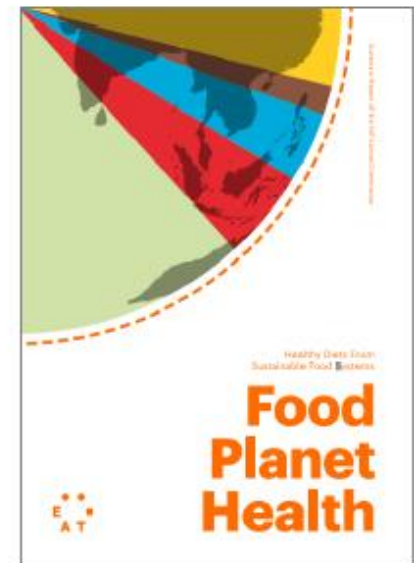
HLPE / FAO (2017)

Nutrition and food systems



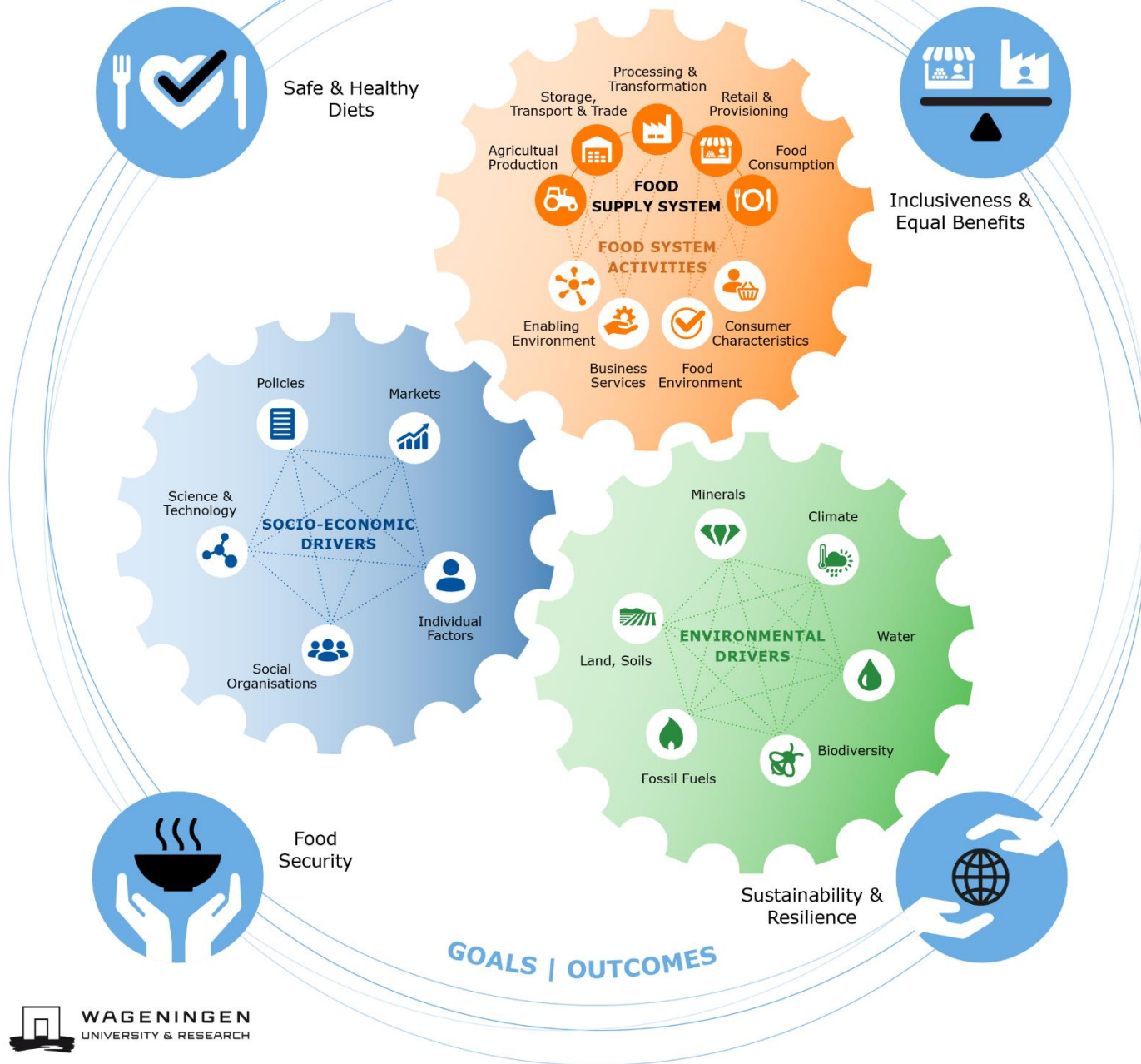
Eat Lancet (2019)

Healthy diets from sustainable food systems



Food systems framework

Van Berkum et al. 2018, Wageningen University & Research



Food Security and Valuing Water



Food Security and Valuing Water – Mission

Contribute to Food Security by combining our interdisciplinary knowledge in the agri-food and water domains to shape the transitions towards sustainable food systems

Programme

Our research contributes to achieving sustainable food and nutrition security by:

- developing new evidence based insights, methods and tools that can be used in **shaping transitions towards food security**;
- by using the **Food System Approach** to analyse and assess relations and feed back loops in Food Systems. This integrated framework includes socio-economic and environmental drivers as well as food system activities such as production, processing, consuming and disposing of food;
- providing new and innovative **interventions** to NGOs, policy makers, investors and researchers.

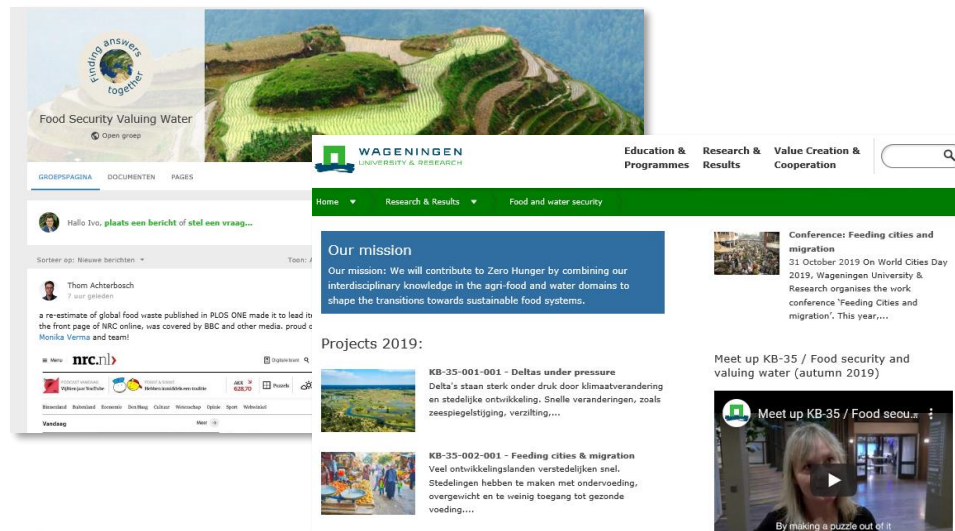
Portfolio

Impact

Future proof

Scientific
excellence

Interaction & Communication



Workshop

When: October 31st (World Cities day)
09:00-17:00h + drinks afterwards
Where: De Reehorst (Bennekomseweg 24, Ede)



WAGENINGEN

Consument verspilt veel meer voedsel dan gedacht

Als landen uit de armoede komen, gaan ze meer voedsel verspillen, ontdekten onderzoekers uit Wageningen.

ANALYSIS

<https://doi.org/10.1038/s41893-019-0418-8>

nature
sustainability



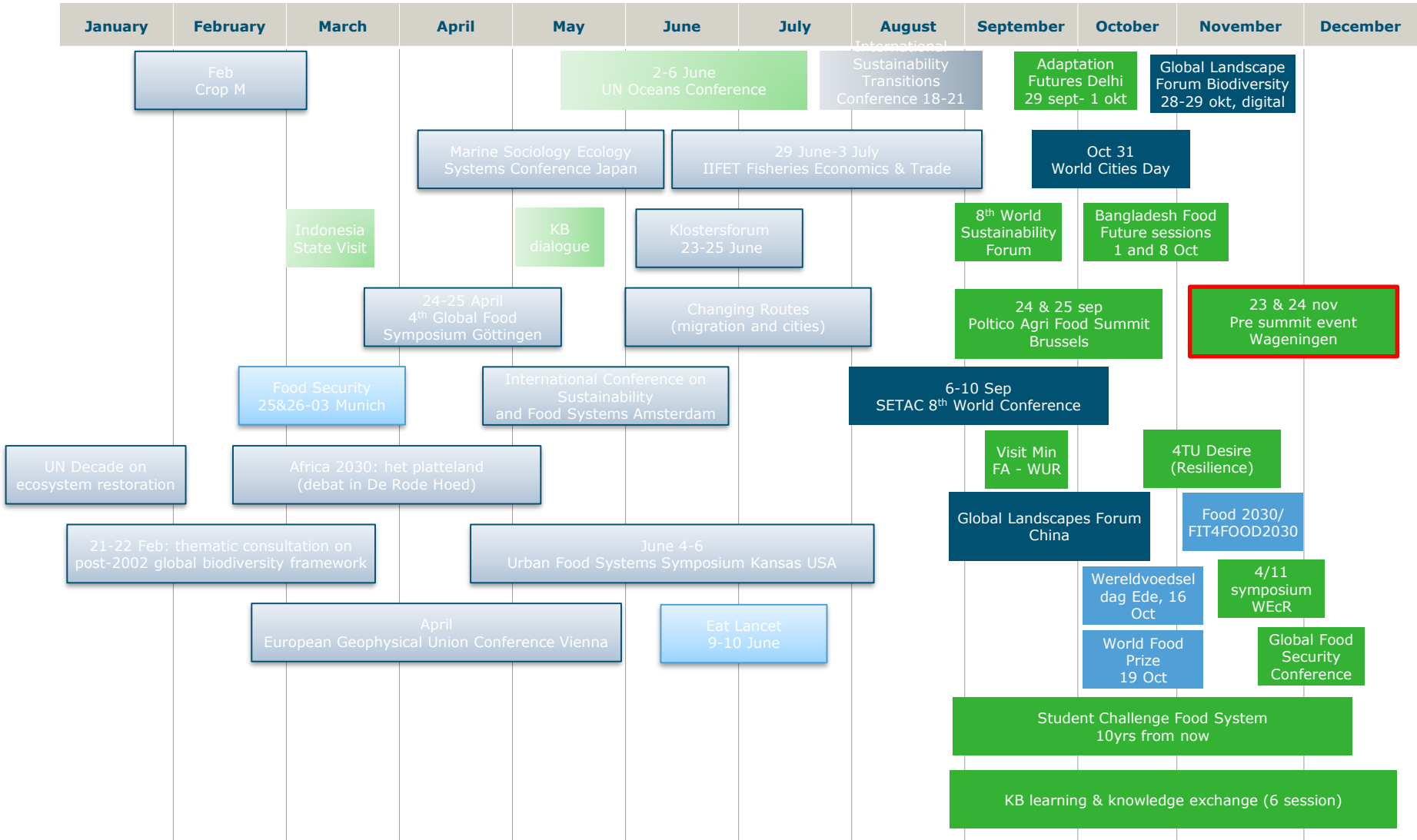
Food and Agriculture Organization
of the United Nations

Integrated scenarios to support analysis of the food-energy-water nexus

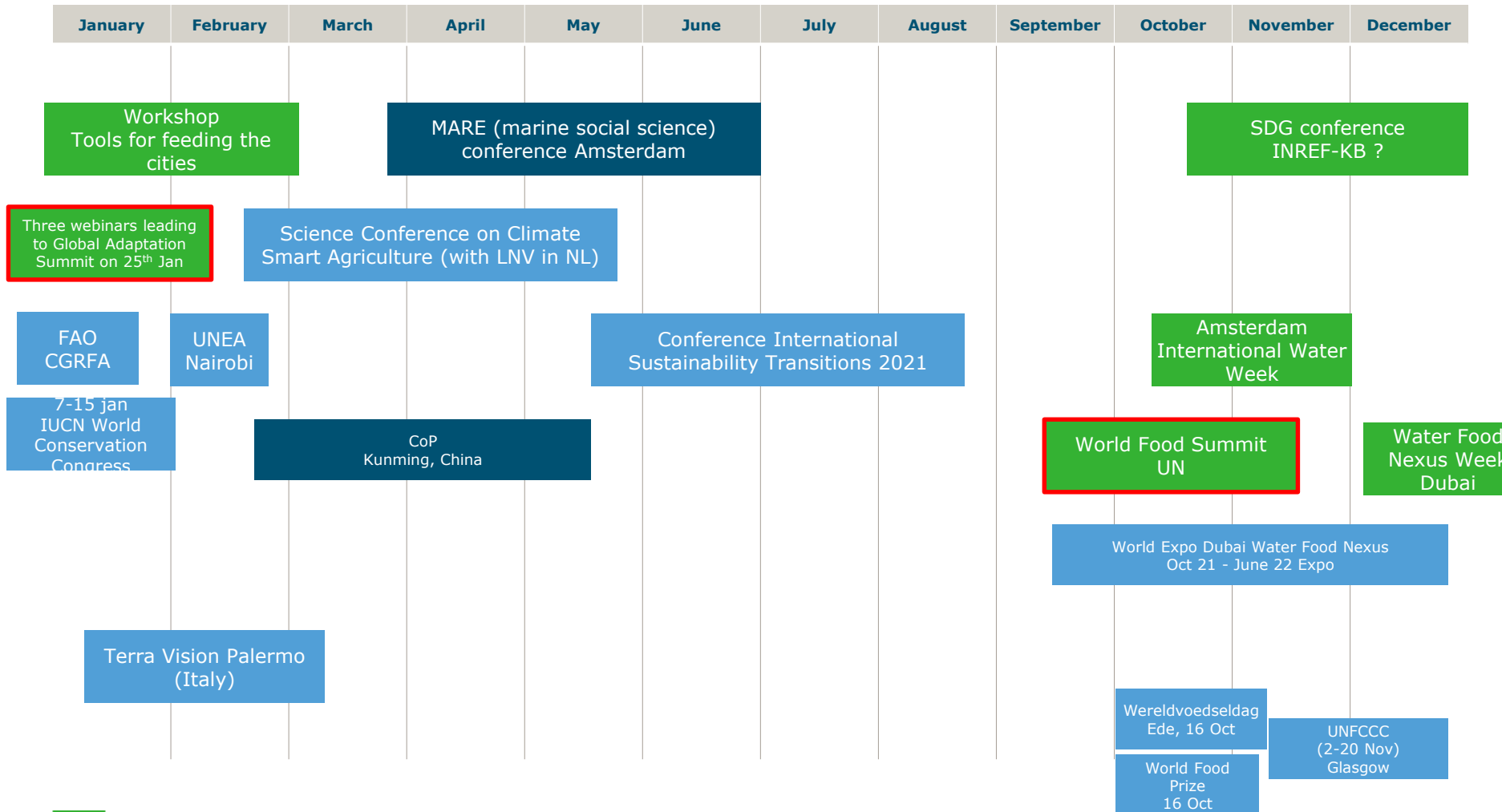
Detlef P. Van Vuuren^{1,2*}, David L. Bijl¹, Patrick Bogaart^{1,3}, Elke Stehfest^{1,2}, Hester Biemans^{1,4}, Stefan C. Dekker¹, Jonathan C. Doelman², David E. H. J. Gernaat^{1,2} and Mathijs Harmsen^{1,2}



Timeline 2020 Food System Events



Timeline 2021 Food System Events



Evaluation Criteria

- **Content:** specific contribution to programme themes; originality and innovation; scientific excellence.
- **Performance/quality:** experimental design and analysis, the standard of presentation, et cetera.
- **Impact/value creation:** journal/peer reviewed publications, valorisation, relevance to societal issues, stakeholders, networking and collaboration, IP, leverage of additional funding
- **Progress against delivery timeframes/project management:** on time, to budget, evidence of effective management of project contributors

Deltas under pressure



Feeding cities & migrant settlements



Less favourable areas in East Africa



Aquatic Systems

Multiple Scales and Extreme Events



Photo: Flora Holland



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Nature Based Solutions + Food and Biodiversity



Transition Pathways



Thank you

"A ship is always safe
at the shore, but that is
not what it is built for."

Albert Einstein



E-mail: Ivo.Demmers@wur.nl

Internet: <http://www.wur.eu/foodsecurity-valuingwater>

Intranet: <https://intranet.wur.nl/Project/FoodSecurityandValuingWater>

Food Security and Valuing Water

Short insights of drivers and our research in research projects a.k.a. 'motifs' (in 2019)

Deltas under pressure



KB Deltas under pressure

Catharien Terwisscha van Scheltinga, Stijn Reinhard, Greet Blom-Zandstra, Jan Verhagen, Dolfi Debrot, Ab Veldhuizen, Gert-Jan Wilbers, Charlotte Verburg, Raymond Creusen, Esther Koopmanschap



Challenge: transitions in deltas

Linking national plans to incentivised local initiatives with regional impact

Impact – Contribute to Zero Hunger

1. Insight in transition pathways in deltas with challenges: sea-level rise, salinity, water quality problems – besides population pressure, urbanization and changing diets
 - Resilient and diversified food production options
 - Robust integrated systems
 - Informed decision making at farmers' level
2. Look at solutions (future, adaptation)
3. Develop knowledge while collaborating with partners in practical cases, linking local, regional, national level

Scope for collaboration

Case Vietnam: Mekong Delta

- The work is linked to phase 1 (2020 – 2023) of the Mekong Delta – Agricultural Transformation Program (MD-ATP) a joint effort by Vietnam and the Netherlands.
- Scientific collaboration with the Mekong Delta Development Research Institute of Can Tho University
- Identifying transitions aiming for stable and improved livelihood for farmers via diversification & integration (livestock & crops) and farmer oriented supporting activities such as breeding and water management.
- Active involvement of breeding companies and the national farmers union, other groups pending.



Case Bangladesh

- National level: Bangladesh Delta Plan 2100 – challenge: how to 'put it on the ground' to facilitate BDP2100's continuous increasing contribution to zero hunger?
- Working from national to local through regional level: linking to Solidaridad activities in Bagerhat, Satkhira and Khulna
- Link to livestock, farmer behaviour, salinity, fisheries
- Identify jointly: transition pathways, resilient futures



Insight & Surprises

Insights

- Focus on quality of product and production system → High value product. Required transition to reach this = diversification
- And additionally: integration (also to improve circularity)

How to combine Diversification & Integration on multiple scales

- Difficult within one farm/ company
- Better model: diversification, integration and cooperation within a region
- Risks, benefits, obstacles, knowledge, value chain, Social/ economic (financial) implications. Requires checks, monitoring, information and communication

Surprises

- Easier than expected interaction & active contribution with local companies and NGO's.

Feeding cities & migrant settlements



Outreach & Research

Katrine Soma (WECR), Bas Hetterscheid (WFBR), Thom Agterbos (WECR), Siemen van Berkum (WECR), Lotte Roosendaal (WCDI), Marion Herens (WCDI), Bertram de Rooij (WENR), Daniel Mekonnen (WECR), Vincent Linderhof (WECR), Marian Stuiver (WENR), Jan Broeze (WFBR), Katherine Pittore (WCDI), Jim Groot (WFBR), Peter Verweij (WENR), Riti Mosterd Herman (WCDI), Herman Agricola (WENR)



Three objectives

The overall aim is to contribute to resilient, sustainable and urban food systems providing food and nutrition security for all

A



Better **understand** the **relationships and outcomes** of an **urban** food system in the Africa and South-Eastern Asia context, in particular for the vulnerable groups in **migration** settlements

B



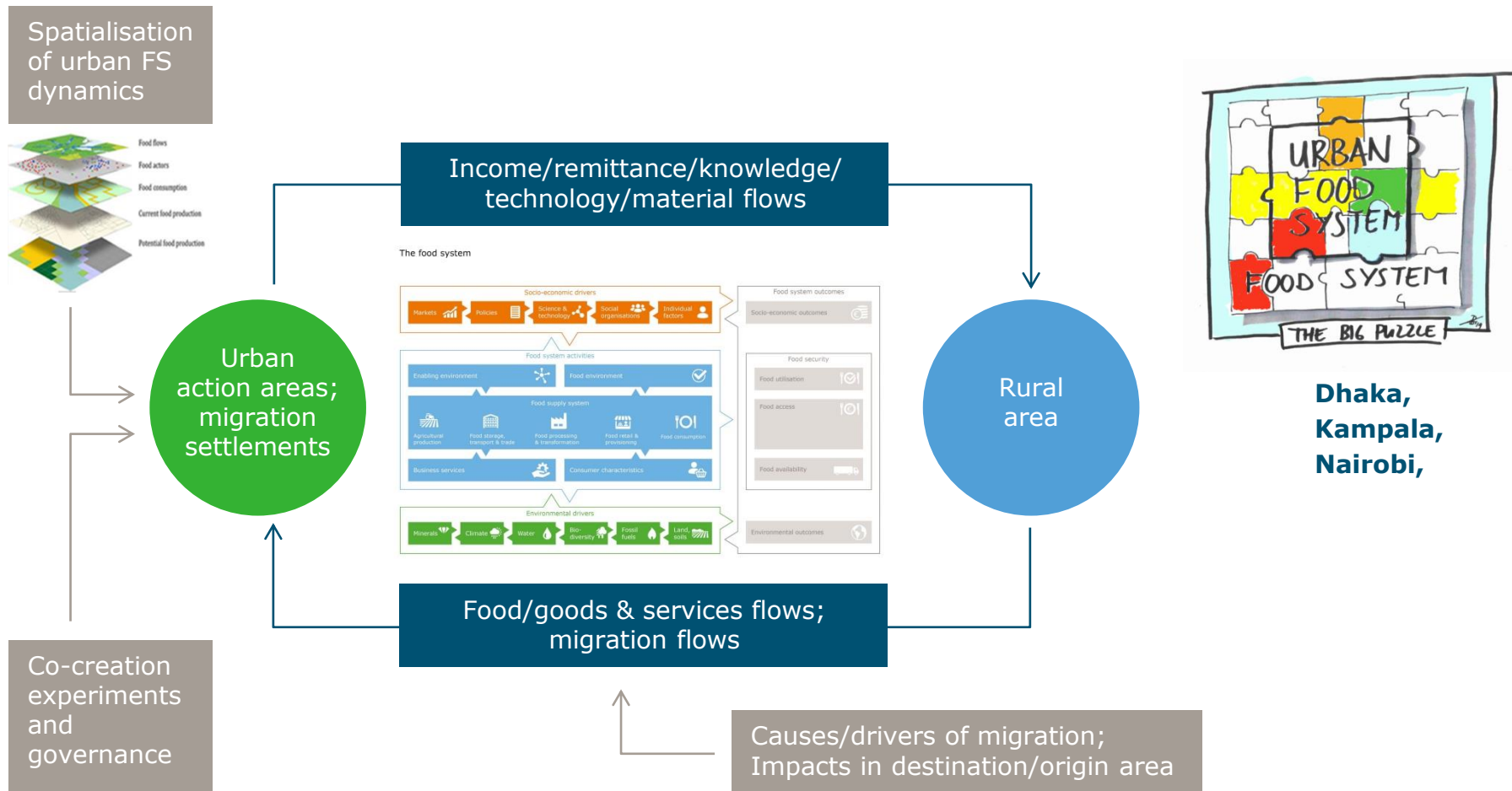
Analyse the **rural-urban linkages** in order to find **leverage points** for improved food systems outcomes in the city and its region

C



Suggest **solutions** for improved food system outcomes, by **simultaneously addressing** socio-economic, technological, spatial and **organizational (governance)** dimensions of food systems functioning and outcomes

Urban... linked to rural



Insight & Surprises

Insights

- Focus on long term (local focus is often on short term solutions, not root causes). Food waste for LMIC more important than expected.
- SDG can be point of entry for circular solutions (Vietnam)
- Urban – Rural linkage is essential. Increase (economic) position of farmers to improve economy and application of (storage) technology

Surprises

- Spatial mapping of rural urban linkages is key for analyses and findings solutions
- Migrants – food – climate nexus should be kept on the agenda

Less favourable areas in East Africa



Objective and approach

Objective:



To identify pathways for less-favored rural areas that contribute to sustainable food systems in East Africa in the period 2030-2050

Approach:



Research steps:

0. Select study object & boundaries
1. Description
2. Diagnosing Food System
3. Exploring scenarios
4. Developing Food System interventions

Multiple scale assessment
drivers, outcomes
of food systems

riorization

Innovation
agenda

Scenario
analysis &
experimentation

Role actors

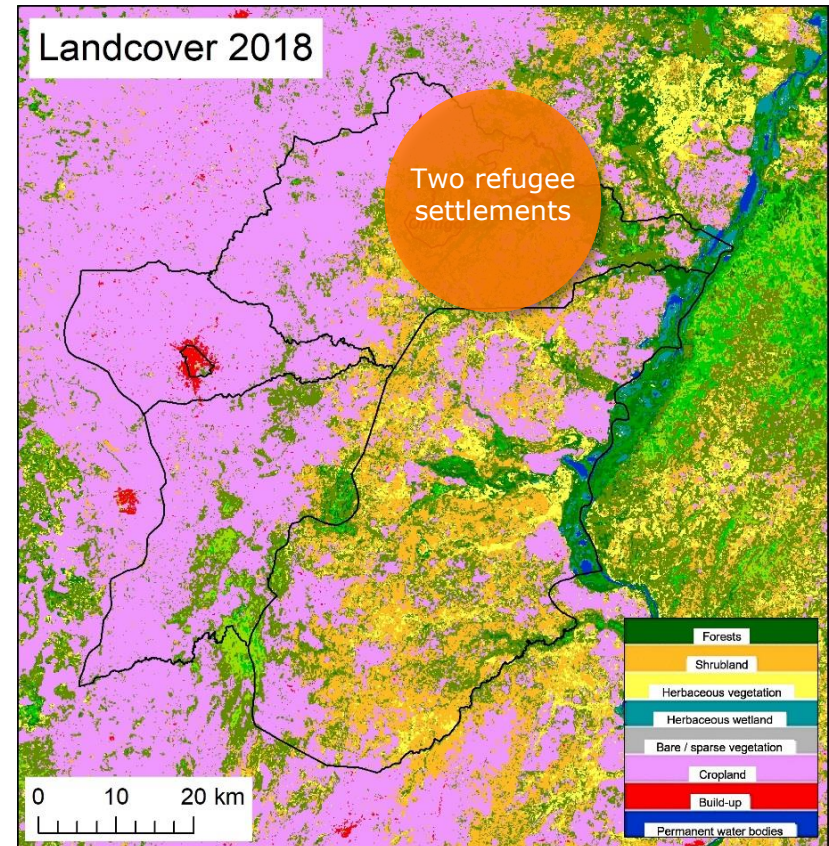
0. Who?
And what roles?
1. Informative
2. Validation & feedback
3. Building / providing support
4. Co-development, Building coalitions

Pilot: Arua district in NW Uganda

Huib Hengsdijk (WPR), Henk Wosten (WENR), Fedes van Rijn (WECR), Jan van der Lee (WLR), Fatima Pereira Da Silva (WFBR), Marlene Roefs (WCDI)

Characteristics:

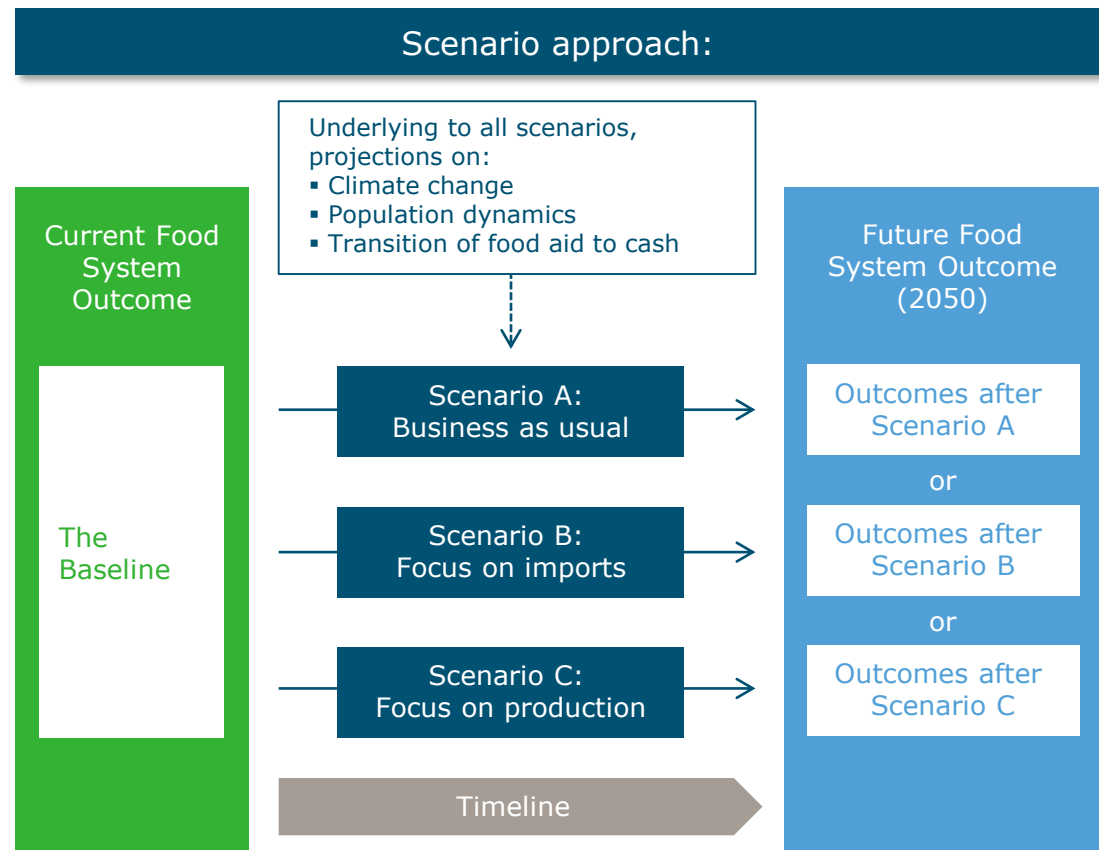
- $\approx 3\%$ annual population growth
- $\approx 25\%$ of population are refugees
- Host and refugee population are food insecure
- Refugees: Change from food aid to cash transfer program
- Predominant subsistence agriculture, few market linkages



Research question: What are the options to feed the future population of Arua in 2040 with a healthy diet?

Research questions, e.g.:

- What is healthy diet? And how relates it to current diets of hosts and refugee population?
- What are production potentials of different crops/animals in Arua?
- How much land is available for agricultural expansion?
- GHG emissions associated with land conversion and intensification?
- Under what conditions hosts and refugees migrate to cities and home country, respectively



Insight & Surprises

Insights

- Refugee camps offer opportunities for regional food systems if introduced properly
- Less favourable: not by precipitation, soil, terrain and agro-ecological characteristics, but because of connections and distance to markets (cities) and vicinity to country borders?
- Data for scenarios needs to be sourced at multiple sources

Surprises

- Great suspicion towards fertilizer and 'technology' (even oxen traction)
- Link with cities more relevant than expected. More insight in drivers needed to build scenarios
- Agro-ecological characteristics not so less favourable as expected

Aquatic Systems



Objectives, geographical focus

Dolfi Debrot, Marloes Kraan, Susan de Koning (WMR), Katell Hamon (WECR), Adrie van der Werf (WPR), Hans Komen (WLR/ASG), Jeroen Veraart (WENR), Heike Axmann (WFBR), Peter van der Heijden (WCDI)

1. Use potential of aquaculture to combat hunger
2. Biology + socio-economics + environment + value chains
3. Use high productive regions as case-study (Indonesia)
 1. Access to data and further data collection
 2. Indonesia: experience with aquaculture
 3. On long term relevant for Dutch companies
4. Identify "*global yield gap+*" (where to start)



Achievements 2019

1. Contacts with industry, universities and NGOs established
2. Papers on understanding behaviour of food producers
3. First modelling approach available
4. Conference presentations on this KB project
5. Familiarized ourselves with the methods/approaches used the different WR institutes



Insights & Surprises

Insights

1. Knowledge transfer to producers appears to be limited
2. Influence of 'behind the scene' relationships
3. Aquaculture does have a positive impact on livelihood (exponential growth)
4. Polyculture does take place
5. Potential for blue revolution limited



Multiple Scales and Extreme Events

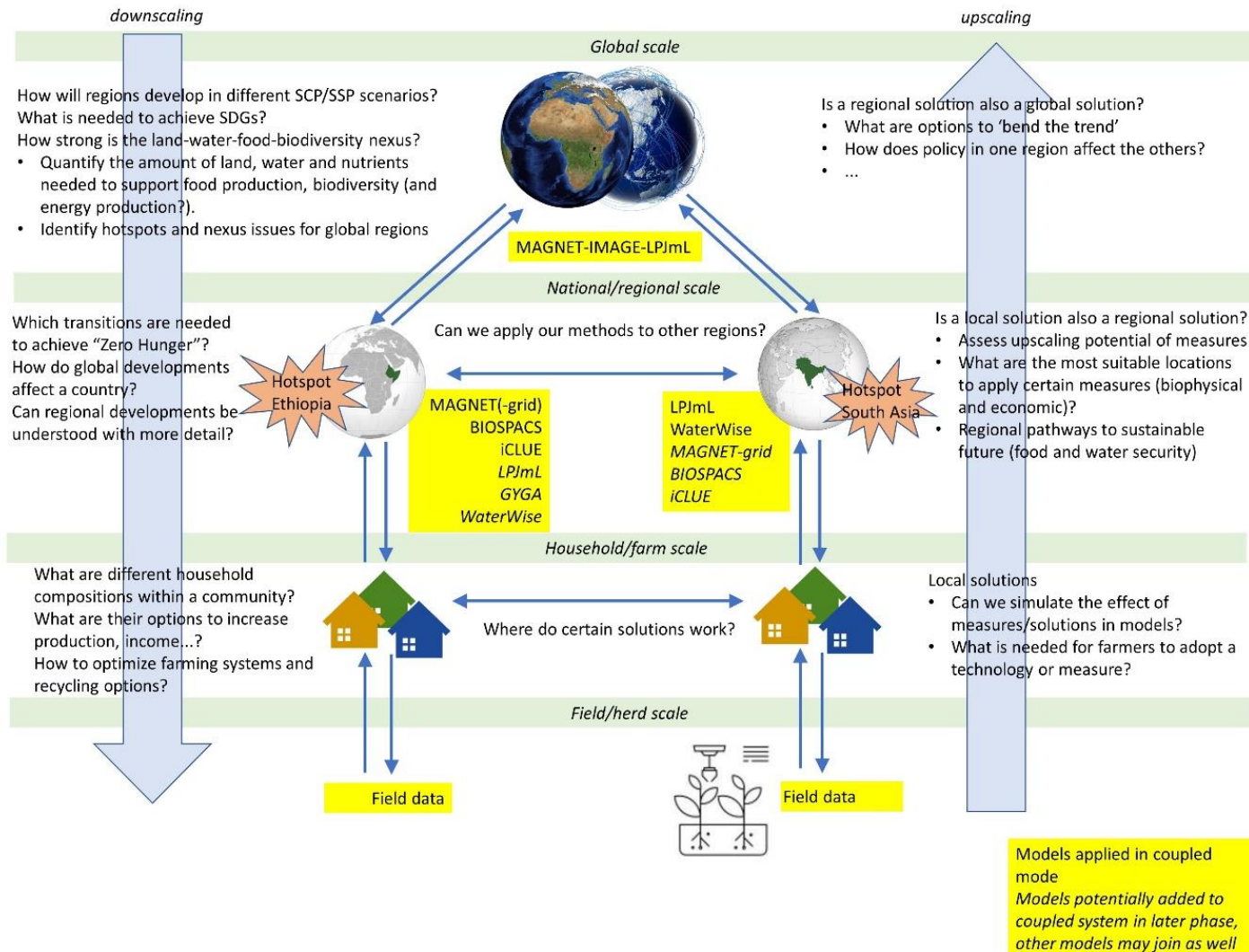


Photo: Flora Holland



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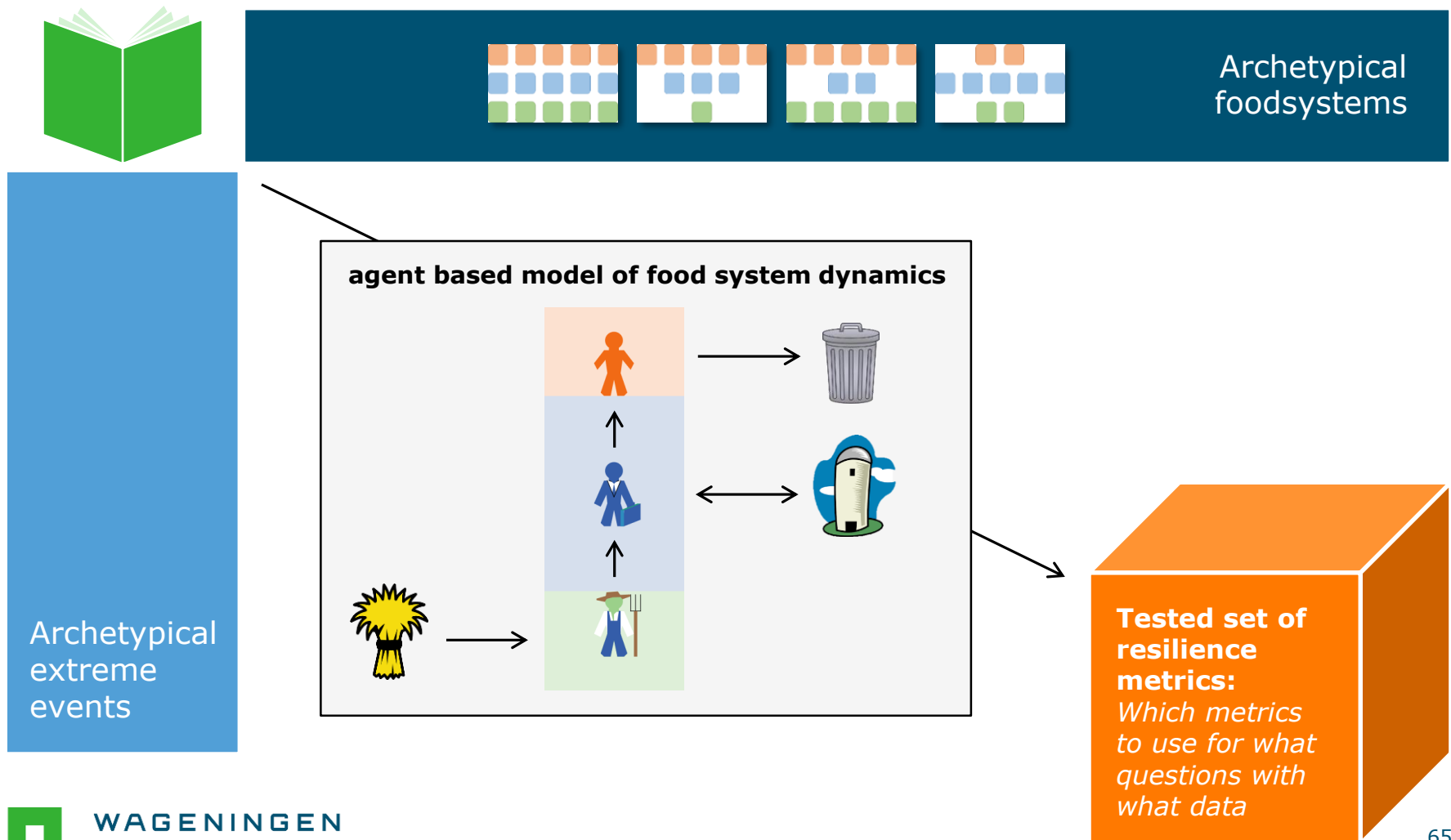
Multiple scales



Geerten Hengeveld (Biometris), Sjaak Conijn (WPR), Marijke Kuiper (WECR), Hester Biemans (WENR), Seerp Wigboldius (WCDI), Don Willems (WFBR)

Extreme events

Testing what resilience metrics & indicators actually measure & indicate



Interesting output

- Research agenda for coming years
- High impact scientific output to build upon in future years
- More papers submitted
- Documented tool for downscaling economic gridmaps

nature
sustainability

ARTICLES

<https://doi.org/10.1038/s41893-019-0287-1>

The global nexus of food-trade-water sustaining environmental flows by 2050

A. V. Pastor^{1,2,3*}, A. Palazzo¹, P. Havlik¹, H. Biemans⁴, Y. Wada¹, M. Obersteiner¹, P. Kabat^{2,5} and F. Ludwig²

ARTICLES

<https://doi.org/10.1038/s41893-019-0305-3>

nature
sustainability

Importance of snow and glacier meltwater for agriculture on the Indo-Gangetic Plain

H. Biemans^{1,2*}, C. Siderius^{1,3}, A. F. Lutz^{4,5}, S. Nepal², B. Ahmad⁶, T. Hassan⁷, W. von Bloh⁸, R. R. Wijngaard^{4,5}, P. Wester², A. B. Shrestha² and W. W. Immerzeel⁵

ANALYSIS

<https://doi.org/10.1038/s41893-019-0418-8>

nature
sustainability

Integrated scenarios to support analysis of the food-energy-water nexus

Detlef P. Van Vuuren^{1,2*}, David L. Biji¹, Patrick Bogaart^{1,3}, Elke Stehfest², Hester Biemans⁴, Stefan C. Dekker¹, Jonathan C. Doelman², David E. H. J. Gernaat^{1,2} and Mathijs Harmsen^{1,2}



Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in
Environmental
Sustainability

Advances in global hydrology-crop modelling to support the UN's Sustainable Development Goals in South Asia
Hester Biemans¹ and Christian Siderius^{1,2}



nature
climate change

PERSPECTIVE

<https://doi.org/10.1038/s41558-019-0502-0>

The need for bottom-up assessments of climate risks and adaptation in climate-sensitive regions

Declan Conway^{1*}, Robert J. Nicholls², Sally Brown^{2,3}, Mark G. L. Tebboth^{4,5}, William Neil Adger⁶, Bashir Ahmad⁷, Hester Biemans⁸, Florence Crick^{1,9}, Arthur F. Lutz^{10,11}, Ricardo Safrá De Campos⁶, Mohammed Said¹², Chandni Singh¹³, Modathir Abdalla Hassan Zaroug¹⁴, Eva Ludi¹⁵, Mark New^{5,14} and Philippus Wester¹⁶

Insight & Surprises

Insights

- Zooming in and out between global to local scales is crucial for the applicability models (for transition pathways)
- Impact of resilience either comes at the cost of loss of efficiency at the same scale, or at the cost of resilience at adjacent scales

Surprises

- Very long duration of net nitrogen output of Ethiopian soils (already published 1990, and reaffirmed in 2012-'14). Do results occur on same field? What are causes, consequences? Are estimates correct?



Nature Based Solutions + Food and Biodiversity



Different types of Nature Based Solutions

Annemarie Groot & Jeroen Veraart (WENR)
with contributions of all Science Groups

Nature-based solutions:

“Solutions that are inspired by or make use of natural processes, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience”



Inspired by nature

Example:

Plant breeding making crops
more attractive to natural
enemies of pest insects



Intrinsic, based on natural processes, local impact on biodiversity

Example:

From mono culture to crop
diversity (field level)



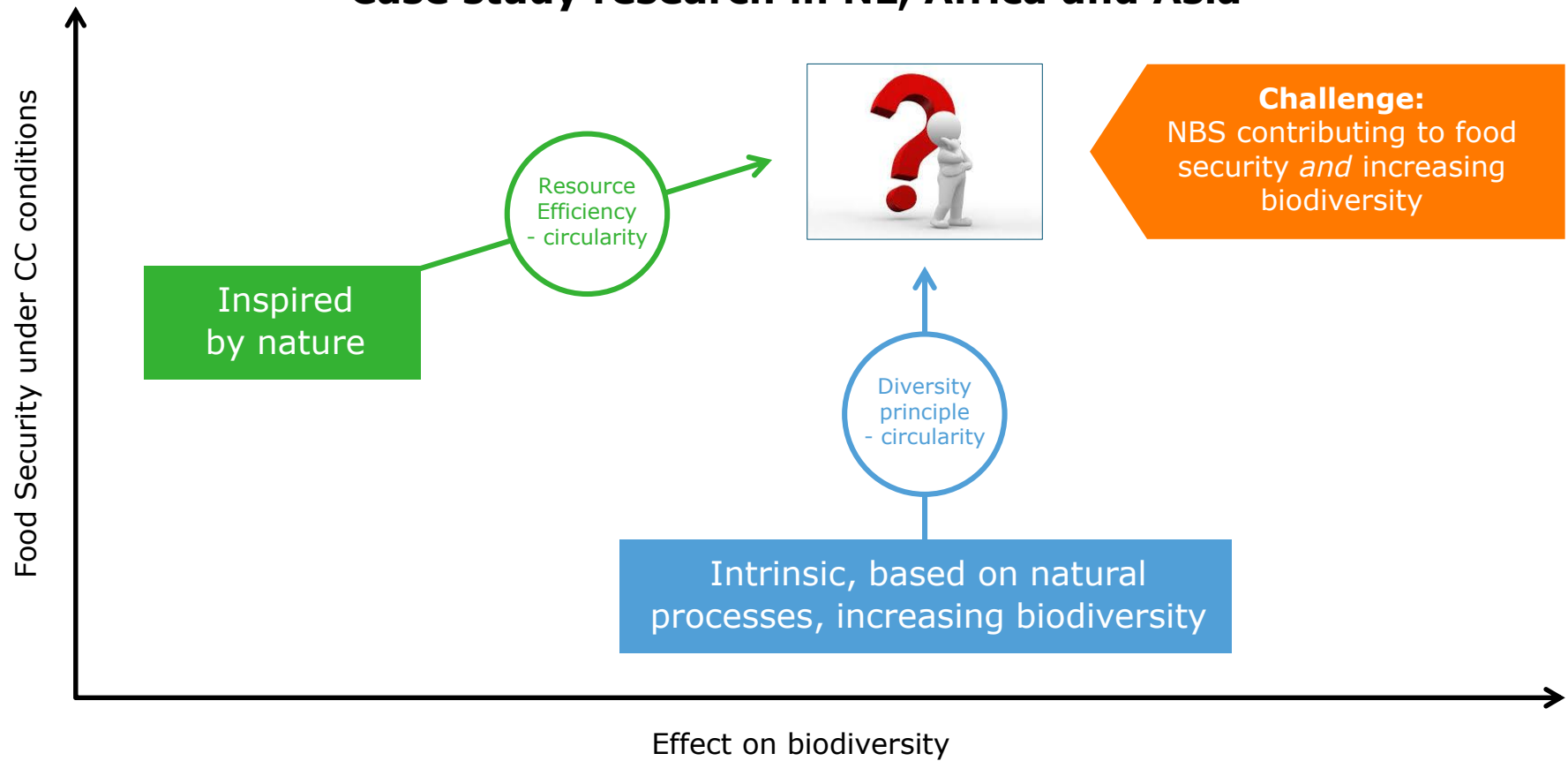
Intrinsic, based on natural processes, wider impact on biodiversity

Example:

Agro-forestry, swamps and water
harvesting ponds at landscape
level addressing water allocation
and water quality issues

Nature-based solutions for food security under climate conditions: hypothesis and challenges

Case study research in NL, Africa and Asia



Transition Pathways



Objectives and achievement

Marijke Dijkshoorn (WECR), Marloes Kraan, Susan de Koning (WMR), Boelie Elzen (WPR), Bram Bos (WLR), Wim de Haas (WENR), Jan Broeze (WFBR), Seerp Wigboldius (WCDI)

Objectives

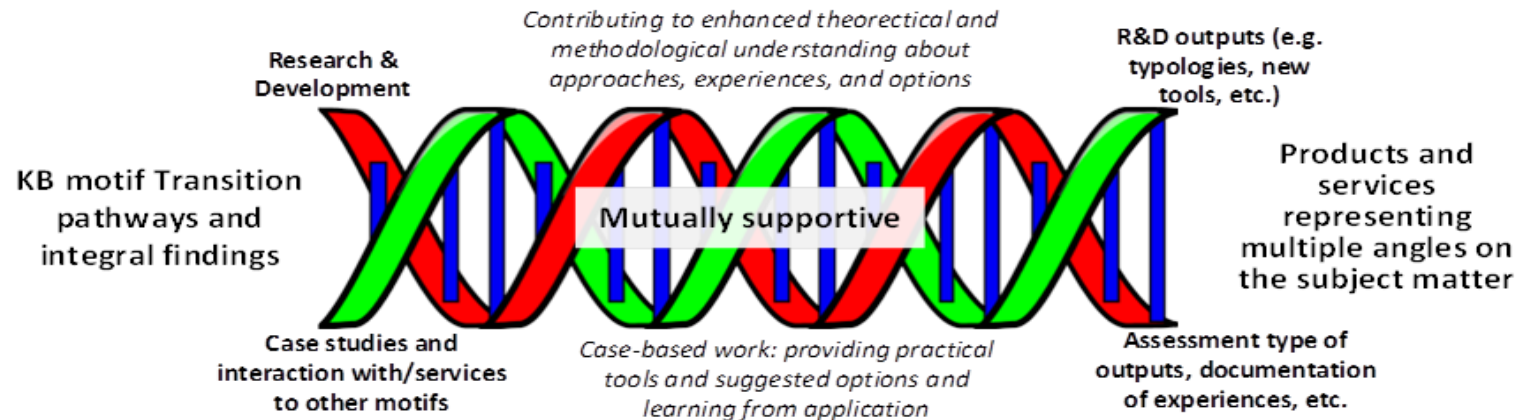
- Analyse **common challenges** of food system transitions
- Identify **barriers and opportunities** to realise food system transitions
- Develop a **transdisciplinary approach (involving stakeholders)** to support food system transitions

Achievement

Improved understanding of what needs to be addressed in relation to conceptualization/orientation, practice (including impacts on and roles of actors and stakeholders), and evaluation of performance and outcomes.

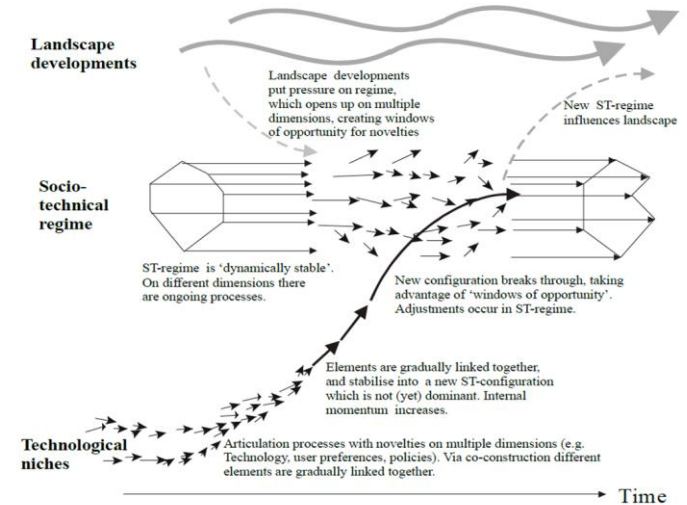
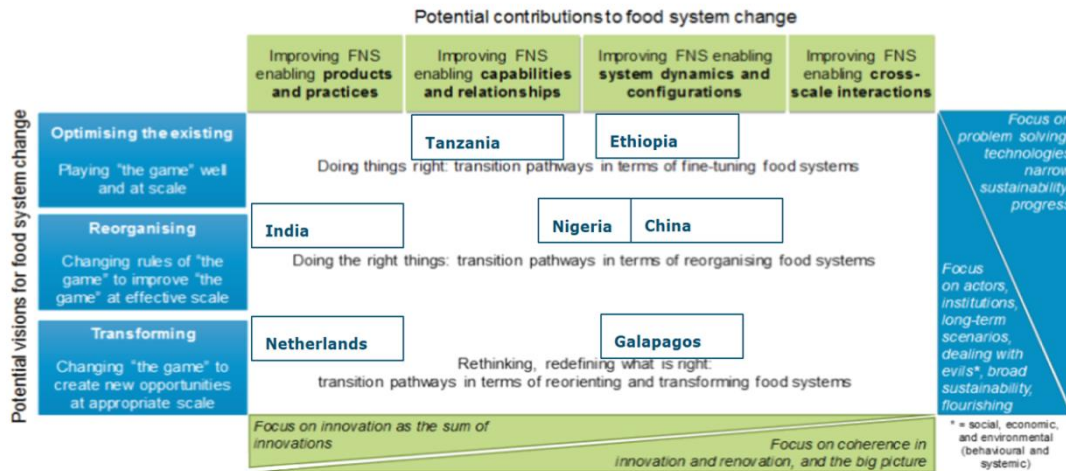
Organisation of the motif

1. Develop new knowledge on transdisciplinarity and stakeholder engagement in transition pathways in food systems



2. Integration of and support to the other motifs
3. Draw generalized and context dependent lessons from the findings from the other motifs

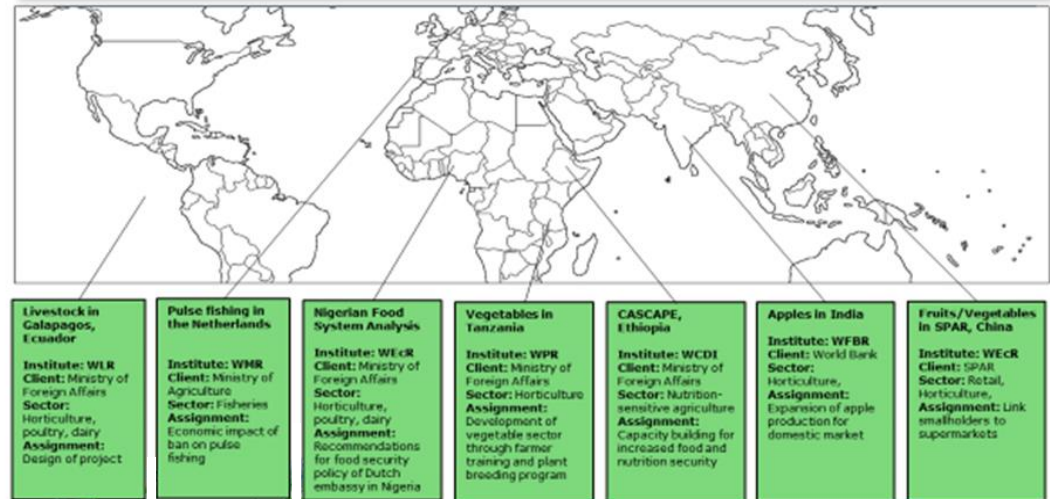
Analytical framework



... and develop a typology of possible transition pathways, their advantages, limitations, and the role of stakeholders in their implementation.

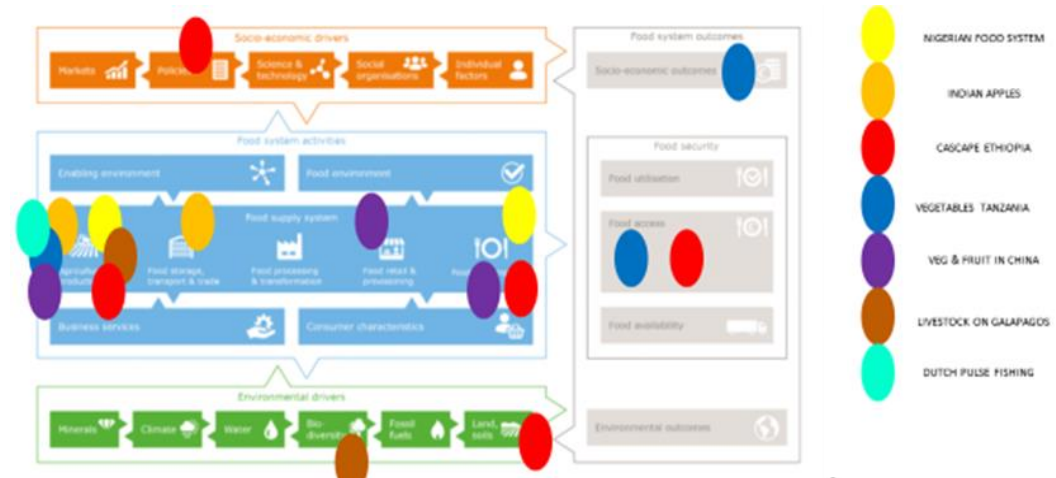
Study of cases and transitions pathways

Case Study Collection



Synthesis of transition cases

... result in an overview of lessons learned and recommendations for other motifs 2020.



Insight & Surprises

Insights

- Food system Transitions: small incremental steps; with micro strategies, hence: constant process of monitoring & evaluative framework,
- Stakeholders are key
- Biodiversity and climate should be included in international (trade) policies (like CETA)

Surprises

- Analysis showed: most projects focus on technical side, even when variety of stakeholders is involved

Small Innovative Projects 2019

Ethiopia Group (SIP 1/4)

Open data,
impact,
Food Systems
as a guiding
principle

Ethiopia Day

Bringing together knowledge and data for future initiatives

11 February 2020 12:00-17:00 – WUR Campus

Ethiopian food system challenges, for example:

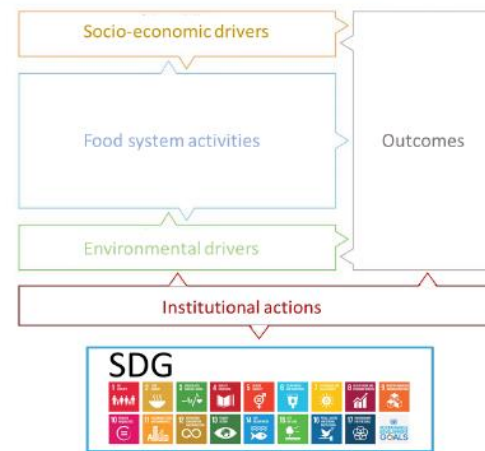
EMPLOYMENT OPPORTUNITIES AND ENTREPRENEURSHIP IN FOOD SYSTEMS

DIGITIZATION IN SUPPORT OF AGRO-ECONOMIC DEVELOPMENT

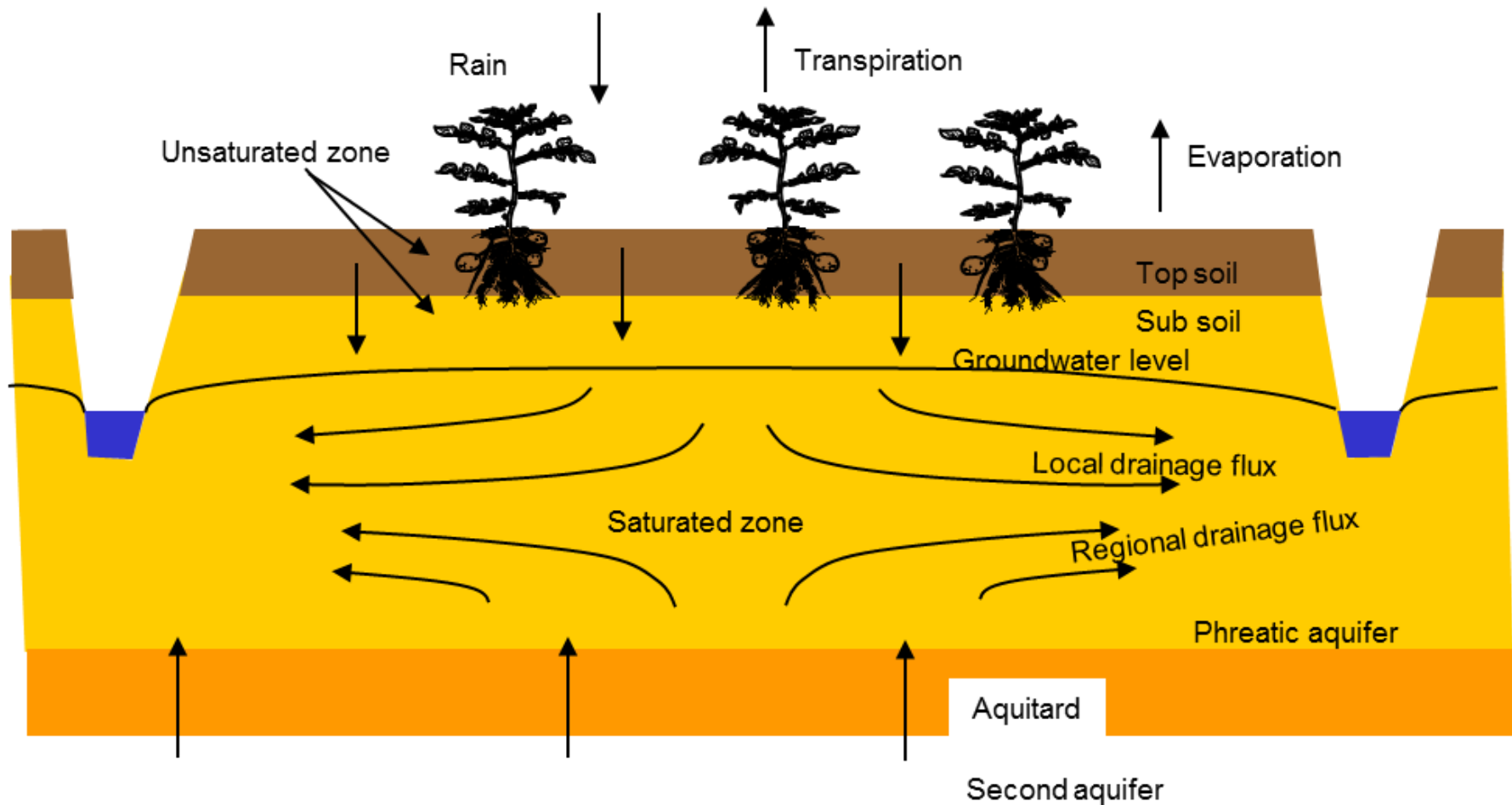
FOOD AND NUTRITION SECURITY

INTEGRATED PLANNING

REGISTRATION by 3 February: Please send your registration for the workshop to: tineke.bremer-vrijlandt@wur.nl with the Subject heading: OneWageningen Ethiopia afternoon. The workshop includes lunch.

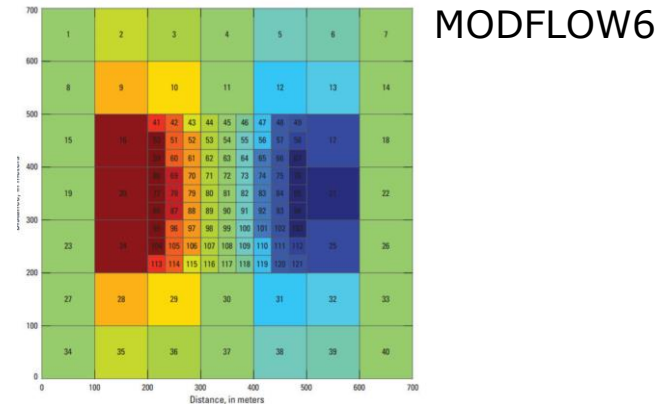


Soil Water Atmosphere Plant (SIP 2/4)



SWAP: Important developments

- Development of MODFLOW6 by the USGS
- New calculation techniques like parallelization on GPU
- New software modules like Basic Model Interface (BMI)
- Lead to new possibilities for Wageningen models - in close cooperation with Deltares -



WOFOST & W-FLOW (SIP 3/4)

WOFOST (Wageningen-UR):

- Model for estimating crop productivity as a function of weather, soil, management
- Operationally applied for crop monitoring and yield forecasting
- Drawback: catchment hydrology not included

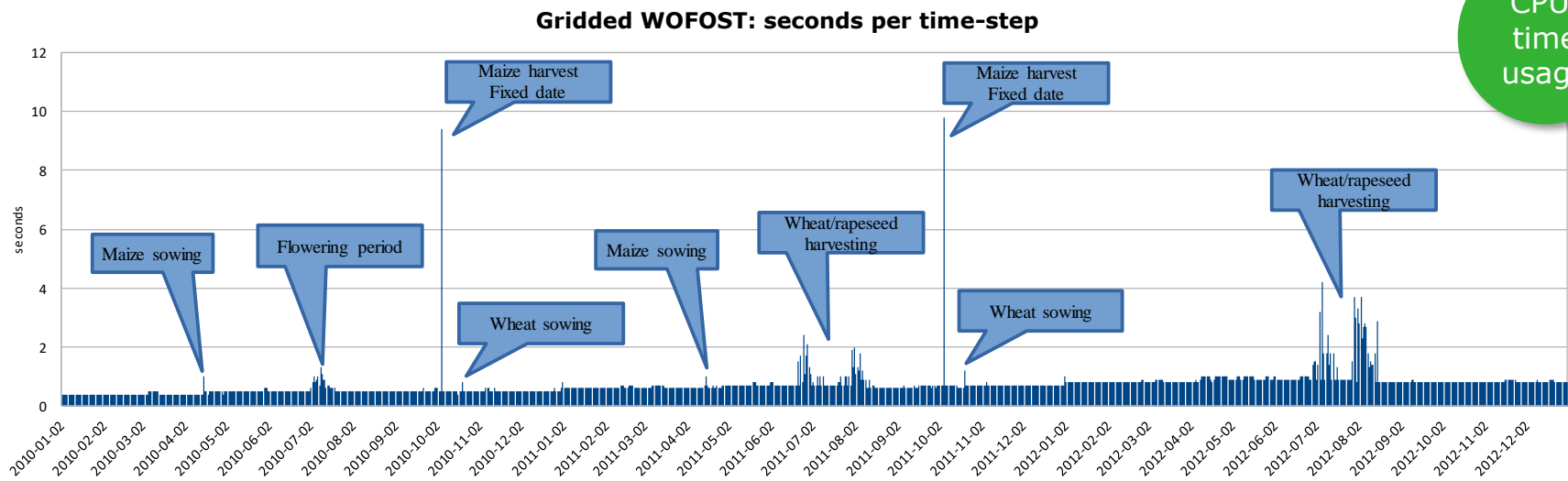
W-FLOW (Deltares)

- Catchment-hydrology model for estimating water fluxes and water availability
- Operationally applied for catchment studies
- Drawback: has no modules for crop productivity

Connecting WOFOST and W-FLOW

Allows direct coupling between hydrology and agricultural productivity:

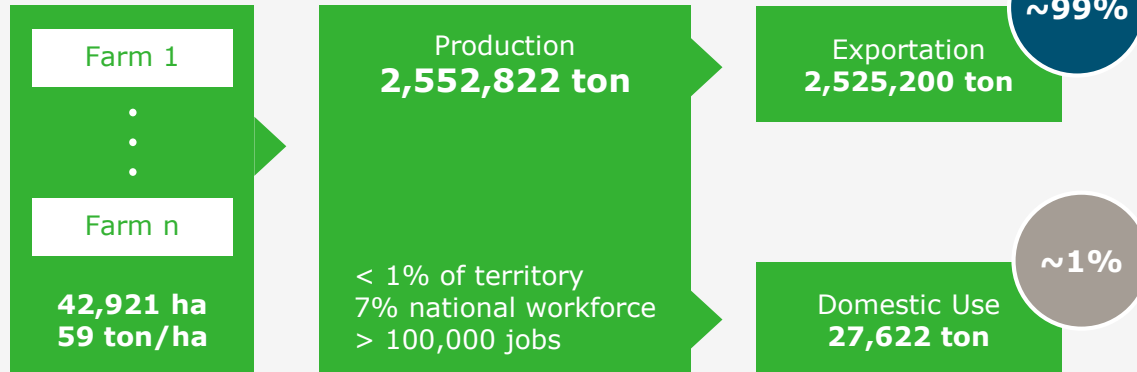
- Impacts of changes in hydrology on the local water availability can be simulated
- Realtime status of root zone soil moisture over the catchment can be used by WOFOST in order to predict crop yields
- Changes in the agricultural system (e.g. use of cover crops instead of bare fields) can now be incorporated in WFLOW and its effect on the hydrology can be taken into account



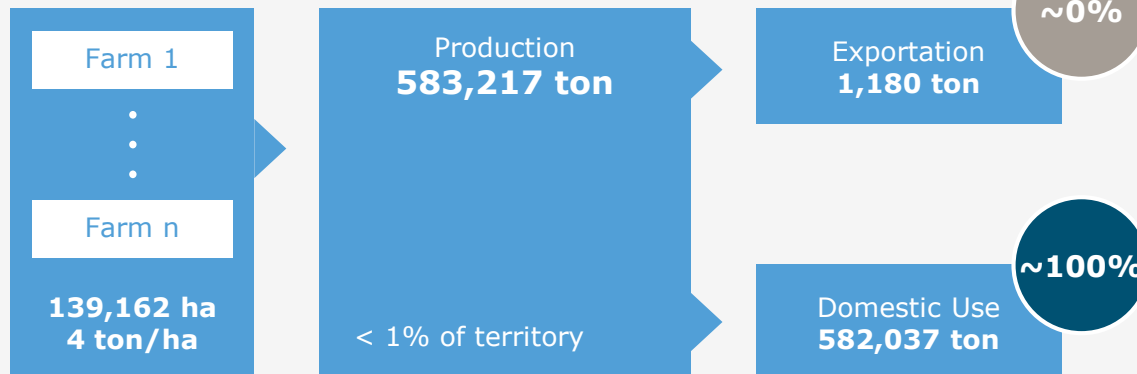
CPU
time
usage

Going Bananas! (SIP 4/4)

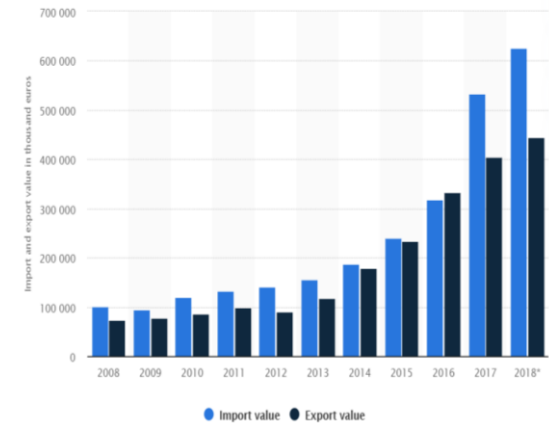
COSTA RICA: Export-driven



UGANDA: Local consumption-driven



Value of the import and re-export of bananas in the Netherlands from 2008 to 2018.



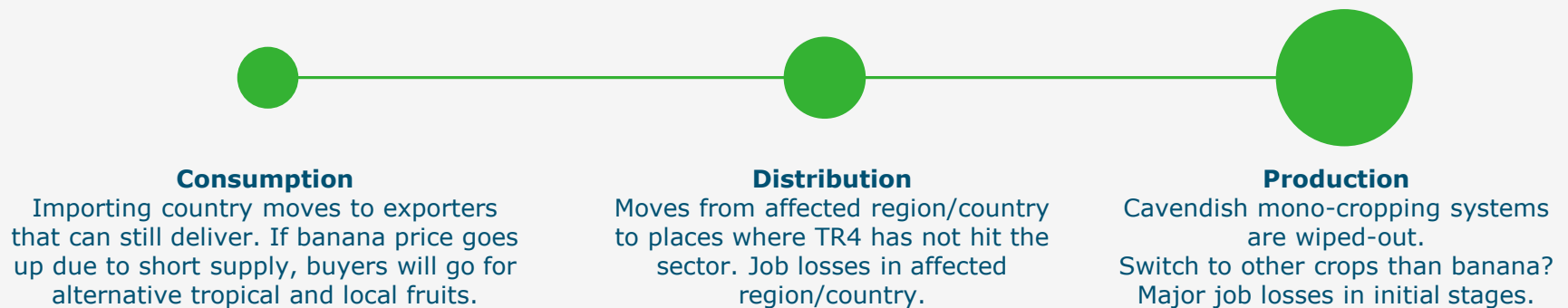
C. Alho (WENR); C. Hendriks (WENR), J. Stoorvogel (ESG), S. Vellema (SSG) and E. Smaling (WENR)

What if banana disease TR4 strikes?

UGANDA: Food security problem



COSTA RICA: Business problem



Thank you

“A ship is always safe at the shore, but that is not what it is built for.”

Albert Einstein



Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development*

Sustainable Development Goal indicators should be disaggregated, where relevant, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics, in accordance with the Fundamental Principles of Official Statistics.¹

Goals and targets (from the 2030 Agenda for Sustainable Development)

Indicators

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1 By 2030, **end hunger and ensure access** by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

2.1.1 Prevalence of undernourishment

2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)

2.2 By 2030, **end all forms of malnutrition**, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.2.1 Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age

2.2.2 Prevalence of malnutrition (weight for height $>+2$ or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)

2.3 By 2030, **double the agricultural productivity and incomes** of **small-scale food producers**, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.3.1 Volume of production per labour unit by classes of farming/pastoral/forestry enterprise size

2.3.2 Average income of small-scale food producers, by sex and indigenous status

2.4 By 2030, **ensure sustainable food production systems and implement resilient agricultural practices** that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.4.1 Proportion of agricultural area under productive and sustainable agriculture

2.5 By 2020, **maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals** and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.5.1 Number of plant and animal genetic resources for food and agriculture secured in either medium- or long-term conservation facilities

2.5.2 Proportion of local breeds classified as being at risk, not at risk or at unknown level of risk of extinction

2.a **Increase investment**, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

2.a.1 The agriculture orientation index for government expenditures

2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector

2.b **Correct and prevent trade restrictions and distortions** in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

2.b.1 Agricultural export subsidies

2.c Adopt measures to ensure the proper functioning of **food commodity markets and their derivatives and facilitate timely access to market information**, including on food reserves, in order to help limit extreme food price volatility

2.c.1 Indicator of food price anomalies