Towards healthy and sustainable Diets - Challenges in Food production

Wouter-Jan Schouten, Wageningen, January 8, 2020
TiFN Sustainable Food Systems Program

TiFN is an independent organizer and integrator of multi-disciplinary Innovation and Research programs in the Agro and Food sector.

Current PPS projects on sustainable Food Systems with TiFN involvement:

- 2016-20: SHARP
- 2017-21: Sustainable ingredients
- 2018-22: Regenerative Farming
- 2020-27: Technology 4 Ecology (Synergia)

Partners in these projects:

- Knowledge: Wageningen University and research, Utrecht University, TU Delft, TU Eindhoven, TU Twente, University of Amsterdam, Radboud University, ‘het Groene Brein’
- Private sector: FrieslandCampina, Unilever, Cosun, Rabo, DSM, Danone, Pepsico, Bel, BO Akkerbouw, NZO, IMEC, Lely, Signify, NXP, Wij.land
The leading paradigm in agriculture since world war II: maximize efficiency

‘Mono’ populations in optimized environments

Cheap and predictable food

Simple ‘ruling’ technology - high inputs – high losses per ha (though low per kg)

Source: Synergia consortium, Peter Groot Koerkamp
Maximize efficiency has been a very successful paradigm:

Global agriculture production has outgrown world population for over 60 years........

At a global level, more calories are produced than needed since app. 1990

…… and land use footprint per kg has been reduced dramatically….

…but land and ecosystem degradation is a global challenge…

Source: World Resources Institute
.... and (soil) biodiversity is threatened globally

Figure 9: Global map showing the distribution of potential threats to soil biodiversity. All datasets were harmonized on a 0-1 scale and summed, with total scores categorized into five risk classes (from very low to very high). 

Key

- Very low
- Low
- Moderate
- High
- Very high
- Not available
- Water
- Ice

Source: WWF Living Planet report 2018
Need to bend the curves on six earth system processes (EAT-Lancet, 2019) but how?

<table>
<thead>
<tr>
<th>Earth system process</th>
<th>Control variable</th>
<th>Boundary (Uncertainty range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>GHG emissions</td>
<td>5 Gt CO₂-eq yr⁻¹ (4.7 – 5.4 Gt CO₂-eq yr⁻¹)</td>
</tr>
<tr>
<td>Land-system change</td>
<td>Cropland use</td>
<td>13 M km² (11–15 M km²)</td>
</tr>
<tr>
<td>Freshwater use</td>
<td>Water use</td>
<td>2,500 km³ yr⁻¹ (1000–4000 km³ yr⁻¹)</td>
</tr>
<tr>
<td>Nitrogen cycling</td>
<td>N application</td>
<td>90 Tg N yr⁻¹ (65–90 Tg N yr⁻¹) * (90–130 Tg N yr⁻¹)**</td>
</tr>
<tr>
<td>Phosphorus cycling</td>
<td>P application</td>
<td>8 Tg P yr⁻¹ (6–12 Tg P yr⁻¹) * (8–16 Tg P yr⁻¹)**</td>
</tr>
<tr>
<td>Biodiversity loss</td>
<td>Extinction rate</td>
<td>10 E/MSY (1–80 E/MSY)</td>
</tr>
</tbody>
</table>

*Lower boundary range if improved production practices and redistribution are not adopted.
**Upper boundary range if improved production practices and redistribution are adopted and 50% of applied phosphorus is recycled.
We cannot solve our problems with the same thinking we used when we created them.

Albert Einstein
Need for a new paradigm: Regenerative, circular, ecology-based agriculture

Diverse production with complex interactions

Changing market dynamics and preferences

Intelligent small scale ‘supporting’ technology

Source: Synergia consortium, Peter Groot Koerkamp
Need new approaches to get to a regenerative and circular system at scale

<table>
<thead>
<tr>
<th>Today’s dominant logic</th>
<th>Required for systemic change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume growth, maximum efficiency; Less Negative impacts</td>
<td>Value growth, optimum efficiency; Net Positive impact</td>
</tr>
<tr>
<td>Supply chains, company by company, commodity by commodity</td>
<td>Integrated Systems: Landscape, value chains, consumers</td>
</tr>
<tr>
<td>Dogmatic: prescribe ‘one size fits all’ agricultural practices</td>
<td>Drive to target outcomes with diversity of agricultural practices</td>
</tr>
</tbody>
</table>
Proposed objectives of a regenerative agriculture system at scale

Need to bend the curves:

- **Climate**: Carbon capture > GHG emissions
- **Land system change**: Improve soil quality, enable nature restoration
- **Freshwater use**: Improve water quality
- **Phosphorous and Nitrogen**: Close nutrient cycles
- **Increase biodiversity**

A regenerative farming system enables production of *sufficient* food and biomass and enables ecosystems to maintain a healthy state and evolve, while contributing to human well-being and economic prosperity.

Three overarching requirements for the bio-physical system:

- **Stocks**: all natural capital stocks above threshold levels for resilient agro-ecosystems
- **Flows**: all ecosystem functions in agriculture areas enabled perpetually
- **Neutral or positive impact on natural ecosystems outside agriculture areas**

Source: Regenerative Agriculture consortium
Need integrated system approaches; combining spatial and supply chain dimensions

And define required outcomes at different system levels

Source: Regenerative Agriculture project
Need diversity of solutions…….

some examples

- Intercropping
- Circular, mixed farm
- Agroforestry
- Managed/strip grazing
- Precision farming
- Silvo pastures

Source: Inaugural address Rogier Schulte (2019)/ WUR-FSE Lighthouse farm network, Regenerative agriculture project
.... in a circular system

- Upcycling grass resources and food leftovers through farm animals
- Closed nutrient cycles
- Optimized land use
- Climate neutral nature + agriculture
Direction in arable farming: Monoculture → intercropping → pixel farming

Today’s dominant model: Mono-culture
Technology controls ecology

Today’s state of the art: Strip intercropping
Technology enables ecology

Future: Pixel farming
Technology collaborates with ecology

Source: van Henten & van Apeldoorn, 2018
Strip/row Intercropping at ERF
(source: inaugural address Rogier Schulte, 2019)
Pioneering ‘lighthouse farmers’ show that business models can be transformed

Always a multi-year transformation process at farm level

<table>
<thead>
<tr>
<th>Today’s dominant business model</th>
<th>Lighthouse farmers have developed one or more of these competitive advantages:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commodity product → price is set on world market</td>
<td>Differentiated products → Price premium</td>
</tr>
<tr>
<td>High and ever increasing input costs</td>
<td>Much lower input costs</td>
</tr>
<tr>
<td>Asset intensive, ‘specialized technology rules’</td>
<td>Less asset intensive, ‘technology supports’</td>
</tr>
<tr>
<td>→ Maximizing volume yields of ‘mono’ populations is the only way to earn a living income</td>
<td>Multi-product synergies (yields and/or costs)</td>
</tr>
<tr>
<td></td>
<td>Revenues from ecosystem services</td>
</tr>
<tr>
<td></td>
<td>Forward integration in short, local, value chains</td>
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</table>
Levers for system change: smart technology, cooperation and governance
(source: inaugural address Rogier Schulte, 2019)

Complexity + **Knowledge** = Food + Ecosystem Services
Recap

- Maximize efficiency has been a very successful paradigm. However, the challenge in primary production is no longer to maximize production per hectare but to bend the curves on planetary boundaries
  - Optimize Soil quality, Climate and carbon regulation, Nutrient cycling, Water purification and regulation, Biodiversity and Primary production

- This requires a paradigm shift in agriculture
  - Biophysical logic: from maximize efficiency in supply chains to regenerative foodscapes
  - Economic logic: from commodity production and volume growth to differentiation and value growth

- Need diversity of solutions, many of which exist today (at small scale)
  - High diversity of practices but all are embracing ecological complexity

- Transformation at scale requires transformation at many individual farms, from asset intensive to knowledge/experience intensive
  - Supported by farmer cooperatives,
  - supported by smart technologies,
  - and supported by effective ‘governance for diversity’ by value chain partners, governments and finance