1. Mega challenges
2. Mega food system trends
3. Progress is significant
4. We need a food system transformation
5. What does this mean for plant nutrition?

- Food and nutritional security
- Mitigating GHG emissions
- Adaptation
- Farming as a viable livelihood
Ending hunger

Kharas et al., 2015 Brookings Institute

% undernourished

Low- and middle-income countries

Current trend

Trend required to reach 0% undernourishment by 2030

How do we scale up change?

Mitigation – an impossible task?

Gt CO$_2$-eq per yr

After overshoot: Negative emissions, e.g. BECCS

For 1.5$^\circ$C
c. 45% by 2030

For 2$^\circ$C
c. 20% by 2030

7 million km$^2$ of bioenergy crops needed by 2050

We will overshoot 1.5 & 2

#1

#2
The mega adaptation challenge

Change in length of growing period in a +4 °C world (2090)

- >20% loss
- 5-20% loss
- No change
- 5-20% gain
- >20% gain

Farming as we know it now, will not be feasible in many places

Thornton (2018; methods as in Jones & Thornton (2015))

We are now at 1°C
Many records are being broken

How, in only 11 years, do we reach 500-750 M farming households with resilient-building services and technologies?

Number of record-breaking monthly temperature extremes now 5X times more
Coumou et al. (2013) Climatic Change

Dry record-breaking events in SSA have increased by up to 50%

Farmers, farming and the food industry are getting a bad press

Global food system is broken, say world’s science academies
Globally, farmers under pressure

20% farms are on brink of bankruptcy (mostly pork and dairy) (2016)

How are agric practices changing?

<table>
<thead>
<tr>
<th>Region</th>
<th>Stepping up (intensifying)</th>
<th>Stepping out (accumulating non-ag assets)</th>
<th>Hanging in (coping)</th>
<th>Scraping by (&gt; 5 food deficit months)</th>
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<tbody>
<tr>
<td>East Africa</td>
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</table>

How do we improve farmer livelihoods? Fast?

Thornton et al. (2018)
By 2030
- Number of cows in U.S.: 50% ↓
- Cattle industry all but bankrupt

Cost of Precision Fermentation
- $1,000,000 /kg in 2000
- $100/kg in 2019
- $10/kg by 2025

We are on the cusp of the fastest, deepest, most consequential disruption of agriculture in history.
Rise in interest in food, with many implications

For example:

- Organic market share:
  - 2005: 2%
  - 2010: 4%
  - 2015: 6%
  - 2018: 12%

  14% increase

Statistics Denmark

51.4 percent – buy organic food every single week

Agro-ecology, organic agriculture, food sovereignty, local food cultures ……

Massive opportunity for African farmers and food companies

Africa’s urban population (billions)

- 230 million more mouths to feed in urban areas by 2030

Africa’s annual food import bill
- $35 billion in 2025
- $110 billion by 2025

UN Department of Economic and Social Affairs. World Population Prospects: The 2017 Revision.

Africa Development Bank
Global initiative

Transforming Food Systems Under a Changing Climate

Over 100 partners have come together in a new initiative to identify pathways for food systems transformation.
1. **Reroute** 
farming and rural livelihoods to new trajectories

2. **de-Risk** 
livelihoods, farms and value chains

3. **Reduce** 
emissions through diets and in value chains

4. **Realign** 
policies, finance, innovation, and support to social movements

1. **Reroute** 
farming and rural livelihoods to new trajectories

   1.1 Zero agriculture land expansion on high carbon landscapes
   1.2 Maintaining soil health in croplands for regenerative agriculture

2. **de-Risk** 
livelihoods, farms and value chains

   2.1
   2.2
### 3. Reduce emissions through diets and in value chains

<table>
<thead>
<tr>
<th>3.1</th>
<th>Healthy and sustainable climate-friendly diets</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td></td>
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</table>

### 4. Realign policies, finance, innovation, and support to social movements

<table>
<thead>
<tr>
<th>4.1</th>
<th>Policy and institutional change as a key to transformation, (subsidies)</th>
</tr>
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<tbody>
<tr>
<td>4.2</td>
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<td>4.3</td>
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</table>
#1 Change is coming – don’t …..

#2. Getting the balance

Propose standards for fertilizer application (e.g. by agro-ecological zone)

Raise ambition of targets related to nutrient use

Campbell et al. 2019
#3. Redirect public support away from distortionary subsidies that incentivize overfertilization

#5. Getting more efficient production

**Fertilizer industry:**
- novel products and methods
- increase energy efficiency in production
- increase nutrient efficiency
- slow nitrification
- enhance soil carbon and its stability

---

Context matters !!!!!!
Self-sufficiency in SSA on lowest emissions trajectory

van Ittersum et al. 2019

Current N efficiency
Current maize yields
Yield trend extrapolated
High NUE
Yield gap closed
50% 80%

Mt CO$_2$-eq

C loss from grass, due to land use change
C loss from forest, due to land use change
SOC loss due to land use change
fertiliser use

Thank you

www.ccafs.cgiar.org
@bcampbell_CGIAR
Stress-tolerant varieties
Potato and sweetpotato can now be developed in 4 years

Drought tolerant maize:
• 2 million smallholders
• 13 countries

650,000 insured in sub-Saharan Africa

10s of millions accessing extension through mobile phones
Within a few seasons of R&D 300,000 farmers paying for climate-informed digital advisory services

Solar powered irrigation as a “remunerative crop”

- Sell to the grid
- Sell water to other farmers
- Win-win for adaptation and mitigation

- USD 21.5 billion
  - → 2.75 M solar irrigation pumps

5% cropland in Africa irrigated – global average 20%
Can solar be an energy and water solution?
"some extreme events were not possible in a preindustrial climate"
But, a significant challenge:

- Massive mitigation challenge
- Climate change intensifying
- Less that 20% of small-scale farmers are stepping up
- Must reach 500 million smallholders
- Disruptive technologies are coming
#5 Raise ambition of targets related to nutrient use
- in Nationally Determined Contributions (NDCs)

Key: getting markets working and incentives right

### How are agric practices changing?

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Thornton et al. (2018)

How do we improve farmer livelihoods? Fast?
Cost of Precision Fermentation
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Food-as-Software

Now available for 1 cent

The Mega Mitigation Challenge

19-29% global GHGs from food systems
Vermeulen et al., 2012 ERER

Current agricultural technologies perhaps can only achieve 20-40% of what is needed by 2030

Wollenberg et al., 2017 Global Change Biology