Resilience (and sustainability) in food systems

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INTRODUCTORY CONCEPTS: RESILIENCE 101
Resilience is the speed which the system returns to stability – and depends on depth and width of cup.

Cup defined by “slow” or controlling variables (e.g. climate, soil “health”)

Ball represents state of the system (e.g. yields)
- Shocks to the system (like extreme weather) displace the ball
- Negative feedbacks return it to stable state

“Cup and ball” depiction of dynamical systems
Resilience: recovery from “shock”

High resilience: system quickly returns to stability

Low resilience: system slowly returns to stability

Soil degradation
Resilience and tipping points

Systems with low resilience can “tip” into alternative stable states – especially if shocks are getting bigger.

Tipping point

High yielding state

Low yielding state
POINT 1: RESILIENCE OF THE FOOD SYSTEM IS NOT THE SAME AS RESILIENT AGRICULTURE
The food system
As yields grow, waste grows faster

Fig 2.19. Nominal and Real global food prices since 1961. Data from World Bank http://data.worldbank.org/

making food cheaper embeds waste as “economically rational behaviour”

A half-century of production-phase greenhouse gas emissions from food loss & waste in the global food supply chain

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Food systems are spatial

...so food system resilience depends on more than local agricultural resilience

The UK as an example of a food system: the countries in blue exported food to the UK 2011-2016
Food system resilience requires resilient transport infrastructure

- 60% US grain export
- 11% cereals trade
- 26% cereals trade ~20% fertilisers
- 14% cereals trade
- 14% cereals trade ~25% fertilisers (50% China's soy and wheat)

https://www.chathamhouse.org/about/structure/eer-department/vulnerabilities-and-choke-points-global-food-trade-project
Food system resilience depends on many factors

- Weather shocks
- Pests, diseases
- Input shocks
- Regulatory shocks
- Geopols and trade

Intensification pressure
(demand growth, resource competition)

System shocks increasing

Markets, market rules and policies:
Concentration, power, WTO, transparency

Impact: prices spikes and volatility

Internal feedbacks:
Speculation, stock levels
Trade policy changes
(export bans, panic buying)

POINT 2: RESILIENCE IS NOT ALWAYS GOOD
“Lock-in” or “inertia” can be the wrong sort of resilience

Low yielding state
Unsustainable state
Inefficient system state

High yielding state
Sustainable state
Efficient system state
POINT 3: CHANGE (CLIMATE, TRADE, SOILS) CHANGES RESILIENCE
Changing resilience

Incremental changes can have little effect until close to a tipping point, where resilience can degrade rapidly.

Time
- Changing climate intensification
- Slow soil degradation
- Loss of biodiversity
- Air or water quality
- Trade patterns
- Social norms
POINT 4: RESILIENCE TO SHOCKS VS RESILIENCE TO CHANGE
Global markets driving (narrow sense) efficiency lead to concentration in intensive farming, crops, places and risks

Over 50% of the world’s crop calories come from wheat, rice and maize, adding sugar, barley, soy, palm, potato gets to 76%

Fig 2.19. Nominal and Real global food prices since 1961
Data from World Bank http://data.worldbank.org/
What we should be eating
(Harvard's Healthy Eating Plate Model)

Milk & Milk Products 8%
Meat, fish, eggs, beans 20%
Cereals and Starches 20%
Fruits & Vegetables 49%
Vegetables 11%
Cereals and Starches 47%
Oils & Fats 3%
Sugar 16%
Milk and Milk Products 4%
Meat, fish, eggs, beans 11%
WHO< 5% Evan Fraser, Guelph, FBS analysis, 2015
The food system is on an unsustainable trajectory

- GHG emissions are contributing to climate change
- Malnutrition in all its forms is growing
- The food system is highly inefficient
- “narrow-sense” efficiency drives concentration of risk in few crops, few breadbaskets, highly connected systems, at the same time that shocks are increasing
Narrow-sense efficiency model is problematic

The system as a whole is very resilient to transformation to a “better” state

Food system functioning
worse current better

Food system governance
(WTO, ag policies, market forces and concentration)
CONCLUSIONS
## Routes to resilience

### Farming
- Genetics
- Soils
- Pests and diseases
- Diversity in space and time (rotations) (bet-hedging, plus reduction of homogeneity)
- Forecasts (seasonal, decadal)
- Infrastructure (irrigation)

### Food system
- Diversify products and places
- Trade rules (export bans)
- Virtual or real regional food stores
- Transparency of stocks
- Transport infrastructure/chokepoints
- Food culture/waste/market expectations (change demand elasticity)
- Food system efficiency

Historically:
- Balance of local and traded
- Diversified (not all eggs in one basket)
- Food stores

Greater concentration on systemic efficiency will reduce pressure on the whole system.
finally

• Systemic resilience may be built around reducing (narrow sense) agricultural efficiency:
  – Efficiency drives scale and concentration on few products
  – Resilience often requires diversification to portfolio
Thank you!

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