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2s3: Risk management and trade-offs

DARTS: Modelling the resilience of food systems in a globalised world

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In order to achieve SDG2 (Zero hunger) food systems should be resilient against shocks. Food systems resilience is supported by a wide variety of food systems properties at all levels of the food system. Here, we have identified four important properties that support food systems resilience:

- Agency (which actions agents can take within their role),
- Buffering: how much reserves agents can keep,
- Connectivity: regional & international trade and
- Diversity: different roles of agents (producing, trading, consuming), differentiation within roles (urban/rural, rich/poor, regional/international orientation). Furthermore regions can differ in productivity and distribution of agent roles.

It is important to understand how these properties affect resilience (including possible trade-offs) to allow effective policy interventions. A starting point is studying existing historical narratives of food system development and their responses to shocks, but these do not cover all possible combinations of food system architectures and shock types. We have therefore developed DARTS: an agent-based model that simulates artificial food systems in which the abovementioned properties can be varied systematically and evaluated against a variety of shocks. This allows us to go beyond existing narratives and investigate what-if scenarios in a highly abstracted description of food systems.

In DARTS, agents produce, stock, trade and consume food in different contexts (urban/rural, rich/poor) with different levels of access to regional and global markets. The regions in the model mimic Northern/Southern/Equatorial countries and have different harvest periods. DARTS applies shocks from 7 generic shock types, including production shocks (by crop failure), cash shocks (economic downturns) and a variety of trade shocks (e.g. import bans). By subjecting the artificial food systems to different shocks we evaluate the resilience of food system functioning (sufficient food for all agents at all times) given the food system configuration.

We present the results of simulations from 16 artificial food systems, transitioning from premodern food systems (no international trade, no urbanization, low income inequality

within and between regions) to a fully modern food system (international trade networks, and urbanization, high income inequality). Our analyses show that resilience varies between food systems in nontrivial and often unexpected ways. For instance, premodern food systems show low resilience to localized shocks, while access to international trade in modern food systems mitigate these localized risks. However, the extent to which these risks are mitigated depends largely on the financial position within the food system both locally and globally.

Keywords: