

Probabilistic Causal Models for Nutrition Outcomes of Agricultural Actions

Using decision analysis techniques to improve development decisions.

Making decisions on how to promote agriculture for nutrition requires approaches that can accommodate complex relationships and translate agricultural activities into nutritional outcomes.

Decision analysis is a set of methods designed to assess decisions and offer a recommended course of action for decision makers. These methods can be used to meet the challenges of system complexity and data scarcity, inherent in development decisions. They have been designed to support decision-making with imperfect information and limited research budgets.

Participatory model building processes are applied to generate impact pathways that integrate expert knowledge and consider system complexity and uncertainty. Proven probabilistic techniques are then used to create simulations that anticipate the future impacts of decisions and provide scientific evidence for decision making under uncertainty.

Decision analysis methods were applied in two case studies under the IMMANA project:

- Household nutrition effects of the introduction of fruit trees into agricultural landscapes of Western Kenya.
- National nutrition impacts of the plan to convert traditional home garden systems in Uganda to large-scale staple crop production.

The Decision Analysis approaches recognize that data is not always available and that rational decision makers do not necessarily require precise information on all factors of interest. **Decision Analysis harnesses the knowledge of the full range of system experts (i.e. from stakeholders like smallholder farmers to nutritionists) to produce a high-level model of a decision, which reflects the best available information on plausible decision impacts.** Because they include all available knowledge, the resulting models include all the factors that experts consider relevant and they are able to meet the ambition of encompassing system complexity and all-important decision impacts, regardless of data availability.

Project facts



PRINCIPAL INVESTIGATOR:
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CO-INVESTIGATORS:
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COLLABORATORS:
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DURATION:
24 months
(from September 2015)



COUNTRIES OF RESEARCH:
Germany, Kenya, Uganda, United Kingdom



GRANT VALUE:
£250,000



OPEN ACCESS:
All the methods, data and model scripts are open access (to apply these, see [decisionSupport R package](#))

Methods are applied in major research projects

Probabilistic Causal Models are now established methods with a broad, international application. They are currently being applied in a wide variety of research projects, most notably:



Decision Analysis and Risk Assessment - Stochastic Impact Evaluation

CGIAR, 2015-2016

This initiative established decision analysis methods in development research at the research-policy interface. The project aimed to further methods for Stochastic Impact Evaluation and apply them to improving stakeholder intervention decisions in WLE priority regions.



Quantifying uncertainty in monitoring soil organic carbon stock and greenhouse gas emissions

CGIAR research Programs on Water, Land and Ecosystems (WLE), 2021-2022

Generating a robust and cost-effective method to quantify uncertainty in monitoring soil organic carbon and greenhouse gas emissions to facilitate measuring, reporting and verification of climate mitigation actions.



Phenological and social impacts of temperature increase – climatic consequences for fruit production in Tunisia, Chile and Germany

BMBF Bioeconomy program, 2017-2020

This project uses decision analysis methods to model the implications of climate change for fruit and nut growers in Tunisia and Chile.



Potentials and obstacles of a regional nutrient cycle economy

German Federal Environmental Foundation (DBU), 2020-2022

This project applies Probabilistic Causal Models to make policy recommendations related to agricultural practices, nutrient flows and the link between animal husbandry and nitrate pollution in the groundwater of North Rhine-Westphalia, Germany.



Innovations for North Rhine-Westphalia to increase resource efficiency and environmental compatibility in horticulture (INRUGA)

Stiftung Zukunft NRW, 2018-2021

The INRUGA study uses participatory modelling approaches to develop decision-making aids for optimised, resource-saving, environmentally friendly crop protection in horticultural crops. Heather (*Calluna vulgaris*) is being investigated as a model plant, which is grown in NRW on 400 ha and has considerable economic significance.



E-flows in support of the sustainable intensification of agriculture in the Limpopo River Basin

United States Agency for International Development (USAID), 2020-2021

This project will provide the necessary evidence to secure environmental flows (e-flows) for increasing the resilience of communities and ecosystems in the Limpopo Basin (South Africa and Mozambique) to changes in stream flow.



A new field of research is established

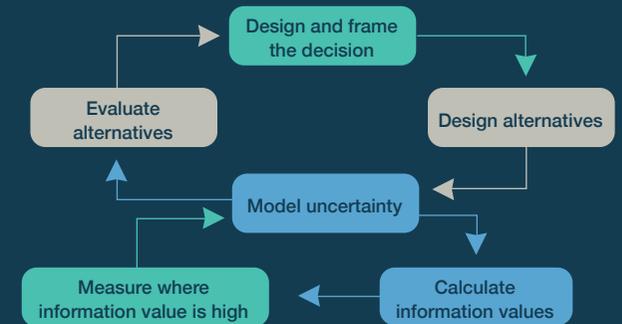
The development of Probabilistic Causal Models has led to new opportunities for researchers. The methodology resonates with students, and researchers are motivated to use it.

- In 2018 Eike Luedeling was promoted to Professor of horticultural sciences, with a particular focus on fruit tree dormancy and holistic systems modelling.
- A [junior research group was established in 2020](#), looking at Bayesian networks and causal modelling in developing contexts at the University of Bonn.
- A new MSc teaching model on decision analysis and forecasting will be taught for the first time in 2021 to [MSc](#) and [PhD](#) students at the University of Bonn. The module will be delivered to 40 students per year.
- MSc student projects related to agroforestry and horticulture have applied the methods:
 - » Adapting sweet cherry orchards to extreme weather events – [Decision analysis in support of farmers’ investments in Central Chile](#)
 - » [Decision analysis of agroforestry options](#) reveals adoption risks for resource-poor farmers



Above. The Kenyan fruit tree workshop hosted in 2016; A volunteer farmer trainer in Kenya (pic: Sherry Odeya).

Right. Decision Analysis Modelling



Timeline

