Business decision analysis principles in research for agricultural development

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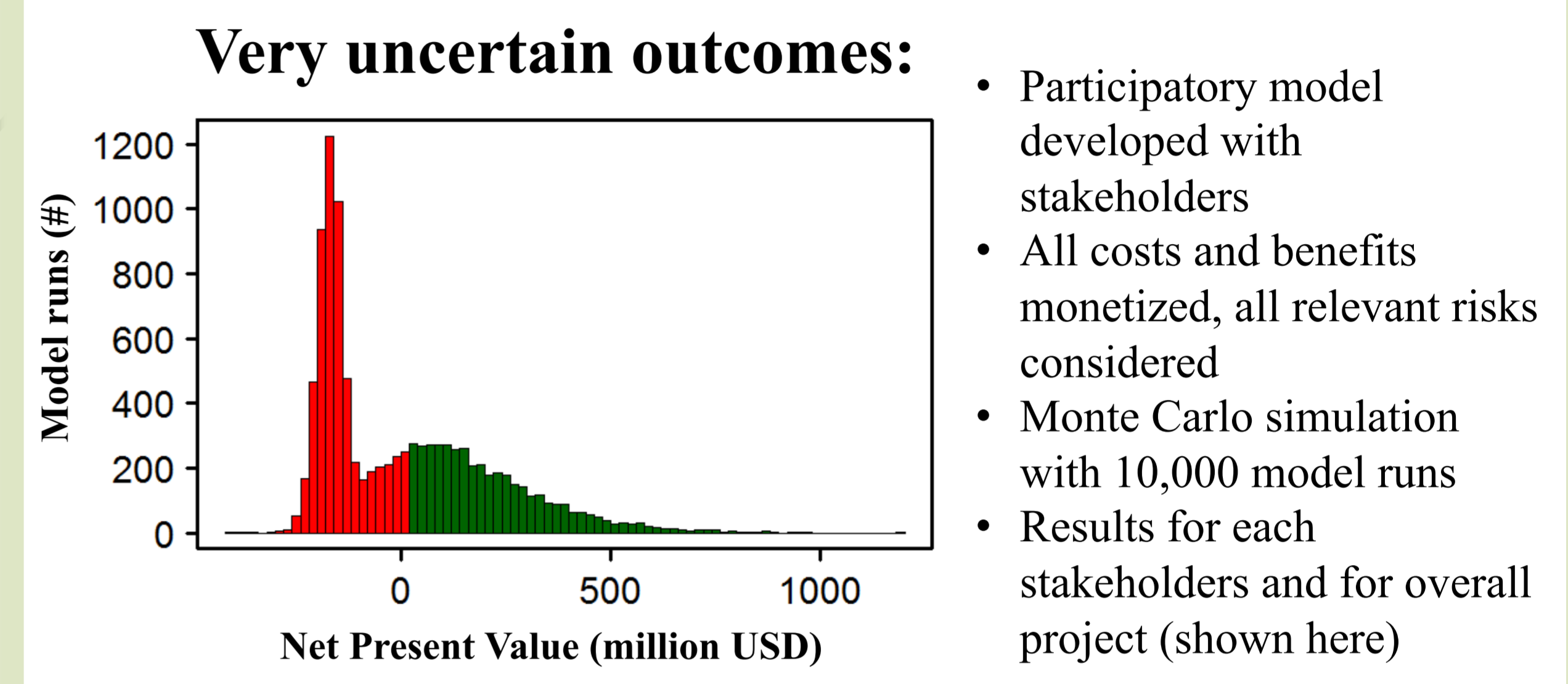
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Uncertainty in agricultural development

Agricultural systems in the tropics are complex, depending on many interrelated drivers that are often poorly understood and not well-described by data. Nevertheless, decision-makers need scientific support for decisions on such systems. Research approaches are needed that can deal with the complexity and imperfect information that is a reality in agricultural development. Decision analysis methods have promise for bridging this gap.
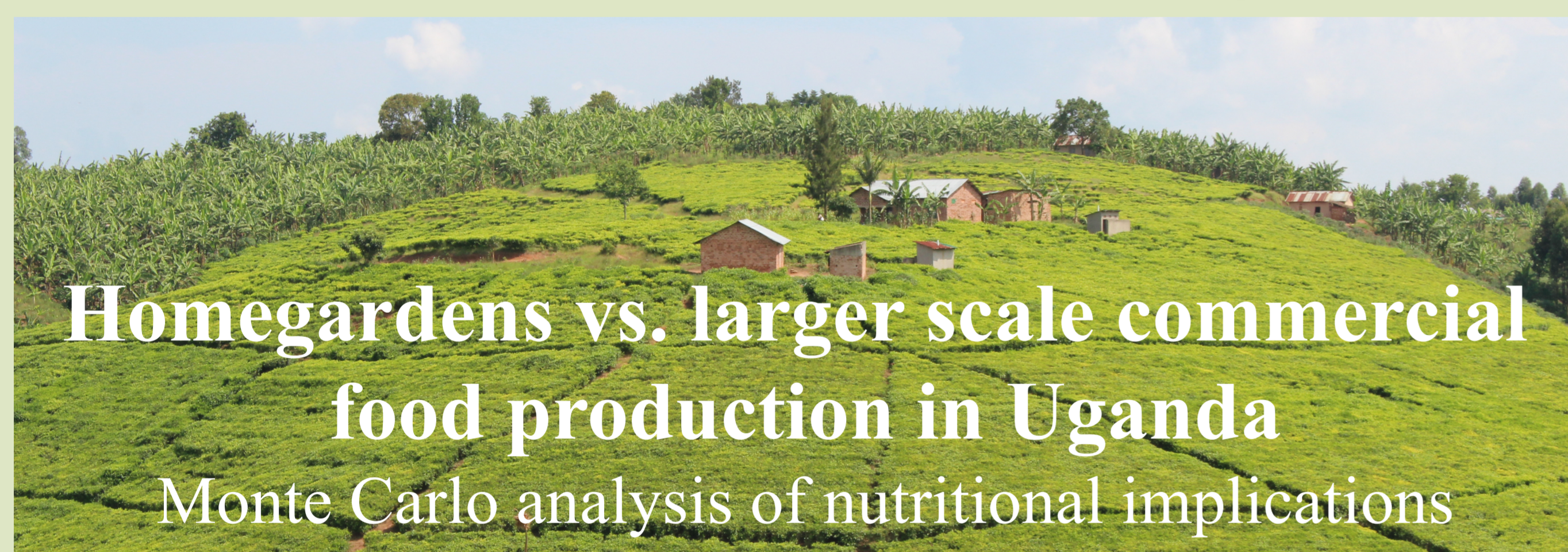
Decision analysis principles

- Work directly with decision-makers and stakeholders on pending decisions
- Consider both social and environmental factors, regardless of state of knowledge
- Model uncertainty and risk
- Make existing knowledge and expected causal relationships explicit in models
- Use all knowledge sources, incl. experts
- Use probabilistic methods, e.g. Monte Carlo simulation or Bayesian Networks
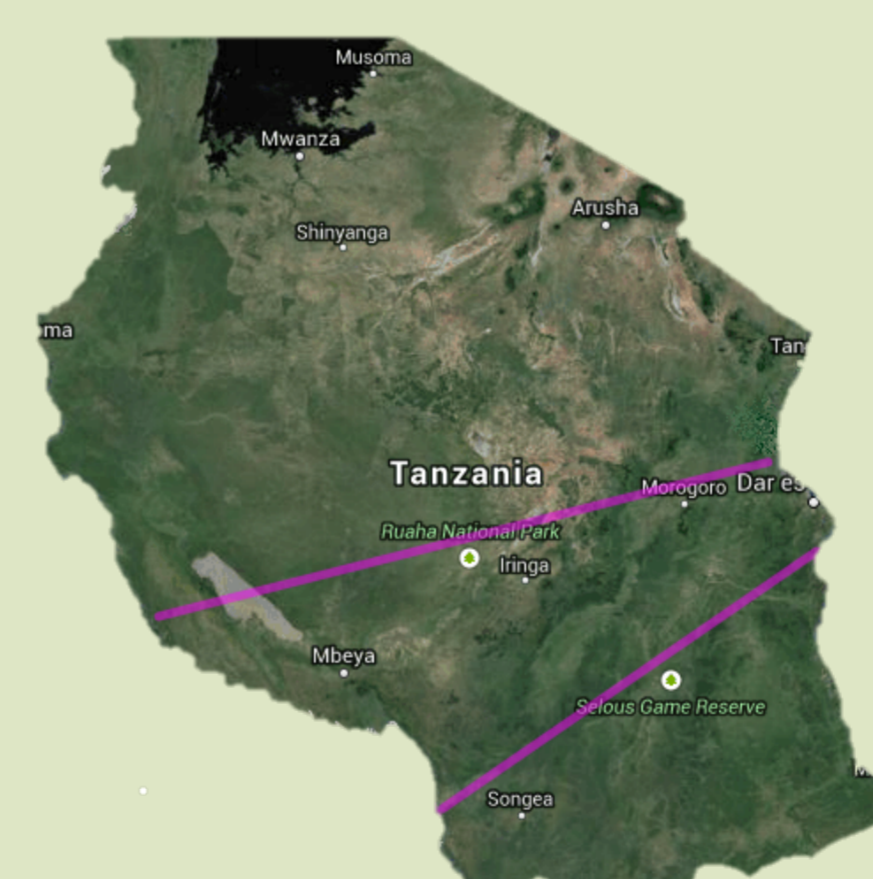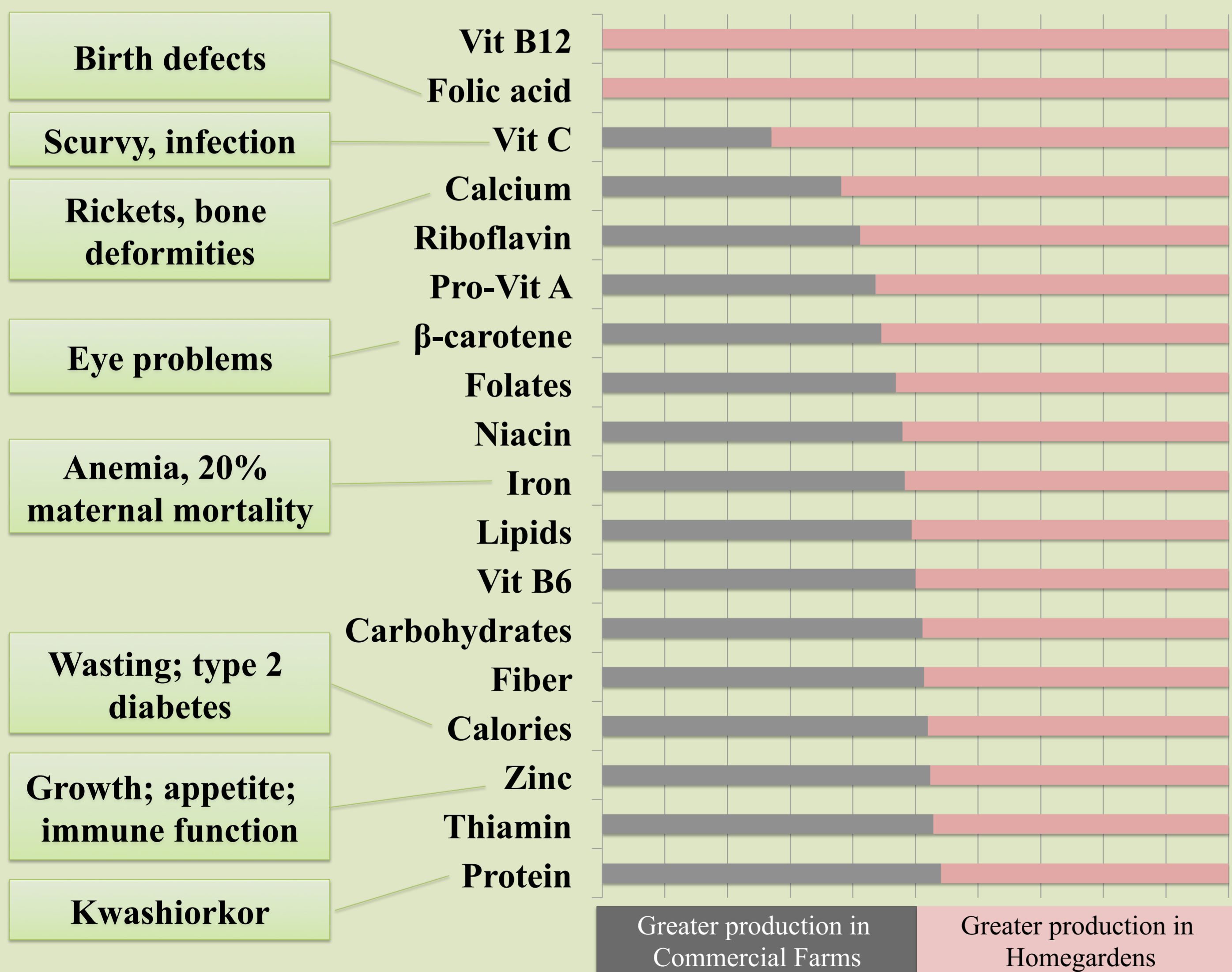
Image: http://www.gtreview.com/

Water pipeline in northern Kenya

Participatory probabilistic ex-ante impact modeling

Very uncertain outcomes:

- Participatory model developed with stakeholders
- All costs and benefits monetized, all relevant risks considered
- Monte Carlo simulation with 10,000 model runs
- Results for each stakeholders and for overall project (shown here)

Critical uncertainties:
- Value of reduced infant mortality
- Risk of political interference
- Economic feasibility of water sales

Luedeling E, Oord A, Kiteme B, Ogalleh S, Malesu M, Shepherd K, De Leeuw J, 2015. Frontiers in Environmental Science 3, 16.

Homegardens vs. larger scale commercial food production in Uganda
Monte Carlo analysis of nutritional implications

10,000 model runs, nutrient contribution from yields: homegardens & commercial farms

| Birth defects | Vit B12 |
| Folic acid |
| Scurvy, infection | Vit C |
| Rickets, bone deformities | Calcium |
| Riboflavin |
| Pro-Vit A |
| Eye problems | β-carotene |
| Folates |
| Niacin |
| Anemia, 20% maternal mortality | Iron |
| Lipids |
| Vit B6 |
| Carbohydrates |
| Fiber |
| Wasting; type 2 diabetes | Calories |
| Zinc |
| Growth; appetite; immune function | Thiamin |
| Kwashiorkor | Protein |

Greater production in Commercial Farms — Greater production in Homegardens

Water use technologies in Southern Tanzania

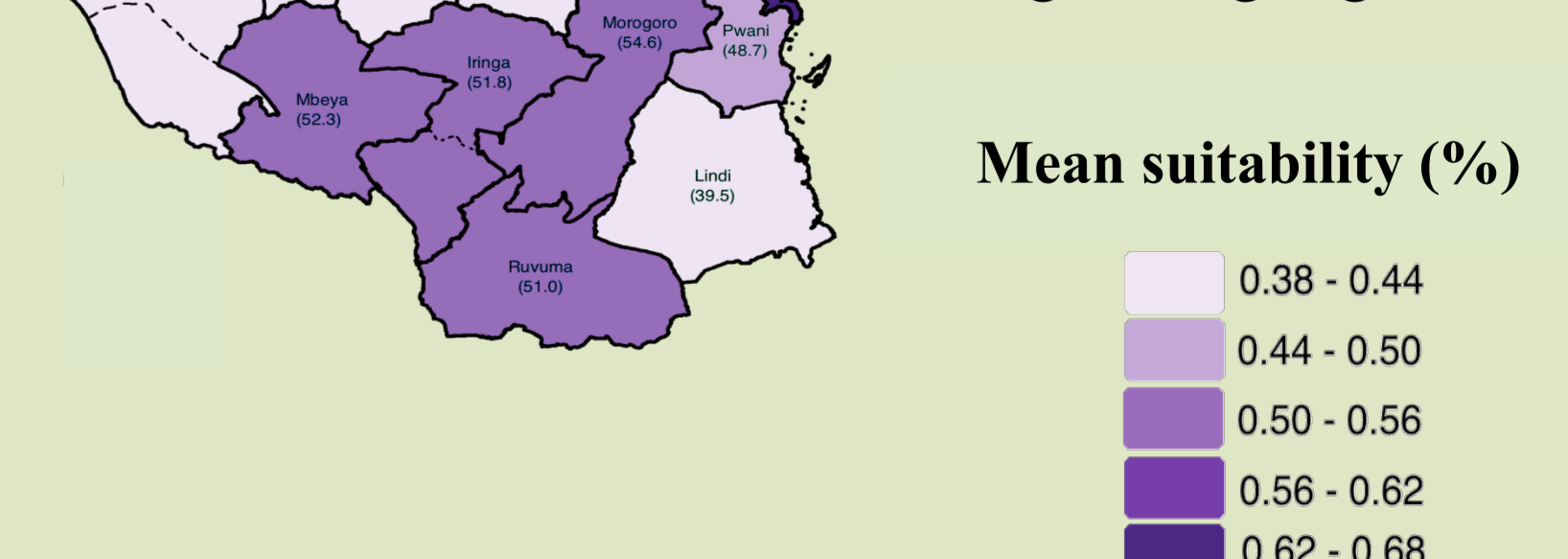Bayesian networks of option suitability

K. Trautmann

- Bayesian network of water use technology suitability
- Based on biophysical, social, and economic factors
- Conditional probabilities from experts and stakeholders
- Results used to implement TZ's Agriculture Climate Resilience Plan

Tanzania's Southern Agricultural Growth Corridor

Charco Dams
Universally high suitability due to low start up costs and low reliance on social assets
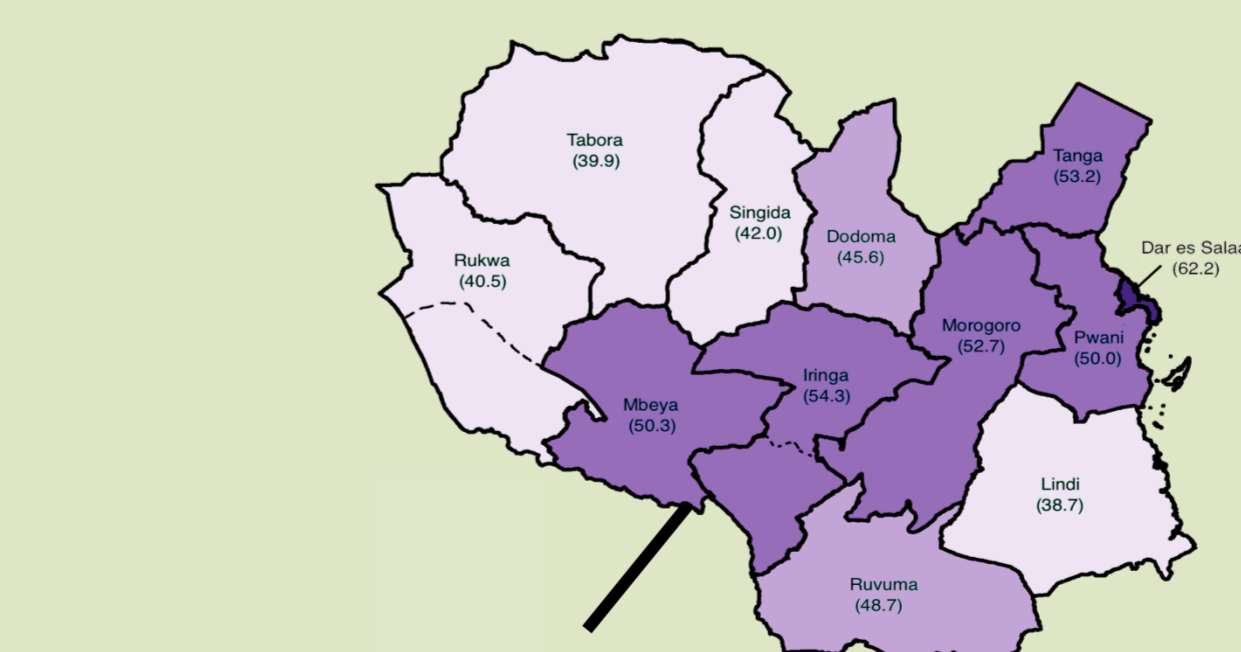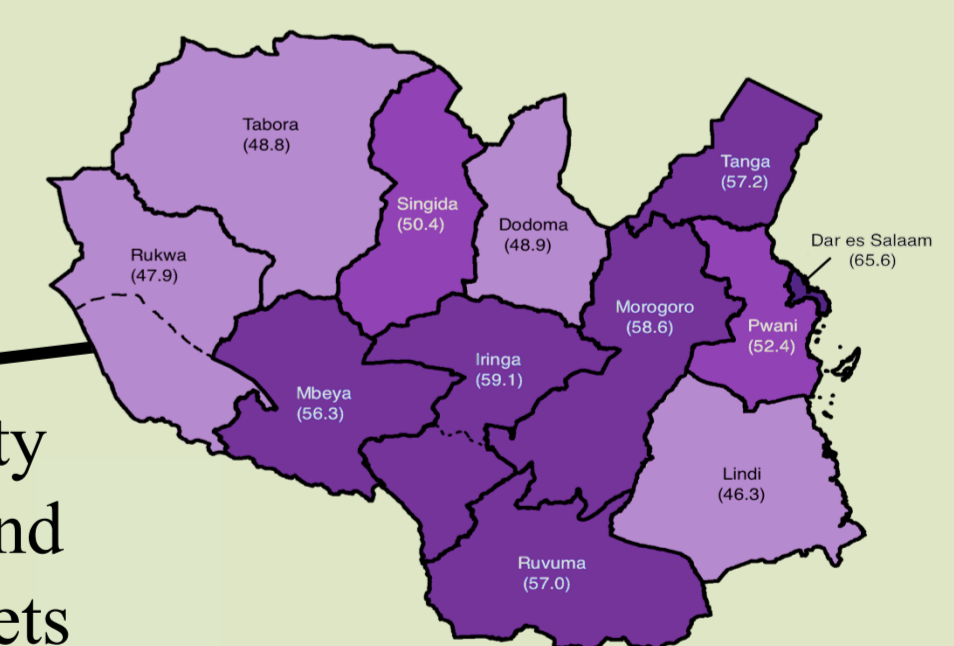
System of Rice Intensification
Highest suitability in rice growing regions

Drip Irrigation
Highest suitability with market access, water availability, and social assets

Mean suitability (%)
- 0.38 - 0.44
- 0.44 - 0.50
- 0.50 - 0.56
- 0.56 - 0.62
- 0.62 - 0.68

Conclusions

- Better guidance for decision-making is possible without expensive long-term data collection.
- Decision models allow probabilistic decision outcome forecasts, but this makes them hard to validate.
- The principles of business decision analysis offer one of the most promising approaches to meeting the challenges of system complexity and data scarcity that appear ubiquitous in agricultural development.