FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Introducing the sustainable intensification assessment framework

Africa RISING West Africa Planning Meeting, Accra, Ghana. 1-2 February 2017

Mark Musumba[1], Philip Grabowski[2], Cheryl Palm[1], Sieglinde Snapp[2]

[1]University of Florida [2]Michigan State University

USAID FROM THE AMERICAN PEOPLE

Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Research Projects: SI Assessment Framework

Lead: University of Florida and Michigan State University

Sieglinde Snapp
Lead PI
(Michigan St. Univ.)

Philip Grabowski
(Michigan St. Univ.)

Cheryl Palm
Lead PI
(Univ. Florida)

Mark Musumba
(Univ. Florida)

USAID
FROM THE AMERICAN PEOPLE

Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

Presentation Outline

- Introduction to the sustainable intensification assessment framework
- Intended use of the framework
- Assessing trade-offs and synergies – Indicator selection
- Application of SI Assessment framework to field and household data
- Way forward
- Questions and comments

Sustainable Intensification Indicator Project

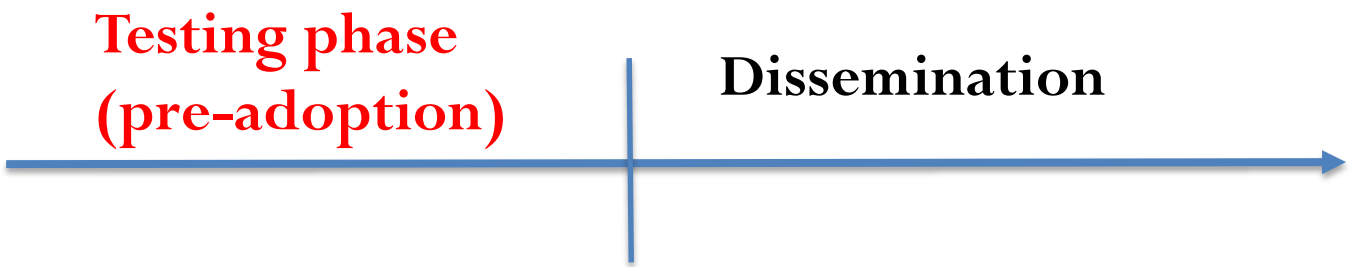
- Project initiative conceived based on a series of stakeholder meetings on SI indicators held in Africa and USA 2012-2014.
- The goal of the project is to develop and recommend indicators and metrics for SI within a framework of five domains at four scales.
  - **Use by agricultural scientists working in research for development projects -- but is flexible and can be used by scientists interested in sustainable intensification.**

Approach to refining indicator list

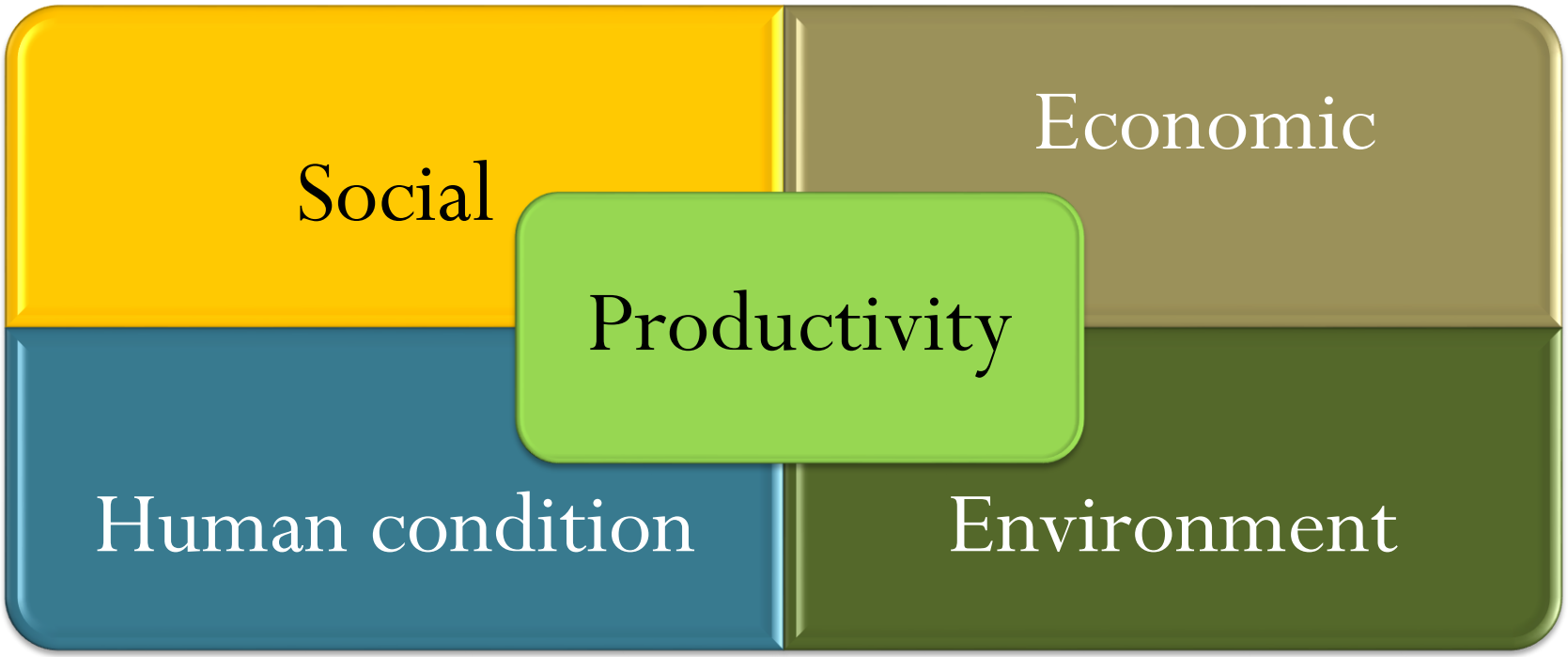
- Synthesis of literature and stakeholder expertise to obtain list of indicators, metrics and methods at the four scales and identify gaps.
- Engage scientists and project managers involved in SI to curate the list of indicators and methods.
  - Meeting and field visit in Mali (October 2015)
    - Discussion and meeting with steering committee and AfricaRISING scientist.
    - Field visit to AfricaRISING sites and MV site
  - Ethiopia visit in November 2015 (AfricaRISING)
    - Visit to AfricaRISING sites
    - Interaction with project partners and scientist
    - Update the framework indicators and protocol (metric methods) list
  - Rwanda (CIALCA) (February and March 2016)
  - Online survey of scientist working in sustainable intensification research projects (May – July 2016)

Three primary uses of the SI indicator assessment framework

1. Guide for indicator identification and selection
2. Assessing performance of technologies
3. Examine trade-offs and synergies



Five domains of Sustainable Intensification



Why 5 domains and 4 scales?

DOMAIN	EXAMPLE INDICATORS
Productivity	Yield Fodder production Yield variability Yield gap
Economic	Profitability Returns to labor Variability of profitability
Environmental	Plant biodiversity Nutrient balance
Human Condition	Nutrition Food Security Nutrition Awareness
Social	Equity (gender & marginalized groups) Level of collective action

SCALE

Landscape/Administrative

Farm/Household

Field

SI Indicators are not new?

- Mesmis framework (Ridaura-Lopez et. al, 2005) over 20 case studies in Mexico and Latin America
- Framework for sustainability and decision support (Zurek et al. 2015)
- System for Environmental and Agricultural Modelling – Linking European Science and Society – Integrated Framework (SEAMLESS –IF) (van Ittersum et al., 2008)
- Indicators for SI across 5 domains – progress and gaps (Smith et al. 2016)

What the framework is not intended to do

- It is **not** intended to replace other frameworks used by individual programs or projects, but rather **to provide a simplified, common framework that facilitates cross-program learning and assessment**.
-
- The framework is **not** intended to define or quantify absolute 'sustainability' or pre-determine an ultimate state of sustainability or specific practices that lead to sustainability.

- It is **not** intended to cover all dimensions or scales of sustainability but only those **commonly focused on by agricultural R&D projects**, but flexible enough to be adaptable to different scales of interest.

Rwanda – (Consortium for improvement of Agricultural livelihood in CentralAfrica)CIALCA

Meeting with IP member in Kayonza

Banana mono-crop (FHIA – 17) in Kayonza

Field visit with CIALCA & IP members - Kayonza

Banana-bean intercrop - Kayonza

Ethiopia –Africa Research in Sustainable Intensification for the Next Generation (Africa RISING)

Enset (false banana)

Soil and water conservation in wheat fields

Tree Lucerne

Storage of seed potatoes

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

SIIL: Focus Countries


Senegal


Ethiopia


Bangladesh


Burkina Faso

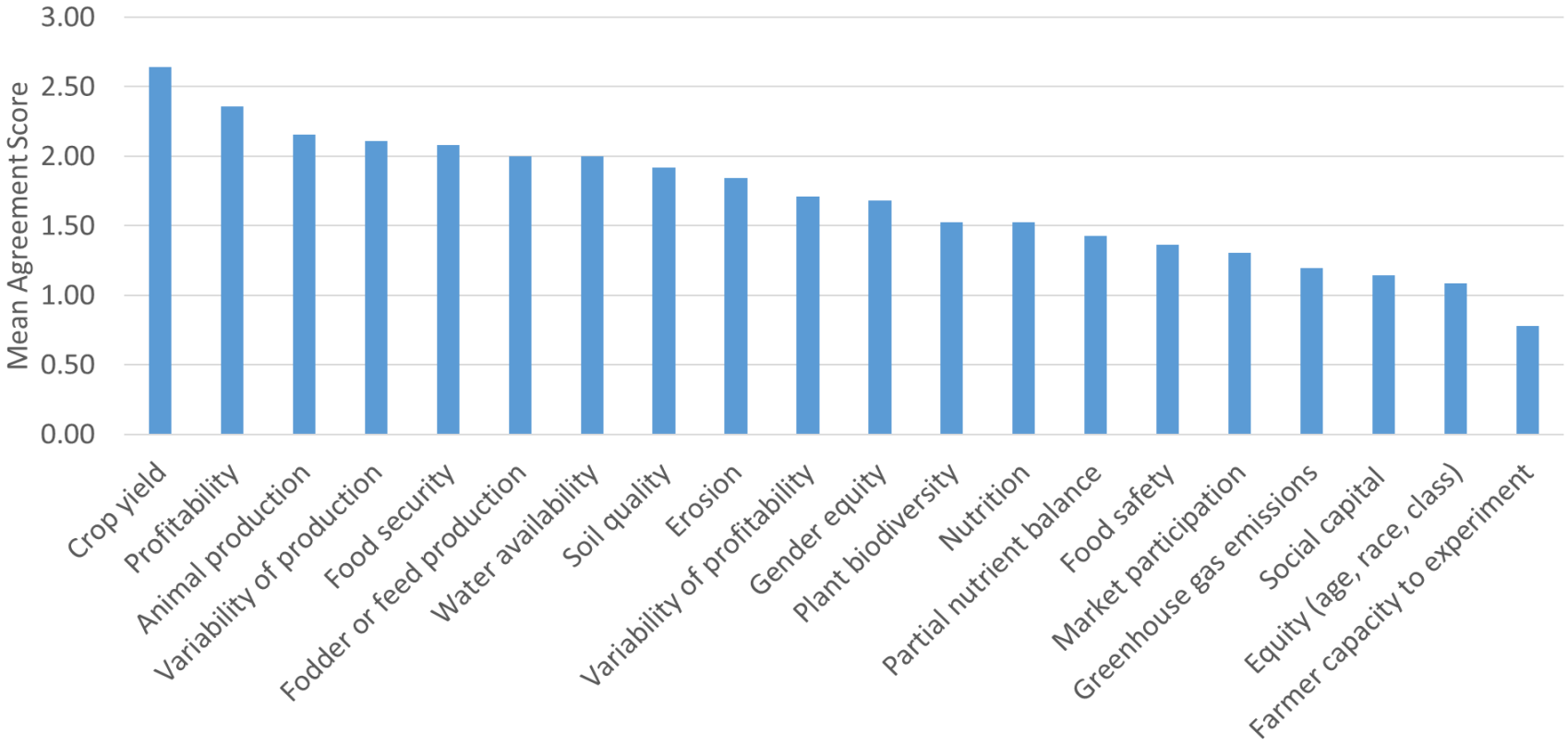

Tanzania


Cambodia

Table 1. Commonly measured indicators used by 44 researchers involved in SI who participated in an on-line survey

Productivity	Economic	Environment	Human Condition	Social
Yield (75%)	Profitability (59%)	Soil carbon (34%)	Production of nutritious foods (25%)	Gendered rating of technology (43%)
Yield variability (50%)	Labor requirements (52%)	Crop water availability (30%)	Capacity to experiment (23%)	Gender equity impact (27%)
Crop residue production (45%)	Input use efficiency (48%)	Nutrient Partial Balance (27%)	Dietary diversity (18%)	Conflicts over resources (11%)

Figure 1: Indicators of sustainable intensification, ranked by average level of agreement (maximum, 3 = strongly agree and minimum, -3 = strongly disagree).



Indicator	Field/plot level metrics	Farm level metrics	Household level metrics	Community/ Landscape + metrics	Measurement method
Crop productivity	Yield (kg/ha/season) [a,b,c](including tree product/area under crown) Rating of yield [d]	Yield (kg/ha/season) [a,b,c]		Net primary productivity (NPP) (kg biomass / ha / yr) [e]	[a] Yield measurements [b] Recall survey [c] Crop models [d] Farmer evaluation [e] Remote sensing
Crop residue productivity	Residue production (kg/ha/season) [a,b,c] Rating of residue production [d]	Residue production (kg/ha/season) [a,b,c]		Net primary productivity (NPP) (kg biomass / ha / yr) [e]	Same as for Yield
Animal productivity	Animal products and by-products (amount / animal / year) [a,b] Rating of animal productivity [c]	Animal productivity per unit land (product / ha / yr) [a,b] Herd composition	Animal productivity per household (product / hh / yr) [a,b]	Net commercial offtake (product / ha / yr) [a]	[a] Recall survey [b] Production measurements [c] Farmer evaluation

USAID FROM THE AMERICAN PEOPLE

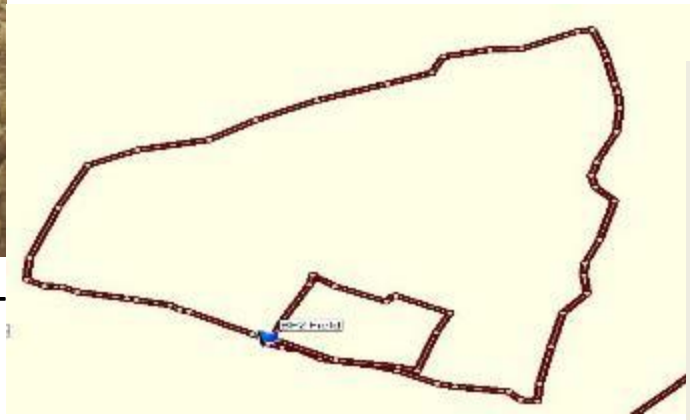
Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

Crop productivity – yield cuts or farmer recall

Crop cut for wheat fertilizer response trial – Africa RISING Ethiopia

Enumerator and farmer – recall survey Zambia



Handheld GPS for measuring field area

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Pigeonpea intercropping in Malawi

Systems compared:

- Unfertilized maize - Continuous sole maize
- Fertilized maize - Continuous sole maize with 69 kg N/ha fertilizer
- Maize-Pigeonpea - intercrop with 35 kg N/ha fertilizer
- Doubled up legume – Groundnut-Pigeonpea intercrop rotated with maize (35 kg N/ha fertilizer in maize phase)

Data sources:

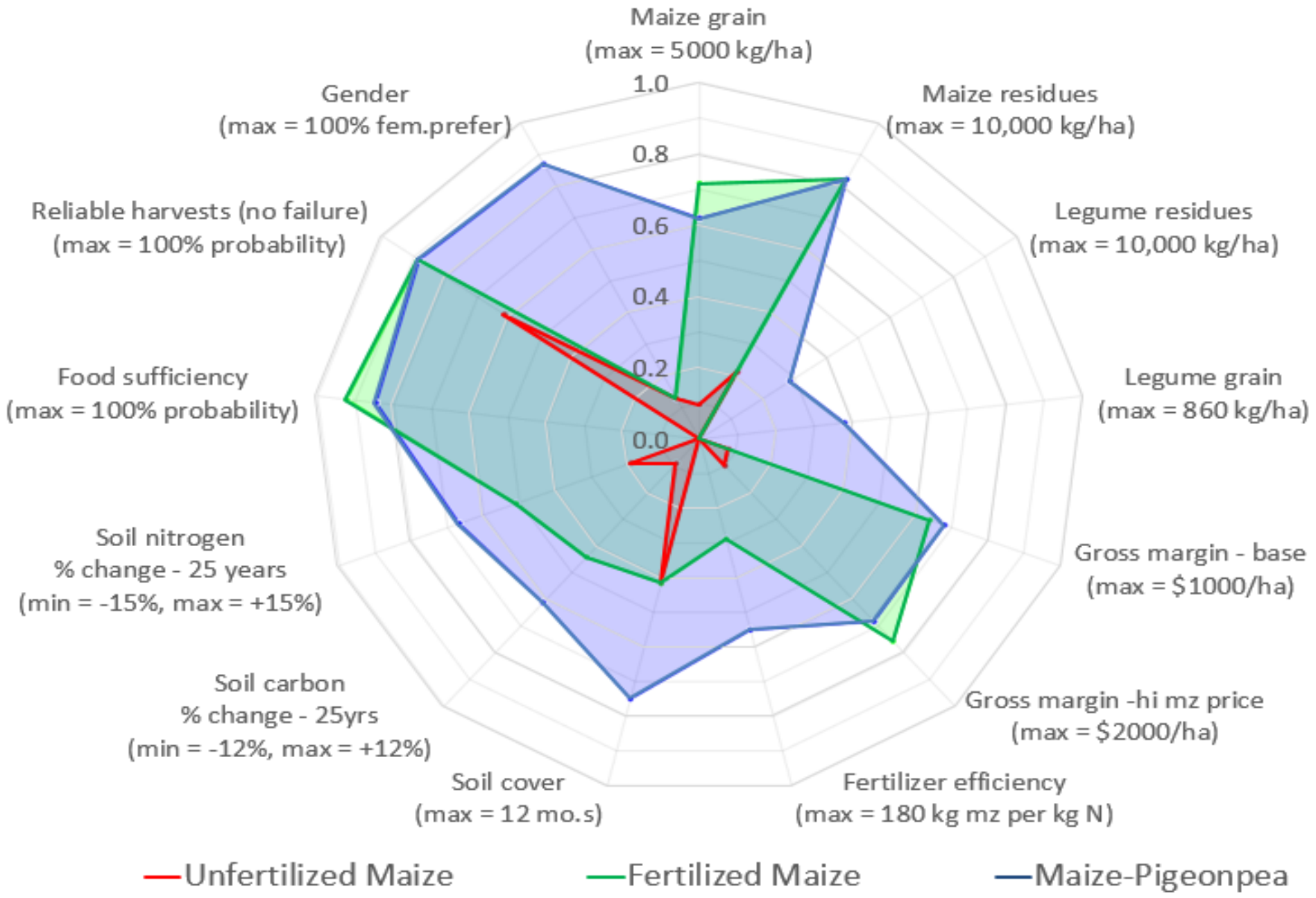
1) On-farm trials
2) APSIM modeling results
3) Survey data

USAID FROM THE AMERICAN PEOPLE

Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

Golomoti

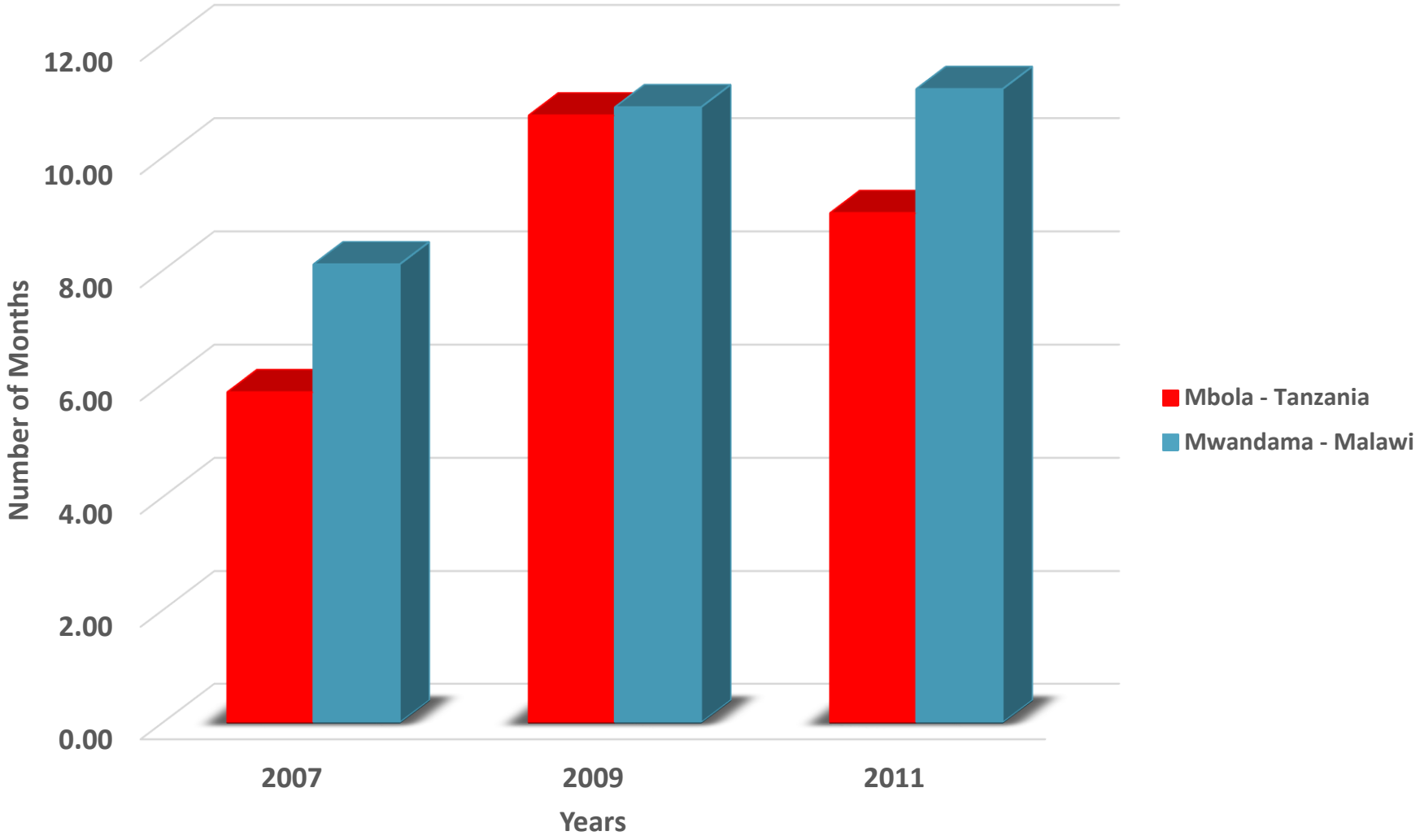

Maize grain
(max = 5000 kg/ha)
1.0
0.8
0.6
0.4
0.2
0.0
Maize residues
(max = 10,000 kg/ha)
Legume residues
(max = 10,000 kg/ha)
Legume grain
(max = 860 kg/ha)
Gross margin - base
(max = $1000/ha)
Gross margin -hi mz price
(max = $2000/ha)
Fertilizer efficiency
(max = 180 kg mz per kg N)
Soil cover
(max = 12 mo.s)
Soil carbon
% change - 25yrs
(min = -12%, max = +12%)
Soil nitrogen
% change - 25 years
(min = -15%, max = +15%)
Food sufficiency
(max = 100% probability)
Reliable harvests (no failure)
(max = 100% probability)
Gender
(max = 100% fem.prefer)
Unfertilized Maize
Fertilized Maize
Maize-Pigeonpea

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

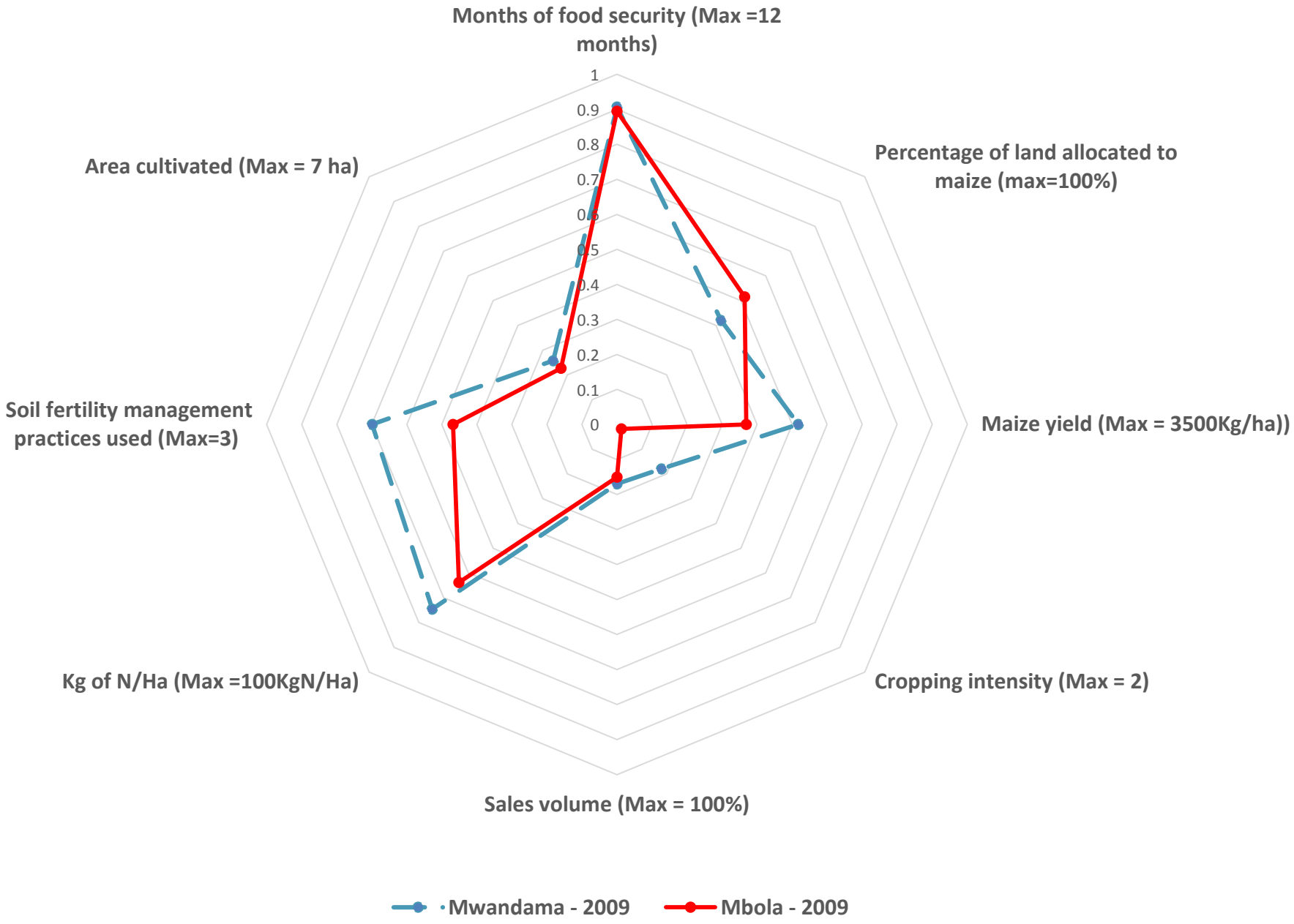
Conclusions

1. Pigeonpea intercropping can reduce risk from climatic variability
2. The SI indicator framework facilitated holistic analysis of legume systems and the identification of important data gaps
3. A transdisciplinary approach (interdisciplinary research collaboratively engaging with farmers) is needed to develop and assess management practices for sustainable intensification

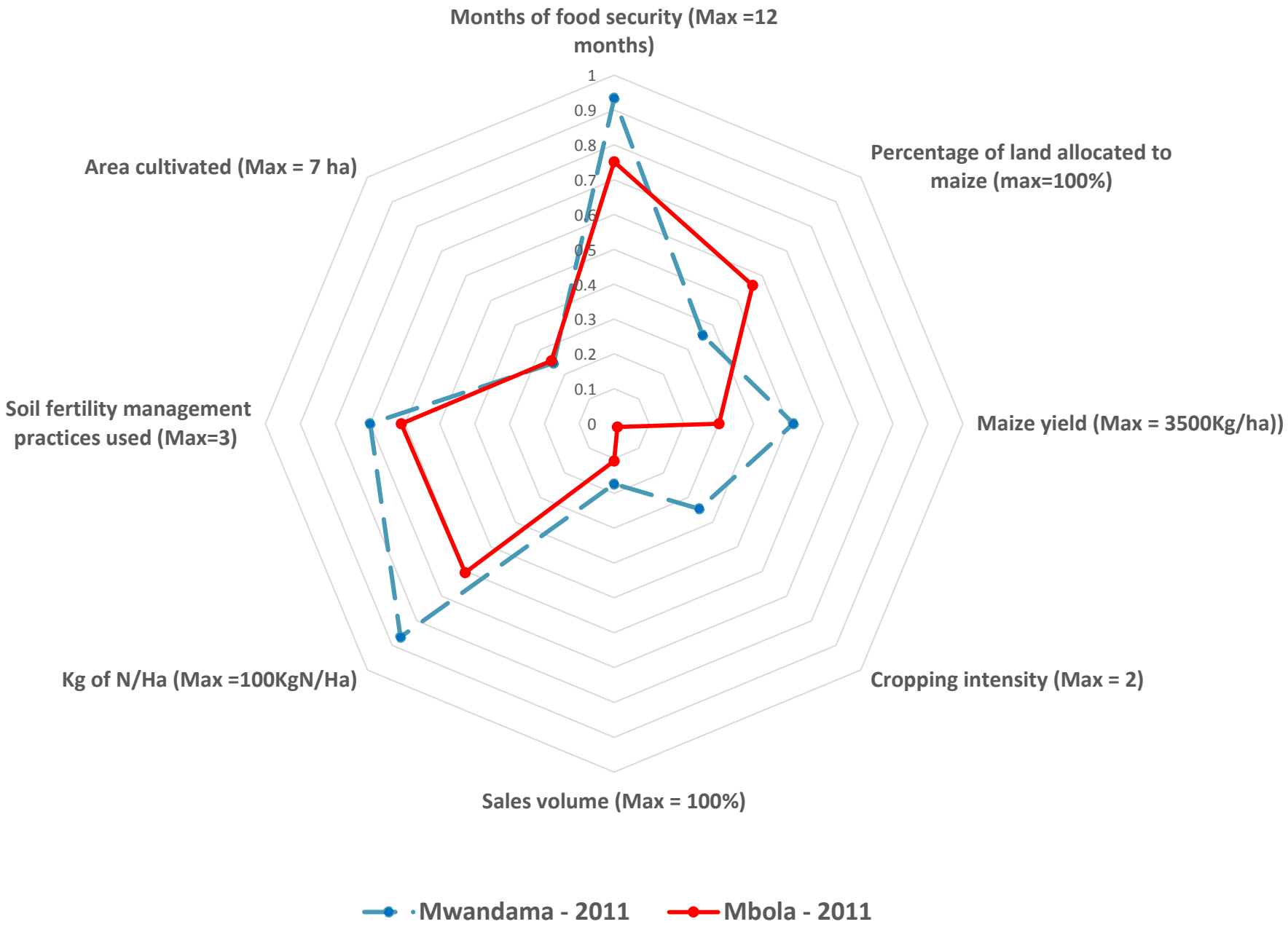
Figure 1. Number of months with enough food to eat



Performance of households in Mbola and Mwandama in 2009



Perfomance of Mwandama and Mbola Households in 2011



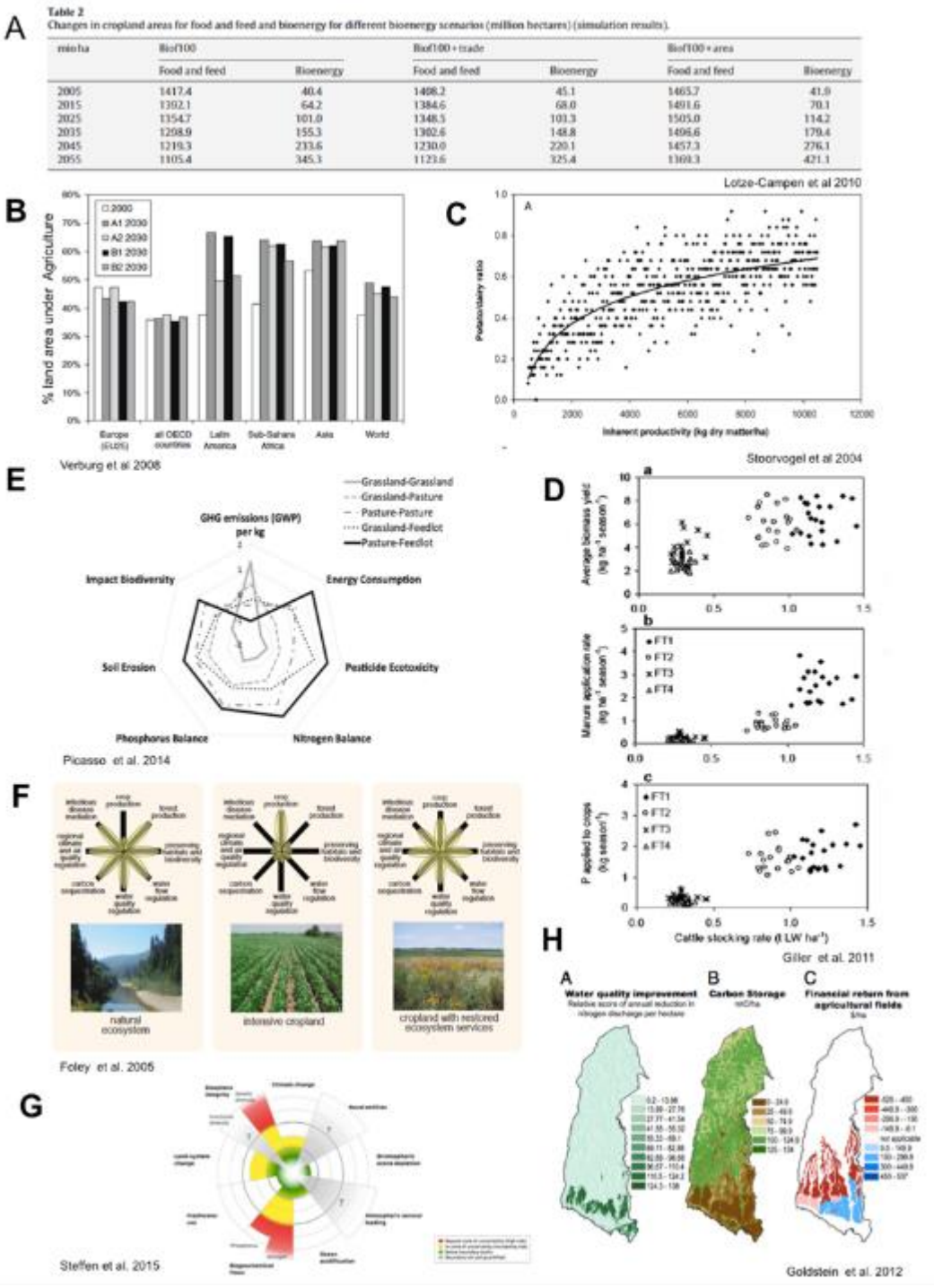
Conclusion

- Goal oriented approach
  - Use framework to select appropriate indicators across domains
  - Whether the indicators have changes over time (baseline/reference point)
  - Distribution on output indicators

Data visualization strategies to assess trade-offs

A. **Tabular matrices**
B. **Bar charts**
C. **Scatterplots**
D. **Matrix of scatterplots**
E. **Spider diagrams**
F. **Radial diagrams**
G. **Petal diagrams**
H. **Spatially explicit maps**

Kanter et al. 2016.
Agricultural Systems.



USAID
FROM THE AMERICAN PEOPLE

Way forward

- Application of SI Assessment Framework
  - SIIL scientists and Africa RISING
- Completion of the manual
  - Description of indicators and metrics
  - Standard measurement and alternative measure
    - Data collection methods and estimation
    - Limitation of measures.

Define the main project objective:

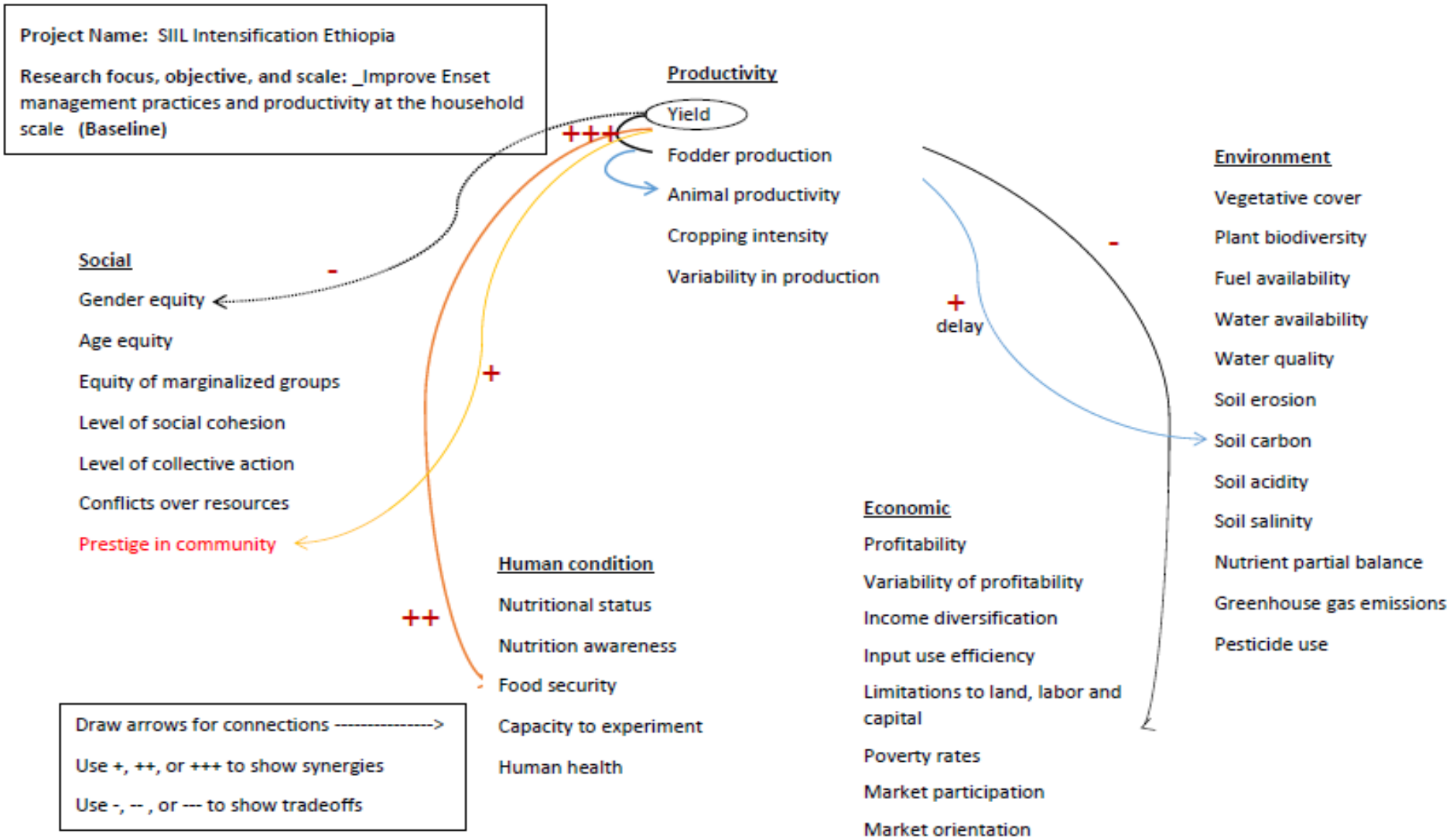
There are multiple objectives that need to be achieved in the process of intensification. List other objectives that you would like to achieve by domain. If possible list, the indicators that might be used to assess each sub-objective and the method of measurement.

Domain	Sub-objectives	Indicators for assessing sub-objectives	Measurement Method	Scale of assessment
Productivity (Pg. 13 *)				
Economic (Pg. 16 *)				
Environmental (Pg. 20 *)				
Human Condition (Pg. 26 *)				
Social (Pg. 30 *)				

***Page number in the SI Assessment framework with the list of indicators, metrics, and methods of measurement.**

An example in Mbola, Tanzania: The **main objective** was to improve food security. There were other **sub-objectives** like to improve soil management and soil quality, increase household incomes, improve nutrition, focus on marginalized groups like women, and increase maize productivity. One of the issues to assess in this case later is the process of achieving these objectives and what trade-offs and synergies may occur. This needs to be assessed to ensure mid-course corrections and examine some additional benefits and costs of the project. Examples of method of measurement are in the last column of the indicator assessment framework by domain.

Example baseline diagram for Enset (false banana) in Ethiopia – notice the negative effect on gender equity due to high female labor requirements in processing

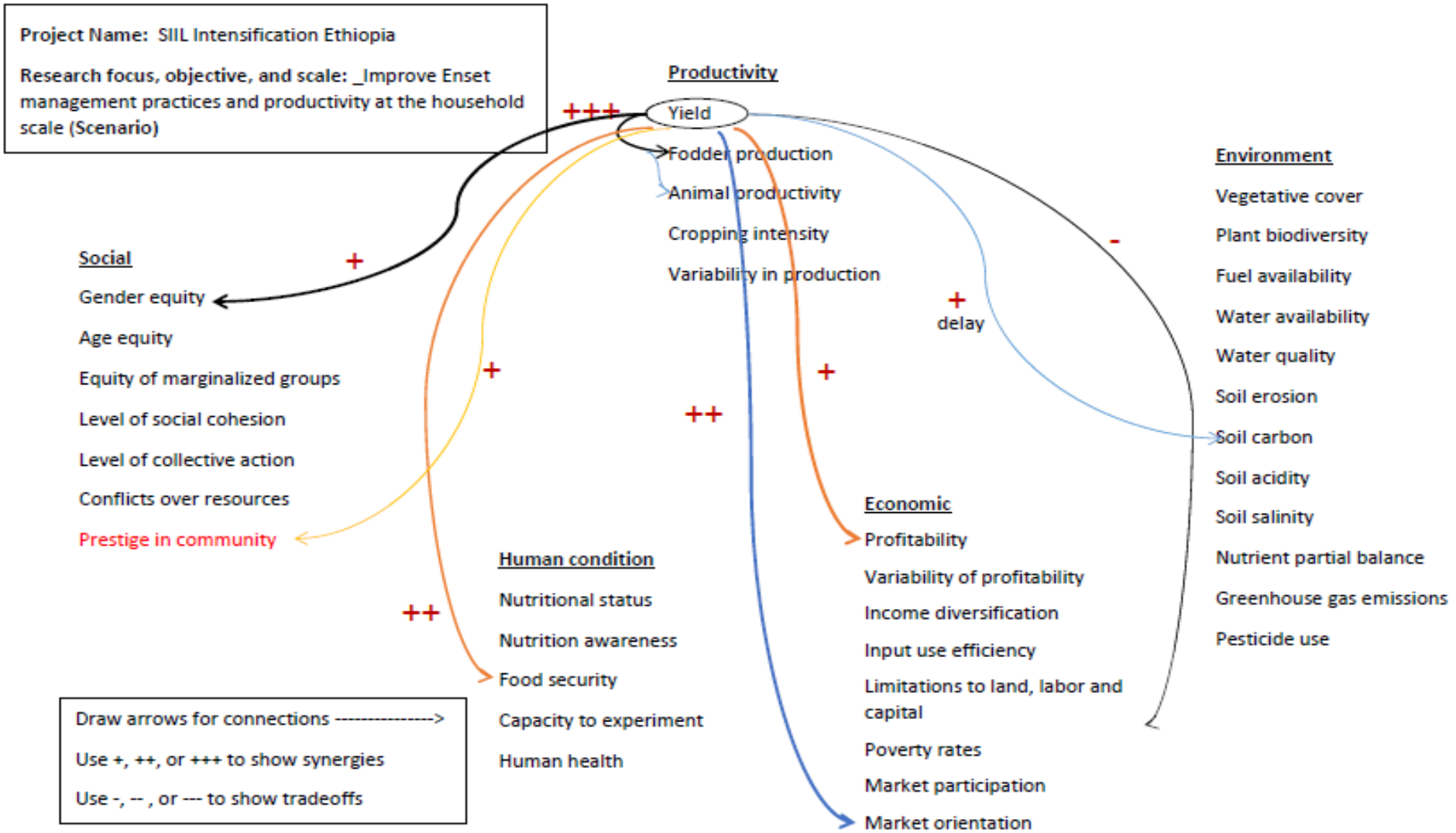


USAID FROM THE AMERICAN PEOPLE

Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

Example diagram of intended changes from Enset intervention – mechanization to reduce female labor, agronomics to improve production and market linkages to improve profits.



USAID FROM THE AMERICAN PEOPLE

Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

www.feedthefuture.gov

USAID
FROM THE AMERICAN PEOPLE

Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY