FEED THE FUTURE

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

Sustainable Intensification Assessment Training

Photo: K. Chung

3 April 2017 SI Assessment Training, Phnom Penh, Cambodia

Philip Grabowski (MSU), Mark Musumba (UF), Cheryl Palm (UF), Sieg Snapp (MSU)

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Feed the Future Innovation Lab — Collaborative Research on Sustainable Intensification

KANSAS STATE UNIVERSITY

Michigan State University — Founded 1855

University of Florida — 1853

Outline

Day 1

1. Intro to SI assessment framework
2. Experience with indicators by domain
3. Selecting indicators

Day 2

1. Tradeoffs and synergies
2. Data analysis and visualizations

Day 3

1. Participatory methods
2. Presentations and feedback

Objectives

At the end of our time, you will…

1. Be able to use the framework to select indicators and metrics relevant to project
2. Have considered, for the selected indicators:
   - what data sources are available?
   - what metrics and methods are feasible?
3. Be able to identify tradeoffs and synergies
4. Have used the tradeoff exercise for your own project
5. Have skills in presenting output from indicators

TIMELINE

- Accra Meeting, 2013, donor community
  - Arusha, Tanzania, 2014, Int'l research partners
    - San Jose, CA, February 2015, U.S. universities, int'l partners, donors, NGOs

SI Assessment Framework Working Group

- Vara Prasad, SI Innovation Lab, KSU
- Sieg Snapp, Michigan State Univ.
- Cheryl Palm, University of Florida
- Mark Musumba, University of Florida
- Philip Grabowski, Michigan State Univ.

Steering committee

- Vara Prasad (KSU, Chair)
- Jerry Glover (USAID)
- Peter Thorne (ILRI/AfricaRISING)
- Bernard Vanlauwe (IITA)
- Gundula Fischer (IITA)
- Fred Kizito (CIAT)
- Bruno Gerard (CIMMYT)
- Sieglinde Snapp (MSU)
- Cheryl Palm (UF)

Project Objective

- 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 more broadly.

What the framework is not intended to do

- 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.

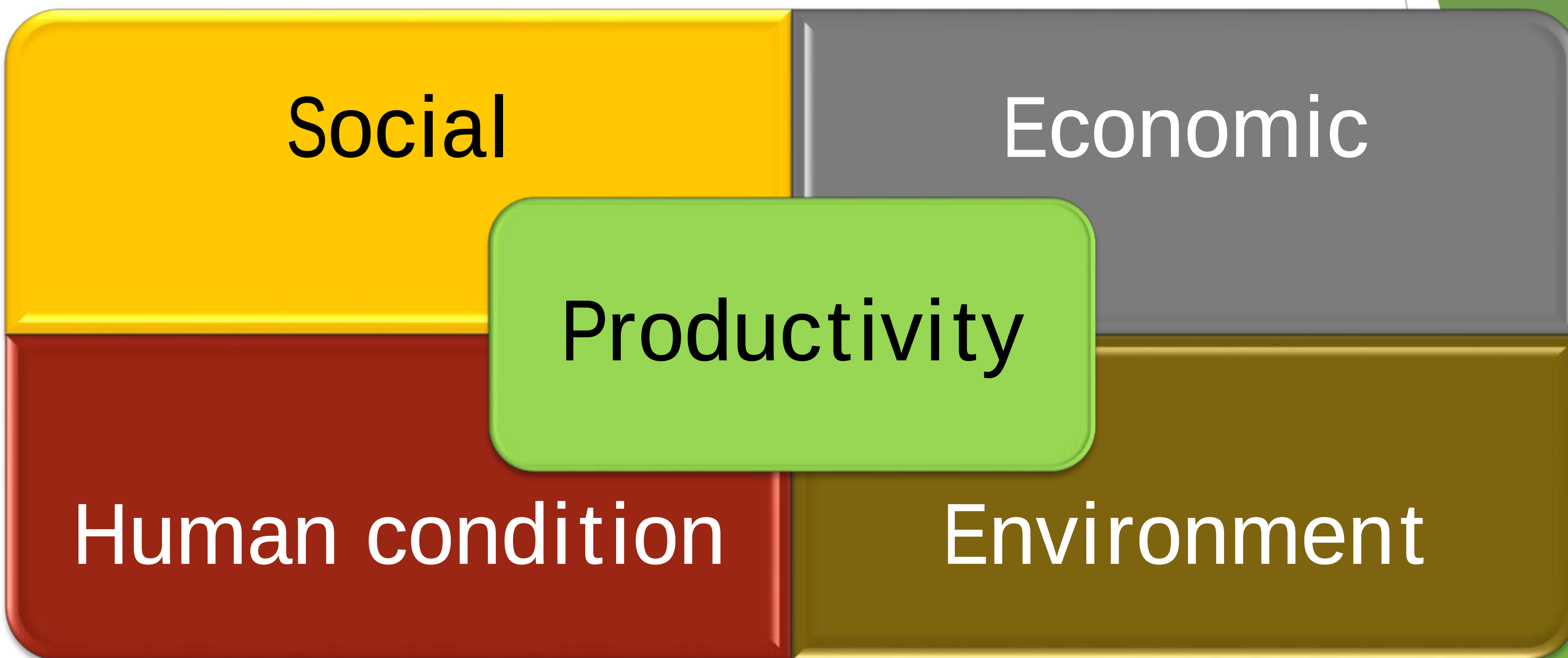
- It is **not** intended to cover all dimensions or scales of sustainability but only those **commonly focused on by agricultural R&D projects**, but flexible enough to be adaptable to different scales of interest.

- 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**.

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 (van Ittersum et al., 2008)
- Indicators for SI across 5 domains – progress and gaps (Smith et al. 2016)

Five domains of Sustainable Intensification



SI indicators by domain and scale

Adapted from the Accra Meeting, 2013, donor community meeting

1) PRODUCTIVITY

- Crop productivity
- Fodder production
- Yield variability
- Yield gap

2) ECONOMIC

- Profitability
- Market participation
- Variability of profitability

3) ENVIRONMENTAL

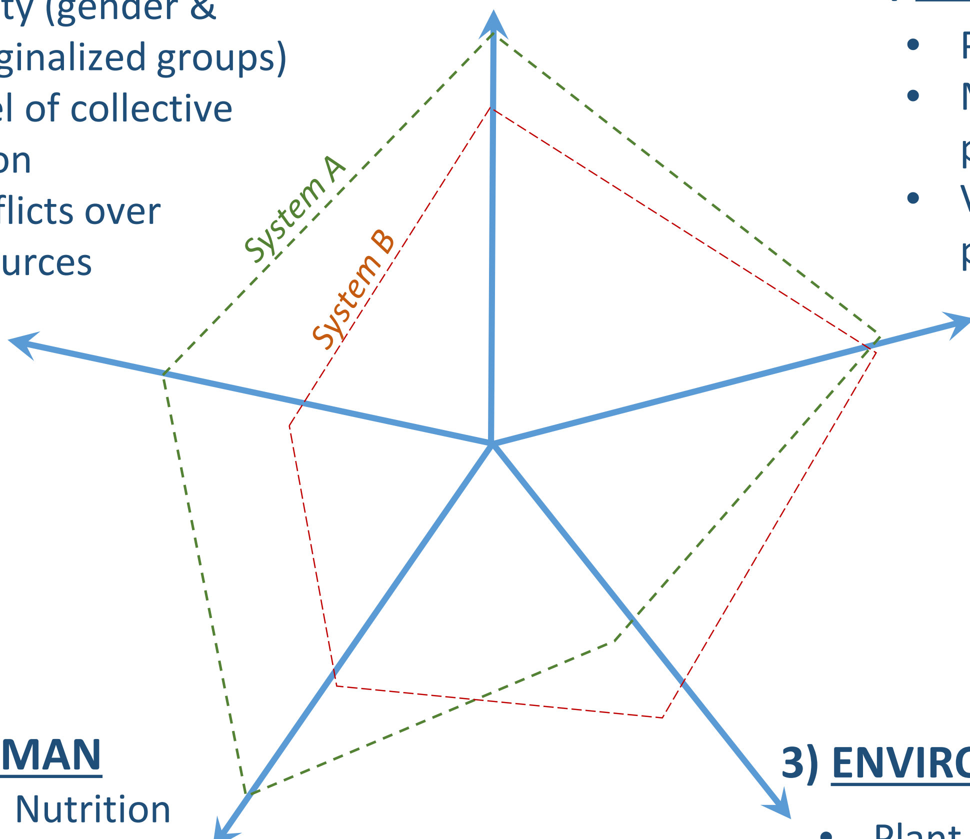
- Plant biodiversity
- Nutrient balance
- Soil physical properties

4) HUMAN

- Nutrition
- Food Security
- Food Safety

5) SOCIAL

- Equity (gender & marginalized groups)
- Level of collective action
- Conflicts over resources



SCALE

Landscape+

Farm/Household Scale

Field/Animal Herd Scale

Approach

- 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 –Mali, Ethiopia, Tanzania, Malawi, Rwanda
- Online survey of 44 scientist working on sustainable agriculture

Tree Lucerne - Ethiopia

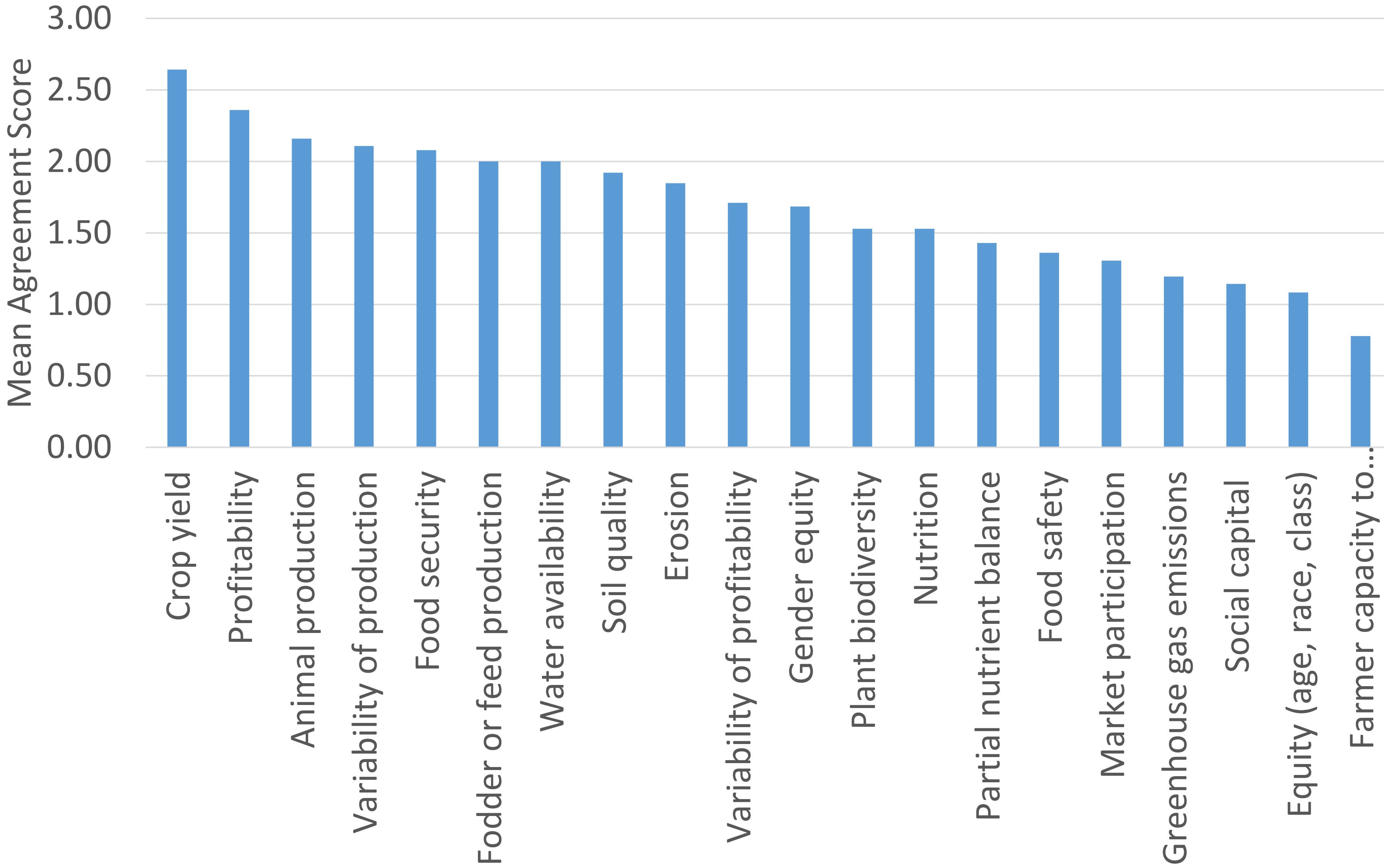
Farm survey - Malawi

Results from Online Survey

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%)

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



What are some challenges identified?

- Scale at which the indicator is assessed
  - Capacity, time, and costs
- Sample size (number of participants)
  - Extrapolating from field experiments
- Indicator gaps
  - Social domain (gender indicators)
- Need for alternative methods
  - For indicators that we cannot measure directly, how can scientist link management practice to indicators?

	Indicators	Field	Farm/Hh	Landscape+	Measurement Method
Productivity	Crop & animal productivity				
Economic	Gross Margin				
Environment	Nutrient Balance				
Human condition	Food Security				
Social	Equity (gender, class, age)				

Defining terms

- Indicator - a “quantitative or qualitative factor or variable that provides a simple and reliable basis for assessing achievement, change or performance” (ISPC, 2014).
- Metric – “represent the values on which indicators are built.” They are computed by aggregating and combining raw data, for example, yield (harvest per hectare) or height-for-age. (ISPC, 2014)
- Measurement Method – a set of activities to generate raw data (observations such as weight, height, plot size, etc.) that can be used to compute metrics

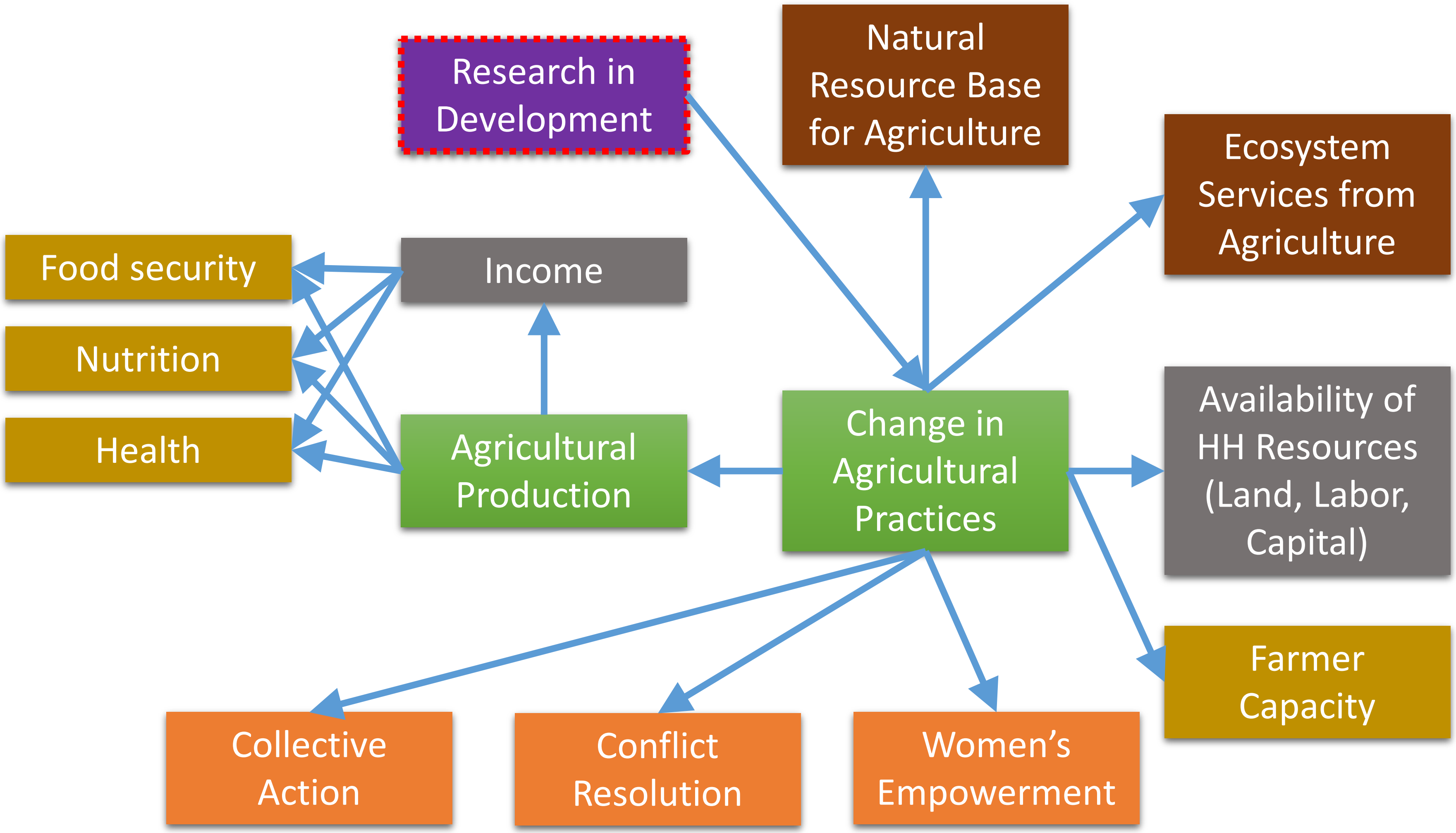
Three primary uses of the SI indicator assessment framework

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

Objective driven assessment

- What is the objective of the project? What indicators have been selected to assess performance of this objective?
  - Use indicator assessment framework, for selection of indicators across domain
- In the process we try to learn
  - What happened (descriptive analysis) in meeting objective
  - What were the trade-offs and synergies across other indicators?
  - Why it might have happened?
  - What would we want to see happen?

There are multiple goals for sustainable intensification

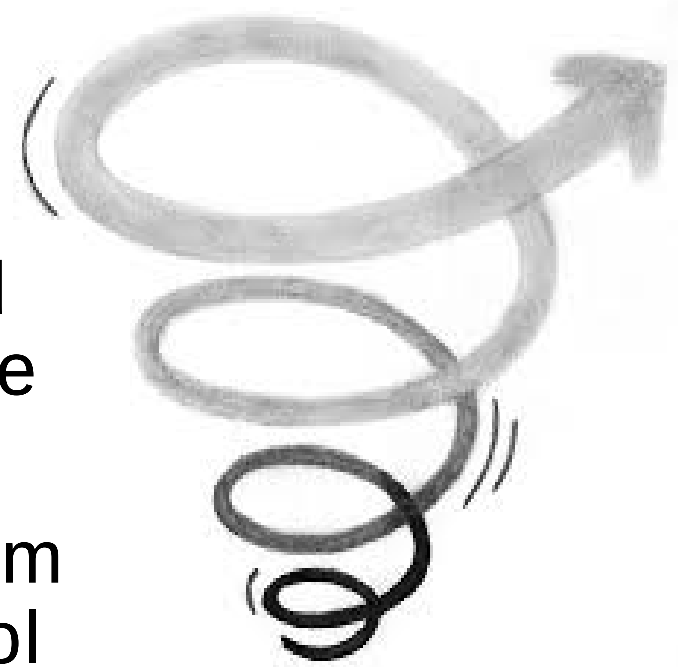


Examples of trade-offs

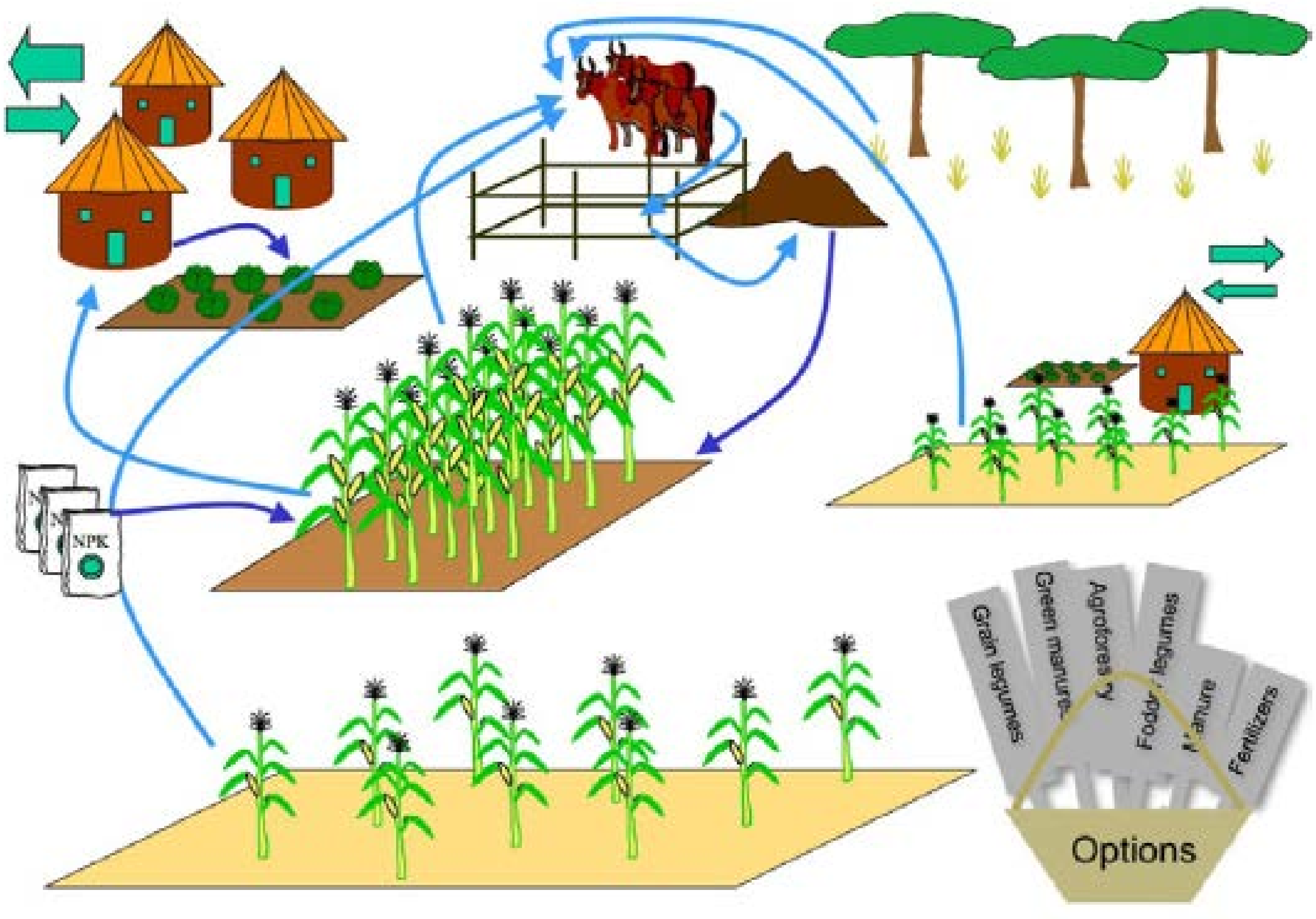
- Within a domain
  - Land for legumes vs. Land for maize
- Across domains
  - Crop residues – Fodder vs. Soil fertility
  - Input use - Production vs. Pollution
- Across spatial scales
  - Farm profitability →agricultural expansion→ habitat loss
- Across time
  - Near term production sacrifice for long term stability
- Across groups in a typology
  - Crop growers vs. Herders

There are synergies as well

- Fertilizer use may stimulate production that leads to improved carbon cycling
- Multi-purpose legumes can build soil fertility and provide a source of nutritious food
- Push-pull systems like Desmodium and Napier grass can help control maize stem borers and provide soil benefits (nitrogen, cover, Striga suppression)



Farming systems have complex interactions



Giller et al. 2011 Communicating complexity: Integrated assessment of trade-offs concerning soil fertility management within African farming systems to support innovation and development. *Agricultural Systems* 104 p.191-203

Methods for Trade-off Analysis

- Participatory research methods
  - Resource flow mapping; Participatory scenario development
  - Games and role plays; Fuzzy Logic Cognitive Mapping
- Empirical analyses - Experiments
- Simulation models
- Optimization models – detailed further in Kanter et al. 2016

Klapwijk et al. 2014 Analysis of trade-offs in agricultural systems: current status and way forward. *Current opinion in Environmental Sustainability* 6: 110-115.

Kanter et al. 2016 Evaluating agricultural trade-offs in the age of sustainable development. *Agricultural Systems* (in press)

Data visualization strategies

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.

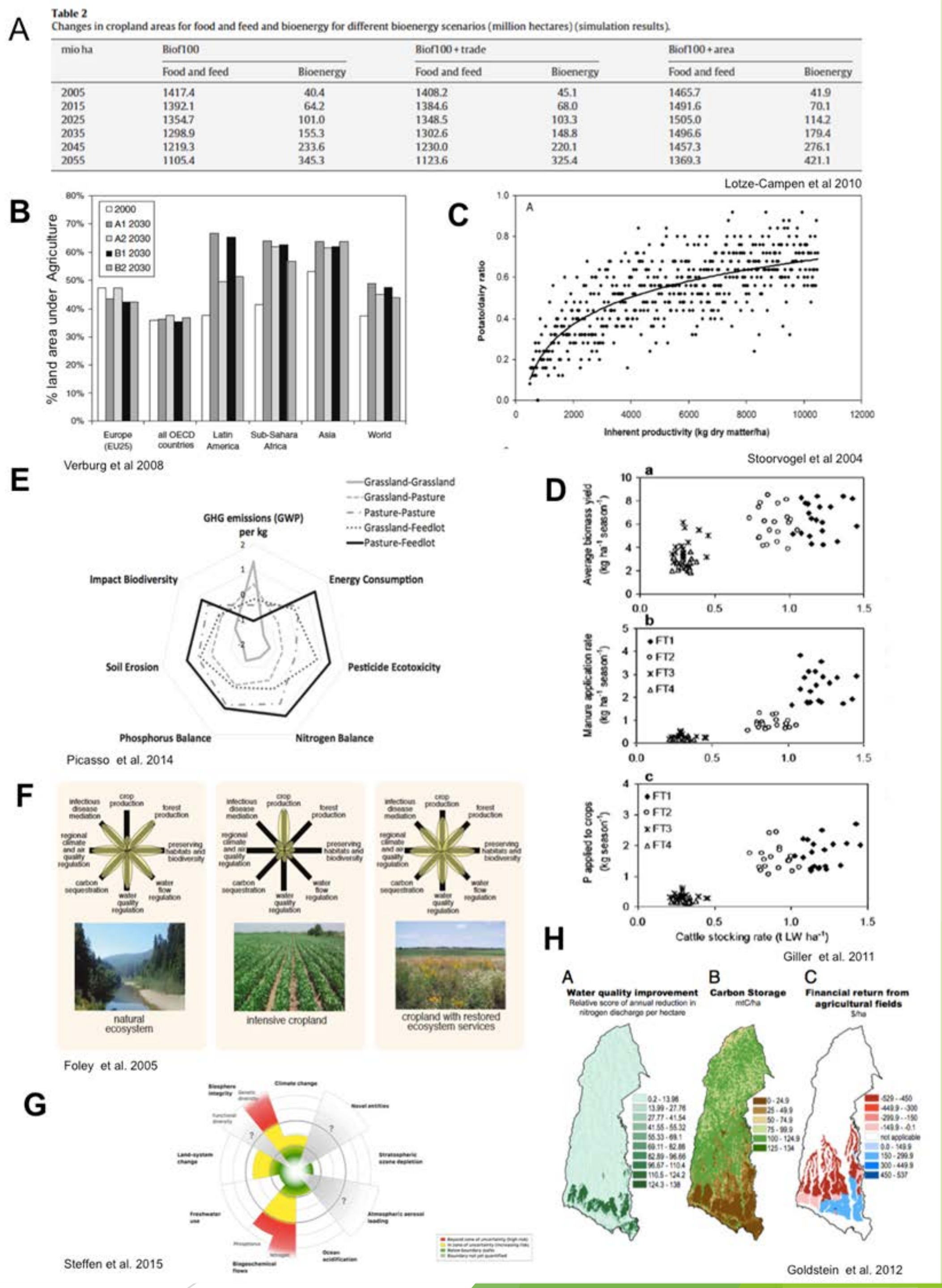


Table 2
Changes in cropland areas for food and feed and bioenergy for different bioenergy scenarios (million hectares) (simulation results).

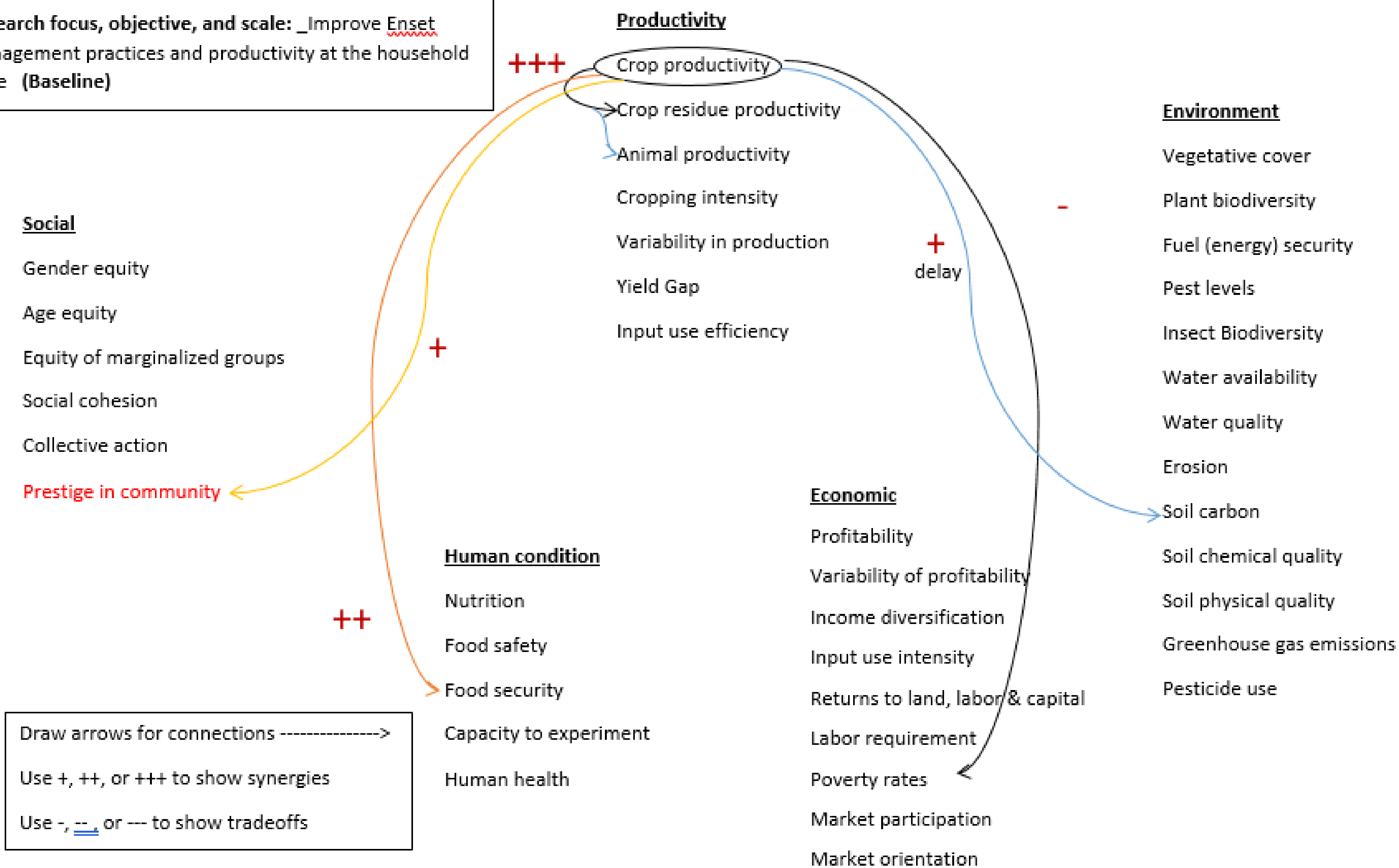
mio ha	Biof100		Biof100 + trade		Biof100 + area	
	Food and feed	Bioenergy	Food and feed	Bioenergy	Food and feed	Bioenergy
2005	1417.4	40.4	1408.2	45.1	1465.7	41.9
2015	1392.1	64.2	1384.6	68.0	1491.6	70.1
2025	1354.7	101.0	1348.5	103.3	1505.0	114.2
2035	1298.9	155.3	1302.6	148.8	1496.6	179.4
2045	1219.3	233.6	1230.0	220.1	1457.3	276.1
2055	1105.4	345.3	1123.6	325.4	1369.3	421.1

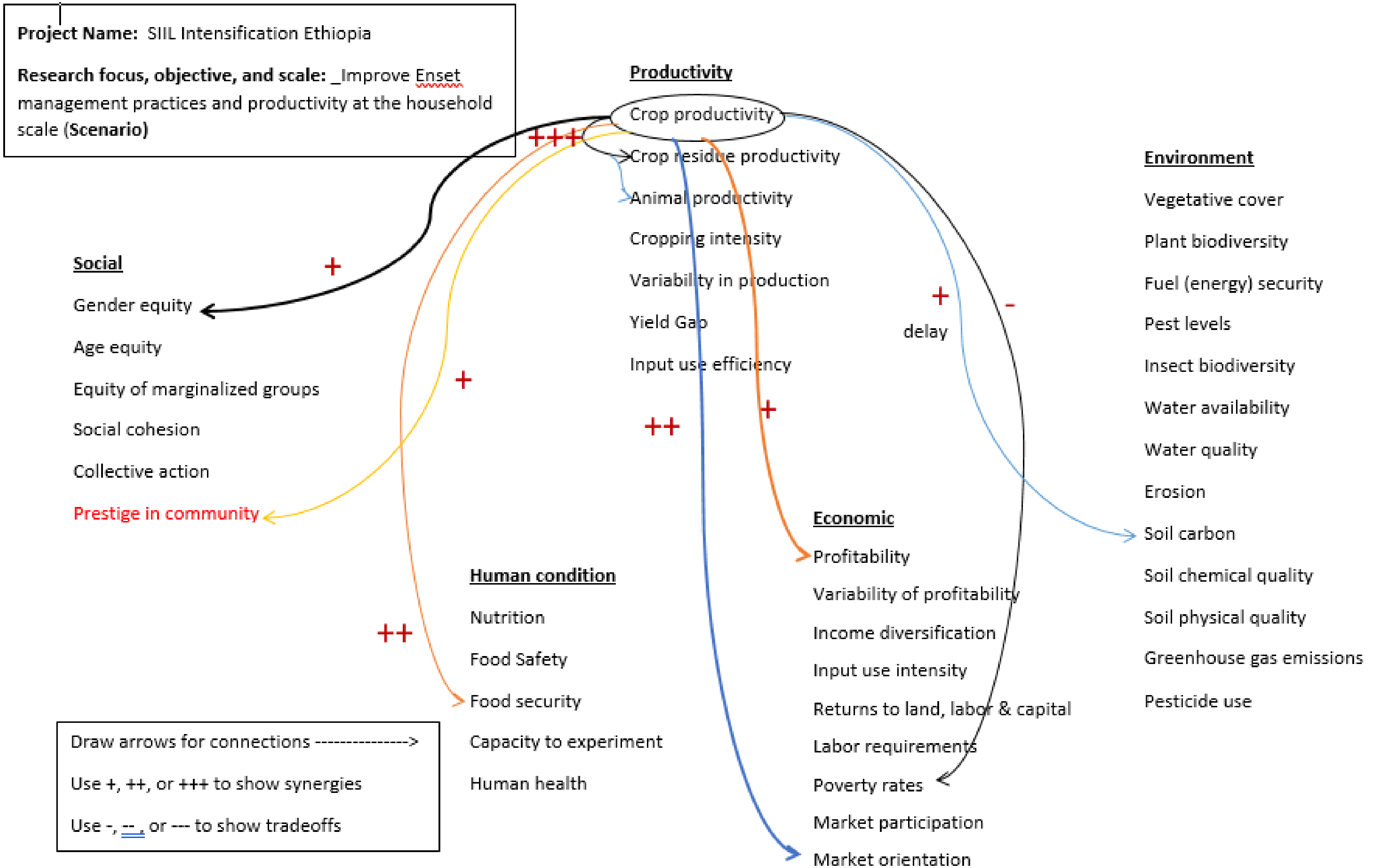
Trade-offs Exercise

- Look at Enset (False Banana)

Project Name: SIIL Intensification Ethiopia

Research focus, objective, and scale: _Improve Enset management practices and productivity at the household scale **(Baseline)**





Project Name: SIIL Intensification Ethiopia
Research focus, objective, and scale: _Improve Enset management practices and productivity at the household scale (Scenario)
Productivity
Crop productivity
Crop residue productivity
Animal productivity
Cropping intensity
Variability in production
Yield Gap
Input use efficiency
Social
Gender equity
Age equity
Equity of marginalized groups
Social cohesion
Collective action
Prestige in community
Human condition
Nutrition
Food Safety
Food security
Capacity to experiment
Human health
Economic
Profitability
Variability of profitability
Income diversification
Input use intensity
Returns to land, labor & capital
Labor requirements
Poverty rates
Market participation
Market orientation
Environment
Vegetative cover
Plant biodiversity
Fuel (energy) security
Pest levels
Insect biodiversity
Water availability
Water quality
Erosion
Soil carbon
Soil chemical quality
Soil physical quality
Greenhouse gas emissions
Pesticide use
+++
+
+
++
++
+
+
delay
-
Draw arrows for connections --------------->
Use +, ++, or +++ to show synergies
Use -, --, or --- to show tradeoffs

Questions?

Contact details:

- Philip Grabowski – grabow21@msu.edu
- Mark Musumba – mmusumba@ei.columbia.edu

Pigeonpea intercropping in Malawi

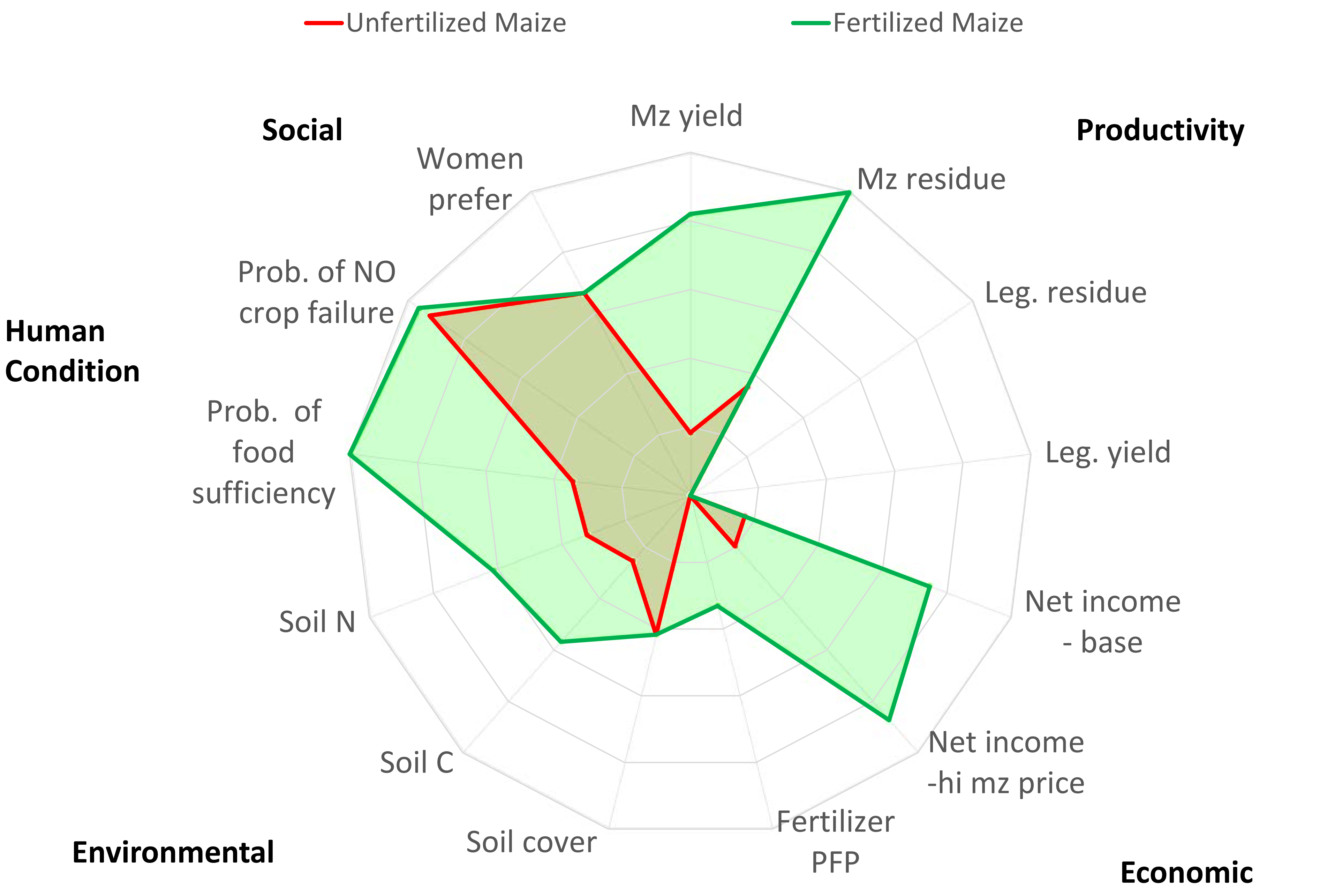
<u>Systems compared:</u>

- 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)

<u>Data sources:</u>

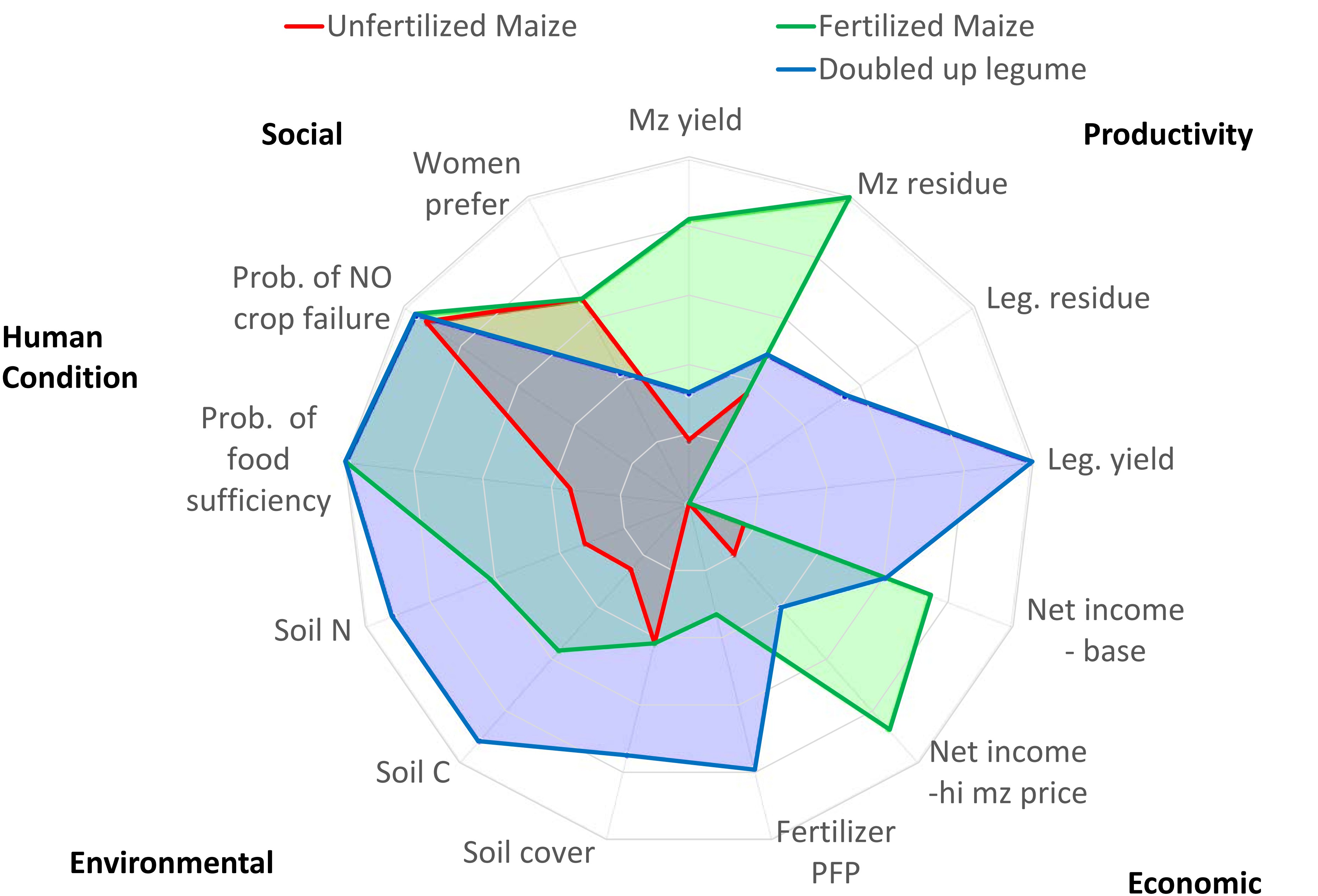
1) On-farm trials
2) APSIM modeling results
3) Survey data

Kandeu



Unfertilized Maize
Fertilized Maize
Social
Productivity
Human Condition
Environmental
Economic
Mz yield
Mz residue
Leg. residue
Leg. yield
Net income - base
Net income -hi mz price
Fertilizer PFP
Soil cover
Soil C
Soil N
Prob. of food sufficiency
Prob. of NO crop failure
Women prefer

Kandeu


Unfertilized Maize
Fertilized Maize
Doubled up legume
Social
Productivity
Human Condition
Environmental
Economic
Mz yield
Mz residue
Leg. residue
Leg. yield
Net income - base
Net income -hi mz price
Fertilizer PFP
Soil cover
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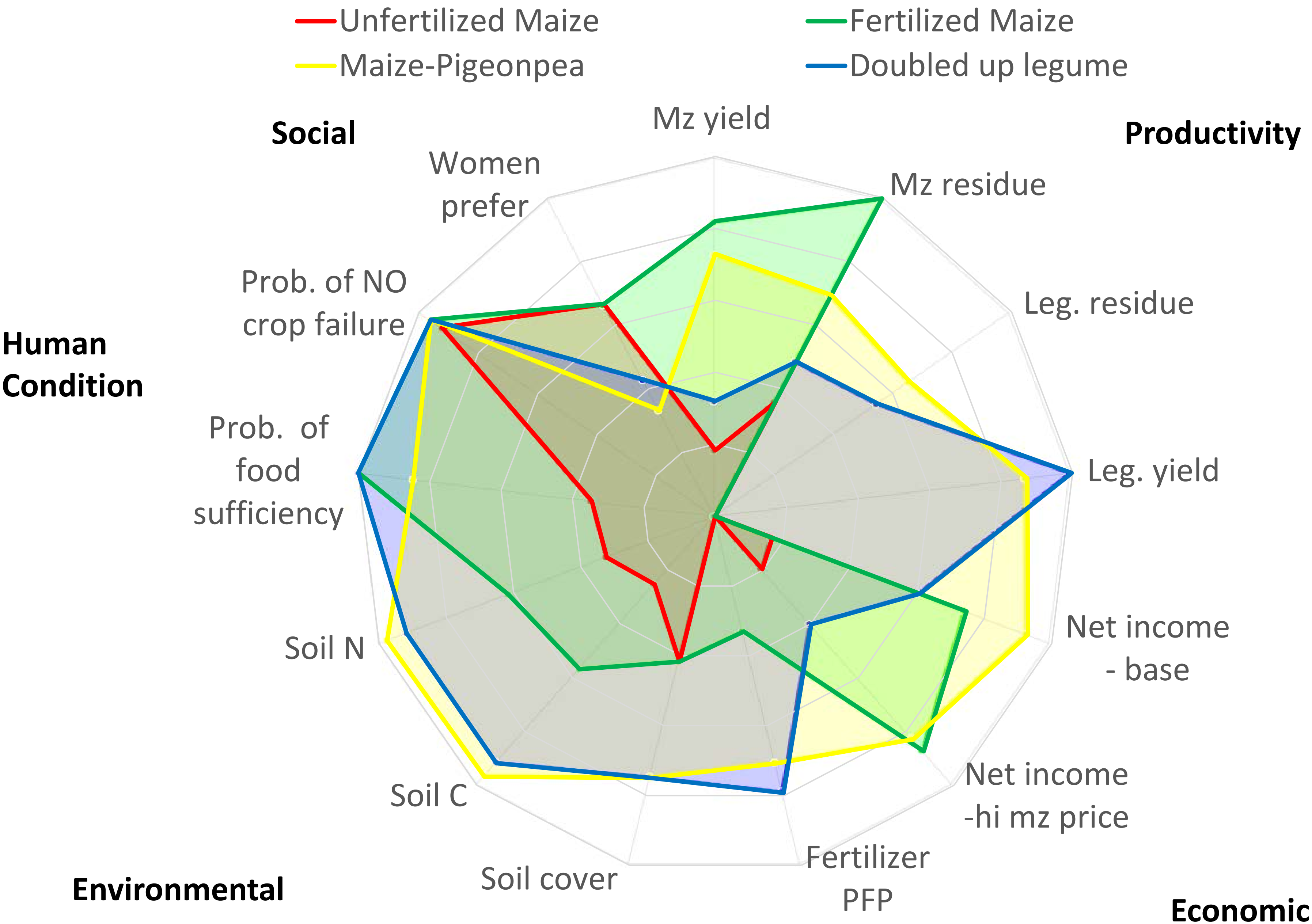
Prob. of food sufficiency
Prob. of NO crop failure
Women prefer

Kandeu



Unfertilized Maize
Fertilized Maize
Maize-Pigeonpea
Doubled up legume
Social
Productivity
Human Condition
Environmental
Economic
Mz yield
Mz residue
Leg. residue
Leg. yield
Net income - base
Net income -hi mz price
Fertilizer PFP
Soil cover
Soil C
Soil N
Prob. of food sufficiency
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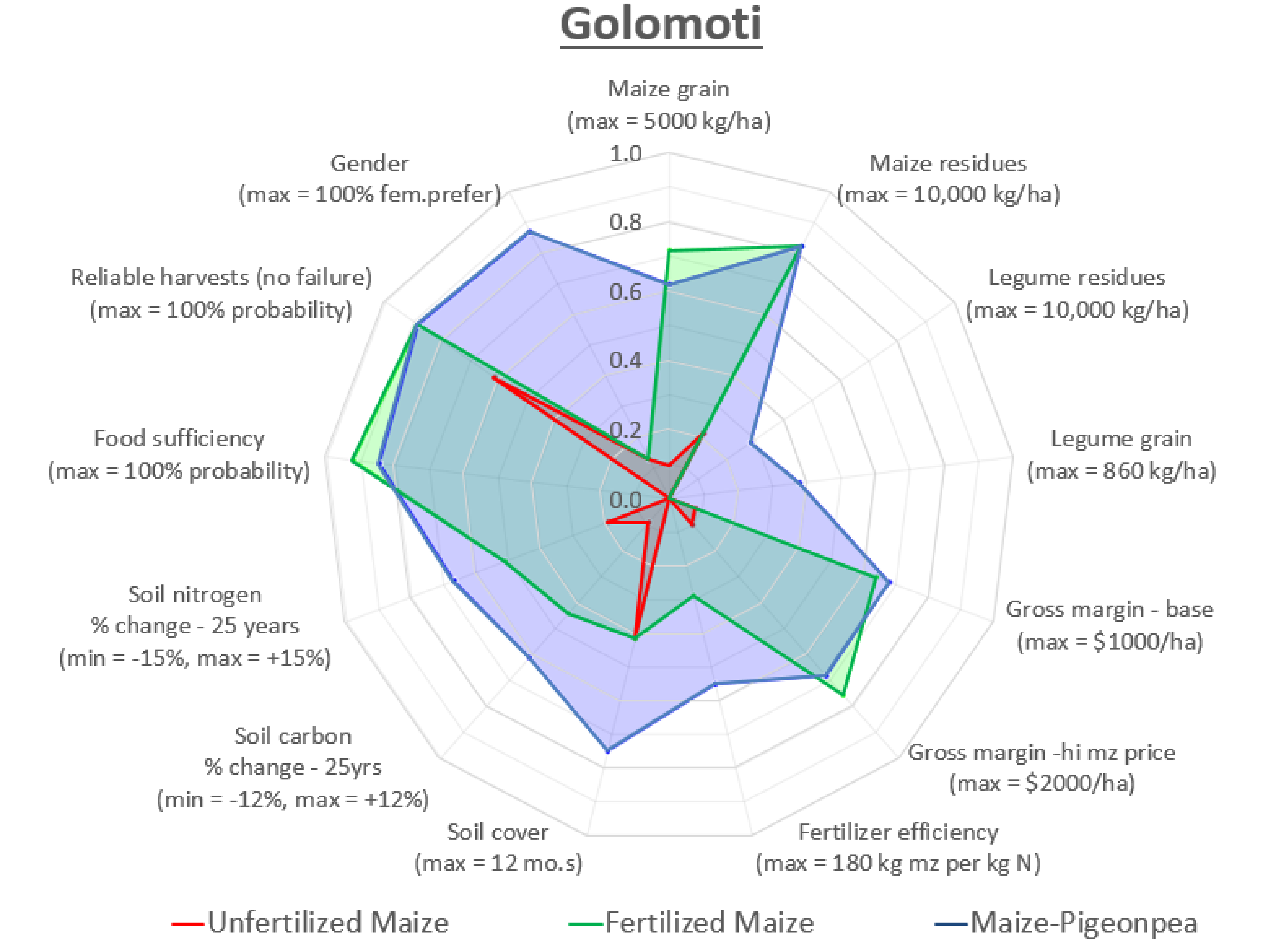
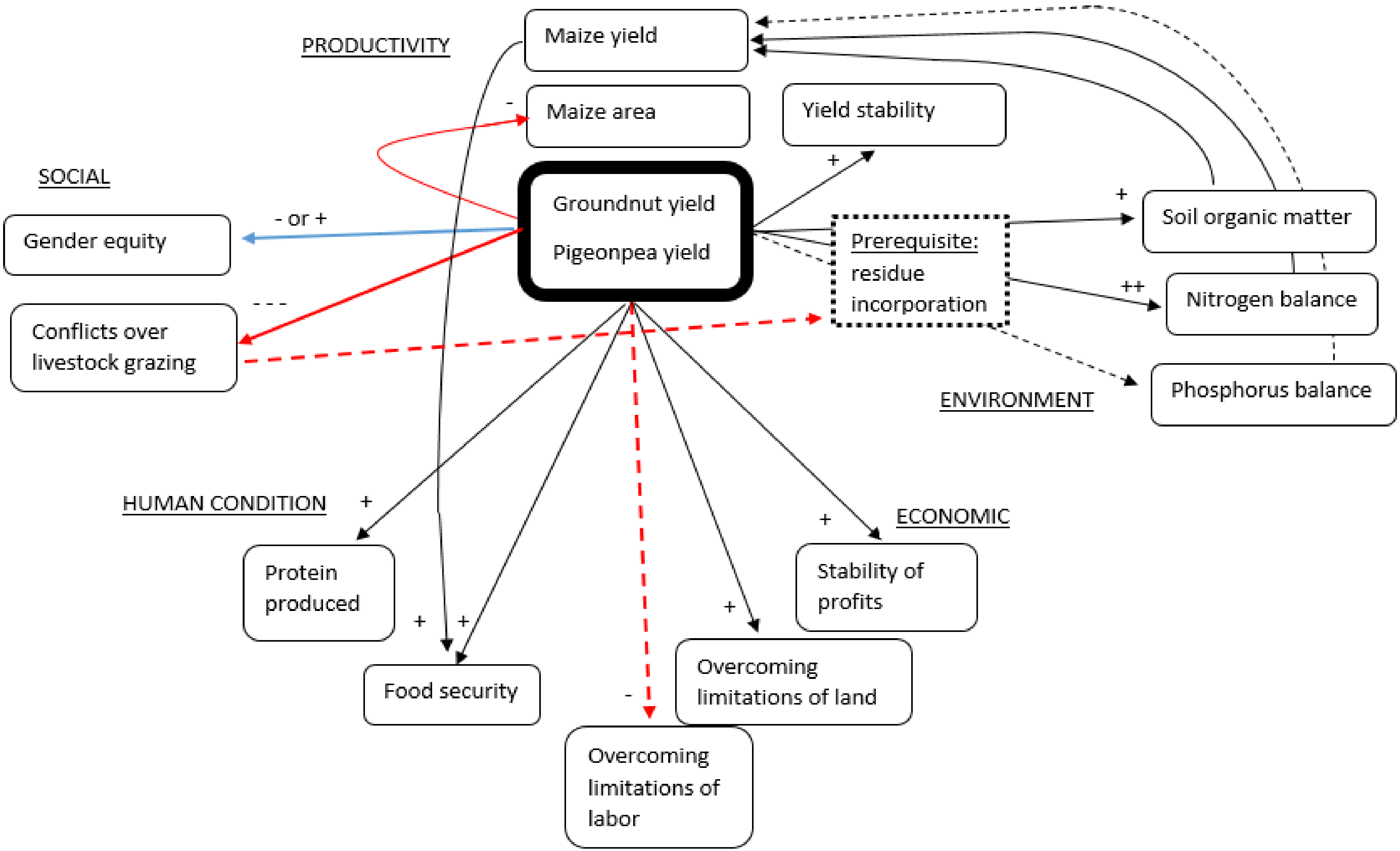

Golomoti
Maize grain
(max = 5000 kg/ha)
Maize residues
(max = 10,000 kg/ha)
Legume residues
(max = 10,000 kg/ha)
Legume grain
(max = 860 kg/ha)
Gross margin - base
(max = $1000/ha)
Gross margin -hi mz price
(max = $2000/ha)
Fertilizer efficiency
(max = 180 kg mz per kg N)
Soil cover
(max = 12 mo.s)
Soil 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)
1.0
0.8
0.6
0.4
0.2
0.0
Unfertilized Maize
Fertilized Maize
Maize-Pigeonpea

Malawi – Africa RISING tradeoffs and synergies

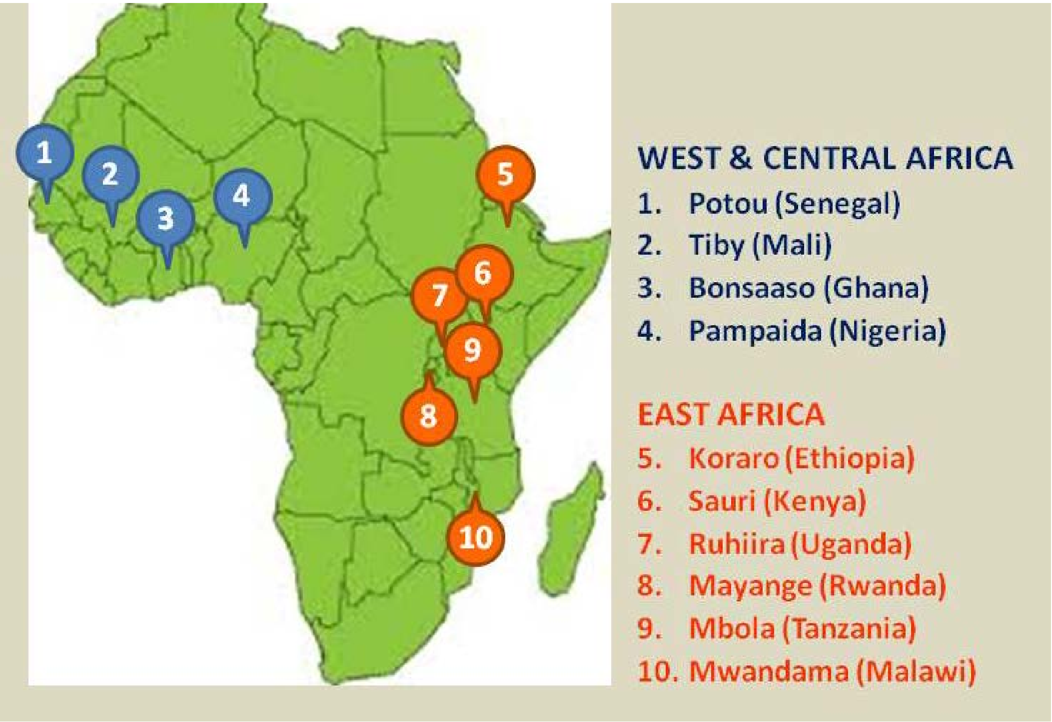


Conclusions

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

Food Security in Mbola and Mwandama

- Critical goal of the Millennium Villages project was **to reduce food insecurity and** poverty.
- In this case, we use the SI Assessment framework as a guide to assessing the performance of two Villages
  - Mbola in Tanzania
  - Mwandama in Malawi
- **Technology** provided to reduce food insecurity
  - **Maize seeds and fertilizer**



Indicators selected per domain

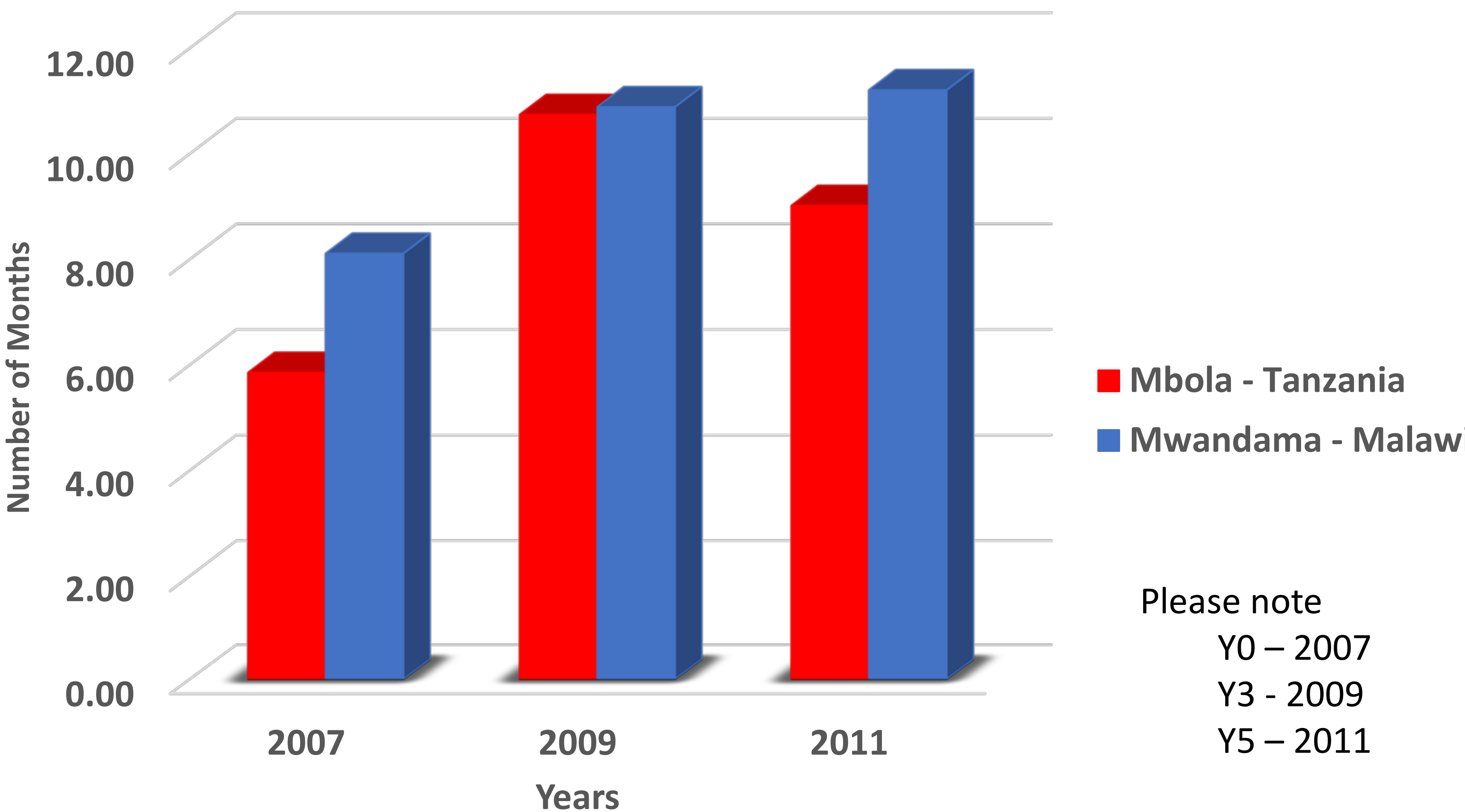
Table 1. Selected Indicators per domain from Mbola and Mwandama

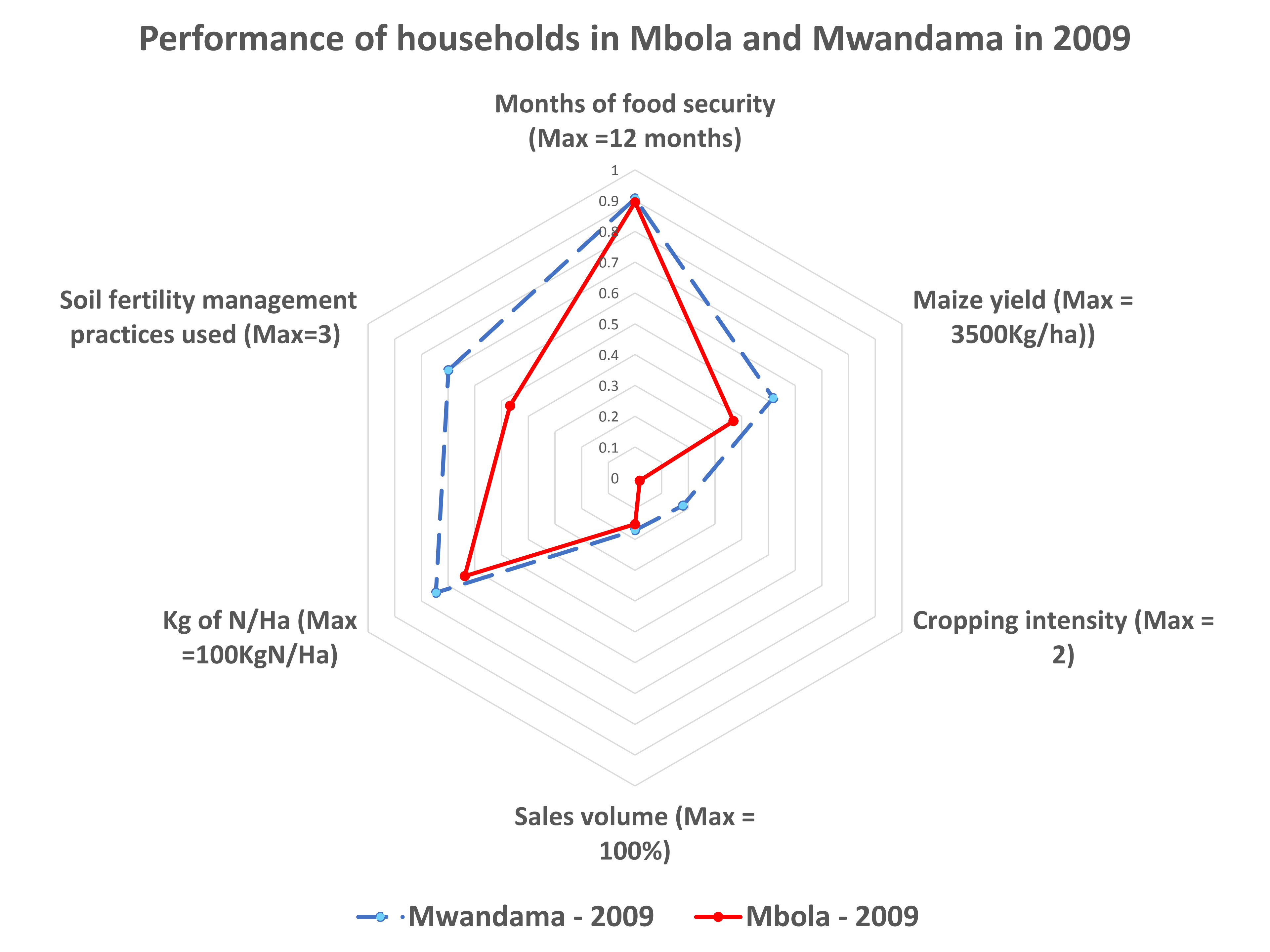
Domain	Indicator	Metric	Scale	Measurement Method
Productivity	Crop Productivity	Maize yield	Field	Survey
Productivity	Cropping Intensity	Cropping intensity	Field	Survey
Economic	Market Participation	Sales volume	Household	Survey
Environmental	Soil Chemical Quality	Kg of N/Ha	Field	Survey
Environmental	Soil Chemical Quality	Soil fertility management practices used	Field	Survey
Human Condition	Food Security	Months of food security	Household	Survey
Social	Equity	Access to resources (disaggregation)	Household	Survey

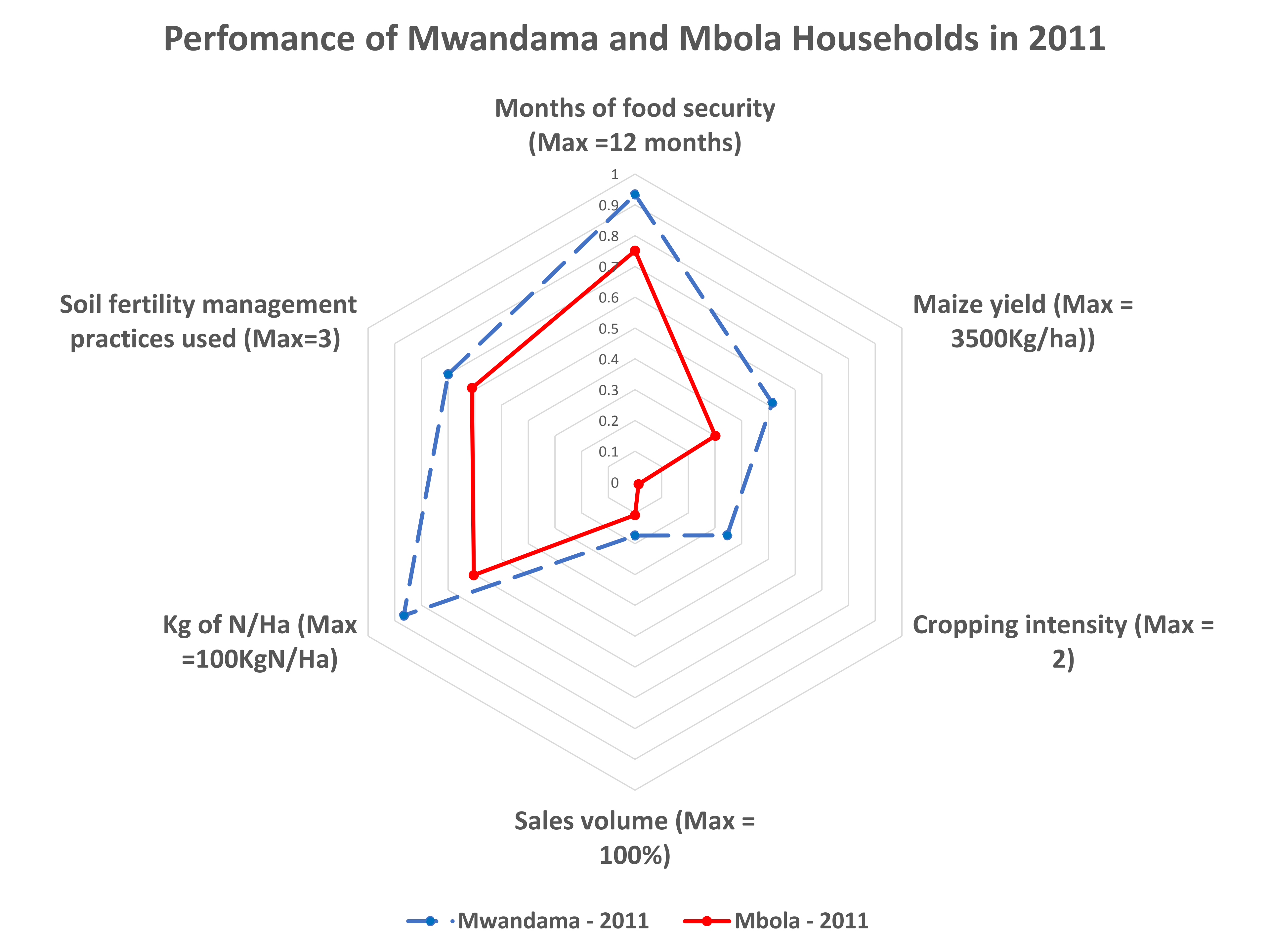
Mbola and Mwandama household performance in 2009 - 2011

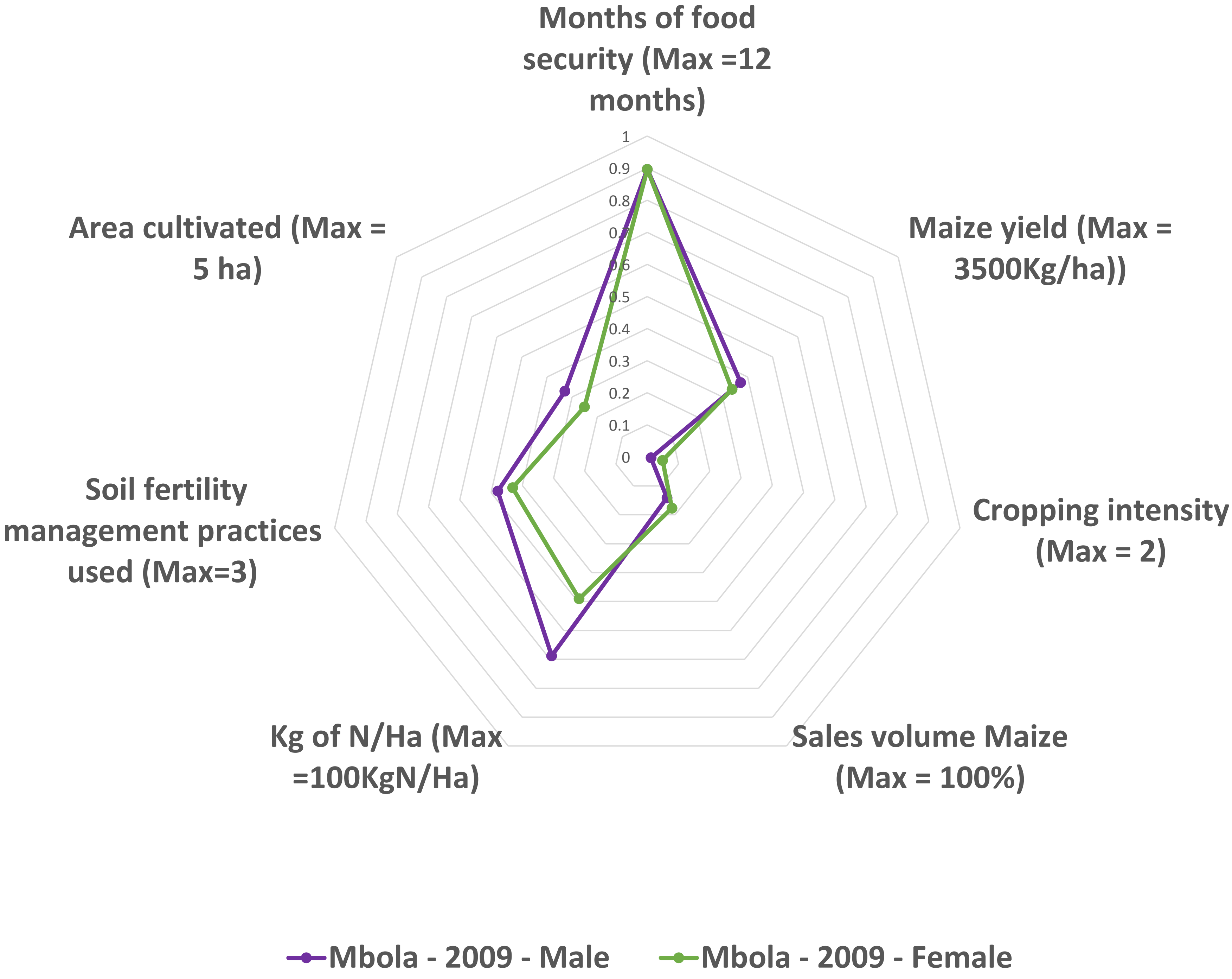
- Variables
  - Cropping intensity for maize (percentage of households growing two crops)
  - Yield
  - Months of food security
  - Fertilizer use
  - Market participation
  - Land allocation (percentage to maize)
  - Number of soil management practices (Chemical fertilizer use, manure use, and residue application)

Figure 1. Number of months with enough food to eat




Performance of households in Mbola and Mwandama in 2009
Months of food security (Max =12 months)
Maize yield (Max = 3500Kg/ha))
Cropping intensity (Max = 2)
Sales volume (Max = 100%)
Kg of N/Ha (Max =100KgN/Ha)
Soil fertility management practices used (Max=3)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mwandama - 2009
Mbola - 2009


Perfomance of Mwandama and Mbola Households in 2011
Months of food security (Max =12 months)
Maize yield (Max = 3500Kg/ha))
Cropping intensity (Max = 2)
Sales volume (Max = 100%)
Kg of N/Ha (Max =100KgN/Ha)
Soil fertility management practices used (Max=3)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mwandama - 2011
Mbola - 2011


Months of food security (Max =12 months)
Maize yield (Max = 3500Kg/ha))
Cropping intensity (Max = 2)
Sales volume Maize (Max = 100%)
Kg of N/Ha (Max =100KgN/Ha)
Soil fertility management practices used (Max=3)
Area cultivated (Max = 5 ha)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mbola - 2009 - Male
Mbola - 2009 - Female

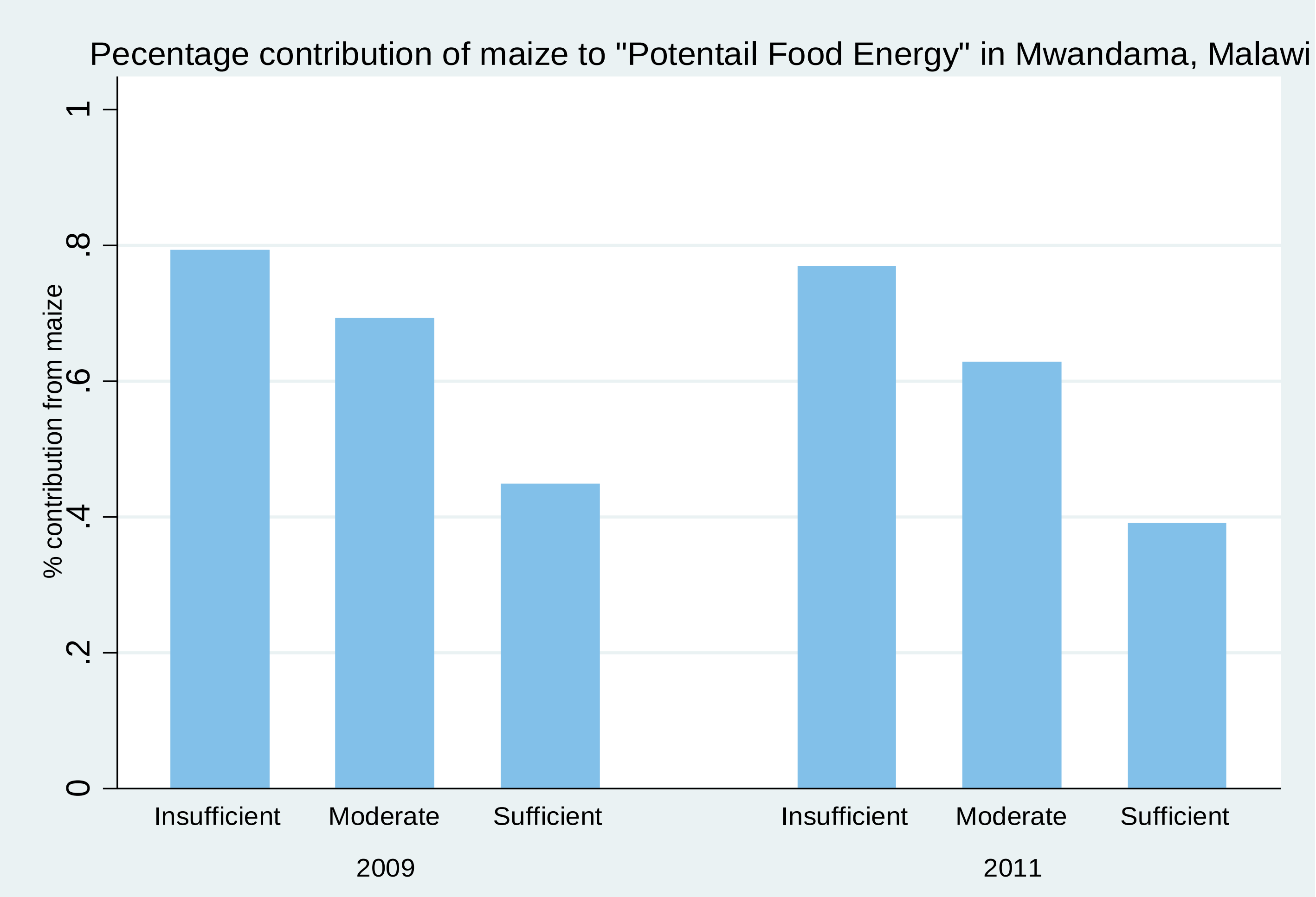
SI Indicators as a pathway for detailed research analysis

- The next section disaggregates the sources of PFE across the potentially food insecure (insufficient PFE) to the potentially food secure (PFE)

PFE is based on Kcal per capita.

- insufficient is less than 1500
- Moderate between 1500 and 4000
- Sufficient is great than 4000 Kcal per capita

Based on Van Wijk et al. 2016



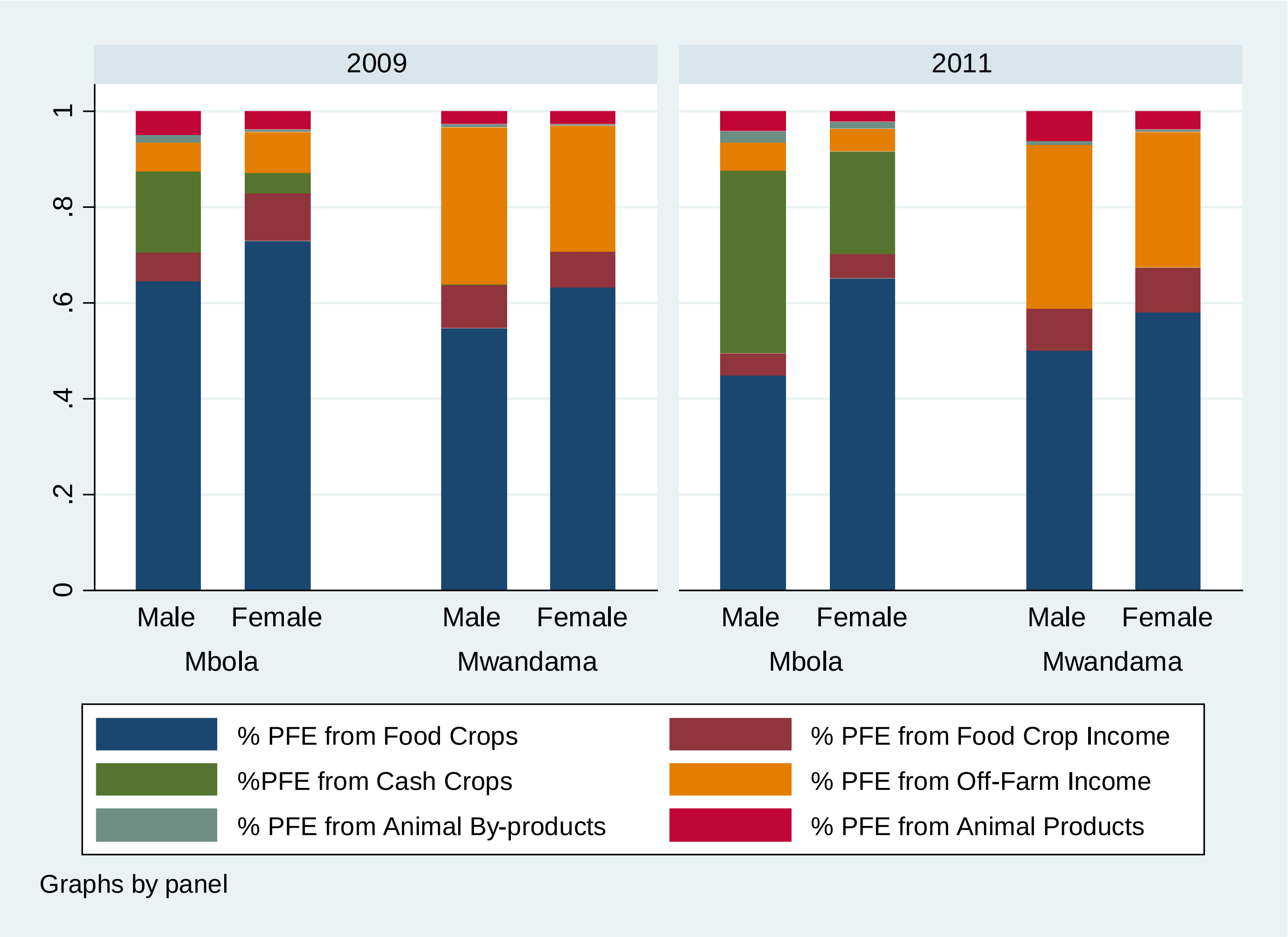
PFE is based on kilo calories (Kcal) per capita.

- **Insufficient** is less than 1500
- **Moderate** between 1500 and 4000
- **Sufficient** is great than 4000 Kcal per capita

Please note

Y3 – 2009

Y5 – 2011



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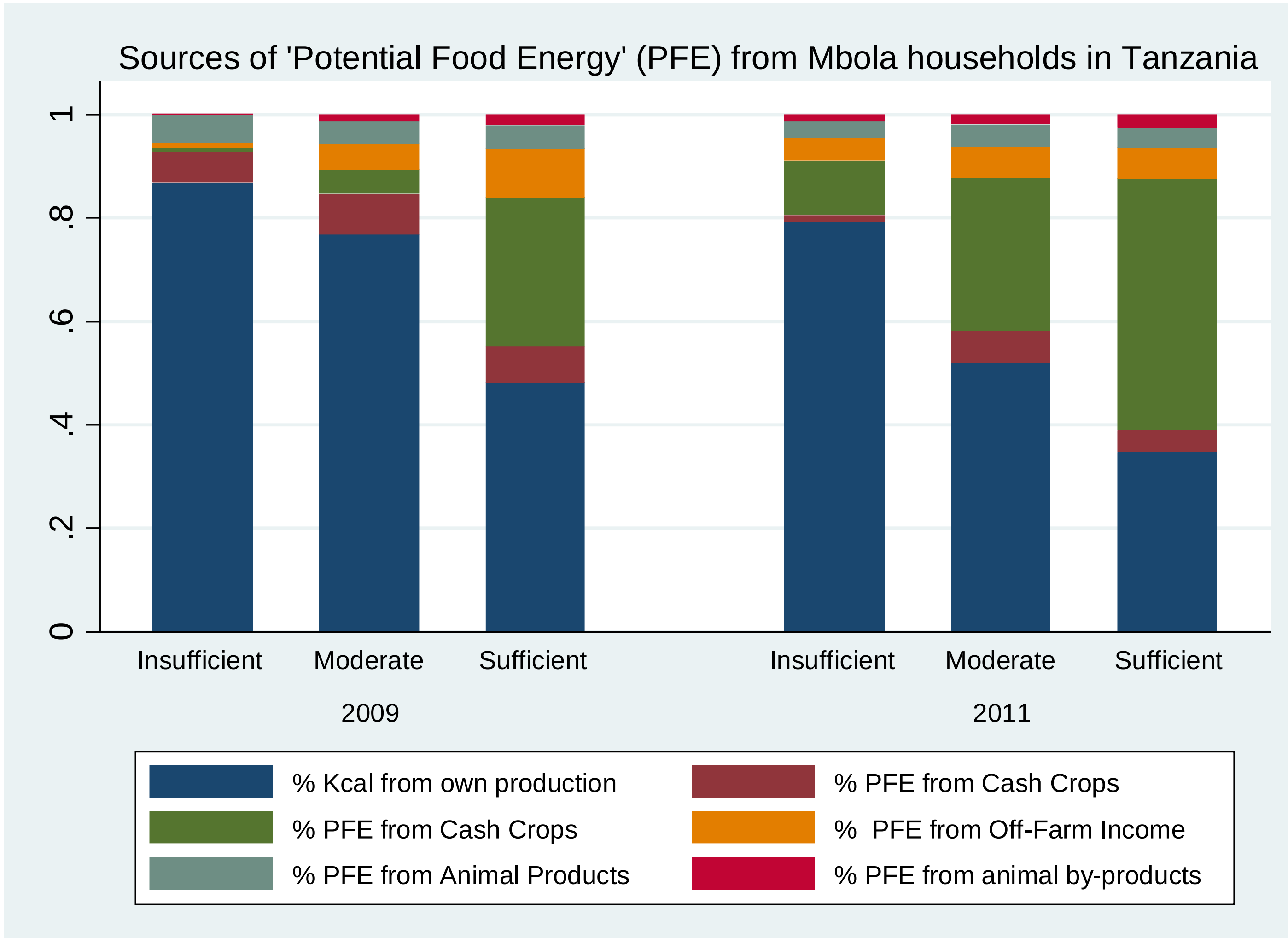

FEED THE FUTURE

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

Part 2: Experience with Sustainable Intensification Indicators by Domain

Photo: K. Chung

3 April 2017 SI Assessment Training, Phnom Penh, Cambodia

Philip Grabowski (MSU), Mark Musumba (UF), Cheryl Palm (UF), Sieg Snapp (MSU)

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Productivity Domain

Productivity Domain					
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]		Remotely sensed measures of crop productivity (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 residue production [d]	Residue production (kg/ha/season) [a,b,c]		Remotely sensed measures of crop productivity (kg biomass / ha / yr) [e]	Same as for Yield
Animal productivity	Animal products (amount / animal / year)	Animal productivity per unit land (product / ha /	Animal productivity per household (product / hh	Net commercial offtake (product / ha / yr) [a]	[a] Recall survey [b] Production measurements [c] Farmer

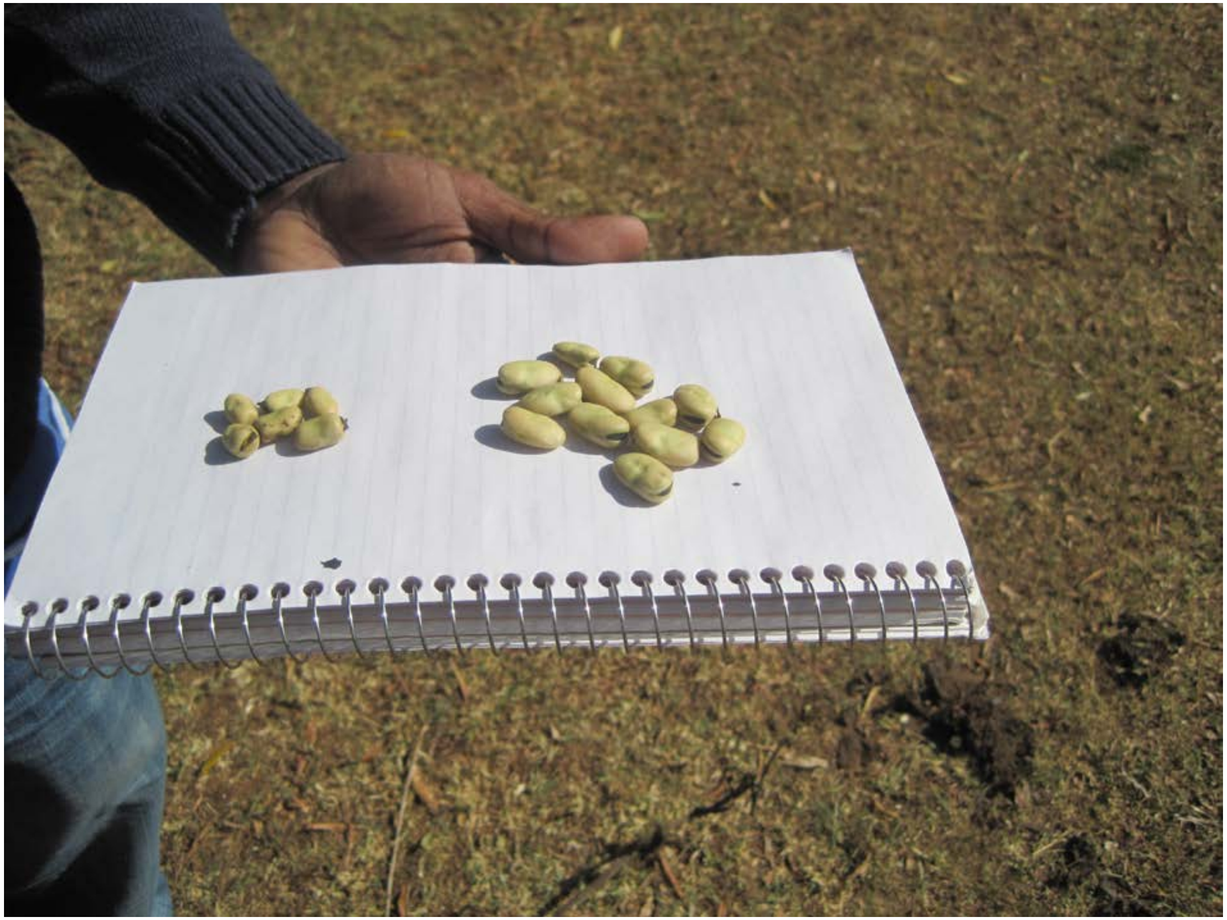
Crop productivity – yield cuts or farmer recall

Crop cut for wheat fertilizer response trial – Africa RISING Ethiopia

Enumerator and farmer – recall survey Zambia

Handheld GPS for measuring field area

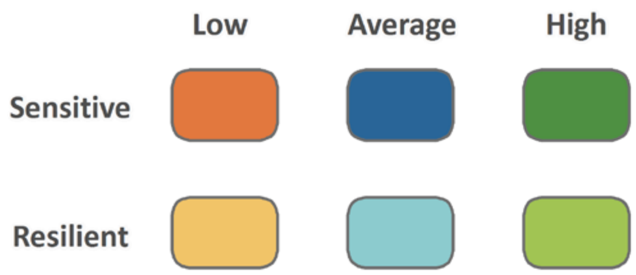
Farmer rating of yield



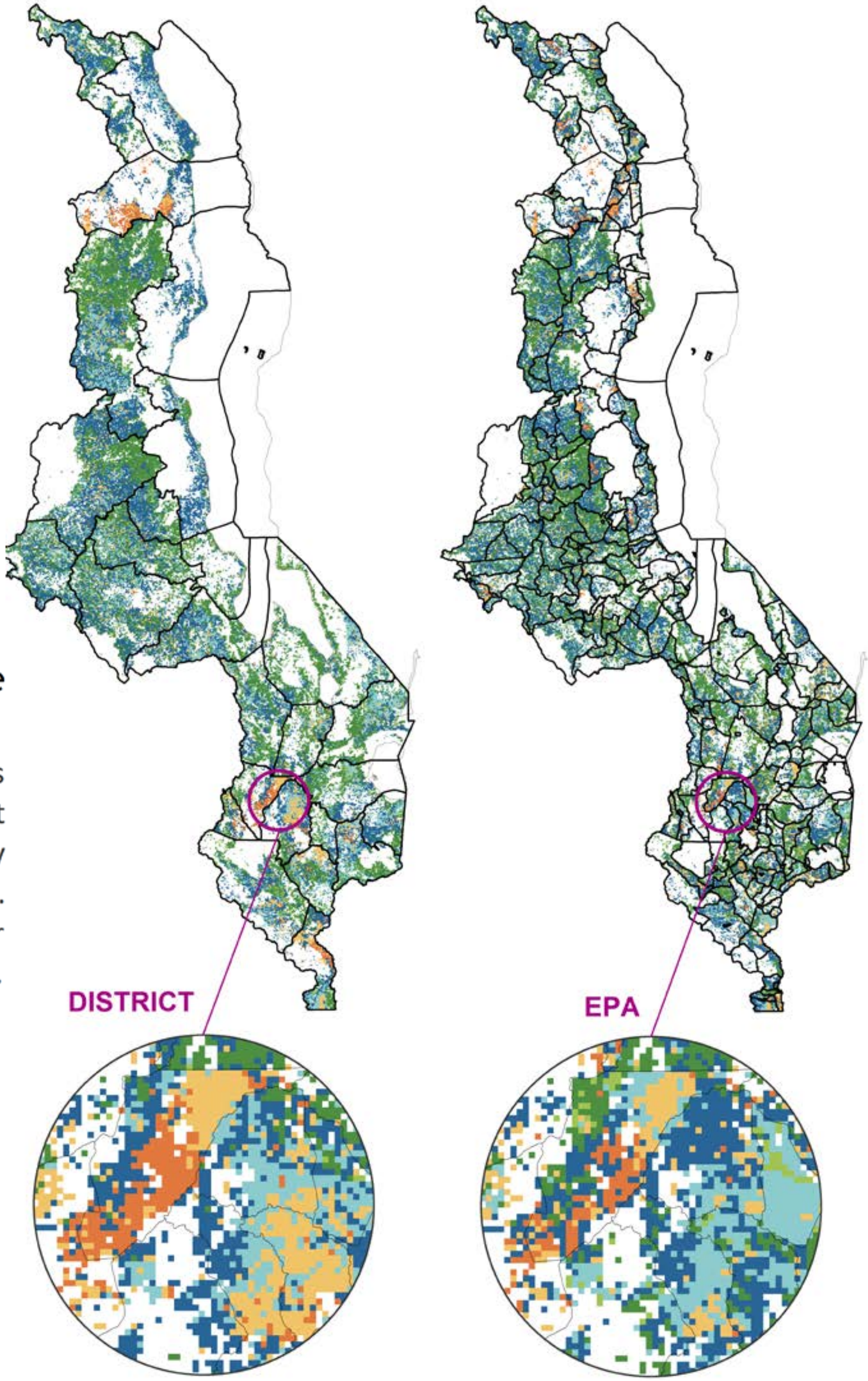
Faba bean varieties – Africa RISING Ethiopia

Remote sensing yield

Crop Production and Sensitivity to Climatic and Biophysical Drive



Agricultural yield trends measured using Net Primary Productivity (NASA MODIS NPP). Data below shown for agricultural land use only.



Messina, J. and Peters, B. 2016

What are the “typical” methods for measuring productivity in Cambodia?

What experiences have you had with alternatives?

ECONOMIC DOMAIN					
Indicator	**Field/plot level metrics**	**Farm level metrics**	**Household level metrics**	**Landscape +**	**Measurement Method**
Profit-ability	Net income [a] ($/crop/ha/ season) Gross Margin [a]	Net income [a,c] (sum of net income across crop and livestock activities) Gross Margin[a]	Net income [a,c] (sum of net income across crop and livestock activities)	Contribut-ion to regional or national GDP [b]	[a] Survey [b] Regional and national statistics [c] Participatory evaluation
Variability of profit-ability	Coefficient of variability of net income [a] Probability of low profitability [a,b]	Coefficient of variability of net income [a] Probability of low profitability [a,b]	Coefficient of variability of net income [a] Probability of low profitability [a,b]		[a] Survey [b] Farmer evaluation
Income diversificat-ion	N/A	Diversification index [a]	Diversification index [a] Number of income sources[a]		[a] Survey
Returns to land, labor and inputs	Net returns [a] (monetary value of output/input used)	Net returns [a] (monetary value of output/input used)	Net returns [a] (monetary value of output/input)		[a] Survey and productivity measurements
Input use intensity	Input per ha [a]	Input per ha [a]	Input per ha [a]		[a] Survey
Labor require-ment	Labor requirement (hours/ha) [a,b]	Labor requirement (hours/ha) [a,b]	Labor requirement (hours/ha) [a,b]		[a] Recall survey [b] Direct observation

What experiences do you have measuring economic indicators?

- Profits and their variability
- Income diversification
- Returns to land, labor and inputs
- Labor requirements
- Poverty
- Market participation and orientation

ENVIRONMENT DOMAIN (Part 1: Biodiversity and water)

Indicator	Field/plot level metrics	Farm level metrics	Household level metrics	Community/Landscape + metrics	Measurement method
Vegetative Cover	% Vegetative cover by type (tree, shrub, grass, invasive) [a,b] % Burned land [a,b] % Bare land [a,b]	% Vegetative cover by type [a,b] % Burned land [a,b]	N/A	% Vegetative cover by type [c] % Burned land [c] % Bare land [c]	[a] Quadrats, transects or visual estimate of cover [b] Participatory exercise [c] Satellite images
Plant Biodiversity	Alpha Diversity Index [a,b] # Species or varieties [a,b]	Beta Diversity Index [a,b] # Species or varieties [a,b]	N/A	Gamma Diversity Index [a,b] % Natural habitat [c]	[a] Vegetation sample [b] Transects [c] Satellite images
Pest levels	Weed abundance and severity [a,b] Parasitic weed levels [a,b] # Pest insects by type [a,b] Presence of invasive species [a,b] Presence and severity of crop diseases[a,b]				[a] Seasonal transects [b] Traps
Insect Biodiversity	# Pollinators [a,b,c] Diversity index [a,b,c] # Beneficial insects [a,b,c]			# pollinators [a,b,c] Diversity index [a,b,c] # beneficial insects [a,b]	[a] Traps [b] Direct observation

ENVIRONMENT DOMAIN (Part 2: Soil and pollution)					
Indicator	**Field/plot level metrics**	**Farm level metrics**	**Household metrics**	**Community/Landscape + metrics**	**Measurement method**
Erosion	Soil loss (tons/ha/yr) [a,b,c] Rating of erosion [a,d]		N/A	Sediment load (mg/L) [e] Erosion (tons/ha/yr) [b]	[a] Direct measurement [b] Models…
Soil carbon	Total carbon (%, or Mg/ha) [a] Labile or 'active' carbon (POXC) [a] and/or CO_2 mineralization[c] Partial carbon budget [b,c]		N/A	N/A	[a] Soil test [b] Survey [c] Measurements
Soil chemical quality	Soil pH (acidity) [a] % Aluminum saturation [a] Electrical conductivity [a] Soil nutrient levels [a] Nutrient partial balance [b] Biological nitrogen	Nutrient partial balance [b] Biological nitrogen fixation [a]	N/A N/A N/A	N/A N/A Nutrient partial balance [a,b]	[a] Soil tests [b] Survey and lookup tables

What experiences do you have measuring environmental effects in Cambodia?

Soil and water analyses?
Other environmental indicators?

Human Condition Domain

Indicator	Field/plot	Household	Landscape or Administrative Unit	Measurement method
Nutrition	Protein production (g / ha) [a,b] Micronutrient production (g / ha)	Access to nutritious foods [a] Dietary diversity [a] Nutritional status (underweight, stunting, wasting) [c] Uptake of essential nutrients [d]	Market or landscape supply of diverse food [e,f] Dietary Diversity [a] Rate of underweight, stunting and wasting [c] Average birthweight [c]	[a] Survey [b] Look up tables [c] Anthropometric measurements [d] Blood tests [f] Participatory mapping
Food security	Food production (Calories/ ha) [a,b]	Food availability [a] Food accessibility [a] Food utilization [a] Months of food insecurity [a] Rating of food security [c]	Total food production [a]	[a] Survey [b] Look up tables [c] Participatory assessment
Food Safety		Mycotoxins (toxicity units per gram) [a] Pesticide contamination [a,b] Post-harvest losses [c]		[a] Chemical testing [b] Health center data [c] Survey
Human health			Incidence of zoonotic diseases [a] Incidence of vector borne diseases [a]	[a] Health center data

Two interventions

Farmer’s practice

Intervention

- Orange flesh sweet potatoes (farmer practice (local) and intervention)
- Main objective of intervention is to:
  - **Improve food security and**
  - **Nutrition**

Selection of indicators

Indicator	Field/plot	Household	Landscape or Administrative Unit	Measurement method
Nutrition	Protein production (g / ha) [a,b] Micronutrient production (g / ha)	**Access to nutritious foods [a]** **Dietary diversity [a]** **Nutritional status (underweight, stunting, wasting) [c]** **Uptake of essential nutrients [d]**	Market or landscape supply of diverse food [e,f] Dietary Diversity [a] Rate of underweight, stunting and wasting [c] Average birthweight [c]	[a] Survey [b] Look up tables [c] Anthropometric measurements [d] Blood tests [f] Participatory mapping
Food security	Food production (Calories/ ha) [a,b]	**Food availability [a]** **Food accessibility [a]** **Food utilization [a]** **Months of food insecurity [a]** **Rating of food security [c]**	Total food production [a]	[a] Survey [b] Look up tables [c] Participatory assessment

Development approach

- Roll out the orange potato technology to household in a region and collected data at the household level to generate these indicators.
- Challenge
  - Cost prohibitive
  - This approach may be suitable for development projects and not research for development

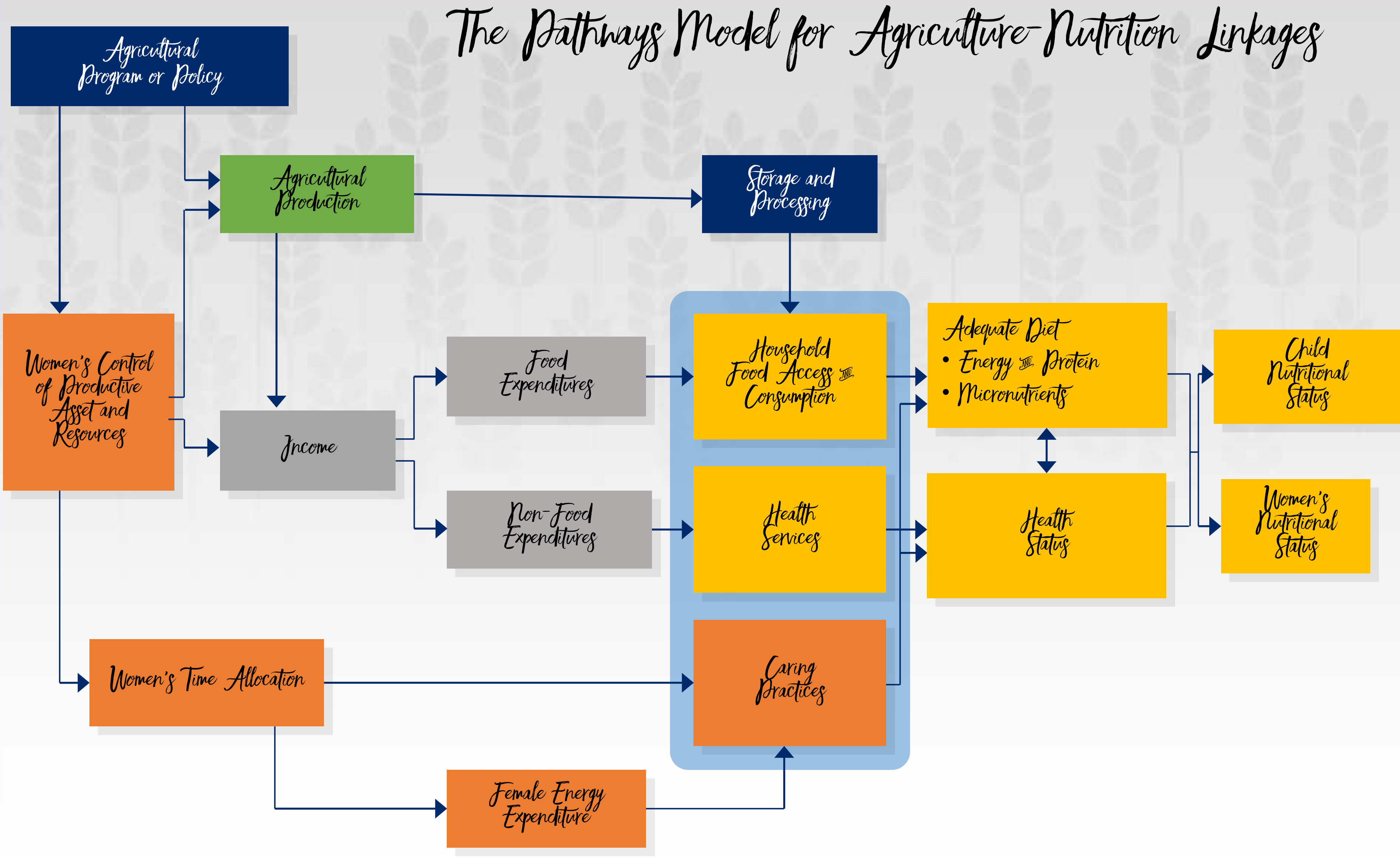
Research Approach to assessing indicators

- Food security and nutrition indicators are mainly assessed at the household level.
- When working at small field scale we are unlikely to measure the effect of the intervention at the household level.
- We may use proxies for food security and nutrition with the assumption that the household will either consume the produce or sell the produce and buy nutritious food.
- **How do we work at the field scale to assess how the intervention might have an effect at the household level?**

Alternative approach

- A participatory one to assess farmers willingness to adopt/adapt the technology.
  - Whether they would consume it or sell it?
  - What other aspects of the technology are influential in its adoption?

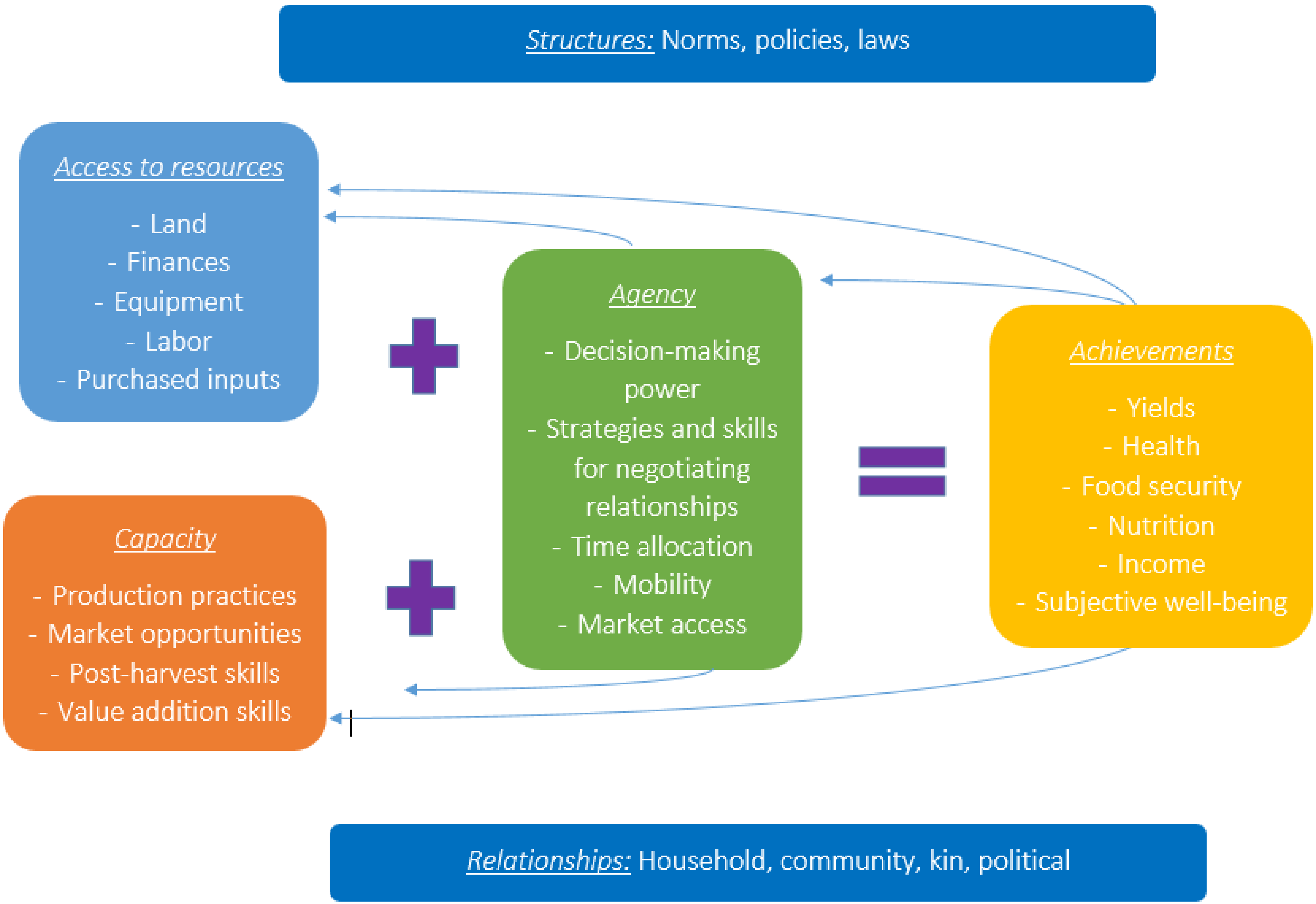
Chung, K. et al. 2015. An Introduction to Nutrition-Sensitive Agricultural Programming. Online course. Washington, DC: USAID's FANTA Project at FHI 360. https://agrilinks.org/sites/default/files/nutrition-training/module1part1/index.htm



What experiences do you have measuring these human condition indicators?

- Nutrition
- Food security
- Health
- Farmer Capacity

Gender issues cut across all domains



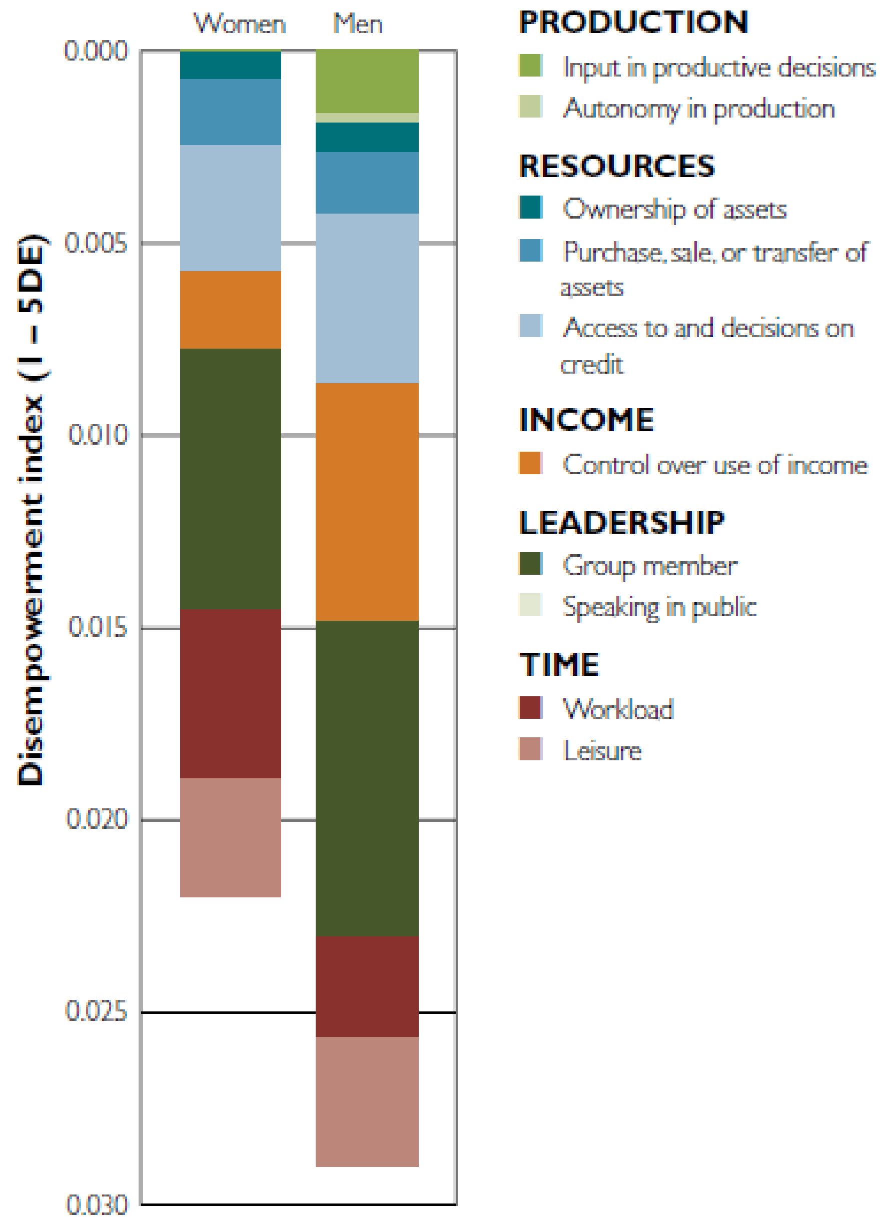
SOCIAL DOMAIN					
Indicator	**Field**	**Farm**	**Household level metrics**	**Community/Landscape + metrics**	**Measurement method**
Gender equity	N/A	N/A	Resources: Land access by gender [a-d] Livestock ownership by gender [a-d] Capacity: Access to information [a-d] Agency: Time allocation by gender [a-d] Management control by gender [a-d] Market participation by gender [a-d] Achievements: Income by gender [a-d] Nutrition/Food security by gender Health status by gender [a-d] Cross cutting: Rating of technologies	Women Empowerment in Agriculture Index [a, d]	[a] Individual survey [b] Participatory evaluation [c] Focus group discussions [d] Household survey
Equity (generally)	N/A	N/A	Access to resources (land and livestock ownership) [a-d] Agency (leadership roles) [a-d] Achievements (income, nutrition, food security, health, well-being) [a-d] Rating of technologies by group [a-d]	Variability and distributions resources, agency, and achievements [a-d]	[a] Key informant interview [b] Participatory evaluation [c] Focus group discussions …
Social cohesion	N/A	N/A	Participation in community activities Level and reliability of social support Family cohesion [a,b,c]	Social groups [c] Participation in social groups [a,b,c] Incidence of social support [a,b,c]	[a] Household survey [b] Focus group discussions [c] Key informant

Gender analysis - conceptual

- **Reflect on the following questions:**
  - Will the use of the technology affect women's access to resources (land, money, household labor)?
  - How will the technology affect women's time differently from men?
  - How does the technology address women's priorities vs. men's priorities?
  - What are possible negative side effects of the technology for women?

What experiences do you have measuring these social indicators?

- Equity
- Gender equity
- Social cohesion
- Collective action



Source: Cambodia Development Resource Institute (2012).

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Part 3: Indicator Selection for Sustainable Intensification Assessment

Photo: K. Chung

3 April 2017 SI Assessment Training, Phnom Penh, Cambodia

Philip Grabowski (MSU), Mark Musumba (UF), Cheryl Palm (UF), Sieg Snapp (MSU)

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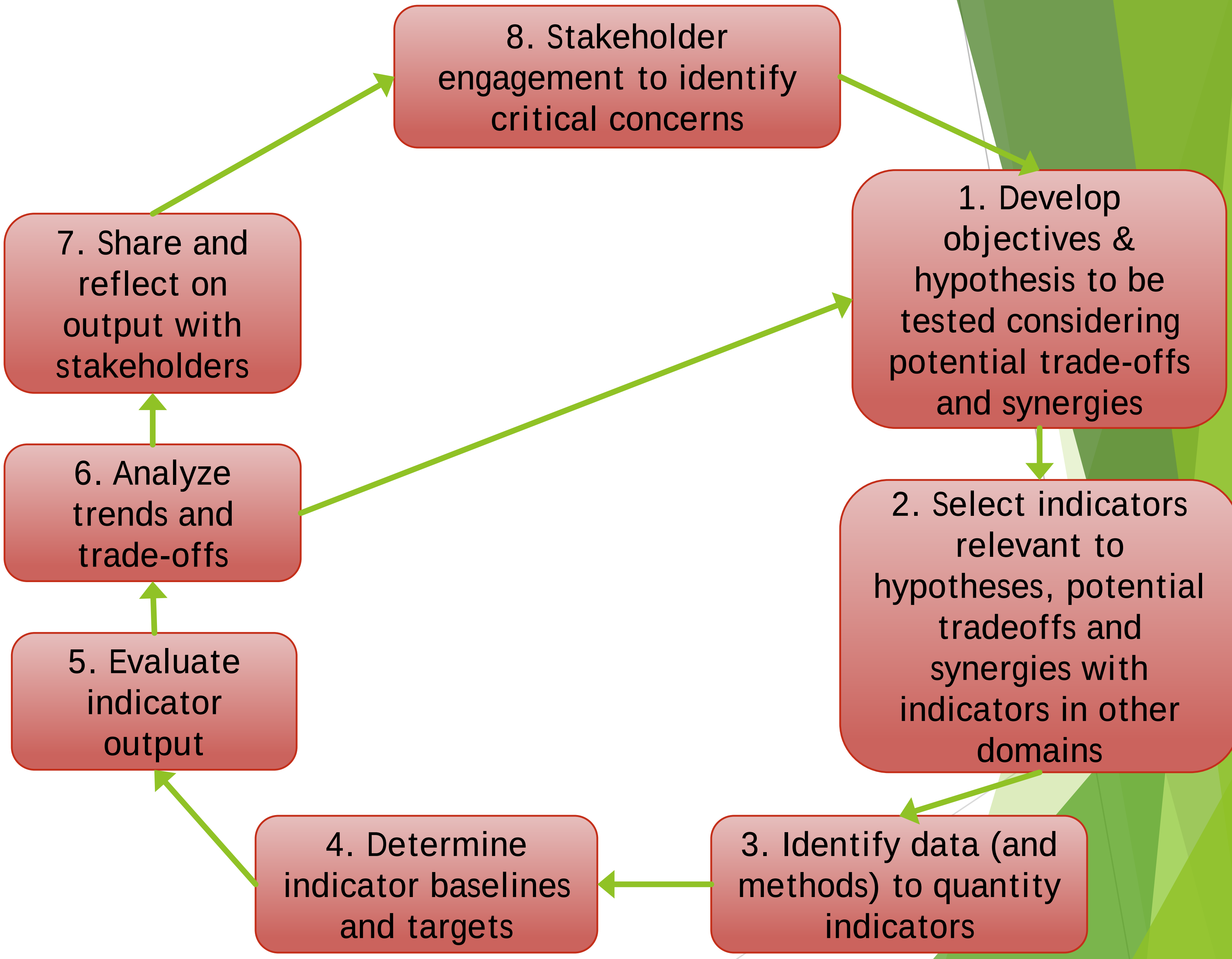

Adaptation from -- Kline, K. 2014; Stoorvogel et al. 2004

Stage:	Situation analysis	Technology testing (pre-adoption)	Dissemination and adaptation
Primary Objective:	Characterization of farming system	Assess possible interventions	Monitor performance at scale
Additional objectives:	Identifying challenges and opportunities	Assess adoption potential	ID facilitators and barriers to adoption Assess drivers of performance
Data:	Baseline survey	Initial experiments	Survey farmer practice
Role of models:	Evaluate baseline performance	Explore system changes	ID areas for adoption, scenarios

Indicator selection

- Primary objective
- Sub-objectives by domain
- Indicators, metrics and methods for each

Activity to Identify and select relevant indicators and data collection methods

Domain	Sub-objectives	Indicators for assessing sub-objectives	Measurement Method	Scale of assessment
Productivity (Pg. 13 *)				
Economic (Pg. 17 *)				
Environmental (Pg. 21 *)				
Human Condition (Pg. 28 *)				
Social (Pg. 32 *)				

If you have too long of a list…

- Rank by importance
- Consider feasibility
- Rank again

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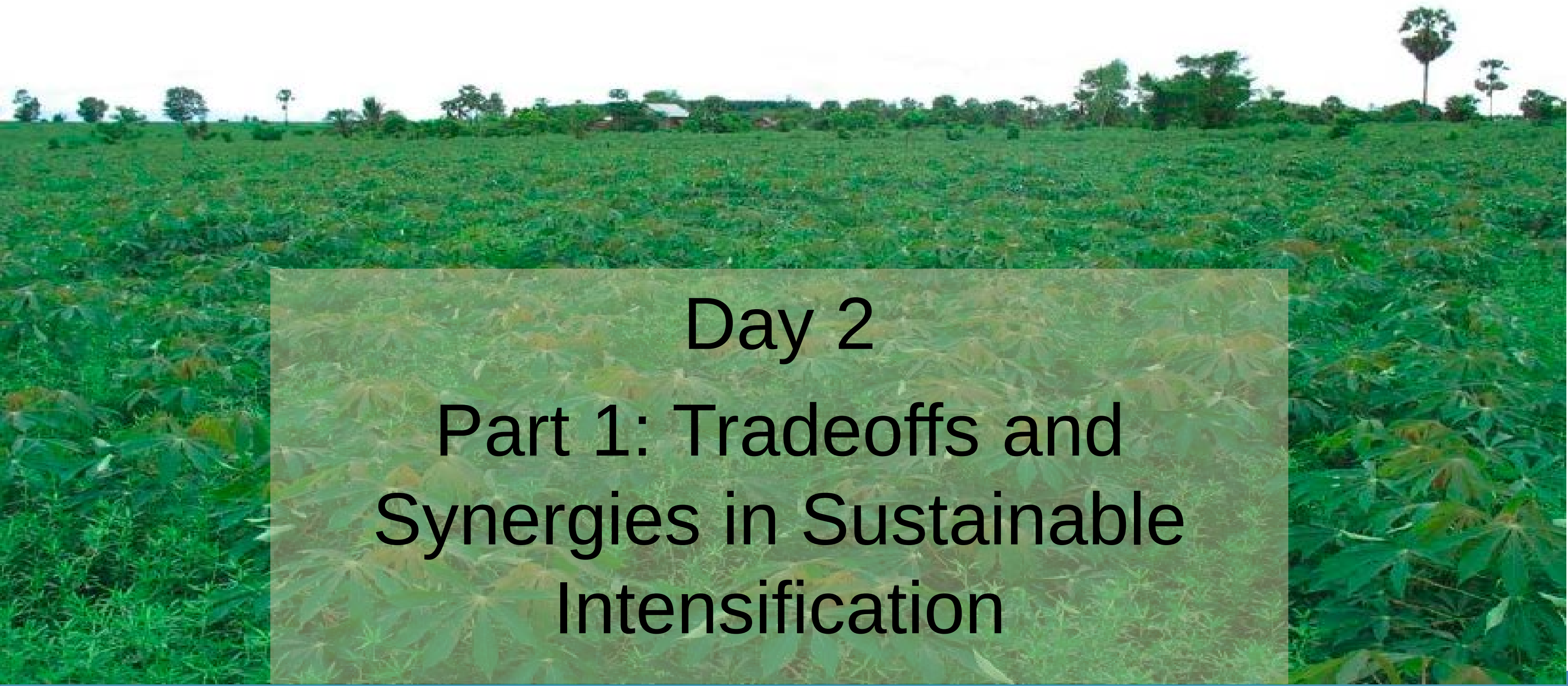

Day 2

Part 1: Tradeoffs and Synergies in Sustainable Intensification

4 April 2017 SI Assessment Training, Phnom Penh, Cambodia

Photo credit: Chabierski et al. 2011

Philip Grabowski (MSU), Mark Musumba (UF), Cheryl Palm (UF), Sieg Snapp (MSU)

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Tradeoffs and Synergies

- How do the objectives and sub-objectives of your project relate to each other?
- What other indirect effects are likely?

Project Name:

Research focus, objective, and scale:

Productivity

Crop Productivity

Crop residue productivity

Animal Productivity

Variability in production

Input use efficiency

Yield Gap

Cropping Intensity

Environment

Vegetative cover

Plant biodiversity

Fuel security

Pest level

Insect Biodiversity

Water availability

Water quality

Soil erosion

Soil carbon

Soil chemical quality

Soil physical quality

Greenhouse gas emissions

Pesticide use

Social

Gender equity

Age equity

Equity of marginalized groups

Social cohesion

Collective action

Economic

Profitability

Variability of profitability

Income diversification

Input use intensity

Returns to land, labor & capital

Labor requirement

Poverty rates

Market participation

Market orientation

Human condition

Nutrition

Food safety

Food security

Capacity to experiment

Human health

Draw arrows for connections --------------->

Use +, ++, or +++ to show synergies

Use -, --, or --- to show tradeoffs

Steps

- Circle one or two indicators directly influenced by the technology
- Draw arrows for the most important indirect effects

Project Name: GMCC

Research focus, objective, and scale:

Productivity

~~Crop Productivity~~

Crop residue productivity

Animal Productivity

Variability in production

Input use efficiency

Yield Gap

Cropping Intensity

Rice productivity

+

Mung bean productivit

-

+

Environment

Vegetative cover

Plant biodiversity

Fuel security

Pest level

Insect Biodiversity

Water availability

Water quality

Soil erosion

Soil carbon

Soil chemical quality

Soil physical quality

Greenhouse gas emissions

Pesticide use

Social

Gender equity

Age equity

Equity of marginalized groups

Social cohesion

Collective action

Economic

Profitability

Variability of profitability

Income diversification

Input use intensity

Returns to land, labor & capital

Labor requirement

Poverty rates

Market participation

Market orientation

Human condition

Nutrition

Food safety

Food security

Capacity to experiment

Human health

Draw arrows for connections --------------->

Use +, ++, or +++ to show synergies

Use -, --, or --- to show tradeoffs

What indicators need to be added based on the tradeoffs and synergies?

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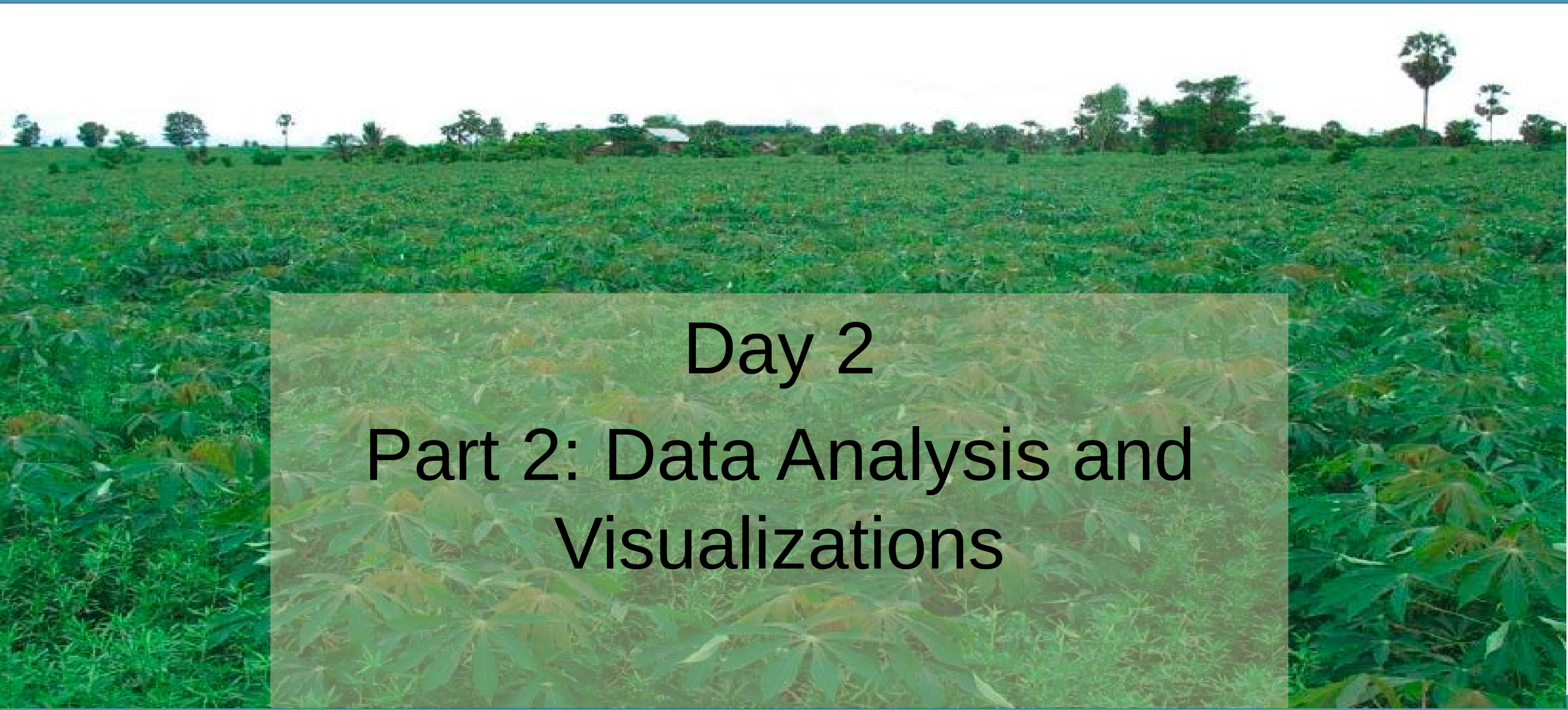

Day 2

Part 2: Data Analysis and Visualizations

4 April 2017 SI Assessment Training, Phnom Penh, Cambodia

Photo credit: Chabierski et al. 2011

Philip Grabowski (MSU), Mark Musumba (UF), Cheryl Palm (UF), Sieg Snapp (MSU)

Handling variability – time, space, typology, etc.

Categorical variability

1. Radar chart with separate lines for each group (e.g. year 1, year 2)
2. Separate radar charts for each group (e.g. location 1, location 2)

Continuous variability

1. Create an axis representing the variability (e.g. yield stability, economic risk, etc.)
2. Present the distribution of the mean alongside the radar chart

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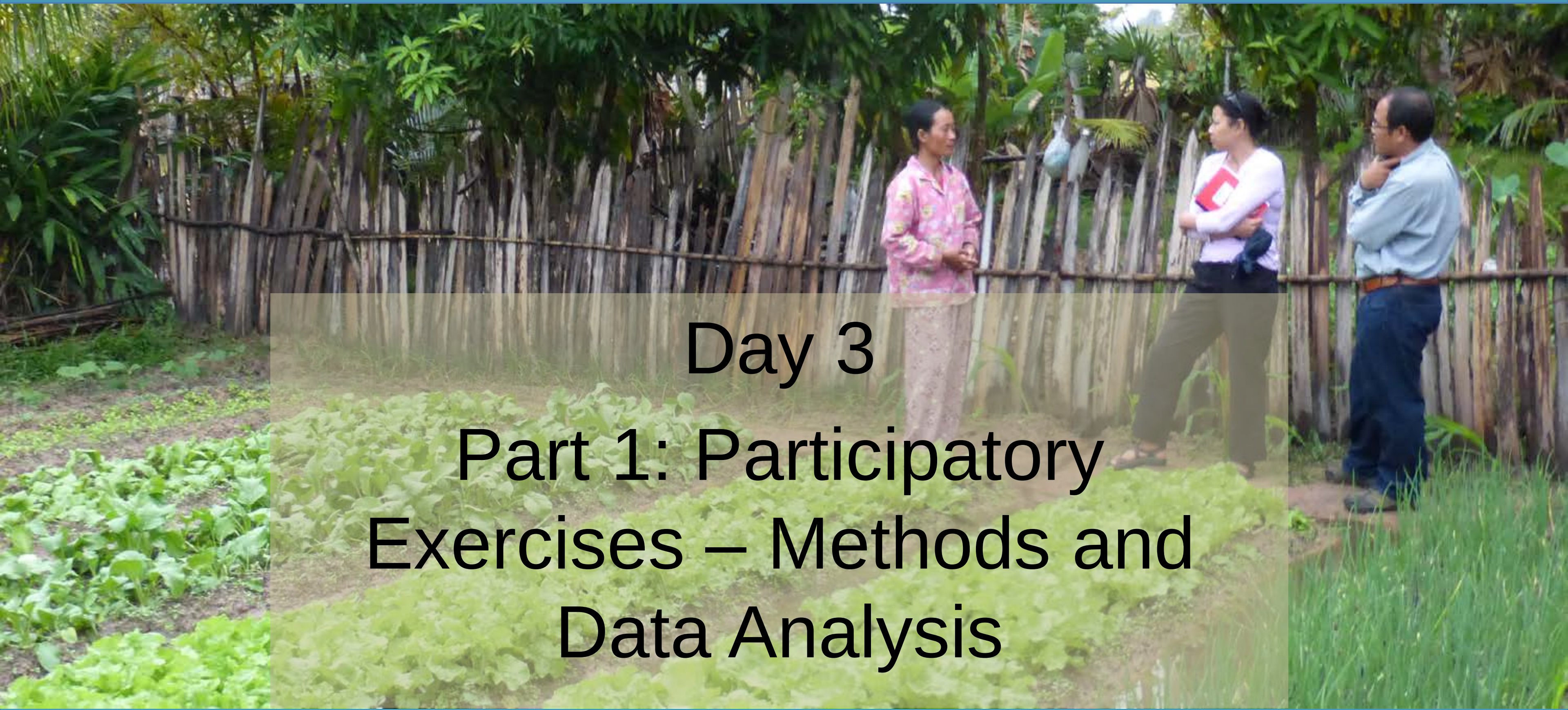

Day 3

Part 1: Participatory Exercises – Methods and Data Analysis

5 April 2017 SI Assessment Training, Phnom Penh, Cambodia

Photo credit: Kimberly Chung

Philip Grabowski (MSU), Mark Musumba (UF), Cheryl Palm (UF), Sieg Snapp (MSU)

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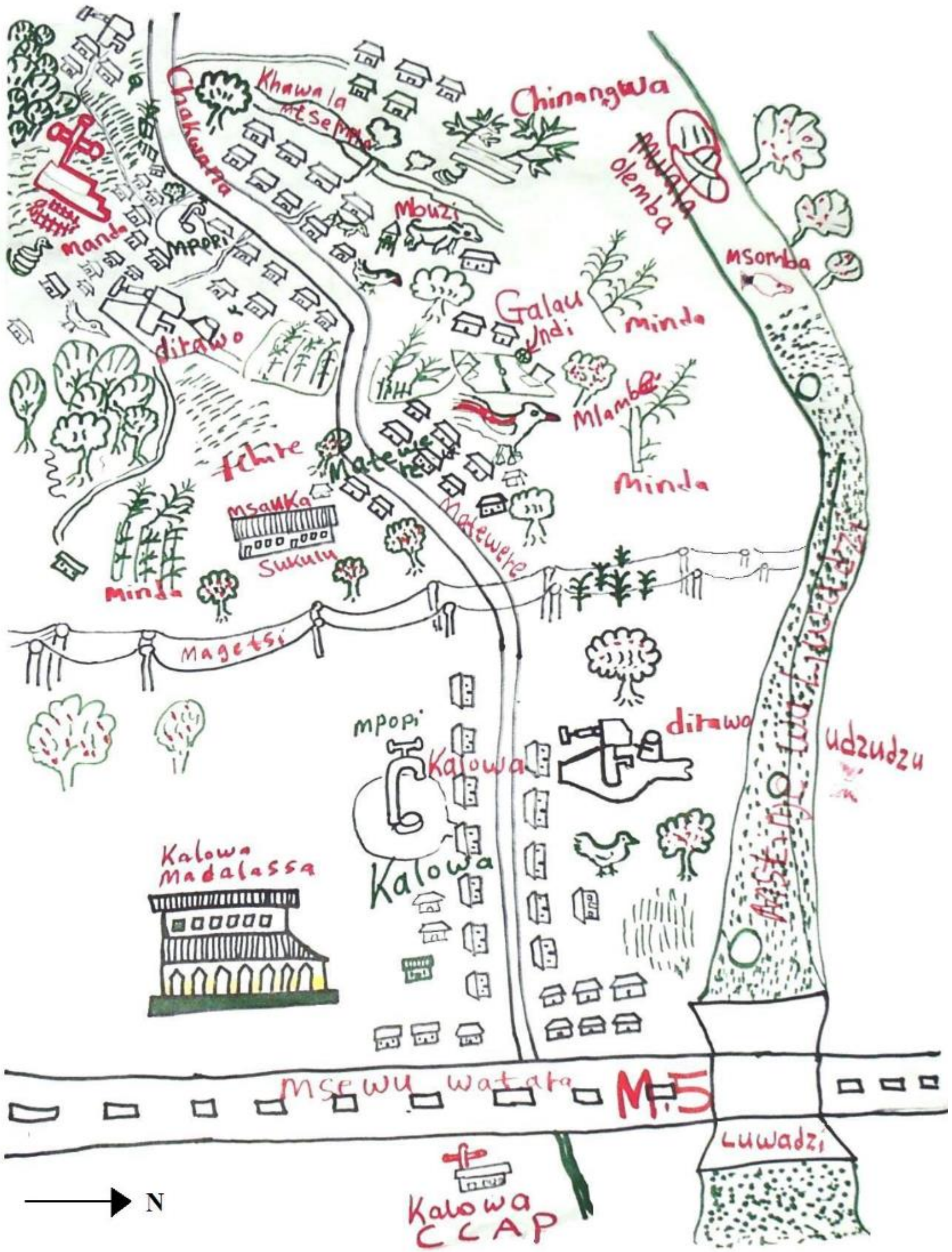
Warm up

- What do you think of when you hear "Participatory Methods"?
- What are the strengths of these methods?
- What are the weaknesses of these methods?

Participatory Rural Appraisal

- Robert Chambers
- Group visual activities



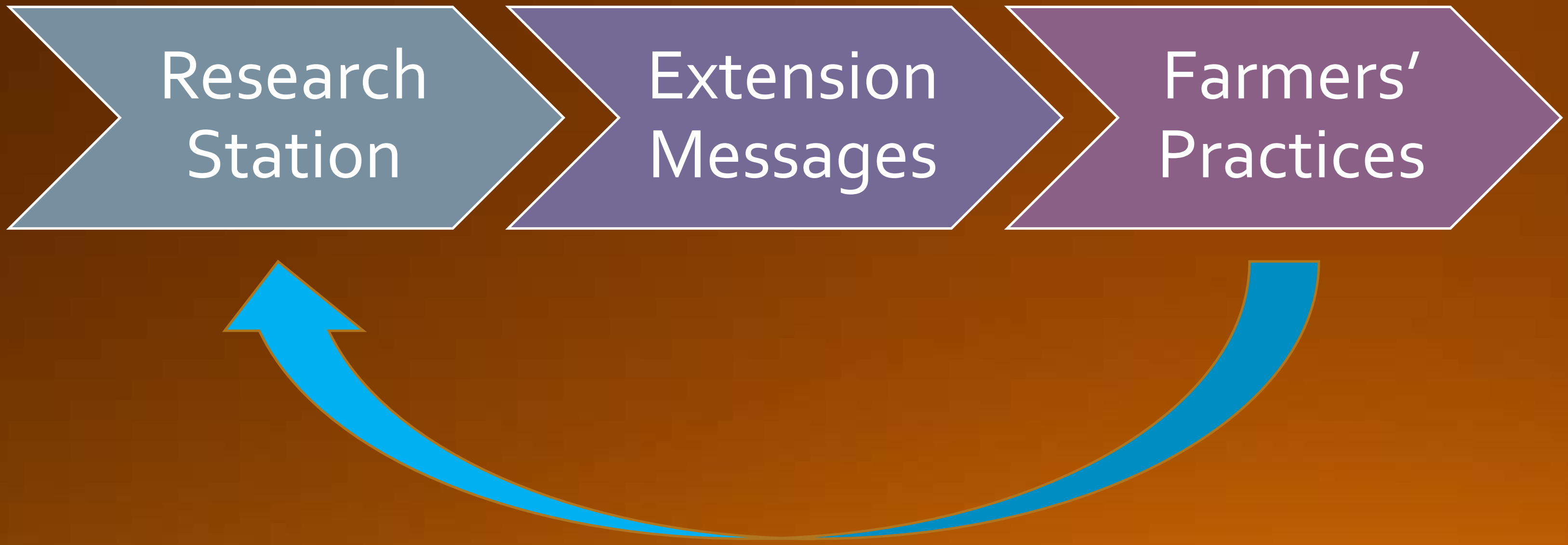
- Going beyond the method
- Attitude and behavior change of facilitator (Chambers, 2008)
  - Humility
  - Listening
  - Ensuring the weakest have a voice

PRA is about knowledge

- In PRA the community is telling the outsiders about their place, their history, their community. And they know all about themselves and they will tell much by using PRA methods. But remember, they still know whatever they didn't tell us. And we don't. We're always the outsider of community knowledge. Keep your questions open and see where they can go.
- Always remember that PRA is about knowledge. Knowledge that the community has, not us.

Steve Michmerhuizen – personal communication

Linear Technology Transfer



PRA requires skill in implementation

- Everything with PRA should be done with the intention of the community putting into the process so that they get something out.
- On the one hand we have a process we want to guide. And on the other we have a community who needs to own this process, call it theirs.
- So, too much push and they shut down and do what we want. Too little guidance and things won't go.

Steve Michmerhuizen – personal communication

Continuum of participation in research

Contractual

farmers hired to run experiments

Consultative

farmers consulted about design & interpretation

Collaborative

regular interaction throughout process

Collegial

researchers strengthen farmers' informal inquiry

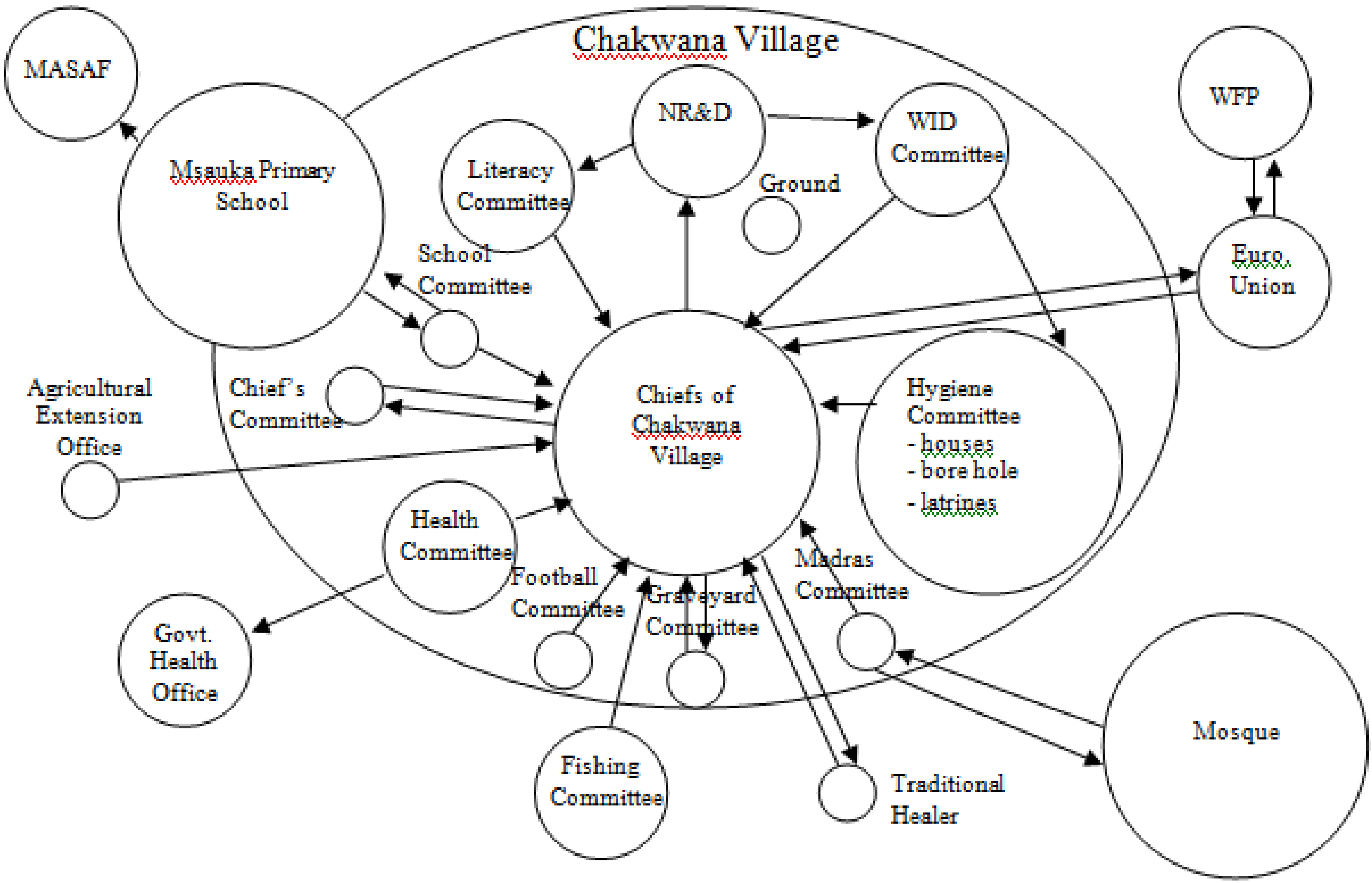
Adapted from Biggs 1989 and Buhler et al. 2005

Participatory Research / Action Research

1. Outside researchers and community members join together in a process of collaborative inquiry
2. Aim is to address real-world issues and practical problems
3. A variety of research methods are used to co-generate knowledge about the problem and possible solutions through iterative cycles of action and reflection

(Greenwood and Levin, 2007; Reason and Bradbury, 2008)

Starting with what you have



An approach, not a method

- Methods can help facilitate effective participation
- Methods themselves are easily coopted by those in control to justify and maintain their position
- Effective participation is best judged by how well it is able to guide effective action.
- Note that focusing too much on achieving the desired action(e.g. adoption of a new practice) can lead to a short-term inability to work towards it.
- Instead consider the values that guide the process, especially democratic communicative space that addresses power imbalances (Reason 2006)

Voting on priorities

Participatory Exercises in SI indicator manual

- Farmer rating of yield/residues/animal production
- Wealth ranking
- Participatory budgeting
- Daily and seasonal labor calendars

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Day 3

Part 2: Presentations and discussion

5 April 2017 SI Assessment Training, Phnom Penh, Cambodia

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Next steps for implementing SI assessments

- What?
- When?
- Who?
- How much?

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