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SUSTAINABLE INTENSIFICATION

Food Security and Agriculture Core Course

Photo: PRICE/Chemonics International



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OBJECTIVES

- Confidence to use of approaches for assessing and strengthening biophysical components enabling agricultural productivity
- Integrate crop, livestock and fisheries production as a bulwark of the food system & food security
- Understand sustainable intensification framework and role of the environment for optimal choices to cope and thrive with shocks





SUSTAINABLE INTENSIFICATION

- Increased productivity on a land, labor, capital basis
- Considers whole-farm & household issues
- Efficient, prudent use of inputs
- Conserve or enhance natural resources
- Increased resilience
- “Livelihood lens” takes into account socio-economic, nutritional, gender & cultural conditions





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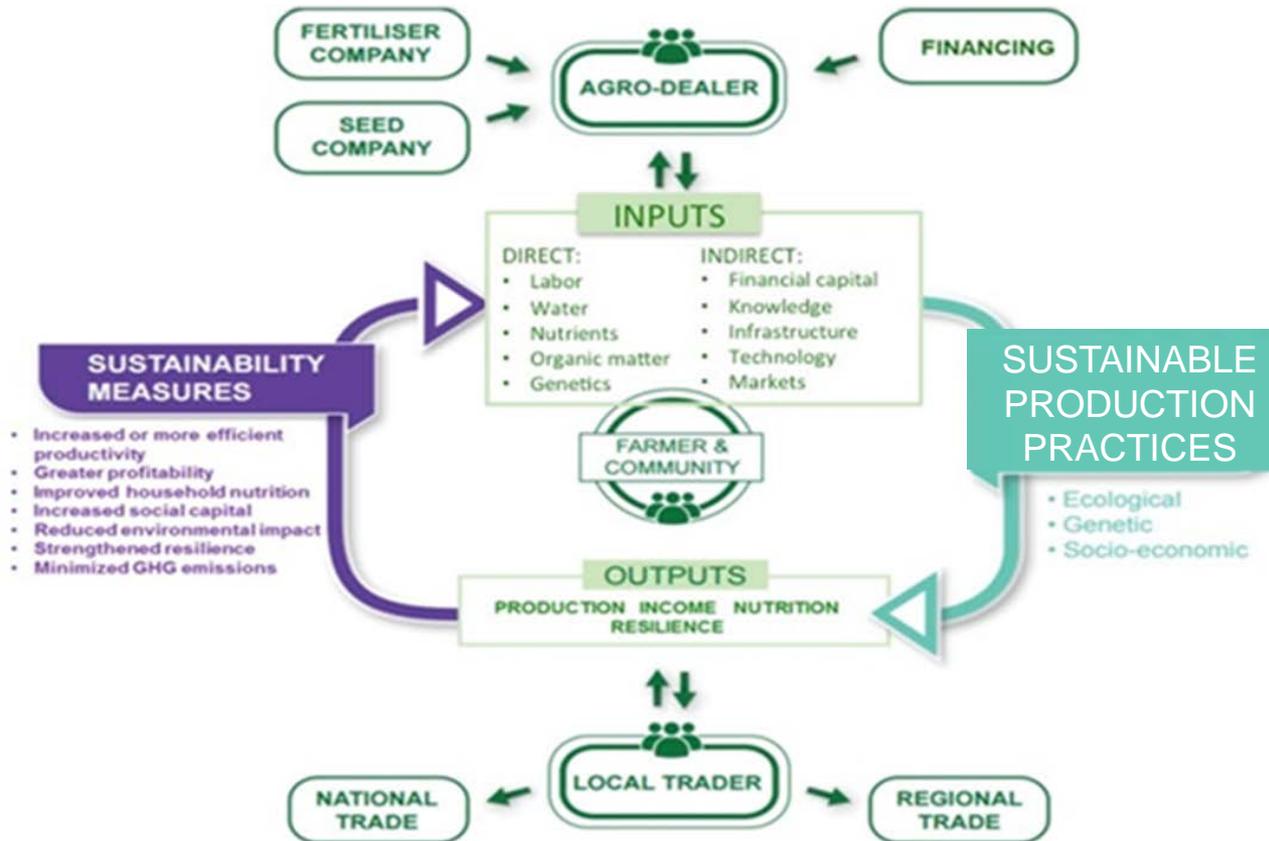


Figure 2. Designing interventions requires a system-wide assessment of the availability of needed inputs, markets and traders, and financial and knowledge capacity. Monitoring of measurable results based on desired outputs allows for mid-course corrections (Adapted from The Montpellier Panel, 2013).



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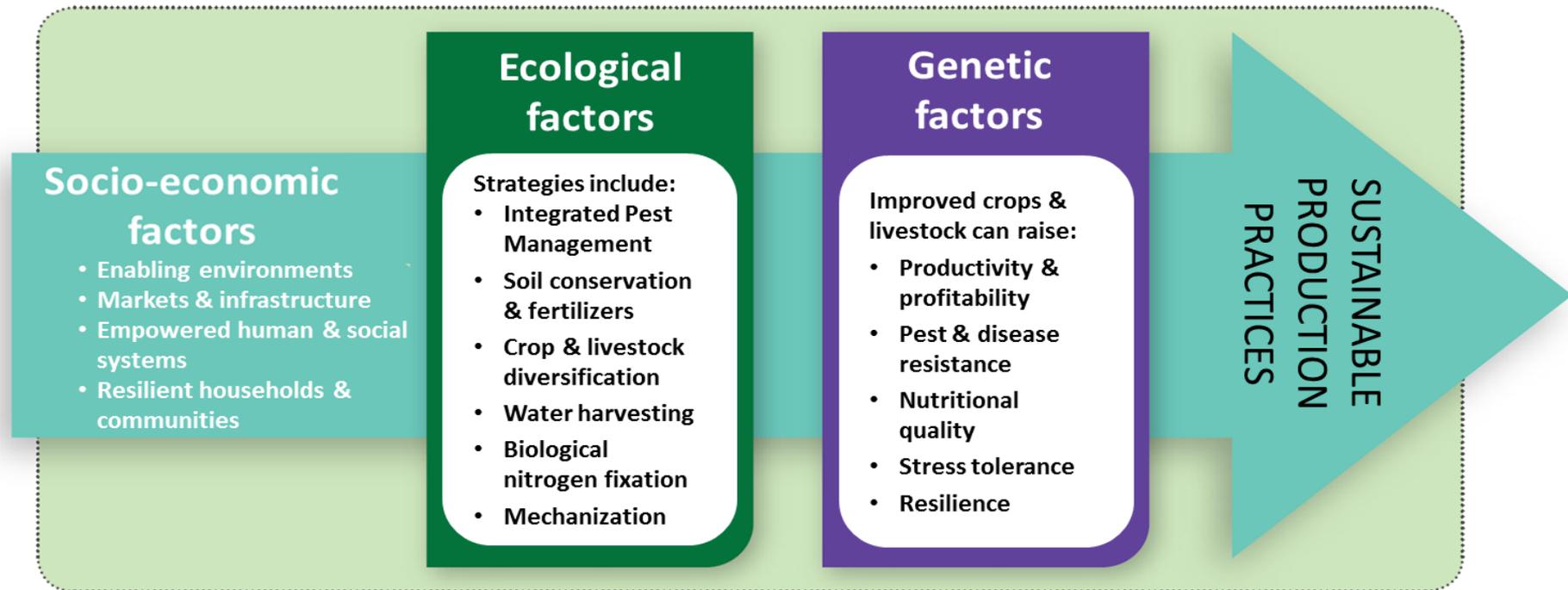
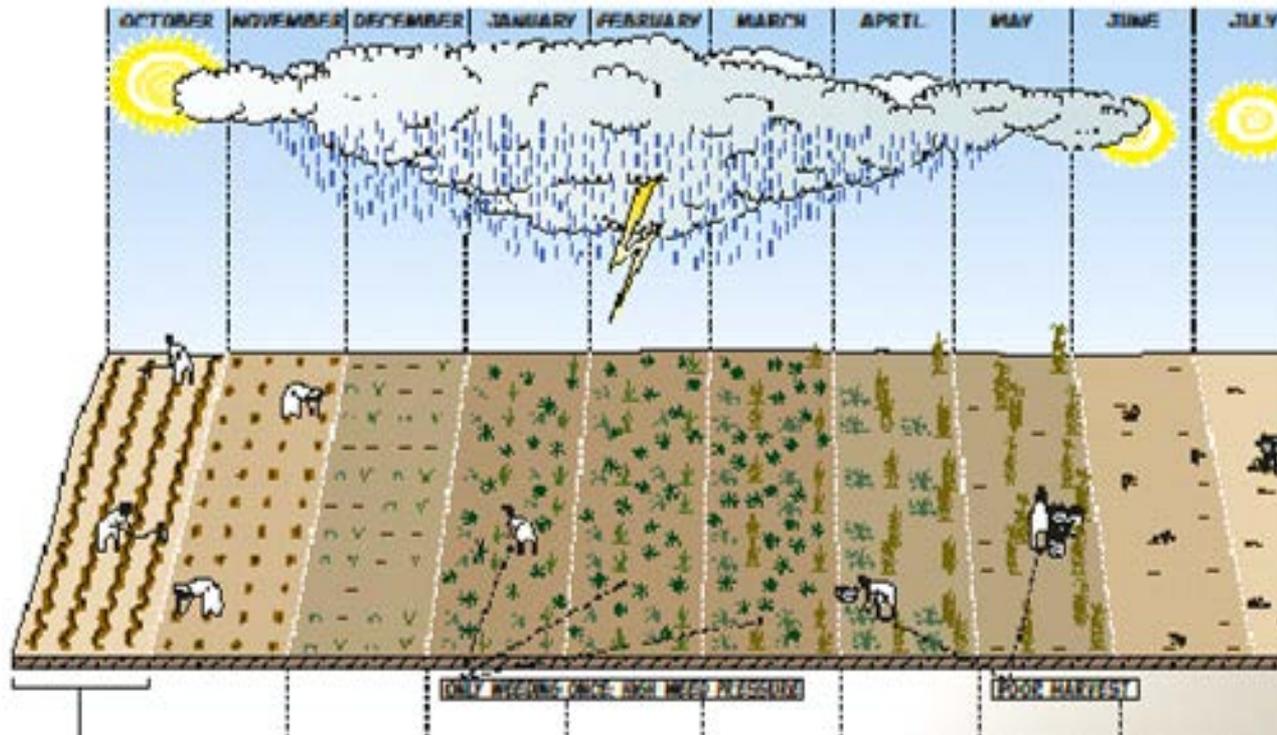


Figure 1. Improvements in socio-economic, ecological, and genetic factors can all contribute to increased productivity. To the extent that this leads to improved economic, environmental, social and human conditions, the increased productivity is more sustainable (Adapted from The Montpellier Panel, 2013).

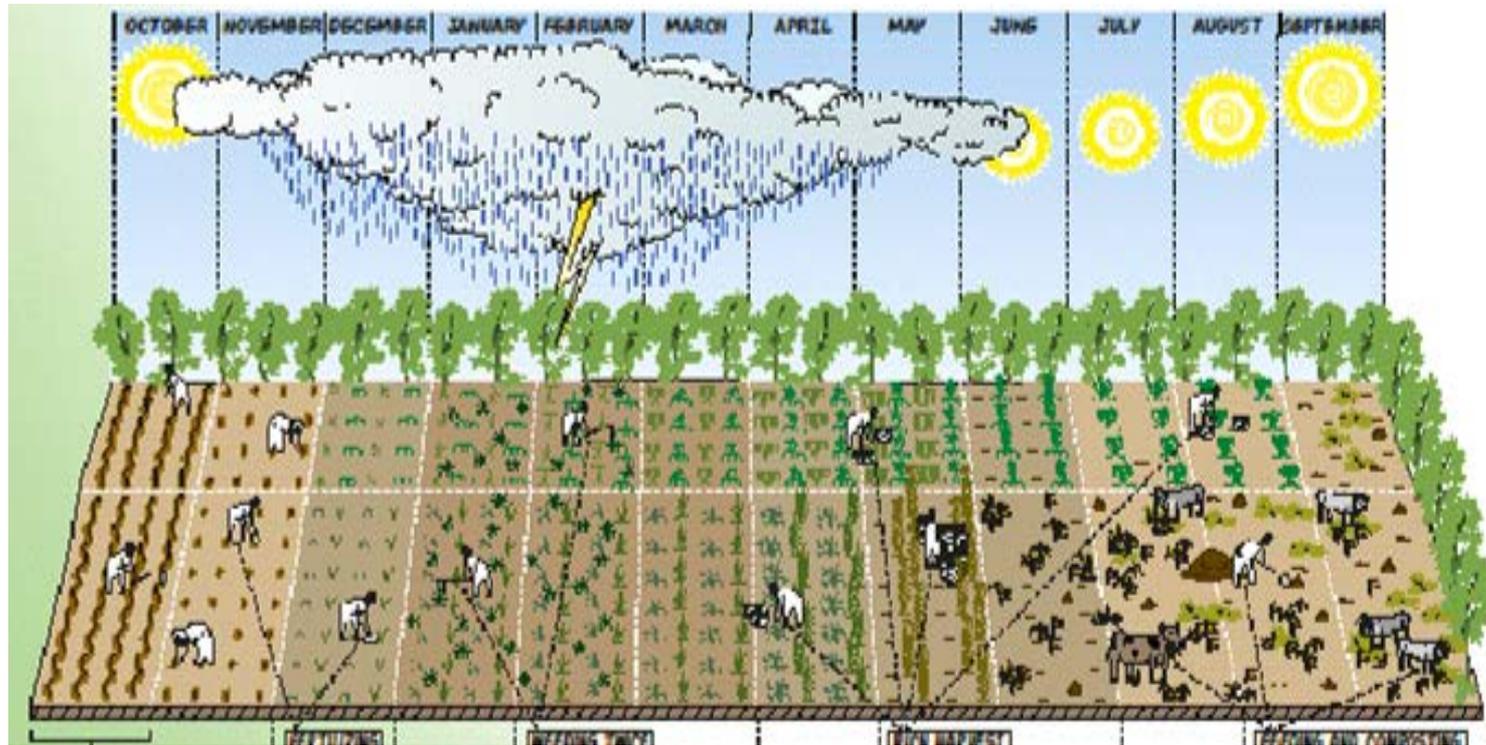


EAST AFRICA MAIZE-LEGUME SYSTEMS: COMMON FARMER PRACTICE



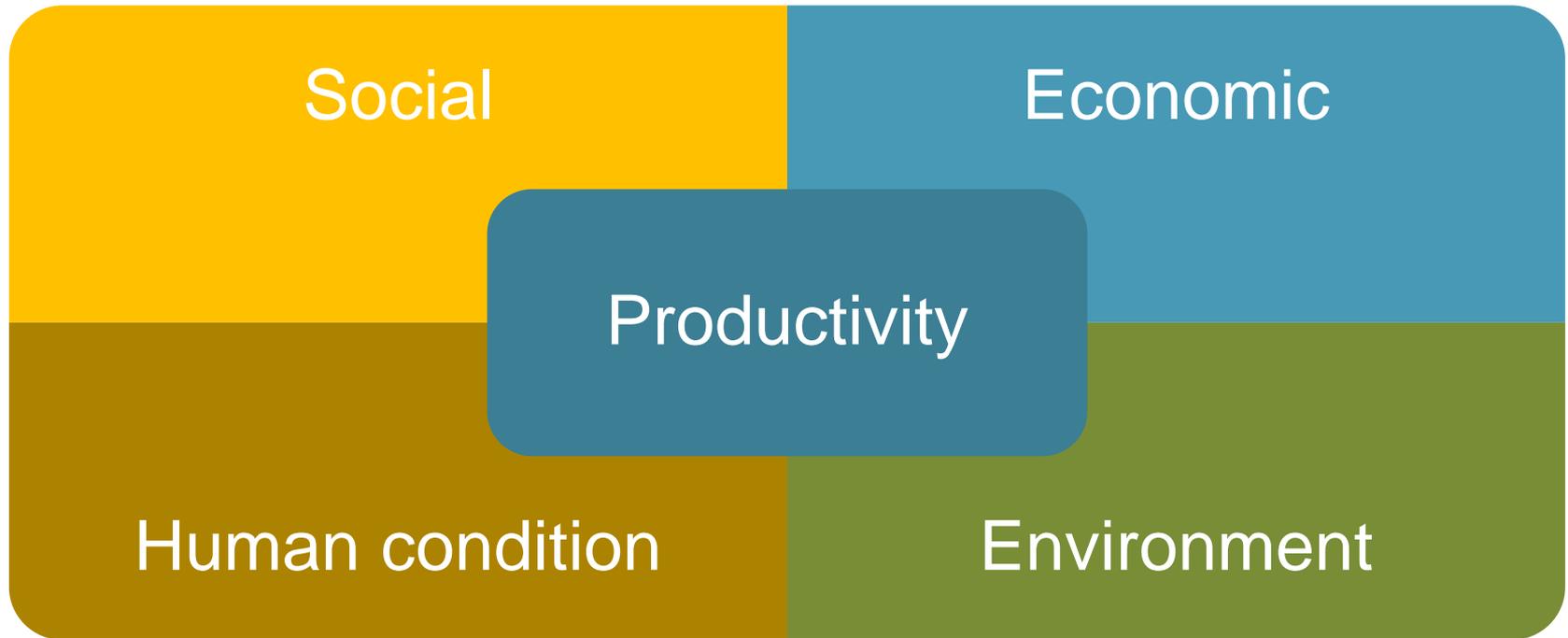


EAST AFRICA MAIZE-LEGUME SYSTEMS: SUSTAINABLE INTENSIFICATION





MULTIPLE SI DIMENSIONS OR DOMAINS





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MALAWI EXAMPLE

Sustainable intensification leading to reduced poverty, improved nutrition, & greater resilience



Photo credit: Jim Richardson



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Rhoda Mang'anya

“In the past, I was growing maize for food. My husband was the one responsible for school fees for my children. Soon after he died I took over his responsibilities.”

Photo credit: Jim Richardson



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She needed to produce enough maize to feed and support 5 people but her degraded land “produced only 3 bags (~300 kg per hectare) of grain ... the main problem was soil infertility.”

Photo credit: Jim Richardson



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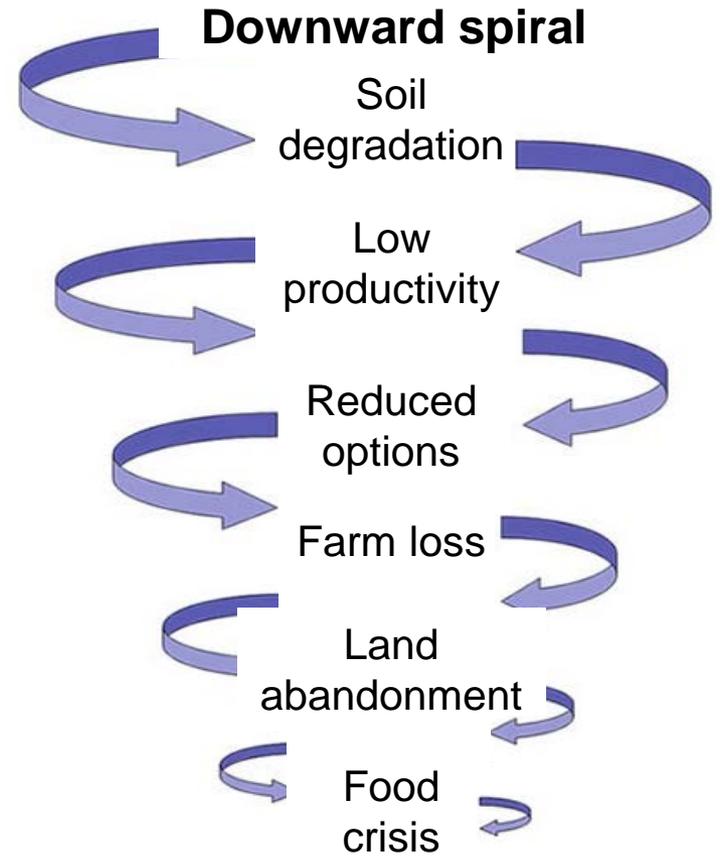


Photo credit: Jim Richardson



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Rhoda began growing soy beans and pigeon peas to improve soil health and, "... I was assisted by a local NGO and extension services with 5 tree species which I planted in my field."

SOCIAL

Photo credit: Jim Richardson



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Complementary use of resources

Extending rooting depth & use of sunlight

Greater crop productivity potential led to use of improved varieties and fertilizer

ENVIRONMENT

Photo credit: Jim Richardson



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“I used to produce 3 bags of maize but now get over 40 ... this field has been improved in terms of soil fertility.”

CROP PRODUCTIVITY

Photo credit: Jim Richardson



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“I started keeping pigs and goats to continue support for my children in school and buy salt, sugar & soap.”

ECONOMIC

Photo credit: Jim Richardson



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Trees improved the soil health and provide other benefits ...
livestock fodder

Photo credit: Jim Richardson



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“... pigs and goats give me a lot of animal manure that I apply to my field.”

She can leave crop residues in the field because she has enough livestock feed.

Photo credit: Jim Richardson



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Fuelwood is a significant 'livelihood' factor.

Photo credit: Jim Richardson



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Increased income & crop and animal productivity (ideally) leads to improved nutrition



HUMAN CONDITION

Photo credit: Jim Richardson



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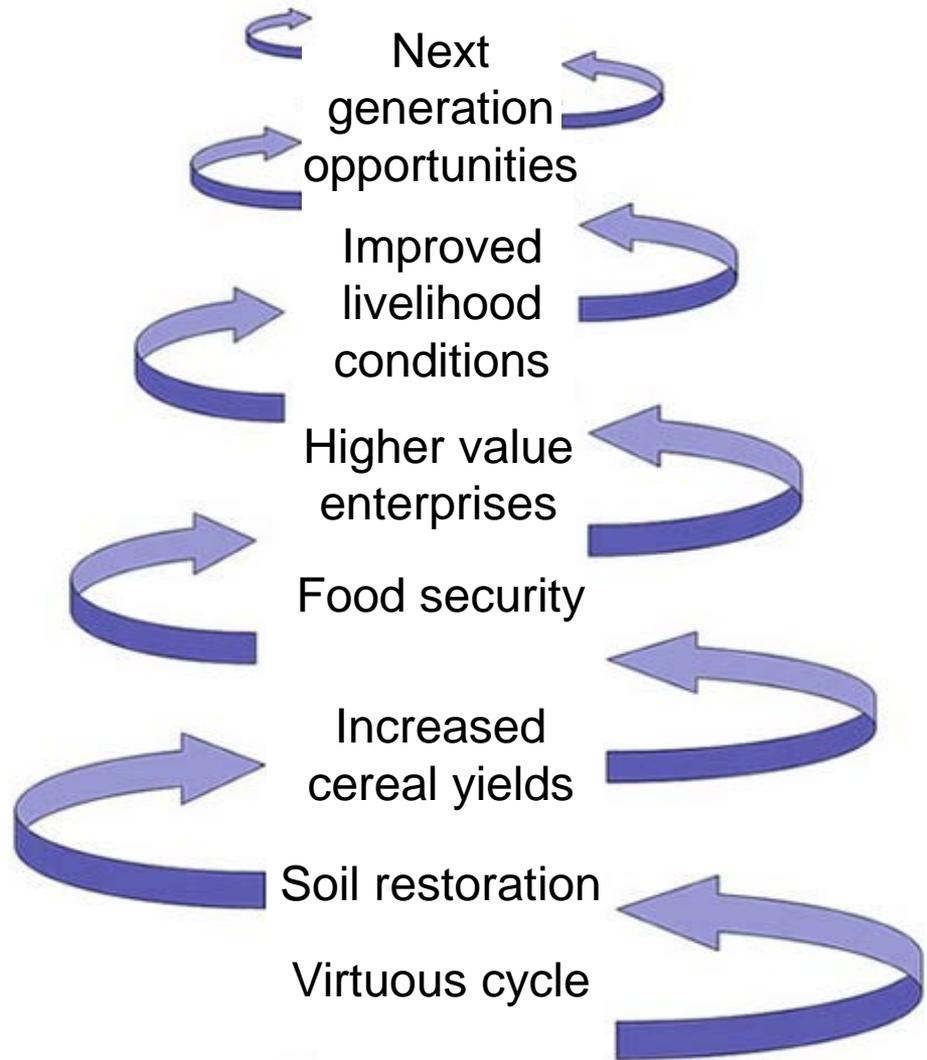


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Photo credit: Jim Richardson



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ASSESSING SUSTAINABLE INTENSIFICATION

- How do we distinguish between “sustainable intensification” efforts?
- How do we consistently assess trade-offs (environment vs. economic)?
- How can we work across development projects and regions?
- How do we practically measure “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





Example from Malawi maize systems:

- Continuous unfertilized maize
- Fertilized maize – Continuous maize with 70 kg N/ha
- 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)

(Snapp et al., 2016)





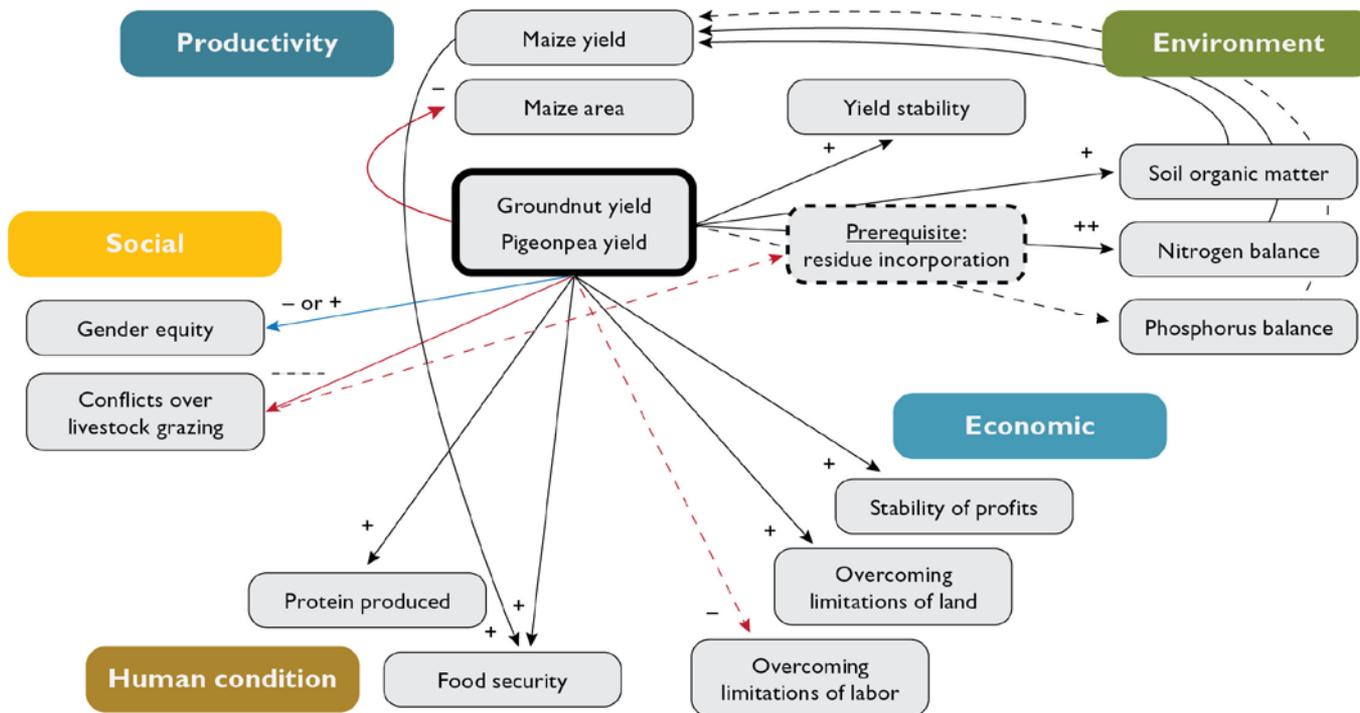
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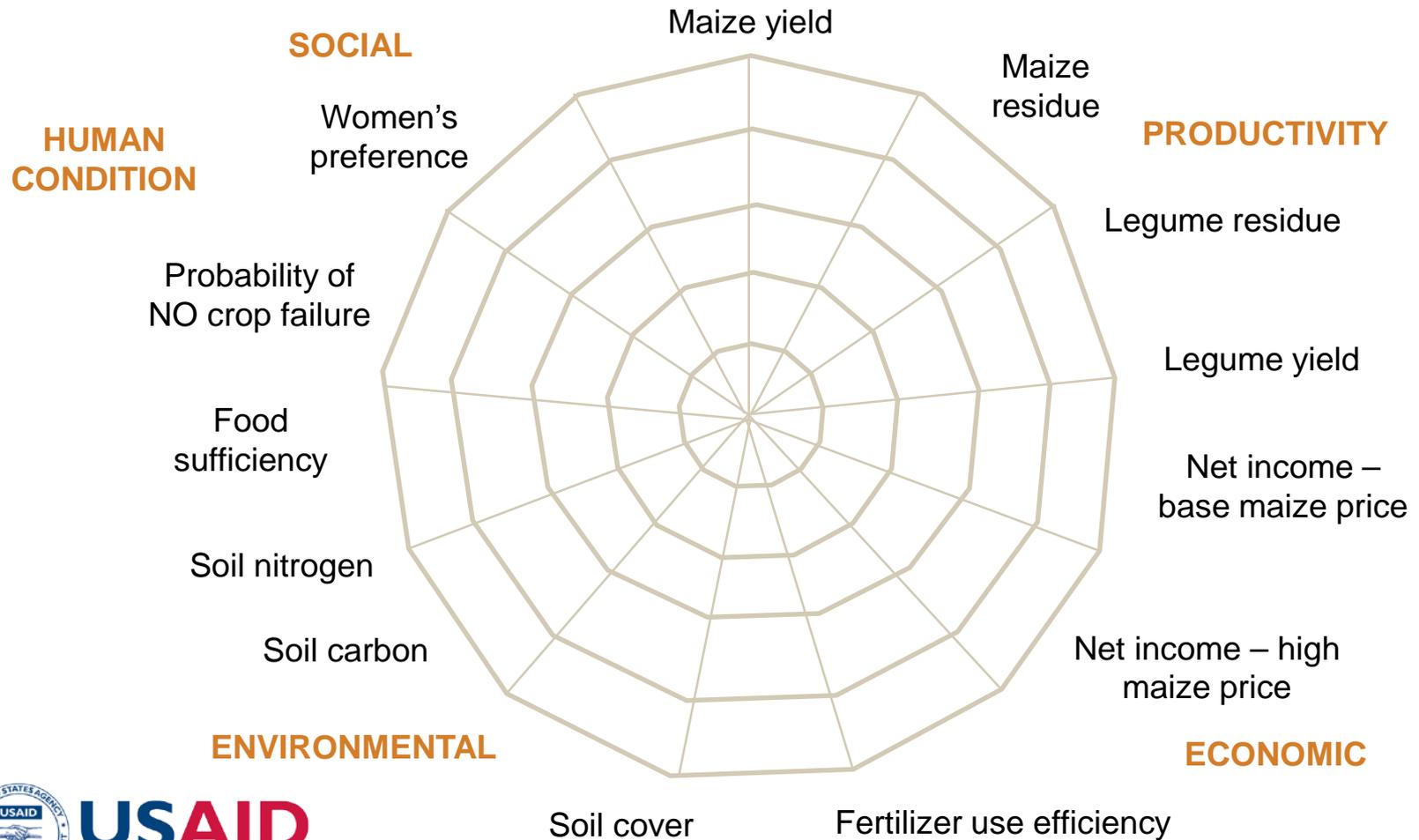
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TRADE-OFFS AND SYNERGIES OF DOUBLED-UP MAIZE-LEGUME ROTATION SYSTEM





EAST AFRICA MAIZE-LEGUME SYSTEMS

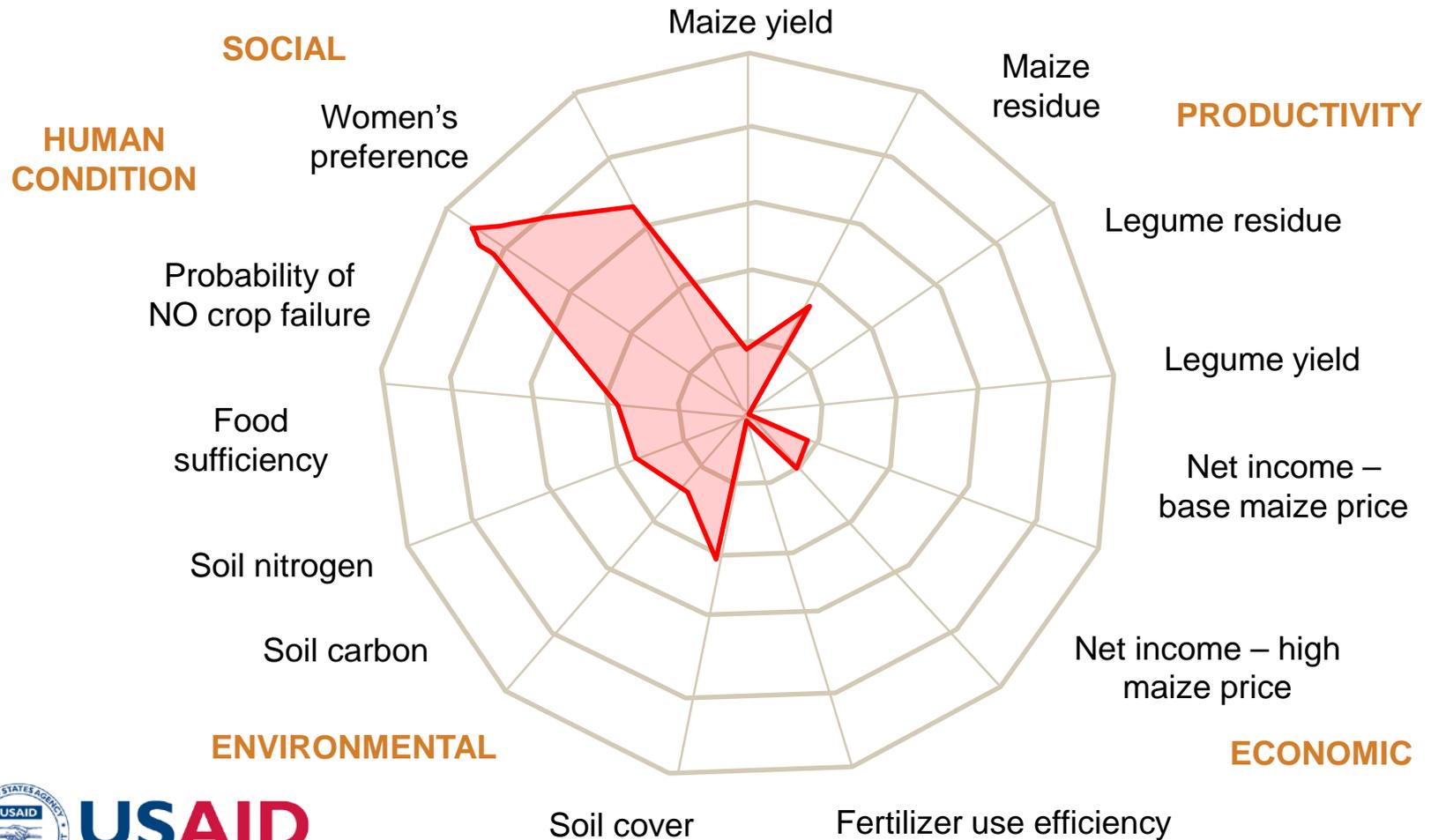




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— TYPICAL FARMER PRACTICE



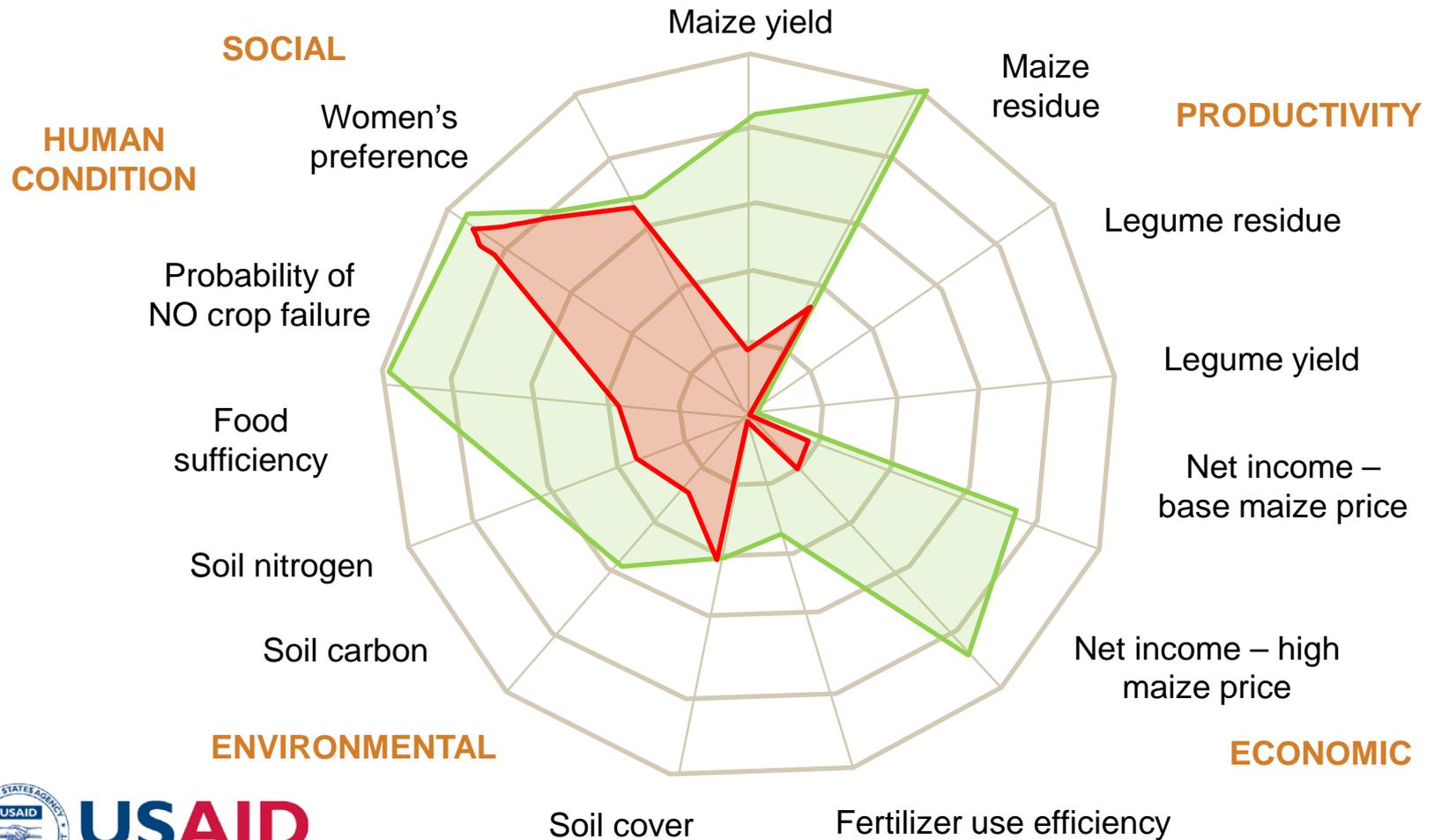
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— TYPICAL FARMER PRACTICE
 — FERTILIZED CONTINUOUS MAIZE



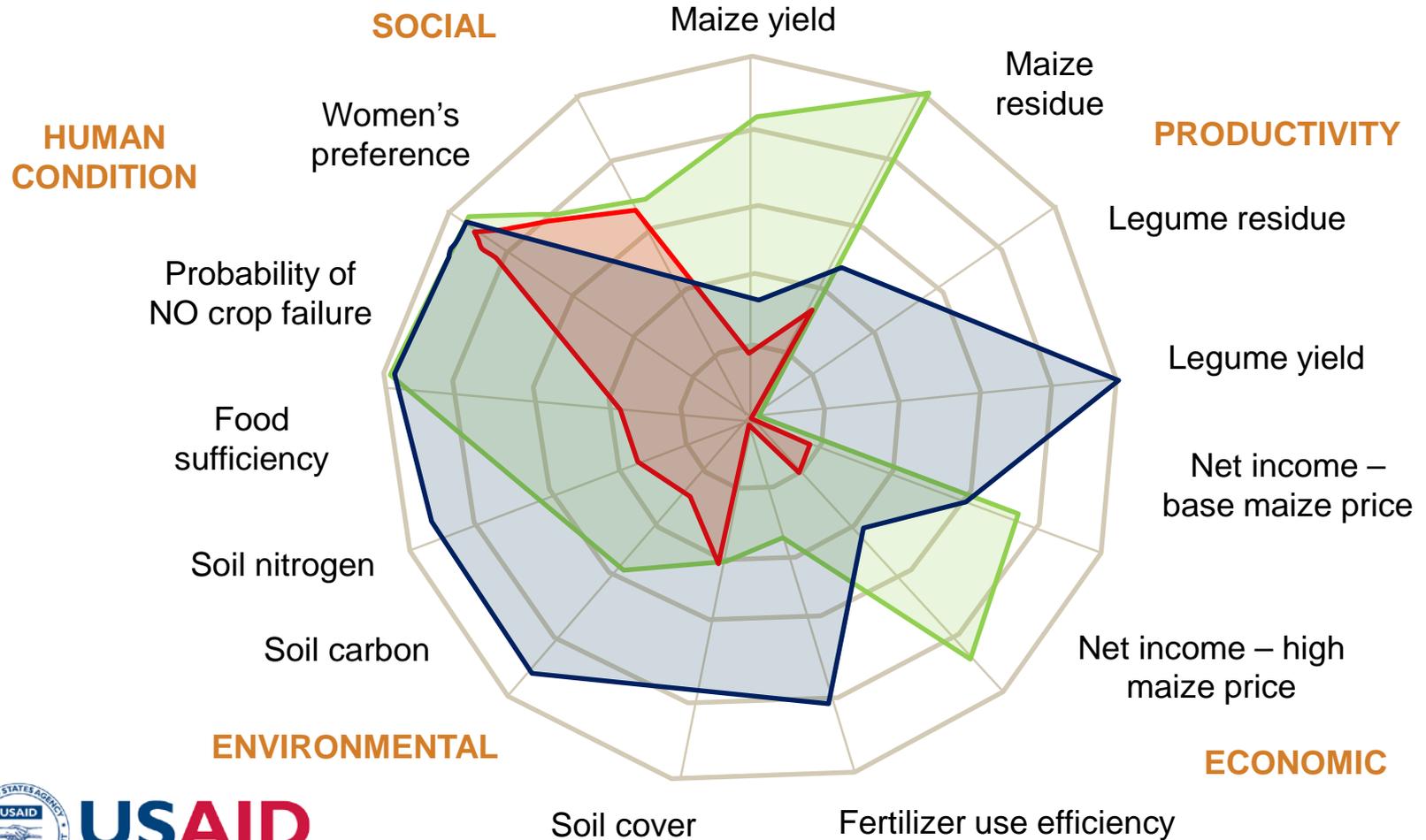
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- TYPICAL FARMER PRACTICE
- FERTILIZED CONTINUOUS MAIZE
- DOUBLED-UP LEGUME INTERCROP

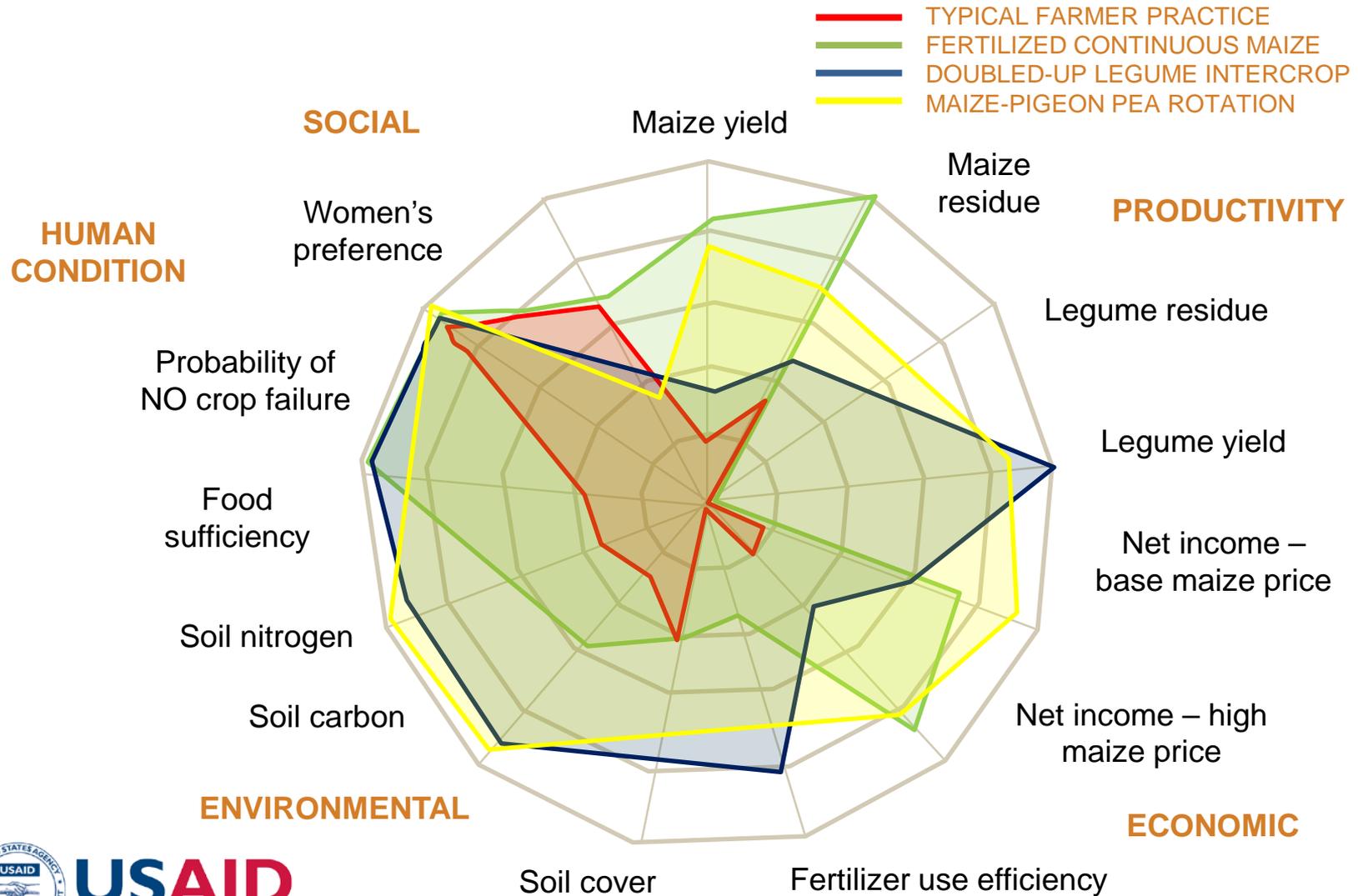


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LIVESTOCK, ANIMAL SOURCE FOODS, AND SUSTAINABLE PRODUCTIVITY GROWTH

OUTLINE

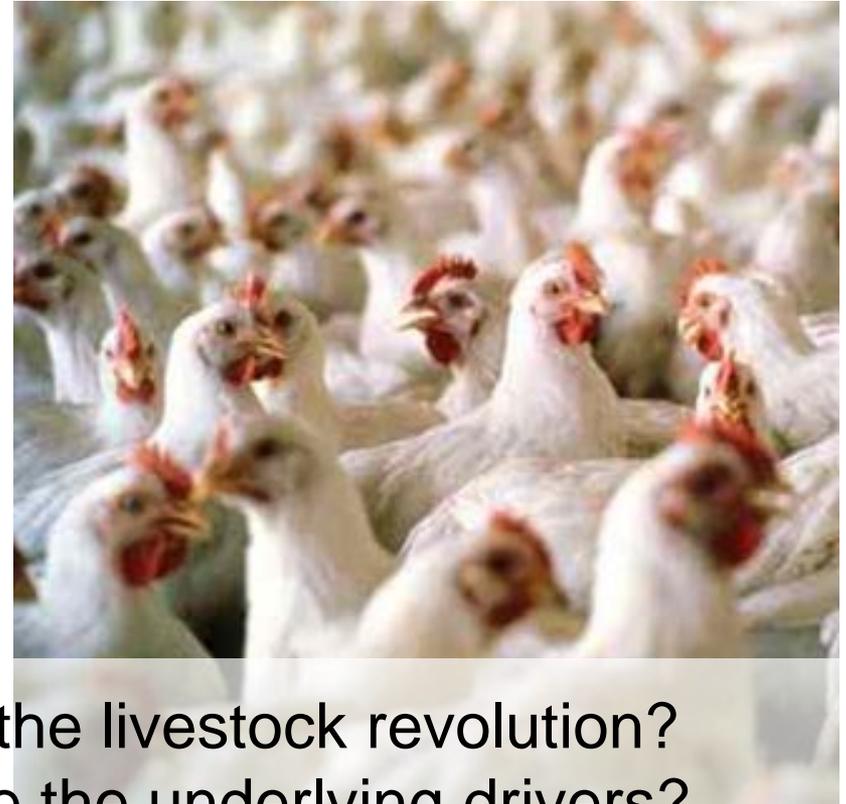
- The Livestock Revolution
- Livestock Production Systems and multi-functionality
- Options to improve livestock Productivity



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LIVESTOCK REVOLUTION

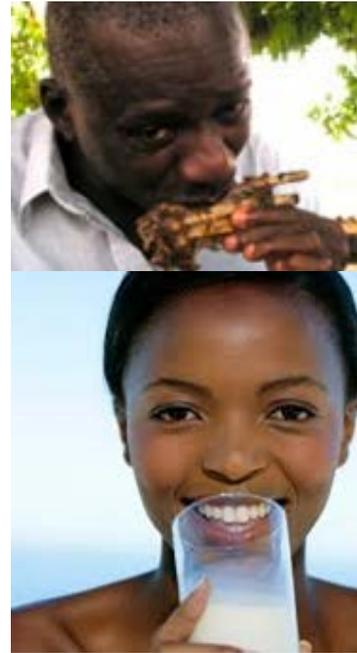
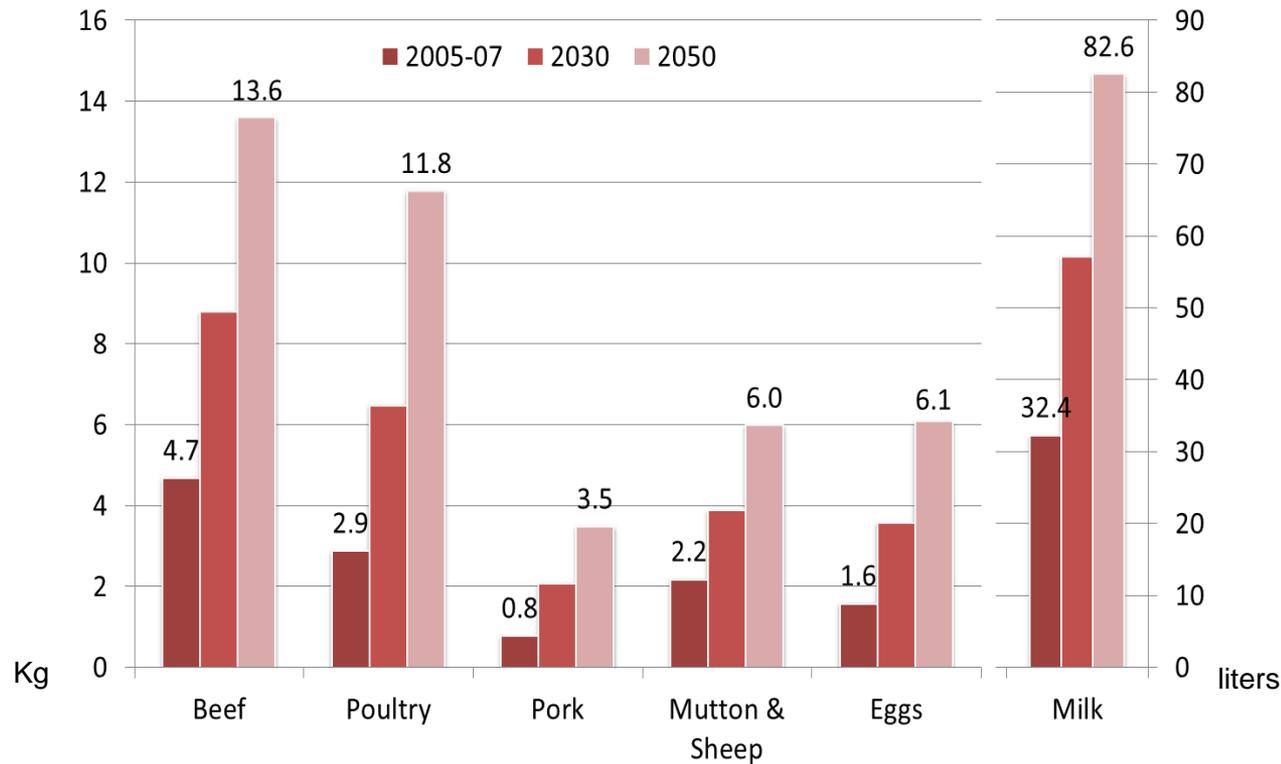


What is the livestock revolution?
What are the underlying drivers?





RISE IN DEMAND - AFRICA



PROVIDING LEADERSHIP IN THE DEVELOPMENT OF ANIMAL RESOURCES IN AFRICA





HOW WILL DEMAND FOR LIVESTOCK COMMODITIES IN DEVELOPING ECONOMIES BE MET?

Scenario #1

Meeting livestock demand by
importing livestock products

Scenario #2

Meeting livestock demand by
importing livestock industrial production know-how

Scenario #3

Meeting livestock demand by
transforming smallholder livestock systems



1.2 Bn people rely on livestock livelihoods
42% of the worlds poor are livestock keepers

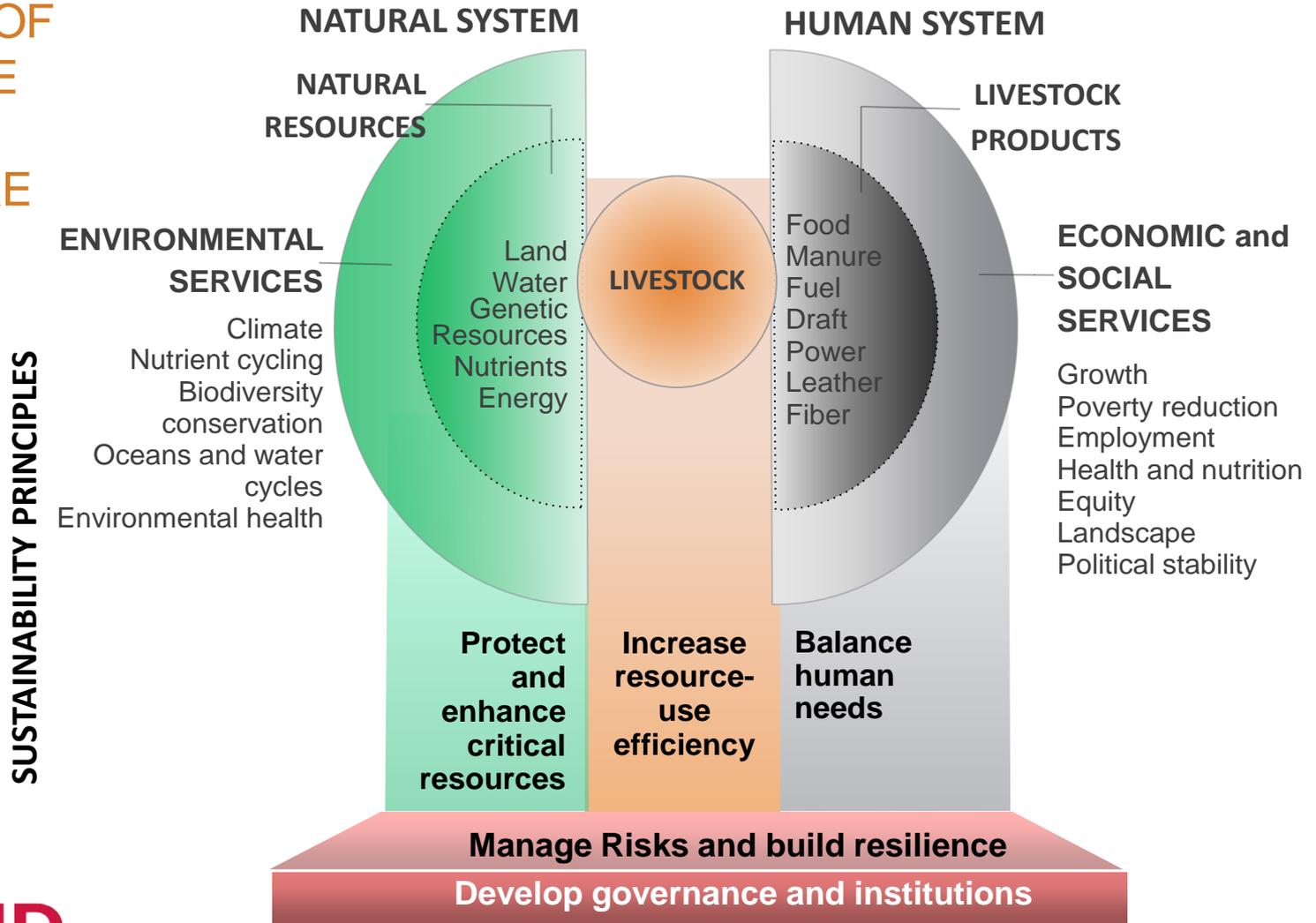




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PRINCIPLES OF SUSTAINABLE FOOD AND AGRICULTURE



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LIVESTOCK PRODUCTION SYSTEMS



Agro-pastoral and extensive grasslands





LIVESTOCK PRODUCTION SYSTEMS



Small holder mixed livestock – crop production





LIVESTOCK PRODUCTION SYSTEMS



Urban/Peri-urban
livestock production





LIVESTOCK PRODUCTION SYSTEMS

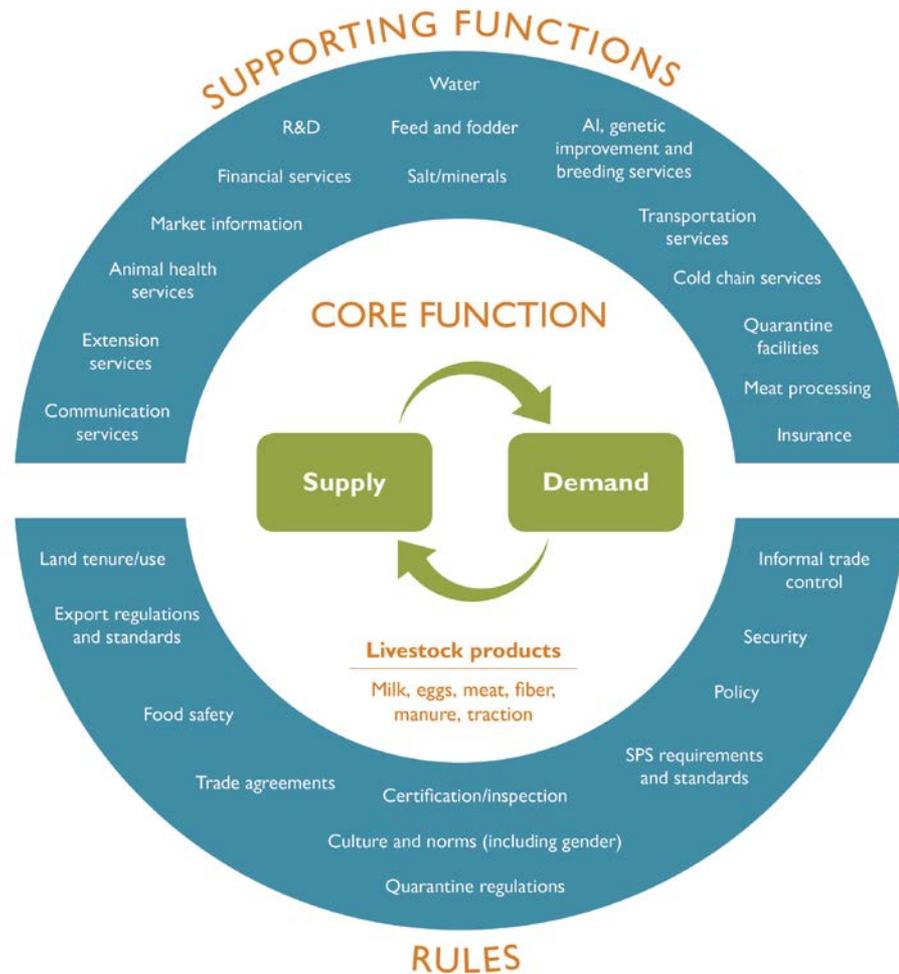


Intensive/Industrial production





MARKET SYSTEM MAPPING FOR LIVESTOCK





MULTI-FUNCTIONAL ROLE OF LIVESTOCK

Provide nutrient dense ASFs within diversified diets

Generate income through markets for animals, ASFs and other animal products and services

Enhance crop production traction, expanding cropping area, improve soil fertility nutrient cycling via manure

Financial and risk management services assets that can serve as financing for expansion and diversification of production activities and non-livestock livelihoods, that spread risks, promote savings and can secure informal credit

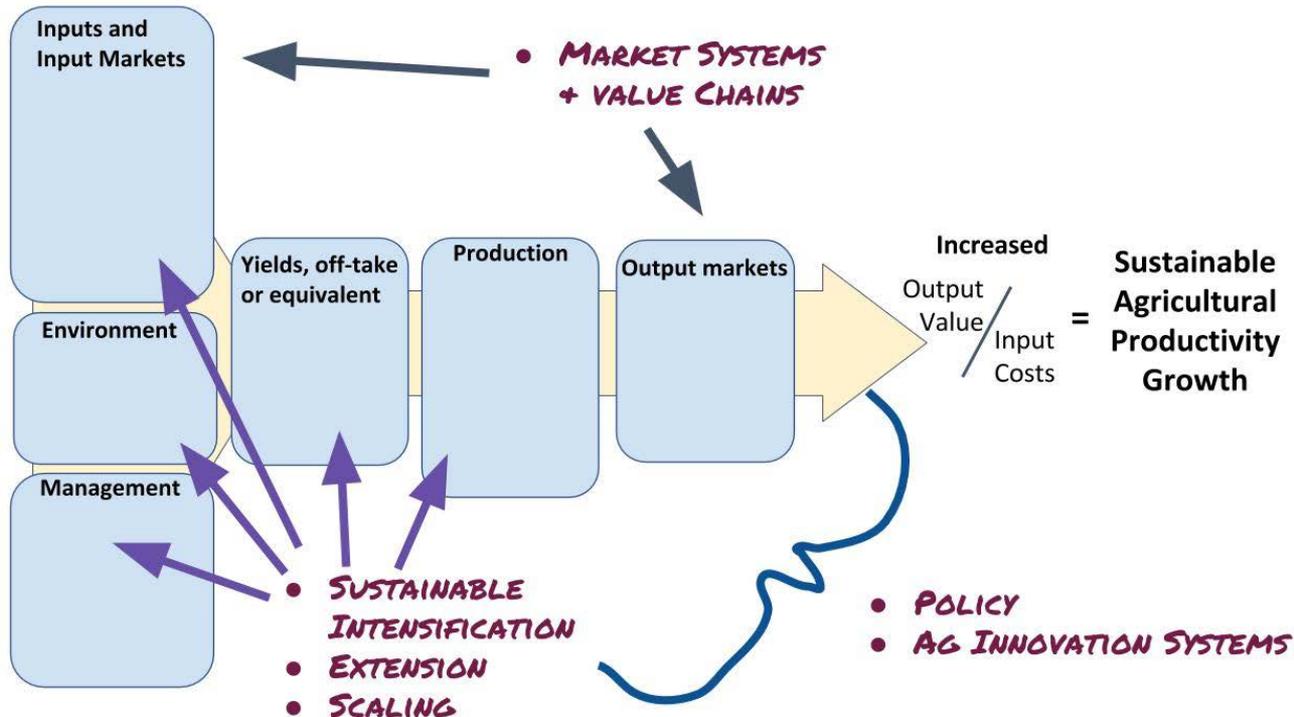
Provide transportation (water, people, goods); Labor saving

Build social capital and informal safety nets
Formal and informal networks, producer groups and linkages





FRAMEWORK: COMPONENTS CONTRIBUTING TO INCREASED AGRICULTURAL PRODUCTIVITY





HOW CAN LIVESTOCK PRODUCTIVITY BE INCREASED?

Inputs and services

- Animal Health
- Animal Feeds (including integration with crop byproducts)
- Research and Extension

Improved farm management

- Animal husbandry and good production practices (including agro-ecology)
- Productivity improvements in crop agriculture and integration of crop-livestock production systems: linked to gains in animal nutrition

Improved genetics and breeding products and services

- Cross-breeding and Artificial Insemination (AI): promote hybrid vigor, and greater genetic production potential
- Selective breeding and genetic modification: enhancing desirable traits for disease resistance and tolerance of climatic extremes





HOW CAN LIVESTOCK PRODUCTIVITY BE INCREASED?

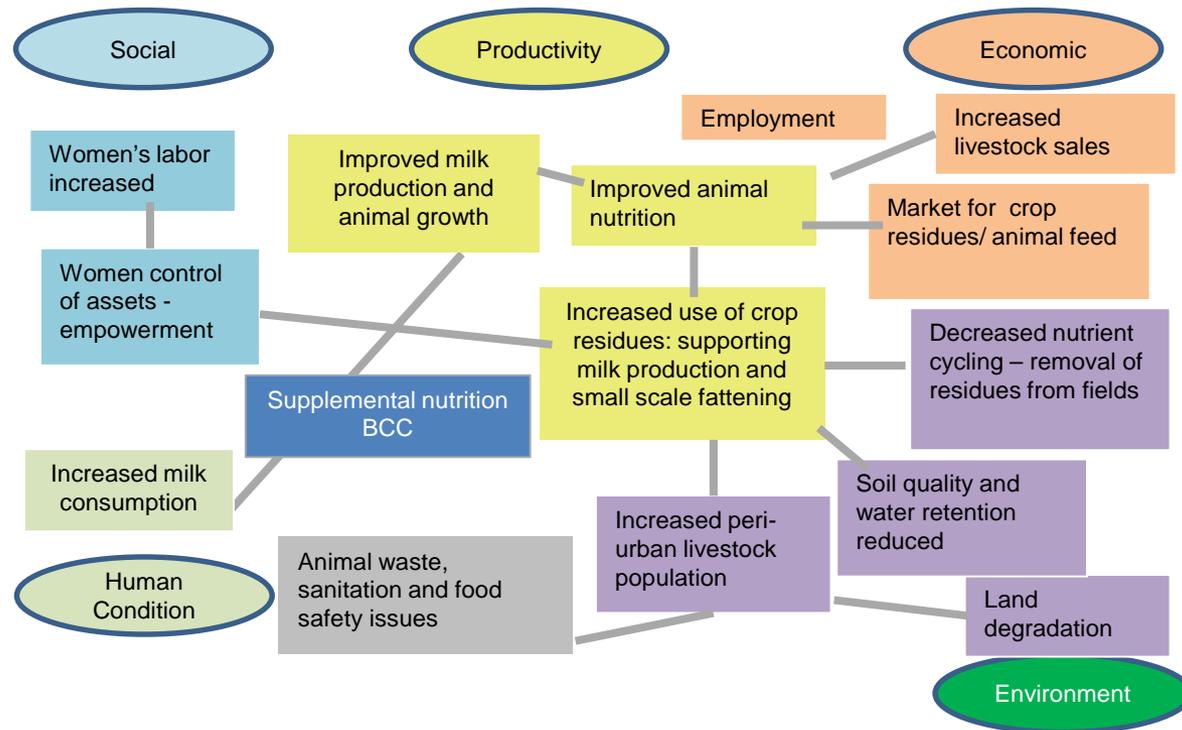
Supportive enabling environment

- **Efficient market systems** (link to market systems session)
- Stakeholder relationships/interactions, coordination and collaboration
- **Supportive Policy Framework**
- **Labor and capital** returns on investments need to be considered
- **Secure land tenure** and access to other natural resources, appropriate land-use planning and management: encourages investments in improving productivity, ensures equity of benefits
- **Socio-economic factors** including equity, cultural acceptance, building social capital (e.g., through producer groups)



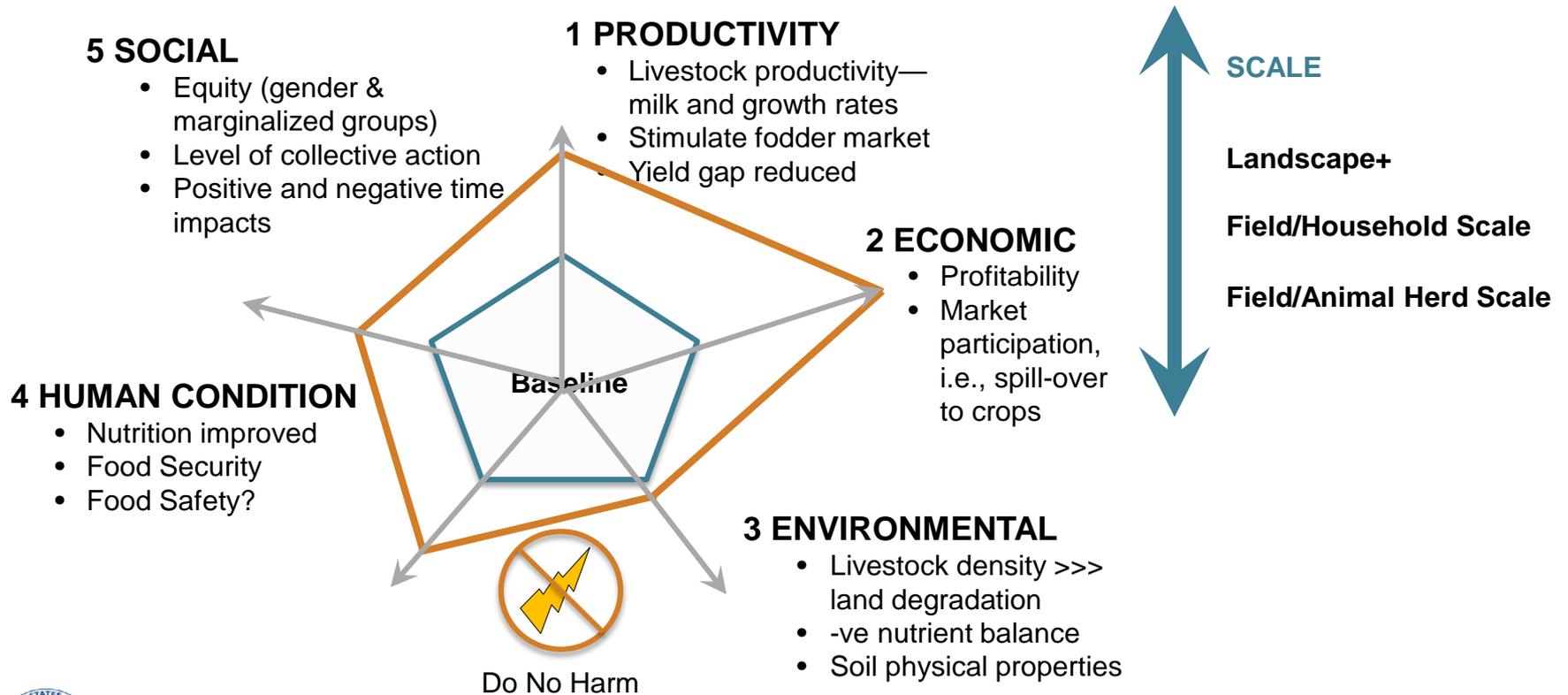


EXAMPLE: INCREASED USE OF CROP RESIDUES AS ANIMAL FEED INPUT





ANTICIPATED IMPACT OF INTENSIFIED USE OF CROP BYPRODUCTS





KEY TAKEAWAYS

- There is increasing demand for ASF (Livestock Revolution)—meeting this demand will require increases in sustainable productivity and narrowing the yield gap
- Adopt a systems approach: describe system characteristics, comparative advantages and constraints
- Consider important interactions between livestock and crops
- Keep in mind the multi-functional nature of livestock systems
- Consider interactions between domains to facilitate analysis, design and monitoring and to foster an inter-disciplinary approach—aim for a balanced impact across the domains
- Natural resources, inputs and markets provide the engine for productivity growth. Policy and governance provide the direction to ensure equity and sustainability
- Achieving optimum solutions in complex systems requires multi-stakeholder analysis and collaboration





AQUACULTURE AND FISHERIES

- How fish production for income and nutrition can be enhanced while maintaining environment and social
- Importance of fish in attaining GFSS





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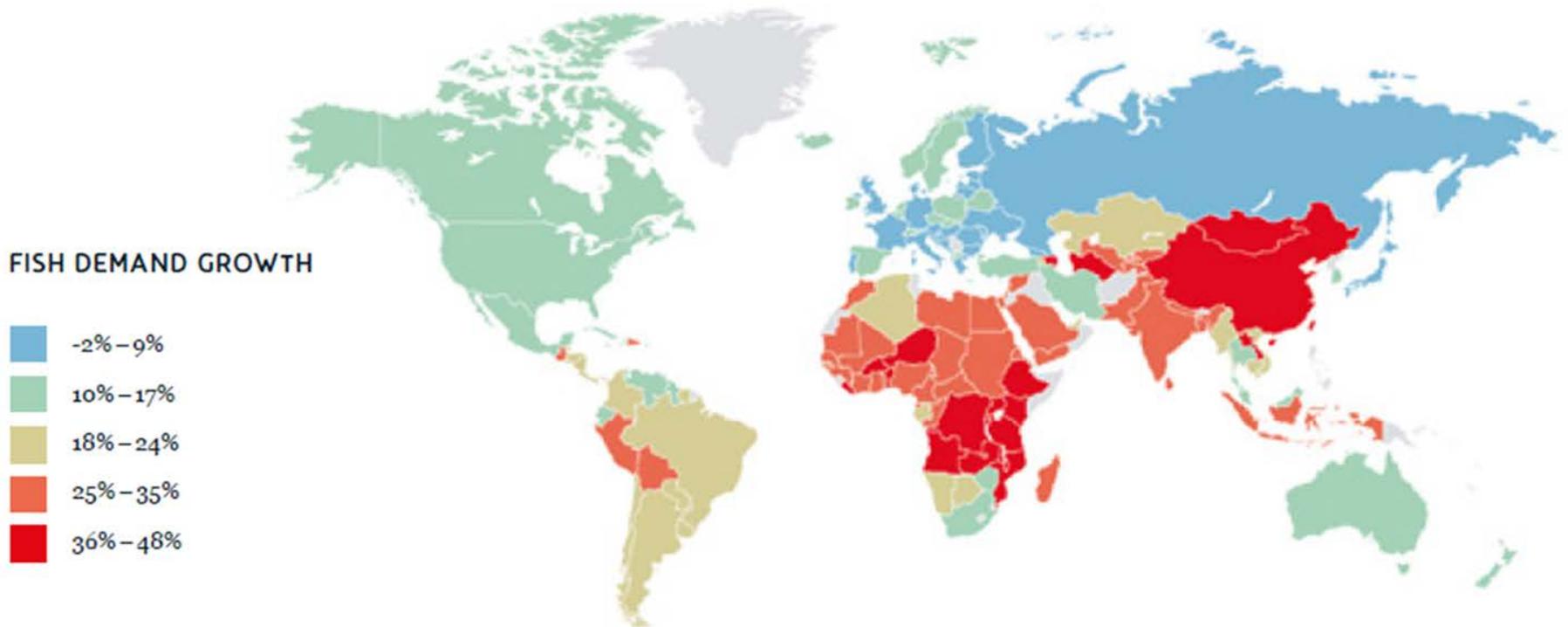
WHERE IS FISH DEMAND?



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GROWTH IN OVERALL REQUIREMENTS FOR FISH

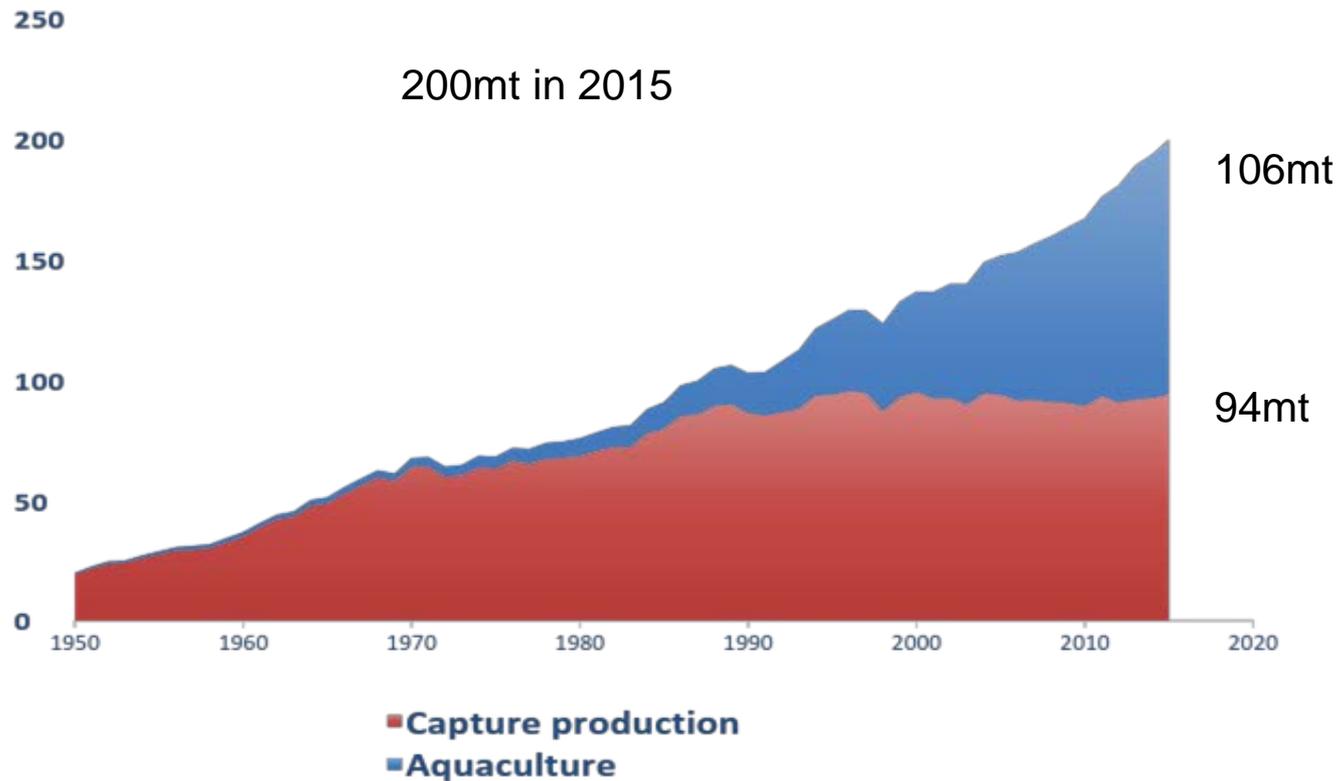


Source: Cai (2011)



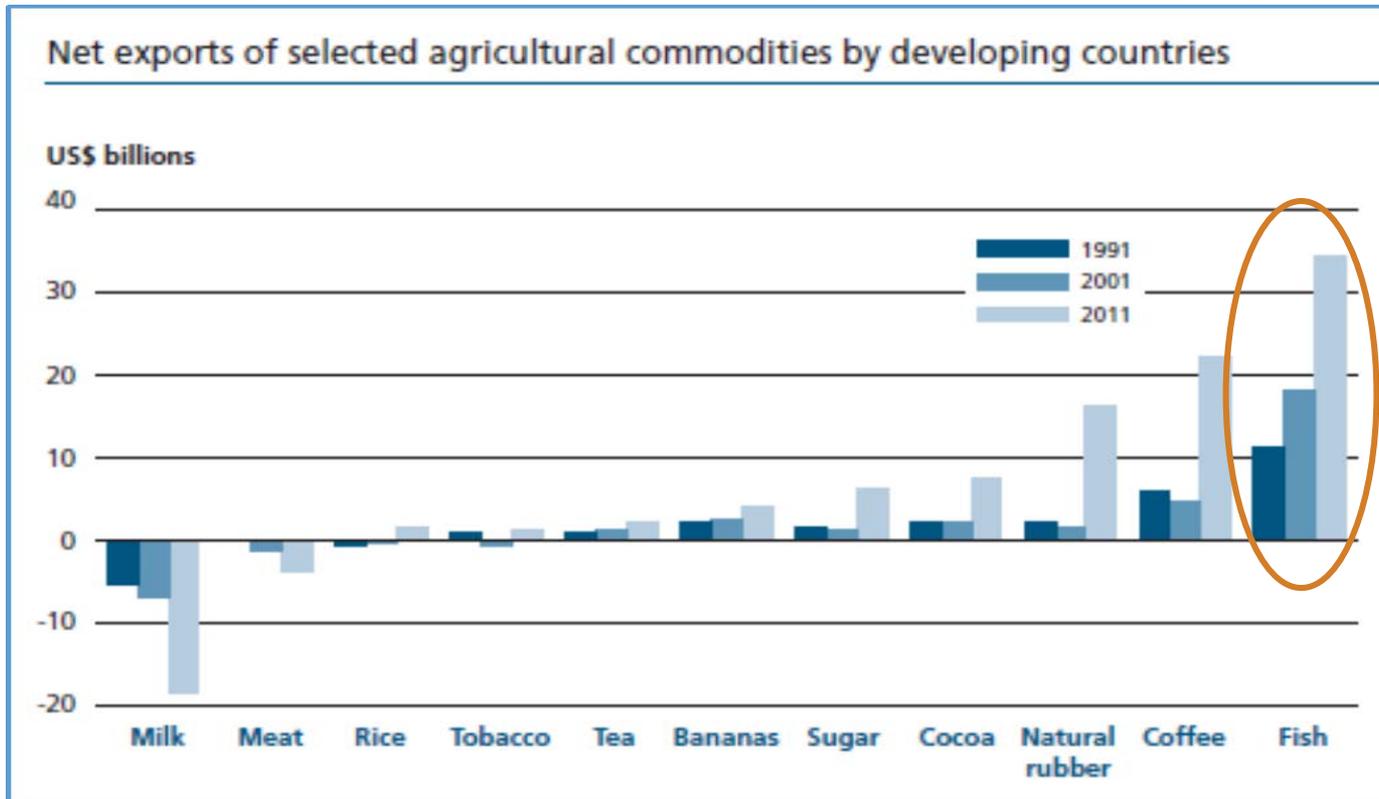


WHAT IS THE GLOBAL FISH SUPPLY?





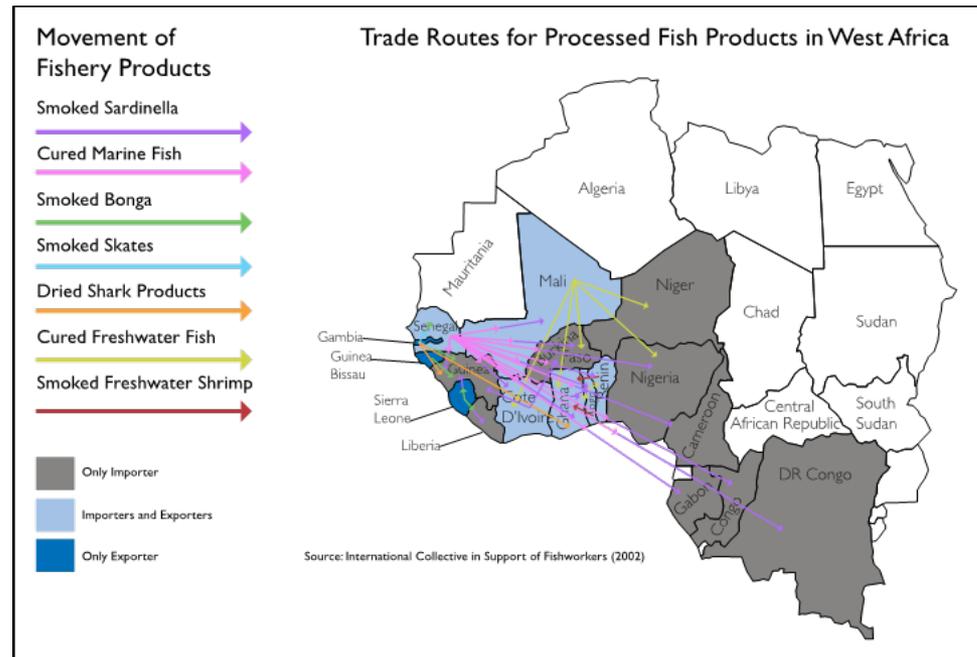
GLOBAL TRADE IN FISH





REGIONAL FISH TRADE SUPPORTS FOOD SECURITY AND NUTRITION

- In West Africa, the informal artisanal fish trade is often undertaken by disadvantaged populations, particularly women, and provides important social and economic benefits.
- More research is needed on informal fish trade routes and their contributions to local food security, household nutrition and livelihoods.



Sources: ICSF 2002, WorldFish 2015, Ayilu et al. 2016





AQUACULTURE IS A HIGHLY DIVERSE SECTOR

- Many species
- All environments
- Multitude of systems
- Array of practices
- Different scales of operation





HEALTH BENEFITS OF EATING FISH

- FAO estimates that fish provide almost 20% of average per capita animal protein intake for more than 3 billion people.
- Fish, particularly when eaten whole, is a significant source of essential vitamins, minerals and fats.
- In several African and Asian countries, including Bangladesh, Ghana, Senegal, Sierra Leone and Indonesia, fish contributes at least 50% of animal protein intake.

*Fish is a primary source of essential nutrients—such as DHA, an omega-3 fatty acid that is critical for early brain development for pregnant mothers and children. **A large study in Denmark demonstrated that maternal fish consumption during pregnancy and throughout breastfeeding is associated with better early child development.***





LIVELIHOODS

- Fisheries and aquaculture sector supports the livelihoods of 12% of the world's population.
- 60 million people are employed as fishers and fish farmers
- Approximately 50% of seafood workers are women, often engaged in post-harvest processing
- Approximately 90% of all people directly dependent on capture fisheries work in the small-scale fisheries sector

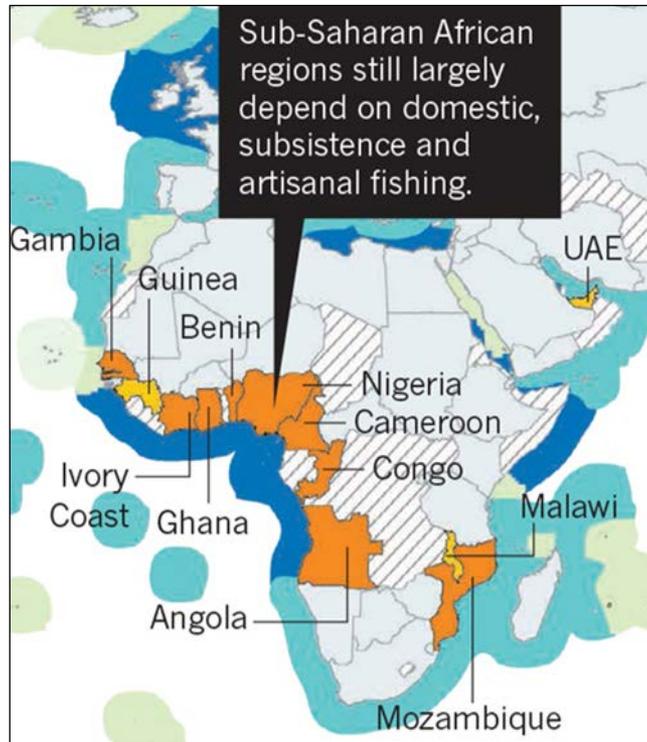


Source: *State of World Fisheries and Aquaculture, 2016.*

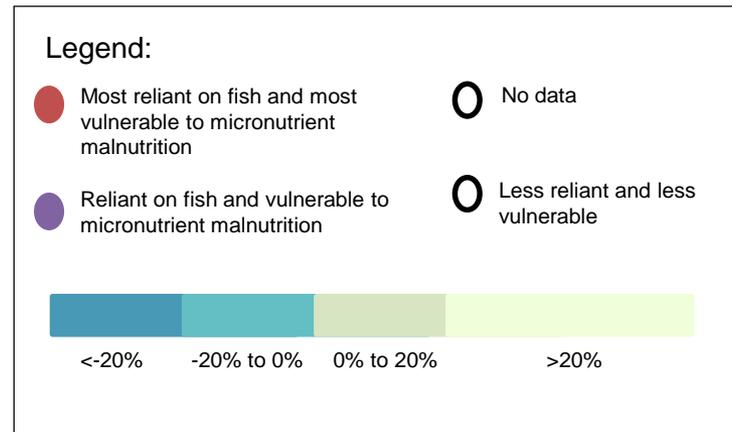




FISHERIES DECLINE CAN LEAD TO NUTRIENT DEFICIENCY



Projected percentage change in maximum marine catch potential by 2050 relative to 2000 levels



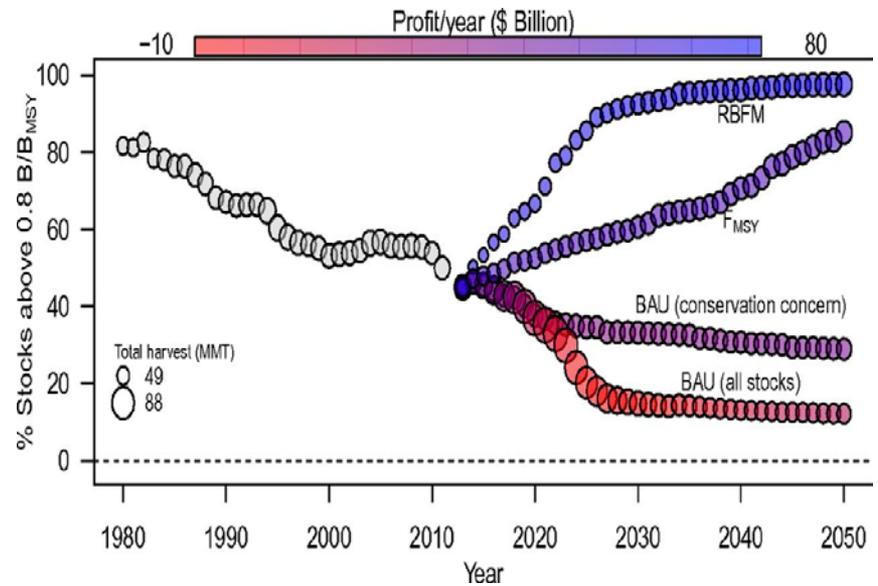
Source: Golden et al. 2016





GOOD MANAGEMENT CAN ENHANCE FISHERIES YIELDS, RESILIENCE

Researchers analyzed data from over 4,700 fisheries worldwide to project the impacts of different management regimes. They estimated that applying the rights-based fisheries management regime—which emphasizes conservation approaches coupled with community/individual access rights to the fishery—to global fisheries could result in a \$83 billion increase in profit and a 16 million metric ton increase in catch, annually.



BAU: Business-as-usual management policy for each fishery
 BAU (conservation concern): Business-as-usual management policy with a focus on fish stocks of conservation concern
 FMSY: Fishing to maximize long-term catch
 RBFM: Rights-based fisheries management



SI INDICATORS BY DOMAIN AND SCALE

5 SOCIAL

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

1 PRODUCTIVITY

- Livestock productivity
- Feed management
- Yield variability
- Yield gap

4 HUMAN CONDITION

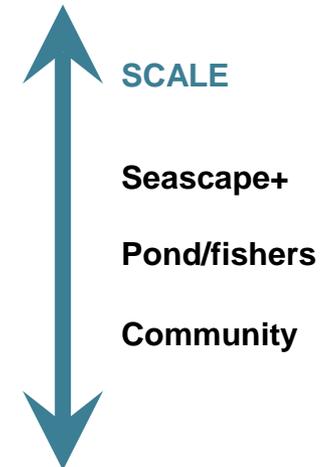
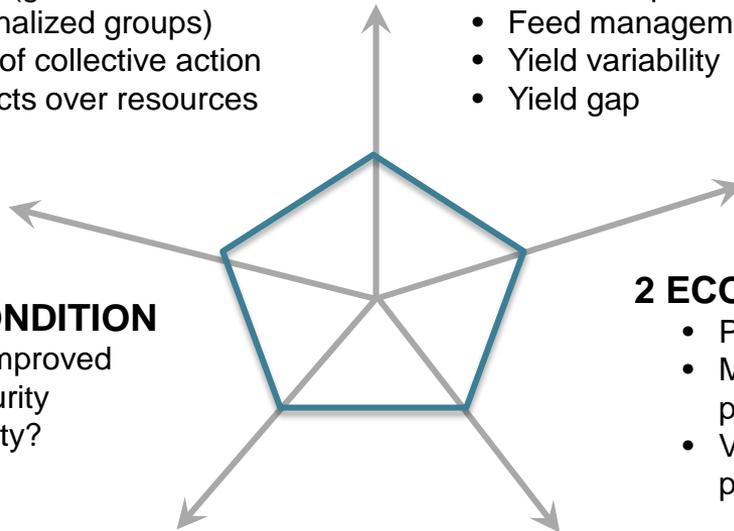
- Nutrition improved
- Food Security
- Food Safety?

2 ECONOMIC

- Profitability
- Market participation
- Variability of profitability

3 ENVIRONMENTAL

- Biodiversity
- Nutrient balance
- Coastal soil & water physical properties





ASSESSING SUSTAINABLE INTENSIFICATION WITH CASE STUDY VALUE CHAIN

- Sustainable Intensification framework is a tool to help assess the system. On page ____ in your participant manual is a Sustainable Intensification diagram for you to use.
- Using your case studies, consider relationship and effect on other domains based on a decision in one.
- In your case study groups, apply the Productivity Domain and the Environment Domain of the Sustainable Intensification framework.

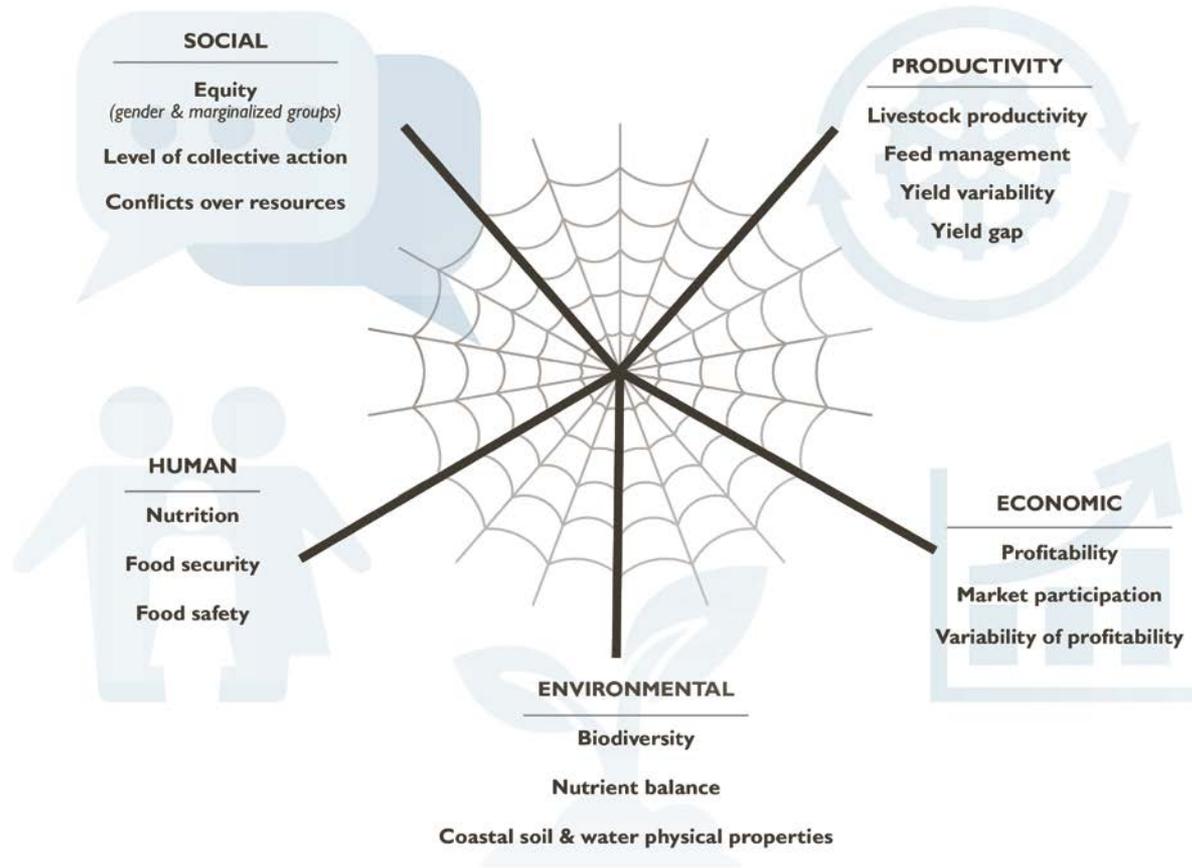




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SUSTAINABLE INTENSIFICATION INDICATORS BY DOMAIN



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SOME GUIDING PRINCIPLES OF SUSTAINABLE INTENSIFICATION

- Assess constraints and limiting factors which influence productivity
- Facilitate regenerative natural resource management—sustain and improve the quality of the natural resource base (soils, water, vegetation, bio-diversity)
- Maximize nutrient cycling (particularly nitrogen, water and carbon cycles)
- Promote local food production and nutritional security
- Integrate local and scientific knowledge to leverage good practices and technologies
- Adopt a do no harm approach—anticipate and address unintended consequences
- Recognize labor as a core constraint and seek to improve labor productivity (note significant gender issues around labor)





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