Kansas: Heartland of Agriculture

Kansas: Ranks Number 1 – Wheat and Sorghum Production in the US. K-State: First Land Grant University (Established: 1863). College of Agriculture: Ranks Number 4 in the US.

Kansas State University:
Students: ~23,000

Manhattan:
Population: ~50,000
Name: Little Apple

Kansas:
Population: 2.92 M
Economy: Agriculture
Cropland: 28.2 M acres
Irrigated: 2.76 M acres
Presentation: Outline

- Global Challenges: Hunger, Malnutrition and Climate Change
- Opportunities: Yield Gaps; Input Use, and Food Loss/Food Waste
- Sustainable Intensification: Meaning and Components
- Sustainable Intensification Innovation Lab – Overview
- Specific Examples of Local Solutions to Global Challenges
- Conclusions
- Questions
Global Challenges: Hunger, Malnutrition, Climate Change, Soil Fertility and Grand Challenge
About 820 M people do not get enough to eat. In regions of Africa and Asia >20% of the population are undernourished.
Global Challenge: Obesity

Percentage of Adults (18+) Obese (Body Mass Index >30) (2016)

Obesity is widespread (>30%) in most of America.
Iron deficiency (anemia) is widespread (>30%) in most of Africa and South Asia. Others issues include Vitamin A and Zn deficiency.
Global Challenge: Soil Degradation

Soil degradation, soil erosion and poor soil organic carbon and soil fertility is a major problem across the world. Particularly in sub-Saharan Africa.
Global Challenge: Declining Yield Improvement

Yield improvement of major food crops are not keeping pace with population. The current yield trends are insufficient to double crop production by 2050 (2.4% per year).
Mean temperatures have increased about 1°C in the last Century. Annual temperatures have changed more rapidly in recent years.
Global Challenge: Water Stress

Considering the demand of water from agricultural, urban, industrial and human demand, water stress around the globe will be increased.
Africa will see maximum increases in population. Most of the countries in Africa will double its population by 2050.
Grand Challenge: Food Security – 2050

Increase food production using **environmentally sustainable, economically viable, and socially acceptable** ways.
Opportunities: Large Yield Gap, Improved Genotypes (Seeds), Inputs (Nutrients), and Food Waste and Loss
Crop Productivity: Attainable vs. Actual (Yield Gap)

Less than 30% of attainable yields in Africa (large yield gap). Thus, opportunities exist for improving yields.

Example:

Attainable: 6 tonnes
Actual: 4 tonnes
Gap = 2 tonnes

Sub-Saharan Arica and South Asia started at same point in 1960, but little progress is made in SSA compared to Asia. Mainly due to government policy, infrastructure and economics.
Crop Productivity: Input Use (Fertilizer and Nutrients)

The SSA Average Application Rate Grows Steadily

- Stagnating close to 12 kg/ha in 2013-16
- Rebound anticipated from 2017
- Expected to reach 15-16 kg/ha in 2020
- What is an ambitious but realistic target?
- Doubling every 10 years would lead to 30 kg by 2030... and 60 kg by 2040?
- Is it enough to meet SSA fast rising food requirements?

Notes: - Average for Sub-Saharan Africa excluding South Africa
- Per hectare of arable land and permanent crops

Source: IFA AGCom, Feb 2017
Sub-Saharan Africa has relatively low adoption of improved varieties. Due to lack of extension, research and capacity in plant breeding and seed production and distribution programs.
Annual Global Food Loss / Waste: ~30% (1.3 B tons; $ 1 Trillion)
Local Solutions: Sustainable Intensification (SI) Practices (Selected Examples around the Globe)
Sustainable Intensification (SI): Meaning

- Increasing food production from existing farmland while minimizing negative impacts on environment and natural resources
- Increase total food production from unit area per unit time
- Produce more from less (efficiently)
- Indicates that both yield increase and environmental sustainability can be achieved simultaneously
How to Achieve Sustainable Intensification?

- Improving resource use efficiency (all inputs – water, nutrients, and labor).

- Diversification of farming systems (e.g. animal husbandry; home gardens; horticulture; and agroforestry) for improving climate resilience and nutrition.

- Creating enabling environment – particularly markets, social networks, and government policies (including subsidies, land tenure and inputs).

- Providing options (multiple portfolios) to producers to make appropriate choices to minimize risks, increase income, enhance resilience and livelihoods.

- Not only related to production, but also consumption practices (diversified diets; alternative and efficient source of protein).

- Reducing waste (during production, transport, processing, storage and at our dinner table).
Sustainable Intensification: Components

**Socio-Economic Intensification**
- Developing markets
- Building social capital
- Creating sustainable livelihood
- Understanding barriers
- Enabling environment

**Ecological Intensification**
- Cropping (farming) systems
- Improved soil & water management
- Integrated nutrient management
- Diversified systems
- Efficient ag. practices & input use
- Integrated pest management

**Genetic Intensification**
- Higher yield
- Resilient to pest and diseases
- Resilient to climate change
- Improving nutrition
- Medicinal value

Focus of SIIL

Improving Food and Nutritional Security for Better Livelihoods.
Sustainable Intensification Innovation Lab (SIIL)
Transforming farming systems of smallholder farmers

✓ One of the 24 Feed the Future Innovation Labs in the US.
✓ Feed the Future Program of USAID.
✓ Kansas State University is the Management Entity.
Sustainable Intensification Innovation Lab (SIIL)
Transforming farming systems of smallholder farmers

Current Focus Countries

Senegal
Ethiopia
Bangladesh
Burkina Faso
Tanzania
Cambodia
SIIL: Focused on Smallholder Farmers – Why

- One third of world’s 7.4 billion people are involved in smallholder agriculture.
- Globally 70% of farmers are smallholders (<1 ha).
- Smallholders manage >80% of > 570 million farms.
- Smallholders and family farms produce ~70% of our food. In Asia and Africa >80%.
- Smallholders are key to sustainable food systems.
- In Africa and Asia >50% of these smallholders are food insecure and undernourished.
- Transformation of smallholders is required for global food and nutritional security.
Innovative Multi-disciplinary Research

Appropriate Scale Mechanization Consortium

Geospatial and Farming Systems Res. Consortium

Policy Research Consortium

Sustainable Intensification Assessment Framework

Crop-Livestock Interactions (Dual Purpose Crops); Cereals – Legume and Vegetables; and Rice – Fallow and Horticultural Crops.

Lead: Michigan State University; University of Florida; and Kansas State University

Lead: University of California – Davis

Lead: Rutgers University

Education, Training, Youth Engagement, and Gender Integrations. Biophysical and Social Sciences.
Sustainable Intensification Innovation Lab (SIIL)
Transforming farming systems of smallholder farmers

We engage 120 scientists, 107 students from 68 different global and national organizations (including 18 U.S. universities and 7 CGIAR centers).
Sustainable Intensification: Global Assessment

Global assessment of agricultural system redesign for sustainable intensification

Jules Pretty1*, Tim G. Benton2, Zareen Pervez Bharucha3, Lynn V. Dicks4, Cornelia Butler Flora5, H. Charles J. Godfray6, Dave Goulson7, Sue Hartley8, Nic Lampkin9, Carol Morris10, Gary Pierzynski11,18, P. V. Vara Prasad12, John Reganold13, Johan Rockström14,19, Pete Smith15, Peter Thorne16 and Steve Wratten17

The sustainable intensification of agricultural systems offers synergistic opportunities for the co-production of agricultural and natural capital outcomes. Efficiency and substitution are steps towards sustainable intensification, but system redesign is essential to deliver optimum outcomes as ecological and economic conditions change. We show global progress towards sustainable intensification by farms and hectares, using seven sustainable intensification sub-types: integrated pest management, conservation agriculture, integrated crop and biodiversity, pasture and forage, trees, irrigation management and small or patch systems. From 47 sustainable intensification initiatives at scale (each >10^4 farms or hectares), we estimate 163 million farms (29% of all worldwide) have crossed a redesign threshold, practising forms of sustainable intensification on 453 Mha of agricultural land (9% of worldwide total). Key challenges include investment to integrate more forms of sustainable intensification in farming systems, creating agricultural knowledge economies and establishing policy measures to scale sustainable intensification further. We conclude that sustainable intensification may be approaching a tipping point where it could be transformative.

Pretty et al. (2018)

It is estimated that 163 million farms (29% worldwide) practicing forms of SI on 453 million ha of agricultural land (9% worldwide total).
There were 47 different initiatives which can be broadly classified into seven types redesigns and typologies of sustainable intensification.
Dual Purpose Sorghum, Millet and Cowpea: Senegal and Burkina

Doohong Min

Augustine Ayantunde
**SI: Water Harvesting – Tied Ridges (Africa)**

Tied Ridges: Ghana, Burkina, Mali and Niger, Tanzania, Malawi

- Flat beds with grass strips
- Tied ridges with grass strips
- Tied ridges with Pigeonpea strips

1217 + 50% 1827

Jessie Naab and Vara Prasad

SARI
SI: Water Harvesting – Contour Ridges (Mali)

+ 50 to 100% yield increases:
sorghum, millet, maize and cowpeas

Mamadou Doumbia and Vara Prasad
**SI: Integration of Legumes (East Africa)**

Doubled-Up Legumes (Pigeonpea / Groundnut or Cowpea):
Tanzania, Malawi, Uganda

- Increases plant efficiency of fertilizer use
- Improves yield of protein-rich grains
- Decreases labor requirement
- Improves family diets

Glover et al. 2012

Sieg Snapp
SI: Integration of Vegetables (Ethiopia)

Irrigation Management and Mulching / Residues

Neville Clarke; and Manny Reyes
**SI: Rice and Fish Systems (Bangladesh)**

Rainy Season: High Zn Rice; Community Rice – Fish

![Image](image1.png)

**Yields and Zn**

![Graph](graph.png)

- Traditional
- BRRI dhan51
- BRRI dhan92
- BINA dhan12
- BRRI dhan62
- BRRI dhan72

**Image Descriptions**

- **Image 1:** A rice field with people working in the background.
- **Image 2:** A group of people standing near a body of water.

**References**

Krishna Jagadish
Sudhir Yadav
SI: Rice – Vegetables/Horticulture (Cambodia)

Rice – Vegetable System – Mulching – Drip Irrigation

Rick Bates; and Manny Reyes
Indigenous Vegetables, Perennial Live Fences and Wild Gardens

Smallholder farmer harvests Acacia pennata (Climbing Wattle) shoots from her ‘Living Fence’
High vitamin A

Wild Gardens – Resource Use Efficiency; Ground Cover and Nutrition
Soil Fertility and Water Management: Zai with Microdose + Compost (West Africa – Burkina, Niger)

+ 200% yield increases: sorghum, millet, and maize

Vara Prasad
Hamidou Traore
Seyene Sirifi
Integrated Nutrient Management: Urea Deep Placement

Multiple Countries in Asia and Africa
Integrated Pest Management: Push – Pull (Africa)

Push-Pull or Stimulo-Deterrent Diversionary Strategy (Vuta Sukuma)

Main Crop

Trap Crop

Attract natural enemies

Moths are pushed away

Attract moths

Desmodium intercrop [legume – volatiles: repels (Push)]

- Napier grass borders [volatiles attracts moths of stem borer (Pull)]

- Brachiaria sp. (grass – attracts – moths of stem borer)
Diversification: Agroforestry Systems (Africa and Asia)

West Africa:
*Faidarbia albida* trees
(Reverse Phenology; Hydraulic Lift; Green Manure And Animal Manure)

Native Shrub – Crop Systems:

Richard Dick
Ohio State University

Africa and Asia:
ICRAF – multistoried system
SI: Mechanization Tools

Appropriate Scale Mechanization Consortium
University of Illinois; Kansas State University; Michigan State University; NCA&T State University; Tillers International; ADM Institute for the Reduction of Postharvest Loss; Bangladesh Agricultural University; Polytechnic University of Bobo-Dioulasso-Burkina Faso; Royal University of Agriculture-Cambodia; Bahir Dar University-Ethiopia

Alan Hansen
Conclusions

- There are opportunities to increase yields of major cereals and legumes through use of efficient practices. Sustainable intensification provides holistic and local solutions to address global challenge of food security, nutritional security and resilience to changing climate and environments.

- Engagement of farmers, youth, and women, value chain partners and private sector is critical and should occur from the start.

- Understanding social networks and barriers to adoption of technologies are equally important (if not more) as developing new technologies.

- Focus should be on creating enabling environment (economic, social, political, knowledge sharing platforms and new communication technologies) for adoption and scaling of innovative technologies.

- Better linkages between agriculture, nutrition and health should be articulated to all audiences (particularly civil society, policy makers and donors).

- Transdisciplinary research and collaboration is critical and needed.

- Human resource and institutional capacity should be enhanced to make programs more sustainable (particularly in countries that are food insecure).
Questions

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