Farmer Decision Making Strategies for Improved Soil Fertility Management in Maize-Bean Production Systems

Legume Innovation Lab Project

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Partner Institutions & Co-PIs

- Iowa State Univ. (R. Mazur, A. Lenssen, E. Luvaga, E. Abbott)
  - Sociology, Cropping Systems, Soils, Economics, Communication
- University of Hawaii (R. Yost)
  - Tropical Plant & Soil Sciences
- University of Illinois (J. Bello Brava, B. Pittendrigh)
  - Communication/Agricultural Extension
- Makerere University, Uganda (M. Tenywa, H. Sseguya)
  - Agricultural Production, Soils
- National Agric. Research Laboratories Uganda (O. Semalulu)
  - Soils, Environment & Agro-Meteorology
- Mozambique Ag. Research Institute (R. Maria, C. Sumila)
  - Soils, Bean Breeding, Socioeconomics, Training and Technology Transfer, Outreach/Extension/Communication

Project Rationale

- *Common beans* serve important roles in *cropping systems, food security, nutrition, incomes, and livelihood resilience* – but *low yields, pervasive poverty* and *food insecurity*.
- *Sustainable intensification* of agriculture production *requires improved soil fertility management* in which *legumes* are an integral part of cropping systems.
- *Poor and declining soil fertility* is the *primary constraint to common bean productivity* (est. 30% of '*yield gap*').
- Addressing soil-related constraints requires understanding farmers' current practices and *enhancing their capabilities in diagnosing and finding solutions* to yield constraints.

Research Project Objectives (1,2,3)

- Characterize smallholder farmers' key goals and *motivations, current knowledge and practices, problem diagnoses, and livelihood and risk management strategies*
- *Develop and refine models* about their *decision-making*
- Develop and validate appropriate *diagnostic and decision support aids*




Research Project Objectives (4)

- Develop and *assess the effectiveness of innovative approaches for dissemination of information and decision support aids, training, and follow-up technical support*

  …to stimulate widespread and sustainable implementation of improved soil fertility mgmt. practices and technologies



Approach and Methods

- *Participatory Rural Appraisal* and *baseline surveys* for activity planning - taking into account critical *social, economic and cultural factors …*
  - *that impact decision making and adoption of new strategies and technologies*
  - for *monitoring changes* over time



- *Local farmer knowledge systems and experiences in experimentation and innovation* combined with *scientific analyses* of soil-related constraints

Participatory Approach & Methods

- On-farm studies using identified possible solutions
  - Site-specific management options and strategies
  - Simple changes (e.g., soil amendments) based on observations and locally available materials
  - More complex changes suggested by farmers and researchers of analyses of field data
  - Fundamental long term changes in cropping systems ?
- Gender equitable development and validation of diagnostic and decision support aids
- Development and pilot-testing of innovative socio-technical approaches for communication, dissemination, and scaling up

Scaling Up for Broader Impact

- Identify most effective and efficient approaches to *promote multidirectional information flows*:
  - Among farmers and other key stakeholders
  - Complementary training and follow-up support
- Information & Communication Technologies (ICTs):
  - Text and audio SMS messaging
  - On-air call-outs to farmers and experts
  - Participatory radio campaigns in local languages
  - Solar-powered MP3-enabled radios (record and replay)
  - Animated videos in local languages used on cell phones


Decision Making Dynamics

- Farmers' *holistic view of crop-soil health* and *decision making processes* are embedded within:
  - Ecosystem with local features, logics and dynamics
  - Array of factors cutting across the biophysical, socioeconomic, political and cultural domains
  - Farming as evolving process of inductive learning
  - 'Work in progress' of interactive skill development, with knowledge tested and re-created each season
- Crop production & soil fertility improvement are *complex knowledge mgmt. processes* in dynamic context of livelihood resources and priorities

Decision Making Dynamics

- Need to understand *farmers' motivations, current knowledge & practices* in bean cropping systems
  - Field selection and preparation
  - Crop and variety selection
  - Intercropping and rotation patterns
  - Planting methods and spacing
  - Inputs used (organic, inorganic)
  - Local methods of monitoring/evaluating experiments
  - Problem diagnoses and solutions adopted to date

Social Dynamics

- ***Groups & social networks*** play key roles in experimentation and adoption of new management practices and technologies, involving ***changes in beliefs, knowledge, and behavior***
- Researchers & farmers ***create continuous community learning environment*** - a 'community of practice' in which farmers ask questions and seek answers, and make sense of each other's experiences and knowledge alongside scientific knowledge
- This process of ***sensemaking*** enables people to collectively:
  - Devolve new 'mental maps'
  - Set their own goals and outcomes
  - Experiment, evaluate, collectively frame & legitimize the 'way forward'
  - Develop a sense of identity, efficacy and pride
  - Encourage each other and persuade others to take similar actions

Contextual Factors in Decision Making

- <u>Livelihoods</u>
  - Livelihood goals and priorities
  - Income level and sources, including off-farm
  - Risk management arrangements, safety nets
  - Food security/shortage experience
- <u>Resources</u>
  - Resources required for production and marketing (natural, physical, financial, human, social)
  - Factors that influence land allocation, especially for legumes, and investment in farm inputs
  - Social relationships and economic costs of accessing / controlling each type of resource
  - Resource constraints (material, labor, etc.)

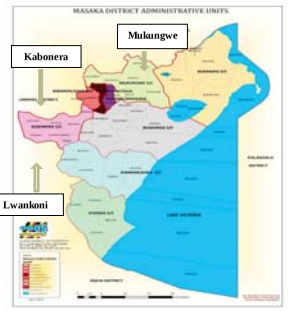
Contextual Factors in Decision Making

- Decision Making
  - Awareness, availability, accessibility, and affordability
  - Criteria (factors considered and importance of each)
  - Information base (nature, sources, credibility)
  - Prior experiences, assessment and 'take away' points
  - Gender and other roles (who makes or negotiates which types of decisions, alone or with others)
- Institutions
  - Farmer and Community-based organizations
  - Extension services
  - Market development and access
  - Governance

Uganda Research Site

- Masaka & Rakai districts in SW
  - Mukungwe Sub-County, Masaka
  - Kabonera Sub-County, Masaka
  - Lwankoni Sub-County, Rakai

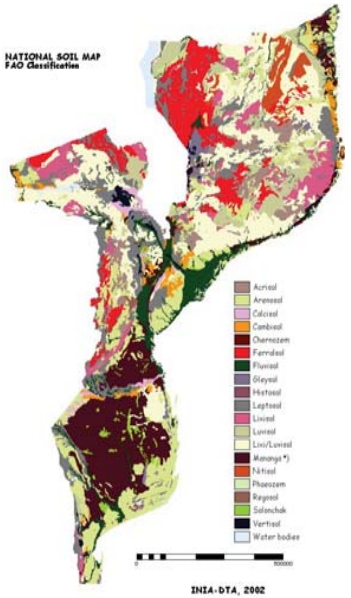
- Farmer criteria
  - Color - black soils more suitable for beans than red soils
  - Soil texture and workable depth
  - Water retention capacity
  - Plants that grow on soils, plant vigor, previous yield results
- Maize, coffee, bananas, beans, cassava
  - Ranked differently vis. food security and cash crops – men/women, community, etc.



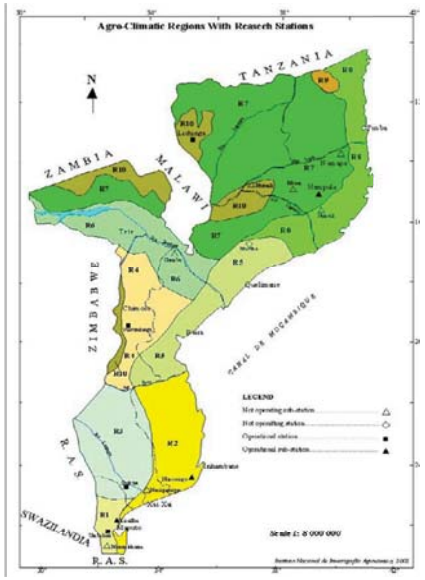
Uganda Research Site

- Activities Currently Used to Increase Production
  - Use of Good Seeds, change varieties over time
  - Crop Rotation (pests, disease, nutrients)
  - Farmyard Manure, Chemical Fertilizers, Pesticides
  - Early planting, proper spacing, weed control
  - Ditches/Trenches, Mulching
  - Fallowing / Agroforestry (leguminous trees) = rare
- Information Sources
  - Extension Services, Training Workshops, Exchange Visits
  - Radio, TV, Newspapers, Phones, Traders, Input Dealers
  - Creativity / Own Experimentation
- Women and men differ in prioritizing crop uses, constraints, trust in information sources, solutions strategies, resource accessibility

Soil Diversity in Mozambique



Agro-Ecologies & their Importance



Zone	Name	Cultivated Area (1000ha)	Farm households
R1	Semi-arid interior south	65.4	51,903
R2	Semi-arid coastal south	461.3	355,981
R3	Arid interior south	180.3	92,599
R4	Mid-elevation central	313.9	185,973
R5	Coastal central	544.9	421,753
R6	Dry semi-arid Zambezia, Manica, Sofala and Tete	468.9	247,631
R7	Interior central and north	848.7	667,014
R8	Coastal north	729.9	608,102
R9	Interior north of Cabo Delgado	20.6	18,363
R10	High altitude	463.0	288,886
Total		**4,096.8**	**2,938,205**

Avg. 1.2–1.4 ha / household

Rainfall Map - Mozambique

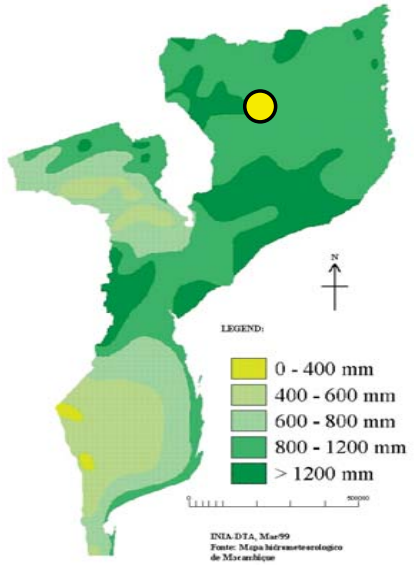
Rainy season:

Oct – April

Dry Season: May – Sept

Temp (°C): 23 in high altitude areas and southern coastal zone;

> 32°C in Tete Province



Soils – Uganda & Mozambique

- Altitude 1000-1200m, annual rainfall 1000-1500mm
- Soils maps available in Ug but not Moz
  - Compare US & FAO soil taxonomies w/ farmer assessments – should allow for better predictions in future
- Chemical and Physical Properties of Farmer Soils
  - pH, OM, available nutrients, texture, aluminum
- Nutrient Omission Study (NOS) (Ug)
  - Three soils: Liddugavu (black), Luyinjayinja (black, stony), Limyufumyufu (red)
  - Provide all required nutrients 'minus one at a time'
  - Modified for a legume
  - N, P, K, Ca, Mg, Zn, Fe, B
  - Rapid assessment (in pot study, in lieu of field research)

Soils - Uganda & Mozambique

- Lime Requirement Study (LRS)
  - Low pH, Ca and Mg availability, and Al toxicity
  - Limestone source being developed in Ug
  - Quick test
- Comparing Bean Production Systems (Ug)
  - Replicated research done on-farm; two soils
    - 1 - Conventional Farmer System
    - 2 - Improved Farmer System based on NOS and LRS
    - 3 - Researcher Developed System
  - Include new and older bean varieties
  - Yield, nutritive value, soil water & infiltration rate, weeds, insects, diseases

Institutional Capacity Building

- Multidisciplinary Research:
  - Soil Scientists and Social Scientists strengthen skills in key areas, incl. systems approaches to crop and soil fertility improvement
  - Social, cultural, economic, institutional and contextual factors which shape farmers' decision making
  - Communication for dissemination/scaling up impact
- Development & application of diagnostic & decision support aids useful in many future research projects
- Short-term Training at Iowa State and Hawaii
  - Technical staff and junior and senior researchers
- Long-term Training:
  - Makerere (2 M.S. students Soil Science, 1 in Extension & Innovation Studies)
  - Iowa State (1 M.S. student in Sustainable Ag. & Sociology, and 1 M.S. student in Communication)
  - U. of Hawai'i (1 Ph.D. student in Tropical Plant and Soil Sciences)

Relevance to Feed the Future

- Two focal countries
  - Uganda (maize and beans promoted in 25 districts across agroecosystems)
  - Mozambique (Nampula & Zambêzia)
- Contribute to Feed the Future goals:
  - Inclusive agriculture sector growth
  - Gender integration
  - Agriculture-nutrition linkages
  - Environment-sensitive development
  - Research and capacity building at multiple levels

Synergies with USAID Projects

- Regional and national programs
  - Conservation Agriculture initiatives and working groups
  - Platform for Agricultural Research and Innovation in Mozambique
  - Bean research networks in Africa (ECABREN, SABREN)
- Complements CGIAR Research Program on Grain Legumes
  - Addresses critical 'technical gap' in Legume CRP by developing and validating diagnostic and decision support aids for sustainable implementation of management practices and technologies
  - Explicitly pro-active on gender inclusion