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Introduction

- Rice is an increasingly important cereal in SSA.
  - Demand increase of 4.4% per annum since 1960s
- Africa’s rice sector has not been able to match growth in demand, dependence on imports (about 40%)
- Weeds one of the most important biotic constraints
  - Annual production losses estimated at US $1.45b
- Parasitic weeds account for roughly a quarter of these weed-inflicted economic losses
  - Annual production loss US $391m (Rodenburg et al., 2014)
  - Yield reductions in infested rice fields between 40 - 100%
    (Gbèhounou and Assigbé, 2003; Rodenburg et al., 2011)
Parasitic Weeds

- Parasitize host roots (rice, maize, sorghum, millet)
  - Extract water, nutrients, assimilates
  - Yield reducing effects (witchweed/ rice vampire weed)

- Difficult to control
  - Copious seeds (5000 to 85,000 per plant), small seeds (0.1 - 0.3 mm - easy spread), viable > (upto 6–14 years)
  - Damage caused before emergence

*Striga hermonthica*  
*Striga asiatica*  
*Rhampicarpa fistulosa*

Growing threat from parasitic weeds

- Parasitic weeds primarily occur in rainfed agro-ecosystems in sub-Saharan Africa (SSA).
  - In Africa 39% rainfed upland, 33% rainfed lowland
  - *Striga spp* (upland), *Ramphicarpa fistulosa* (lowland)

- Increasing threat from parasitic weeds
  - Presence: *Asiatica* (42), *Hermonthica* (37), *R. fistulosa* (36)
Obligate Parasite - *Striga spp.*
Facultative Parasite - *R. fistulosa*

Parasitizing Ramphicarpa

Independently growing Ramphicarpa
PARASITE Project

- Parasitic weeds mainly affect resource-poor farmers
- Farmers lack knowledge and means to effectively address parasitic weed infestations
- Extension services not always aware of extent of the problem, often unable to backstop farmers
- Large time gap between outbreak and response
- Parasitic weeds a complex agricultural problem
Integrated Research

- Preparing African Rice Farmers Against Parasitic Weeds in a Changing Environment
- Integrated programme NWO-WOTRO, CCAFS
- WUR, AfricaRice and NARS of Tanzania, Benin, Cote d’Ivoire
- 3 PhD-projects, 1 postdoc project
  - Project 1: Environmental effects
  - Project 2: Management strategies
  - Project 3: Economic losses/ costs
  - Project 4: Institutional innovations
Sub-project 1 (Stella Kabiri) – Weed biology and ecology

- Pot experiments and field measurements

- Key findings:
  - Striga and Rhamphicarpa have distinct ecological niches
  - Valley bottoms are the preferred habitat for R. fistulosa
  - Attachment to the host results in growth improvement, increased seed production of Rhamphicarpa
  - Stunts host growth, reduces tiller production and leaf area, complete failure in grain setting
Sub-project 2 (Dennis Tippe) – Locally acceptable management strategies

- Participatory development and dissemination of control options:
  - Survey with rice farmers/ extension; Researcher-managed on-farm trials; Farmer-managed test plots; Exchange days and FFDs

- Key findings:
  - Rice husks as alternative soil fertility amendment in infested rice fields
  - Reproduction of parasitic weeds relies on optimal synchronization with the host plant (sowing time as control)
  - Farmers risk aversive: compromise between rice yield and weed control
Sub-project 3 (Simon N’cho) – Economic impacts, determinants of parasitic weeds

- Socio-economic surveys:
  - Production data, perceptions of impacts, preferences for management practices, field data on infestation levels/damage

- Key findings:
  - *Rhamphicarpa* infestation higher on soils with poor fertility and in the valley bottom
  - Lower infestation with late sowing, timely application of post-emergence herbicide, frequent weeding, fertilizer application and fallow
  - *Rhamphicarpa* control requires awareness raising, reaching out to women
Sub-project 3 (Simon N’cho) – Gender

- Higher infestation rates on rice plots managed by female-headed households (N’cho et al., 2014).
- Population pressure forces farmers to cultivate fields in less favourable positions e.g. valley bottom.
  - Often women are the recipients of marginal fields characterized by low soil fertility and weed problems (Demont et al. 2007).
- In the sample, only 26% of lands owned by farmers belonged to female-headed households.
  - 61% of these female-managed plots located in valley bottom.
**Sub-project 4 (Marc Schut/Josey Kamanda) – Innovation Systems**

- Systems approach - crop protection problem not just outcome of a crop-pest interaction
  - Taking into account context in which problem is embedded

- Innovations as outcomes of combined advances of technological, social or institutional elements
  - Different levels - farm, community, national, region, international (Leeuwis 2004)
  - Interactions between different stakeholders in the sector (Hounkonnou et al. 2006, Klerkx et al. 2012)

- Evaluate and address the institutional organization and preparedness of crop protection systems in SSA
  - emerging biotic constraints under changing environments
  - from an innovation systems perspective
Institutional Innovation

- **Institutions**
  - Usually misunderstood to mean organizations
  - Rules of conduct that facilitate coordination or govern relationships between individuals or groups
  - Hardware (laws), software (informal norms), orgware

- **Innovation**
  - Usually misunderstood to mean invention or technology
  - Innovation involves putting new ideas (both technological and institutional) into use.

- **Institutional innovation**
  - New ways of working e.g. new ways of organizing R4D
Systems approaches to innovation in crop protection

- What are systems approaches to innovation?
  - “System” as understood by natural/social scientists

- There has been limited attention for institutional and political dimensions of crop protection
  - Focus has been on farm or national level, while multi-level interactions are rarely analysed
  - Need to consider biophysical, technological, socio-cultural and economic dimensions at different levels

- Stakeholder involvement in analysing crop protection problems, and identifying solutions remains limited
  - Need for transdisciplinary research

(Schut et al. 2014)
Methods: Rapid Appraisal of Agricultural Innovation Systems (RAAIS)

- Operational frameworks required for AIS analysis
- Participatory tool for ‘rapid’ systems diagnostics
- Researcher (outsider) and stakeholder (insider) systems analysis
- Use of multiple methods (workshops, questionnaires, interviews, secondary data analysis)
- Identify coherent innovation strategies
  - Specific: Directly related to problem under review
  - Generic: Related to innovation capacity in agricultural system

(Schut et al. 2015)
Entry points for innovation in parasitic weed management in Tanzania

- Specific entry points for innovation
  - Parasitic weeds awareness (farmers, extensionists)
  - Co-develop parasitic weed strategies (multi-stakeholder collaboration)

- Generic entry points for innovation
  - Multi-level interaction (development and implementation of agricultural policy)
  - Policy coherence and structural allocation of resources (investment in human resources and adequate backstopping and incentive structures and monitoring and evaluation mechanisms for extension officers)

(Schut et al. 2015)
Embedding of Constraints within Nested Systems

Farmers

Civil Society

Private Sector

Government
Features of Crop Protection/ Plant Biosecurity Systems

- Biosecurity (Reed & Curzon, 2015)
  - "Practices, routines, technologies and modes of organizing and securing agricultural spaces, animals and plants from infectious diseases and invasive species"
- Pre-border, border, post-border preventive actions
- Control actions if species spread and become weeds
- Success depends on actions of many stakeholders
  - Actions have implications for risks faced by others
  - "Weakest link" public good that requires coordination
- Thus the need for a deeper understanding of the institutional environment for crop protection
Ongoing Postdoc Work - Analysis of Agricultural Institutions

- Positive analysis - What institutions exist? What are their opportunities? Why are they dysfunctional?

- Normative analysis - How can they be improved?

- Three sectors – public, private, community
  - Is there market failure regarding this service?
  - What can the state do to address market failure?
  - What role can community-based solutions play to address the market or government failure

- What governance solutions can be identified? Which ones fit best?
Ongoing Postdoc Work - Objectives

- Map the CP/ plant biosecurity system in Tanzania
  - Roles of public, private, community in providing CP services
  - Information flow in case of a biotic stress e.g. Striga

- Governance challenges in the CP/ biosecurity system
  - What is lacking, incentives/ disincentives of actors
  - Reasons for market, state and community failure in implementing specific prevention and control strategies

- Options to address governance challenges in CP
  - What changes need to occur at what level, good fit
  - Stakeholders identify/ prioritize institutional innovations
What does a CP system look like?

Crop Protection
- Pest Management
- Disease Management
- Weed Management

Preventive Mechanisms
- Mapping Vulnerability
- Surveillance
- Limiting of Spread

Control Mechanisms
- Biological
- Chemical
- Cultural & Mechanical
- Genetic

Integrated Approaches

Reactive (PHS focus on pest outbreaks)

Willingness of farmers to pay for advise (unlike vet services)

Market Failure

Research

Production

Dissemination

Regulation

Private Sector (Regulation)

Structural coherence

Challenges implementing Phytosanitary measures

Research

Willingness of farmers to pay for advise (unlike vet services)

Market Failure

Challenges implementing Phytosanitary measures

Research

Structural coherence

Private Sector (Regulation)
Integration of the four subprojects

Multilevel

Multidisciplinary

Social sciences

Economics & management sciences

Disciplines

Targeted stakeholders

Multi-stakeholder

Interconnected projects
Value of integrated approach

- Multiple reasons why farmers in Kyela (Tanzania) are reluctant to use agricultural inputs:
  - Institutional; the lack of quality control of agricultural inputs (adulteration of chemicals, fertilizers and seeds)
  - Economic; purchasing power of farmers is low
  - Socio-cultural; concerned that use of improved varieties will contaminate aromatic qualities of local rice varieties
  - Political; frequent changes and incoherence policies
  - Agronomic; farmers afraid for undesired side effects to the crop, e.g. higher weed infestation with the use of manure

- Learning across disciplines
  - Methodologies, being open to different levels of abstraction
  - Reducing and (or) explaining jargon
  - Time, effort and resources required to plan and execute integrated research
Thank you

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