Online Interactive Session with GLDC-IAC
15-16 October 2020

Presenter: Bayala Jules (ICRAF)
FP 3: Integrated farm and household management
Objectives of GLDC-FP3

Main objective

FP3 aims to capacitate stakeholders such that they can improve the productivity, profitability and sustainability of SFS using on-farm and in-HH innovations to ensure HH nutritional security and enhanced income generation through integrated crop, tree and livestock production systems.

Specific objectives

- To co-design, test and scale improved crop-tree-livestock management options and their interactions to optimize productivity and enhance resource use-efficiency;
- To increase the productivity and agro-biodiversity in farming systems and strengthen HH livelihoods through improved nutrition and dietary diversity;
- To increase the climate resilience of farming systems through integrated SCWN management approaches;
- To manage and conserve the NR base and close nutrient cycles to avoid soil fertility losses; and
- To use (FP1 and cross-cutting MPAB) Innovation Platform (IP) approaches to identify opportunities for value chain enhancement.
GLDC-FP3 sites

CoA 3.1: Innovations for managing abiotic and biotic stress

CoA 3.2: Cropping systems management

CoA 3.3: Testing, adapting and validating options
Updates in brief for Cluster 3.1 - Innovations for managing abiotic and biotic stresses

Cluster co-leads
- Manuele Tamò, IITA
- Julie Dusserre, CIRAD
Biotic stresses: Monitoring of emerging diseases
Identify critical weather factors and crop growth stage for disease and insect-pest outbreaks in chickpea and Pigeonpea to develop weather based forewarning models

- Development of forewarning models for *Helicoverpa armigera*
  - Chickpea and Pigeonpea (*Helicoverpa*) trap data from ICRISAT
  - Chickpea and Pigeonpea (*Helicoverpa*) – Egg and Larva from ICRISAT

- For quantitative data, forewarning models were developed for
  - Crop age at first appearance of disease or pest,
  - Crop age at maximum disease severity / pest population
  - maximum disease severity / pest population

- Model fitted well for and there was good agreement between forecasts and observed status.

For pigeon pea interaction of maximum temp & Relative humidity and rainfall & bright-sunshine are significant variables

For chickpea interaction of maximum & minimum temp and relative humidity morning & bright-sunshine are significant variables

- Developed online decision support tool to forecast the pest population in a cropping season using weather based forecast model
Biotic stresses: Monitoring of emerging diseases

Activity: 1. Farm level status of emerging diseases of Chickpea and Pigeonpea to identify risk areas for mapping the spatial and temporal distribution in India

Activity: 2. Monitoring, characterization and virulence profiling of *Fusarium* spp. in chickpea and pigeonpea

### Pest and disease surveillance mapping on target population environments

#### Chickpea

1) Ascochyta blight
2) *Fusarium* wilt (FW)
3) Helicoverpa pod borer

1) Dry root rot (DRR)
2) Collar rot (CR)
3) *Fusarium* wilt
4) Helicoverpa pod borer

1) *Fusarium* wilt
2) Rust
3) Helicoverpa pod borer
4) Beet armyworm

### State FW (%) DRR (%) CR (%)

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<thead>
<tr>
<th>State</th>
<th>FW (%)</th>
<th>DRR (%)</th>
<th>CR (%)</th>
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<tbody>
<tr>
<td>Telangana</td>
<td>0</td>
<td>5-10</td>
<td>2-30</td>
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<tr>
<td>Karnataka</td>
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<td>5-30</td>
<td>10-30%</td>
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<td>Maharashtra</td>
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<td>2-40</td>
<td>5-40</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>3-35</td>
<td>2-50</td>
<td>5-60</td>
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1) Fusarium wilt
2) Dry root rot
3) Rust
4) Helicoverpa pod borer
5) Beet armyworm

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REAL-TIME SURVEILLANCE DECRYPTS DRY ROOT ROT SPREAD IN CENTRAL INDIA
Biotic stresses: Management options - biocontrol and chemical

Biocontrol of the legume pod borer *Maruca vitrata*

In the framework of the USAID Feed the Future Legume Systems Research lab, a total of 18,000 biocontrol agents *Therophilus javanus* (specific against the pod borer *Maruca vitrata*) were shipped by IITA-Benin using commercial air carriers to Burkina Faso, Niger and Nigeria, and were successfully released on untreated cowpea fields and patches of wild vegetation. At the same time, our country teams have established local mass rearing for future releases.

Picture on the left: Nigeria co-PI Dr. James Ojo releasing pod-borer specific parasitoids with Nigerian Plant Quarantine staff around Ilorin, Nigeria, July 2020.
Biotic stresses: Management options - biocontrol and chemical

Antagonistic activity of *Streptomyces albus* CAI-21 against *Macrophomina phaseolina* (Charcoal rot disease causing on sorghum) under *in-vivo* and *in-vitro* conditions.

**Dual plate assay (DPA)**

- *M. phaseolina*
- CAI-21 vs MP

**Secondary metabolite assay (Crude residue)**

- *M. phaseolina*
- CAI-21 crude

**Blotter paper assay (BPA)**

- Control
- MP
- CAI-21

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Dual Plate assay</th>
<th>Secondary metabolite assay</th>
<th>Blotter paper assay</th>
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<tbody>
<tr>
<td>CAI-21</td>
<td>15mm</td>
<td>73.8%</td>
<td>1</td>
</tr>
<tr>
<td><em>M. phaseolina</em></td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
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</table>
Antagonistic activity of CAI-21 against *M. phaseolina* (MP) under greenhouse and field conditions using toothpick inoculation method

<table>
<thead>
<tr>
<th>Isolate</th>
<th>In greenhouse</th>
<th>In field condition</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>infected nodes (number)</td>
<td>Infection length (cm)</td>
</tr>
<tr>
<td>CAI-21</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><em>M. phaseolina</em></td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

%Inhibition (length of infection): 84

Scanning electron microscopy photographs of CAI-21 showing morphological changes in the stalks of sorghum
Input combinations for soybean consisting of P, K, lime (L) and *Bradyrhizobium* inoculum (I) at two sites (Gurue and Angonia) demonstrated that the combination of all the four inputs produced the highest grain yields in both ecologies (2.8 tons ha\(^{-1}\) for Gurue and 2.0 tons ha\(^{-1}\) for Angonia). However, specific input combinations were more profitable:

- In Gurue, a combination of lime and inoculum generated the highest gross margin of $795 ha\(^{-1}\) (Blue bar) compared to $580 ha\(^{-1}\) (Red bar) for the Standard (using certified seed and best management practices but no inputs) and $182 for a farmer using poor quality seed with no input.

- In Angonia, using P only (yellow bar) was the minimum input usage that generated the highest gross margin of $365 ha\(^{-1}\) compared to $235 ha\(^{-1}\) for the standard. Severe drought affected yield at this location.
Integrative effects of AMF inoculation with inorganic fertiliser application, legume intercropping and rhizobia inoculation on striga incidence and maize grain yield in Uganda

- Striga incidence (emergence and density) in maize was lower in all treatments than that for the control, except intercropping with bean without additional technologies.
- The lowest striga incidence occurred in systems where beans, AMF inoculation and P fertilization were combined.
- Maize grain yields negatively correlated with striga incidence.

Effects of striga control treatments on maize grain yield

Accumulated striga emergence (top) and biomass (bottom) 8 WAP as affected by 10 treatments: Control = no striga technology; B = intercropping with bush bean; AMF = inoculation with arbuscular mycorrhizal fungi; 15P = 15 kg P ha\(^{-1}\); R = *Rhizobium Inoculant*; IR = Imazapyr-coated IR maize seed.
Updates in brief for Cluster 3.2 - Cropping systems management

Cluster co-leads
• Steve Boahen, IITA
• Sigrun Dahlin, SLU
**Sustainable intensification using doubled up legume systems for increased productivity and profitability among smallholders in Malawi**

- Intercropping pigeonpea and groundnut in a system known as **doubled-up legume technology** provides a new opportunity to develop cropping systems that are productive, profitable and sustainable.
- Gross margin analysis based on field trials show that the competitive advantage of groundnut can be realised through intercropping with pigeonpea.

### A. High potential area

- Total revenue (US$)
- Total variable costs (US$)
- Net returns (US$)

### B. Low potential area

- Total revenue (US$)
- Total variable costs (US$)
- Net returns (US$)
Identify agro-ecological options to optimize interactions between plants (diversification of cropping systems) in Burkina Faso

- Characterization of companion or “service” plants for intercropping: A collection of plants was set up at the Gampela station and evaluated for adaptation to Sahelian conditions
- Characterized "functional traits" for light acquisition and space occupation strategies, biomass production in quantity and quality.
- List of plants: *Macrotyloma uniflorum, Lablab purpureus, Vigna aconitifolia, Vigna radiata, Sesbania sesban, Senna tora/obtusifolia, Mucuna pruriens, Crotalaria retusa, Crotalaria juncea, Brachiaria ruzizensis, Arachis hypogea, Vigna subterranea, Cajanus cajan, Vigna unguiculata*
- Set up of a participatory experimental platform to test with farmers different combination of plants, in Gonsé, Burkina Faso. Testing intercropping systems of sorghum between other crops (pearl millet, cowpea, sesame, mungbean, peanut, Bambara bean, finger millet, fonio).
Drivers for cropping system optimization

Optimizing sorghum/cowpea intercropping

Output 1: Test cultivars bred for their performance in intercropping sorghum with cowpea
(In connection with GLDC-FP4-2.54.1 Identify and create sorghum genetic resources with midge and striga tolerance/resistance and with better adaptation to intercropping)
=> a trial was set up at the Gampela station (Burkina Faso) to characterize the response of 32 sorghum varieties in intercropping with cowpea. An analysis of the variability of different traits (phenology, leaf area, LAI, biomass, yield) in pure stand and in intercropping will be carried out.

Output 2: Exploration of the variability of the adaptation of sorghum and cowpea to the traditional intercropping system in the same hills
=> an article submitted by the doctoral student Aminata Ganeme
Co-design GLDC options for improving farmers' livelihoods, agro-ecosystem resilience and crop-tree-livestock systems in Burkina Faso, Mali, and Niger (ICRAF)

Multi-country multi-location trials implementation

- Sorghum Soubatimi and Fadda
- Peanut
- Millet
- Zai pit experiment in Burkina Faso
  - Two Masters students; 1 Ph.D. student being trained
  - 490 samples being of GLDC crops and fruits being analyzed for nutritional composition
- Cowpea Wilibali 70 days after sowing
Updates in brief for Cluster 3.3 - Testing, adapting and validating options

Cluster co-leads
• Shalander Kumar, ICRISAT
• Katrien Descheemaeker, WUR
Co-designing Profitable and Resilient crop-livestock systems (Whole farm IAT model)

South Asia (India)

WCA (Niger, Burkina Faso and Mali)

An Example

Potential impact of different interventions on household cash flows compared to base (% change from the baseline scenario) in Niger

1. Improved feeding practice for SR
2. Improved cowpea
3. Improved (Cattle+Millet+SR)
4. Improved Cattle
5. Improved small ruminants (ISR)
6. 30% legume area shifted to improved millet
7. Prophylaxis (SR)
8. ISR + Prophylaxis
9. ISR + Prophylaxis + 15% increase in price of ISR
10. 50% local Cattle + 50% improved Cattle
11. 30% legume area shifted to millet
12. 30% millet area shifted to legumes
13. 30% legume area shifted to improved millet
14. Improved cowpea
15. Improved feeding practice for SR

Measuring sustainability of farming systems in SA and WCA

Multidimensional framework

Online tool

About The Projects

How It Works

Show The Project Instructions
GLDC-FP3.3.6.2: Criteria and Indicators for assessing Farming System Sustainability
(Progress from October 2019 to October 2020)

• Newly holistic set of criteria and indicators combined complementary approaches:
  ✓ **Thematic domains of sustainable intensification**: productivity, economic, human well-being, environmental and social sustainability
  ✓ **Solution-oriented mechanisms**: subsidiary linkages, self-organizing capacities for system resilience
  ✓ **Resources criticality**: criticality of FS resources, level of supply risks, critical farm design options
  ✓ **Farmers perceptions and prioritizations**

  ▪ **Participatory Multi Criteria Assessment of FS sustainability versus interventions and farm types**
    ✓ **Considered Interventions**: improved seeds, legume-cereal associations (individual and combined)
    ✓ **Farm types**: main typologies empirically identified and tested
Summary of outputs and outcomes

• Outputs
  ✓ Progress in ISI publications:
    o 1 article (on the role of women empowerment and labor dependency on adoption of integrated soil fertility management in FS) published in Applied Geography (from a mapped research activity)
    o 1 manuscript (on system- and solution-based approach for assessing the resource criticality of agricultural livelihood systems) resubmitted (after minor revision) to Ecological Indicators journal (with a hope to be accepted in 2020)
    o 1 manuscript *in-preparation* on Integrating Complementary Approaches in Theories and Frameworks on C&I for Agricultural Livelihood Systems’ Sustainability (incl. Resilience): Review, Cases and Recommendations (initially started, will be continued in 2021).
  ✓ Technical report: Multi-stakeholder workshop report in Ethiopia on C&I on FS Sustainability
  ✓ Data set: a collection of 200+ referred journal articles for writing the above in-prep manuscript.

• Outcomes toward impacts
  ✓ 60 representative farmers + 20 staff of national/local agricultural research/development organizations trained in sustainability assessments (in ICARDA-GLDC study sites in Ethiopia and Burkina Faso)
  ✓ Contribution to university curriculum development (new/improved curricula, learning/teaching materials) is on-going in University of Nazi BONI (formerly Polytechnique University of Bobo Dioulasso), Burkina Faso.
Understanding the climate and market risks farmers face in SSA and SA to co-design better farm-level interventions (Whitbread et al.)

- Crop modelling methodology used to develop climate risk profiles for Nigeria, Kenya, Tanzania and Malawi.
- Scenarios of cropping systems modelled for all regions.
- Piloted ICT agro-advisories for Kenya and 2021 scaled to other countries.

**Digital platforms for information**

- ICT approaches for sending agro-advisories, severe weather warnings, pests and disease, marketing and input information.

In Kenya, the USAID supported Agri Value Chain Development project (AVCD) has established *messaging service reaching >4000 farmers* from 5 wards. Message last week:

"Forecasts indicate a very high probability for the coming season to be below normal. Consider planting more area with drought tolerant crops and short duration varieties to minimize the risk of crop failure” USAID-FtF-ICRISAT (ICRISAT and SourceTrace)
Farm Mechanisation for Crop Residue Processing enhances crop-livestock integration in Nigeria

Sorghum produces on average 8 t DM ha\(^{-1}\). Processed with stover crusher.

Crushed and mixed with crushed legume stover or with concentrate leads to almost 100% intake by ruminant.
Risk analysis in southern Mali

Take home messages:
1. Highest concern for hazards related to animal and personal health, and climate variability
2. Risk perception did not differ between resource endowment groups.
3. Differences within the household were related to the generational factor and decision power, and not to gender.
4. 25% of hazards: high frequency and a high impact on food availability and income.
5. Low resource-endowed farms were more often exposed to high risks than other farm types.
6. Farmers applied a variety of coping, yet in many cases farmers lacked a response
7. Development interventions should not focus on either agronomic or economic options separately, but combine both to strengthen social well-being and agricultural production
High resolution remote sensing (Sentinel 2) based identification of hardpan landscapes in Niger supports upscaling of reclamation interventions.

- Hardpans identified on the ground in Matamye
  1. Large patches within agricultural areas
  2. Larger patches of hardened iron oxide gravel
  3. Vegetated hardpans with natural shrubs and grasses

- Sentinel 2 multispectral imagery based indices relevant to soil surface characteristics were used in multi-linear regression

- Women farmers group was encouraged to own hardpan land near the village to adopt IMO’s to improve the soil condition and penetrability along with economic incentive from the produce.
Spatial distribution of cropping pattern in Niger with high resolution sentinel 1 and 2 imagery to scale-up sustainable farming systems (Irshad et al. prep.)
A landscape perspective for managing functional biodiversity and pests in tree-crop agroforestry systems (Valérie Soti & Thierry Brévault (CIRAD, Senegal))

Tree species identification from a WorldView-3 imagery and assess effect of tree abundance and species on the natural control of the millet head miner (MHM), *Heliocheilus albipunctella*

**Major outputs**

- A tree map including four major species in Bambe parklands (one paper in *Int J Appl Earth Obs Geoinformation*).
- Identification of the community of natural enemies of the MHM and of tree species favorable to natural pest control at the landscape scale (one paper in *Crop Protection*, two papers in *Agroforestry & Ecology* in prep.).

**Outcomes**

- Evidence of the contribution of tree species and abundance to natural pest control and ultimately crop productivity in parklands.
- Lessons for managing trees and related functional biodiversity in a way that improve the resilience of agroecosystems in the Sahel in a context of global change including climate and land-use.
Recommendation 1: Interactions between FPs

FP1
Review on GLDC-based farming systems impacts on:
• SOC (review) and
• NRM (impact assessment using drones)
• Gender

FP4 and FP5
• Systems modelling scenarios could inform FP4 and potentially FP5 understanding the relative importance of different traits/cultivars/crops in different regions considering climate change
• FP3-FP4 joint workshop with CoA leads and some key activity leaders to identify 2-3 joint studies or foster some ongoing studies for delivery in 2021

Other CRPs
• CoA3.1 with Maize-CRAP for Fall Army Worm
• CoA3.3 and PIM on livestock value chain and
• FP3 and FP2 of WLE/IWMI.

Market and partnership in agri-business (MPAB)
CoA3.3 and Markets and Partnerships in Agri-Business (MPA) cross-cutting theme on sorghum value chain

Gender
- Organize a two days workshop on gender integration during FP3 activity leaders meeting in the first quarter of 2020
- Develop gender researchable questions and identifying data needs particularly focusing on
  - Participation of women and age groups
  - Women empowerment

Capacity development
- Relooking at the ToC/ Zoom call 8 June 2020
- Defining and reporting Cap Dev in view of CGIAR CD framework
- Identify actors who are important to achieve the outcome of FP3 activities
Online Gender Integration workshop took place from 1-3 September 2020

- 43 Participants were invited
- 18 participants attended day 1
- 15 participants attended day 2
- 14 participants attended day 3
- All the COAs were represented

Day 1. Designing a gender research question (Practical examples?)

Day 2. Implementing a qualitative study – or mixed methods – what one can do? An example

Day 3. Institutional arrangements for delivery of Gender Research: Examples of what has worked

Agreed to prepare a gender legacy paper
Recommendation 2: Evidencing Impact

NRM evidence for inclusion of GLDC crops in farming systems

Presentation of the review protocol and preliminary findings of a scoping search to the Reference group
Shem Kuyah, Tarirai Muoni and Ingrid Öborn

Flow diagram of the review process

Examples of drone images orthomosaic (left) and derived DTM (right)

Ingrid Öborn (SLU/ICRAF), Shem Kuyah (JKUAT/ICRAF), Tarirai Muoni (ICRAF/SLU), Jules Bayala (ICRAF), Kumar Shalander (ICRISAT), Sreenath Dixit (ICRISAT), Karl Hughes (ICRAF/FP1), Kai Mausch (ICRAF/FP1), Mattias Jonsson (SLU), Sileshi Weldesemayat (Addis Ababa U), Sigrun Dahlin (SLU), Steve Boahen (IITA), Katrien Descheemaeker (WUR), Pierre Chopin (SLU/INRA)
Recommendation 3: GLDC and CG reform

• The team thought we are doing fairly well up to now in the collaboration domain with key stakeholders and rather proposed to discuss how our area of activity will fit into the new one CG research priorities.

• Tamo Manuel was tasked to produce a first draft (of position paper) that will be amended by the rest of the team.

• Deadline for draft outline by mid-November 2020 (delivery affected by conflicting messages about the OneCGIAR and COVID-19)
Thank you

http://gldc.cgiar.org