Grain Legumes and Dryland Cereals GLDC

Updates – FP3

Jules Bayala (ICRAF)
FP3-leader
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.
CoA 3.1: Innovations for managing abiotic and biotic stress

CoA 3.2: Cropping systems management

CoA 3.3: Testing, adapting and validating options
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Updates - CoA 3.1: Innovations for managing abiotic and biotic stresses
Manuele Tamò, IITA
Julie Dusserre, CIRAD
FP3.O1. Pest and diseases controlled safely and with reduced agro-chemical inputs

Achievements 2019

• Maps of risk areas of pests and diseases produced to help developing better surveillance strategies.

• Varieties screened for their tolerance to pests and diseases (use of bacteria and parasitoids)

• Approaches being developed to control Fall Armyworm that minimize the use of pesticides.

• Integrated management (seed treatment, spray of fungicides at various dates and use of bio-agents) of pests and diseases developed

• Reported work covers West Africa and South Asia and includes testing efficiency of plant extracts, parasitoids, fungicides, genetics for both varieties and pathogens and finally changes in disease incidence in link with climate change.

Milestone 2019

• Pest and diseases management components for the target pests in different regions fine-tuned
FP3.O1. Soil-crop-water and nutrient interactions enhanced

### Achievements 2019

- Impacts of mycorrhizal inoculation on striga emergence evaluated.
- Environmental fit of varieties of cowpea and sorghum assessed by comparing their yields with that of a locally adapted.
- Effects of compost prepared with 3 microbes on Plant Growth Promotion (PGP) evaluated.
- Organic materials (woody litter, composted urban wastes) used alone or in combination with mineral fertilizers on sole crops (sorghum, millet, cowpea and peanut) or their combinations in West Africa tested

### Milestone 2019

- Efficiency of nutrients and water improved
Biotic stresses: Monitoring of emerging diseases

- Farm level mapping of spatial and temporal distribution of emerging diseases of chickpea and pigeonpea in India
- Identified risk areas will help developing a surveillance strategy for these diseases

**Chickpea**

1. Ascochyta blight
2. Fusarium wilt
3. Helicoverpa pod borer
4. Dry root rot
5. Collar rot
6. Fusarium wilt
7. Helicoverpa pod borer

**Pigeonpea**

1. Powdery mildew
2. Cercospora leaf spot
3. Phytophthora blight
4. Fusarium wilt
5. Helicoverpa pod borer
6. Maruca pod borer
7. Pod Fly
8. Phytophthora blight
9. Fusarium wilt
10. Sterility mosaic disease
11. Helicoverpa pod borer
12. Maruca pod borer

Farm level mapping of spatial and temporal distribution of emerging diseases of chickpea and pigeonpea in India

Identified risk areas will help developing a surveillance strategy for these diseases

Biotic stresses: Monitoring of emerging diseases
### Biotic stresses: Monitoring of emerging diseases

#### Characterizing virulence spectrum of DM and blast pathogens of pearl millet

**Downy mildew (DM) incidence (%) of *Sclerospora graminicola* isolates on host differentials**

<table>
<thead>
<tr>
<th>Isolate</th>
<th>DM (%) on host differentials</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P7-4</td>
<td>P310-17</td>
</tr>
<tr>
<td>Sg 678</td>
<td>39.4</td>
<td>19.9</td>
</tr>
<tr>
<td>Sg 672</td>
<td>43.2</td>
<td>42.3</td>
</tr>
<tr>
<td>Sg 674</td>
<td>34.4</td>
<td>6.5</td>
</tr>
<tr>
<td>Sg 673</td>
<td>32.8</td>
<td>16.2</td>
</tr>
<tr>
<td>Sg 680</td>
<td>65.6</td>
<td>38.1</td>
</tr>
<tr>
<td>Sg 681</td>
<td>31.3</td>
<td>22.0</td>
</tr>
<tr>
<td>Sg 677</td>
<td>7.5</td>
<td>10.1</td>
</tr>
<tr>
<td>Sg 679</td>
<td>4.7</td>
<td>27.7</td>
</tr>
<tr>
<td>Sg 675</td>
<td>10.7</td>
<td>16.2</td>
</tr>
<tr>
<td>Sg 676</td>
<td>10.5</td>
<td>18.2</td>
</tr>
<tr>
<td>Mean</td>
<td>28.0</td>
<td>21.7</td>
</tr>
</tbody>
</table>

A total of 27 DM infected samples/isolates were collected during 2019 survey; All the isolates were successfully established on susceptible check 7042 S.

*Disease reaction of 10 isolates is given in the table and remaining 17 isolates are being characterized.*

Geographically and pathogenically diverse pathotype-isolates Pg 138, Pg 204, Pg 232 and Pg 118 have been selected for greenhouse screening.

Pathogenic groups/pathotypes of *Magnaporthe grisea*
Biotic stresses: Biocontrol of the legume pod borer (Maruca vitrata)

• Within the Norway-funded CSAT project in Niger, we have successfully released some 5,500 adult specimens of the parasitoid (Therophilus javanus), a biocontrol agent against the pod borer (Maruca vitrata). The releases occurred 29-30 Aug 2019 on unsprayed cowpea fields around Maradi and Zinder. An initial colony rearing of the parasitoid has been established at INRAN Maradi station.

• In Benin, we were able to recover adults of the parasitoid Therophilus javanus from parasitized caterpillars collected from cowpea pods. This is really a breakthrough, indicating that this parasitoid is still well established 3 years after the first experimental releases in the region. Pod-borer populations have been consistently low, with an average of 86.3% reduction as compared to prior to releases.
Biotic stresses: Fall Armyworm in sorghum

How do we fight it?
A meticulous, step-wise plan is needed to manage FAW outbreaks to prevent development of resistance to insecticides and to protect the environment.

1. "Push-pull" strategy: Use repellant plant (e.g. Desmodium) as intercrop in "push" and trap plant (e.g. Napier, Brachiaria grass) in "pull"

2. Physical destruction: Mass collection and destruction of egg and larval population

3. Mass trapping: Phenomenal traps and solar light traps to monitor and destroy

4. Poison ball: Mixing chemical insecticides with natural base and applying on test spots

5. Biopesticides: e.g. 5% Neem oil

6. Biocontrol agents: Fungi (e.g. Beauveria), Insecticides, Assurne rapier, predators and parasitoids

7. Chemical pesticides: Application of recommended pesticides

Efficacy of insecticides and bio-pesticides

Per cent mortality of FAW
Biotic stresses: Screening sorghum mini-core collection for resistance to Fall Armyworm (FAW)

- Two field trials and one screen-house experiments were conducted to screen the sorghum mini-core collection for resistance to FAW
- 250 Lines screened
- Field trial 1: natural infestation during rainy season
- Field trial 2: natural infestation but irrigated
- Screen-house: infested trial
- 5 Accessions (IS27557, IS14010, IS11026, IS6351 and IS4515) showed resistance with scores ranging from 2 to 3, on a 1 to 9 scale
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Updates - CoA 3.2: Cropping Systems Management
Steve Boahen (IITA)
Sigrun Dahlin (SLU)
FP3.02.(1) Cropping systems sustainably intensified and diversified

Achievements 2019

- Land use suitability mapped to guide on-farm trials.
- Demo plots established in different agro-ecologies considering gender differentiation.
- Intercropping cereals with shrubs and locally available high biomass productive legumes tested
- Georeferenced data collected for farm-household typologies and evaluation of production systems efficiencies and modelling.
- Participatory crop rotation, intercropping and doubled up legume systems evaluated for increased productivity, resource use efficiency and risk reduction.

Milestone 2019

- Map out areas suitable for crop diversification using GIS. Participatory field trials under smallholder conditions to evaluate the different cropping systems under different environments in different countries for farmers with landholdings less than 1 ha.
Cropping systems sustainably intensified and diversified

Achievements 2019

• Several demonstration plots established and on-farm trials for intercropping conducted

• Integrated systems with leguminous fodder trees, livestock and cereal tested

• Crop-livestock production systems that increase system productivity, economic returns and reduce risks being promoted

Milestone 2019

• At least two options per site per country to promote diversified, profitable and sustainable crop livestock systems discussed and agreed upon with local communities and researchers
Participatory trials: Integrating new drought tolerant soybean genotypes to intercropping and rotation systems across agro-ecologies in Mozambique

In collaboration with the Soybean Innovation Lab (SIL), 32 soybean varieties from private and public sources across Africa were evaluated in two agro-ecologies in Mozambique in 2019 to identify best performing ones for release and integration into the cropping systems.

The best yielding varieties also had the largest seed size.

Top five performing varieties in Angonia, Tete province and Namarripe, Zambezia province, Mozambique

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield (kg ha⁻¹)</th>
<th>Variety</th>
<th>Yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC Spike</td>
<td>5,120</td>
<td>SC Signal</td>
<td>3,977</td>
</tr>
<tr>
<td>SC Signal</td>
<td>5,123</td>
<td>TGx2014-21FM</td>
<td>4,017</td>
</tr>
<tr>
<td>GAZELLE</td>
<td>5,463</td>
<td>TGx2002-35FM</td>
<td>4,170</td>
</tr>
<tr>
<td>S1180-5-54</td>
<td>5,527</td>
<td>S1180-5-54</td>
<td>4,317</td>
</tr>
<tr>
<td>S1079-6-7</td>
<td>5,790</td>
<td>SC SAGA (Check)</td>
<td>4,367</td>
</tr>
</tbody>
</table>
Participatory trials: Evaluating Soybean responses to inputs

- **236** demonstration plots evaluating soybean variety responses to input application were established on farmers’ fields; a total area of **13.9 ha**; **36%** of the host farmers were women.
- Generally, **no significant differences in yields** were observed between male and female.

![Soybean yield responses to input application in Tete and Zambezia provinces, 2019](image1)

Soybean yield responses to input application in Tete and Zambezia provinces, 2019

![Soybean yield responses to input application in Tete and Zambezia provinces disaggregated by gender, 2019](image2)
110,000 are benefitting the doubled-up legume systems in the 8 extension planning areas located in 7 districts in Malawi.

Overall, groundnut and pigeonpea were identified as the most preferred commodity amongst ICRISAT’s mandate crops across agro-ecologies.

FGDs participants indicated that food security, household income, nutrition security, adaptation to agro-ecological conditions and easy access to seeds were the main reasons of these choices.
Participatory trials: Optimizing sorghum/cowpea intercropping

- ORACLE project in 3 communes in the central northern region of Burkina Faso: Guibare commune (Bam province), and Boussouma and Korsimoro communes (Sanmatenga province), enabled to identify 13 varieties of sorghum to intercrop with the local variety of cowpea, and 11 varieties of cowpea to intercrop with the local variety of sorghum.
- Strong genotypic variability for adaptation to the traditional intercropping system among 11 cowpea varieties

Grain yield of 10 cowpea varieties as a function of the control cowpea grain yield (number of plots per variety: Beng-raaga (control, Bgr) 34, Beng-yaanga special (Bgy) 12, Dablo (Dab) 11, Gourgou (Gou) 11, Komcalle (Kom) 7, Kvx 396-4-5-2D (Kvx3) 8, Kvx 780-1 (Kvx7) 12, Niizwe (Niiz) 9, Pisnu local (Pisn) 9, Tiligre (Tili) 9, Yiisyande (Yiis) 7.)
• ORACLE project in 3 communes in the central northern region of Burkina Faso: Guibare commune (Bam province), and Boussouma and Korsimoro communes (Sanmatenga province), enabled to identify 13 varieties of sorghum to intercrop with the local variety of cowpea, and 11 varieties of cowpea to intercrop with the local variety of sorghum.

• A comparatively small variability has been revealed among the 13 sorghum varieties tested.

Figure 2: Grain yield of 12 sorghum varieties as a function of the control sorghum grain yield (number of fields per variety: Fiib miougou (control, Fiibm) 32, Balinpelga (Balin) 3, BF 88-2/31-3 (BF88) 12, CSM 63-E (CSM) 12, Fibsablega (Fibs) 6, ICSV 1049 (ICSV) 8, Mitindaade (Mitin) 7, Pisnou (Pisn) 2, PSE08 G1/21-1G-1 (PSE8) 6, PSE09 G1/19-1-1-1 (PSE9) 12, Rouko 1 (Rouk) 8, Sariasso 15 (Sar15) 10, Sariasso 18 (Sar18) 10).
Updates - CoA 3.3: Testing, adapting and validating options for sustainable intensification

Shalander Kumar (ICRISAT)
Katrien Descheemaeker (WUR)
<table>
<thead>
<tr>
<th>Achievements 2019</th>
<th>Milestone 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Whole farm bio-economic household models for evaluating trade-offs and co-designing farming systems have been parameterized and validated at multiple locations in SA and SSA-India, Niger, Burkina Faso, and Mali.</td>
<td>• Portfolios of household activities, enterprises and management practices that materially and equitably enhance livelihoods (as defined at sub-IDO level) while minimizing negative externalities</td>
</tr>
<tr>
<td>• Capacity of extension systems built to use whole farming system model as decision support to promote climate resilient and sustainable FSs.</td>
<td></td>
</tr>
<tr>
<td>• A comprehensive framework for farming system sustainability assessment developed.</td>
<td></td>
</tr>
<tr>
<td>• Online tools developed for the large-scale use of sustainability assessment by stakeholders globally.</td>
<td></td>
</tr>
</tbody>
</table>
FP3.O3. Tested, adapted and validated options applied for sustainable intensification and livelihood diversification by farmers

Achievements 2019

• Impacts of GLDC innovations in managing biotic and abiotic stresses in agro-ecosystems assessed as well as gender-disaggregated impact of GLDC interventions on food and nutrition security in Burkina Faso, Mali, Niger, and Ethiopia.

• A holistic package of nutrition education through messaging and other methods designed to lay the foundations of nutritional knowledge and attitudes in SAT, India

• Intensive cropping systems modelling work being deployed in SA and SSA to generate tools/guides to better manage climate risks for improved productivity and resilience as well as informed trait discovery.

Milestone 2019

• Portfolios of household activities, enterprises and management practices that materially and equitably enhance livelihoods (as defined at sub- IDO level) while minimizing negative externalities
Measuring sustainability of farming systems in SAT: framework

Shalander Kumar, Katrien Descheemaeker, Bao Le Quang

- A comprehensive framework for farming system sustainability assessment (SA) developed
- The SA framework implemented in one location in India (Nalgonda) for each functional farm typology
- One masters student submitted her thesis based on part of the work (ICRISAT)
- One Masters student at SLU reviewed SA frameworks
- Work in progress on development of online tool for sustainability assessment
Performance of different farm types across sustainability domains

Overall sustainability index score of different farm types (maximum score=100)
Whole farm bio-economic model and FS cash flows scenarios to inform crop-livestock value chains in Niger

Model results for baseline

Alternative farming system scenarios: Potential impacts of different interventions on HH cash flows

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Farm type 1</th>
<th>Farm type 2</th>
<th>Farm type 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Improved dual purpose cultivar of pear millets</td>
<td>5%</td>
<td>9%</td>
<td>4%</td>
</tr>
<tr>
<td>2. Improved local cow (in place of existing low yielding cows)</td>
<td>50%</td>
<td>40%</td>
<td>27%</td>
</tr>
<tr>
<td>3. Improved small ruminants (in place of existing breed)</td>
<td>2%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>4. Improved dual purpose millets + Improved local cow</td>
<td>54%</td>
<td>76%</td>
<td>43%</td>
</tr>
<tr>
<td>5. Improved dual purpose millets + Improved local cow + improved SR</td>
<td>54%</td>
<td>77%</td>
<td>44%</td>
</tr>
<tr>
<td>6. Improved dual purpose millets + Improved local cow + improved SR + 15% higher price for cattle and SR</td>
<td>57%</td>
<td>80%</td>
<td>45%</td>
</tr>
</tbody>
</table>
Deploy Bio-economic models for 3 contrasting farming systems in South India

Achievements on whole farm modelling

- A common protocol for integrated assessment developed by standardizing parameters for whole farm modelling
- Training Workshops for 20 Survey Enumerators from 10 KVKs in 3 locations
- In collaboration with KVKs farming systems data have been collected and digitized for 500 rural HHs from 10 districts of Andhra Pradesh (2), Telangana (2) and Maharashtra (6) by ICRISAT
- The whole farm models are being parameterized using IAT to generate farming systems scenarios to be shared with each collaborating KVK.
- NARS partners’ capacity build on systems modelling

Capacity Building and data

- NARS: Whole modelling team was at ICRISAT on 5th and 6th Sept and learned parameterization and running the whole farm model using their own data set.
- Training Workshops for 20 Survey Enumerators from 10 KVKs in 3 locations
- Data collection-18 FGDs, 450 Households from 9 KVK districts in AP, TS and Maharashtra completed
- Data entry have been done using CsPro software
- Model parametrized for three districts
Managing climate risks for improving productivity

Crop response to agronomic practices varies from one season to the other

Effect of different sowing dates on simulated grain yield based on ensemble of contrasted GCMs for two climate periods [near-future (2010-2039) and mid-century(2040-2069)]
Complementarity of farming components (crop-tree-livestock) for improved household nutrition in Burkina Faso, Mali and Niger

- Based on the analysis of farm households’ nutrition security and determinants in the three GLDC focus countries, crop diversification came out strongly as a way to reduce nutrition insecurity.

- Protocols were co-developed for promoting small households’ fruit and vegetable gardens of jujube (Ziziphus mauritiana), tamarin (Tamarindus indica), baobab (Adansonia digitata) and moringa (Moringa oleifera) combined with annual legume crops like okra, amaranth, corchorus, etc.
  - A 36 m² fenced fruit and vegetable garden plots were established next to the compounds of 100 HH in Mali and 80 HH in Burkina Faso in August 2019.

- Production and nutritional properties of the products of these crops will be evaluated as well and their contribution in improving the diets in the targeted HHs.

- 2 master students from Mali and 1 PhD student from Burkina Faso were are currently conducted their field work.
A holistic package of nutrition education through messaging and other methods designed to lay the foundations of nutritional knowledge and attitudes in SAT, India

- The Knowledge-Attitudes-Practices (KAP) model applied in nutrition-related behavior changes in Adilabad, India
- Improving knowledge changes attitudes and behaviors to reduce the human and economic burden of food- and nutrition-related diseases
- Changing attitudes lead to changing practices thus leading to enhanced nutrition awareness
- Finally leading to enhanced capability to make better dietary choices for self, family and community as a whole

Outcome: Women empowered to make healthy food choices
Thank you

Demand-driven Innovation for the Drylands

In partnership with CGIAR Centers, public and private organizations, governments, and farmers worldwide

http://gldc.cgiar.org