CRP-GLDC
Flagship Program 5

Pre-Breeding and Trait Discovery

CRP-GLDC Science Week
Break-Out Sessions
Nairobi, Kenya
24th to 29th November, 2019

Rajeev Gupta, PhD (Cantab)

FP5 Leader- CRP GLDC

Principal Scientist & Theme Leader-
Genomics & Trait Discovery (GTD), ICRISAT

CGIAR RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

FP5: Vision & Mission

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

CGIAR

"To develop and deploy modern genetic, omics, molecular resources and tools for structural, comparative, translational and functional genomics approaches for mapping, dissection and characterization of target traits by exploring natural and induced diversity leading to genes/marker/allele/events discovery and improved processes for deployment in breeding to accelerate the rate of genetic gain in GLDC crops"

FP5: Core Team

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

Flagship Program 5 (FP5): Pre-breeding & Trait Discovery	
FP5 Leader	Rajeev Gupta (ICRISAT, India)
CoA 5.1 Pre-breeding	Ousmane Boukar (IITA, Kano) Jean-Francois Rami (CIRAD, France)
CoA 5.2 Trait discovery	Damaris Odeny (ICRISAT, Nairobi) Laurent Laplaze (IRD, France)
CoA 5.3 Enabling technologies	Pooja Bhatnagar (ICRISAT) Aladdin Hamwieh (ICARDA)

An Excellent Team!

FP4 & FP5: Discussion Points in Break Out Session

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals
CGIAR

(A) Discussion with partners: 9:15 AM to 11:45 noon:

- What are the research priorities for 2020 and beyond? Is there a change in what was prioritized by GLDC?
- Feedback on international nurseries?
- Did the partners use HTPG platform in breeding?
- Ideas around phenotyping platforms? What phenotyping is most critical?
- Expectations around TPEs?
- Expectations on crop network groups and capacity building?
- FP5 specific
  - Suggestion on traits discovery reprioritization (in on going traits) as we can't add any new traits in middle of CRP
  - Markers and their use in NARS programs (10 SNP panels, MAB programs etc.)
  - Material inputs from NARS for initial validation of QC panels
  - New technologies access to NARS
  - How CG and NARS can complement each other to avoid redundancies and competition
  - How can we work together on pre-breeding activities
- Any other?

FP4 & FP5: Discussion Points in Break Out Session

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals
CGIAR

(B) With FP1 team and MPAB: 11:45 noon to 1:00 PM & 2:00 PM to 2:30 PM

- FP4 expect the narration of IFPRI contested with data as it drives the investment of CtEH and have consequences to investment in GLDC's crop improvement programs
- Can FP1 team study the successful seed systems models in Myanmar (CP) or Bangladesh (Lentil) or India (all leagues in seed hub model) to understand what elements made it successful to reach our >95 area that is unthinkable for legumes in our priority countries. This builds a case study better than the example from private sector or private finance sector.
- Plant based meats? --with MPAB
- Systems dynamic economist from MPAB will discuss regarding on going scenario work on emerging traits.
- Any other?

Gender specific questions.

- Can we study the role of youth and gender in the successful seed models of Myanmar (CP) or India (seed hubs for all legumes)?
- Soybean new variety with high protein driving women and youth enterprises.
- Any other?
- Gender related traits and technologies in FP5

(C) With Thomas: 2:30 PM to 3:00 PM

- Understand about the capacity building and what the FP4 team can do for better metrics of CapDev and also organizing capped.
- Any other?
- In addition to regular activities what else can be done in FP5 for CD?

(D) With FP3 team: 3:00 to 3:30 PM

- Can we build evidence on contribution of improved legume varieties in intercrop or crop rotation to soil nutrient sustainability and environmental sustainability?
- Opportunities where the improved seeds and component technologies can be delivered together. Examples?
- Any other.

FP5: Major outcomes from Break Out Session

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

Trait discovery & Markers

- HTPG/SNP panels: Pearl millet, sorghum, finger millet, chickpea (both ICRISAT, ICARDA), pigeonpea, groundnut, cowpea (IITA), common bean (CIAT).
  - Lentil (ICARDA) to come on board in 2020
- Several examples of use both by CG and NARS
- Refinement of panels and deployment to continue
- Molecular Breeding products advances: e.g. chickpea, pearlmillet, groundnut, sorghum (with NARS)
- QC panels work to continue with input material from NARS for validation
- Marker validation on current breeding lines

- Trait discovery, characterization, dissection and mapping to continue for priority traits aligned with product profiles and priorities.
- Technology and tools (5.3) work to continue with access to NARS continue
- Trainings, workshops, exchanges, knowledge sharing to continue for FP5 specific CD

Deliberations to be considered for POWB2020

FP5: Major outcomes from Break Out Session

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

Transgenic:

- Stem borer Bt events in sorghum at IIMR advanced
- Pigeonpea events characterized at ICRISAT should be shared between IIPR and ICRISAT for field trials and advancement
- Transgenic supported by ICAR-ICRISAT should be reported in GLDC
- Aflatoxin work being advanced with NARS in Africa, proposal development in process

Pre-breeding to better incorporated in region

- IIPR would like to access pigeon pea wild pops
- AICRP-PM need to access pearl millet wild pops for A1 zones

Gender: traits (e.g., rancidity in Pearl millet, snap trait in finger millet) directly/indirectly impacting gender

MPAB: Discussion on modeling game changer traits (e.g. rancidity in pearl millet)

CD:

- Align activity with CD scale in MEL
- All students to be mapped to CD in MEL
- Training technician in breeding programs?

Deliberations to be considered for POWB2020

FP5: POWB Process 2020

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

CGIAR

General Guidelines

More focus on on-going activities/areas which could deliver before end of CRP
In general no totally new area or activity
More or less flat budget/funding
Directly relevant to critical focus area of FP5 and with bilateral funding or not required any w1/w2 support
Better integration with partners

Critical Focus Areas (CFAs) of FP5

Pre-breeding of Priority traits (wide-hybridization, Transgenic)
Discovery activities for priority traits (mapping & dissection, markers, GS, MAB)
Resources/tools/technologies (GE, 2G-TX, RGT, mutant pops-TILLING etc.) especially to leverage public private partnerships (PPP)
Data management (curation, migration, sharing, management etc.)

FP5: Cluster of Activities (CoAs)

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

Cluster of activities	Major activity
CoA 5.1: Pre-breeding	Use of natural (e. g., in un-adapted germplasm) or induced (e. g. mutants populations, transgenic) diversity available in key priority traits in GLDC crops
CoA: 5.2: Trait discovery	Trait discovery, dissection and elucidation with molecular, omics, biochemical and physiological tools to provide markers/alleles/events/knoweldge for use in breeding
CoA 5.3: Enabling technologies	Modern enabling tools, technologies, and platforms to facilitate efficient trait discovery and breeding

Most on-going activities to continue from 2019 to 2020

Research Priorities for 5.1: Pre-Breeding

CGIAR RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

- Wild hybridization and introgression to continue with on-going activities
- Transgenic: Bt pigeon pea, Bt chickpea, aflatoxins RNAi
- Genetic populations for breeding applications: NAM, BCNAM, MAGIC, etc.

Research Priorities for 5.2: Trait Discovery

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

Markers:

- SNP panels: development, validation, refinement and deployment
- Molecular breeding products
- Forward breeding
- QC panel: development, validation and deployment
- Focused GS activities

Trait discovery, characterization, mapping to continue on priority traits aligned with product profiles/breeding priorities

- Multi-pronged approach for intractable traits like striga, rancidity, aflatoxin etc.

Genetic and genomic resources for current and future trait discovery

Research Priorities for 5.3: Enabling Technologies

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

- Forward and reverse genetics platforms (e. g., TILLING) for functional validation of genes
- Gain-of-function/loss-of-function platforms for functional validation of candidates
- 2nd generation (Quick Transformation) transformation in cereals (sorghum, pearl millet)
- Genome editing platforms
- RGT platform for speed breeding (aligned with Avisa)

Leveraging Public-Private-Partnership (PPP)

Capacity Development Priorities for FP5

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

- Trainings, workshops, symposiums, knowledge sharing etc. in modern resources, tools and technologies
- Student/researchers trainings & exchanges also leverage bi-laterals projects (e. g., BBSRC-GCRF funded projects like TIG2RESS, MillNETi)
- Multidisciplinary, multi-partners and focused proposals (e. g, striga, bio-fortification etc. write-shops tomorrow)
- Data management (curation, migration, sharing, management, trainings etc.)

Potential Areas of Integration of FP5

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

FP5&FP4

- Markers validation and deployment in breeding programs
- QC panels development, initial validation and deployment
- & More

FP1&FP3: Trait prioritization, impact studies etc. (mainly Integration through FP4)

Gender: traits (e.g., rancidity in Pearl millet, snap trait in finger millet)

MPAB: Modeling on game changer traits (e. g. rancidity in pearl millet)

CD:

- Align all activities with CD scale in MEL
- All students to be mapped to CD in MEL
- Related activities to be discussed with CD team
- MEL to be fully used to capture all CD activities

FP5: Activity Leaders 2019

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

FP5 Activity Lead	Lead Centre
Daniel Foncéka	CIRAD
David Pot	CIRAD
Jean-Francois Rami	CIRAD
Aladdin Hamwieh	ICARDA
Shiv Kumar Agrawal	ICARDA
Abhishek Rathore	ICRISAT
Damaris Odeny	ICRISAT
Hari Kishan Sudini	ICRISAT
K Himabindu	ICRISAT
Mahendar Thudi	ICRISAT

FP5 Activity Lead	Lead Centre
Mamta Sharma	ICRISAT
Manish Pandey	ICRISAT
Manish Roorkiwal	ICRISAT
Pooja Bhatnagar	ICRISAT
Rachit Saxena	ICRISAT
Rajan Sharma	ICRISAT
Rajeev Gupta	ICRISAT
Rajeev K Varshney	ICRISAT
Rakesh K Srivastava	ICRISAT
S Gopalkrishnan	ICRISAT

FP5 Activity Lead	Lead Centre
Santosh Deshpande	ICRISAT
Shivali Sharma	ICRISAT
Sobhan Sajja	ICRISAT
Boukar, Ousmane	IITA
Chigeza, Godfree	IITA
Chigeza, Godfree	IITA
G. Chigeza	IITA
Laurent Laplaze	IRD
Rémy Pasquet	IRD
Yves Vigouroux	IRD

Demand-driven Innovation for the Drylands

CGIAR RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

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

www.gldc.cgiar.org

Thank You!

CoA 5.1: Pre-Breeding

Prioritized traits (high to low) for pre-breeding in GLDC crops	
Crop	**Priority traits for pre-breeding**
Chickpea	Resistance to *Helicoverpa* and dry root rot
Cowpea	Resistance to flower thrips, striga
Groundnut	Resistance to late leaf spot, Spodoptera
Pigeonpea	Resistance to phytophthora blight, *Helicoverpa* and Maruca
Pearl millet	Striga and Blast resistance
Sorghum	Shootfly and stem borer resistance
Lentil	Stemphylium blight, collar rots

Examples of Traits

Table FP4.2. Focus traits for improvement of GLDC crops by FP4 and FP5 interventions.

Crop	Traits for all target regions	Traits specific to target regions
Chickpea	Drought and heat tolerance*, pod borer resistance; high protein, Fe and Zn content	*Ascochyta* blight resistance (ESA, CWANA), dry root rot resistance (SA), herbicide tolerance* (SA)
Cowpea	Drought tolerance*, aphid and Rhizoctonia resistance	Striga* (WCA); Alectra resistance (ESA)
Groundnut	Drought tolerance*, stem rot resistance, high oil content*, high Fe and Zn content, aflatoxin resistance	Resistance to rosette (WCA, ESA), Early leaf spot (ELS) resistance, fresh seed dormancy (SA)
Lentil	Drought and heat tolerance*; high protein, Fe and Zn content; earliness	Resistance to *Ascochyta* blight, rust and root diseases, water logging tolerance (Sub-Saharan Africa). Resistance to *Stemphylium* blight, rust and root diseases, herbicide tolerance, high biomass (South Asia)
Pigeonpea	Resistance to fusarium wilt, sterility mosaic disease and pod borer; high protein, Fe and Zn content	Resistance to sterility mosaic disease and pod fly (SA); resistance to *Cercospora* and pod sucking bug (ESA)
Soybean	Drought tolerance/escape; shattering, lodging, rust resistance	Seed size, Frogeye resistance, Biological Nitrogen Fixation, day length insensitive (SA and WA)
Finger millet	Drought tolerance, blast resistance; high Fe, Zn and Ca content	Resistance to Striga and downy mildew (ESA)
Pearl millet	Drought tolerance*, downy mildew resistance, high nutritional quality (Fe, Zn), low flour rancidity	Blast resistance (SA), Striga resistance* (WCA and ESA)
Sorghum	Drought tolerance*, nutritional quality (Fe, Zn), fodder digestibility	Striga resistance* (WCA and ESA)

Color codes for the traits: Abiotic stress, biotic stress, grain nutrition value and consumer preferred for market pull. * 'no-regret' traits

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

CGIAR

CoA5.2: Trait Discovery

Prioritized Target Traits in GLDC Crops

CoA 5.3: Enabling Tools and Technologies

Group of Tools & Technologies	Examples of Enabling Tools and Technologies	Current status	Targets 2022
Structural genomics	High throughput SNP markers for genotyping	Not available in most of GLDC crops	HTP markers platform in 2 cereals and 2 legume
	Genomic selection (GS)	Not available in most of GLDC crops	GS implemented at least in 1 cereal and 1 legume
	Markers assisted forward breeding	Not available in most of GLDC crops	FW a routine in at least 3 cereal & 3 legumes
Functional genomics	TILLING or other systematic mutant populations	Not available for most GLDC crops	TILLING population in at least 1 cereal and 1 legume available and used
	Gain or loss of function transgenic platforms	Transgenic platforms available in groundnut, pigeonpea, and chickpea, Arabidopsis & tobacco	High throughput functional validation platform established and/or used in at least 4 GLDC crops or model plants.
	Genome editing platform	Not available in most of GLDC crops	This platform will be established for at least 2 GLDC crops.
Biochemical platform	Nutritional quality research lab	Available in SA at ICRISAT-HQ in India	Functionally established and made available at one center each in ESA and WCA
Precision phenotyping in controlled environments	Leasyscan for precision screening for abiotic stress (for WUE) and biotic stresses (glasshouse screens for diseases and pests)	A lysimeter facility and a LeasyScan Phenotyping Platform & boitic stress screening facilities available at ICRISAT-HQ	These platforms will be standardized for use in at least five GLDC crops. Such platforms will be developed for screening against other target key traits in GLDC crops such as diseases.
Rapid achievement of homozygosity	Doubled haploid (DH) technology	Not available in most GLDC crops	Will be made available in at least 2 GLDC crops.
	increase # of generations per year or shuttle breeding	Not available in most GLDC crops	Will be made available in at least 2 cereals and 2 legumes