International Virtual Experts Meeting on Promoting Sustainable Agriculture Development in Drylands

Riyadh, Kingdom of Saudi Arabia 10th August 2020
Plant breeding and better crop selection for improved dryland stress resistant varieties development to enhance productivity

Breeding for diversified cropping systems
Example of sorghum based systems in Central North zone of Burkina Faso

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Urgent need to introduce greater diversity to cropping systems

- Environmental variability
  - Soil
  - Climate

- Management
  - Risk management

- Sustainability
  - Multi-functionality of the cropping systems
  - Multipurpose
  - Ecosystems services

- Functional understanding of the systems

Breeding for diversified cropping systems
Environmental variability
Target Population Environments

Identification of limiting factors by models according to different management practices (varieties, fertilisation, sowing density…)

Reflect semi arid zone crop types/ environments/ situation
⇒ Optimization of crop management
⇒ Target traits to guide breeding

Modeling to guide varietal selection in the South
Environmental variability
Coordination of plant breeding at the regional and national levels

ABEE project-West Africa Breeding Networks and Extension Empowerment

- 20 varieties from the 5 speculations evaluated in the 5 countries since 2018
- Standardisation of phenotyping methods
- Harmonized database (BMS)

5 countries (Burkina Faso, Mali, Niger, Sénégal, Togo)

Breeding
Phenotyping
Genotyping
IBM

Regional concerted network of breeders
Sustainability
Multi-functionality of the cropping systems

In semi arid zone of Burkina: sorghum based systems and mostly intercropped.

Multi-species cover (more than two species)
- Several genotypes per species
  - Mix of synbreeding varieties (e.g. millet, sorghum, wheat, etc.)
  - Typically used in CA (e.g. sorghum, intercropping)

Bi-species cover
- Several genotypes per species
  - Mix of synthetic varieties (e.g. millet in CA, but occurs in agroforestry or intercropping)
  - May occur in CA or other systems (e.g. sorghum in agroforestry)

Single-species cover
- One genotype per species
  - Natural diversity (e.g. wild varieties)
  - May occur in CA or other systems (e.g. wild varieties in agroforestry)

Approaches to plant breeding
- No development yet
- Test of the ability of a variety to perform in 'association' with other varieties
- Evolutionary plant breeding
- Traditional selection schemes with genalogic and recurrent selection

Need for breeding programs to include diversity in their program

Litrico and Violle, 2015
Single species cover: « Traditional » selection schemes

Conventional breeding goals (for sole crop) should evolve to innovative decentralized and participatory selection scheme (done for sole crop in Burkina Faso)

Define varietal type according to farmers needs and their production systems

Training of farmers to produce locally quality seeds
Partnership with farmers’ organization to enhance seeds access
Bi-species cover: Test the ability of variety to perform in association with others

Building on farmers’ knowledge to improve sorghum-cowpea systems in North Central Burkina Faso → 99% of farmers practices intercropping in the Central Nord zone of Burkina

Farmers’ practice: in the same hill

Researcher recommended practice: inter-row

→ System resilient to climatic variability
→ Performance of varieties different according to the cropping systems

Importance to optimize agronomic traits in breeding programs, but for intercropped systems, there is a need to look at other traits (showing the ability to live and perform well with other plants)

→ functional traits related to resource-use = interaction traits

Performance of a genotype in pure culture ≠ its performance in mixed culture
Define plant traits that are important for intercropped systems

**Agronomic traits**

- **Good sorghum yield**
- **Good cowpea yield**

**Interaction traits** (variance decomposition)

- **Plant traits contributing to sorghum yield**
  - Plant health
  - Flowering
  - Plant health maturity
  - Biomass yield
  - Plant health 30 DAS
  - Plant height
  - Sorghum cycle

**Intercropped**

- Photosynthesis losses
- Plant health
- Plant health 30 DAS
- Biomass yield
- Plant height
- Farmers appreciation

**Sole crop**

- Contribution of grain yield to sorghum

**Importance of phenology and plant height for intercropped systems (complementary traits)**

Optimize the mean value of agronomic traits and the variance of interaction traits
In semi arid zone of Burkina: sorghum based systems, mostly intercropped

**Environmental variability**
- Modeling to guide varietal selection in the South (better target)
- Regional concerted network of breeders
- Need for breeding programs to include diversity in their program

**Sustainability**
- Importance of farmers perspective and involvement
- Performance of a genotype in pure culture ≠ its performance in mixed culture
- Optimize the mean value of agronomic traits and the variance of interaction traits

Breeding for diversified cropping systems
Single-species → Bi-species → Multi-species
Conclusions: premises of breeding for bi-species cover (let alone multi-species)

In West Africa, for crop selection for improved dryland stress resistant varieties development to enhance productivity we have:

1. A network of concerted breeders working together
2. Tools (models and imagery/phenotypage) to characterize the diversity of environments and better target the stress of interest

→ There is a need to further strengthen these approaches for intercropping systems

3. Use of 1 and 2 for intercropped systems (not only pure crop): initial work in Burkina Faso (collaboration INERA-CIRAD)
4. Include soil microbiology for evaluation « in situ » of soil diversity versus legumes endophytes symbiose
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Thanks for your invitation