Stress resilient Maize Variety Development and Development

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Presentation to Ethiopian Maize Breeding Team
October 17th, 2018, Bako, Ethiopia
Outline

• Product profile and trait prioritization
• CIMMYT-GMP breeding approaches
  – New tools and technologies to accelerate product development:
    – Breeding is a number game
• Product development and advancement decision
  – Product development
  – Regional testing network
  – Identification of new testers
  – Heterotic grouping
• Seed system @CIMMYT GMP
  – Seed producibility research
  – Parental trials
  – DUS and VCU
  – Variety Replacement Plan
GMP’s current product advancement process

- Breeding program is decentralized
- Sub-Saharan Africa:
  - 95% white and 5% yellow (pro vitamin A)
  - Priority traits: Grain yield, drought, *Striga*, MLN, FAW, and other leaf diseases
- Latin America:
  - 50% white and 50% yellow
  - Priority traits: Grain yield, drought, TSC, and other leaf diseases
- Asia:
  - 95% Yellow and 5% white
  - Priority traits: Grain yield, heat, water logging, drought, and other leaf diseases
Product profile and trait prioritization

• Which are the traits to be added into one product?
  – Must have traits (Yield, GLS, ET, MLN?)
  – Important to have (FAW?)
  – Nice to have (high zinc, QPM)

• Flagship products by region not project specific product profile

• Mainstreaming biofortified traits (and FAW?) into product development is challenging
  – Pre-breeding might be necessary prior to using the trait in final product development
  – More time needed for introgressing the value addition traits into elite
  – Can we have a dedicated breeder for such traits?
An integrated approach for increasing breeding efficiency

• GMP have five complementary teams
  – Product development
  – Phenotyping supporting team
  – Molecular breeding
  – DH
  – Seed systems

• Development of phenotyping and genotyping tools should be prioritized by the team
  – New tools and technology quickly integrated into product development
  – Have a common planning and advancement meeting
  – Slots allocation to breeders for specialized service (DH, MLN, quality lab vs. charge back)
CIMMYT-GMP Breeding Approaches

Accelerate forward breeding – recycling elite lines from different breeding streams
- DT elite line x DT elite line
- DT elite line x Insect resistant elite line
- DT elite line x NUE elite line
- DT elite line x MLN tolerant line
- DT elite line x Off-PVP line

Integrated application of technologies to enhance genetic gains and breeding efficiency
- DH technology
- MARS and GS in breeding pipelines
- Trial networking system
- Decision support tools (META-R, AGD-R, GEA-R)

Product profiles for targeted agro-ecologies
- Descriptors for lines and single cross
- Male and female yield, Flowering synchronization
Product advancement process in GMP

1. Stage I – breeder /partner controlled
   – First testcross evaluation; one tester; 2 reps, 3-5 sites

2. Stage II – breeder/partner controlled
   – Selected lines (15-20% SI) from Stage I trials, 3 testers; 2 reps, 8-10 sites

3. Stage III- breeder/partner controlled
   – Selected lines from Stage II trials (10-15% SI)
   – Crossed with 5-7 testers
   – 2 rep, 10-15 locations

4. RT (collaboration)
   – best products from stage III
   – 2 row, 2 reps, 45-60 entries (CIMMYT, Monsanto, NARS), 60 sites
   – Run in partnership

5. NPT- selected hybrids evaluated in NPT by public partners
Breeding is a number game

# DH lines and Hybrids Evaluated in WEMA Project (2008 - 2017)

- DH lines developed and use
- Hybrids developed and evaluated

Average # DH/population = 135
Drought tolerant and susceptible hybrids under managed drought at Kiboko in 2017

- Date of planting: 4th June 2017
- Date of 1st irrigation: 5th June 2017
- Date of last irrigation: 24 July 2017
Identify appropriate testing locations for various biotic and abiotic constraints

Managed drought-Kiboko

Turcicum leaf blight - Kakamega

Optimum-Embu

MLN-Naivasha
What about marker assisted selection

![Diagram showing stages of conventional and molecular plant breeding]
Correlation between observed and predicted on 853 lines

![Graph 1: Obs vs Pred](image1)

- Observed vs Predicted
- $R^2 = 0.7249$

![Graph 2: Obs vs Pred](image2)

- Observed vs Predicted
- $R^2 = 0.7582$
Responses of some commercial maize hybrids against MLN
Identification of MLN -Tolerant Lines

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<th>Susceptible</th>
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CIMMYT
MLN tolerant hybrid at Naivasha Demo plots in 2017
Genetic Gain by Year for Grain Yield, by Site under optimum Locations

Genetic gain estimates in other regions of the world

<table>
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<tr>
<th>Country</th>
<th>Gain kg/ha/year</th>
<th>Reference</th>
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<tr>
<td>Argentina</td>
<td>132</td>
<td>Luque et al., 2006</td>
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<td>Eastern and southern Africa</td>
<td>109.4</td>
<td>Masuka et al., 2017a</td>
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<td>China</td>
<td>94.7</td>
<td>Ci et al., 2011</td>
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<td>Bruulsema et al., 2000</td>
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<td>This study</td>
<td>147</td>
<td>Unpublished</td>
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GY = 6.942 + 0.147*Year; (2% per year)  
R-Square = 0.0310;  Pr>|t| = 0.0426
FAW tolerant line (CML71) at Kiboko under artificial infestation- July 2018
Thank you for your interest!