Pearl millet improvement program - WCA

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4th Sept 2018, Regional Pearl millet Convening, CERRAS, Thiess, Senegal

All Photo credit: Prakash Gangashetty, ICRISAT
**Introduction**

- In world the pearl millet crop ranks sixth in importance followed by wheat, rice, maize, barley and sorghum.
- Staple food and fodder crop in the African Sahel.
- Highly adapted to drought, low soil fertility and marginal lands
- Incalculable amount of genetic diversity in land races is available in West Africa
- Highly nutritious crop- High Fe (40-75 ppm Fe and 30-50 ppm Zn), which contributes for nutritional security

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Country</th>
<th>Area (M ha)</th>
<th>Production (mt)</th>
<th>Yield (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Burkina Faso</td>
<td>1.3</td>
<td>1.0</td>
<td>793</td>
</tr>
<tr>
<td>2</td>
<td>Ghana</td>
<td>0.2</td>
<td>0.2</td>
<td>1077</td>
</tr>
<tr>
<td>3</td>
<td>Mali</td>
<td>1.7</td>
<td>1.4</td>
<td>808</td>
</tr>
<tr>
<td>4</td>
<td>Niger</td>
<td>6.7</td>
<td>3.2</td>
<td>467</td>
</tr>
<tr>
<td>5</td>
<td>Nigeria</td>
<td>4.2</td>
<td>5.7</td>
<td>1358</td>
</tr>
<tr>
<td>6</td>
<td>Senegal</td>
<td>0.9</td>
<td>0.6</td>
<td>699</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>15</td>
<td>12.1</td>
<td>867</td>
</tr>
</tbody>
</table>

_mean Area, Production and Yield of Millets (FAO year book 2014)_
Agro climatic zones of West Africa
Pearl millet breeding, ICRISAT, WCA

PCN1
(Early duration pearl millet OPVs with disease resistance for adaptation to sahelian zone of West Africa)

PCN2
(Medium duration pearl millet OPV with disease and pest resistance, for adaptation to better endowed environments)

PCN3
(High yielding pearl millet hybrids for adaptation to better endowed environments of West Africa)

Target countries

Base Genetic Material
Germplasm
Released varieties
Introduced genetic stock
Breeding pipeline/genetic stock

Open pollinated varieties (OPVs)

S1/F2
S2/F3
S3/F4

RM1
RM2
RM3

Downy mildew screening
Striga hermonthica screening

Head miner Screening (Heliocheilus albipunctella)

Fe and Zn

Testing PCN1/Year1
Testing PCN1/Year2/Selected on farm/Demonstration
Large scale on farm testing/Demonstration

Testing PCN2/Year1
Testing PCN2/Year2/Selected on farm/Demonstration
Large scale on farm testing/Demonstration

Testing PCN3/Year1
Testing PCN3/Year2/Selected on farm/Demonstration
Large scale on farm testing/Demonstration

Release/Registration

Seed parents program
Restorer program

Test cross
Fertile F1

RXR, Germplasm

S1/F2
S2/F3
S3/F4

Hybrids
Restorer program

Hybrids
Seed parents program

Hybrids
# Pearl millet improvement program - WCA
*(Target countries- Niger, Nigeria, Mali, Burkina Faso and Senegal)*

<table>
<thead>
<tr>
<th>Product concept</th>
<th>Estimated area (ha)</th>
<th>% area/effort</th>
<th>Target and spillover agro-ecologies</th>
<th>Maturity (days)/Rainfall</th>
<th>Resistance/tolerance required</th>
<th>Must have traits</th>
<th>Nice to have traits</th>
<th>Product development goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) High yielding, early maturing pearl millet OPVs for adaptation to sahelian zone of West Africa</td>
<td>~8 m ha</td>
<td>40</td>
<td>Target: Sahel Agro-ecology predominantly Niger, Mali, Burkina Faso, Senegal, and Nigeria Spillover: Chad, Ghana, Gambia, Mauritania, Cameroun and India</td>
<td>Early maturity/Up to 90 days (350 -500 mm/annul)</td>
<td>Biotic stresses: Downy mildew, Millet head-miner Striga hermonthica</td>
<td>Grain Yield of &gt;0.9 tons/ha, Downy mildew resistance</td>
<td>Head length (30-40 cm)</td>
<td>High grain iron and zinc content. Striga tolerance Drought tolerance Head miner tolerance</td>
</tr>
</tbody>
</table>
PCN1 Testing sites in WCA
<table>
<thead>
<tr>
<th>Product concept</th>
<th>Estimated area (ha)</th>
<th>% area/effort</th>
<th>Target and spillover agro-ecologies</th>
<th>Maturity (days)/Rainfall</th>
<th>Resistance/tolerance required</th>
<th>Must have traits</th>
<th>Nice to have traits</th>
<th>Product development goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Medium maturity, high yielding pearl millet OPV for adaptation to better endowed environments of West Africa</td>
<td>~7 mha</td>
<td>40%</td>
<td>Target: Sudan Agro-ecology (Niger, Mali, Nigeria, Burkina Faso and Senegal) Spillover: Ghana, Chad Gambia, Cameroun</td>
<td>Medium maturity/ &gt;90 days (500 -800 mm/annum)</td>
<td>Biotic stresses: Downy mildew resistance, Head miner tolerance, Striga hermonthica tolerance</td>
<td>Grain Yield of &gt;1.3 tons/ha, Downy mildew resistance Tolerance to head miner Head length (40-65 cm)</td>
<td>High grain iron and zinc content. Striga tolerance Flowering period heat tolerance</td>
<td>10% increase in grain yield over improved check Niger- ICMV 167005 and ICMV 167006 Nigeria-SOSAT-C88 and SUPEROSAT Mali- Syn0006 and SOSAT-C88 Burkina Faso- ICMV 167005, ICMV 167006 and IKMV-1 Senegal- Souna-3, SOSAT-C88</td>
</tr>
</tbody>
</table>
PCN2 Testing sites in WCA
<table>
<thead>
<tr>
<th>Product concept</th>
<th>Estimated area (ha)</th>
<th>% area/effort</th>
<th>Target and spillover agro-ecologies</th>
<th>Maturity (days)/Rainfall</th>
<th>Resistance/tolerance required</th>
<th>Must have traits</th>
<th>Nice to have traits</th>
<th>Product development goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) Early maturity, high yielding hybrids for adaptation to better endowed environments of West Africa</td>
<td>20 %</td>
<td></td>
<td>Target: Sudan Agro-ecology (Niger, Nigeria, Burkina Faso, Senegal, and Ghana) Spillover: India, ESA</td>
<td>Early 70-90 days / (500-800 mm/annum)</td>
<td><strong>Biotic stresses:</strong> Downy mildew resistance Head miner tolerance</td>
<td>Grain Yield of &gt; 2.0 tons/ha Downy mildew resistance</td>
<td>High grain iron and zinc content. Striga tolerance Drought tolerance Flowering period heat tolerance</td>
<td>15% increase in grain yield and Stover yield over improved check with &gt;40 ppm Fe</td>
</tr>
</tbody>
</table>

**Product pipeline**
- ICMH 157222
- ICMH 177111
CHAKTI
High Fe (60 ppm), high yielding (1.2 t/ha), early maturing (65 days), Biofortified, Pearl millet Variety

Released in 2018

PCN 1: High yielding, early maturing pearl millet OPVs for adaptation to sahelian zone of West Africa

Photo credit: Prakash Gangashetty, ICRISAT
CHAKTI harvest at farmers field in Maradi, Niger

Photo credit: Prakash Gangashetty, ICRISAT
PCN 2: Medium maturity, high yielding pearl millet OPV for adaptation to better endowed environments of West Africa

Varieties registered in 2018

ICRI-Tabi

ICMV 167005

PPBV Serkin Hausa

Photo credit: Prakash Gangashetty, ICRISAT
PCN3: Early and medium maturity, high yielding hybrids for adaptation to better endowed environments of West Africa

- Seed parents development program (A/B)
- Restorer line development program – R Line
- Hybrid development
  - Top Cross hybrids
  - Single cross hybrids
    - Test Cross evaluation (A x ?)
    - Preliminary hybrid yield testing
    - Advanced hybrid yield testing along with demonstrations in research stations
    - On farm testing and release proposal

Photo credit: Prakash Gangashetty, ICRISAT
Pollen fertility and sterility percentage in West African pearl millet varieties

ICMA 177001
ICMA 177002
ICMA 177005
ICMA 177007

Exborno, ICMV IS 99001, ICMV IS 89305, HKP, ICMV IS 94206, Moro,

60 WA released pearl millet varieties and breeding pipeline populations

ICMV 167005, ICMV 167006, ICMV 167001, ICMV IS 92222, SOSAT-C88

Maintainer (A/B)
Restorer (R)

F1 (Fertility/Sterility %)

X

70%
85%
15%
30%
### Seed parents development program (A/B)

<table>
<thead>
<tr>
<th>Designation</th>
<th>CMS</th>
<th>D50%F</th>
<th>DM %</th>
<th>Head length</th>
<th>Fe (ppm)</th>
<th>Zn (ppm)</th>
<th>Hybrids</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICMA 177001</td>
<td>A1</td>
<td>55</td>
<td>0</td>
<td>Medium (40-50 cm)</td>
<td>40</td>
<td>35</td>
<td>ICMH 147003</td>
</tr>
<tr>
<td>ICMA 177002</td>
<td>A1</td>
<td>55</td>
<td>0</td>
<td>Long (&gt;50 cm)</td>
<td>35</td>
<td>31</td>
<td>ICMH 177111</td>
</tr>
<tr>
<td>ICMA 177003</td>
<td>A1</td>
<td>60</td>
<td>0</td>
<td>Long</td>
<td>38</td>
<td>35</td>
<td>ICMH 157222</td>
</tr>
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</table>
## Restorer program

<table>
<thead>
<tr>
<th>Designation</th>
<th>Restoration CMS</th>
<th>D50%F</th>
<th>Fe (ppm)</th>
<th>Zn (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICMR 08666</td>
<td>A1</td>
<td>55</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td>ICMR 08777</td>
<td>A1</td>
<td>60</td>
<td>39</td>
<td>33</td>
</tr>
<tr>
<td>ICMR 08888</td>
<td>A1</td>
<td>55</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>ICMR 09666</td>
<td>A1</td>
<td>60</td>
<td>45</td>
<td>35</td>
</tr>
<tr>
<td>ICMR 09999</td>
<td>A1</td>
<td>50</td>
<td>39</td>
<td>33</td>
</tr>
</tbody>
</table>
ICMH 177111

Downy mildew resistant
Long headed (45 cm)
High yielding (2.1 t/ha)
Early maturing
(90 days)
Pearl millet hybrid

Photo credit: Prakash Gangashetty, ICRISAT
ICMA 177002

Photo credit: Prakash Gangashetty, ICRISAT
Hybrid seed production

Photo credit: Prakash Gangashetty, ICRISAT
Farmer field in Konni, Niger

Farmer field in Maradi, Niger

Photo credit: Prakash Gangashetty, ICRISAT
Donors and Collaborators

[Logos of various organizations]
Thank You for your attention!

Photo credit: Prakash Gangashetty, ICRISAT