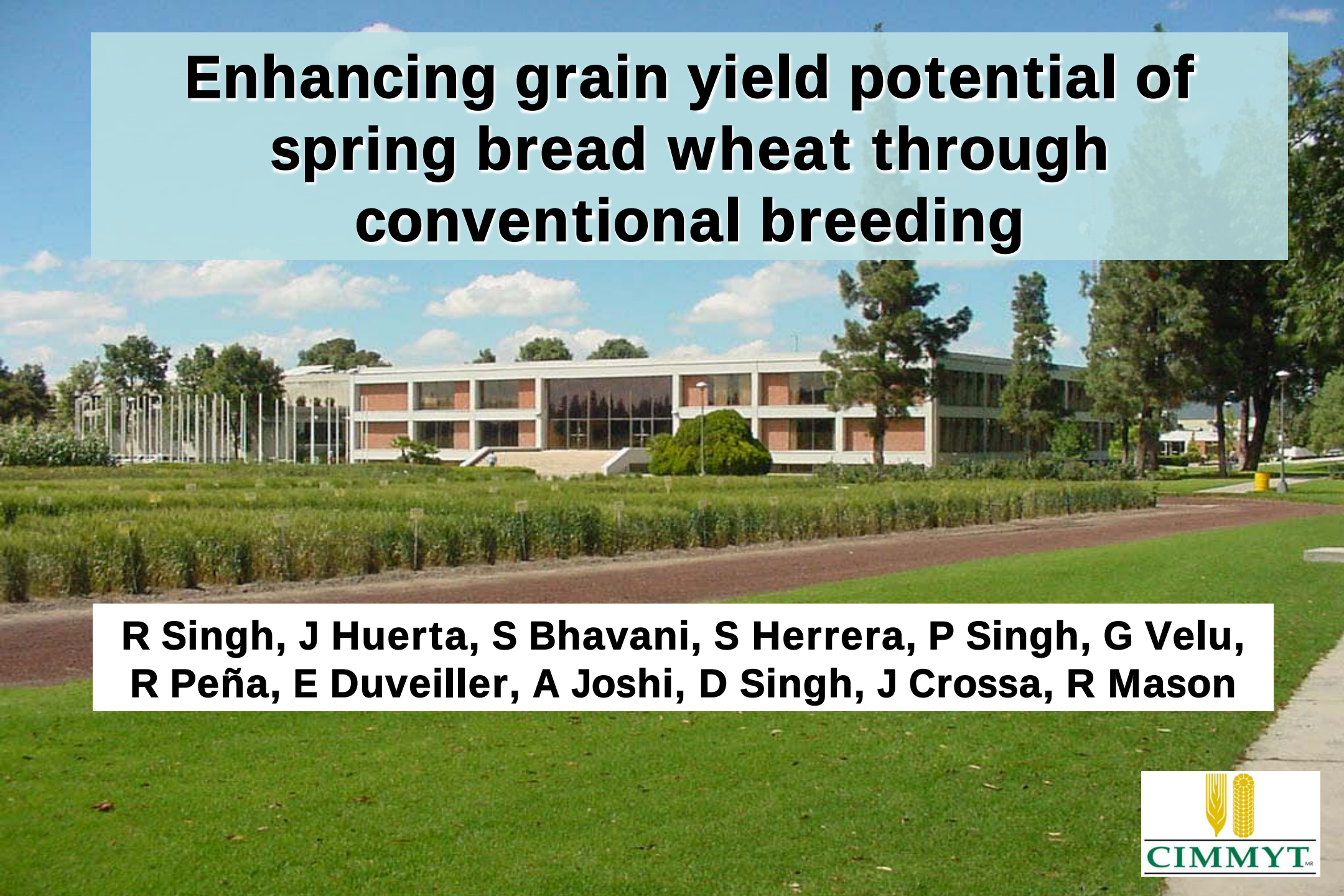
Enhancing grain yield potential of spring bread wheat through conventional breeding



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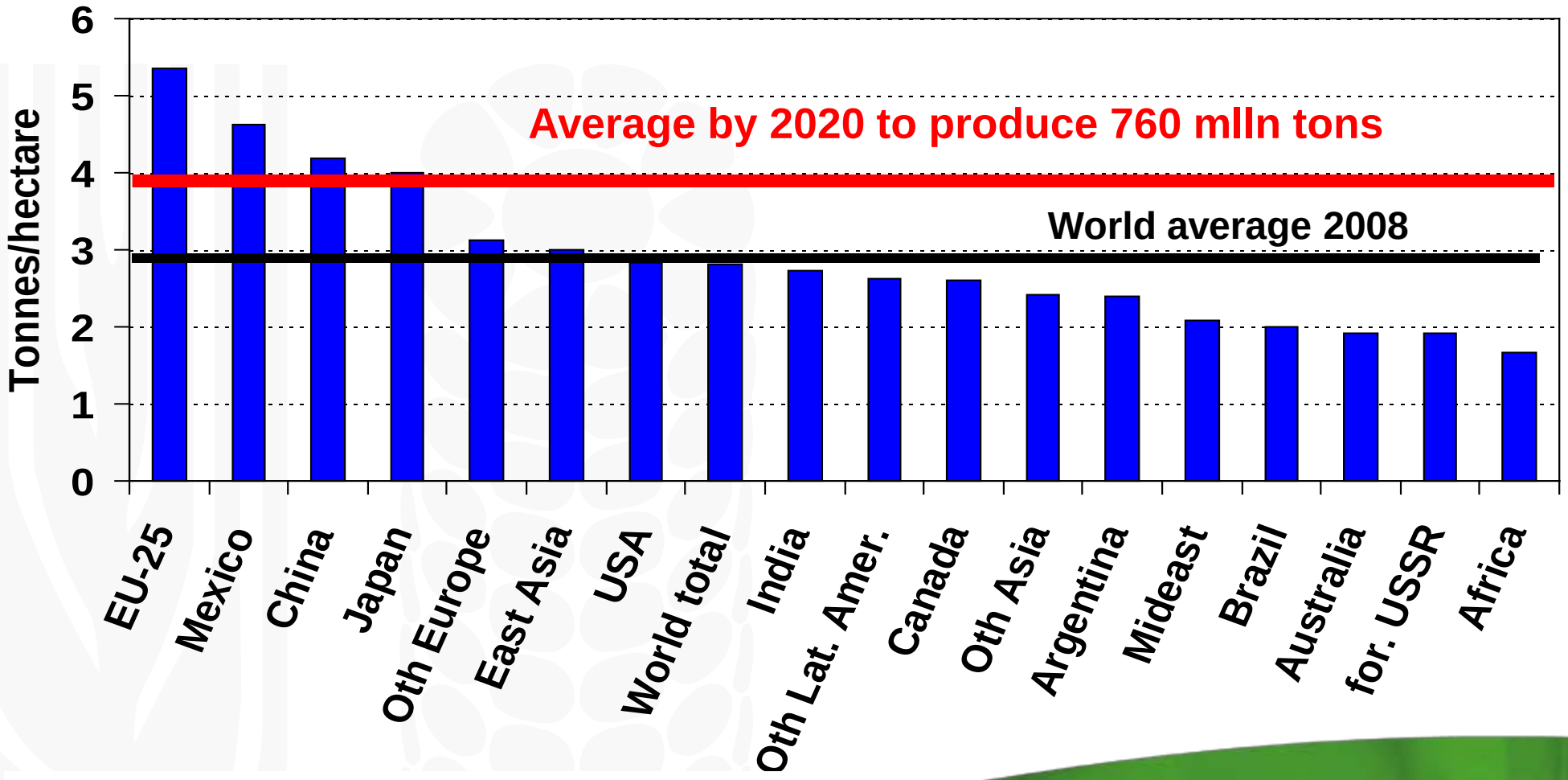
Why increase grain yield potential?



UN/FAO production goal for wheat 4 tons/ha by 2020

(slide source: H-J Braun)

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Global Wheat Program- Breeding Priorities

- High and stable yield potential
- Durable disease resistance
  - Rusts- Stem (Ug99), Stripe and Leaf
  - Fusarium – Scab and myco-toxins
  - Septoria leaf blight, Spot Blotch, Tan Spot
  - Soil Borne Diseases
- Water use efficiency/Drought tolerance
- Heat tolerance
- Appropriate end-use quality
- Enhanced Zn and Fe concentration
- Adaptation in conservation Agriculture
- Human Resource Development

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Wheat Breeding at CIMMYT

Mexico based

- Irrigated spring bread wheat improvement
- Rainfed spring bread wheat improvement
- Durum and triticale improvement
- Germplasm enhancement

Regional based

- Turkey-CIMMYT-ICARDA winter and facultative wheat improvement for CWANA region
- CAAS-CIMMYT winter and facultative wheat improvement for China

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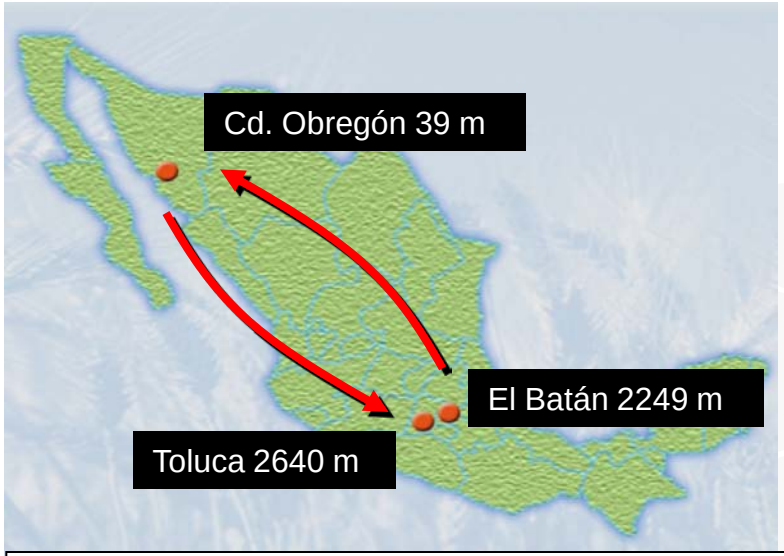
Recurrent Breeding Approach:

Data collected worldwide, used in centralized program

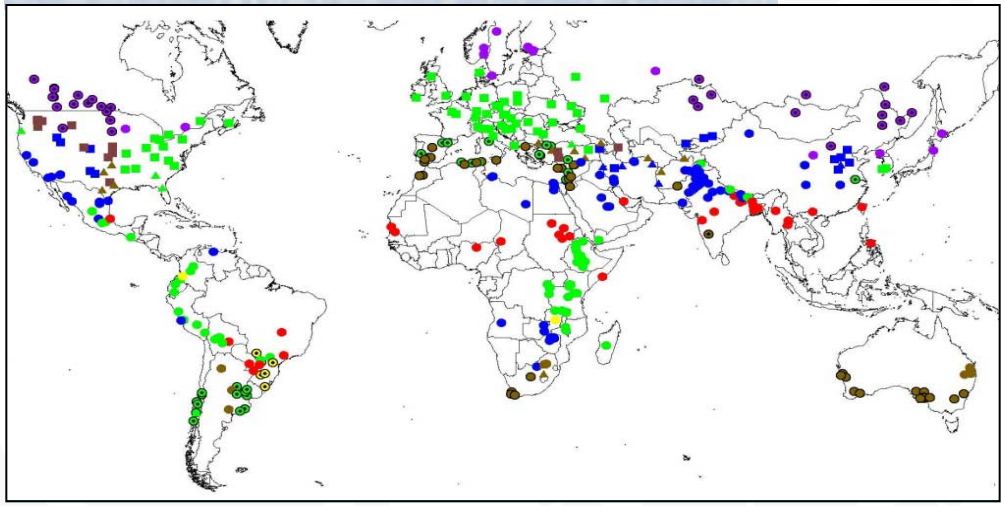


Crossing

Shuttle Breeding in Mexico

Evaluation in Mexico and hot spot sites worldwide

Distribution of improved germplasm through IWIN



Collection and interpretation of multi-location data

> 40% of Spring Wheat area sown with CIMMYT germplasm

Crossing and selection schemes continue to evolve in CIMMYT breeding program

- Simple, three-way (top) and 4-way (double) crosses with pedigree selection until mid 1980s
- Simple, three-way and occasional single-backcross during mid 1980s-early 2000s combined with modified-bulk selection scheme
- Single-backcross (50% crosses), 3-way (25%) and simple (25%) crosses with selected-bulk selection scheme
  - Large population sizes of about 400 plants in F1-Top and BC1

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Selection Method: Selected Bulk

(Harvesting and threshing one spike from each of the selected plants of a population as bulk)

- Conducted from BC1/F1Top through F4 or F5 generations
- Individual plant selection in F5 or F6
- Permits selection of unlimited number of plants that have good agronomic features and desired level of resistance to diseases
- Increases possibility to identify transgressive segregants due to larger population sizes
- Field operation is easy, fast and economic thus leaving resources for more yield trial plots
- Allows easier movement of germplasm for international shuttle breeding

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Yield testing of advanced lines at Cd. Obregon, Mexico

- 1st year yield trials (5000 new entries in 2009-2010):

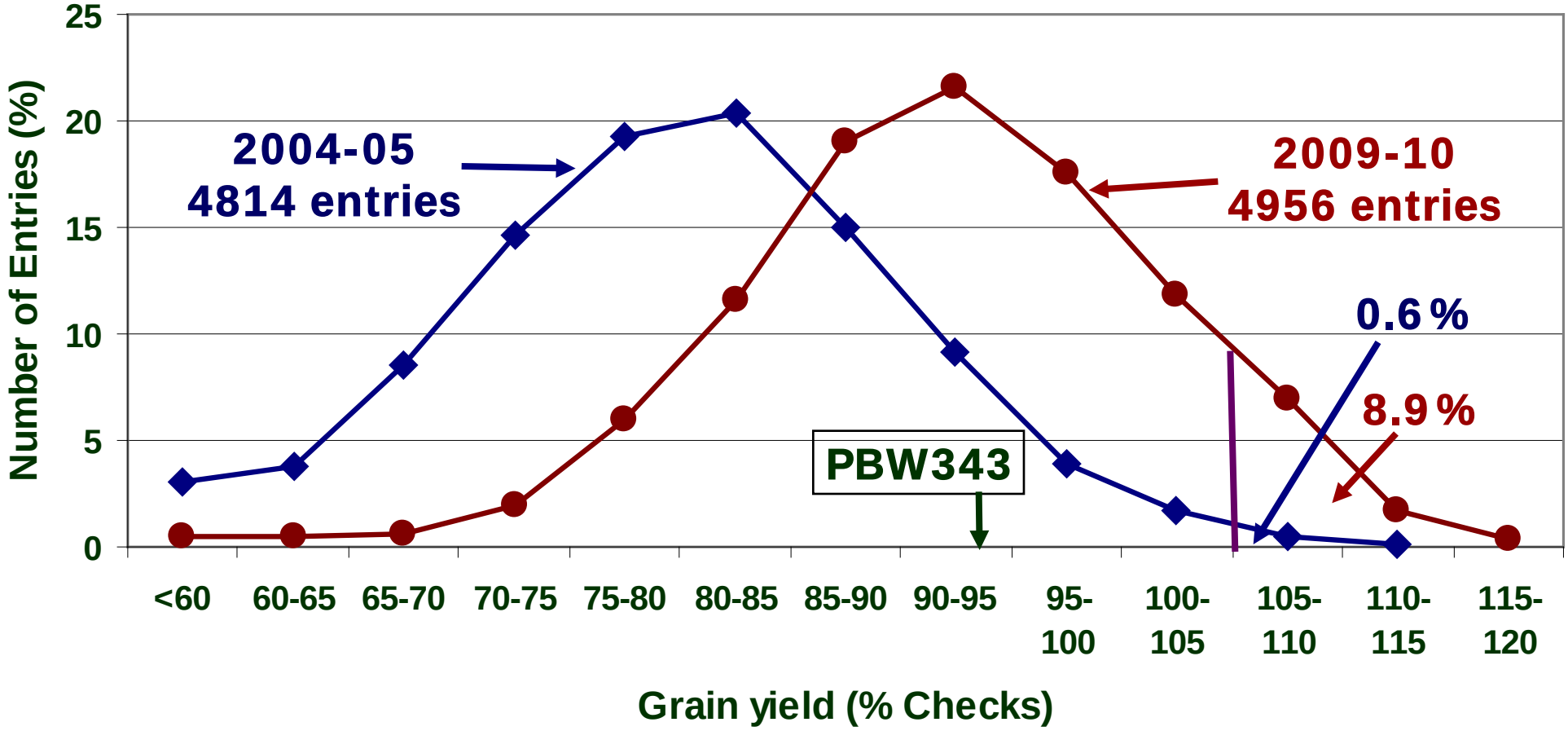
  alpha-lattice design, 3 reps.
  - raised bed 5-irrigations (>8 t/ha)

- 2nd year yield trials (about 500 entries):

  alpha-lattice design, 3 reps.
  - Raised bed, zero-tillage- 5 irrigations (>8 t/ha)
  - Flat-5 irrigations (>8 t/ha)
  - Raised bed-2 irrigations (4-5 t/ha)
  - Raised bed- drip irrigation (2.5-3 t/ha)
  - Raised bed-Late (85 days delay) sown- (3.5-4 t/ha)

Grain yield, agronomic, disease resistance and end-use quality information used in selecting the best yielding lines in different maturity groups in forming International Yield Trials (e.g. ESWYT) and Screening Nurseries (e.g. IBWSN)

Progress in grain-yield potential of new breeding lines after one 5-year cycle of selection (Cd. Obregon 2004-05 and 2009-2010)



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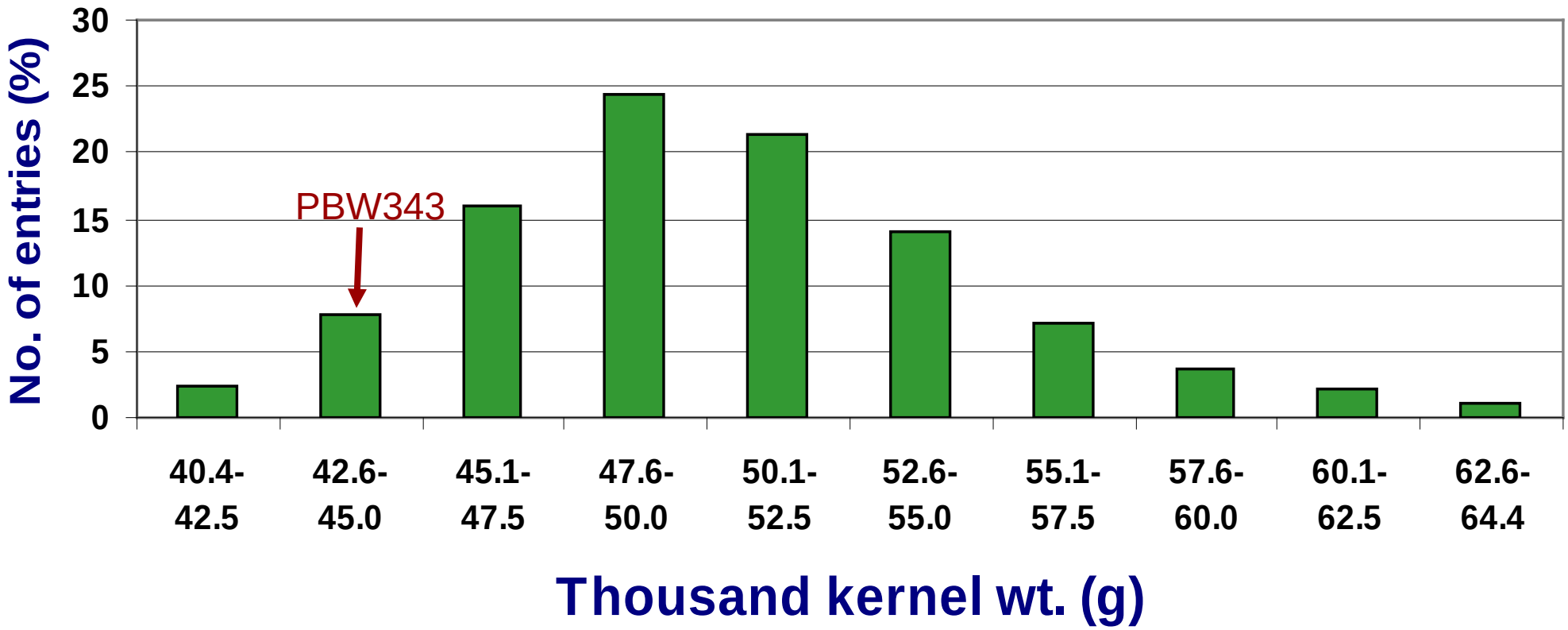
Shifting towards larger kernels through sieving selected-bulk populations

Kernel weight of 504 entries selected from 2008-2009 1st year yield trials at Cd. Obregon, Mexico



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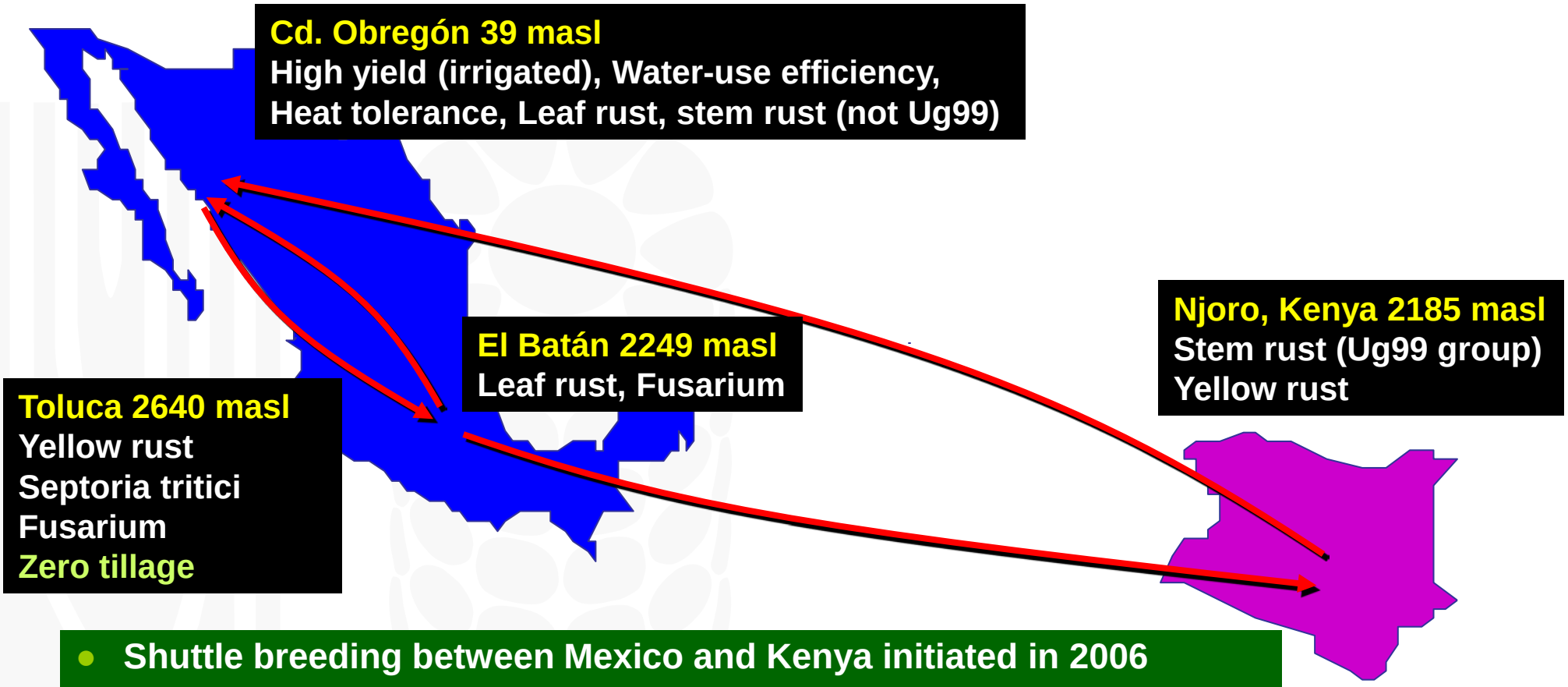
Breeding for durable, adult-plant resistance to rusts at CIMMYT

Mexico (Cd. Obregon-Toluca/El Batan)- Kenya International Shuttle Breeding: a five-year breeding cycle)



- Shuttle breeding between Mexico and Kenya initiated in 2006
- >1000 F3/F4 populations undergo Mexico-Kenya shuttle
- High yielding, resistant lines from 1st cycle of Mexico-Kenya shuttle under seed multiplication for international distribution in 2010

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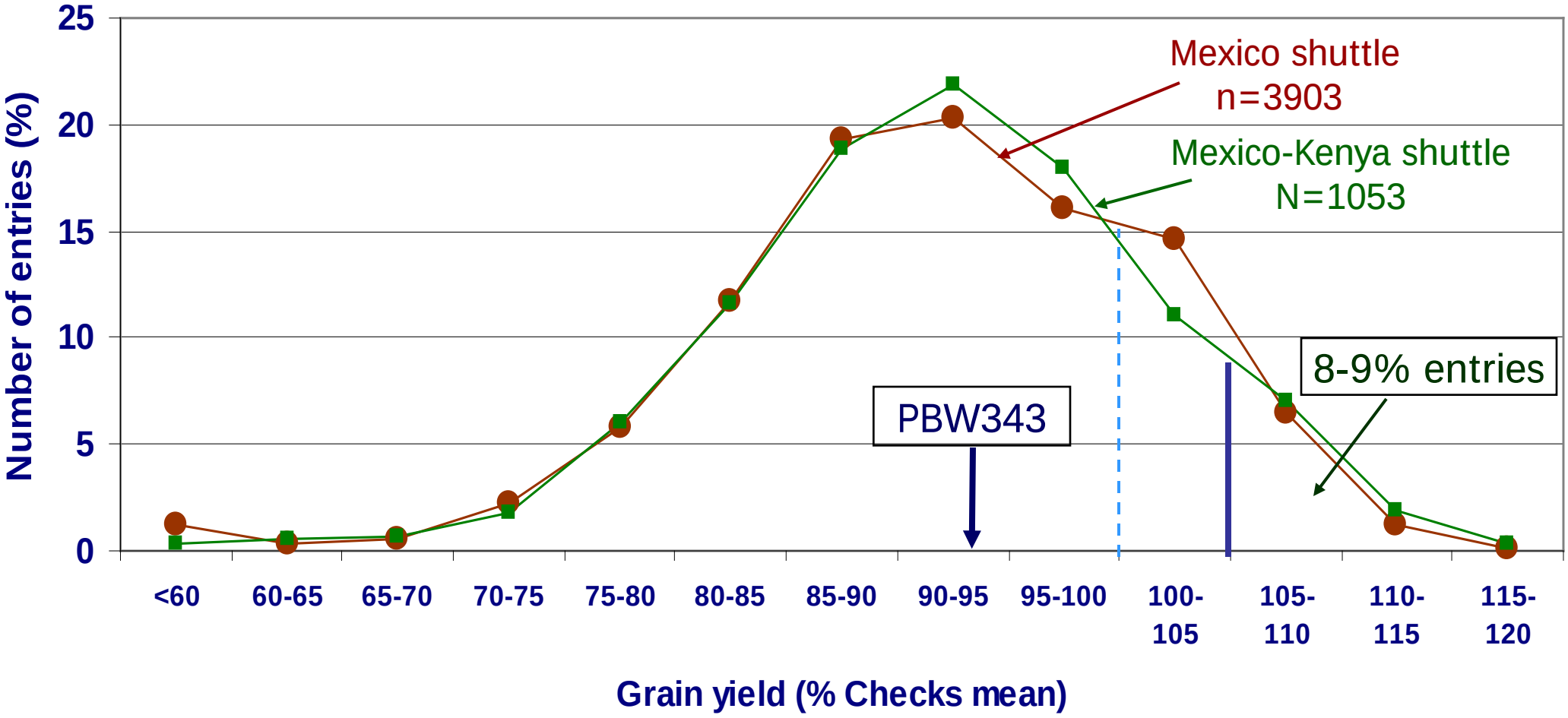
Grain yield performance comparison: Mexico Shuttle vs. Mexico-Kenya Shuttle Breeding, Cd. Obregon 2009-2010



No effect of selection in Kenya on grain yield performance

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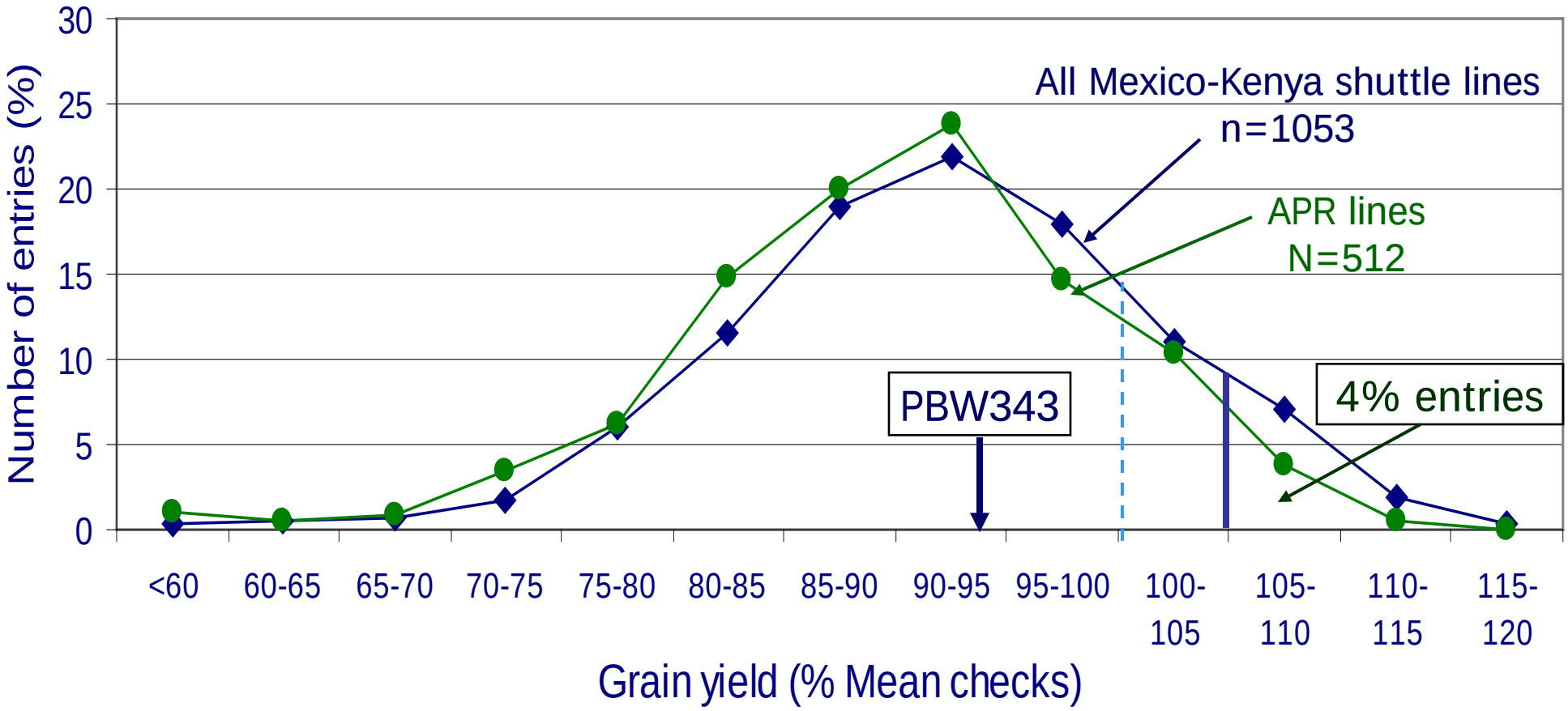
Grain yield performance comparison: All Mexico-Kenya Shuttle Breeding lines vs. APR lines (NIR, R & R-MR category), Cd. Obregon 2009-2010



- **High grain yield potential and multigenic APR can be combined**
- **Large population sizes to recover rare lines with high yield & high level of APR**

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New technological interventions

- Necessary to increase annual growth rate of grain yield potential through breeding from 1% current to 2% needed
- Promising tools: physiological (e.g. CTD) and molecular (e.g. genome-wide selection)
- Questions:
  - When to intervene- parents, segregating populations advanced lines before yield testing
  - Speed of data turnover
  - Cost-benefit analysis
- Modeling and focused studies using the existing and new breeding populations could provide the lead

Acknowledging agencies supporting bread wheat improvement & rust research

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Harvest Plus Project

Syngenta Foundation

Farmers' organizations:

Agrovegetal, Spain
Cofupro, Mexico
GRDC, Australia
Patronato-Sonora, Mexico

Governments

ICAR, India
USAID, USA
USDA-ARS, USA
SDC, Switzerland
ACIAR, Australia

Thank you

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