Maize: 50 years of CIMMYT's contributions

The quest for efficiency and impact in a crop producing 300 M tons on 90 M ha while providing >30% of food calories for 300 million people

Greg Edmeades

Phase 1: pre 1966 - 1972: Classifying, sorting and forming populations

- **Rockefeller Foundation** Office of Special Studies

- Collected, evaluated and classified **landraces**
- Formed **populations** targeted at specific consumer groups
- 1970-73: International Maize Adaptation Nurseries (**IMAN)**: varieties from 13 countries tested in 47 countries

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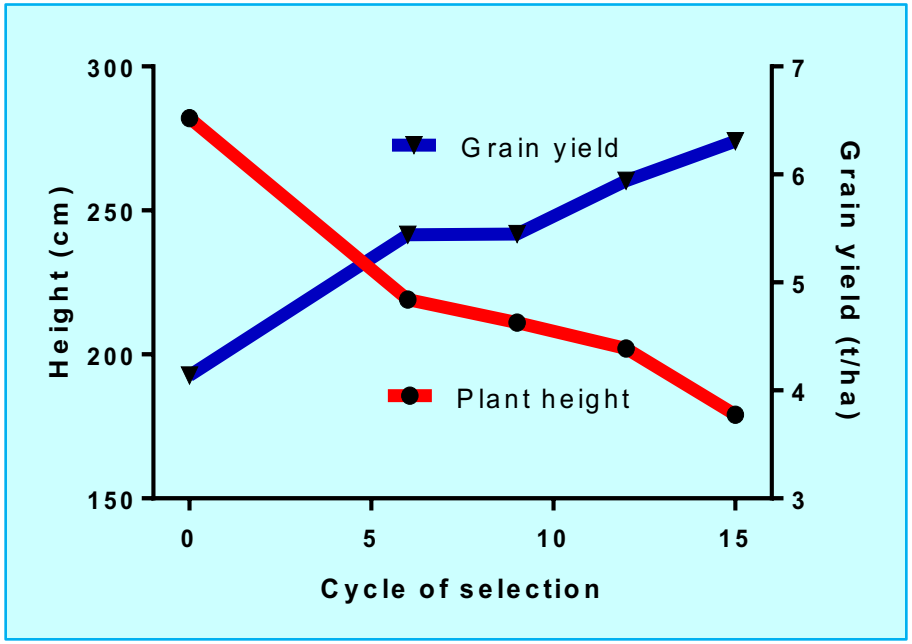
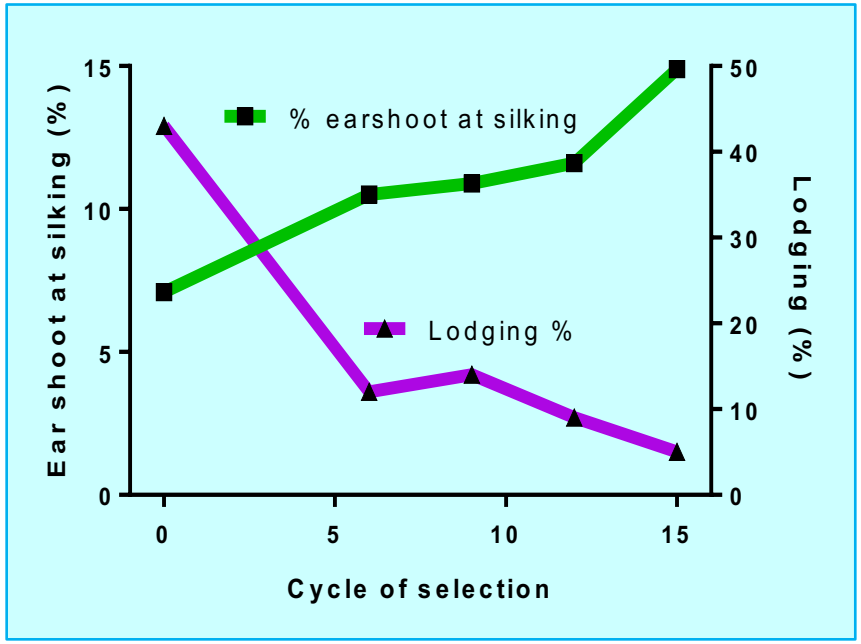
Phase 2: 1972 -1985: International testing, population improvement, plant type

- Development of **experiment stations**
- Pool and **population focus**; **QPM** conversions
- Backup and Advanced Units: **~80 populations** in combinations of adaptation, maturity, texture, color, endosperm type
- 1972: **International progeny testing** initiated
  - 1988 1000 OPV trials/year: a stream of germplasm
- Direct **germplasm transfers** to climate analogs
- Collaboration with **socioeconomists**: OFR
- Strengthened **NARS** through reciprocal visits
- Improving **plant type**

Beauty and the Beast: changing partitioning by reducing plant height

Shorter plants: more efficient, lodging resistant, and tolerant of high density





On-farm research – an important technology test-bed

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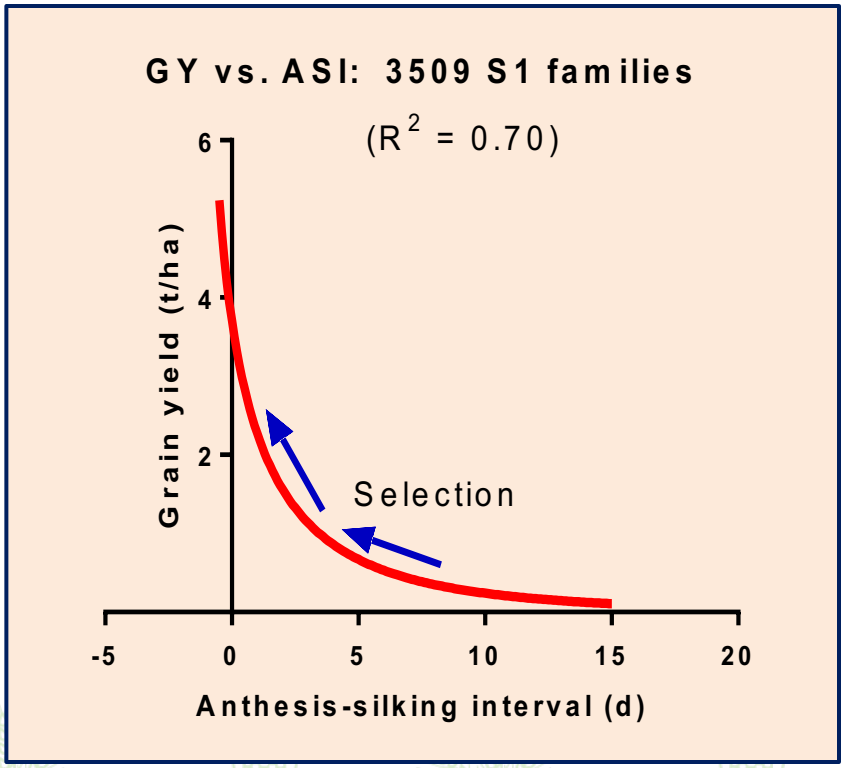
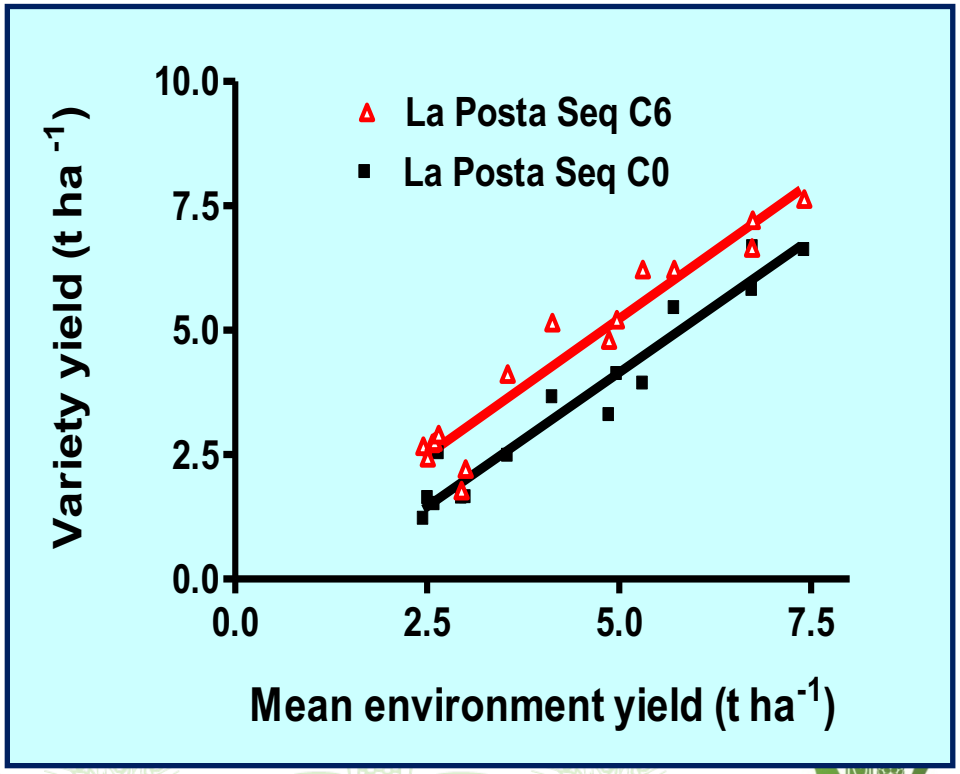
Phase 3: 1985-1996: Methodologies: hybrids, stress tolerance, conservation

- 1985: Dr S.K Vasal appointed **Hybrid** Maize breeder
  - **Developing heterotic groups:** Group A (Tuxpeño types) and B (non-Tuxpeños)
  - Today: 577 fully characterized **CMLs** available on request
- **Stress tolerance** – needed in tropical environments!
  - **Insects**: Mainly after 1977 (bazooka!)
  - **Diseases**: notably DMR (70s),MSV (80s),GLS (90s) and MLN (today)
  - **Abiotic**: drought (1975), soil acidity (1977), low N (1986), waterlogging (2003), heat (2011)
- **Megaenvironments** and priority setting
  - Lowlands 60%; midaltitude 34%; highland 6%
- **Wellhausen-Anderson Germplasm Bank**
  - Now iso-certified with 28,000 accessions, backed by Svalbard

Drought: kernel loss a common problem

To the rescue:
Partitioning for faster ear growth





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Tropical maize grows in N stressed environments

Low soil fertility in Kenya …….. and in Mexico

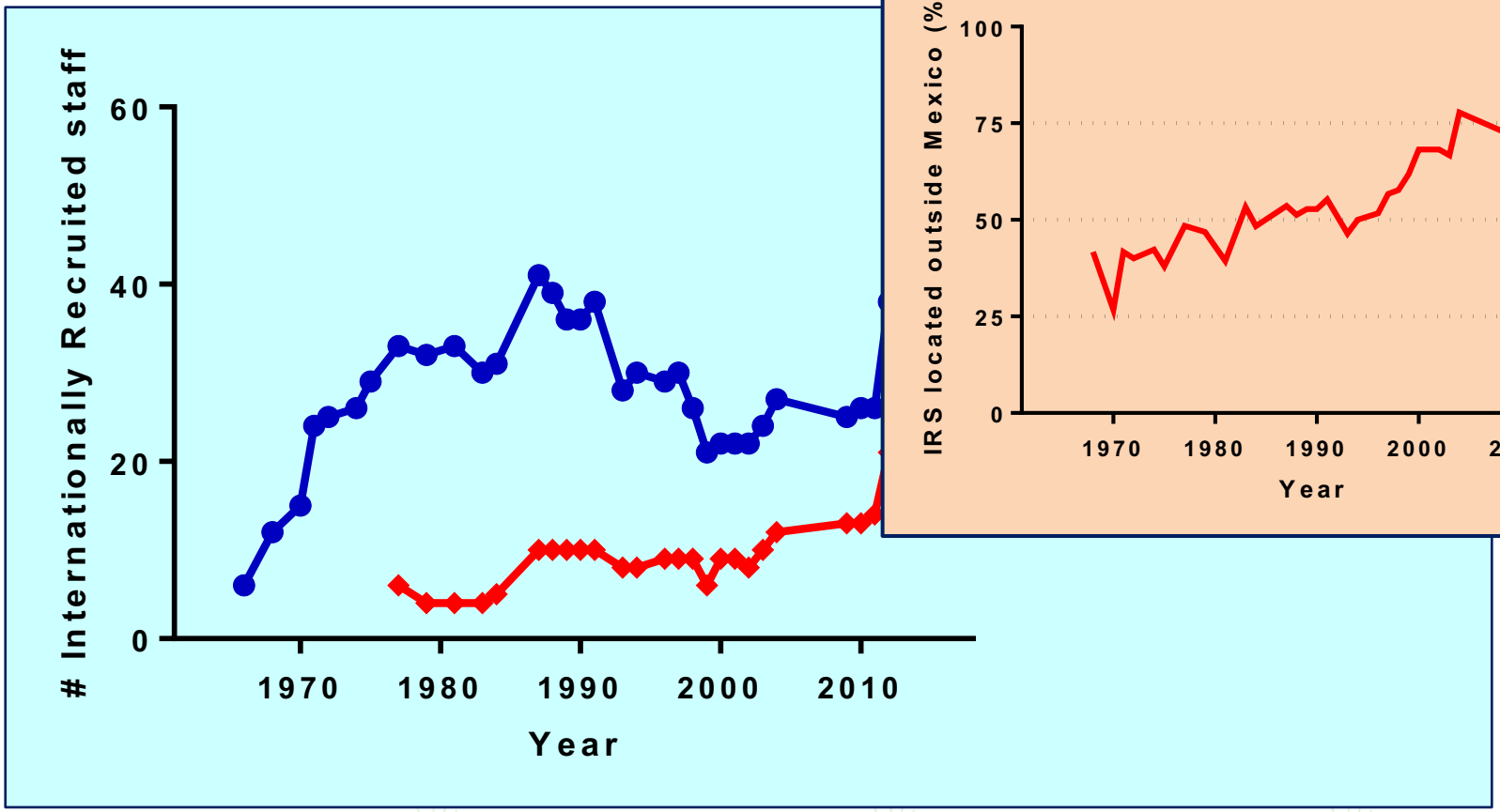
Complementary maize agronomy

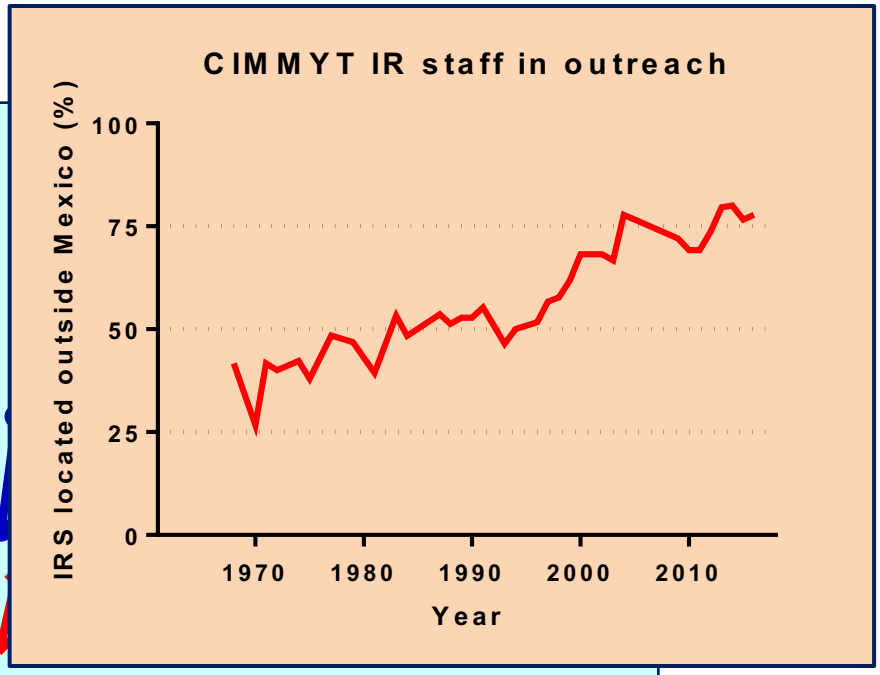
- **Poor agronomic practices** are common
- Exploits **G x E x M**
- 20-30% of staff were agronomists
- **Now**: large **sustainable intensification** efforts in Africa, Mexico and South Asia using conservation tillage, remote sensing, big data and smart phones.

Phase 4: 1997- 2006 Pivot to sub-Saharan Africa

- **Collaboration with IITA** became much closer
- **Focus on stress tolerance** - low N and drought, and major diseases
  - Heterosis improves stress tolerance
- **Decentralizing**:
  - Director of GMP based in **Nairobi**
  - Significant increase in **IRS based in SS Africa;** a later surge to Asia

Internationally recruited staff numbers followed funding trends and priorities





Phase 5: 2007- 2016: Projects, Progress and PPPs

- Large **longer-term** projects
  - **Stress tolerance** projects for
    - Africa (DTMA, WEMA, IMAS, now STMA and TAMASA)
    - Asia (HTMA);
    - Latin America (acid soils)
  - **Sustainable maize systems**
    - SIMLESA, CSISA and TAMASA
  - **Seed deployment**
    - NSIMA, DTMASS – Eastern and southern Africa
    - MASAGRO - IMIC-LA in Mexico
  - **Genetic diversity**
    - SeeD – in Mexico

- **PPPs** through projects - WEMA, IMAS and the IMICs

Drought TEGO™

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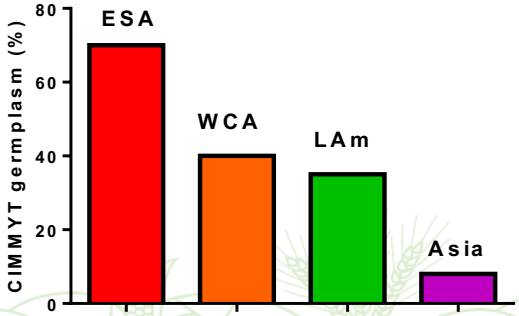
Adoption and Impact

- **1996-98 studies** (Morris et al):
  - Hybrids dominated (95%) seed sales of tropical maize
  - 62% area to modern varieties; 36% of this CIMMYT
  - Rate of return: estimated at 24 to 95
- **QPM**: Many releases, total area grown 1.4 M ha
- **2016 anecdotal**: ~40% of all tropical commercial releases trace to CIMMYT germplasm



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People motivated by a vision

Improve resilience, income, nutrition, and productivity of poor and vulnerable families that depend on maize

- **Gender** has a clear role in ensuring research effectiveness

- "CIMMYT Maize Program produces two main products: improved germplasm and **trained, motivated and focused research staff"** - *Ernie Sprague*

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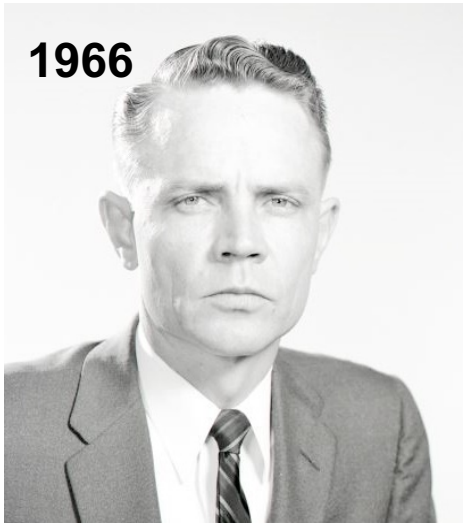
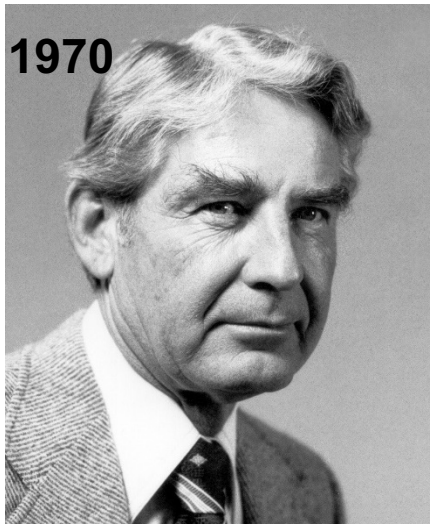
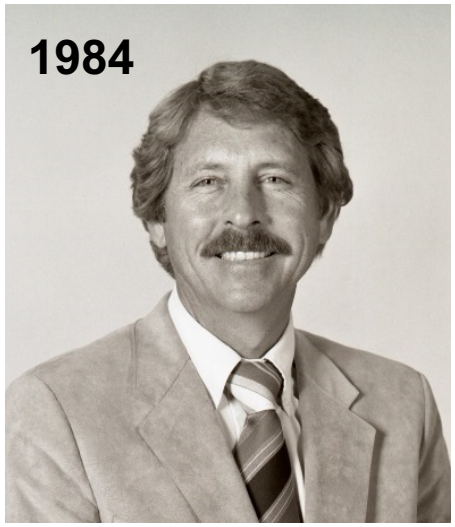
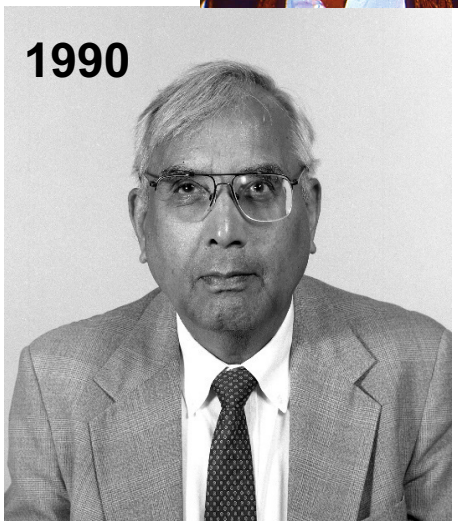
A history of competent and inspi leadership









We stand in the shadow of giants…

Dr. Elmer C. Johnson

Dr. Surinder K. Vasal

Dr. Hugo Cordova

Our amazing support staff

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The Global Maize Program today

- 46 IRS and 210 LRS in 14 countries
- **1.2 million seed envelopes shipped** annually
- Largest **managed stress** screening network in SSA
  - **Heat tolerance** in Asia and Africa
- **Seed support**:
  - 20% staff are seed specialists, work with >200 seed companies
- **Seed sales** by partners
  - **DTMA**: 230 released hybrids and OPVs producing >60,000 tons of certified drought-tolerant maize seed/year
  - **IMIC Latin America** –company sales 24,000 tons in 2015
- Staff **gender balance** improving ….. Now 15% female

Defending gains against threats

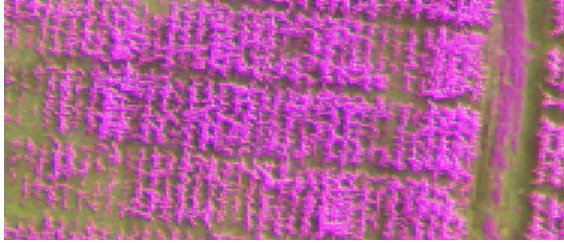
MLN: Reported first in 2012

- 2014-15: Losses worth $110 M

- Screening center established in Naivasha, Kenya
  - 5 MLN tolerant hybrids released in East Africa, 22 more in NPTs

Striga

- Tolerance
- imazapyr-resistant seed



Accelerating gains

- **Doubled haploid technology** halves time to produce an inbred line
  - 80,000 DH lines produced this year in Kenya and Mexico
  - Tropically adapted inducers now available
- **Marker-assisted breeding**: MARS/Genomic selection doubles rate of gain under drought
  - **Production markers**: 30,000 DH lines screened for MSV; ready for haploid induction rate and nutritional traits
- **Introgression** of elite **temperate** lines
- **High throughput phenotyping:** remote and proximal sensing
- New **genetic variation** from SeeD (e.g. TSC)
- **Transgenes and gene editing**

The age of the CRP - MAIZE

- **Launched in 2012**
  - Staff: CIMMYT (76%) and IITA (24%) with >350 partners
  - Team of breeders, agronomists, socioeconomists and gender specialists
- **In 2015**:
  - 18 million farmers benefited from 8 M ha of varieties derived from MAIZE germplasm; 64 new releases
  - “Nutrient Expert”
  - High throughput phenotyping
- **The next generation of scientists**:
  - PhD, MS training: 51 graduated in 2015
  - 40,000 people /yr (30% female) attend training events

Unfinished business…

- **Genetic gain**
  - Mainlining marker-assisted selection
  - Partitioning and high plant density tolerance
- **Climate change**: Increase rate of varietal turnover
- **Stable and long-term funding** for a program with proven performance
  - Unrestricted core funds (W1/W2): 67% (1983); 40% (2006); 8% (2016)
  - **The long look**: Drought tolerance = 40 years of continuous investment. The main breeding program has the same needs

Acknowledgements

- **Congratulations,** CIMMYT **Maize staff!**
- Our **NARS** colleagues and partners
- **Investors**: no investors = no program
- **Our hosts**: the Mexican Government and its people
- Our **families**: for their patience, support and share in the vision
- **Directors;** Prasanna, Erenstein, Bänziger, CRP Manager Watson and Mike Listman

Dedicated to

Resource-poor maize farming families for whom we remain committed to providing better choices in life

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