From research to impact

Martin Kropff
The International Maize and Wheat Improvement Center (CIMMYT)
A redefined demographic map

Source: David Ruyet, Word Press, 2012
Feeding the world M & W: Need by 2030 + 40%

Maize provides 15-56% of total calorie intake in Sub-Saharan Africa, Latin America and Asia.

Wheat is the largest primary commodity. Global production is over 735 million metric tons.

Preferred staple food to 900 million people living on less than $2 a day.

Global production in 2016 was 1026 million metric tons.

Wheat provides 18% of our total available calories to 2.5 billion people in 89 countries.
Food and Nutrition security

Calorie undernutrition
- 800 million people

Micronutrient deficiency
- 2 billion people

Obesity
- 650 million people

World Health Organization (WHO) children under 5 prevalence data

IFPRI (2014) Global nutrition report 2014: actions and accountability to accelerate the world’s progress on nutrition.
Impacts

Global production losses

- Wheat 7%
- Maize 10%
- Soybean 11%
- Rice 7%

Price increase

- X4
- X5

Human cost

- Humanitarian crisis
- Food riots
- Stock market losses
  - 10% in EU
  - 5% in US
Modelled impact of changing climates on maize production in Africa

Future mega-environments 2039-2070

Sonder et al., 2015
Climate Change and Food Prices

For food prices **to remain constant**, annual yield gains **would have to increase**:

**Maize**: 1.2% - 1.7%

**Wheat**: 1.1% - 1.7%
The need for Climate Smart Agriculture

Climate-smart agriculture combines policies on:

- Adaptation
- Food Security
- Mitigation

Source: UN FAO 2013
Mission
Maize and wheat science for improved livelihoods.

CIMMYT around the world
1,200 staff from over 50 countries!

Countries with offices:
Afghanistan
Bangladesh
China
Colombia
Ethiopia
Guatemala
India
Iran
Kazakhstan
Kenya
Mexico
Nepal
Pakistan
Turkey
Zimbabwe

Projects in over 40 countries
The big impact

Annual benefits of $3.5 - 4 billion.

50% of maize and wheat in the developing world is based on CIMMYT varieties.

Trained over 10,000 agricultural experts and scientists.
CIMMYT strategy 2017-2022

Key global challenges

- Population growth
- Food and nutritional insecurity
- Environmental degradation
- Economic development
- Climate change
Integrated research agenda

**Genetic diversity**
- Conserve and use diverse maize and wheat collections
- Seed health
- Unlocking genetic potential

**Develop and improve access to varieties**
- Stress, disease and pest resilience breeding
- Molecular tools
- Developing seed sectors
- Nutritional and end-use quality

**Farming systems**
- Sustainable Intensification
- Crop management practices
- Mechanization
- Participatory research

**Increasing impact**
- Social sciences
- Big data
- Gender and youth
- Foresight and impact assessments

**CROSSCUTTING**
- Capacity development – Partnerships

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CIMMYT
Global Seed Distribution Network
The CGIAR provides 80% of seed to the world

Source: GCDT; online database collections, publications and communications between GCDT and responsible banks, 2008-2010
All wheat varieties releases by region and origin 1994-2014

Percentage of releases (%)

- China
- EU and other high income countries
- Former Soviet Union Countries
- Latin America
- South Asia
- Sub-Saharan Africa
- West Asia and North Africa
- World

Non-CGIAR parents

Varieties with CGIAR Ancestry

CGIAR Parent
2016 maize releases

Varieties commercialized by CIMMYT partners with traits preferred by smallholder farmers – based on available information only.
CIMMYT’s approach to biotic food production threats

- Early warning and monitoring
- International partnerships
- New technologies: gene editing
- Combined disease control measures: (breeding, crop management, national capacity building)

Wheat blast  
Fall armyworm  
Maize lethal necrosis
Adaptation to existing climate variability

The previous El Niño caused $35$ billion USD in global economic losses.

In 2016, an estimated $40$ million people were food insecure in southern Africa.
Stress Tolerant Maize during El Niño

Margaret in Murewa, Zimbabwe

Peter Setimela
Biofortification of staples

QPM: Full range of amino acids in the grain; grown on 1.2 million hectares

25% of daily vitamin A; 100,000 households reached

Up to 50% of daily zinc needs

PROVITAMIN A MAIZE → QUALITY PROTEIN MAIZE (QPM) → HIGH ZINC MAIZE → HIGH ZINC WHEAT

First high-zinc maize for Latin America just released
A global phenotyping network for wheat improvement targeted at less developed country priority traits

green=operational red = planned

Precision phenotyping, early access by NARS breeders to elite germplasm
A change in thinking: From commodities to agri-food systems

Agri-food systems are...

The activities and relationships that determine how food is produced, processed, distributed and consumed, together with the human and biological systems that shape these activities at every stage
Impacts in Mexico

- > 300,000 Producers participating
- 1,322,177 Hectares with improved technologies
- $7 profit for farmers on each $1 invested
- 58 Maize hybrids developed
- 1 million Bags of improved maize sold in 2016
- > 100 Young researchers involved
- 380 Technicians trained
- Guatemala and Colombia, Future expansion possibilities
Partnerships for sustainable sourcing

The model

• Farmer capacity building and market integration
• Agri-food companies source grain from local farmers who use sustainable intensification practices

Agreements in Mexico

- **Kellogg’s**
  - Source 100,000t grain between 2017 and 2020
  - US $12.5 million investment
  - Benefits 300 small-medium producers

- **Nestlé**
  - 100% sustainable sourcing by 2022
  - $5 million investment, national economic benefit of $50 million
  - Benefits 2,200 producers

- **Grupo Bimbo**
  - Source 50,000t wheat and 25,000t sustainable maize

- **Heineken Mexico**
  - 15-20% water savings in the field through sustainable barley

- **CIMMYT**
SI: Remote sensing tools available at different scales and prices

GreenSat (Spot and Sentinel-2 satellites)

Manned Airplane

Drone- UAV

Big data: AI deep learning linked with modelling

120,000 USD

30,000 USD

5,000 USD

500 USD
Social sciences research

**GENNOVATE** study into impact of gender norms on ability to adopt and benefit from agricultural innovations

- Global comparison: 11 CGIAR research programs, 137 village-level case studies in 26 countries
To achieve food and nutrition security in the face of global challenges, we need to invest more in public global R&D in Agrifood and not wait for a new food crisis: international networks.
Discussion

• What is the most exciting new technology / research area with the potential for large-scale impact?

• (Word cloud)

• What is the best way for research to have an impact on food security?
  A. High-impact publications
  B. Policy impact
  C. Public-private partnerships
  D. NGOs and development projects
The need for a systems approach
• Diego Rivera Tlatelolco Market Mural
Thank you!
Heat tolerant wheats prove their value in farmers’ fields in Mexico

Adaptation

Wheat yield (t/ha)

Night Temperature during wheat grain filling (°C)

Black: Current wheats

Red: Heat tolerant wheat

Yield increase
Through breeding

Source: H.-J. Braun and I. Ortiz-Monasterio, CIMMYT
CIMMYT history

1940s
The Office of Special Studies (OSS) is created

1950s
OSS develops high-yield, disease-resistant, semi-dwarf wheat and shuttle breeding

1960s
The Green Revolution in India and Pakistan
CIMMYT is officially founded

1970
Norman Borlaug is awarded the Nobel Peace Prize

2000s
CIMMYT scientists win the World Food Prize

1980-90s
The Wellhausen-Anderson Plant Genetic Resources Center opens

2016
CIMMYT launches new strategy with focus on nutrition and livelihoods

2017
CIMMYT receives the Chinese International Science and Technology Cooperation Award
Sustainable intensification and mechanization

Conservation Agriculture Advantages:
- Savings in production costs
- Higher profitability
- Soil conservation
- CO2 emission reductions
- Less water consumption
- Climate Change mitigation

- 50% average reduction in farm work
- 70% drop in fossil fuel consumption
- 0.5 ton/ha CO2 sequestration

The two-wheeled tractor

Relatively cheap and easy to operate, the two-wheeled tractor can be used for many different applications.

- Attachments can be used to speed up crop establishment with smaller tractors while improving soils through reduced tillage and precision fertilizer application.
- Axial flow pumps can tap surface water resources for irrigation.
- Threshing and shelling tools add value to crops while helping farmers to reach the market on time.
- Can be used by farmers to start rural commercial and household transport services.

A hand tractor used in Asia and Africa.