

**Stress Tolerance for Food Security**

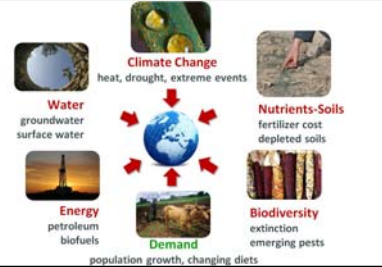
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CIMMYT – International Maize and Wheat Improvement Center

**Converging challenges to Food Security**

*“In the next 50 years we will need to produce as much food as has been consumed over our entire human history.”*

Megan Clark, CEO of the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia

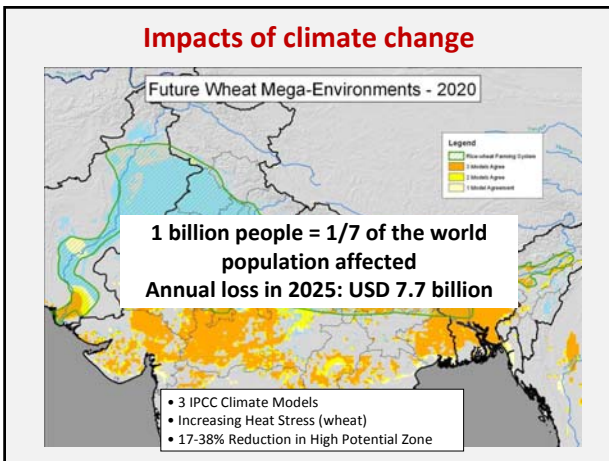
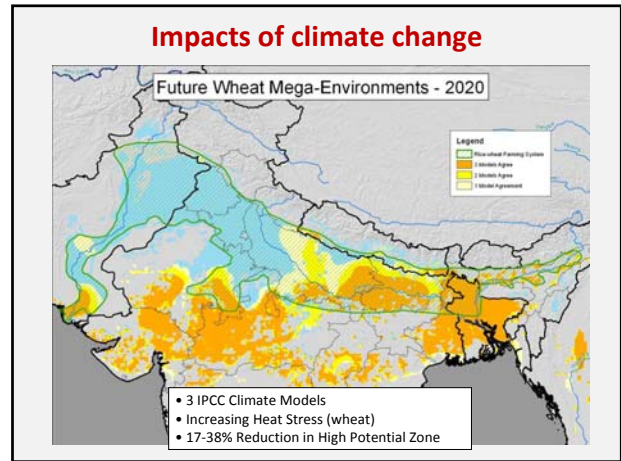
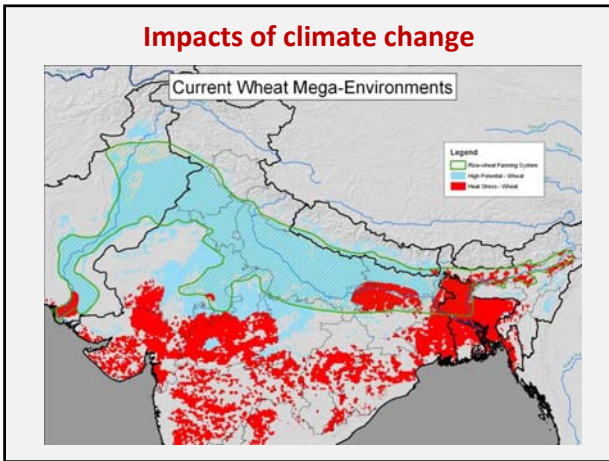


**Real food price changes predicted over the next 20 years**

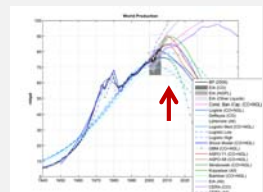
Increase in world market export prices in 2020 relative to 2010

Commodity	Baseline	Climate change
Maize	~100	~150
Paddy rice	~100	~150
Wheat	~100	~150
Livestock	~100	~150
Processed rice	~100	~150
Processed meat products	~100	~150
Other crops	~100	~150
Other processed food	~100	~150

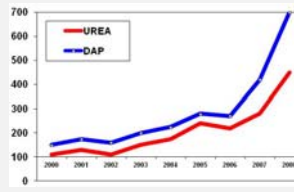
Source: D. Willenbockel 2015 "Exploring Food Price Scenarios Towards 2050", DITF and IIS



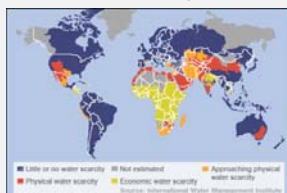
**Peak oil**




**Fertilizer prices**



**Water shortage**



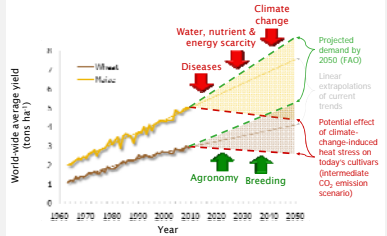
**Land degradation**



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

- From 1.2% to 1.7% for maize
- From 0.8% to 1.2% for rice
- From 1.1% to 1.7% for wheat
- On essentially the same land area, with less water, nutrients, fossil fuel, labor and as climates change

- The more we delay investments, the steeper the challenge



**If we don't act ....**



**We can change our future —**

Science provides us with tremendous opportunities

Regulators have opportunities and means to act



**Drought tolerant maize - a reality in Africa**



Breeding progress:  
~ 100 kg ha<sup>-1</sup> yr<sup>-1</sup>



**New drought tolerant varieties are available  
However: Time to farmer 5-10 years**

OPV	Countries	Hybrid	Countries
ZM309	ZW, MW, SZ	PAN53	ZW, MW, ZM, GH, ZA, SZ
ZM401	ZW, TZ (Tan250)	Longe H7	UG
ZM423	AO, ZA, ZM, ZW	MH26	MW
ZM523	MW, ZA, ZW	WH403	KE
ZM623	CD, LS, MW, TZ, ZW	WH504	KE
ZM625	ZM (Kamano)	Pris601	ZW
ZM721	CD, TZ (Tan254), ZM	CAP9001	SZ, ZA, MW
WS103	KE	TAN H600	TZ
Melkassa 4			
KDV1			
KDV4			
KDV6			



**Why are new varieties only slowly reaching farmers?**



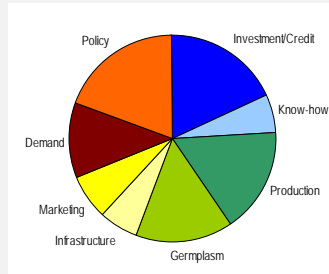
## Accelerating time to farmers

### Action steps

- Liberalize seed trade and price policies => larger markets
- Reduce over zealous barriers to variety release
- Facilitate access to business credits
- Invest in reliable seed production areas
- Increase seed quality control - combat fake seed

Source: CIMMYT, 2008

Variety descriptors => Fingerprints (LIC) + Sequences (HIC)



## Accelerating breeding gains

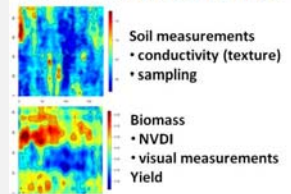
Year	System	No data points
2006	Illumina 1536 OPAs	1.7M
2009	Illumina 55k	16.5M
2011	Genotyping-by-sequencing	≥ 120M

### Thermal imagery



Large genotypic variation

### Monitoring soil moisture Characterizing field variability



## What about transgenics?

Drought tolerance, nitrogen use efficiency ....



Collaboration with Monsanto, Pioneer, AATF, and several African countries

### Bottlenecks

- Extent of single gene effect: 8-15%
- Translating lab results into consistent results in the field (GxG and GxE)
- Price of the technology => Humanitarian licenses

## Seeds of Discovery

Exploring the untapped biodiversity for maize and wheat

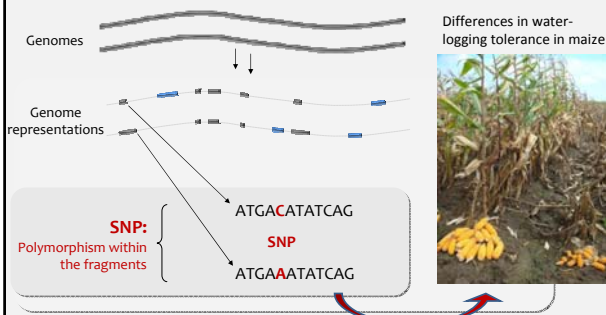


> 150,000 ancestral genotypes in 27,000 pop's

> 180,000 ancestral genotypes

New technologies enable us to unlock the entire native genetic diversity of maize, rice or wheat for the price of commercializing 1-2 transgenics

## Genotyping-by-sequencing (GBS)



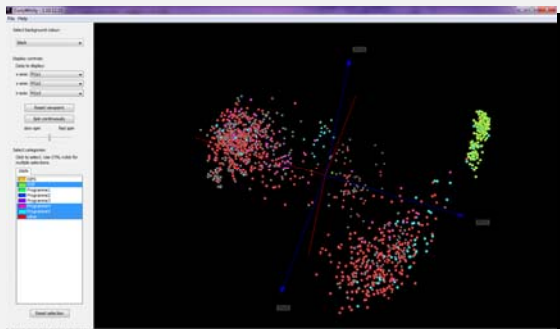
## Seeds of Discovery

### Goals:

- Fully characterize the untapped biodiversity of maize and wheat.
- Enable breeding programs worldwide to use maize and wheat biodiversity to meet tomorrow's challenges
- Public data release on a level playing field → Proactive IP strategy



## Making the data available as “Breeder’s digest”: visually intuitive genetic information



(rotatable 3D plots linked to individual accessions in database)

## Sharing of germplasm and data

- **Dissemination of data** and information over web
  - Encourage a “level the playing field” => Focus on simple tools and low hanging fruits
  - **Pre-competitive domain:** discourage IP protection on project products *per se* (sequences, markers) while allowing/encouraging IPR on downstream products (varieties)
- **Potential to making benefit-sharing real:**
  - Revenues from IP-protected downstream products to contribute to a fund for farmers in the center of origin



## Seeds of Discovery will find heat tolerant wheat



## Coordinated action plans are available



## Conclusion

2010 - 2050: Food security will become an escalating concern



Science, policy makers, regulators must provide solutions