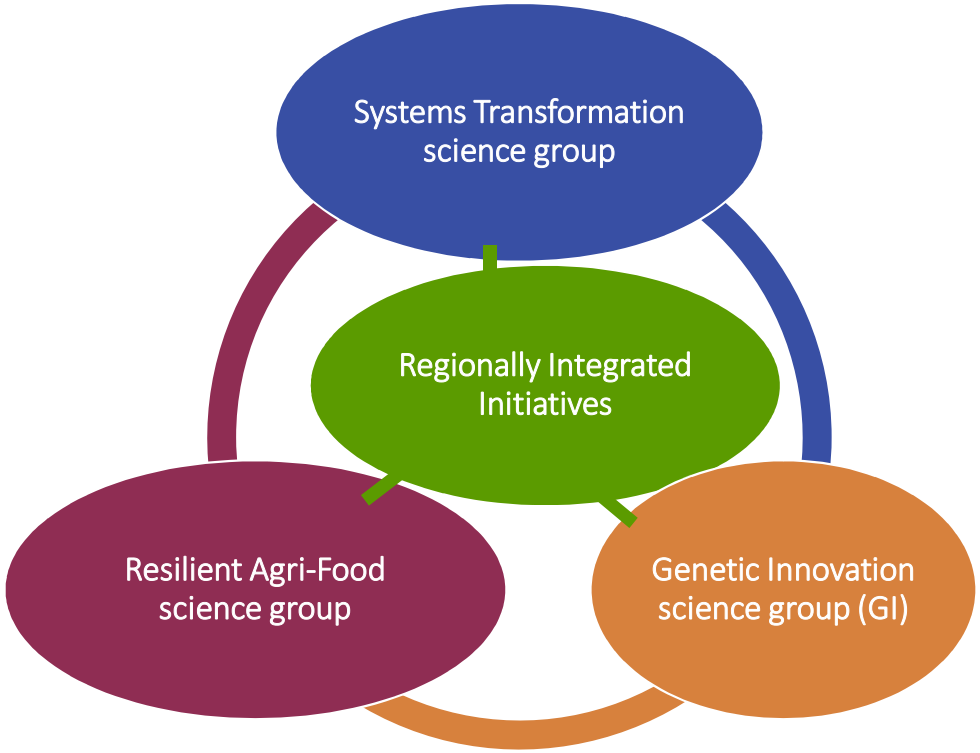
What are the impacts and risks to agriculture from climate change and what role can new plant varieties play in delivering solutions?

John Derera, Senior Director – Plant Breeding & Pre-Breeding

One CGIAR consolidates work from 13 CG research Programs & Platforms into 4 Groups



Impact Areas

- Nutrition, Health & Food Security
- Poverty Reduction, Livelihoods & Jobs
- Gender Equality, Youth & Social Inclusion
- Climate Adaptation & Mitigation
- Environmental Health & Biodiversity

CGIAR CROP IMPROVEMENT PROGRAMS

Institution	HQ Country	Started	Crop Programs
CIMMYT	Mexico	1966	Maize, Wheat, Sorghum, Pearl & Finger Millets, Groundnut, Pigeon Pea, Chickpea
IRRI	The Philippines	1960	Rice
CIAT	Colombia	1967	Cassava, Rice, Common Bean, Brachiaria Forages
IITA	Nigeria	1967	Cassava, Yam, Maize, Banana, Plantain, Soybean, Cowpea
AfricaRice	Cote d'Ivoire	1971	Rice
CIP	Peru	1971	Irish Potato, Sweet Potato
ICARDA	Morocco	1977	Wheat, Lentil, Barley, Chickpea

Increases in temp & water-related stresses affect global agricultural productivity

Increased productivity in temperate environments

- Increased temperature (1–3^{0}C), CO_2 & rainfall changes
- Extended growing season

A decline in productivity in tropical and subtropical environments

- More frequent extreme weather (drought, heat, flood)
- Lower production by limiting the length of the growing season
- Implications: compromised resource capture and processes underpinning growth and yield

Extreme weather events posing a serious threat to agriculture in the tropics*

- An estimated **21-34% loss in global** agricultural productivity growth since 1961
- About **26-30% in Africa**, Latin America and Caribbean
- Impact of reduce productivity high on small land holding
- Limited technology options
- Reduced availability of agricultural land due to urbanization
- Lack of capital to mitigate

**(Ariel Ortiz-Bobea et al. 2021 Nature Climate Change (VOL 11: 306–312) | www.nature.com/natureclimatechange)*

Excesses of temperature and precipitation - *El Niño* & *La Niña* events affect agricultural productivity e.g., in Southern Africa

- La Niña years bring the growing conditions closer towards the optimum
- El Niño years result in stress growing conditions of heat & drought
- Rising Jan - Mar temperatures posing a threat to agricultural productivity growth
- Increasing dry spell duration during the reproductive growth stages reduce maize yields
- Increasing wet spell duration leads to waterlogging
  - Excessive wetness reduce maize yield
- Maize yield decreases associated with *El Niño* events tend to be larger than corresponding yield increases during La Niña events.

Unprecedented climate extremes in South Africa and implications for maize production. Catherine D Bradshaw et al 2022 Environ. Res. Lett. 17 084028

Rising temperatures support Emergence of new pests in new places – the case of devastating fall armyworm in sub-Saharan Africa




Adaptation solutions & the role of new plant varieties

Agriculture contributes to climate change

- Agricultural emissions contribute about 25% GHGs which must be reduced
- Conversion of forests to agricultural land

Therefore, there is need to adopt agricultural practices that contribute to capturing the excess carbon generated by agriculture, and other industries

- Intensification of agriculture will reduce deforestation
- Reducing tillage, expanding crop rotations, planting cover crops
- Integrating livestock into crop production systems
- Irrigation
- Breeding climate change resilient crop varieties

CGIAR Research program on climate change and food security


Nutrition, Health & Food Security


Poverty Reduction, Livelihoods & Jobs

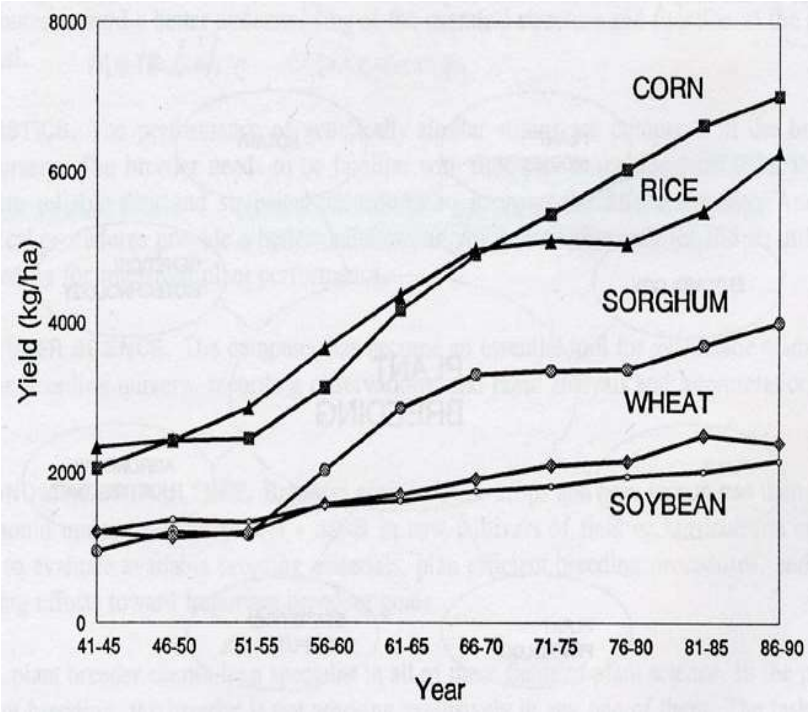

Gender Equality, Youth & Social Inclusion

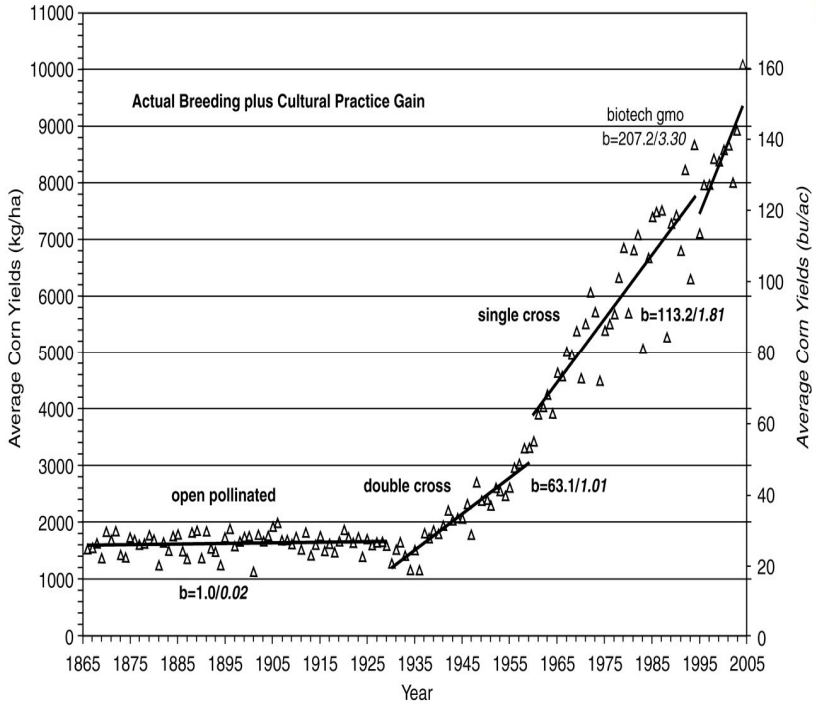

Climate Adaptation & Mitigation


Environmental Health & Biodiversity

- Research on climate-smart technologies and practices to transition to climate-smart agriculture at a large scale
- Reduction of GHG emissions and increase carbon sequestration in the agriculture sector
- Effective climate information & advisory services for farmers and climate-informed safety net interventions
- Increased production and distribution of burdens and benefits in agriculture among women and men
- Fast-track solutions to millions of farmers and food system actors

The role of new plant varieties- incredible yield improvements in a changing climate – a result of genetics improvements

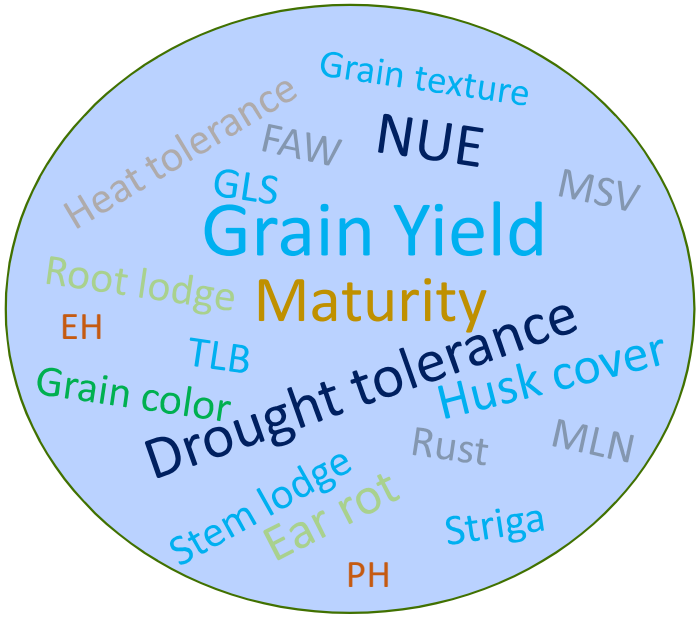




- At least 50-60% of yield increases of USA maize (corn) is attributable to genetic improvement
- CGIAR breeding programs target variety improvements for disease and pest resistance, and abiotic stress resistance (high/low temperature, excessive water/flooding, drought, high salinity, alkaline soils).
- This results in continual increase of genetic gain under challenges of climate change

CIMMYT, IITA and national partners have made a tremendous progress to deliver climate smart maize varieties in SSA

Multiple traits improved to adapt maize to climate change challenges



No.	Country	# hybrids	Center
1	Ethiopia	2	CIMMYT
2	Ghana	5	IITA
3	Kenya	8	CIMMYT
4	Malawi	4	CIMMYT
5	Mozambique	1	CIMMYT
6	Nigeria	20	IITA/CIMMYT
7	Rwanda	4	CIMMYT
8	Tanzania	2	CIMMYT
9	Zambia	15	CIMMYT/IITA
10	Zimbabwe	8	CIMMYT

Accelerated Genetic Gain (AGG) project making significant gains in delivering stress tolerant & input responsive maize varieties. More than 60 new varieties were deployed across SSA in 2020-2021. Yield highs of 9-15 t/ha were recorded on station.

Conclusion

Climate change could cause catastrophic effects on agricultural productivity through increases of GHG emission that reduces productivity by about 30% on farm.

Agriculture contributes to climate change therefore, there is need to adopt agricultural practices that contribute to capturing the excess carbon generated by agriculture, and other industries

Improved agronomic practices alongside development of new plant varieties that are climate resilient could contribute to incredible yield improvements in a climate crisis.

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Science for a food-secure future

Thank You!