Biofortified Sorghum – Creating Options for African Farmers and the Continent

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Agenda

- Introduction – DuPont Pioneer and me
- Why Africa and why sorghum?
- Challenges
- Solutions
- Summary

PIONEER: THE EARLY YEARS

1913 Henry A. Wallace makes his **first hybrids**, crosses between two open pollinated varieties, with inconsistent results.

1919 Wallace starts **breeding hybrid corn**, using the inbred-hybrid method

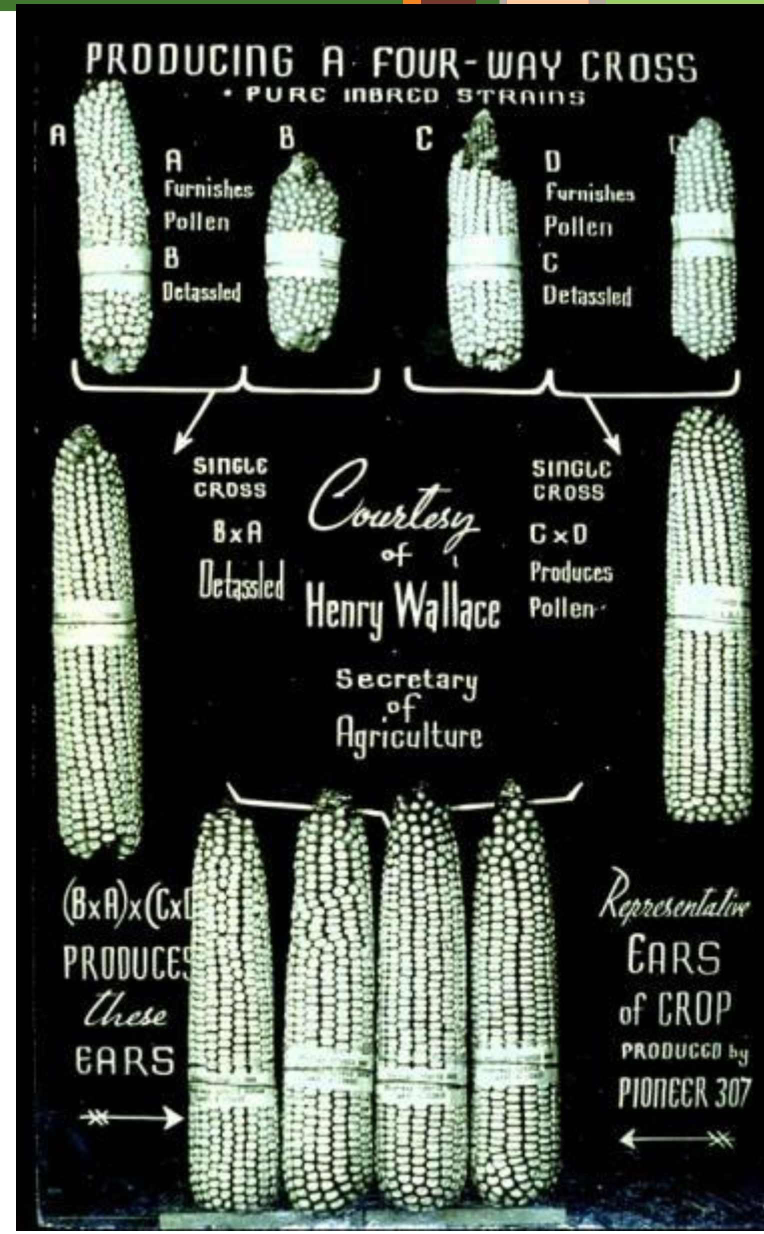
1926 Wallace **incorporates the Hi-Bred Corn Company**, $7000 in capital stock, breeding for drought stress

H.A.Wallace, 1930

The best combinations of inbred strains have the ability to outyield the best ~~varietal strains~~ open pollinated varieties of corn of the same maturity, by at least ten per cent. At the present time there may be room for difference of opinion as to whether the advantage is somewhat greater or somewhat less than this. But looking towards the future we may expect an advantage considerably greater than ten per cent in favor of first generation hybrid corn produced by the combining of inbred strains.

1934 &1936 **Drought across corn belt** – Pioneer® hybrid 307 was a top performer during drought

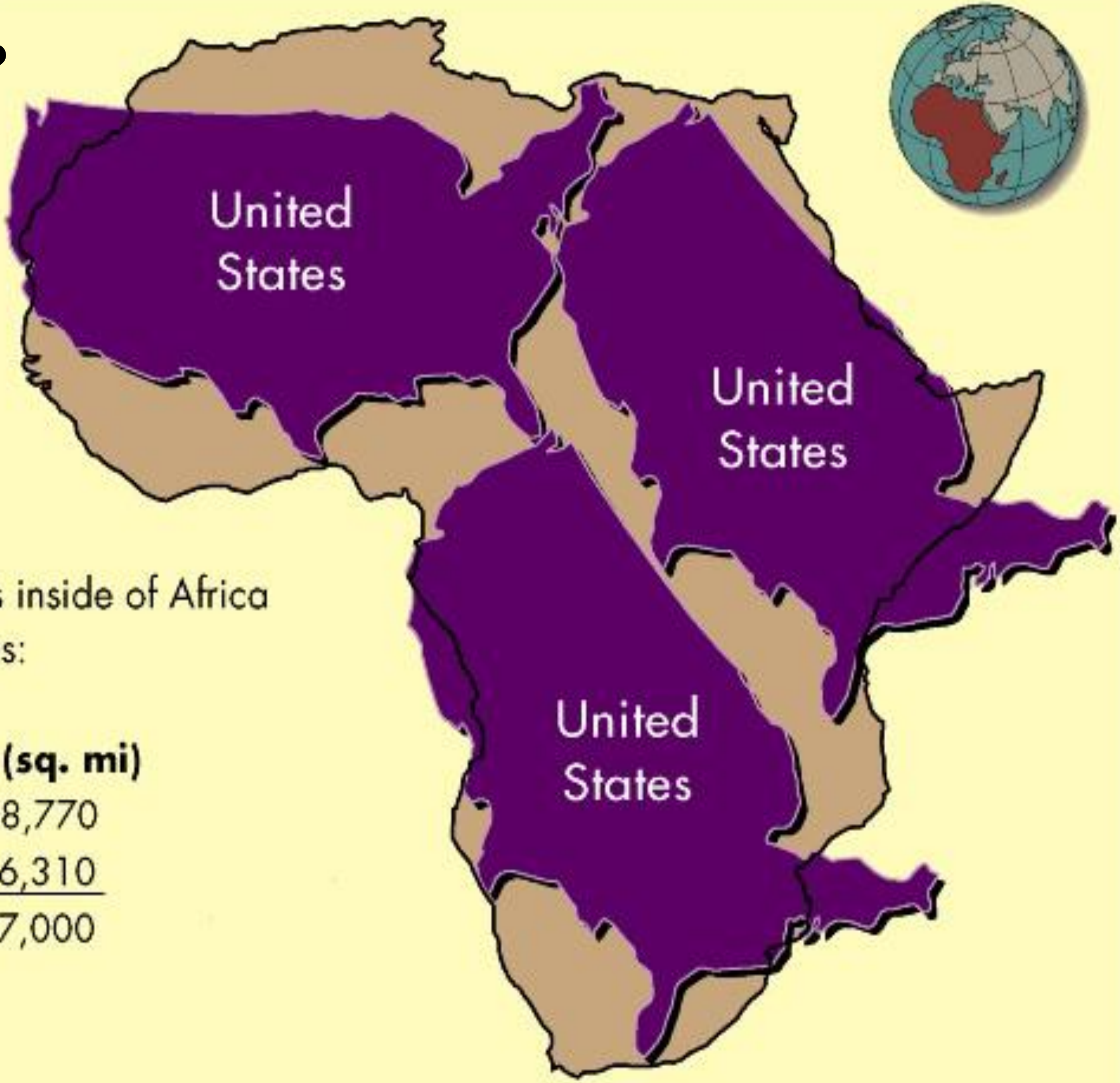
1957 **First dedicated drought breeding station** established in York, NE by Dr Stan Jensen



Education and Experience

JACKRABBITS
SOUTH DAKOTA STATE UNIVERSITY

Why Africa?



The continental USA fits inside of Africa approximately 3.5 times:

	Area (sq. mi)
United States	3,618,770
(US area x 3=)	10,856,310
Africa	11,707,000

Why Africa?

- A young and fast-growing population
- Economies are growing rapidly
- By 2050
  - ~ 41 per cent of the world's births
  - ~ 40 per cent of all under-fives
  - ~ 37 per cent of all children under 18

  will be African

UNICEF Generation 2030 Africa, 2014
http://www.unicef.org/publications/files/UNICEF_Africa_Generation_2030_en_11Aug.pdf

Why Sorghum?

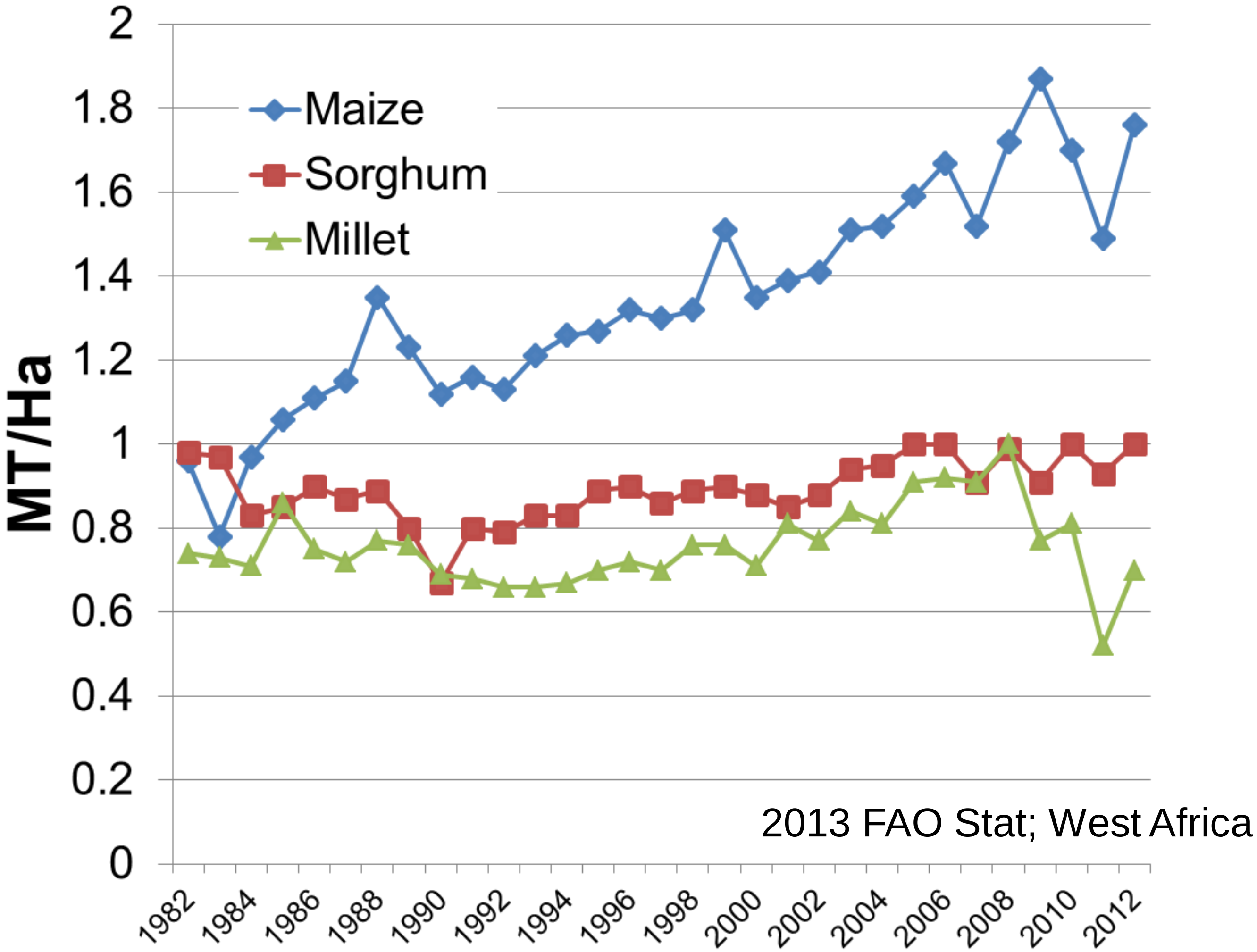
- Fifth most important grain for food use globally

- A staple food for 300 million people in Africa
  - Very low nutritional content

- Primary cereal in arid and semi-arid geographies

- Drought tolerance
  - Changing environment and demands

West Africa Maize, Sorghum, and Millet Yield Trends 1982 to 2012



Area under sorghum cultivation has doubled in same time frame

Micronutrient Deficiencies and Stunting

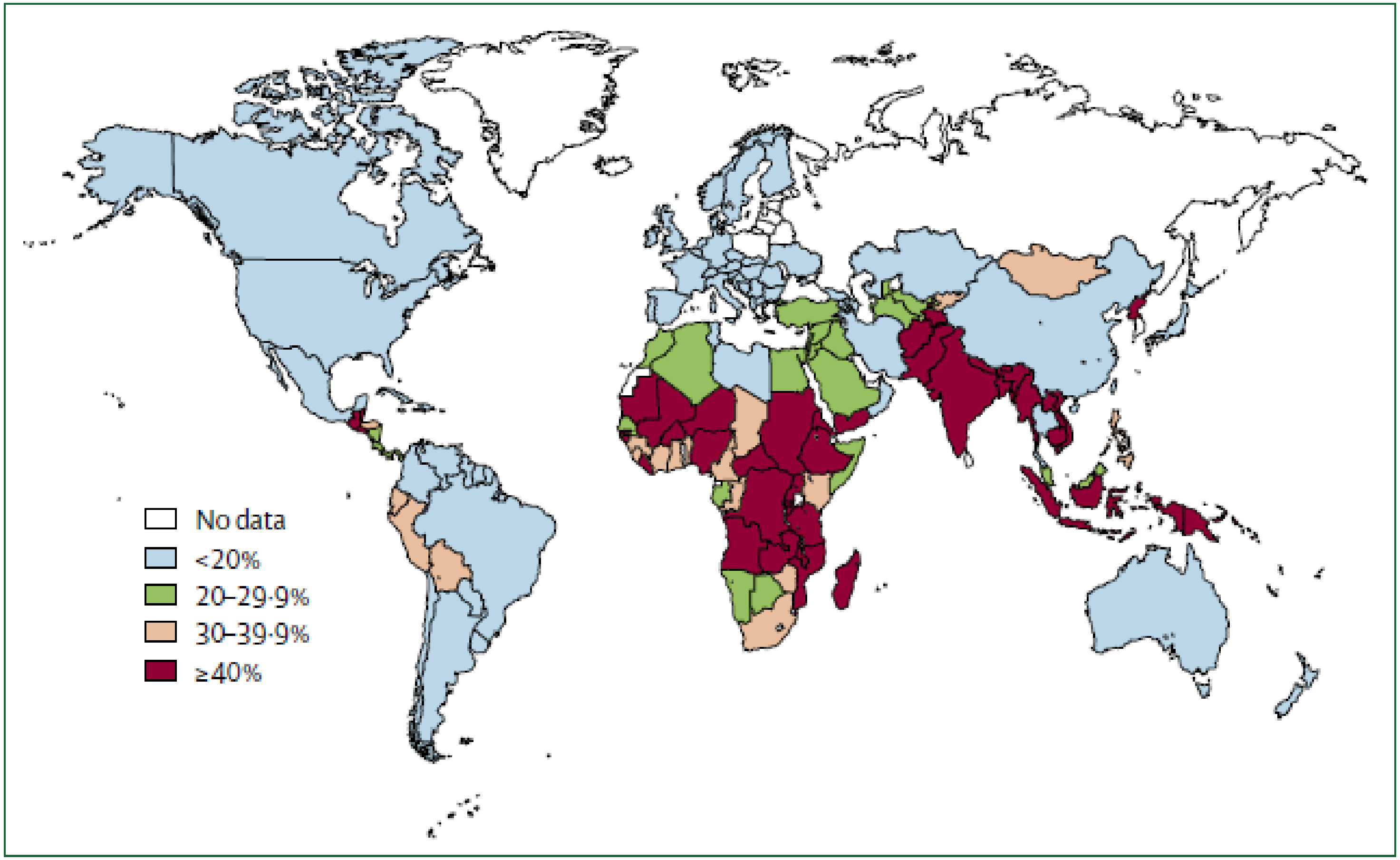


Figure 2: Prevalence of stunting in children under 5 years

"Vitamin A and zinc deficiencies have by far the largest remaining disease burden among the micronutrients considered"

Black et al. 2008. Maternal and child undernutrition: global and regional exposures and health consequences. www.thelancet.com

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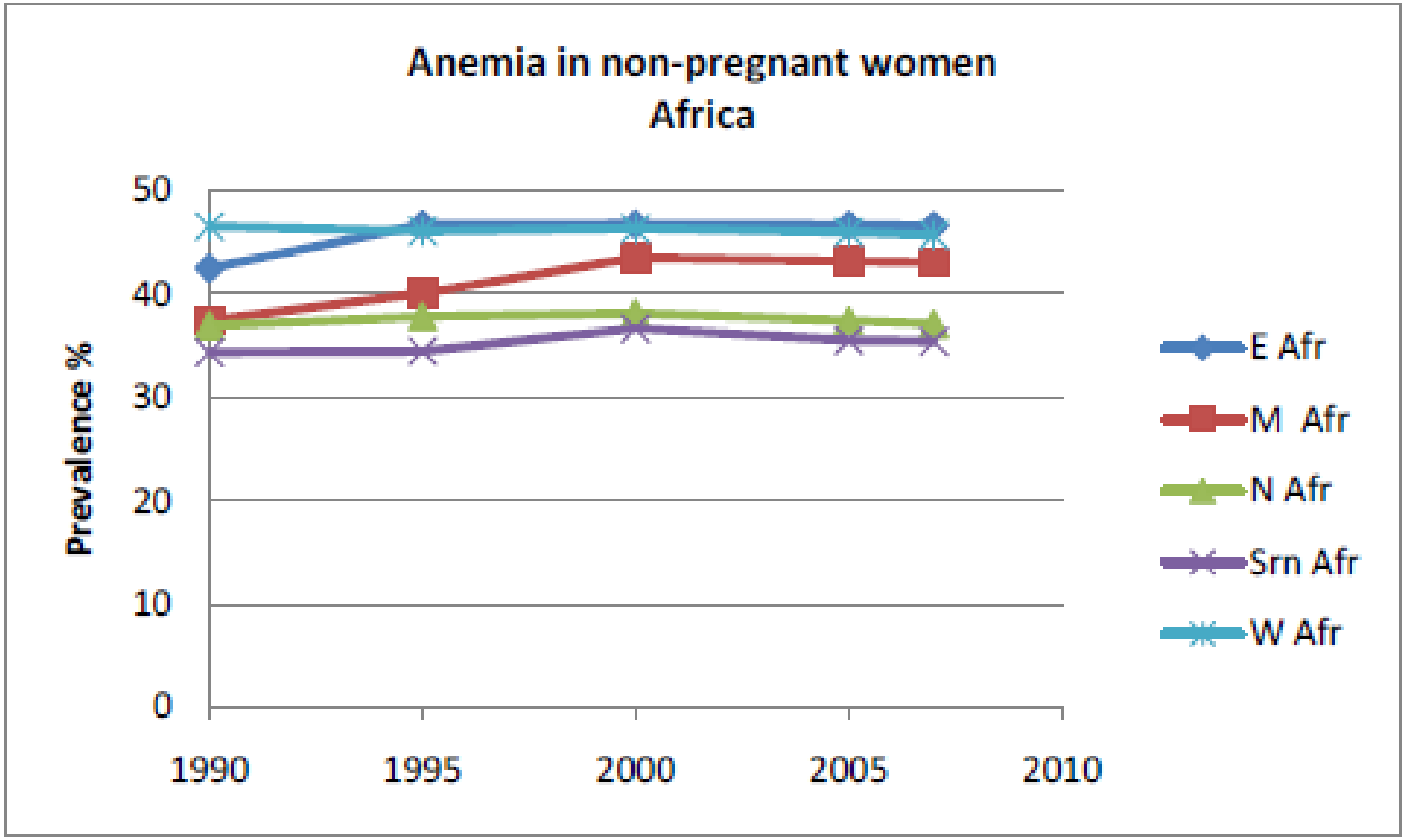
Anemia Levels Relatively Unchanged Throughout Africa



Based on 6th Report on Progress in Nutrition. 2010.

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Solutions and Progress – Technology for Sorghum

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Biofortified Sorghum: A Collaborative Effort

- Majority of resourcing from Bill and Melinda Gates Foundation ($12M)
- Secondary contributor and majority technical contributor is DuPont Pioneer ($6.5M)
- Current efforts concentrated with Africa Harvest, Institute of Ag Research (Nigeria), and Kenya Ag and Livestock Research Organization (KALRO, former KARI)

Biofortified Sorghum Initiative

- Beta carotene (Vitamin A)
- Fe and Zn availability
- Regulatory framework in Africa
- Capacity building
- Sorghum breeding/transformation
- Seed systems

WT

ABS203

Biofortified Sorghum Initiative

Gene	Function	Source
CRTI	β-carotene accumulation	*Erwinia uredovora*
CRTB		
PSY1		*Zea mays*
HGGT	β-carotene stabilization	*Hordeum vulgare*
OS-NAS2	Fe and Zn uptake	*Oryza sativa*
OS-YSL2	Fe and Zn accumulation	
PhyA	Phytate breakdown	*Aspergillus niger*

- Ubiquitous in nature
- None are alergens
- Common in food
- Opportunity of history of safe use status

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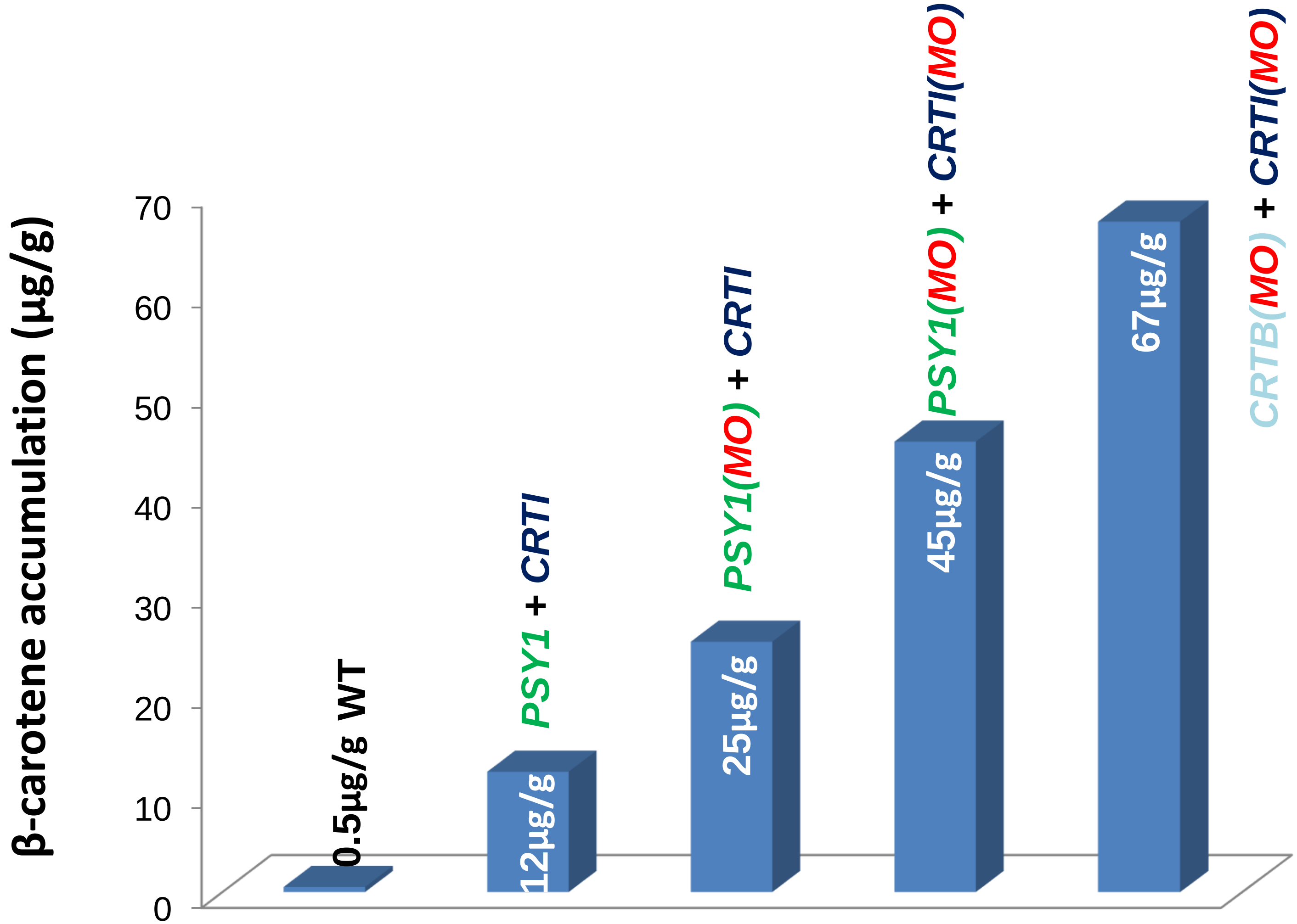
Beta-carotene in sorghum:
50 – 70 micrograms/gram achieved



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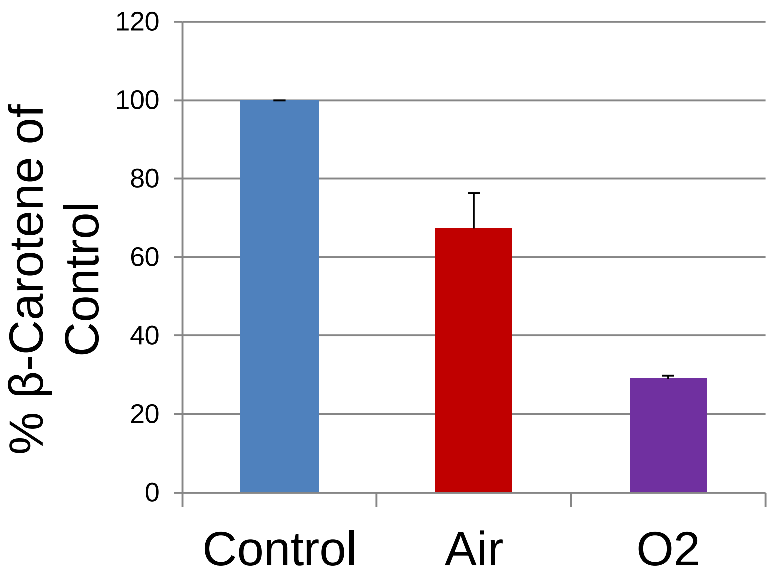
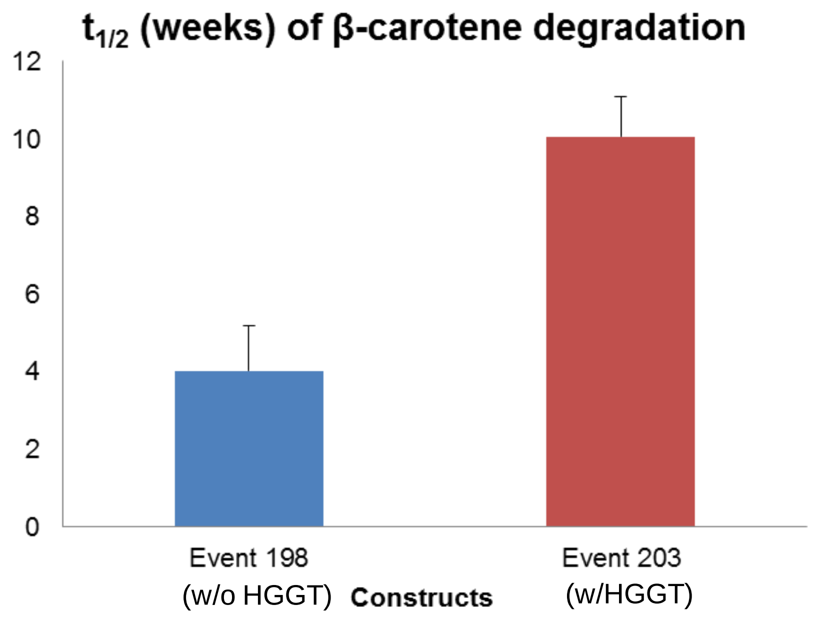
Enhancing Beta-Carotene Stability



• The samples exposed to either air or oxygen for 2 weeks at room temperature
• ~35% of β-carotene is degraded in air and ~70% is degraded in O2



➢ Oxidization is the major factor for beta-carotene unstability
➢ β-carotene can be stabilized by vitamin E (tocotrienols)

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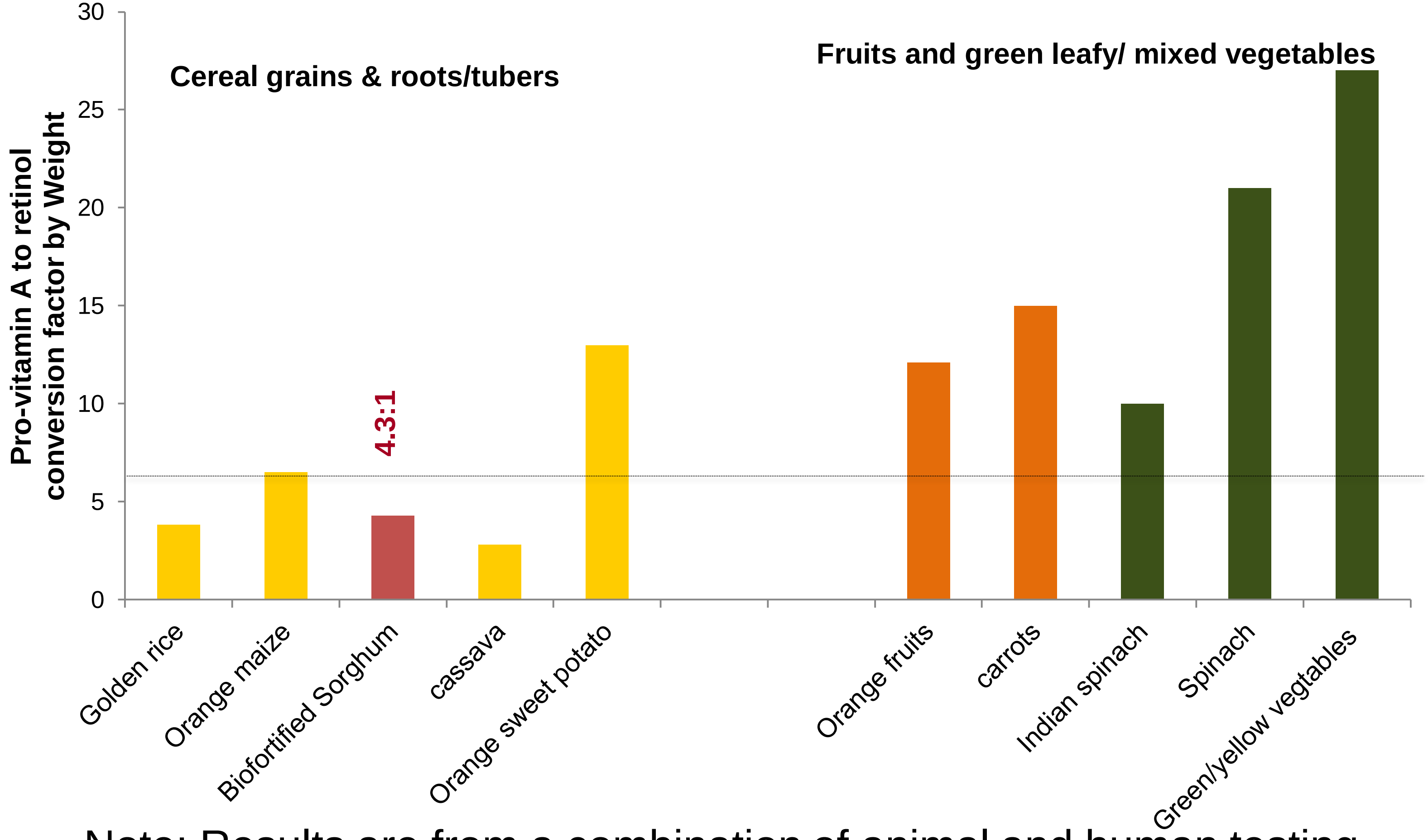
β-Carotene in Sorghum is Efficiently Bio-Converted to Vitamin A



Note: Results are from a combination of animal and human testing

Sorghum Results from:
You, H., Zhang, Y., Zhao, Z.-Y., Che, P., Albertsen, M.C., Glassman, K., White, W.S. Quantifying the bioefficacy of b-carotene-biofortified sorghum using a Mongolian gerbil model. FASEB J 2015;29(1): Supplement 605.3. Presented at Experimental Biology 2015, Boston, MA, March 28-April 1.

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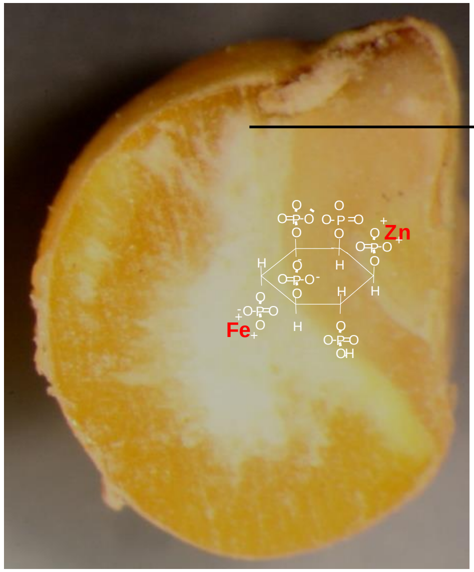
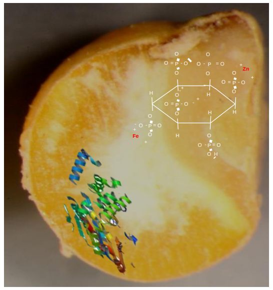
Phytase Gene Makes Fe and Zn Available

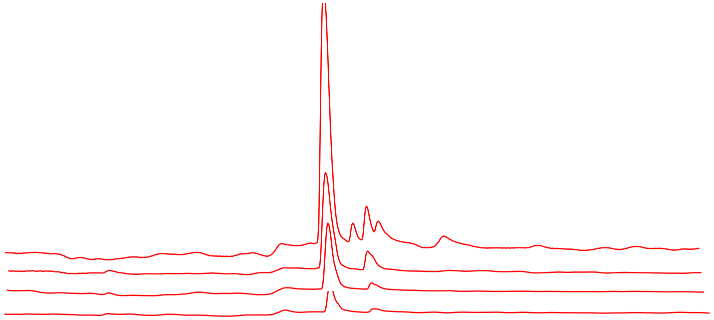


LEG1-Phy A

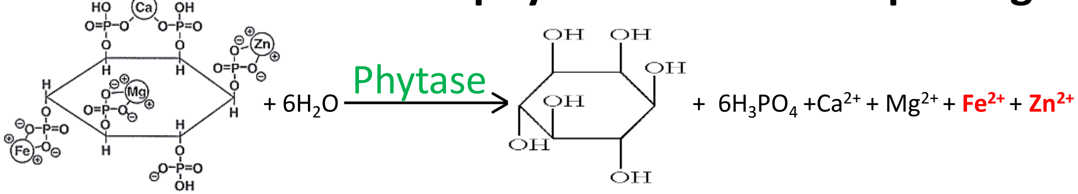


Soaking with water

Phytate



90% phytate reduction in porridge



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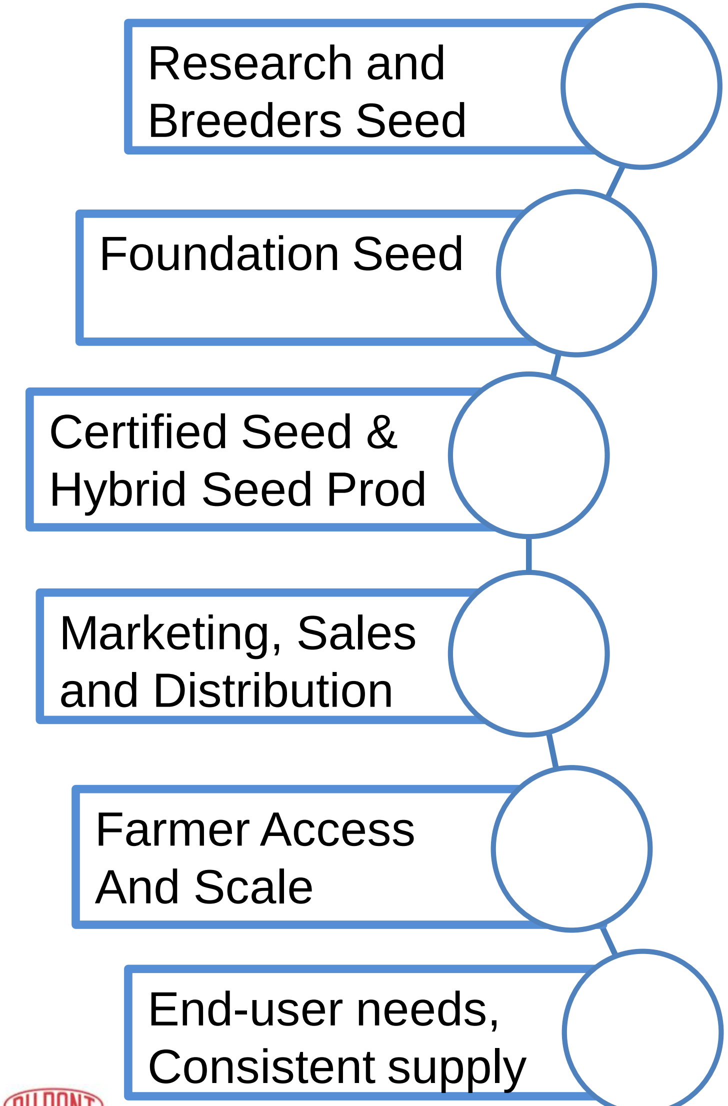
Objectives and Achievements

	Target	Achieved	Meaning
β-carotene	30 µg/g	67 µg/g	50 – 100% EAR of Vitamin A*
Bioconversion	6.5:1	4.3:1	
β-carotene ½-life	8 weeks	10 weeks	
Germination/ Phytate reduction	80% of normal	90% of normal	80% EAR of Fe and Zn*
Fe and Zn availability	50% improvement	100% improvement	

*with consumption of 100 g/day sorghum

Partnership for the Development of Sorghum and Millet in Africa



agropolis fondation

HEARTLAND GLOBAL
INNOVATION ARCHITECTS

- Initial meeting:
  - 30 participants
  - 20 organizations
  - 12 countries
- Agreed to focus on:
  - Seed systems
  - Agronomy
  - Product development
  - Market and value chains

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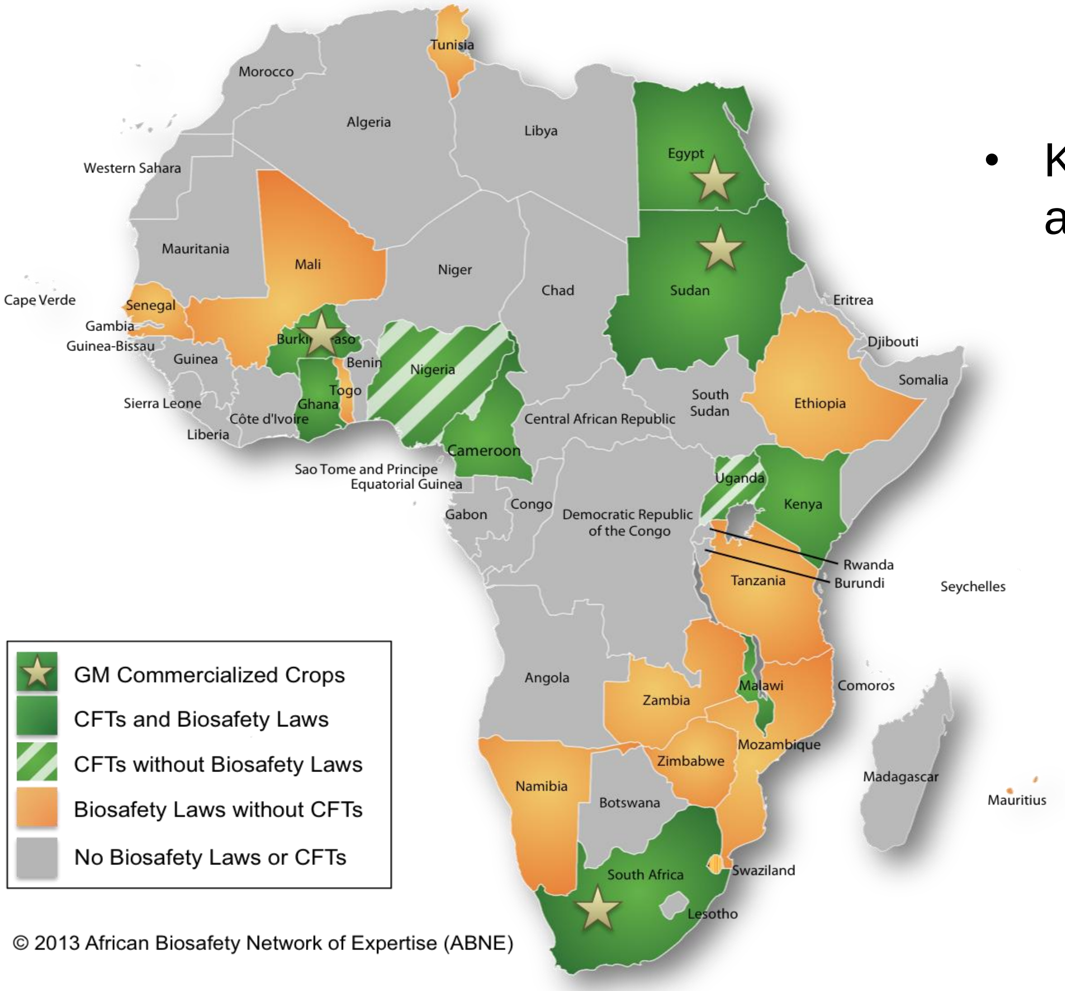
Regulatory Capacity Building in Africa



- Kenya, Nigeria, and Burkina Faso are ready for biofortified sorghum
  - Multiple confined field trials conducted in Kenya and Nigeria
  - Regulatory science data package agreed upon
  - Burkina has conducted multiple Bt cowpea trials, as an example

KENYA! Bt Maize cultivation approval!!!

Note Changes: Egypt has a moratorium on GM
Namibia has draft biosafety laws only
Nigeria has fully functioning biosafety laws

Agricultural Development at DuPont Pioneer

- Professionalism
  - Improve overall professionalism of the seed industry and smallholder farmers
- Prosperity
  - Contribute to greater prosperity of smallholder farmers and their families
- Technology
  - Apply available technology and research efforts in challenging environments
- Resources
  - Develop resourcing and collaborations for efforts we would not undertake on our own
- Trust
  - Develop greater trust in new technology and goodwill with DuPont Pioneer and Pannar

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How Does Any of This Relate to You?

- Career options and opportunities
- Skill sets to think about
- Your education and curiosity

Summary

- Micronutrient deficiencies in Africa are a persistent problem
- Seed system development is critical
- Improved nutrition will help Africa realize its full potential
- Your role