WORKSHOP

INNOVATIVE RESEARCH TOWARDS GENETIC PROGRESS

CHARACTERIZATION, CHALLENGES, AND USES OF SORGHUM DIVERSITY TO IMPROVE SORGHUM THROUGH PLANT BREEDING

MAXIMISING RESULTS THROUGH GENETIC DIVERSITY, INNOVATION AND SEED QUALITY

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INSTITUTE DESCRIPTION

UC-ANR KEARNEY AG, RESEARCH & EXTENSION CENTER

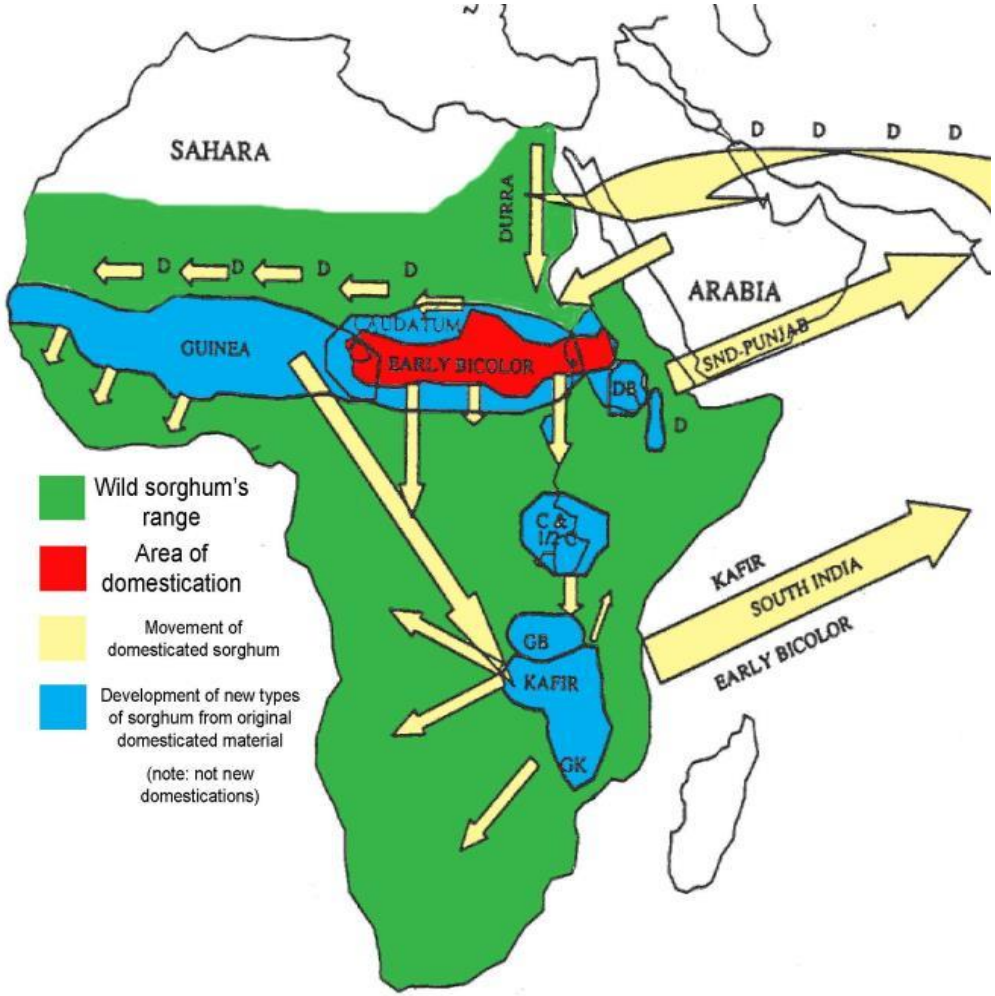
- Largest Research & Extension Center in the UC-ANR system
- Located south of Fresno, California in the heart of some of the richest farm land in the Nation
- We grow over 49 different crops on the Center and conduct approximately 80 research projects a year
- Part of the Land-Grant system established 151 years ago by Abraham Lincoln
  - UC Berkeley, Davis, and Riverside are part of the Land Grant in California.
- Sorghum research is working to establish a field based screening nursery for drought
  - Mediterranean climate with little or no summer rainfall
  - Ideal for studying drought on a field based scale

WHY ARE WE TALKING ABOUT SORGHUM ?

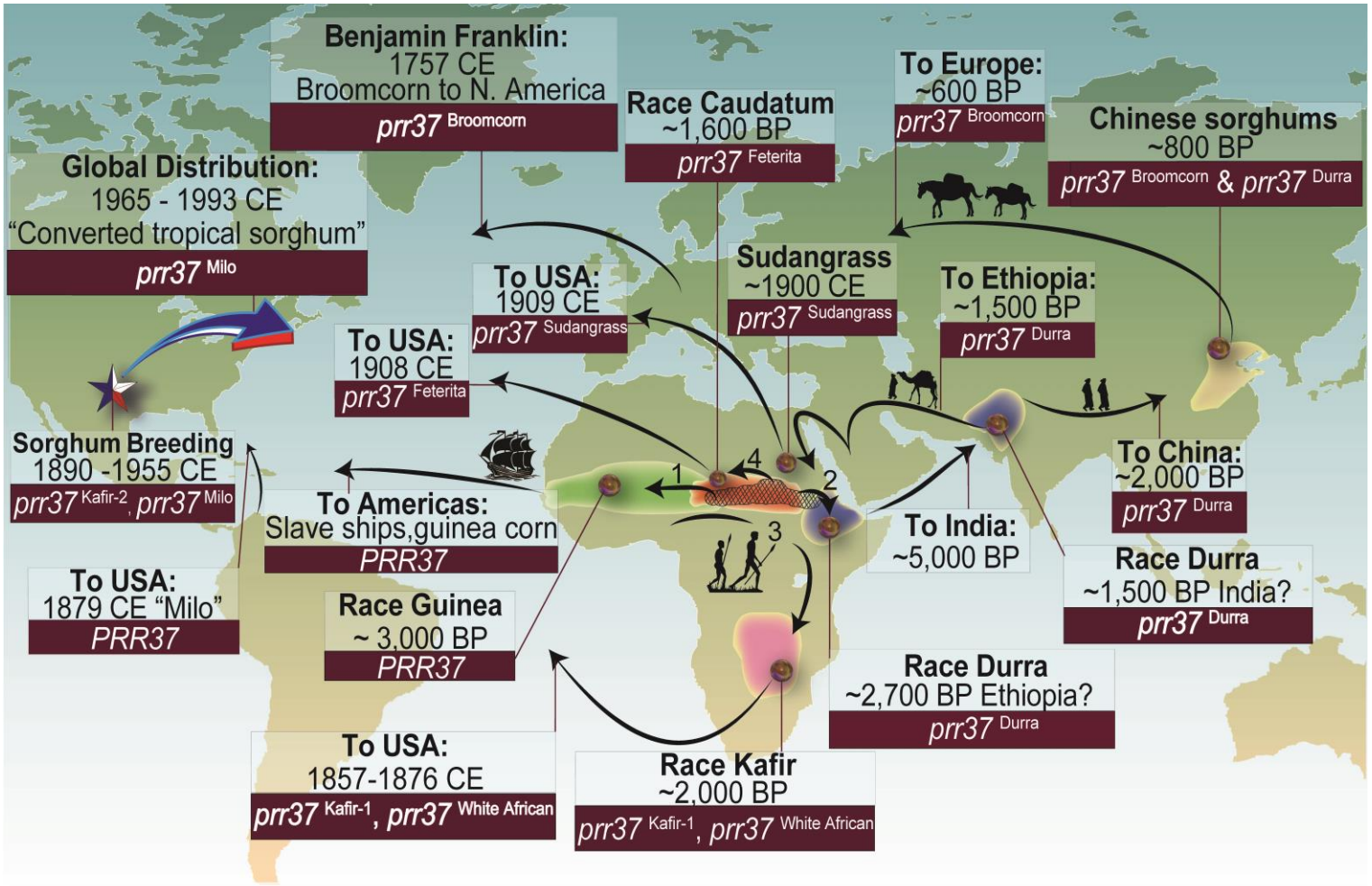
SORGHUM IS AN ANCIENT CROP !

Nabta Playa,
Southern Egypt

A BRIEF HISTORY OF SORGHUM



DISPERSAL CONFIRMED THROUGH GENOMIC RESEARCH



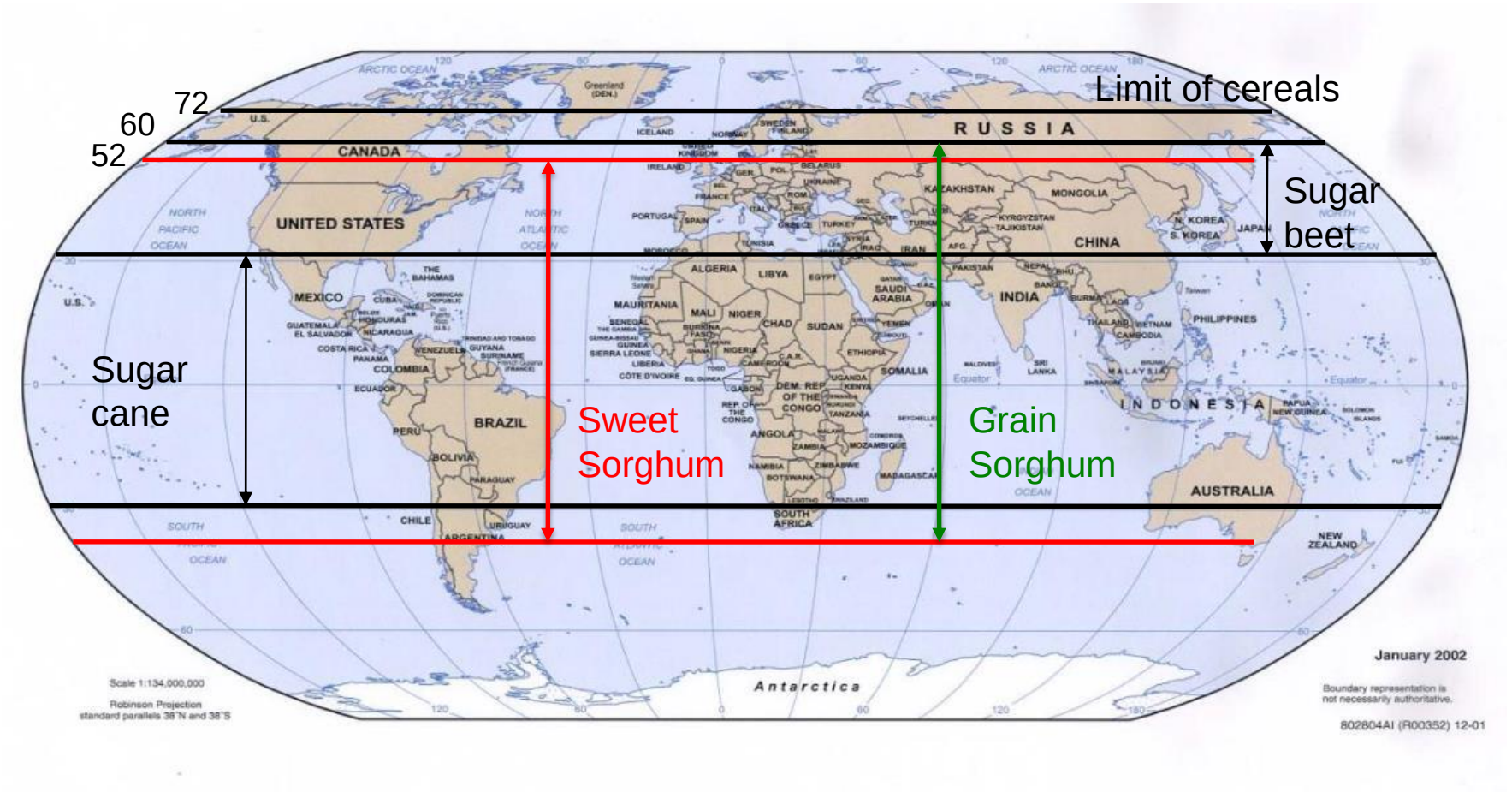
SORGHUM DIVERSITY








WIDE ADAPTATION OF SORGHUM



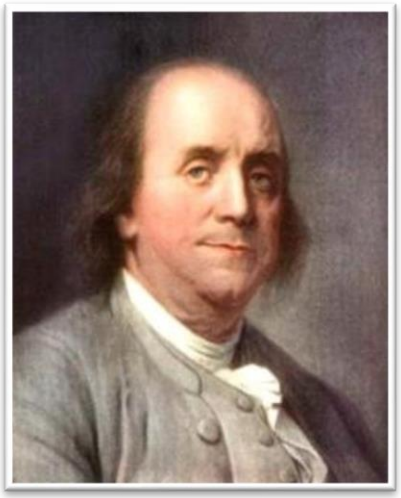
DIVERSITY HAS LED TO LARGE WORLD COLLECTIONS

Country	Institute	No of accessions	% of total holdings (194,250 acc.)
USA	USDA-ARS-PGRCU	43,104	22.2%
Global	ICRISAT	36,774	18.9%
India	NBPGR	18,853	9.7%
China	CAAS	18,250	9.4%
Ethiopia	IBC	9,772	5.0%
Brazil	EMBRAPA	8,017	4.1%
Russia	VIR	7,335	3.8%
Zimbabwe	NPGRC	7,009	3.6%
Australia	DPI	5,403	2.8%
Sudan	PGRU-ARC	4,191	2.2%
Mali	IER	2,975	1.5%
France	CIRAD	2,690	1.4%
Kenya	NGBK	1,320	0.7%
Zambia	NPGRC	1,005	0.5%
South Africa	NPGRC	428	0.2%
Malawi	NPGRC	401	0.2%
Nigeria	NCGRB	159	0.1%
Serbia	Inst. Field and Vegetable crops	152	0.1%
Global	ILRI	52	0.0%
	TOTAL 19 institutes	**167,890**	**86.0%**

Review from Crop Trust 2015

THE US COLLECTION

- First record of sorghum was in 1757
- USDA introduced various sorghum in 1800s
- Prior to the introduction of hybrids, 13,500 had been collected
- Serious collection began in early 1980s



Dear Sir,

I enclose you some of the Grain called Whisk Corn, or Broom Corn…

The Grain is good for Bread, and for Fowls, Horses & c.being a kind of Millet, and of great Increase…

Benjamin Franklin in letter to Samuel Ward, March 24, 1757

CHARACTERIZATION IS THE BIGGEST CHALLENGE FOR LARGE COLLECTIONS

- The USDA-ARS National Collection may be the most characterized with over 892,225 data points
- Greatest challenge is phenotypic data
  - Global Grin to standardize data collection
  - Most of the collection is photoperiod sensitive, making phenotypic screening limited to primarily the tropics
- Drone and drone technologies may provide some strategies for gathering robust, timely data points

US DESCRIPTORS

Descriptor	Distinct Accessions
Chemical	19,761
Cytological	49
Disease Resistance	63,653
Growth	62,360
Insect Resistance	30,536
Restorer	1,790
Morphological Screening	531,656
Other	11,982
Phenology	55,838
Production	30,784
Quality	29,067
Abiotic Stress	17,632
Taxonomy	37,117
Total number of observations	**892225**

RESEARCHING THE PHENOTYPING CHALLENGE

- Developing a drone platform to measure crop biomass and water stress
- Perform field experiments to identify varieties resistant to drought & high salinity
- Use genetic sequencing & molecular phenotyping to determine which genes control drought tolerance
- Produce new sorghum varieties tolerant to drought and can be grown on marginal land

BLUE RIVER TECHNOLOGY

MEASURING SORGHUM BIOMASS WITH DRONE-BASED LIDAR

BREEDING CHALLENGES IN SORGHUM

- **Traditional Breeding**
  - Time
  - Mostly Recurrent Selection
  - Large photoperiod sensitive collections
- **Genomics**
  - Marker Assisted Selection limited by lack of phenotypic data
  - Not as robust as hoped for
  - Creating huge datasets
- **Phenotyping**
  - Challenge of time and accuracy
  - Can we accurately correlate with genome across populations
  - Huge datasets

VISION: PRECISION BREEDING "SYSTEM"

INTEGRATION OF BIOLOGY × ENGINEERING × COMPUTER SCIENCE

TERRA
Crops × Bots × Bytes

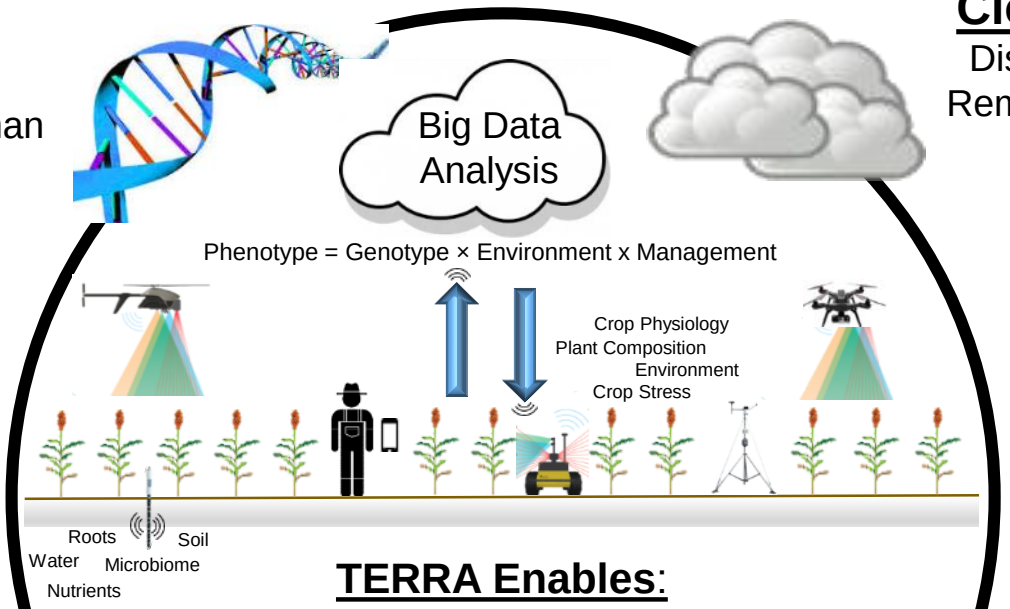
Crop Genetic Gain and Resilience

Genomics
Plant, Animal, Human and Microbial

Gene and Trait Associations

Cloud Computing
Distributed Databases, Remote Access, Scalable

Prediction Algorithms



Phenomics
Phenotype Reference Standards (Lab & Field)

High Resolution Crop Phenotypes

Data Analytics
High Performance Information Pipelines

AI - Machine Learning

TERRA Enables:

- Crop Breeding
- Field Research
- Farm Management
- Conservation
- Market Connectivity

Sensors
Plant, Root, Soil, Microbial and Environmental

High Throughput Field Data Acquisition

Robotics
Field Deployable, Scalable and Economical

QUESTIONS ? ?