



1ST EUROPEAN SORGHUM CONGRESS

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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BUCHAREST
3-4 NOVEMBER 2016



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**



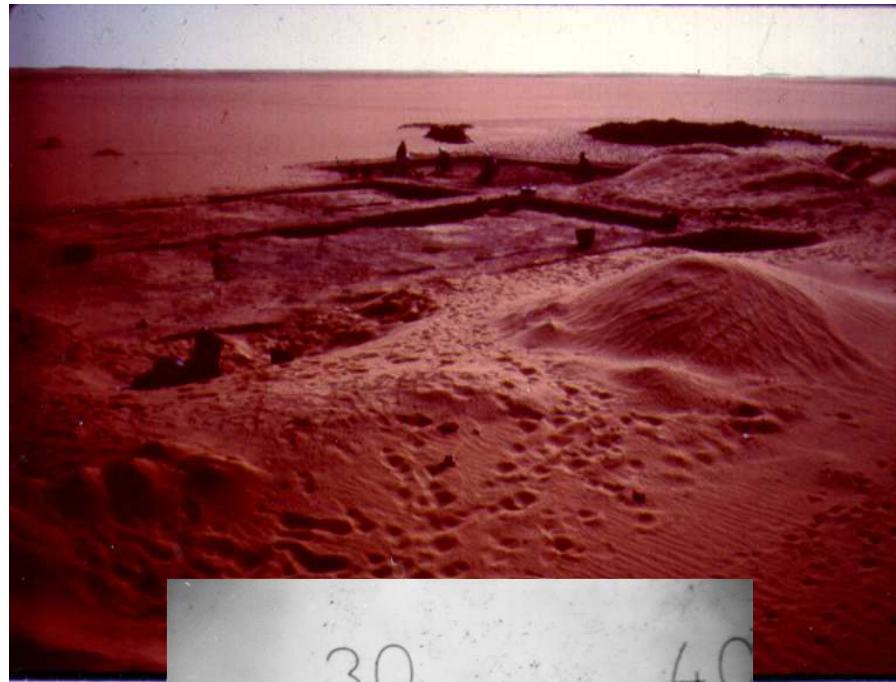
WHY ARE WE TALKING ABOUT SORGHUM ?



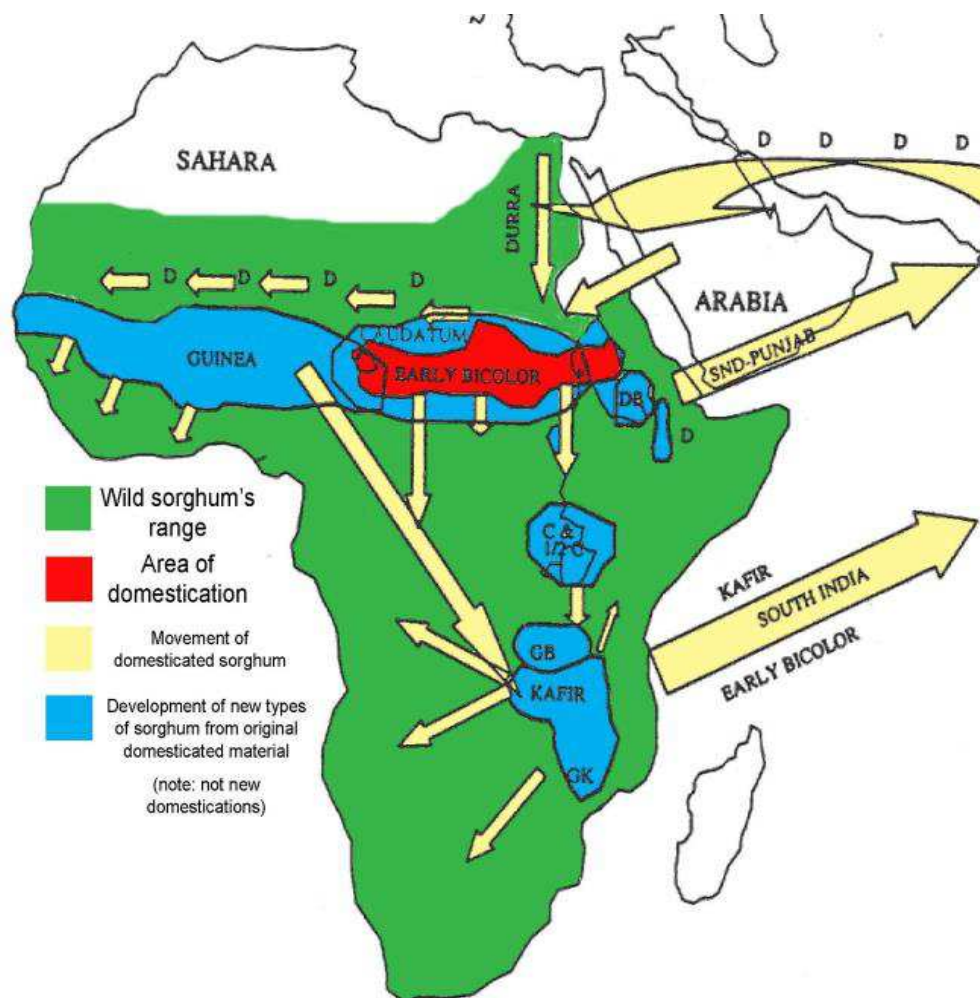


SORGHUM IS AN ANCIENT CROP !

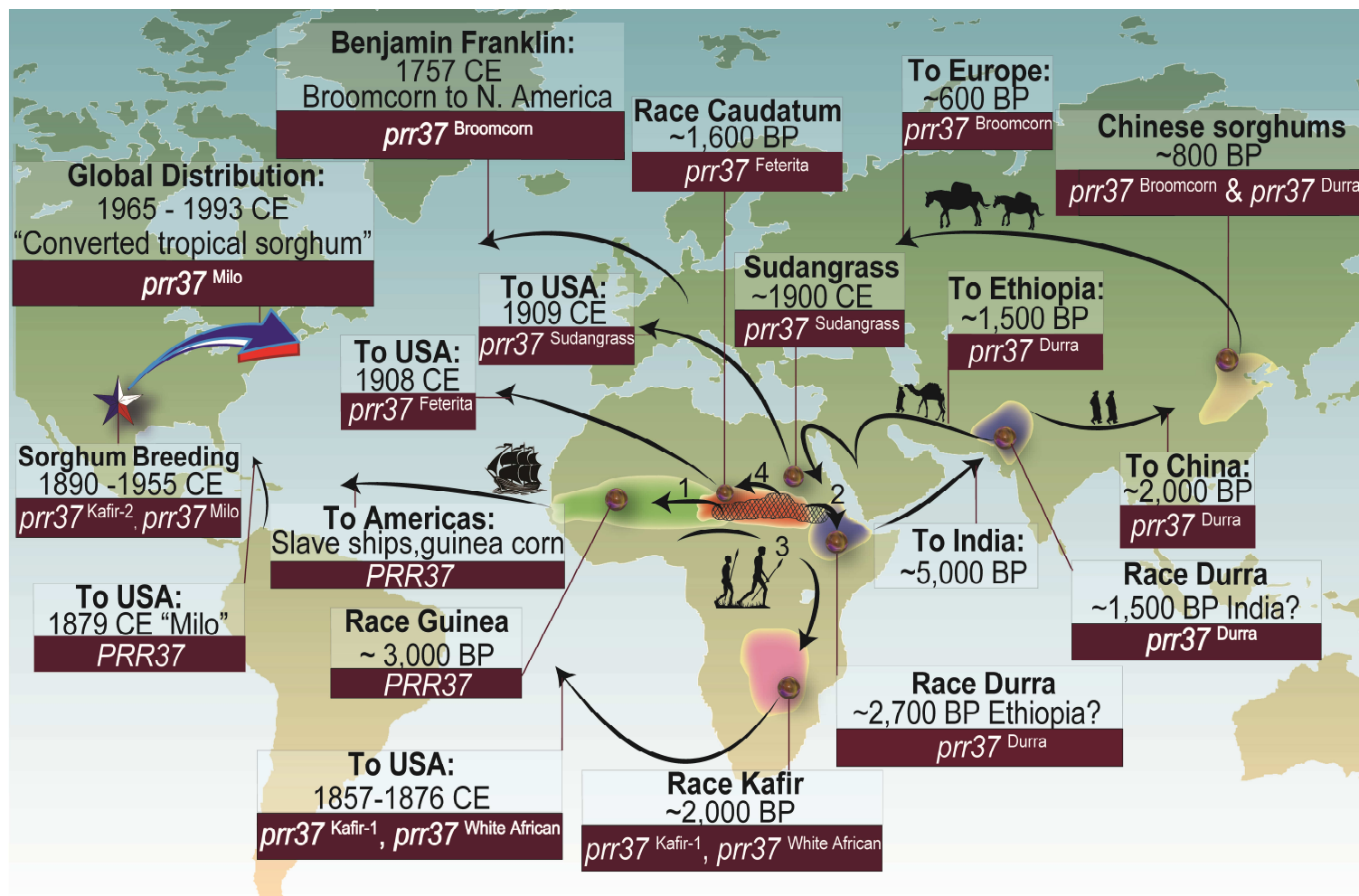
Nabta Playa,
Southern Egypt



A BRIEF HISTORY OF SORGHUM



DISPERSAL CONFIRMED THROUGH GENOMIC RESEARCH

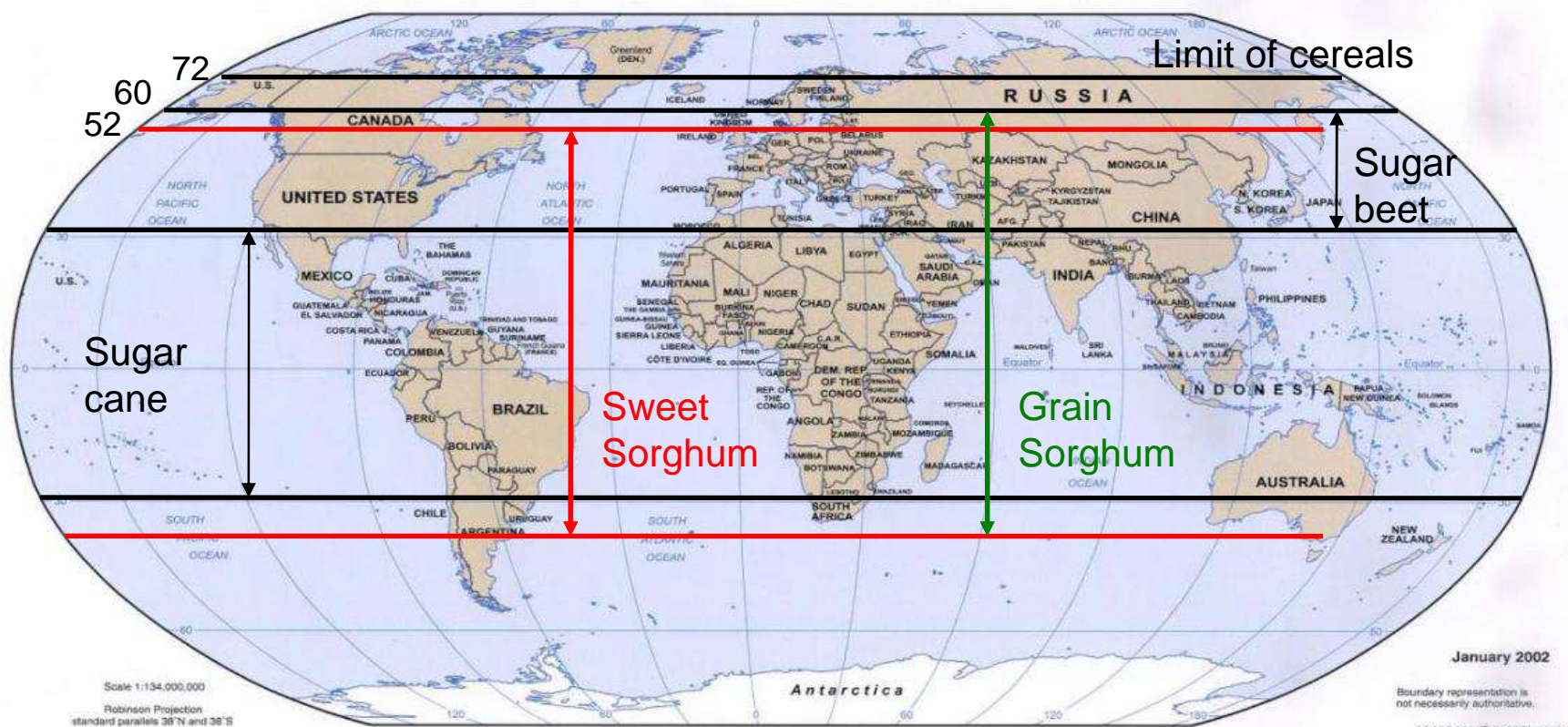




SORGHUM DIVERSITY



WIDE ADAPTATION OF SORGHUM





DIVERSITY HAS LED TO LARGE WORLD COLLECTIONS

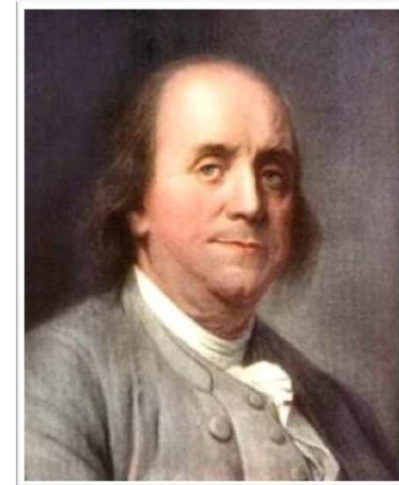
| Country | Institute | No of accessions | % of total holdings (194,250 acc.) |
|----------------------------|---------------------------------|------------------|------------------------------------|
| USA | USDA-ARS-PGRCU | 43,104 | 22.2% |
| Global | ICRISAT | 36,774 | 18.9% |
| India | NBPGR | 18,853 | 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 | NPGR | 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 | NPGR | 1,005 | 0.5% |
| South Africa | NPGR | 428 | 0.2% |
| Malawi | NPGR | 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*

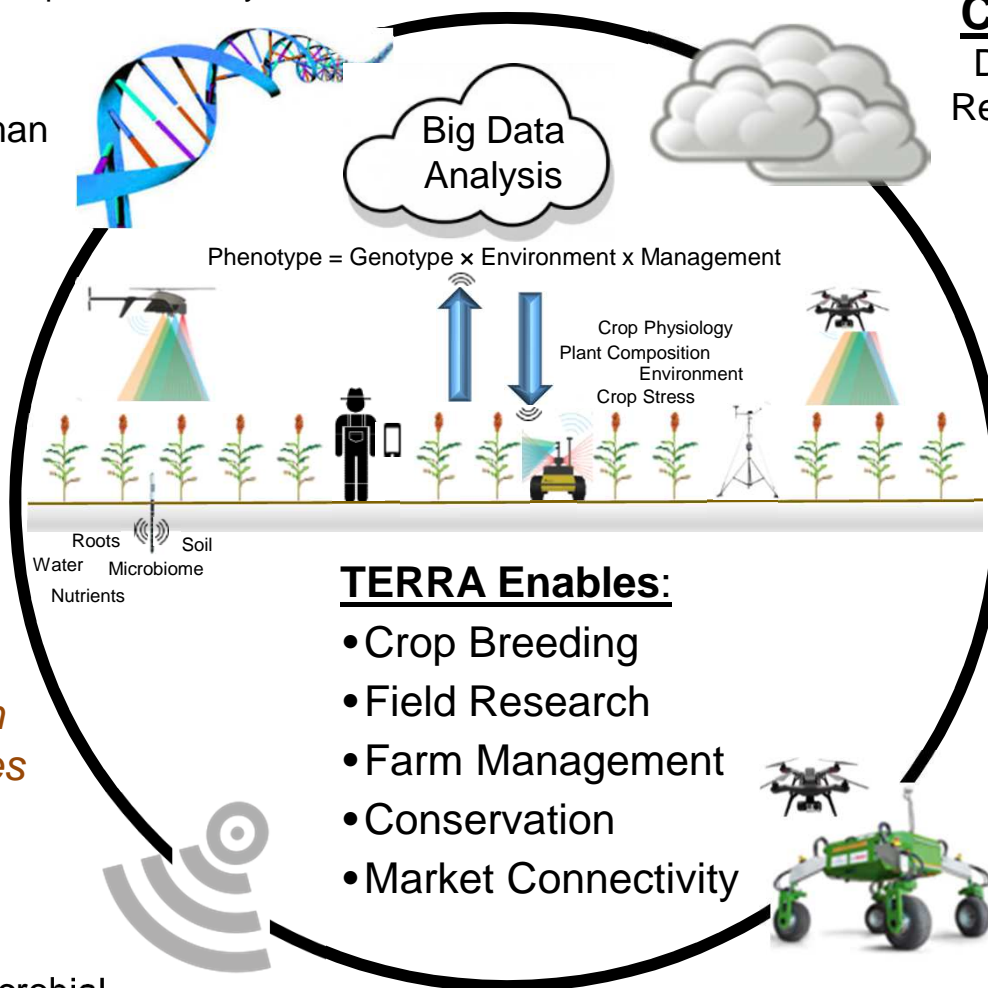
Phenomics

Phenotype Reference
Standards (Lab & Field)

*High Resolution
Crop Phenotypes*

Sensors

Plant, Root, Soil, Microbial
and Environmental



TERRA Enables:

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

*High Throughput
Field Data Acquisition*

Cloud Computing

Distributed Databases,
Remote Access, Scalable

*Prediction
Algorithms*

Data Analytics

High Performance
Information Pipelines

*AI - Machine
Learning*

Robotics

Field Deployable,
Scalable and Economical



QUESTIONS ? ?

