# Agricultural Initiative to Cut Hunger in Africa

## GCP21

## The Global Cassava Partnership for Genetic Improvement of the 21st Century

C. Fauquet

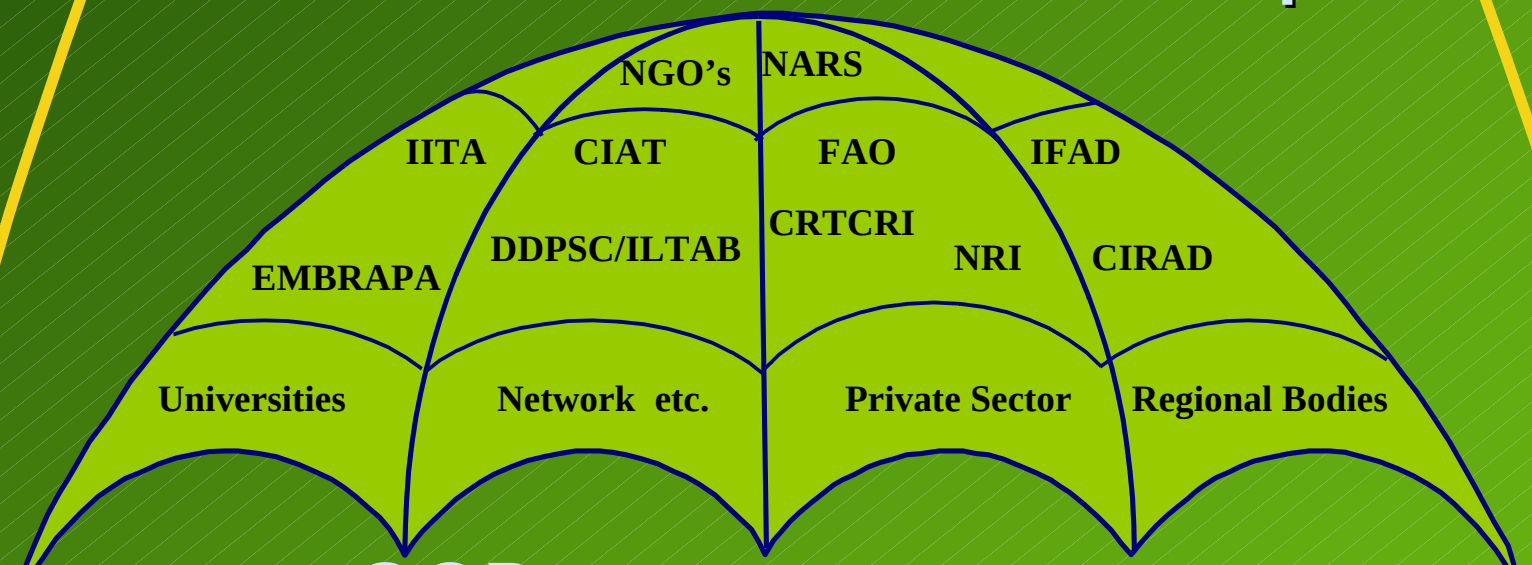
ILTAB/ Danforth Center

# Multi-Institutional Research and Development Project

# GCDS GOVERNANCE STRUCTURE

GLOBAL MEETINGS & ORGANIZATIONS ↔ GCDS Coordination Committee ↔ DONORS AND INTL. DEVELOP. AGENCIES

## Global Cassava Partnership

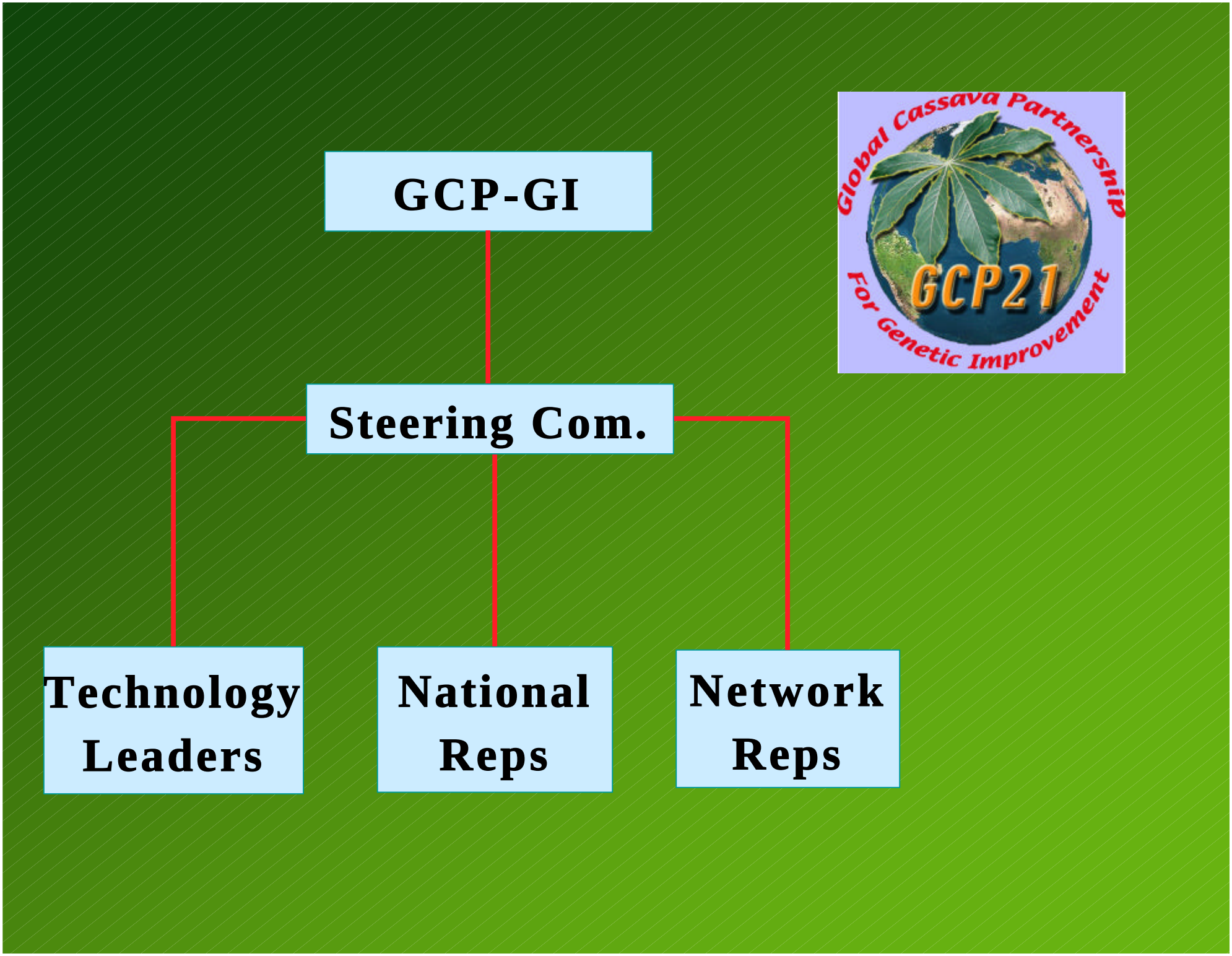



**GCP**
**For Genetic Improvement**

**GCP**
**For Marketing and Processing**

# Founding Institutions

- FAO
- CIAT
- IITA
- Embrapa
- Danforth Plant Science Center (ILTAB)
- CTCRI, India
- FAO/IAEA, Austria
- NARO, Uganda
- NABDA, Nigeria
- RILTC, Indonesia
- RTIP, Ghana
- ETH, Switzerland
- University of Bath, UK
- South China Institute of Botany, CAAS, China
- Biosystems Biology Institute, Seattle, USA…


GCP-GI
Steering Com.
Technology Leaders
National Reps
Network Reps
Global Cassava Partnership
GCP21
For Genetic Improvement

# GCP-GI

## Technology Leaders

Biodiversity: Alves,

Genomics: Tohme & Gruissem,

Double Haploids Ceballos,

Transformation: Taylor,

Micro-Propagation: Otim-Nape,

## Trait Leaders

Viruses: Thresh

Bacteria: Verdier

Post Harvest Deterioration: Beeching

Insects: Bellotti

Drought: Fregene

Starch: Visser

Proteins: Gruissem

Biofortification: Dixon & Ceballos

Cyanides: Mueller

# GCP-GI

## African Leaders

Nigeria: Omaliko
Ghana: Safo-Kantaka
Ivory Coast: Sangare
Cameroon: ?
Uganda: Otim-Nape
Kenya: N'Dolo
Tanzania: ?
Mozanbique: Zacarias
Angola: ?
Congo DR: ?
Madagascar: ?

## Asian Leaders

India: Edison
Indonesia: Hartojo
China: Zhang
Thailand: ?
Philippines: ?
Vietnam: ?

## American Leaders

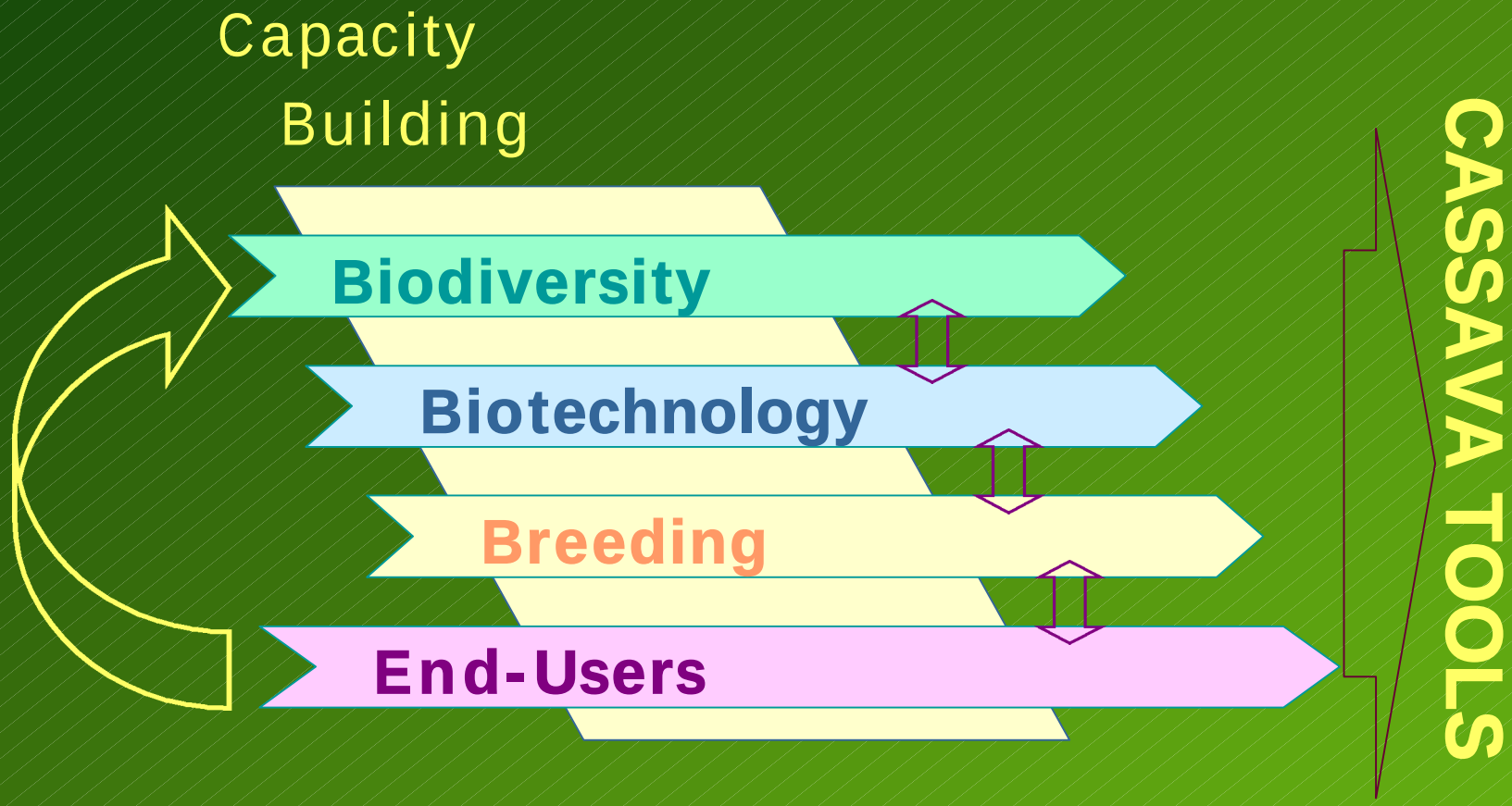
Brazil: Alves
Paraguay: ?
Colombia: Ospina
Cuba: ?

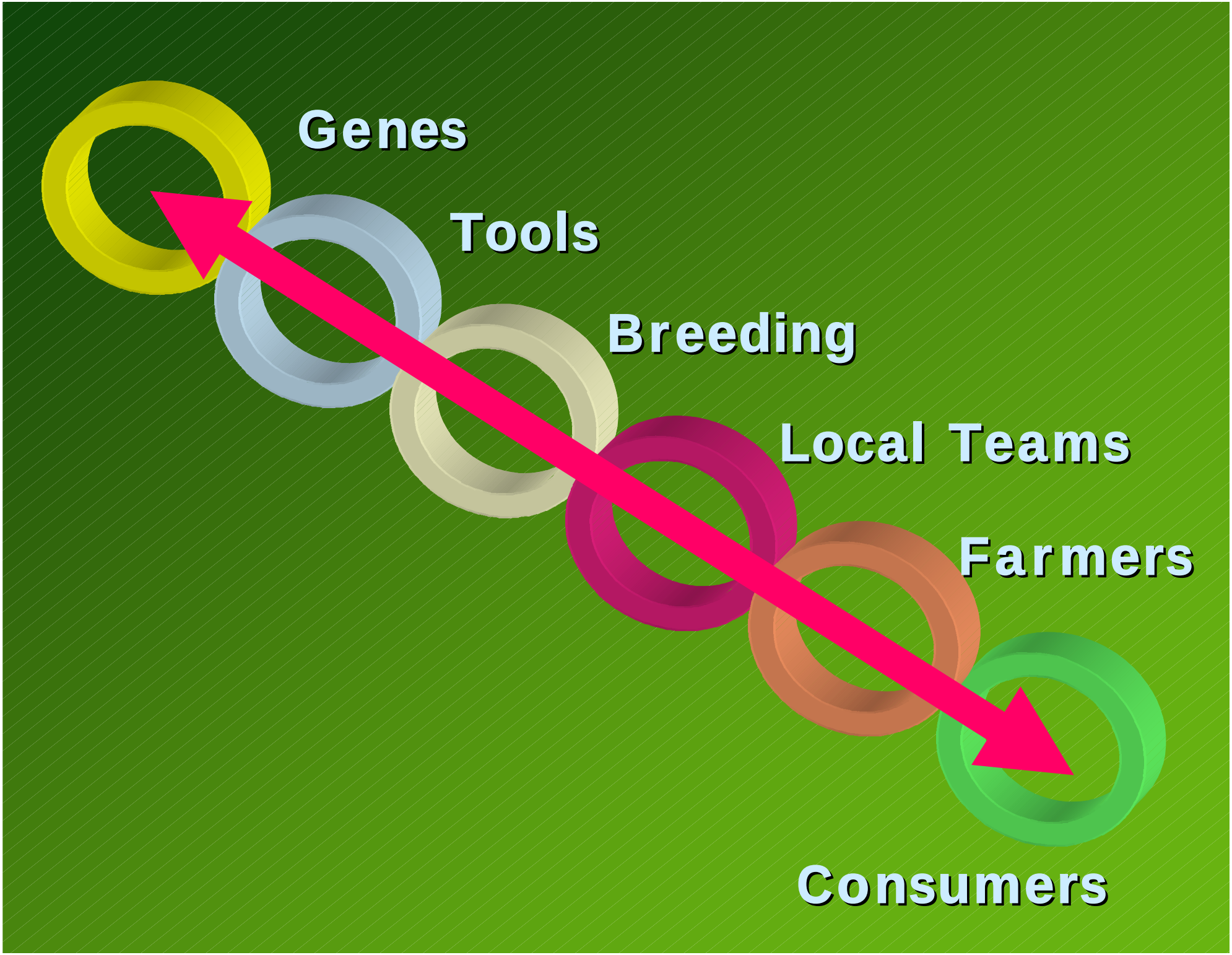
# GCP-GI

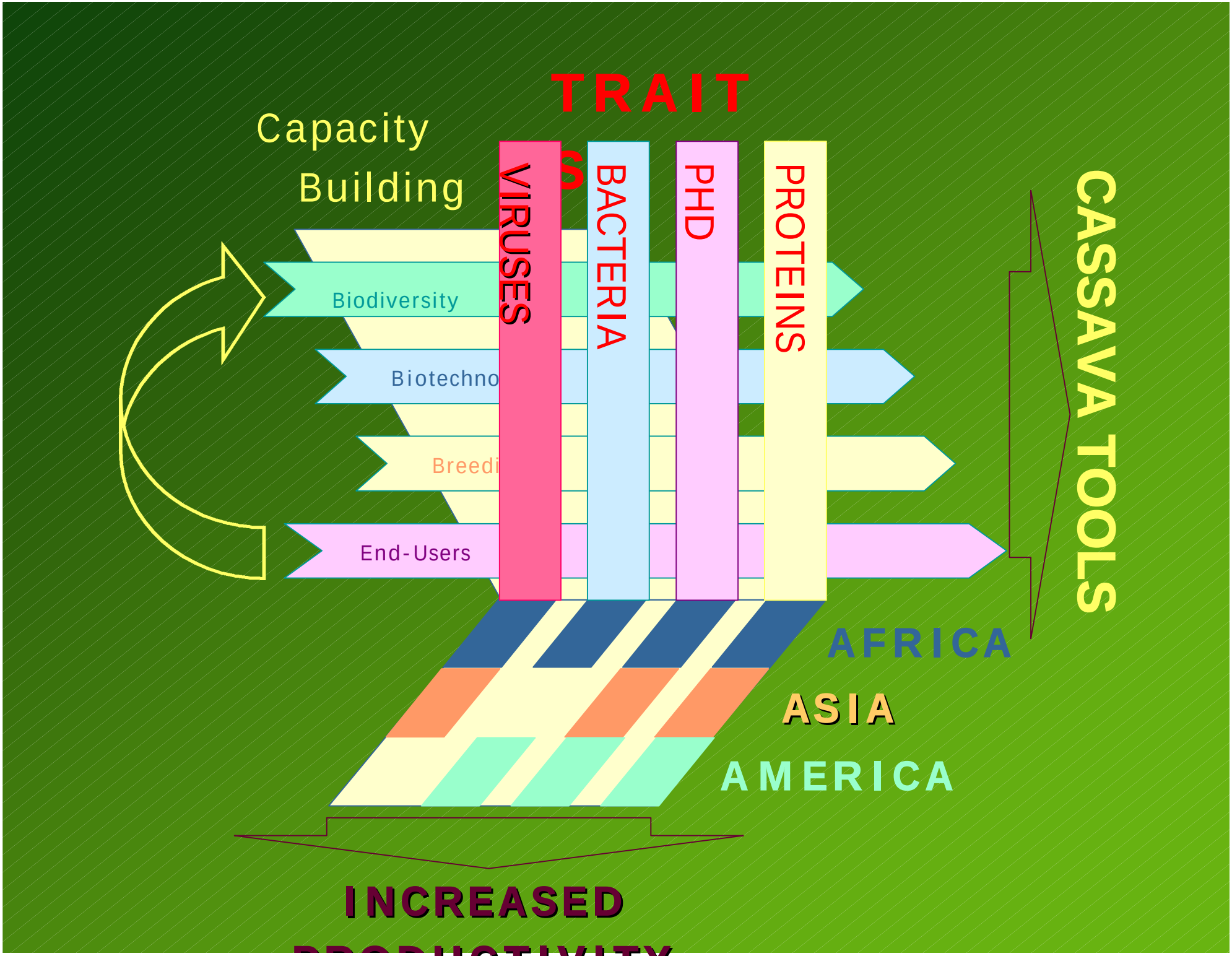
**Regional Associations**

**And Networks**

**ASARECA:**
**CORAF:**
**SADC:**
**EARRNET:**
**SARRNET:**
**CLAYUCA:**
**AAPARI:**


Capacity
Building
Biodiversity
Biotechnology
Breeding
End-Users
CASSAVA TOOLS


Genes
Tools
Breeding
Local Teams
Farmers
Consumers


TRAITS
Capacity Building
VIRUSES
BACTERIA
PHD
PROTEINS
Biodiversity
Biotechno
Breedi
End-Users
CASSAVA TOOLS
AFRICA
ASIA
AMERICA
INCREASED PRODUCTIVITY

# Biological Constraints for Cassava

Viruses

Bacteria

Post Harvest Deterioration

Insects

# Cassava and Geminiviruses

# Heavy Losses due to Viruses in Africa

**Losses from 35 to 50 M tons/year**

**Losses due to the viral disease are from 30 to 100%!**

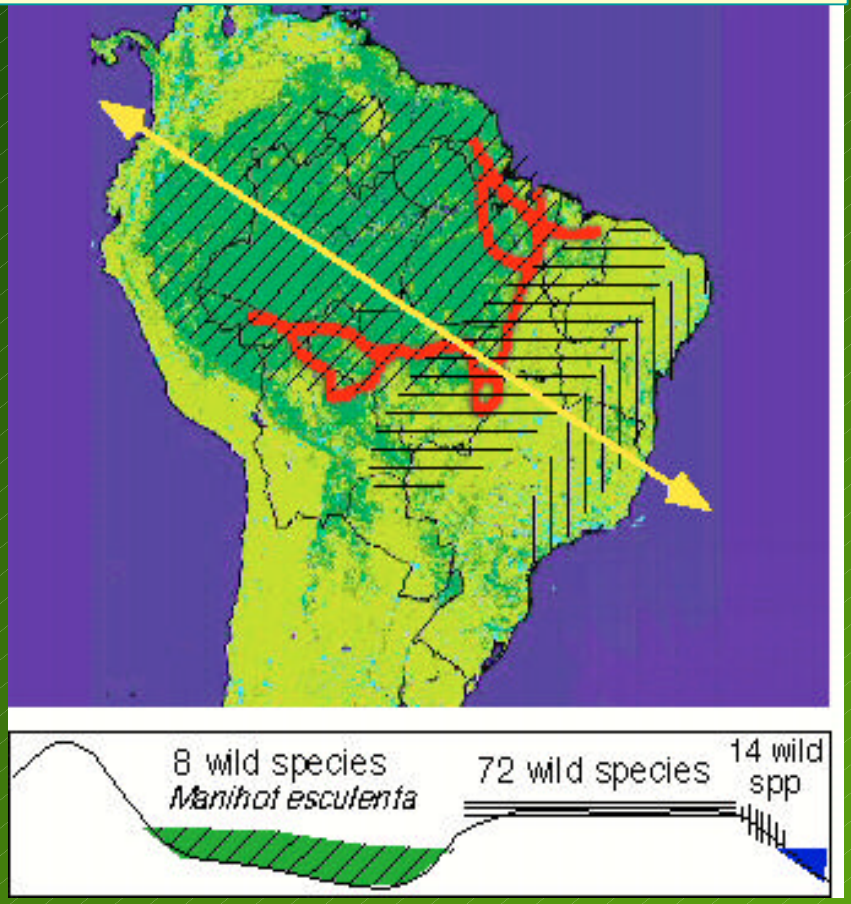
**90 million tons / year**

**8 tons /Ha**

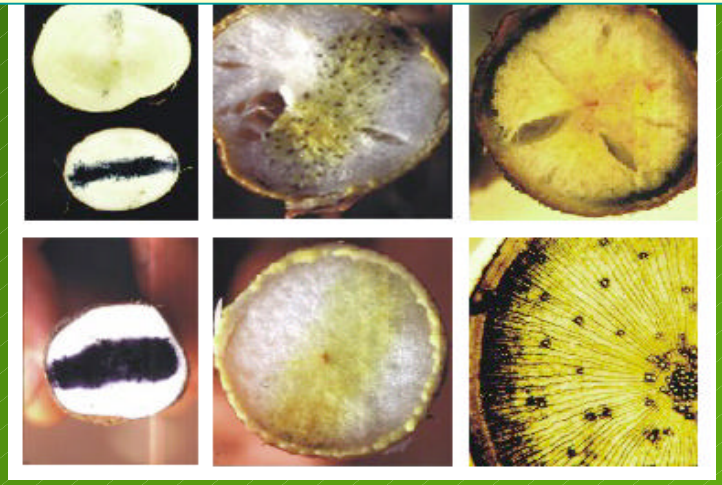
**60 tons / Ha**

# Cassava Biodiversity

- Cassava Biodiversity



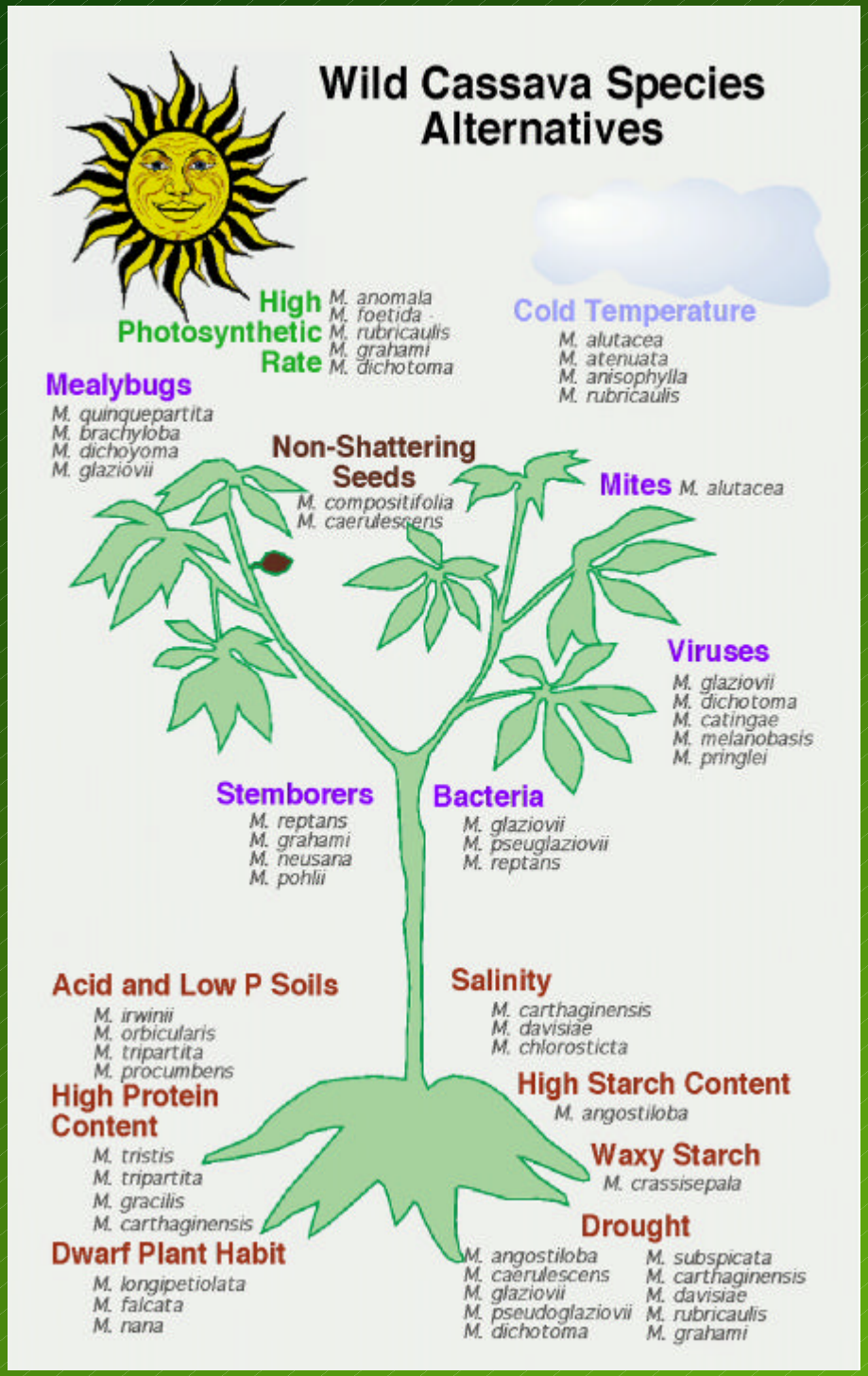

- Different starches



- Vitamin Content

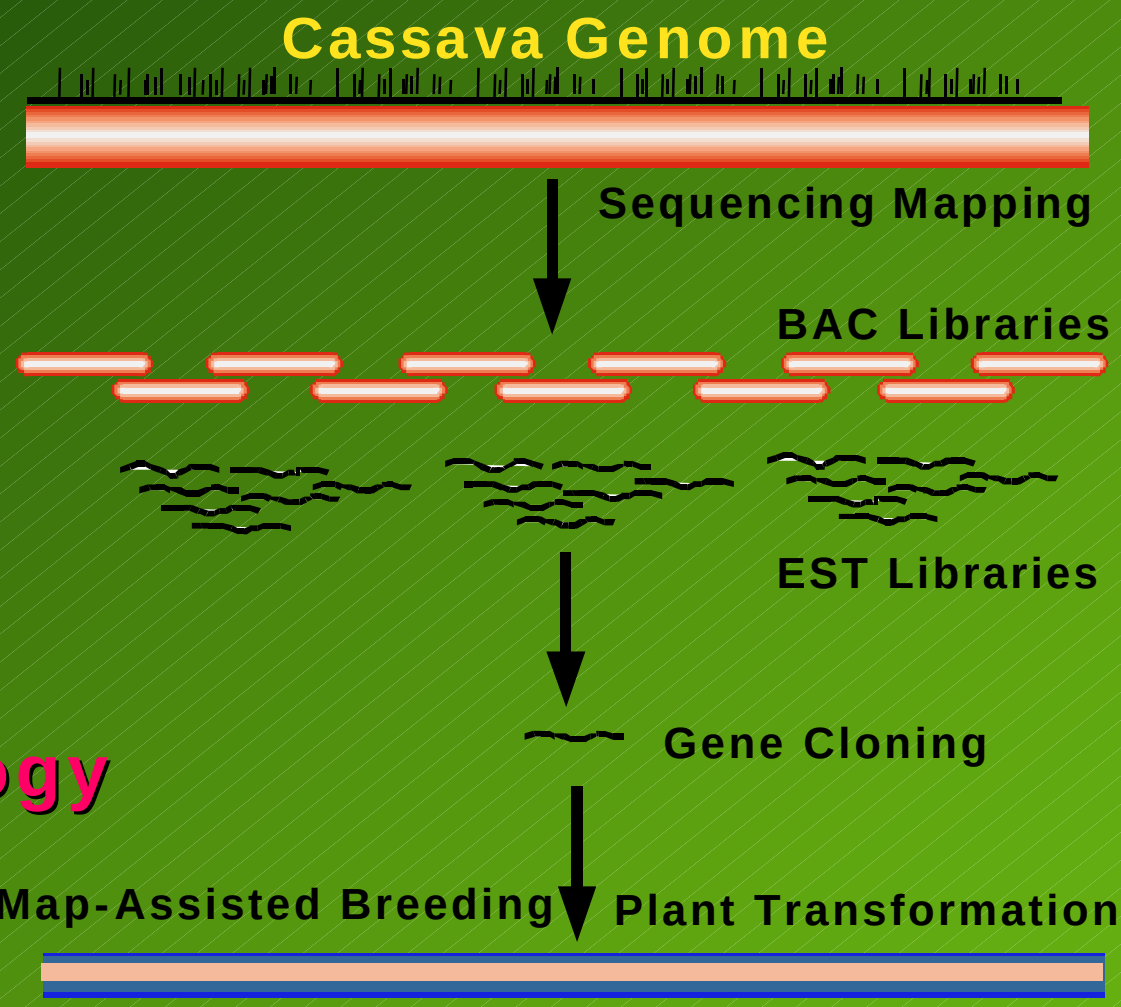
- Protein Content : 9%

# Cassava Biodiversity




**Wild cassava species are full of resistance genes that could be used in cultivated cassava through genetic engineering**

# Basic Concept of the Global Cassava Plan for Genetic Improvement




**Cut and Paste Technology**

**Land race, Improved Cassava Genotype**

## Global Cassava Partnership
### for Genetic Improvement

# 4 Biotechnological methods

**Double Haploids**

**Micro-propagation (sanitation)**

**High Density Mapping (Happy)**

**High efficiency genetic transformation**

## Global Cassava Partnership
### for Genetic Improvement

**Biotechnological method available**

**Micro-propagation (sanitation)**

**Low tech system available to propagate quickly virus free cassava genotypes to reach thousands of farmers**

# Biotechnological method not available

## Double Haploids in Cassava:

- Conventional breeding problematic in cassava due to strong heterozygosity and inbreeding depression

**Production of double haploids would:**

1. allow production of homozygotes
2. facilitate effective back crossing
3. reduce breeding cycle from 9 to 3 years
4. reduce genetic load (presence of undesirable alleles)

## Global Cassava Partnership
### for Genetic Improvement

**Biotechnological method not available**

# High Density Mapping (Happy)

**20,000 PCR based marker system (MRC Cambridge) using 5'-end BAC sequences producing a marker and physical map simultaneously - 1 year - $1.75M**

## Global Cassava Partnership
### for Genetic Improvement

**Biotechnological method partially available**

**High efficiency genetic transformation**

**To integrate any gene in any genotype appreciated by farmers or improved by breeders**

# GCP Biosafety issues

- Benefiting from other cases like:
  - Virus resistance for potatoes
  - Protein profiling modifications
- Generating and sharing specific biosafety and risk assessment information for cassava

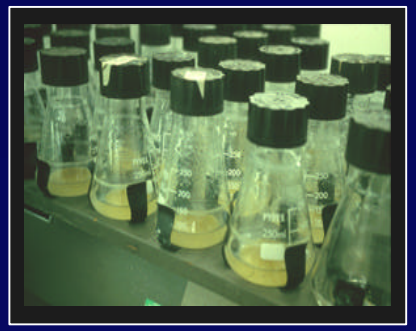
# IPR and GCP

- AATF
  - Clearing house for IPR in Africa
- Danforth Center is taking initiatives
  - Retaining licensing rights for LDCs
  - Inviting Ag Companies to donate technologies to cassava

# Genetic Transformation in Cassava

Cassava cultivar for improvement

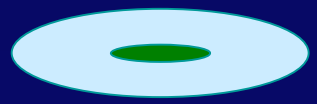
Production of embryogenic target tissues



Molecular biologists identify and isolate gene(s) of interest

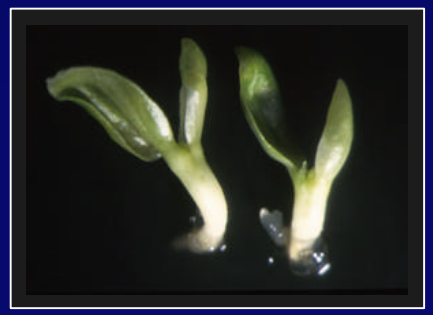
GENE TRANSFER

Plant tissue



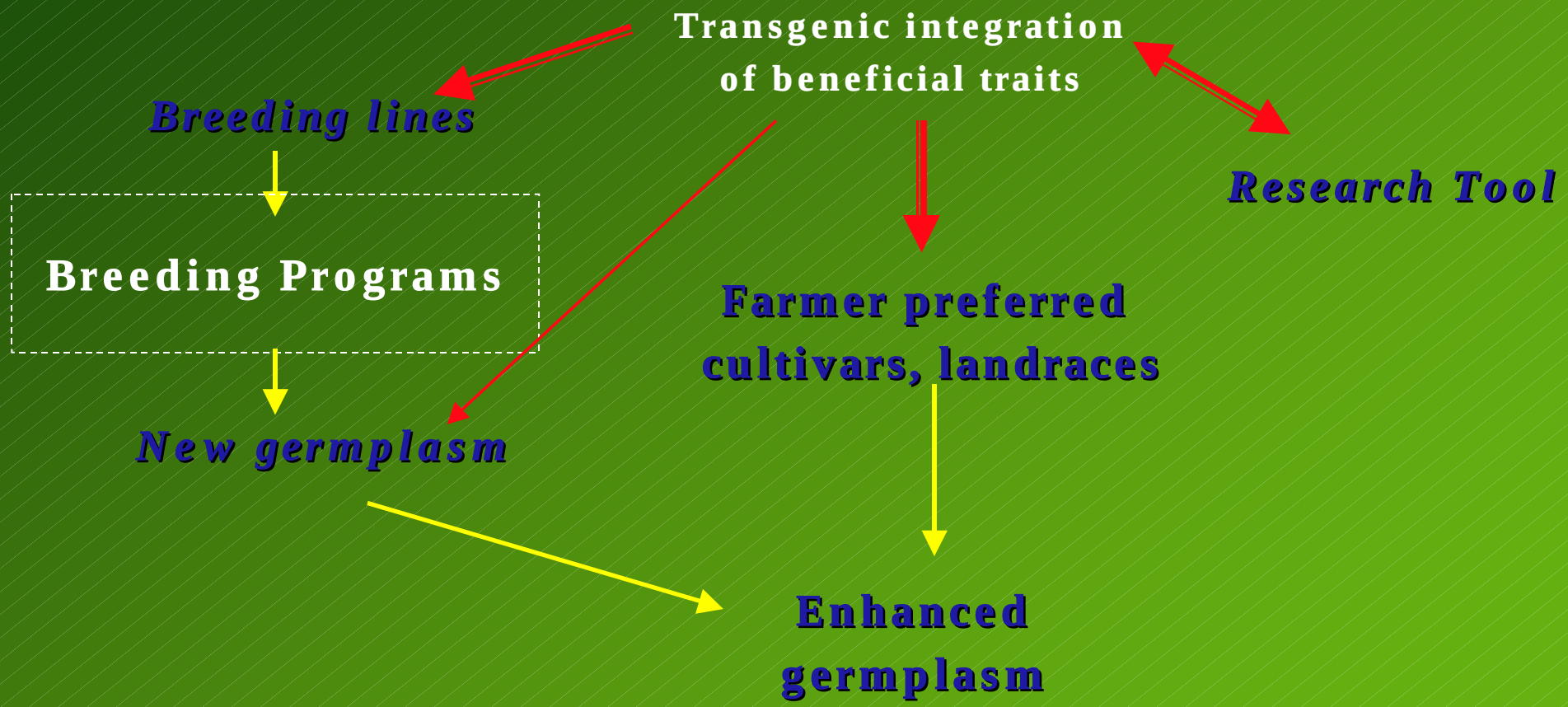
Gene insertion by particle bombardment or *Agrobacterium*

Selection of transgenic tissues



Regeneration of genetically Transformed plants

# Routes by Which Transgenics Can Generate Enhanced Planting Material



# Transgenic Systems Central to Exploiting the Benefits of Cassava Biotechnology

Traits from wild relatives

Genes from plant genomic programs

Novel traits from non-plant origins

Genes from cassava genomic programs

Transgenic Systems

Marker assisted breeding

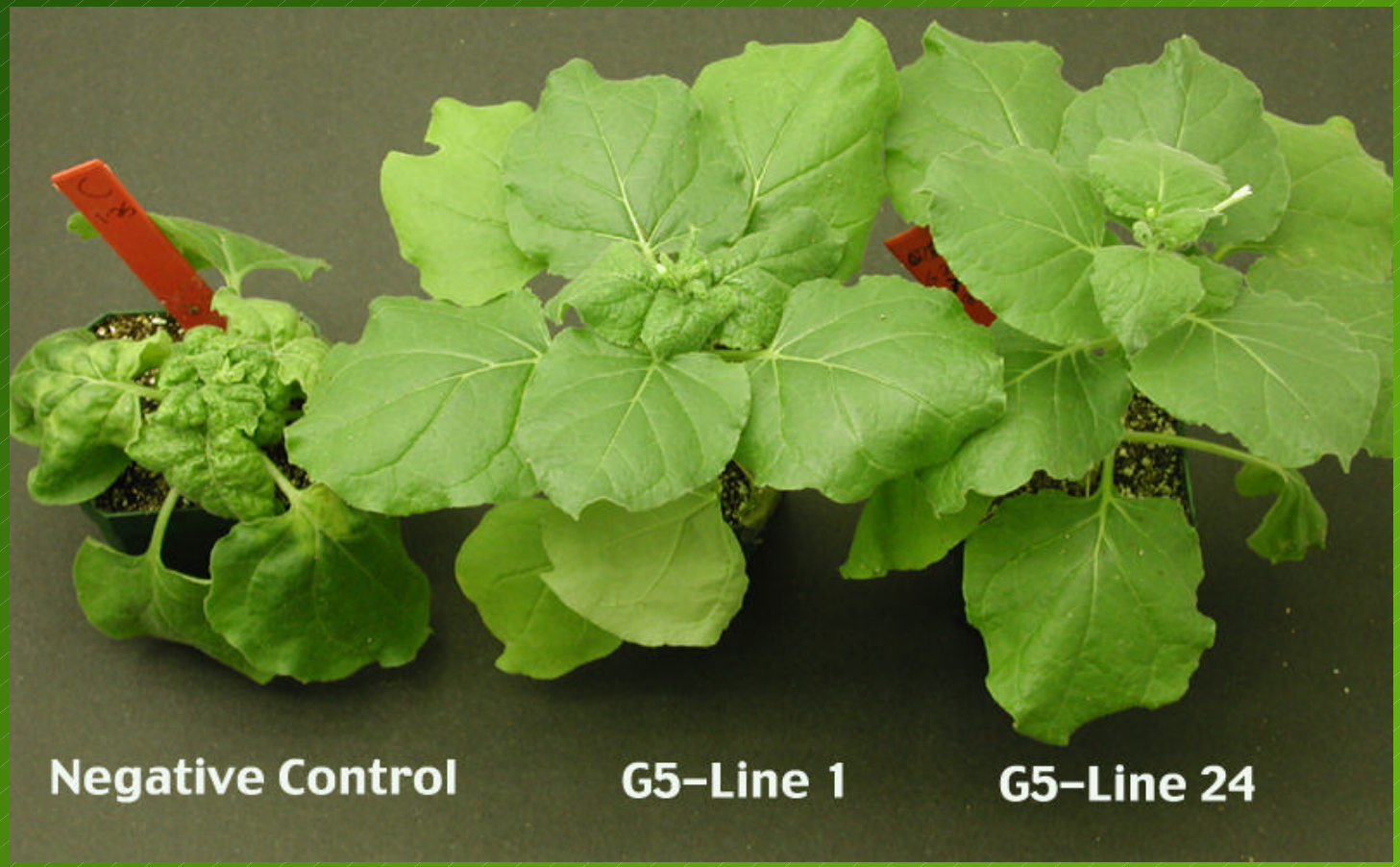
Transgenic Cassava Plants
ILTAB

# A Virus Derived Control Strategy

**Highly resistant plants against ACMV, EACMV and SLCMV, or to the mixture ACMV+EACMV**

# ILTAB

**Engineer broad protection against cassava viruses like ACMV, EACMV-UG, EACMV-CM, EACMV-MW, SACMV, ICMV and SLCMV**



# Capacity Building

- **Training**
  - Science
  - Management
  - IPR
  - Biosafety
- **Facilities**
- **Regulations**
- **Communications**
- **Collaborations**

# Transfer of Technology

- **Focus on a few countries**
  - Ghana, Nigeria, Uganda
  - India, Indonesia
- **Training in:**
  - **TC / transformation**
  - **Virology**
  - **Field testing**
- **Transfer to other cassava cvs**
- **<u>Continuous</u> collaboration with these teams**

# Challenging of Cassava Plants

# National Team in Ghana

## Tissue Culture Facilities Need Improvement and Efficiency

Good Team in Tissue Culture and
Field Experiments

# Excellent Extension Services to reach 400,000 farmers in 3 years

A lot of consumers!