Soybean breeding in Africa

H. Agrama

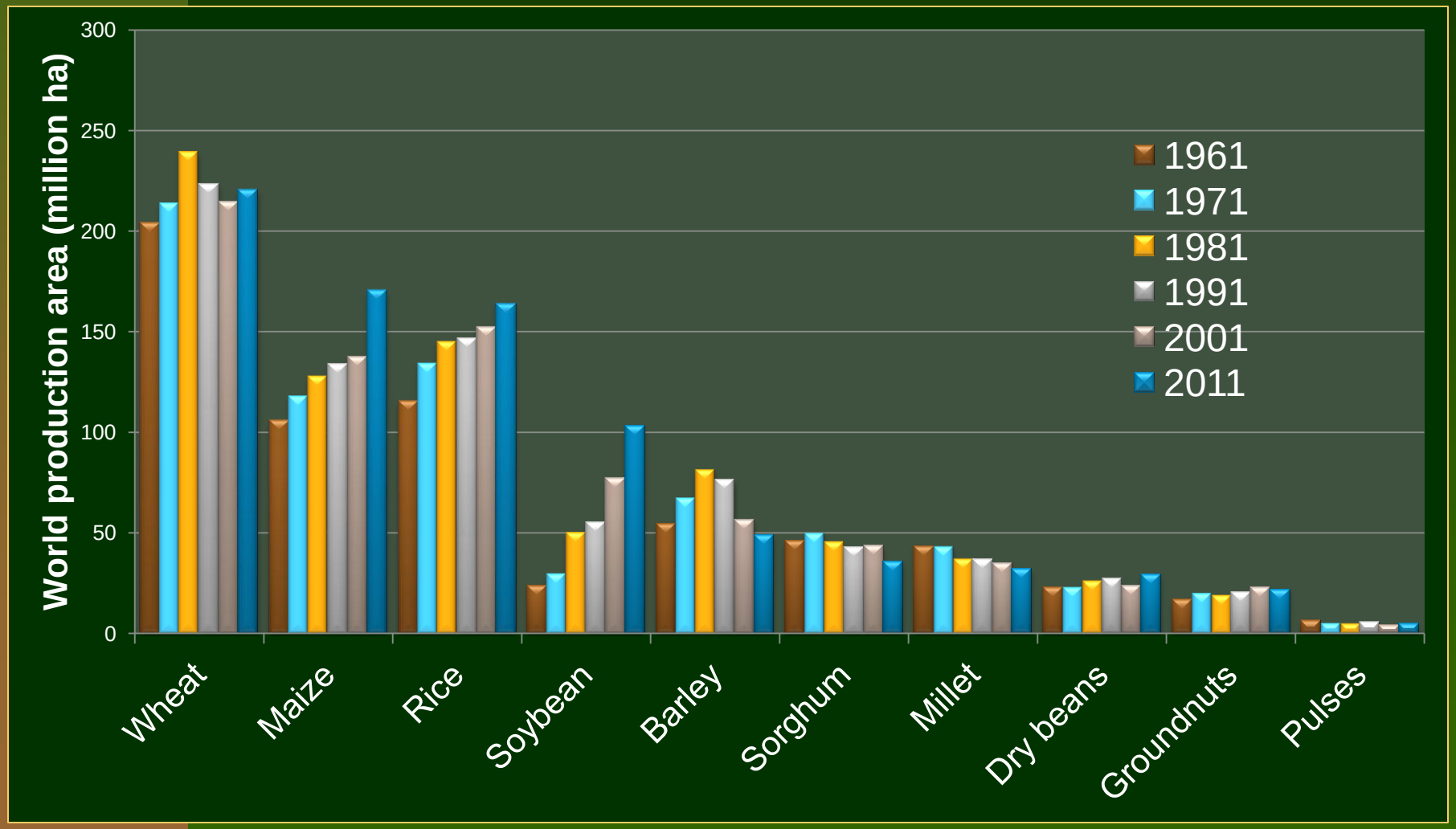
Soybean Breeder

International Institute of Tropical Agriculture (IITA)

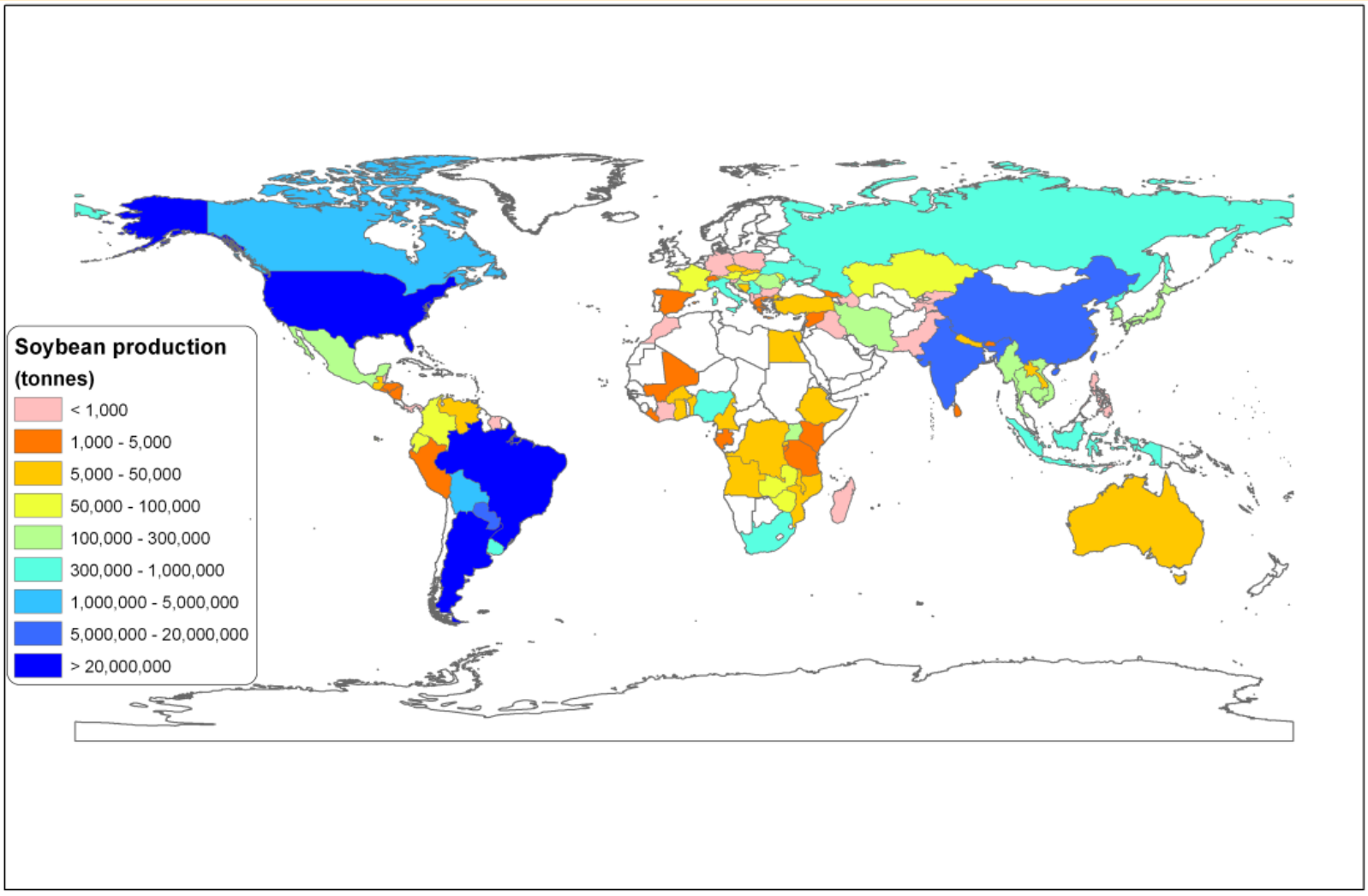
Soybean in Africa

- Improve human nutrition
- Major animal feed source
- Improve soil fertility
- Increase farmers income

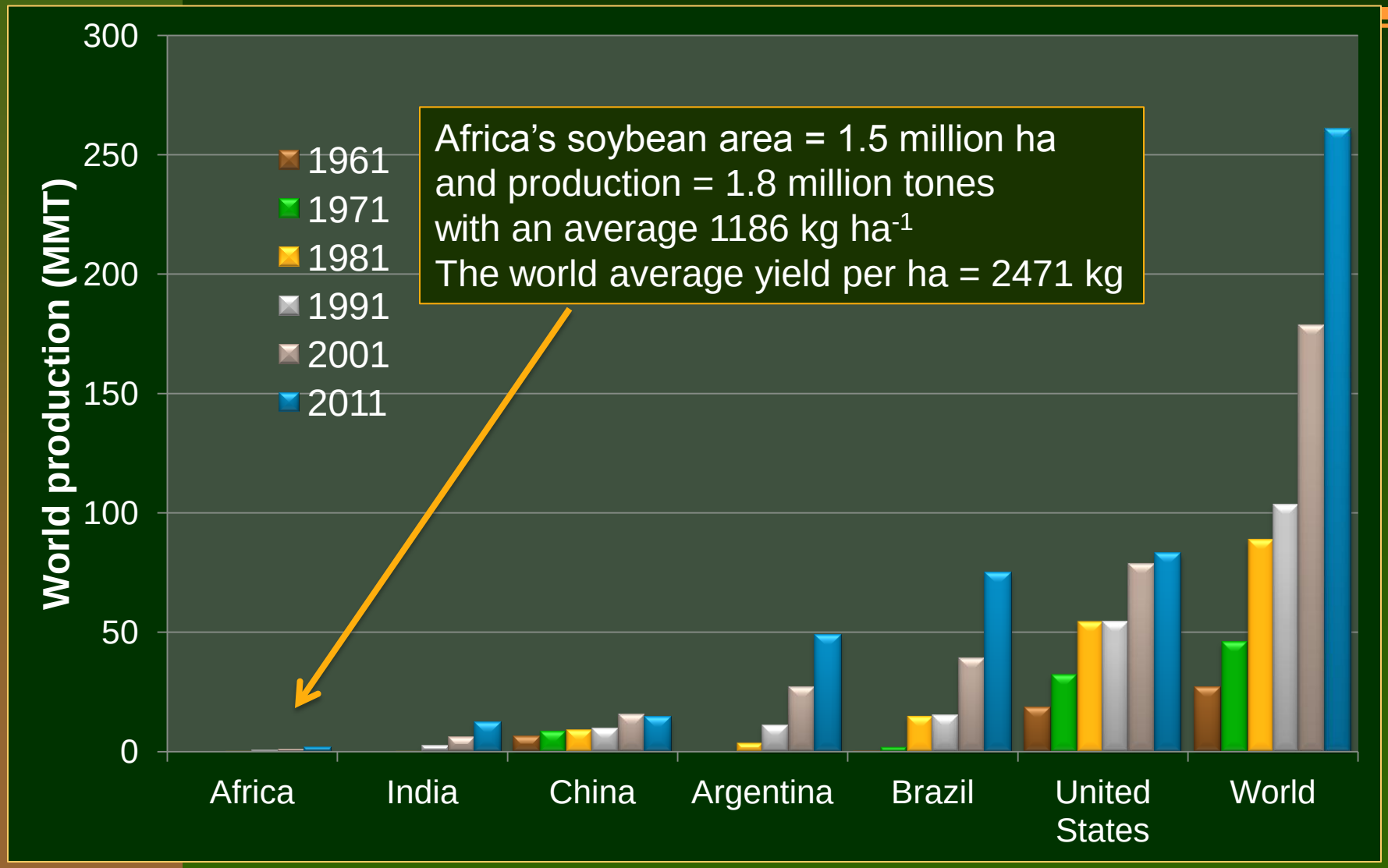
Production area of the major field crops in hectares (ha)



World soybean production



World soybean production



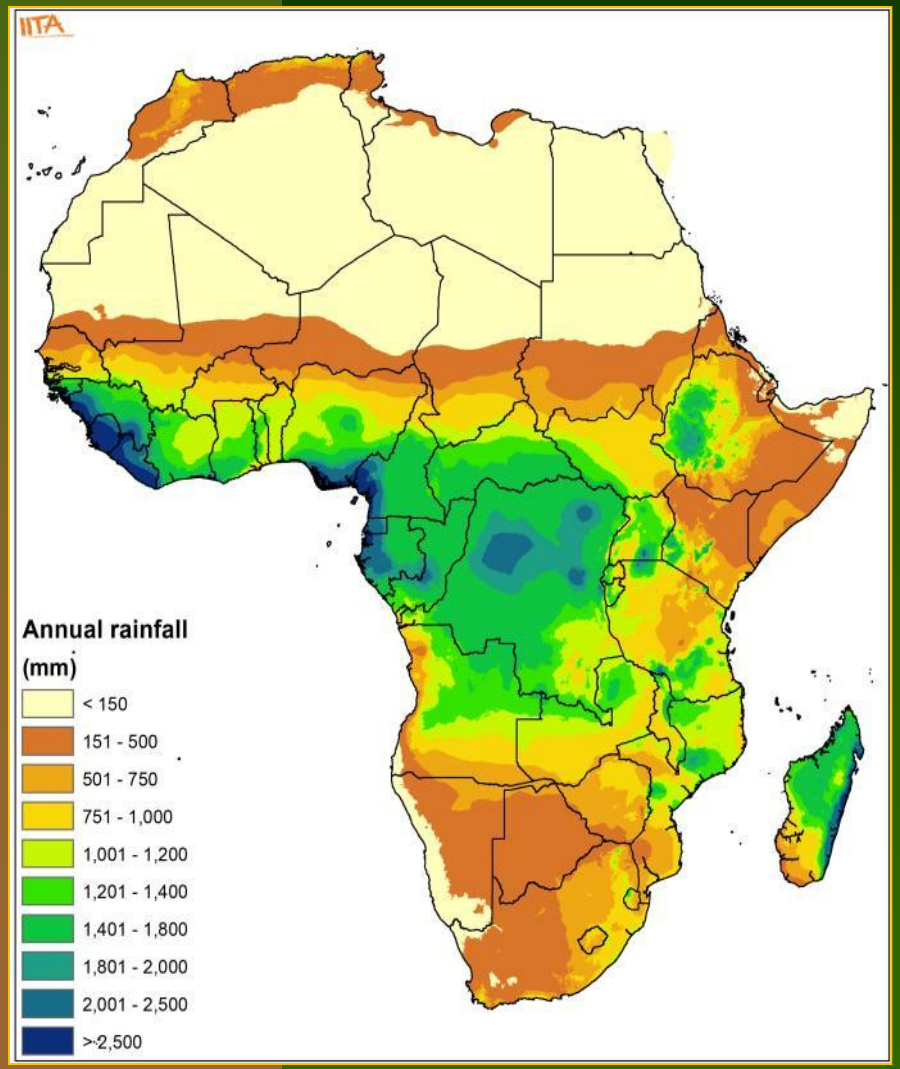
Why soybean were considered by IITA

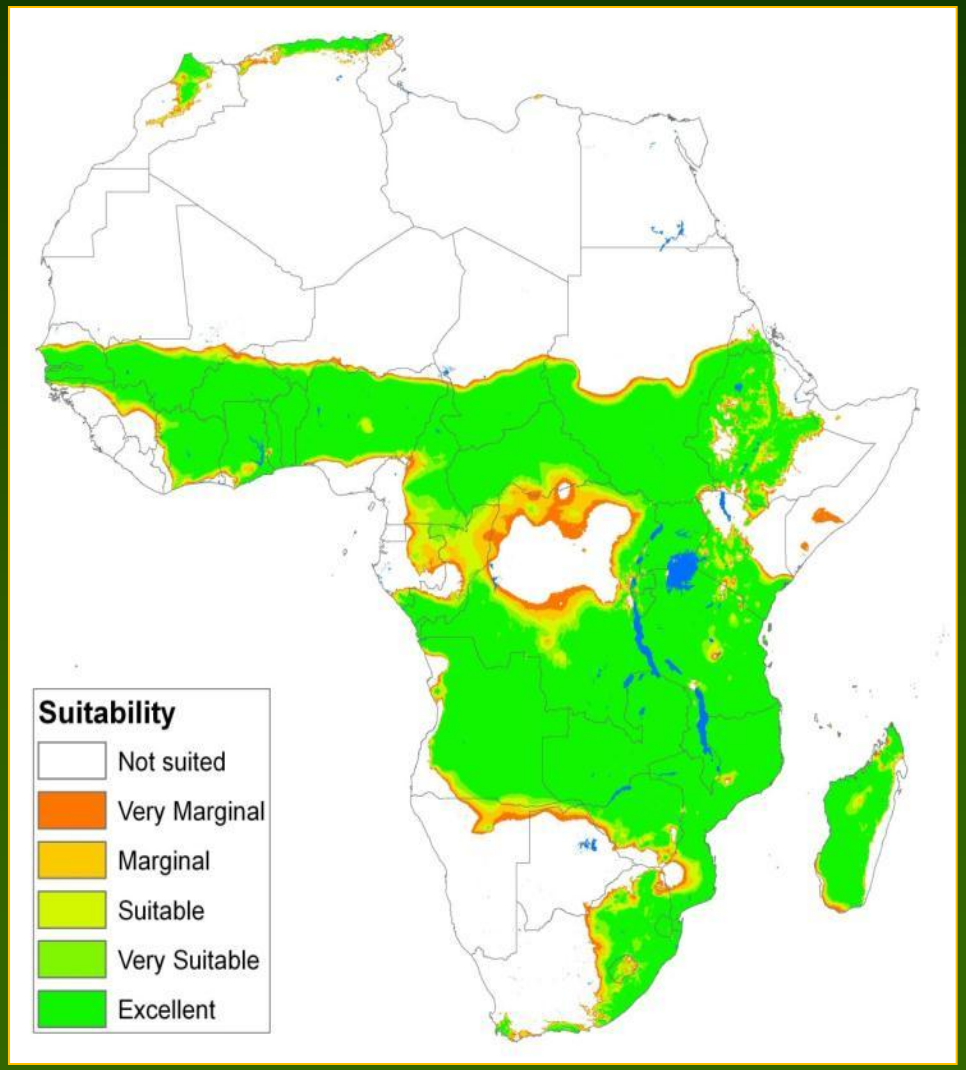
- Little effort in improving soybean in Africa
- Yield was extremely low
- Low seed viability
- Poor nodulation with native *Rhizobium*
- High shattering in the moist and dry savanna

Some characteristics of soybean breeding locations in sub-Saharan Africa

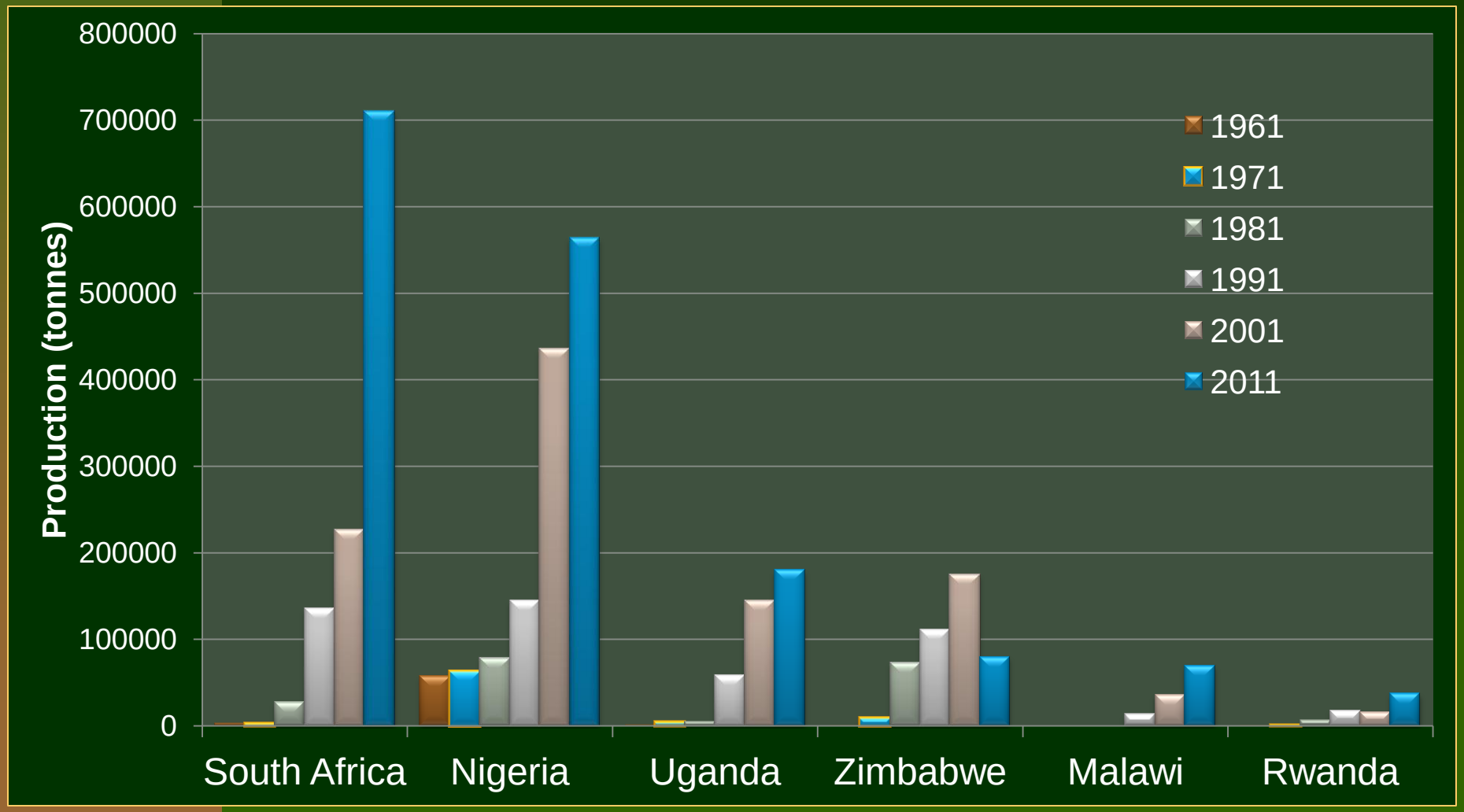
Location	Coordinates	Elevation (masl)	Rainfall long-term average (mm)	Vegetation
Mokwa, Nigeria	6°5'N, 9°48'E	308	1100	Southern Guinea savanna
Zaria, Nigeria	11°11'N, 7°38'E	685	900	Northern Guinea savanna
Kano, Nigeria	12°47N, 9°2E	700	600	Sudan savanna
Chitedze, Malawi	15° 55' S, 35° 04' E	1146	892	Plateau

Suitable Areas for Soybean Production in Africa

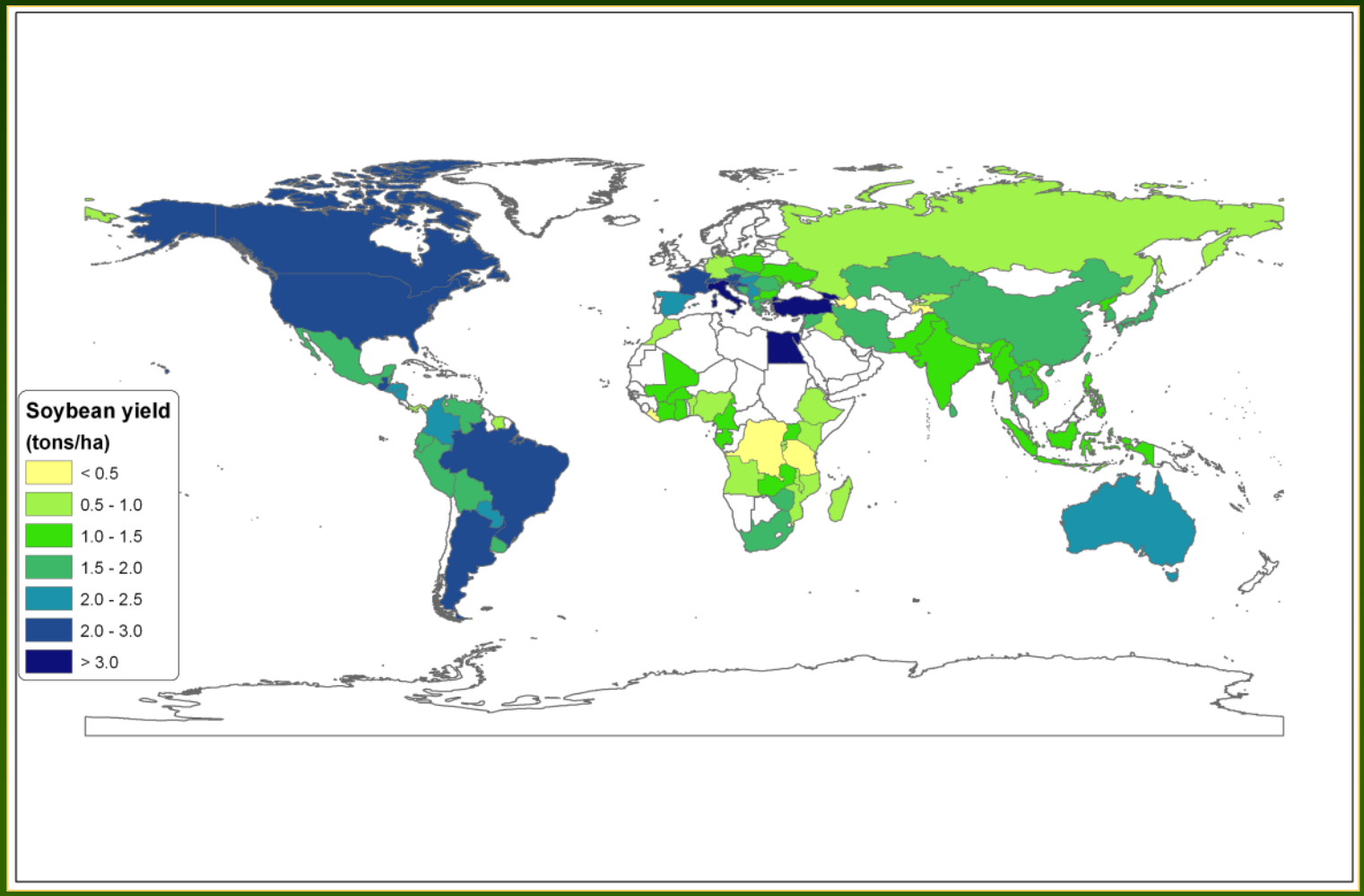




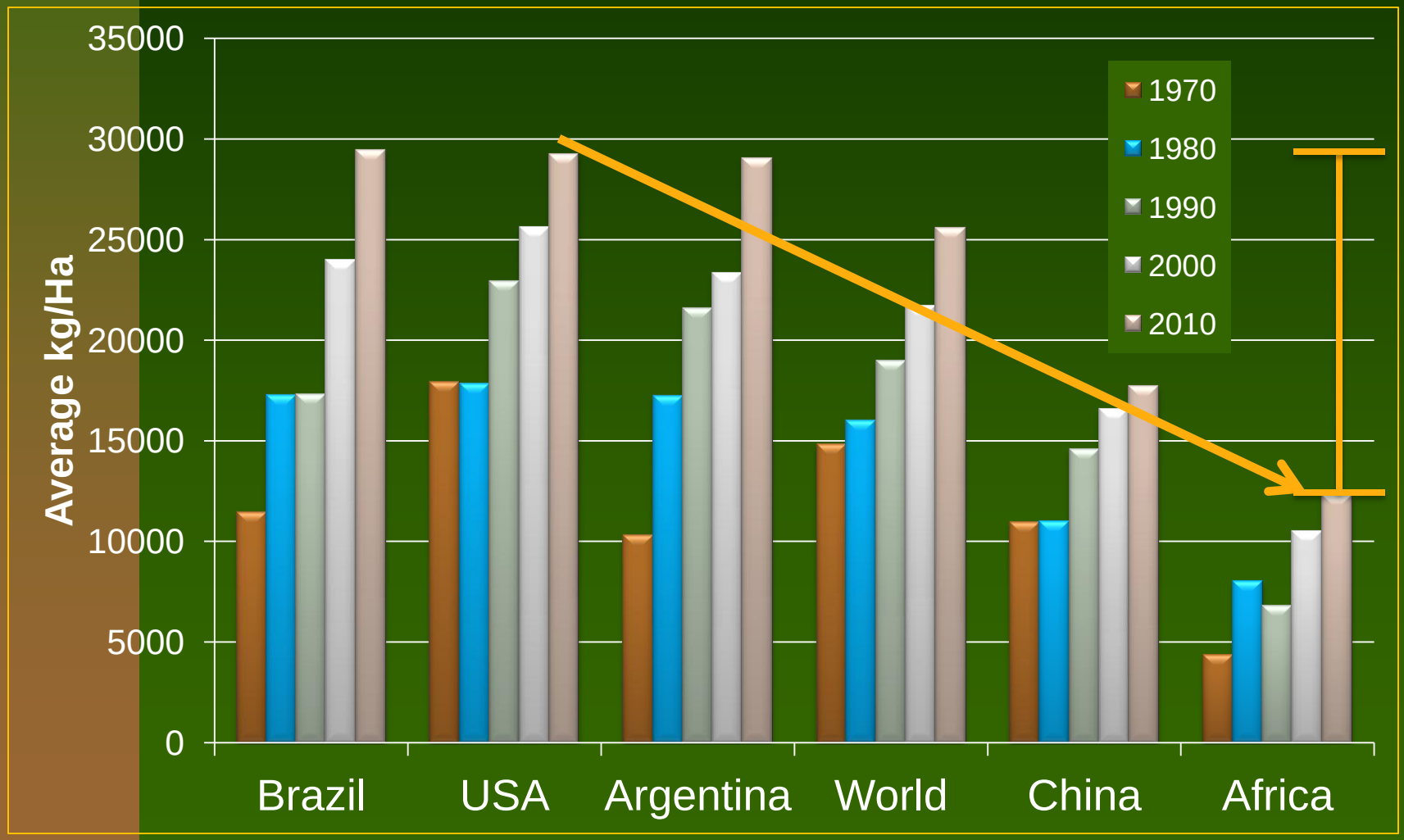
Trend of soybean production in major countries in Africa



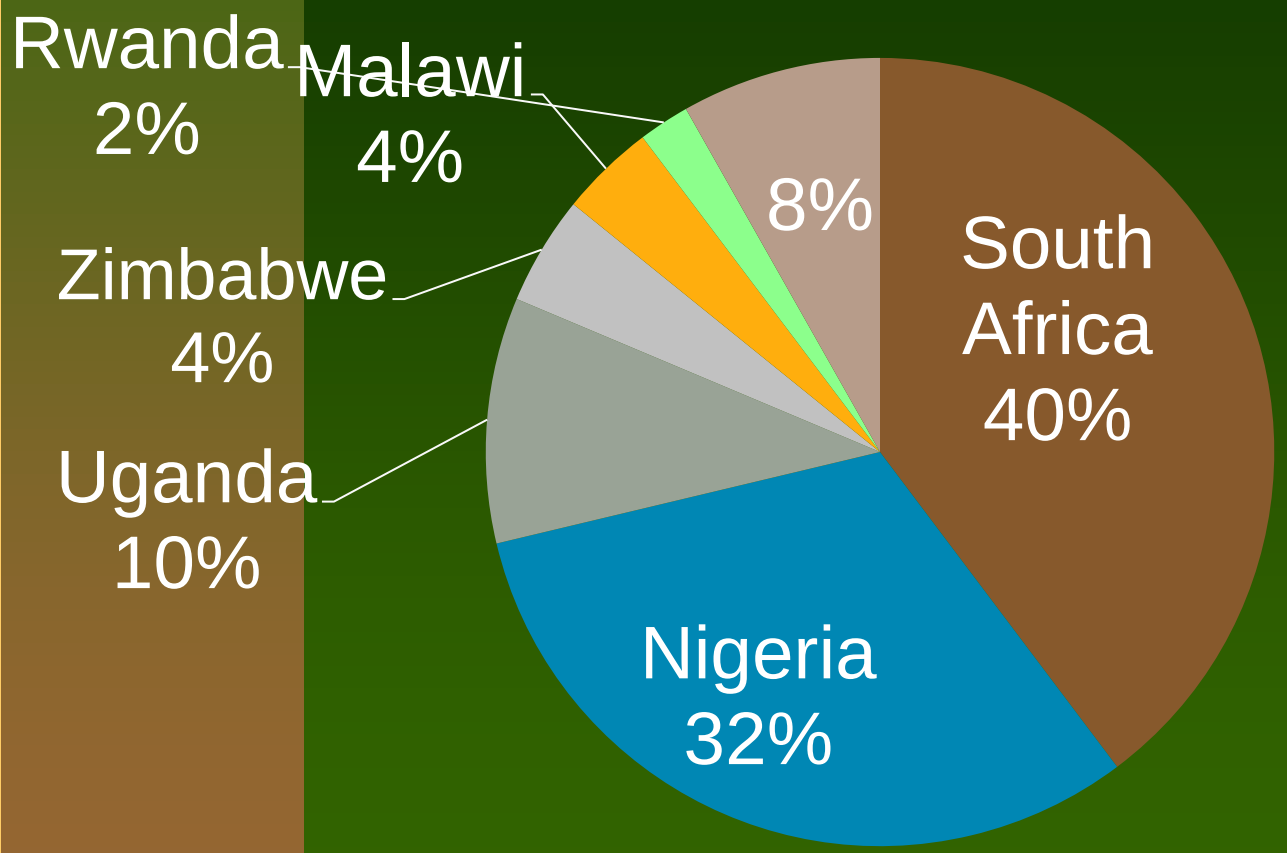
World soybean yield



World soybean yield



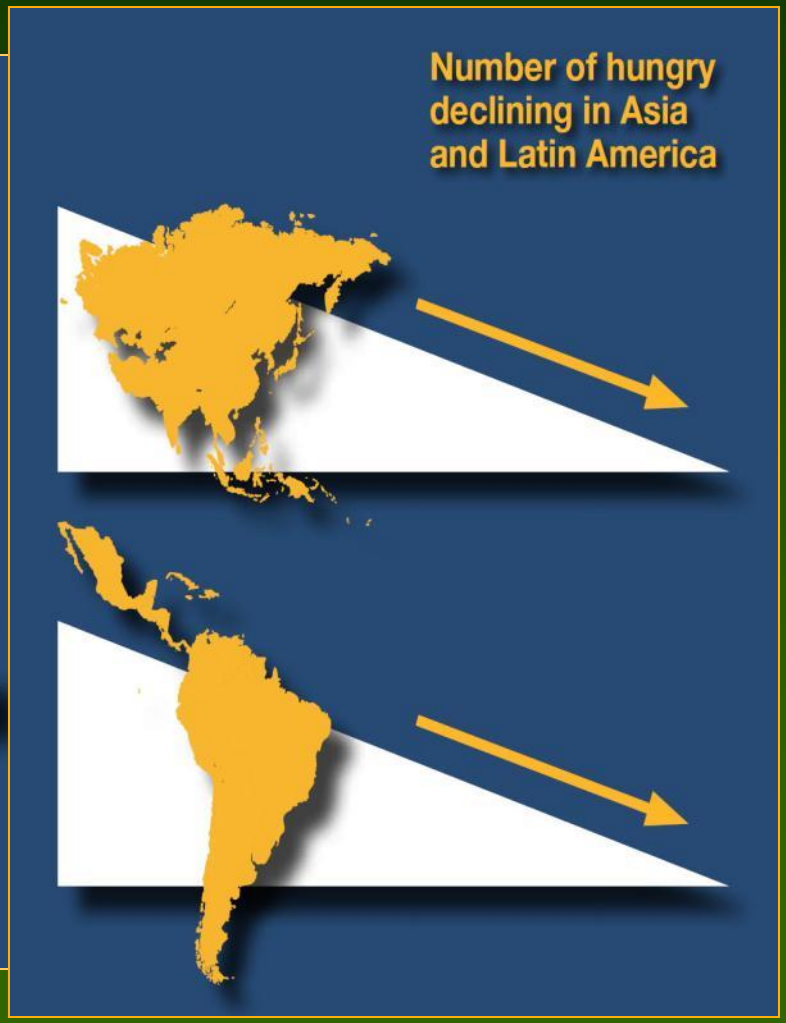
Soybean production in Africa, 2011



Country	Yield (kg ha^{-1})
South Africa	1578
Zimbabwe	1574
Uganda	1202
Nigeria	946
Malawi	700
Rwanda	632

1,787,270 tones

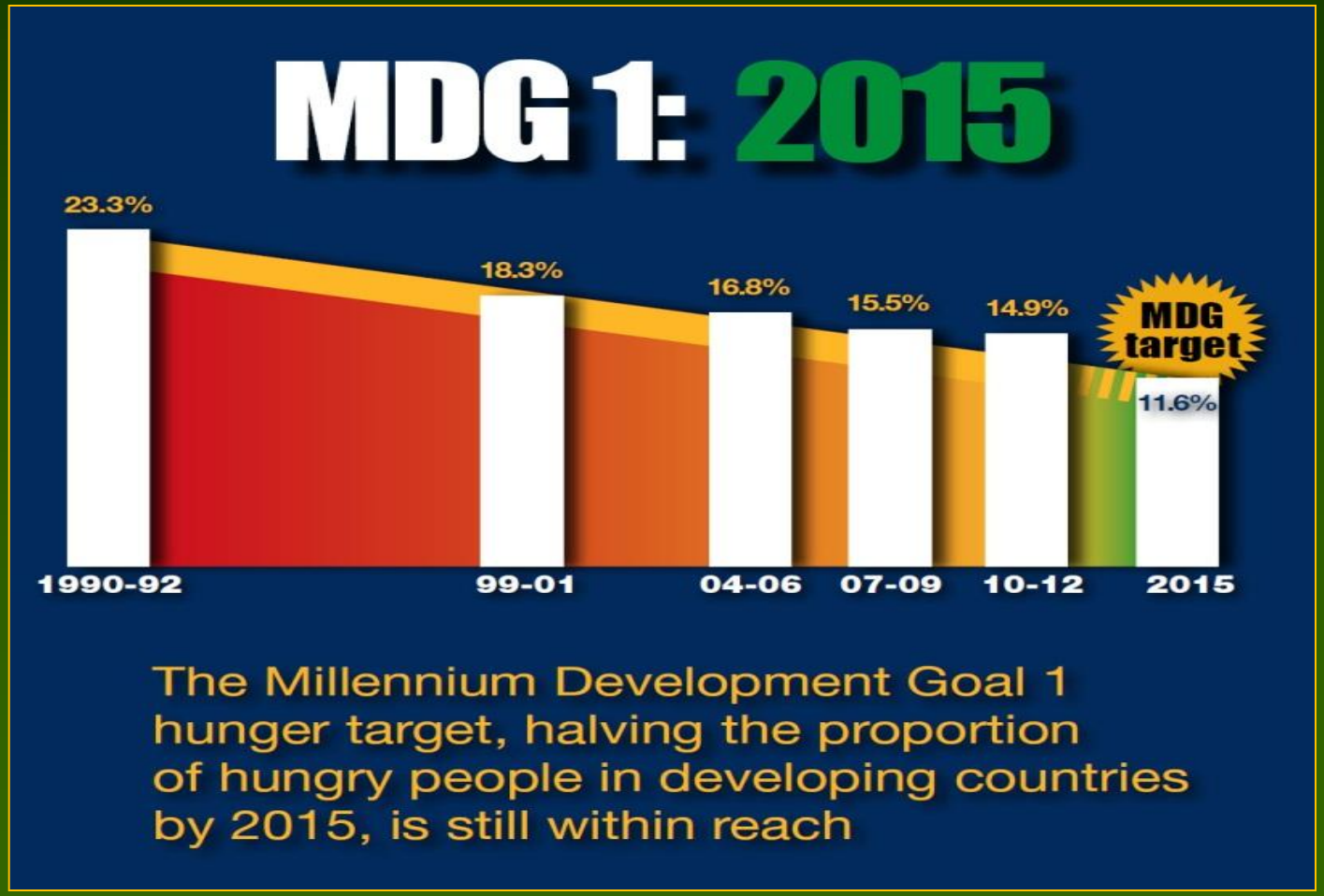
The State of Food Insecurity in the World 2012



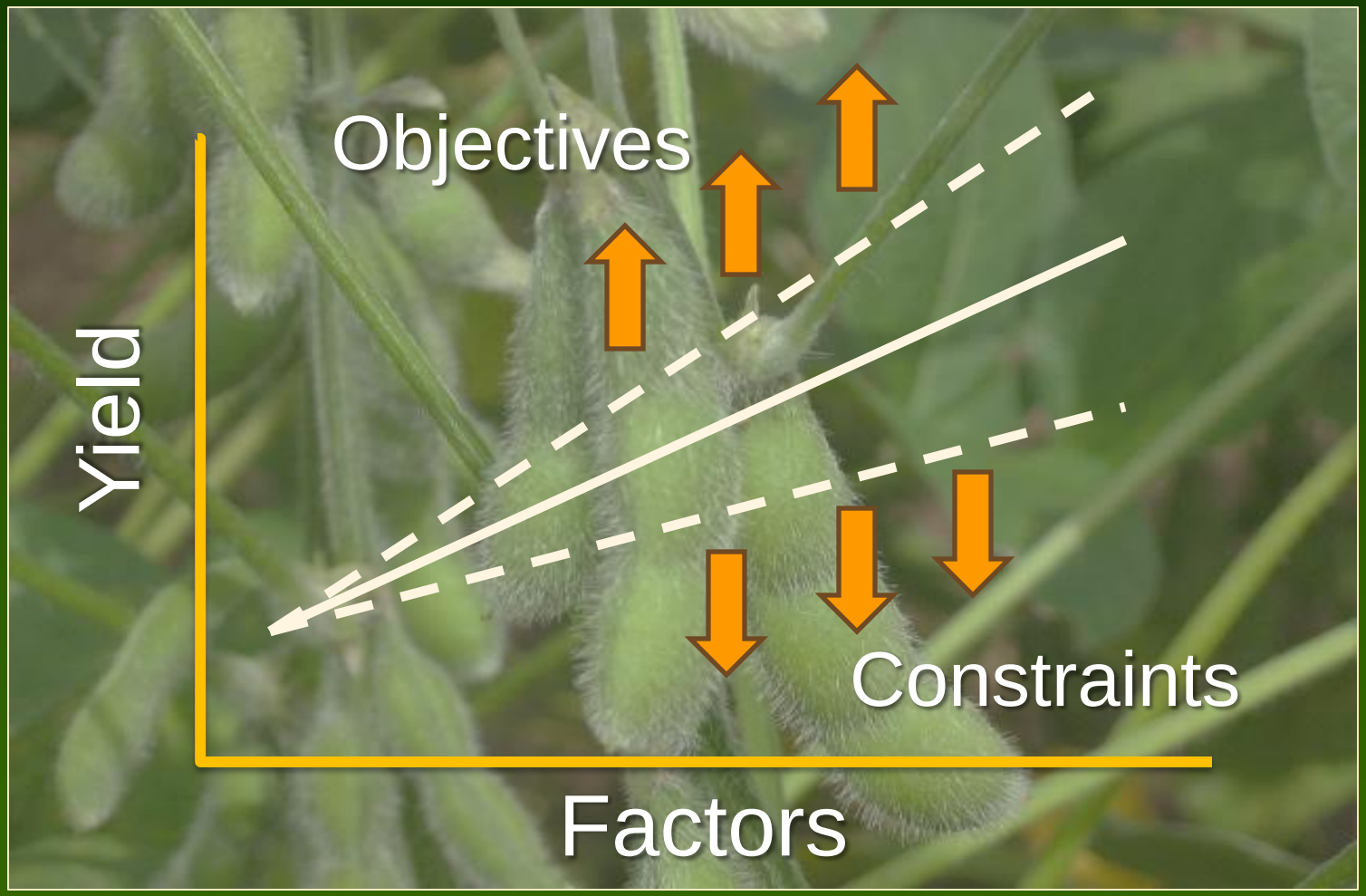
FAO infographic SOFI 2012-en

Number of hungry people, sub-Saharan Africa

Millennium Development Goal 1



Soybean yield improvement



Production constraints

- Lack of high yielding varieties tolerant to droughts
- Lack of varieties tolerant to diseases such as rust
- Lack of seed production and distribution systems
- Lack of organized market
- Lack of processing knowledge for home consumption

Objectives of program

- Breed for high grain and fodder yield
- Breed for early maturity
- Breed for disease/pest, shattering, lodging and drought tolerance
- Breed for promiscuity in nodulation
- Breed for good human consumption quality

How: Proposed Activities

The main goal of is to enhance the productivity of soybean in the farmers' fields in target countries of SSA and demonstrate its processing for small-scale households and link them to markets

This will be achieved through two general objectives:

- Develop improved soybean varieties, and
- Promote soybean processing and utilization at the household and community level and link them to soybean supply chain

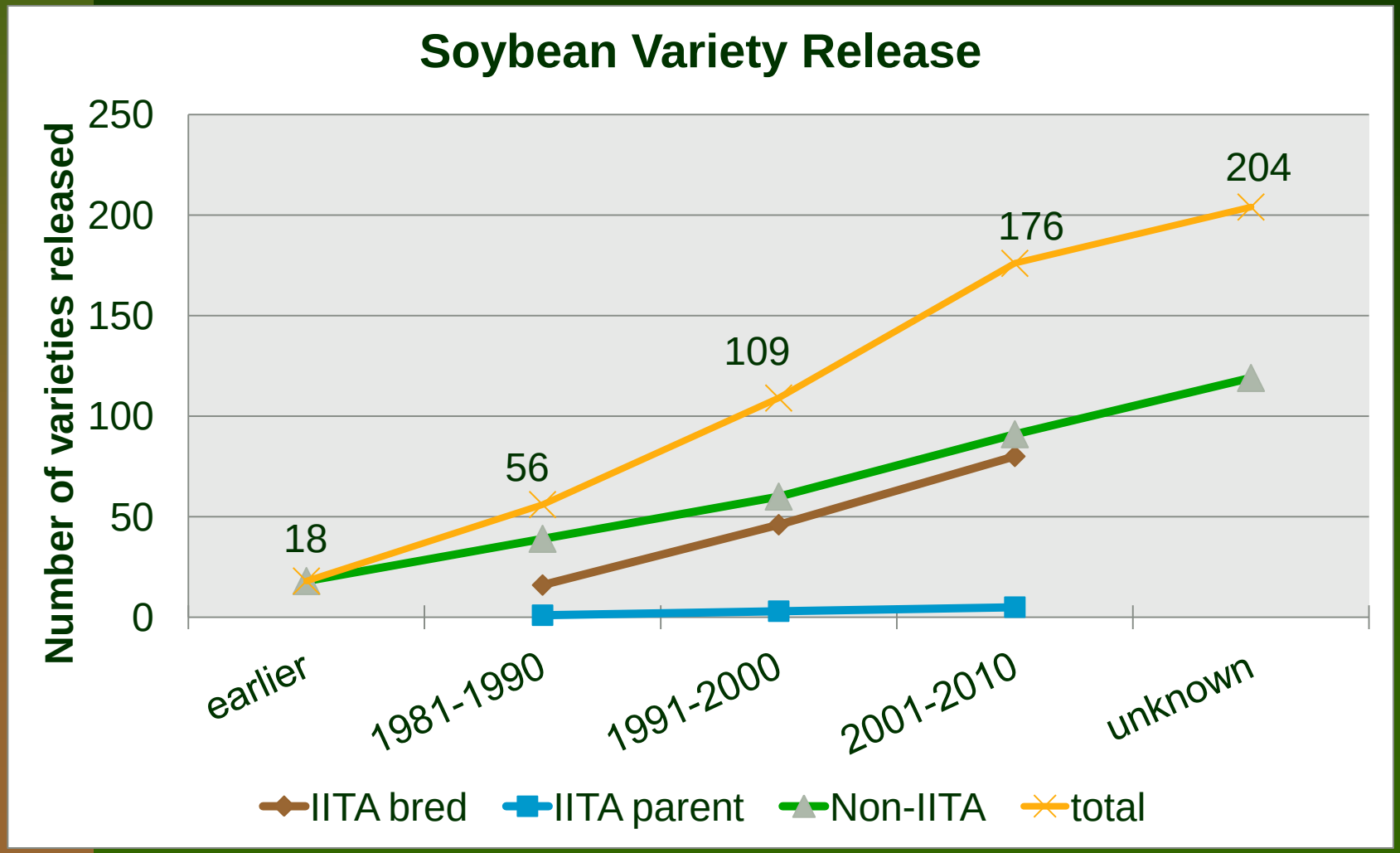
Breeding approach

Concentrate various traits into superior and adapted varieties

Crosses

Selection (on-station & on-farm)

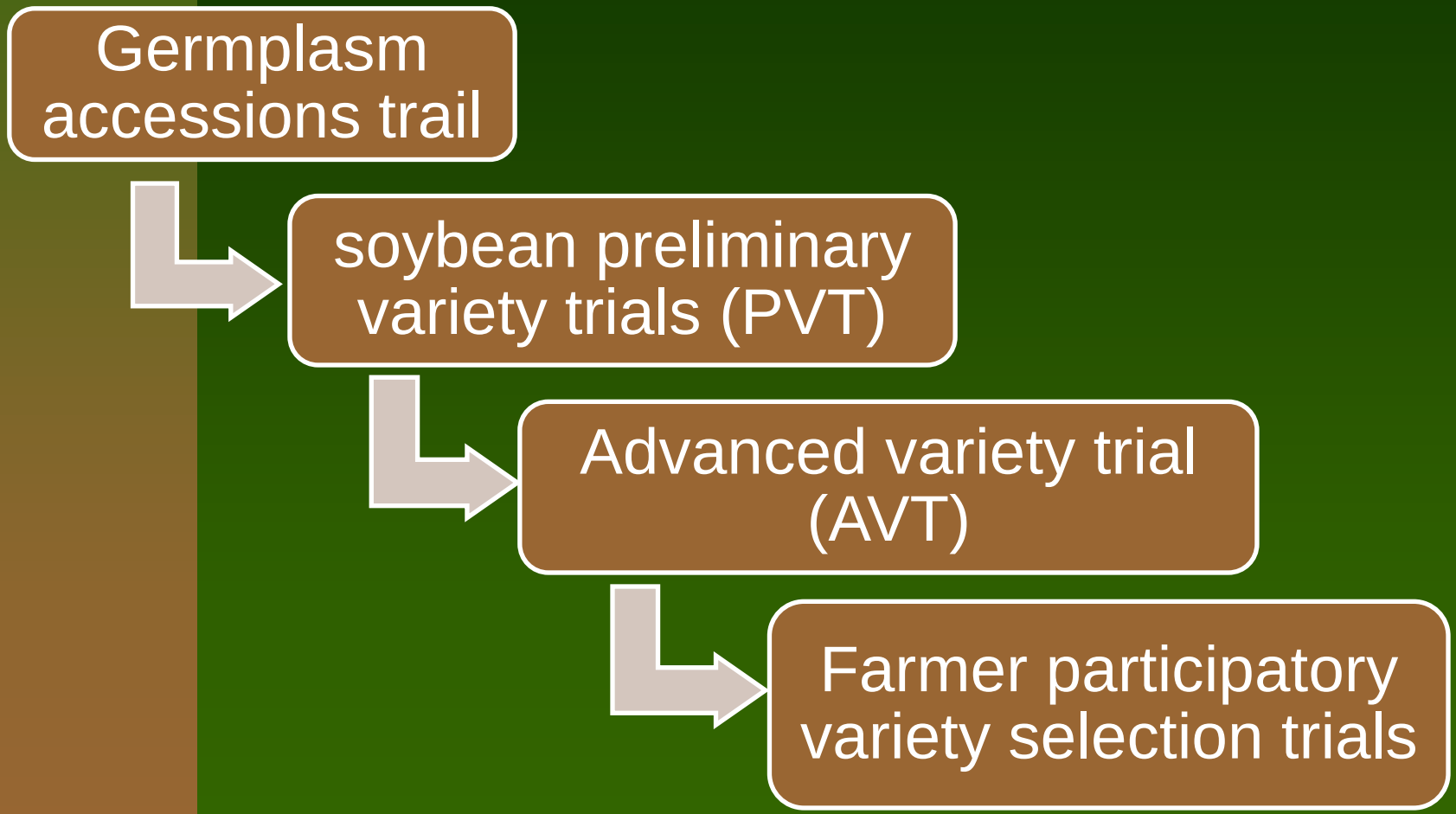
Soybean varieties released in Africa



Development of soybean varieties/ lines tolerant to drought and soybean rust with enhanced BNF

Variety	Country/Year	Traits Improved
TGx 1835-10E	Nigeria (2008)	Rust resistance
Nyala, Hill, Black Hawk, Gazelle, EAI 3600	Kenya (2009)	Grain yield, adaptation
TGx 1904-6F	Nigeria (2009)	Grain, biomass
TGx 1740-2F, TGx 1895-33F	Kenya (2010)	Yield, adaptation
TGx 1987-10F, TGx 1987-62F	Nigeria (2010)	Yield, rust
TGx 1740-2F *(Tikolore)*	Malawi (2011)	Yield, earliness
TGx 1740-2F, TGx 1908-8F, TGx 1904-6F, TGx 1937-1F, TGx 1485-1D	Mozambique (2012)	Grain and biomass yield, adaptation

Breeding for improved soybean to the benefit of African farmers



List of Trials in Malawi in 2011/12

- Advanced variety trial: Early set
- Preliminary variety trials: Sets 1, 2, 3, 4 & 5
- Farmer participatory variety selection trials
- Germplasm accessions trial (screening for rust resistance and promiscuity in nodulation)
- Segregating populations

Segregating Populations

- 24 parental lines (grain and biomass yields, earliness, rust tolerance, drought tolerance, seed quality, farmer's preference)
- F_2 generations from 24 crosses were grown in 2011/12
- F_3 generations from 38 families were grown in 2012
- F_4 generation from 20 crosses (669 single plants) in 2012
- F_5 generation from 20 crosses (536 families) in 2012
- F_6 generation from TGx 1987-14F x Nasoko (53 families) and Nasoko x TGx 1740-2F (91 families) in 2012

Germplasm accessions trail

Objectives

- Assess adaptation
- Select for resistance to soybean rust disease
- Select for promiscuity in nodulation
- Germplasm collection and their seed increase

Materials & Methods

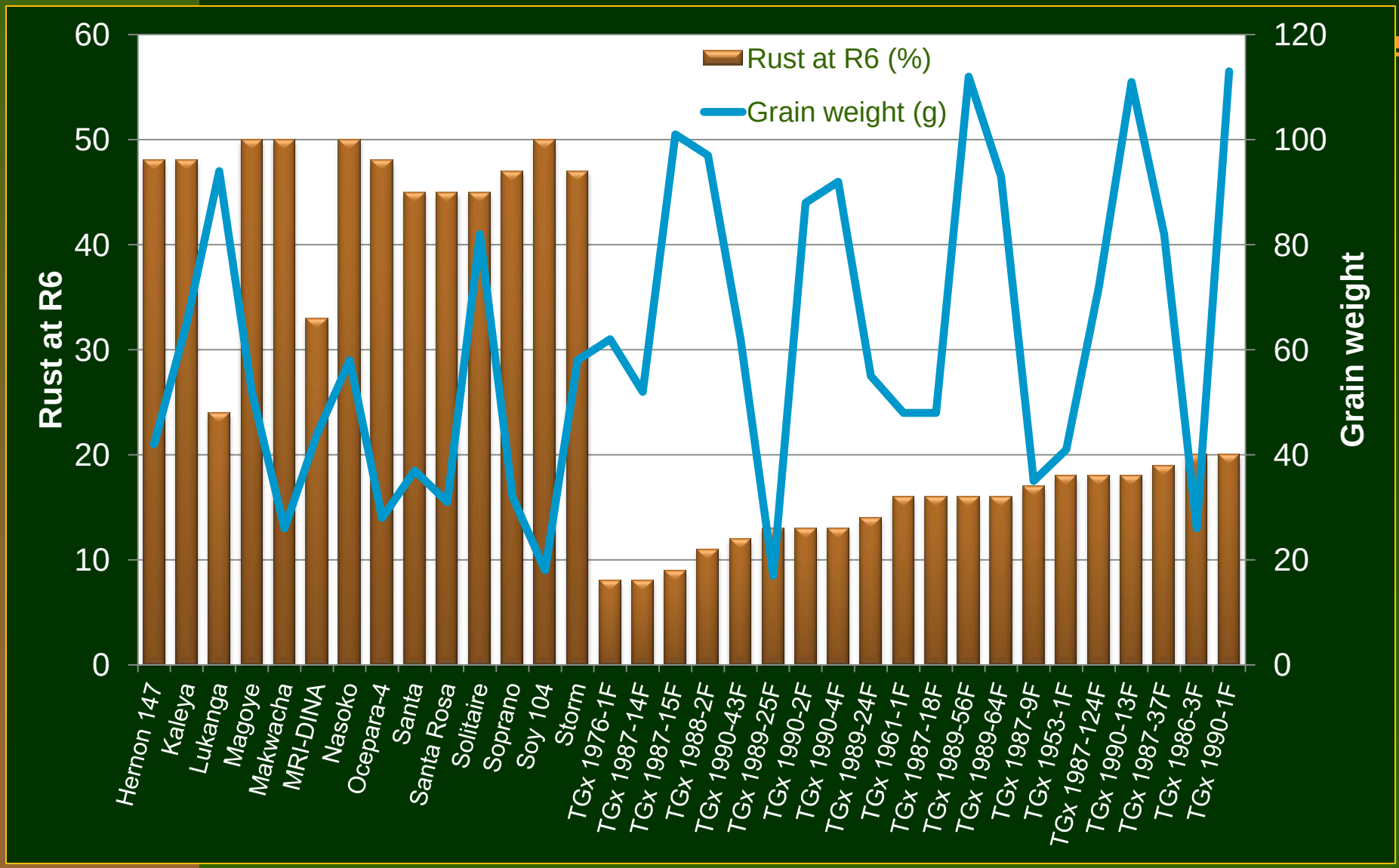
- 260 genotypes planted at Bvumbwe in 3 reps
- 2m single row plot size used
- Late planted on 14 January 2012 for rust exposure
- No seed inoculants (rhizobia) applied

Results

- Severe rust attack recorded on most of the genotypes
  - 11 TGx genotypes scored 35% and below
- Highly promiscuous genotypes were identified
  - TGx 1988-12F and TGx 1989-52F gave largest nodule dry weights of 456mg and 358mg per plant respectively

Germplasm accessions trail

Phakopsora pachyrhizi



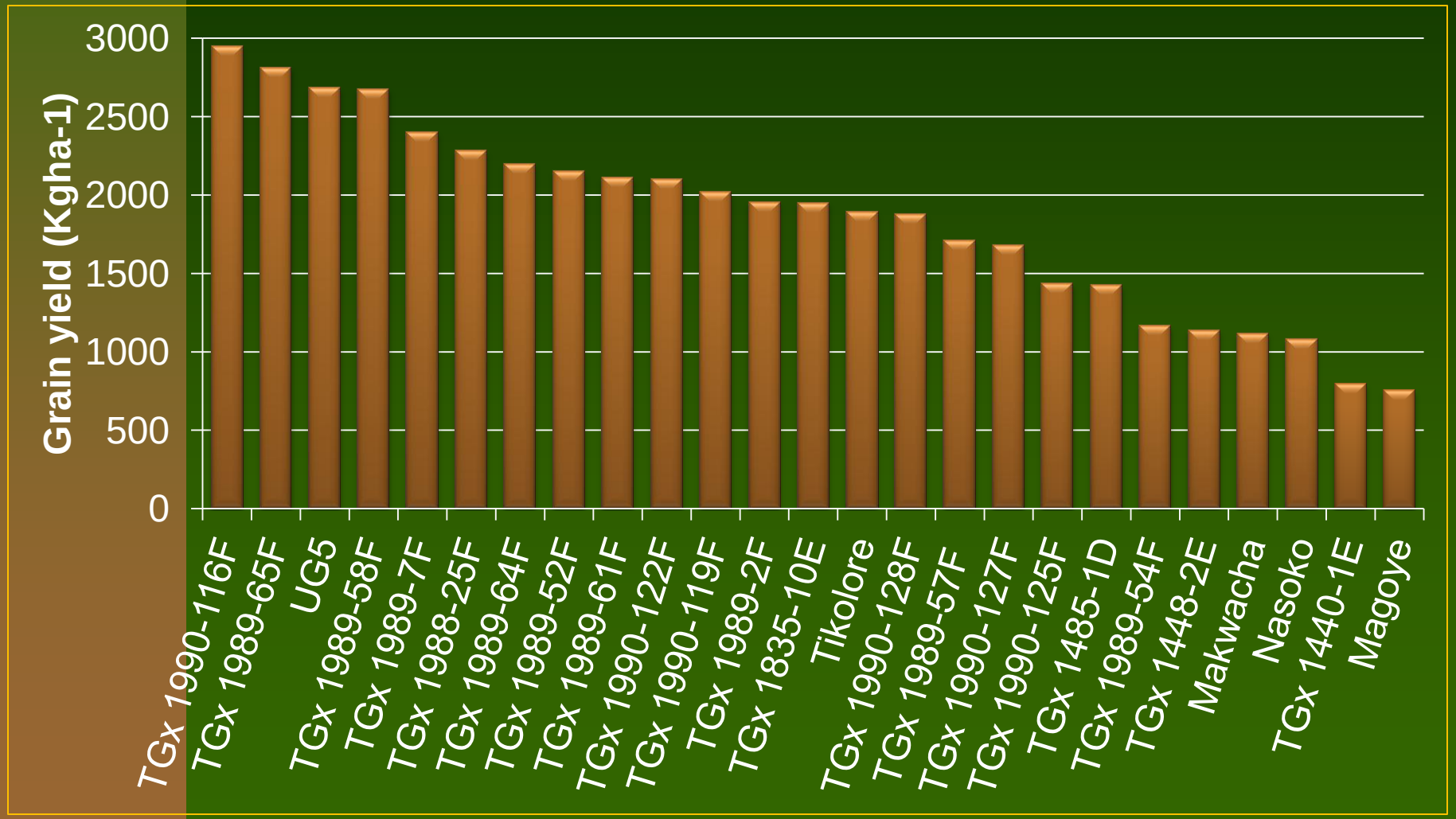
Preliminary Variety Trial (PVT)

- The objective was to assess the adaptability and yielding ability of the IITA developed soybean lines
- From nursery and IITA-Nigeria; and Chitedze and Chitala, Malawi

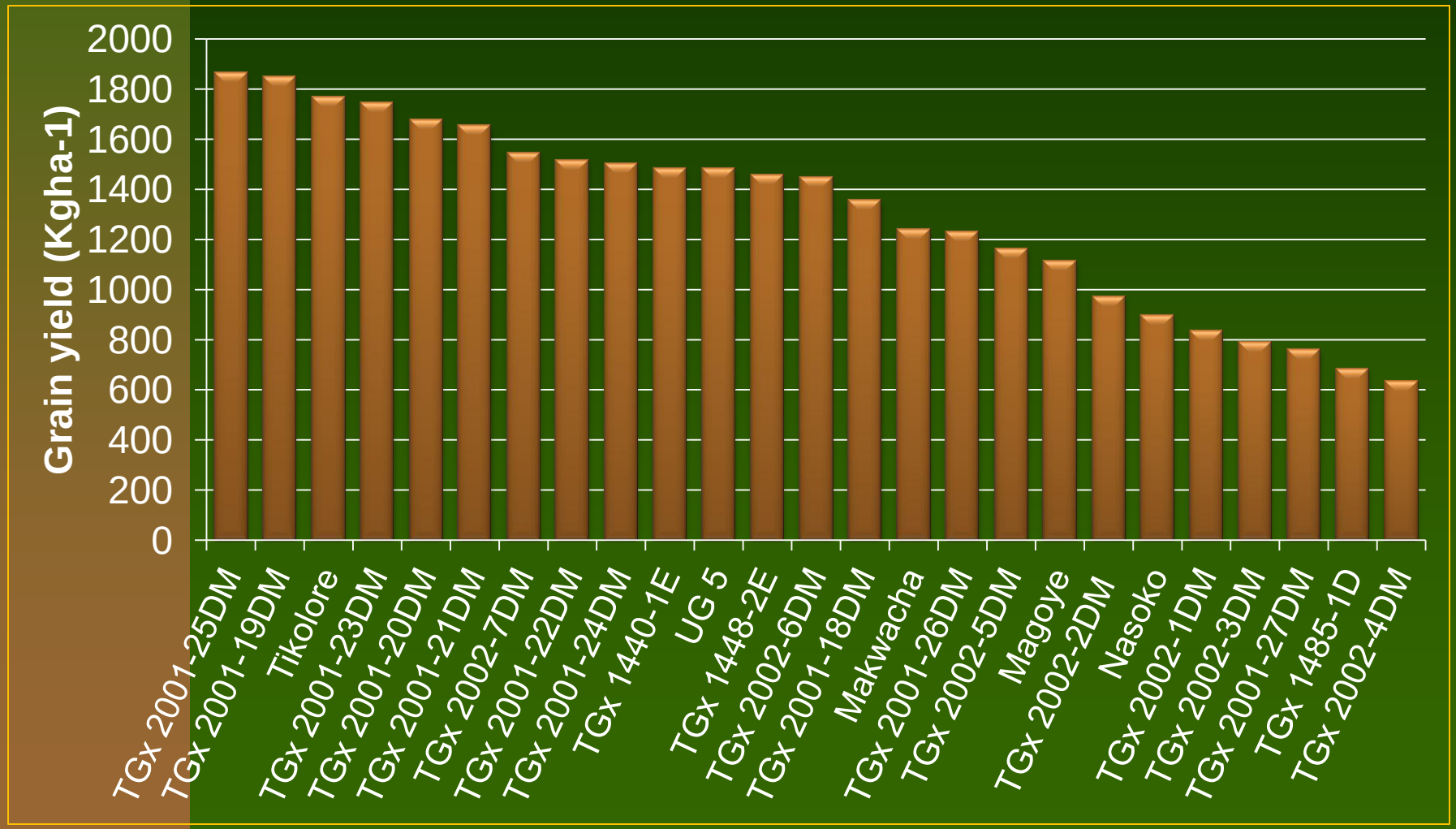
Preliminary Variety Trial (PVT)

- Three sets (sets 1, 2 and 4) of PVT comprising of 25 genotypes each were evaluated at Chitedze Research Station
- Eight recommended varieties; Nasoko, Makwacha, Magoye, UG5, TGx 1448-2E, TGx 1440-1E, TGx 1485-1D and Tikolore

Mean performance of 25 soybean genotypes tested in PVT set 1



Mean performance of 25 soybean genotypes tested in PVT set 3



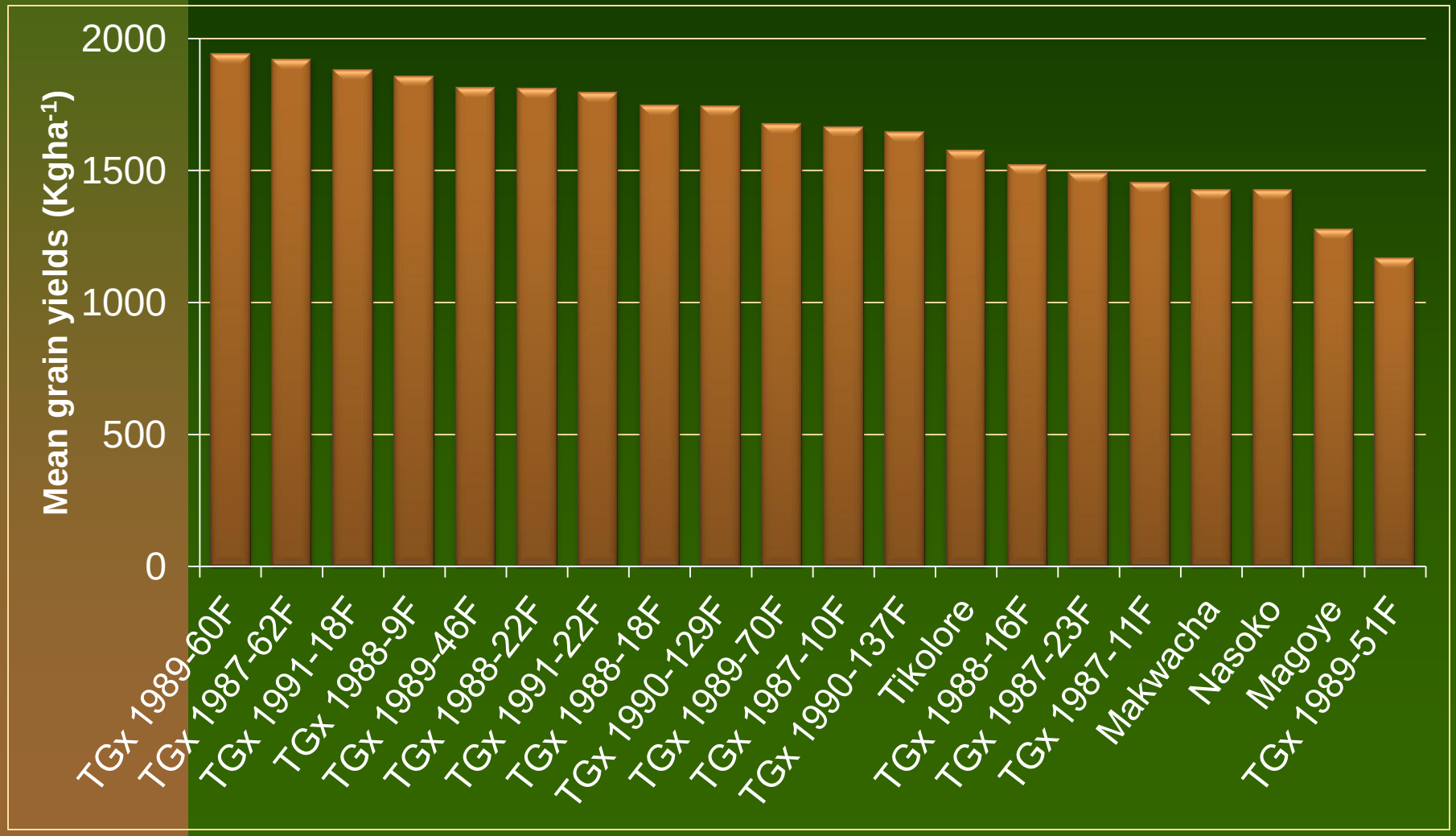
Advanced variety trials (AVT)

Objective

to compare the field and yield performance of introduced IITA varieties with four recommended check varieties (Tikolore, Magoye, Nasoko and Magoye)

- The locations were Bvumbwe, Chitala, Chitedze, Makoka, Mbawa
- The entries (16 IITA varieties & 4 recommended varieties)
- The Design: RCBD with 3 replicates
- PS: 6m x 2m with 4rows spaced at 50cm

Advanced variety trial



Participatory Variety Selection (PVS) Trials

Objective

To compare the adaptability and yield performance of promising genotypes with the checks and identify new superior genotypes that can be considered for release for commercial production

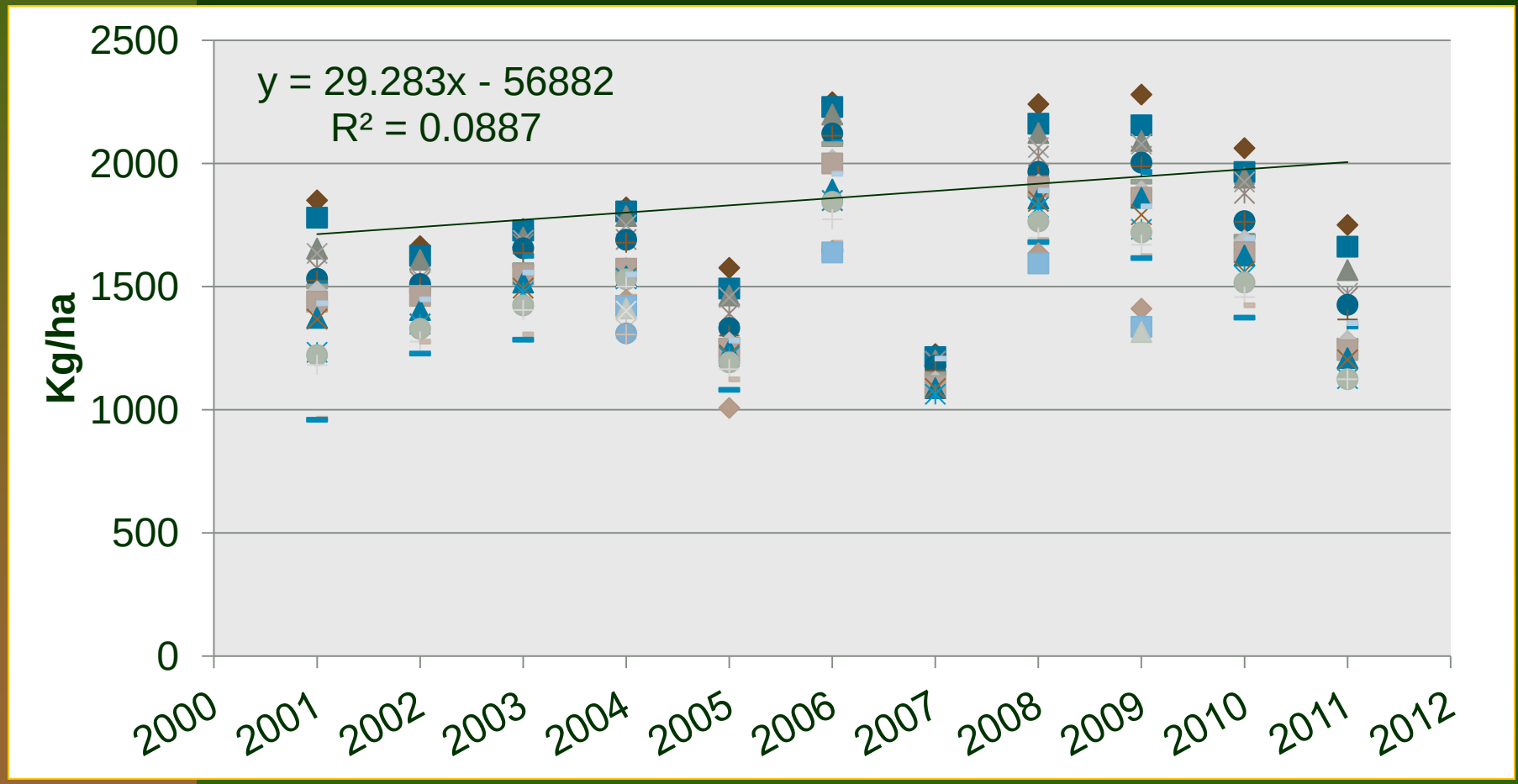
Materials & Methods

- Districts: Lilongwe (Chitekwere/Chigodi EPA) and Dowa (Nachisaka EPA)
- No. of farmers: 40 (20 per district)
- Genotypes: 8 (three checks & five tests)

On-farm PVS Trial

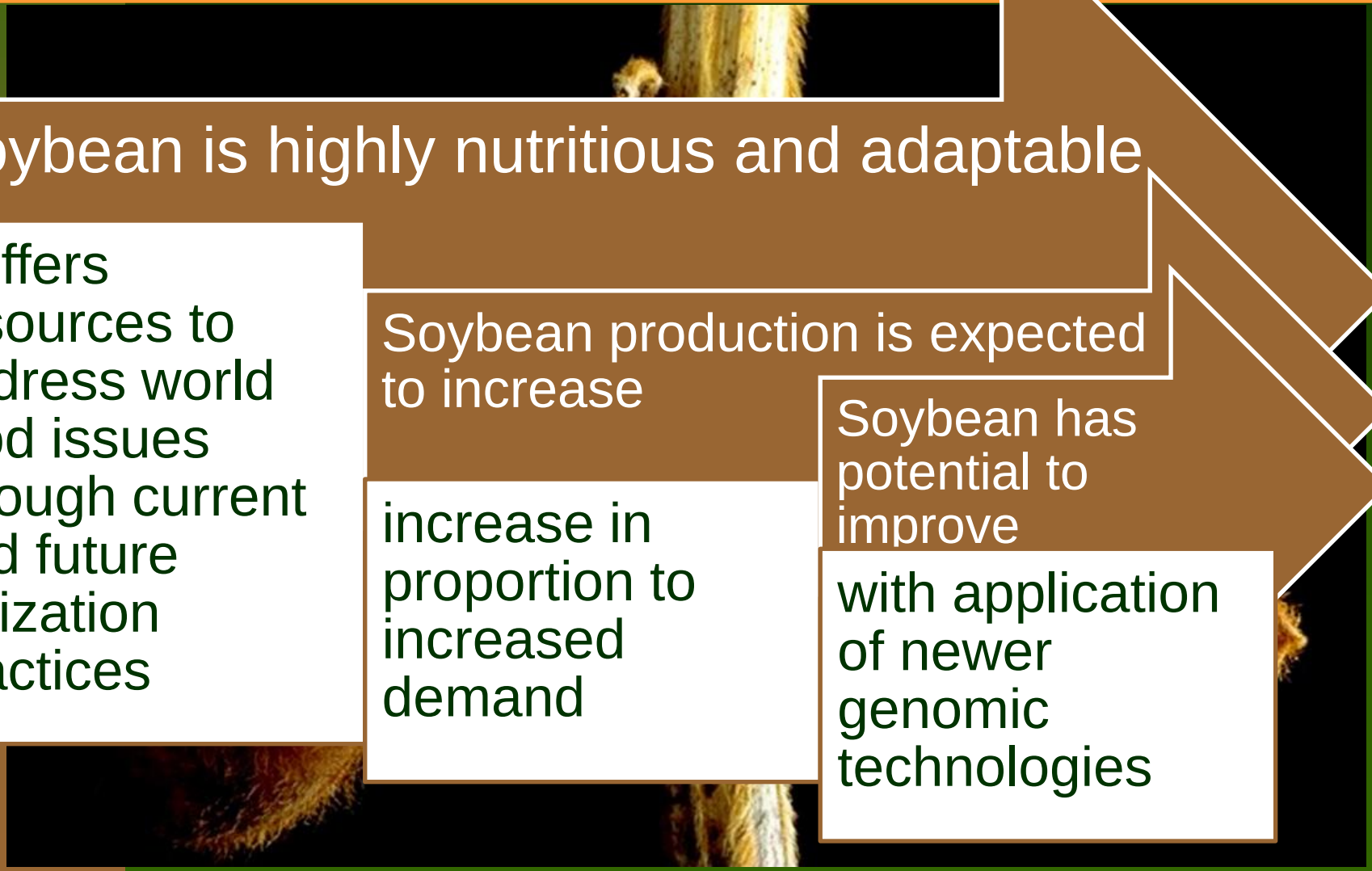
Grain yield of varieties tested in 2011/12 in Lilongwe and Dowa districts, Malawi

Advanced variety trials 2000-2011



Medium maturity trails

Future considerations



Soybean is highly nutritious and adaptable

it offers resources to address world food issues through current and future utilization practices

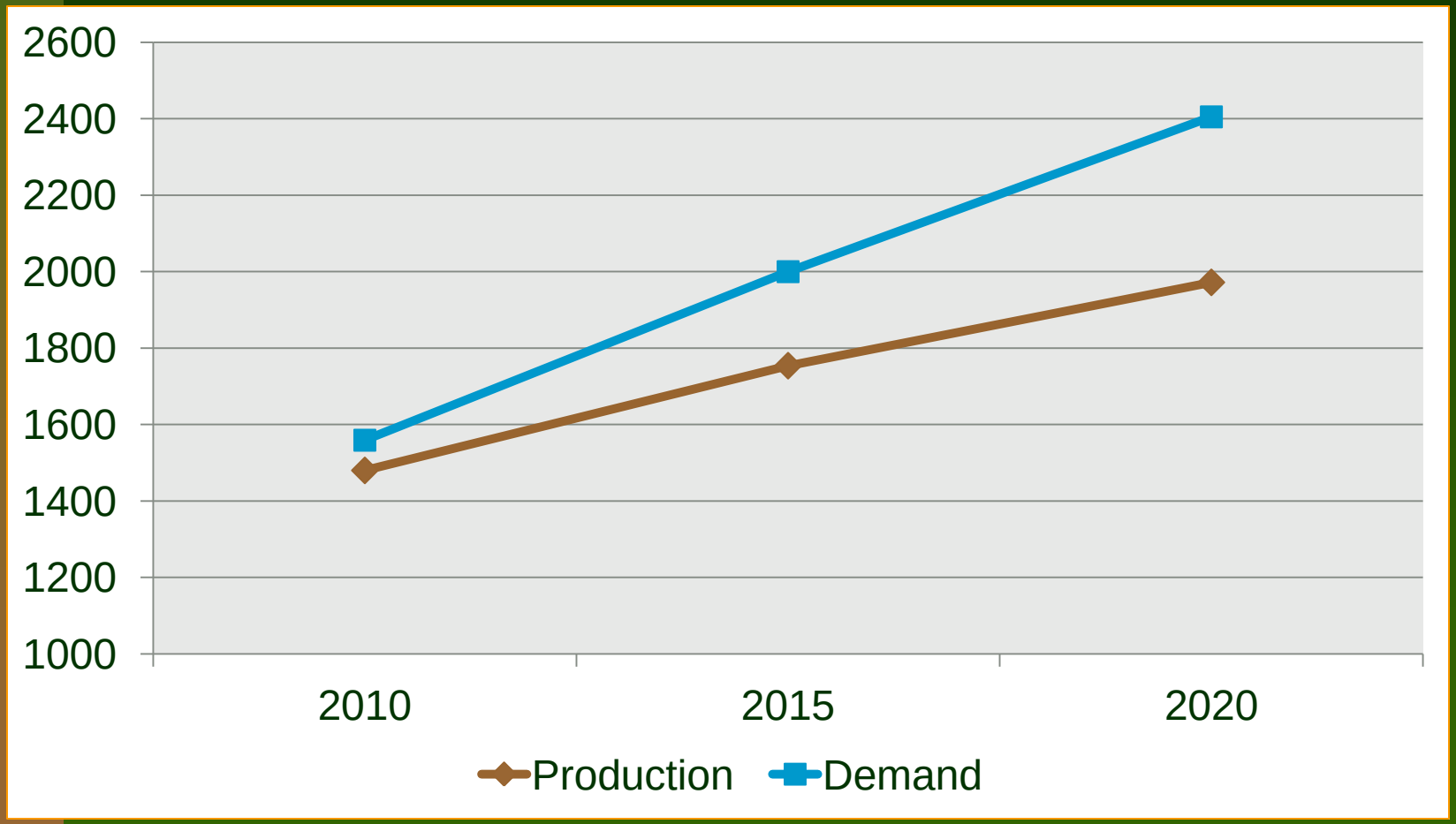
Soybean production is expected to increase

increase in proportion to increased demand

Soybean has potential to improve

with application of newer genomic technologies

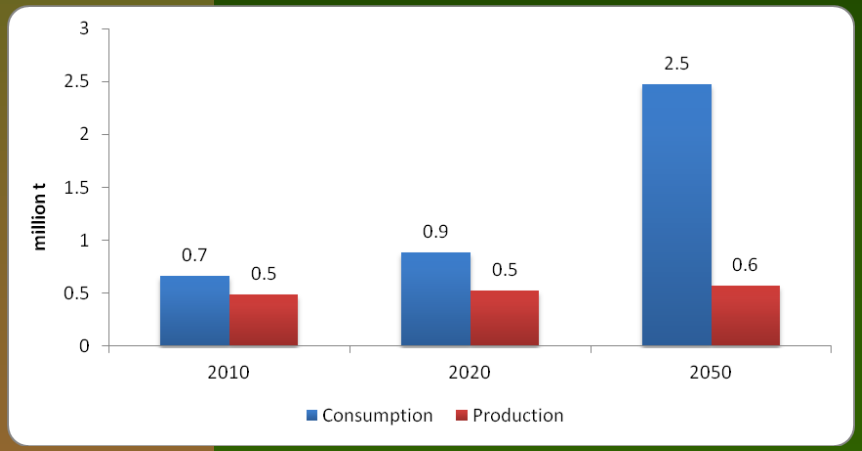
Production and national demand projections (1000 MT) for soybean in Sub-Saharan Africa



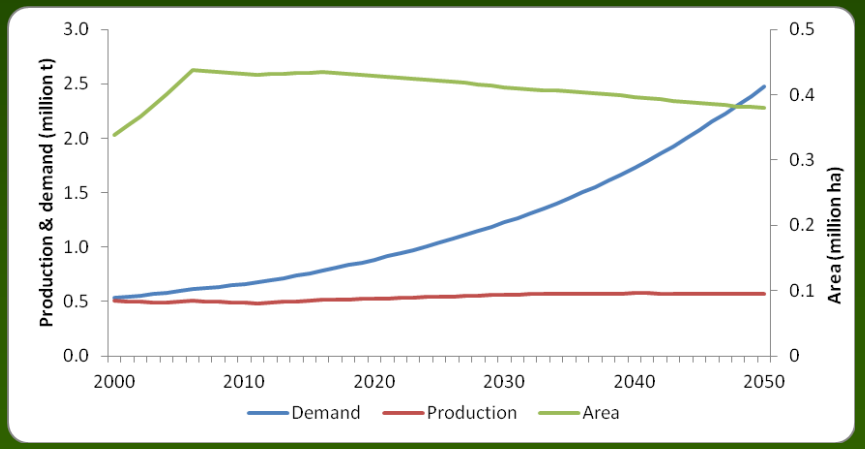
Source: IFPRI IMPACT model results for 2020 (Rosegrant et al. 2001)

Supply and demand projections of Soybean

Production and consumption of soybean in ESA



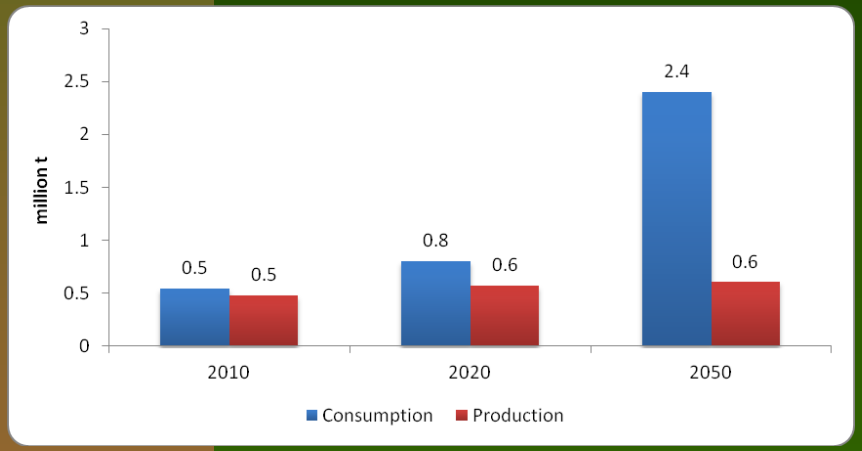
Area, demand and supply projections for soybean in ESA



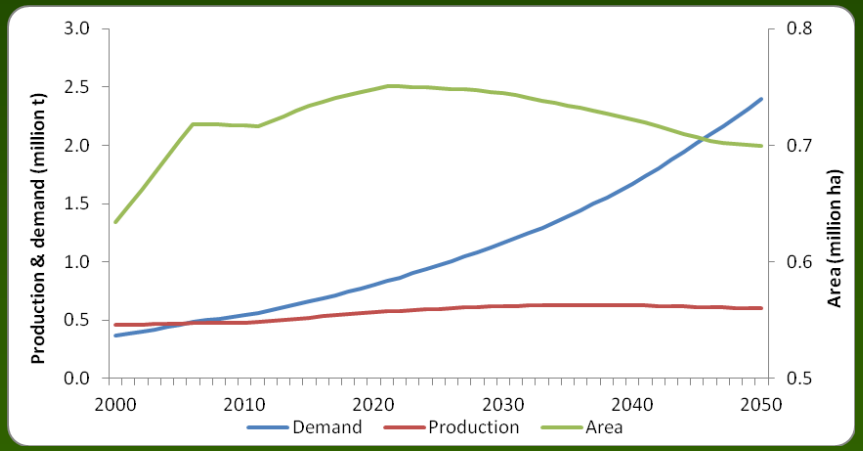
Eastern and Southern Africa (ESA)

Supply and demand projections of Soybean

Production and consumption of soybean in WCA



Area, demand and supply projections for soybean in WCA



Western and Central Africa (WCA)

Meeting the demand

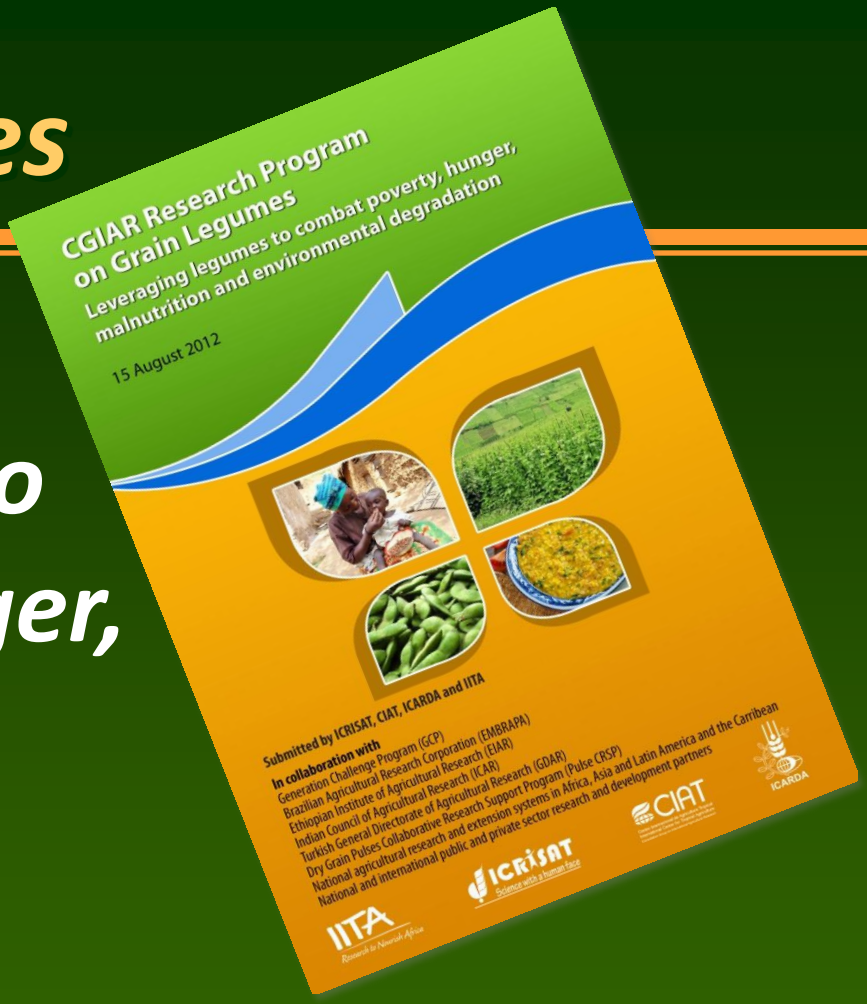
Tropical Legumes (I&II)

- Target regions: Sub-Saharan Africa and South Asia
- Objective 7: Enhancing soybean productivity and production in sub-Saharan Africa

TLII Objective 7

- Activity 1. Development of varieties/lines tolerant to drought with enhanced BNF
- Activity 2. Development of varieties/lines with tolerance to soybean rust and other diseases with enhanced BNF
- Activity 3. Soybeans with improved quality traits
- Activity 4: data management of breeding activities
- Activity 5. Facilitation of household and community level processing and utilization of soybean

CGIAR Grain Legumes



Leveraging legumes to combat poverty, hunger, malnutrition and environmental degradation

CGIAR RESEARCH PROGRAM ON Grain Legumes

Led by ICRISAT Science with a human face

In partnership with CIAT Centro Internacional de Agricultura Tropical International Center for Tropical Agriculture; ICARDA; IITA Research to Nourish Africa

and public and private institutes and organizations, governments, and farmers worldwide

Priority Crops and Regions

Area	Number of Poor (<US$2 per day)				Total Area (M hectares)
	HIGH (>750million)	**MEDIUM** (250-750 million)	**LOW** (<250 million)		
	SSEA (1.3 billion)	**SSA** (539million)	**CWANA** (64 million)	**LAC** (55 million)	
HIGH (>0.5M hectares)	Soybean, oil (11.4) **Chickpea (9.0)** **Groundnut (7.9)** Mung bean (5.0) **Pigeonpea (4.2)** **Lentil (1.7)** Pea (0.78)	**Groundnut (10.8)** **Cowpea (10.4)** **Bean, common (5.8)** **Soybean (1.4)** **Faba bean (0.50)** **Pigeonpea (0.50)**	**Chickpea (1.2)** **Lentil (0.6)**	Soybean, oil (4.4) **Bean, common (2.7)**	**Groundnut (19.02)** **Chickpea (10.71)** **Cowpea (10.62)** **Bean, common (8.75)** Mung bean (5.00) **Pigeonpea (4.74)** **Lentil (2.43)** **Soybean (1.58)** Pea (1.47) **Faba bean (1.04)**
LOW (<0.5M hectares)	Cowpea (0.17)	Pea (0.45) Chickpea (0.42) Bambara nut (0.12) Lentil (0.11) Pea (0.04)	Faba bean (0.4) Bean, common (0.25) Soybean (0.18) Groundnut (0.13) Pea (0.13) Cowpea (<0.01)	Groundnut (0.19) Faba bean (0.14) Chickpea (0.09) Pea (0.07) Cowpea (0.04) Pigeonpea (0.04) Lentil (0.02)	

Bean | Chickpea | Cowpea | Faba bean | Groundnut | Lentil | Pigeonpea | Soybean

Focused Product Lines: Soybean

- Abiotic stresses
  - PL1 – Drought and low-phosphorus tolerant
- Nitrogen fixation
  - PL4 – High nitrogen-fixing

Project Goals and CRPGL Vision

TL1 - contribute to the development of improved legume varieties in sub-Saharan Africa and South Asia by advancing molecular breeding for traits of importance in both regions

TL2 - Improve the livelihoods of smallholder farmers in drought-prone areas of Sub-Saharan Africa and South Asia through enhanced grain legume production and productivity

The CRPGL Vision is that in 10 years, increased production, sales and consumption of grain legumes will reduce poverty, hunger, malnutrition of smallholder farmers, while improving the health of mankind and the planet.

Synergies: TLII with CRP Grain Legumes

- **TL1 and TL2 goals and objectives are consistent with CRP Grain Legumes**
- **Significant portion of CRP GL deliverables are likely to happen through TL**

Together we can do it!

Thank you