



SESSION 2 - Facilitator - Prof Pieter Swanepoel

Speaker 5: Dr Leandro Eugenio Cardamone Diniz - EMBRAPA

- Biologist with a PhD in Genetics and Plant Breeding.
- Postdoctoral fellowships in Molecular Biology (IRD, France) and Biotechnology (KUL, Belgium).
- Researcher at Embrapa since 2007, currently at Embrapa Soybean since 2022.
- Expertise in plant genetic transformation, gene editing (CRISPR), genetic diversity analysis, functional characterisation of microorganisms, and bio-input development.
- Published over 45 international papers and book chapters.
- Holds nine patents in Biotechnology innovation.
- Currently, he serves as the international liaison for Embrapa Soybean.



OPDT/OAC



Improved Technology used in Brazil that is Increasing Soybean Production Efficiency

Leandro Diniz, PhD

Embrapa Soybean researcher /
International Affairs Officer

Pretoria/Bothaville, 29-31/07/2025



MINISTÉRIO DA
AGRICULTURA E
PECUÁRIA



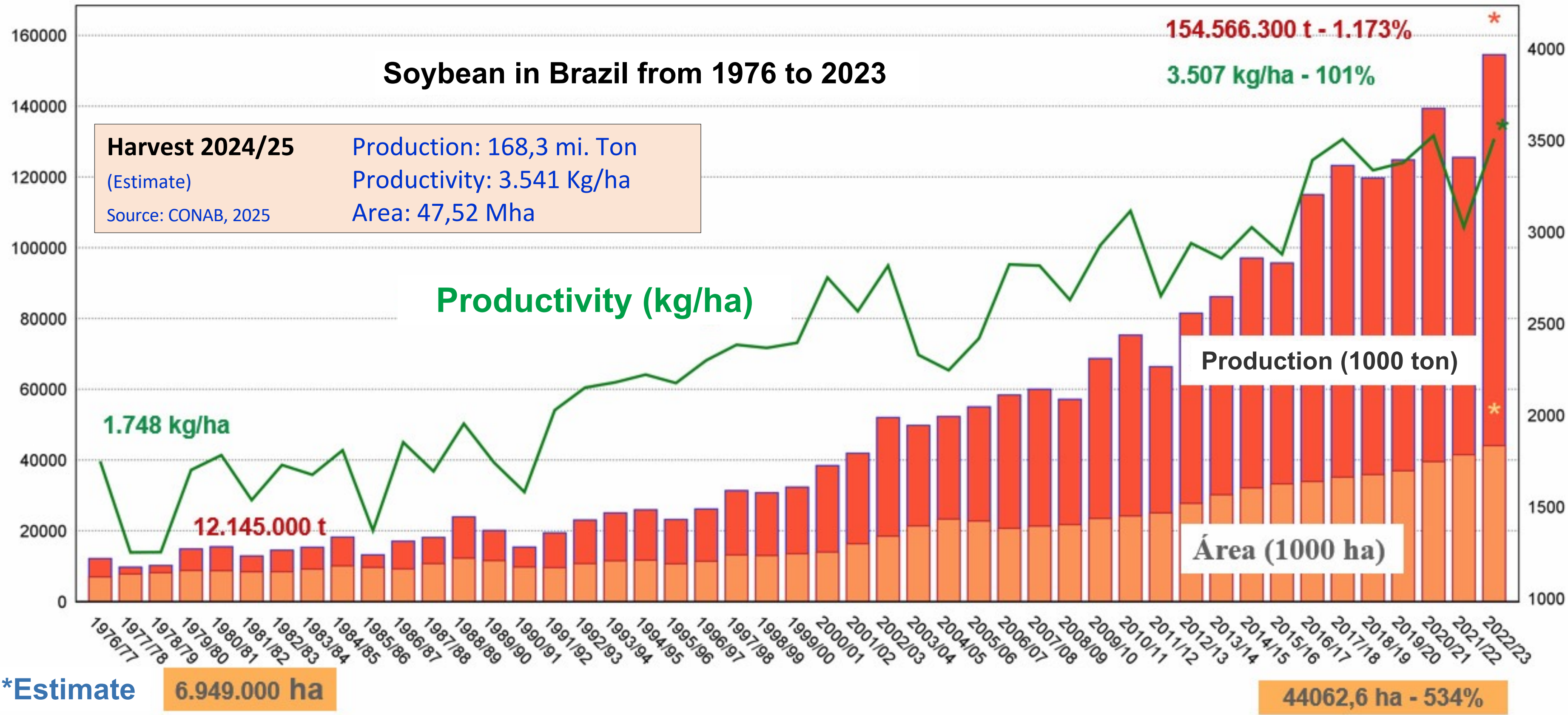
An overview on the Brazilian agriculture

- Agricultural area: 282 Mha (~33% Brazilian territory);
- Cultivated area (Grains): ~77 Mha / Soybean 47,5 Mha (2024/25);
- **~165 Mha of pastures, ~ 30 Mha will be converted into crops in the next 20 years;**
- ~17 Mha were cropped under “agriculture-livestock-forest integration (iLPF in Portuguese)” – potential to reach 48 Mha incorporating unproductive areas and degraded pastures;
- In 2024/25, around 16,8 Mha of maize were cultivated after soybean on the same area in the same year (second harvest);
- Wheat: the last commodity to be tropicalized. Nowadays ~8 Mtons, to ~20 Mtons by 2030.



Evolution of soybean production in Brazil

Soybean in Brazil from 1976 to 2023



Evolution of soybean yields in Brazil: some reasons



**Plant breeding: early-maturing varieties,
with higher adaptation and yield potential**



**Soil management, conservation and fertility
(examples: Land Save Technologies)**



**Technologies for pest control
(disease, insects and weeds)**



Seed production technologies



Machinery Improvement

Expansion of Soybean in Brazil

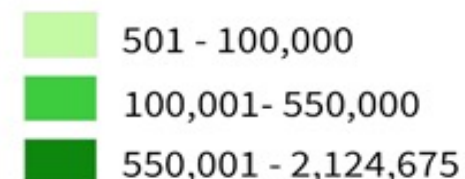


CAPRICÓRNIO

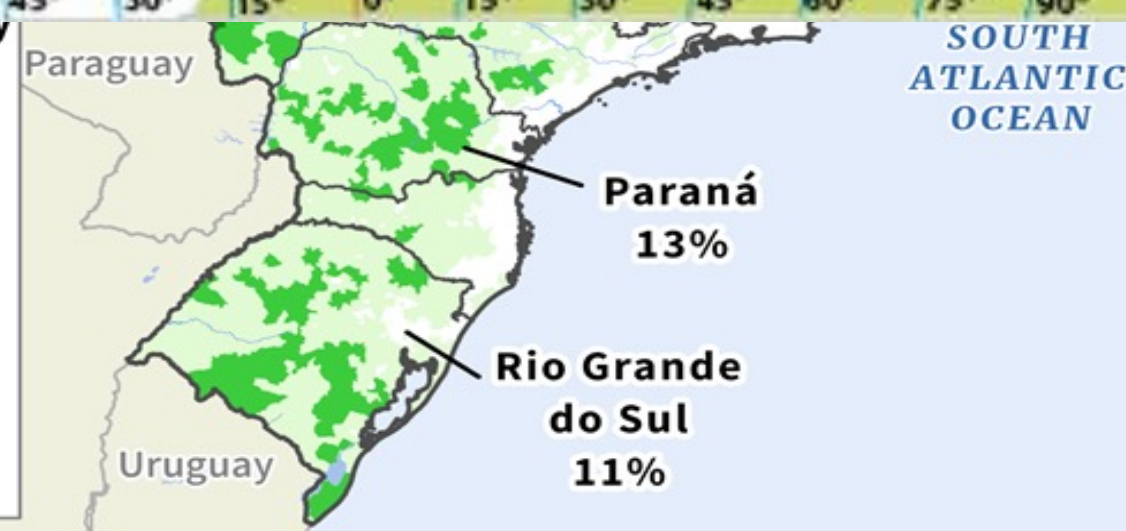
Production by Municipality

3-year average

2021-23, metric tons



Percentages (%) indicate percent of national production.



Paraná
13%

Rio Grande
do Sul
11%

3° 27'

Source: IBGE - Produção Agrícola Municipal

Brazilian Soybean Breeding Program

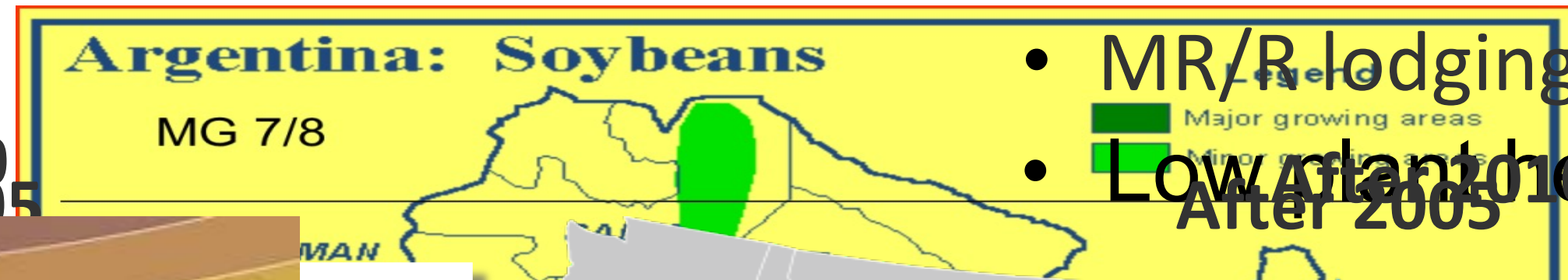
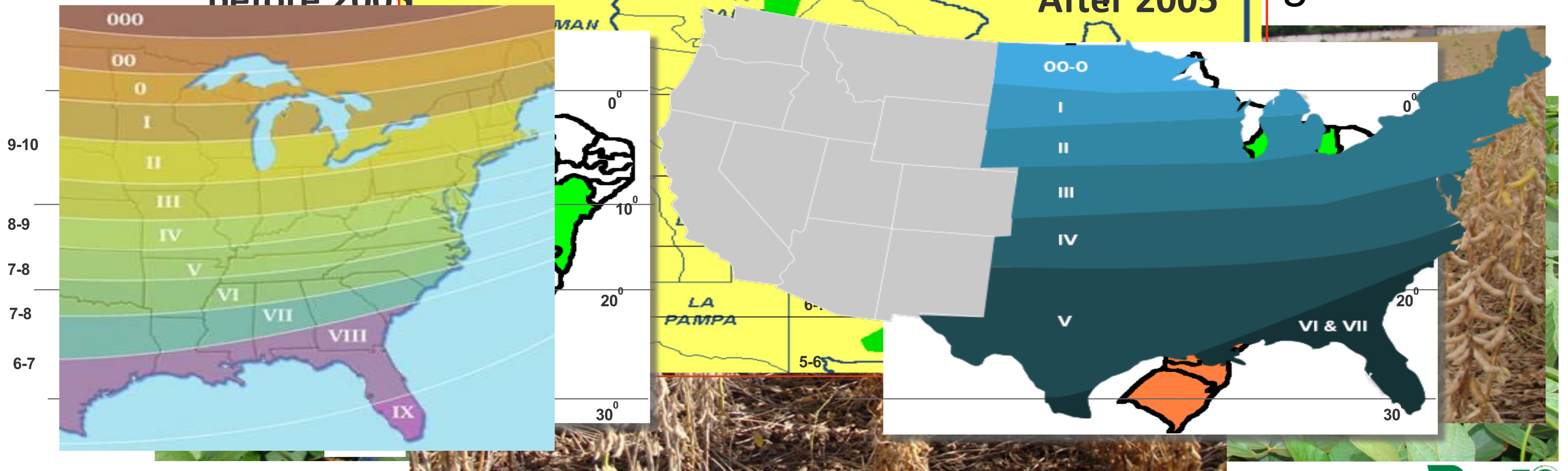
Before

- MG – 6.8 to 9.4
- Determinate
- S lodging
- High plant height

Nowadays

- MG – 4.5 to 8.2
- Indeterminate
- MR/R lodging
- Low plant height

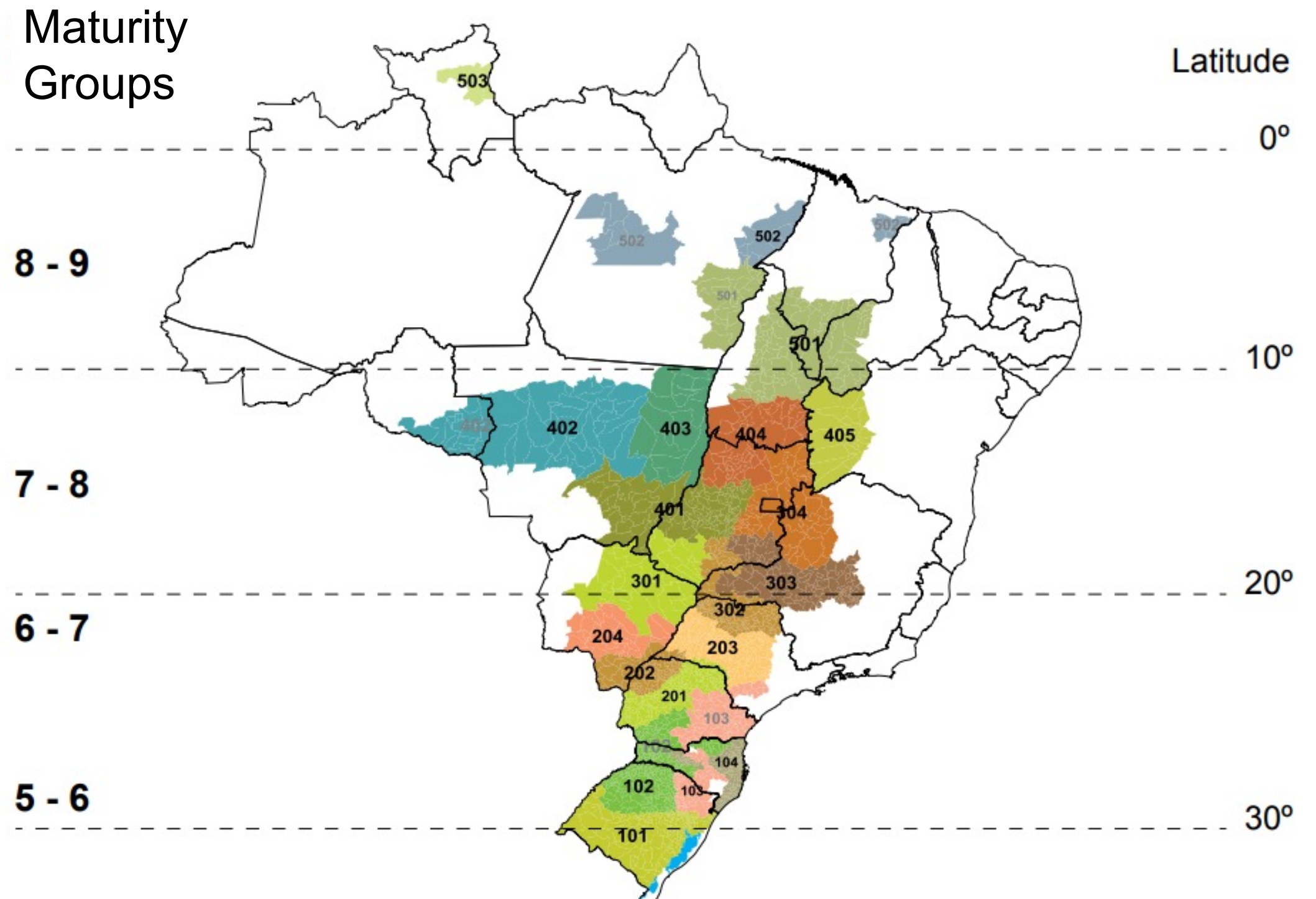
Before 2010
before 2005



Embrapa Soybean Breeding Program

Main Objectives

- » **Productivity and Stability**
- » Suitable maturity group
- » Suitable plant architecture
- » Lodging resistance
- » Disease and nematode resistance
- » Insect tolerance (caterpillars and stinkbugs)
- » Seed quality
- » Oil and protein content and quality
- » Herbicide tolerance



When did each platform at Embrapa start?



Since
1975



Since
1997

(Glyphosate Tolerant)



Since
2010

(GT + BT (Cry1Ac))



Since
2018

(GT + Dic)



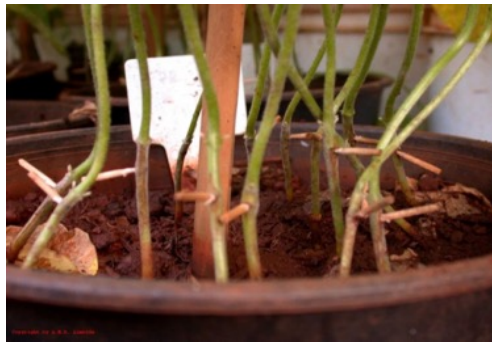
Since
2018

(GT + Dic + BT + SIP2
(Cry1A.105 + Cry2Ab2))



Embrapa Breeding Program (2015 to 2025)

- R or MR mandatory:



Stem canker
(*Diaphorte aspalathi* f. sp. *meridionalis*)



Frogeye leaf spot
(*Cercospora sojina*)



Bacterial pustule
(*Xanthomonas citri* pv. *glycines*)



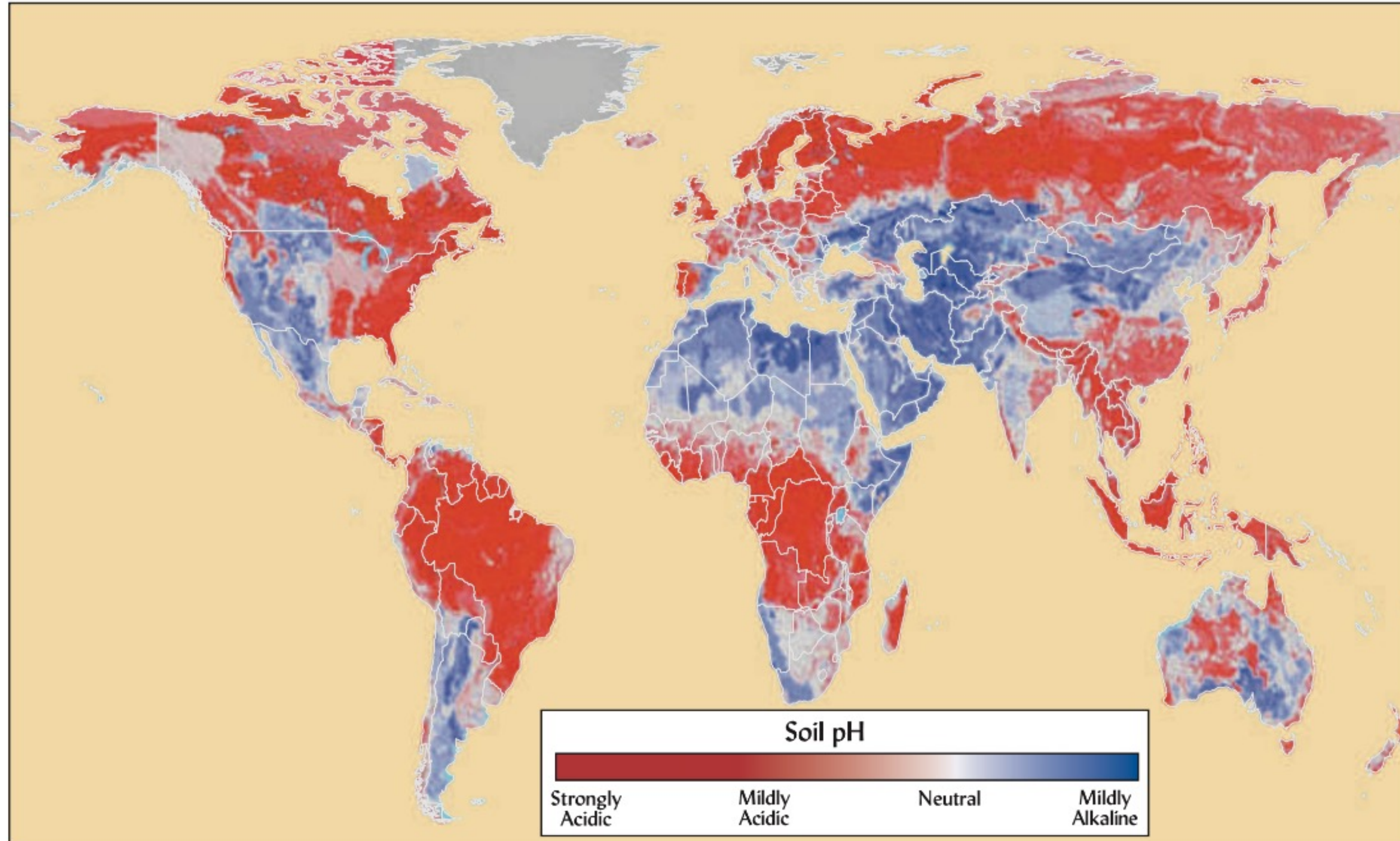
Phytophthora root rot
(*Phytophthora sojae*)

Wildfire
(*Pseudomonas syringae* pv *tabaci*)

- **77 new soybean cultivars:**
 - **18 Non-GMO**
 - **25 RR (Glyphosate Tolerant)**
 - **25 IPRO (GT + BT (Cry1Ac))**
 - **4 XTD (GT + Dic)**
 - **5 I2X (GT + Dic + BT + SIP2)**
(Cry1A.105 + Cry2Ab2)

Soil management: Soil and climate conditions in Brazil

Soils



Red yellow Latosol (Oxisols)

Soil management - Fertility: example from Brazil

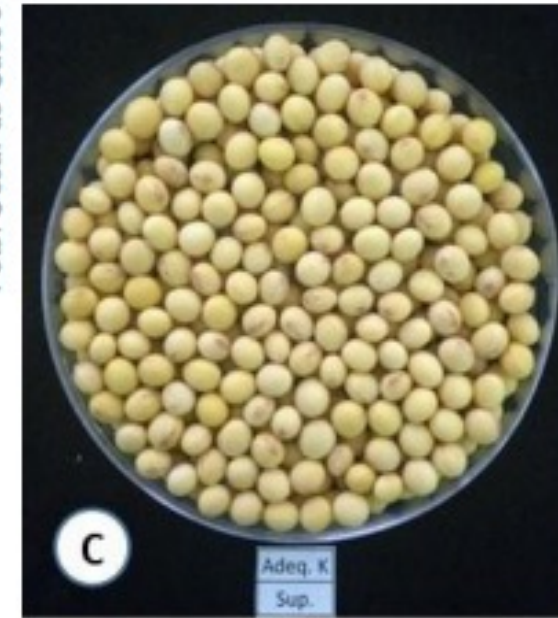
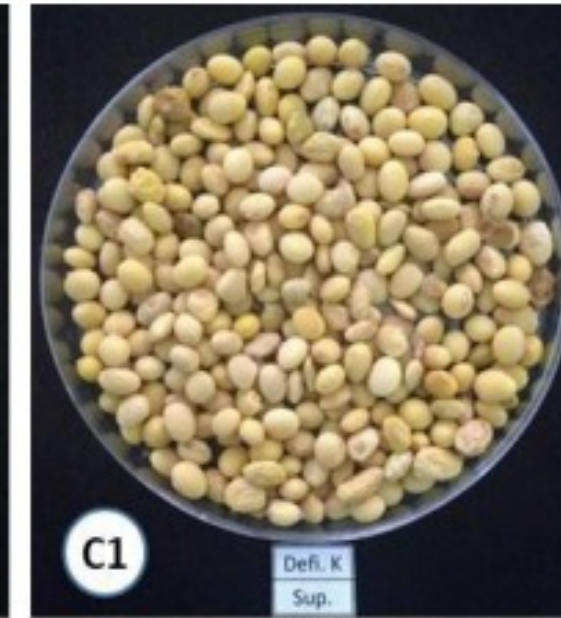
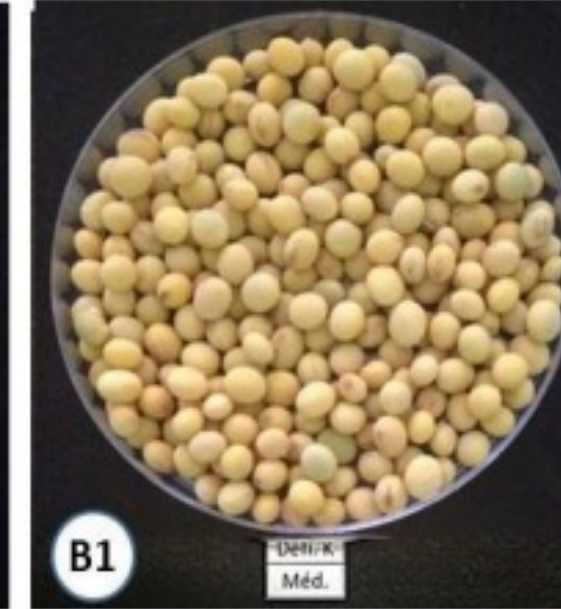
Most common nutritional disorders in field conditions

How does it affect grain quality and productivity?

Soybeans harvested in areas with high (0.31 cmolc/dm³) and low (0.06 cmolc/dm³) K content in the soil.

- Grains from the lower third (A and A1)
- Grains from the middle third (B and B1)
- Grains from the upper third (C and C1)

Foto: César de Castro



The fertilizer scene in Brazilian agriculture

Producers



Nitrogênio **N**

1º China

2º Rússia

3º EUA

Fósforo **P**

1º China

2º EUA

3º Marrocos

Potássio **K**

1º Canadá

2º Rússia

3º Bielorrússia

Fonte: GlobalFert (2021b). Elaboração DPE/SAE

Import in Brazil:

N 80%

P 55%

K 95%



Consumers



Nitrogênio **N**

1º China

2º Índia

3º EUA

4º Brasil

Fósforo **P**

1º China

2º Índia

3º Brasil

4º EUA

Potássio **K**

1º China

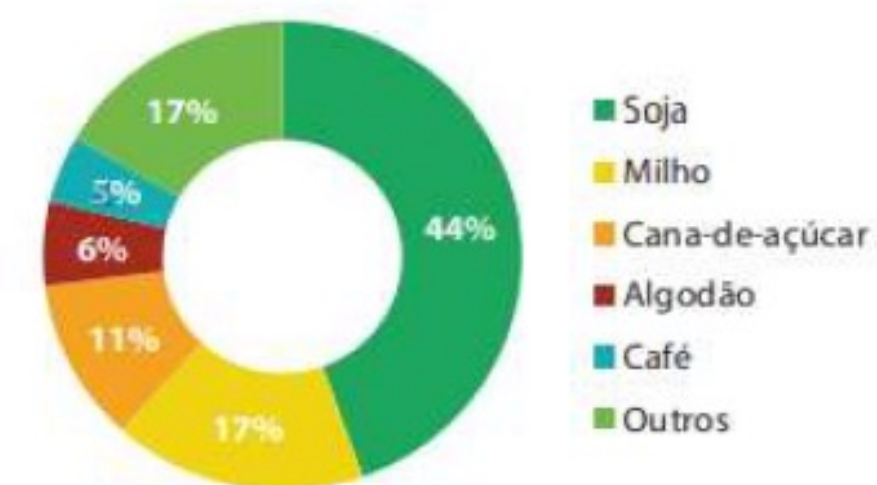
2º Brasil

3º EUA

4º Índia

Fonte: GlobalFert (2021b). Elaboração DPE/SAE-PR.

Consumo de fertilizantes por cultura em 2020

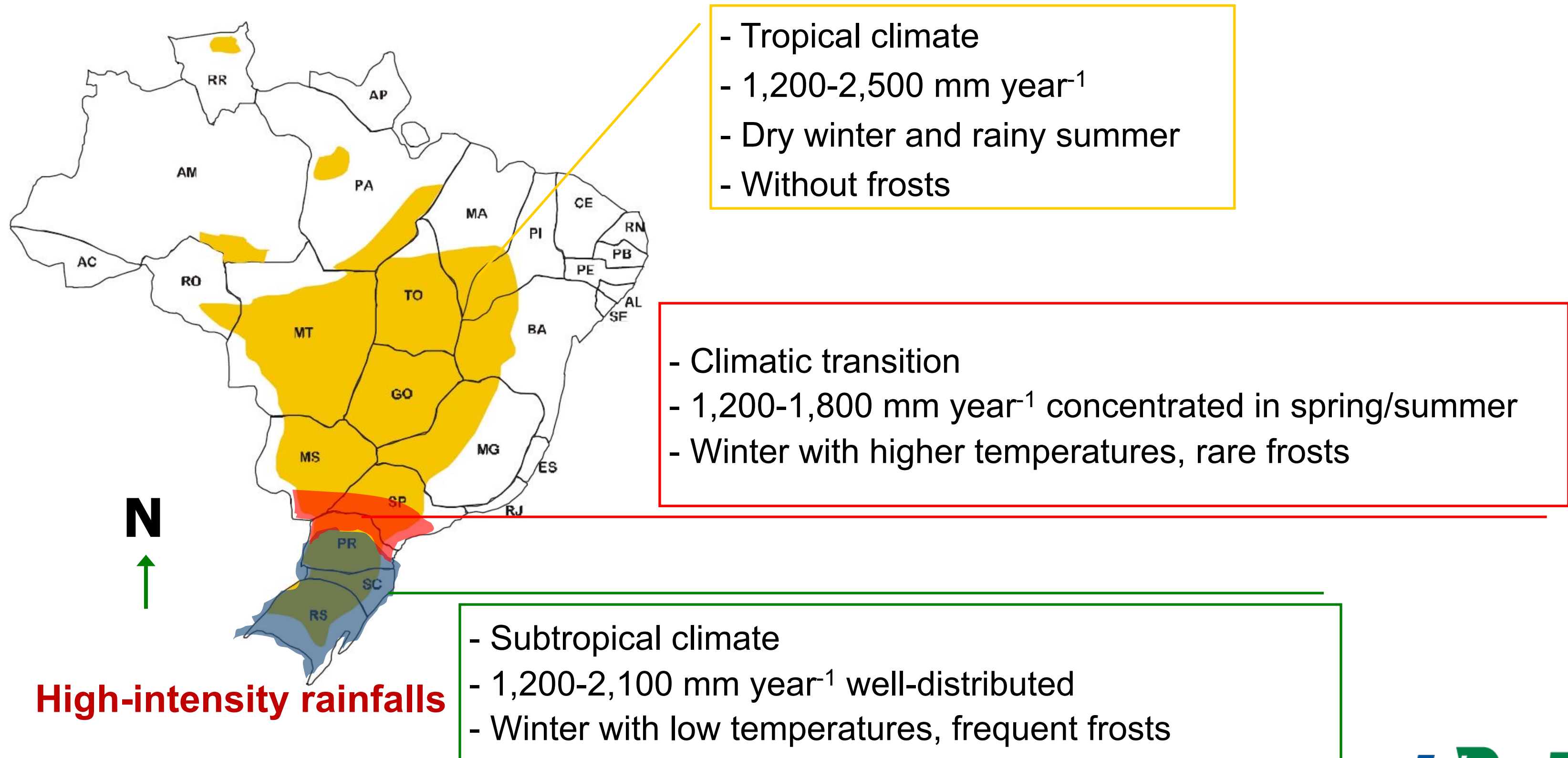


Fonte: GlobalFert (2021a).

Source: Plano Nacional de Fertilizantes 2050

Soil and climatic conditions in Brazil

Climate



Relative production %

100
90
80
70
60
50
40
30
20
10
0

Maximum production potential

Potential production

Plantability and seeds

Weeds

Pests and diseases

Inappropriate cultivar

Physics / Biology of soil

Low fertility

Water deficit

Adaptado: Havlin et al., 2017

Agricultural Zoning for Climate Risk



zarc[®]
Zoneamento Agrícola
de Risco Climático

2024/25



Soil management: Examples of Land-Saving Technologies



No-tillage



Crop-livestock-forest integration (iLPF)



Biological Nitrogen Fixation (BNF)



Plant Growth-Promoting Microorganisms (PGPM)

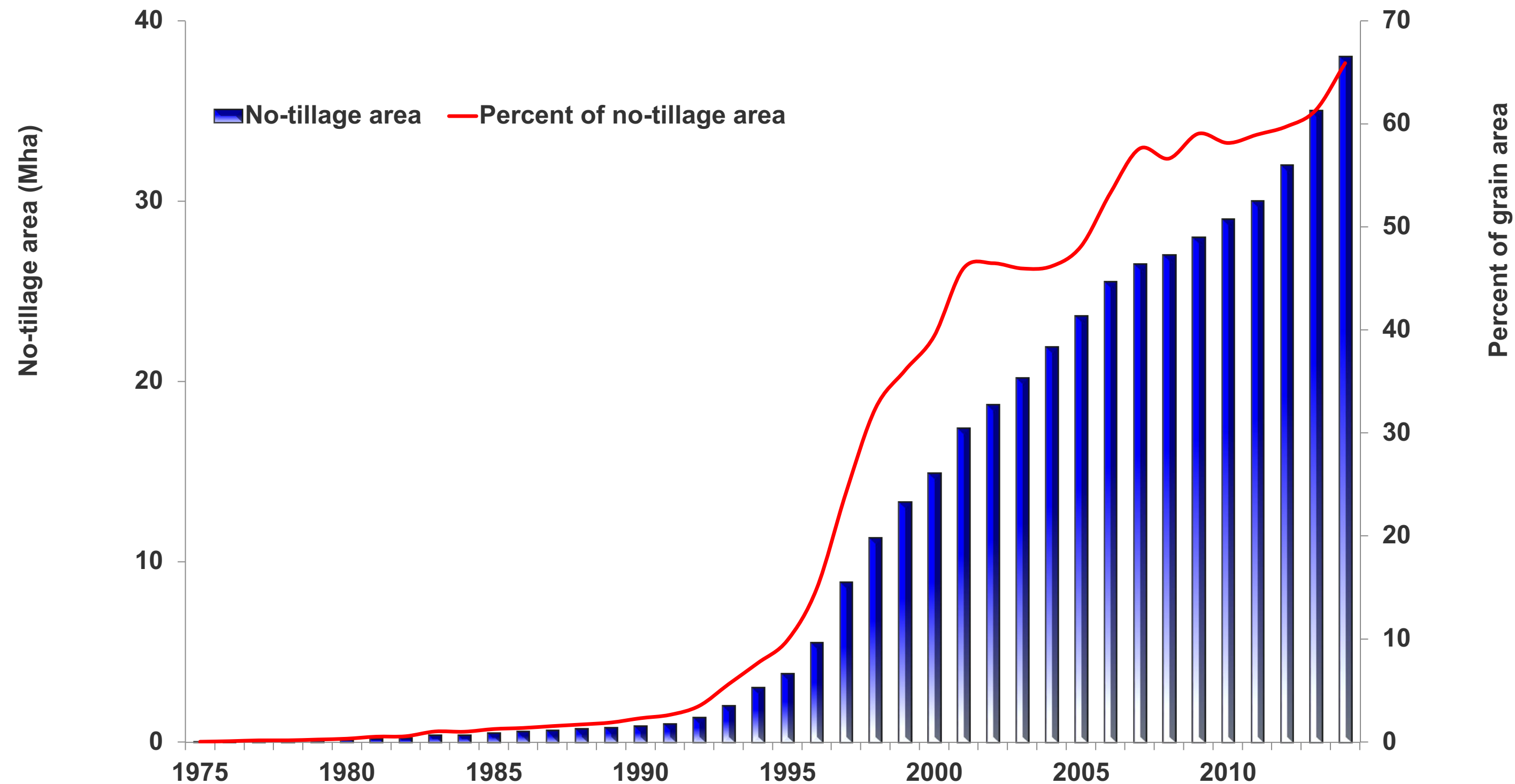


Bioinputs



Low-Carbon Agriculture

No-tillage area and percent of the Brazilian grain area



Source: Gazzoni, D. L. & Dall'Agnol, A. A Saga da Soja: de 1050 a.C. a 2050 d.C. Embrapa Soja, Londrina-PR. 2018, 199 p.

No-tillage: Key principles



- Soil disturbance only in the seeding row (special planters)
- Soil surface covered with plants or residues from previous crop (mulching)
- Crop rotation (succession)
- Continuous NT: long-term benefits

Conventional tillage: 1970's, 1980's, 1990's

Disk plow



Disking (heavy disk harrow)

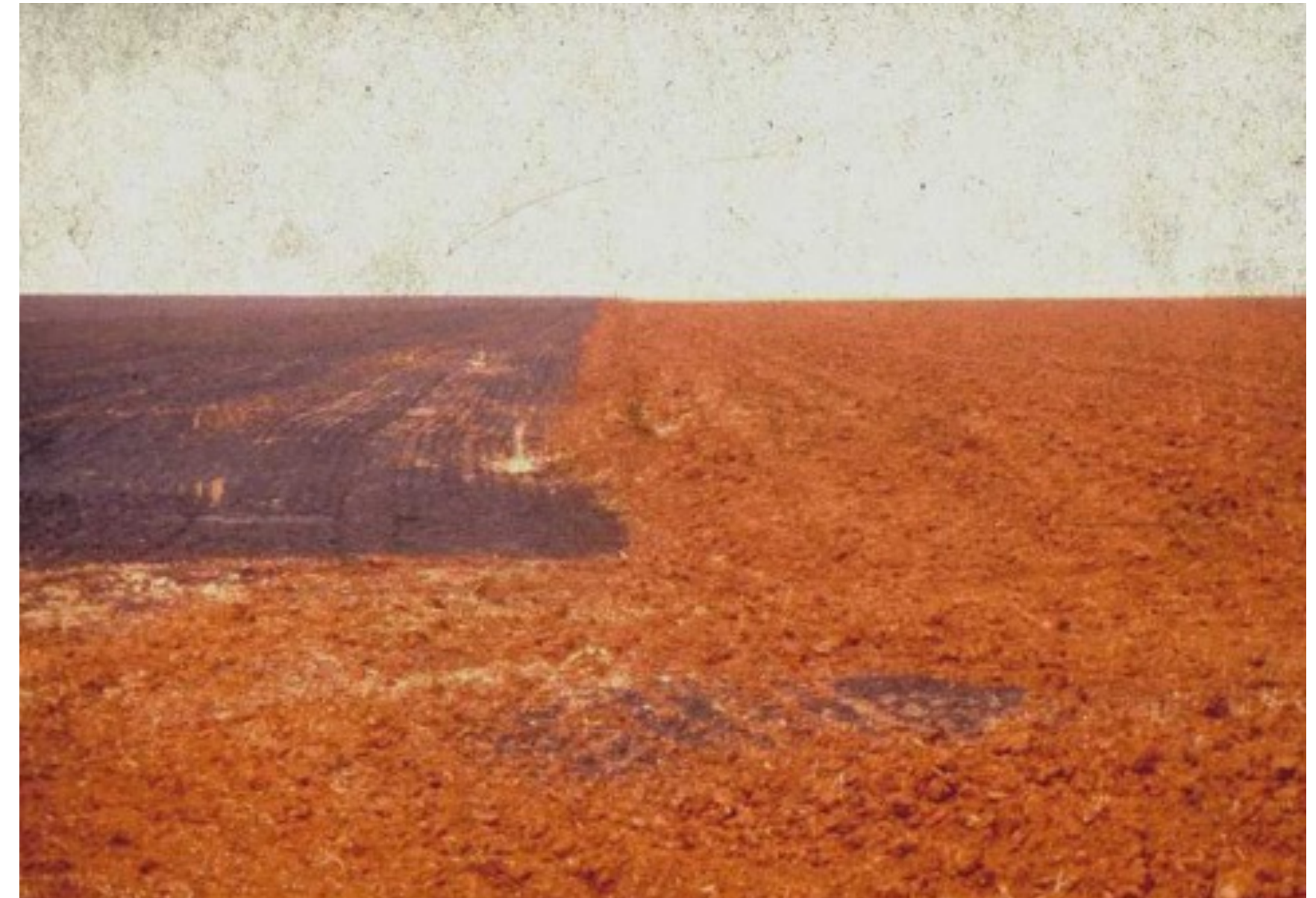


Actual soybean planters



Conventional tillage: 1970's, 1980's, 1990's

Wheat straw burned + conventional tillage



Source: Bartz's Family collection

Actual soil conservation before soybean sowing



Conventional tillage: 1970's, 1980's, 1990's

Soil losses by water erosion: 20 metric ton ha⁻¹ year⁻¹



For each cm of soil lost by erosion, soybean yields are reduced in 150 kg ha⁻¹ (Gaertner et al., 2003)

Contour Farming: Soil erosion reduced by 95%



Photo: Joaquim M. da Costa (Coamo – Campo Mourão)

No-tillage: improvement of soil quality

Winter-fall crops (tropical)



↓ 115 days with *Brachiaria ruziziensis*



2,5 m

No-tillage: Land use intensification



No-tillage: Cropping systems in Brazil

Current, predominant cropping systems (NT)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Soybean		Fallow		Wheat				Fallow		Soybean	
or											
Soybean		Maize					Fallow			Soybean	
Southern											

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Agriculture-livestock-forest integration (iLPF)

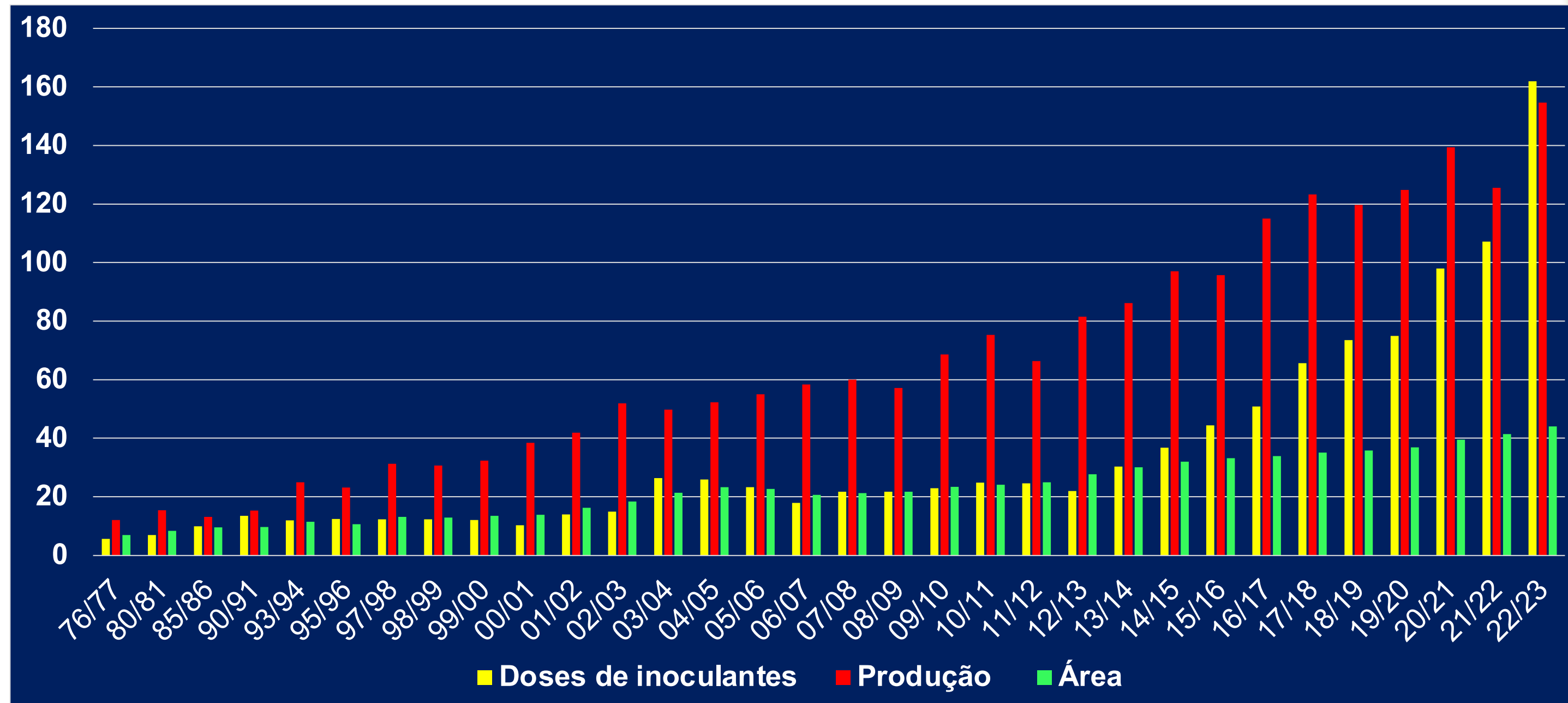


Foto: Gabriel Rezende Faria

>17 Mha (80% ILP)
Recovery of degraded pastures

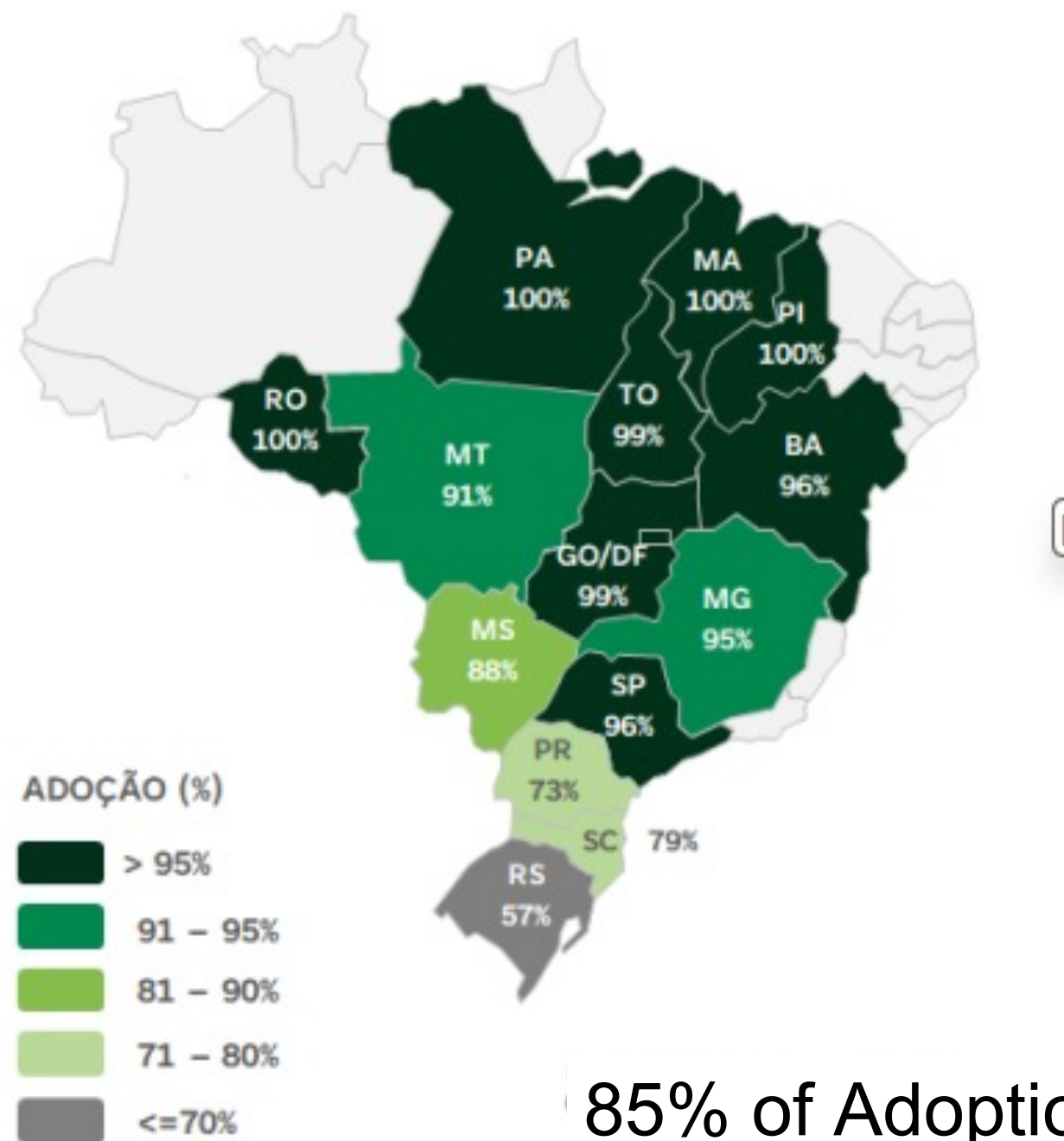
Soybean inoculation with *Bradyrhizobium* spp. for Biological N Fixation (BNF)

Million (doses, tons or ha)



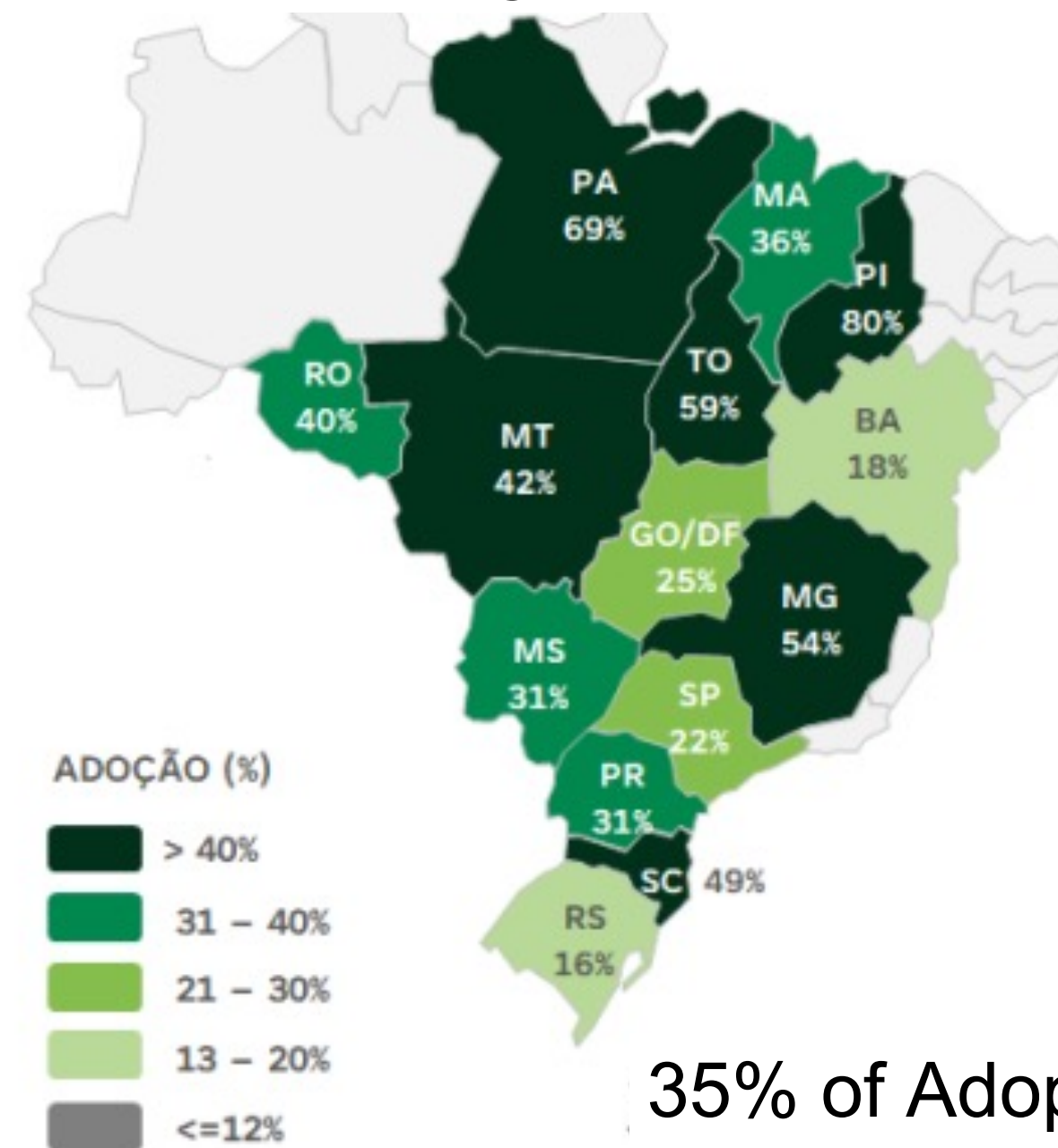
Soybean inoculation in Brazil

Adoption rate of inoculants in soybeans



85% of Adoption
Harvest 2022/23

Adoption rate of co-inoculation in soybean



35% of Adoption
Harvest 2022/23

Co-inoculation with *Azospirillum* improves BNF in soybean

***Bradyrhizobium* spp.:**
symbiotic bacteria that
form nodules on
soybean roots,
responsible for fixing
atmospheric nitrogen

• ***Azospirillum* spp.:** Plant
growth-promoting bacteria
that stimulate root
development, nutrient
absorption, and tolerance to
abiotic stress.



Bradyrhizobium spp.
inoculation

Azospirillum brasilense
Bradyrhizobium spp.
co-inoculation

AGROADVANCE
Escola de Negócios Agro

The numbers of BNF in Brazil



Considering only Soybean (2019-2020)



- ✓ One of the most successful cases of using microorganisms in agriculture;
- ✓ Advantages for the farmer and the environment.

Soybean Pests: Chemical and Biological control



BACTERIA



VIRUSES



FUNGI



NEMATODES



CATERPILLARS



STINKBUGS



WHITE FLY



WEEDS

Diseases – Soybean cycle

DAMPING OFF

- Anthracnose
- Phytophthora
- Rhizoctonia
- Sclerotium
- Fusarium
- Pythium

EARLY

- Brown Spot (*Septoria*)
- Cercospora Blight
- Bacterial Blight
- Rust
- Phytophthora

MIDDLE

- Powdery Mildew
- Rust
- Phytophthora
- Anthracnose
- Rhizoctonia
- Target Spot
- Sudden Death
- Sclerotinia Stem Rot
- Viruses
- Bact. Pustule

END OF CYCLE

- Brown Spot
- Cercospora Blight
- Charcoal Rot
- Rust



Nematodes (galls, cyst, lesions)

BACTERIA

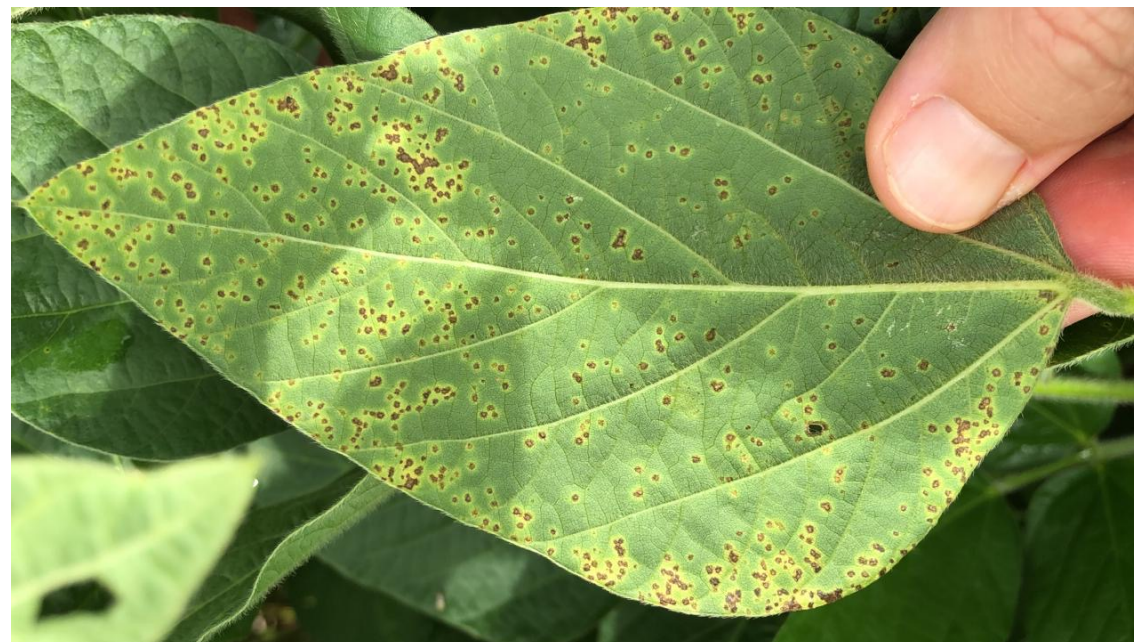
Bacterial blight – *Pseudomonas savastanoi* pv *glycinea*

Bacterial pustule – *Xanthomonas axonopodis* pv *glycines*

Wildfire – *Pseudomonas syringae* pv *tabaci*



Bacterial blight



Bacterial pustule



Wildfire

VIRUSES

Cowpea Mild Mottle Virus (CpMMV) – Carlavirus transmitted by White flies

Tobacco Streak Virus (TSV) - transmitted by thrips



CpMMV



TSV

FUNGI (controlled by genetic resistance)

Frogeye leaf spot – *Cercospora sojina*

Stem canker - *Diaporthe aspalathi*; *D. caulivora*

Phytophthora root - *Phytophthora sojae*

Brown stem rot – *Cadophora gregata* (South)



FROG EYE SPOT
Cercospora sojina



Phytophthora root



Stem canker



Brown stem rot



FUNGI (controlled by fungicides)

Target spot – *Corynespora cassiicola*

Brown spot – *Septoria glycines*

Anthraxnose – *Colletotrichum truncatum*

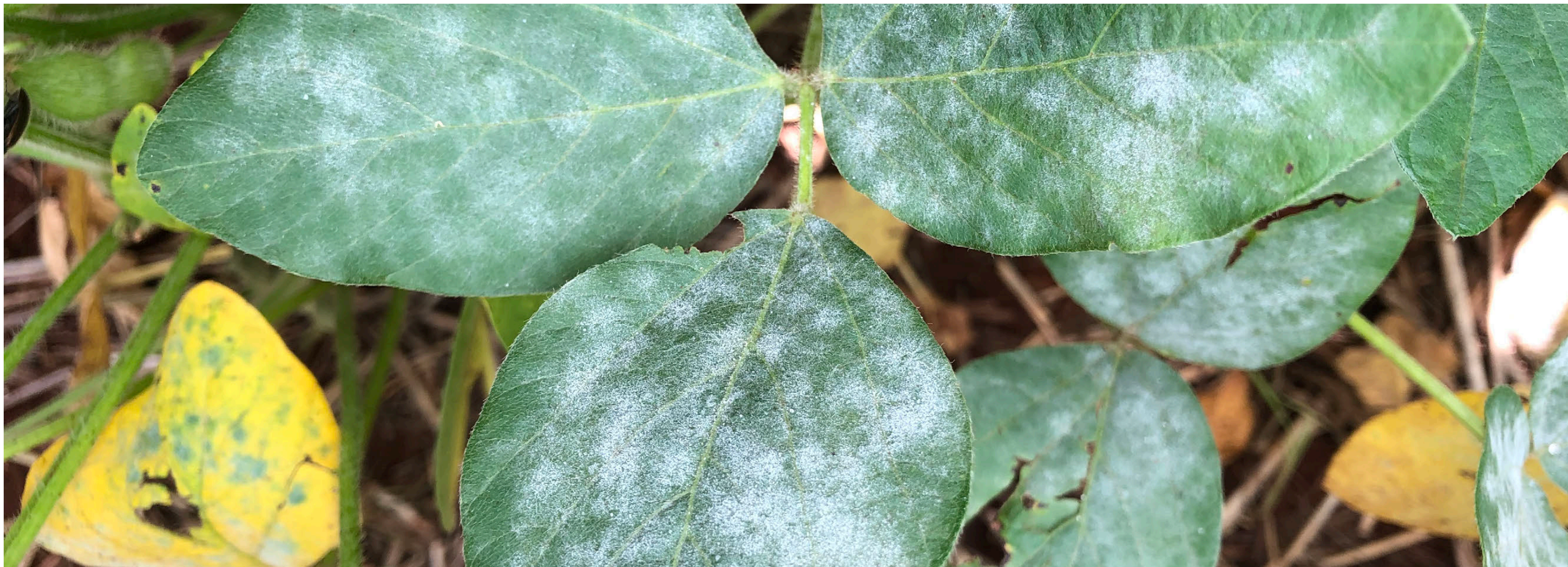
Phomopsis seed decay – *Diaporthe longicolla*, *D. ueckerae*

***Powdery mildew** – *Microsphaera diffusa*

***Cercospora leaf blight** – *Cercospora spp.*

***White mold** – *Sclerotinia sclerotiorum*

***Asian soybean rust** – *Phakopsora pachyrhizi*



Powdery mildew

Microsphaera diffusa

Premature defoliation

Cool temperatures

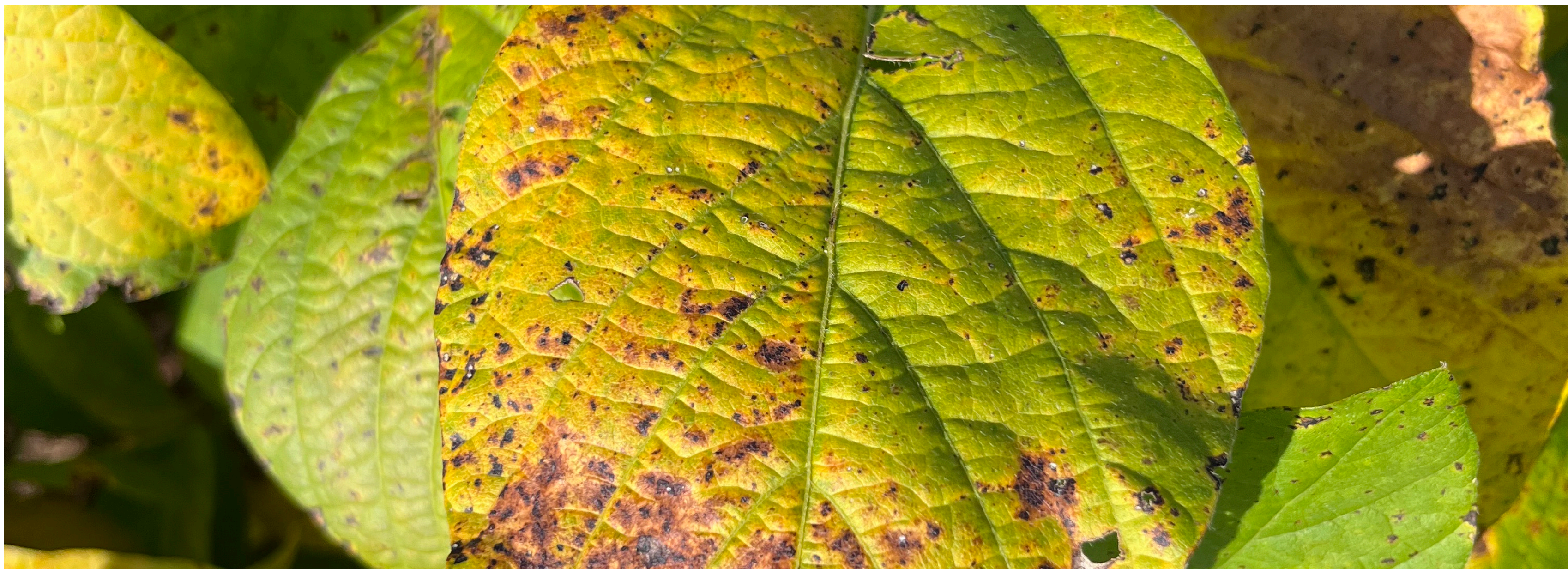
Losses 10-50%

Control:

Resistant varieties

Fungicides - R3 to R5.1

Benzimidazoles (MBC), triazoles (DMI)



Cercospora leaf blight

Cercospora cf. flagellaris and *Cercospora cf. sigesbeckiae*

Premature defoliation

Yield losses of up to 20%

-Control:

- Resistant varieties
- Clean seeds
- Crop rotation
- Seed Treatment
- Foliar Fungicides
R3 to R5.1

Benzimidazoles (MBC),
triazoles (DMI),
strobilurins (Qol),
carboxamides (SDHI)



White mold/ Sclerotinia stem rot

Sclerotinia sclerotiorum

3 - 4 million hectares
(altitude > 700 m)

Yield losses of up to 40%

Control:

- Certified Seeds
- Crop rotation (corn, rice, wheat)
- Wide row spacing
- fungicides applied as protectants before infection, especially during the bloom period (fluazinam, procymidone)



ASIAN SOYBEAN RUST

Phakopsora pachyrhizi

Premature defoliation – fewer pods, fewer seeds per pod, seeds of reduced weight

Yield losses of up to 90%

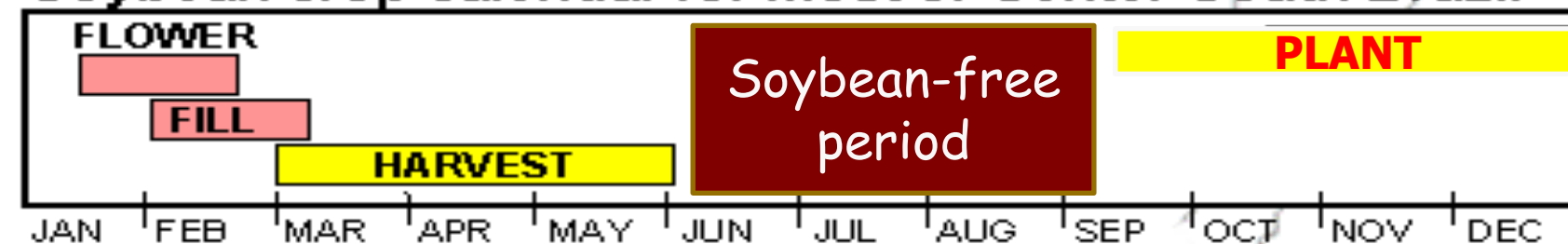
Most severe disease in soybean

Asian soybean rust: Control measures



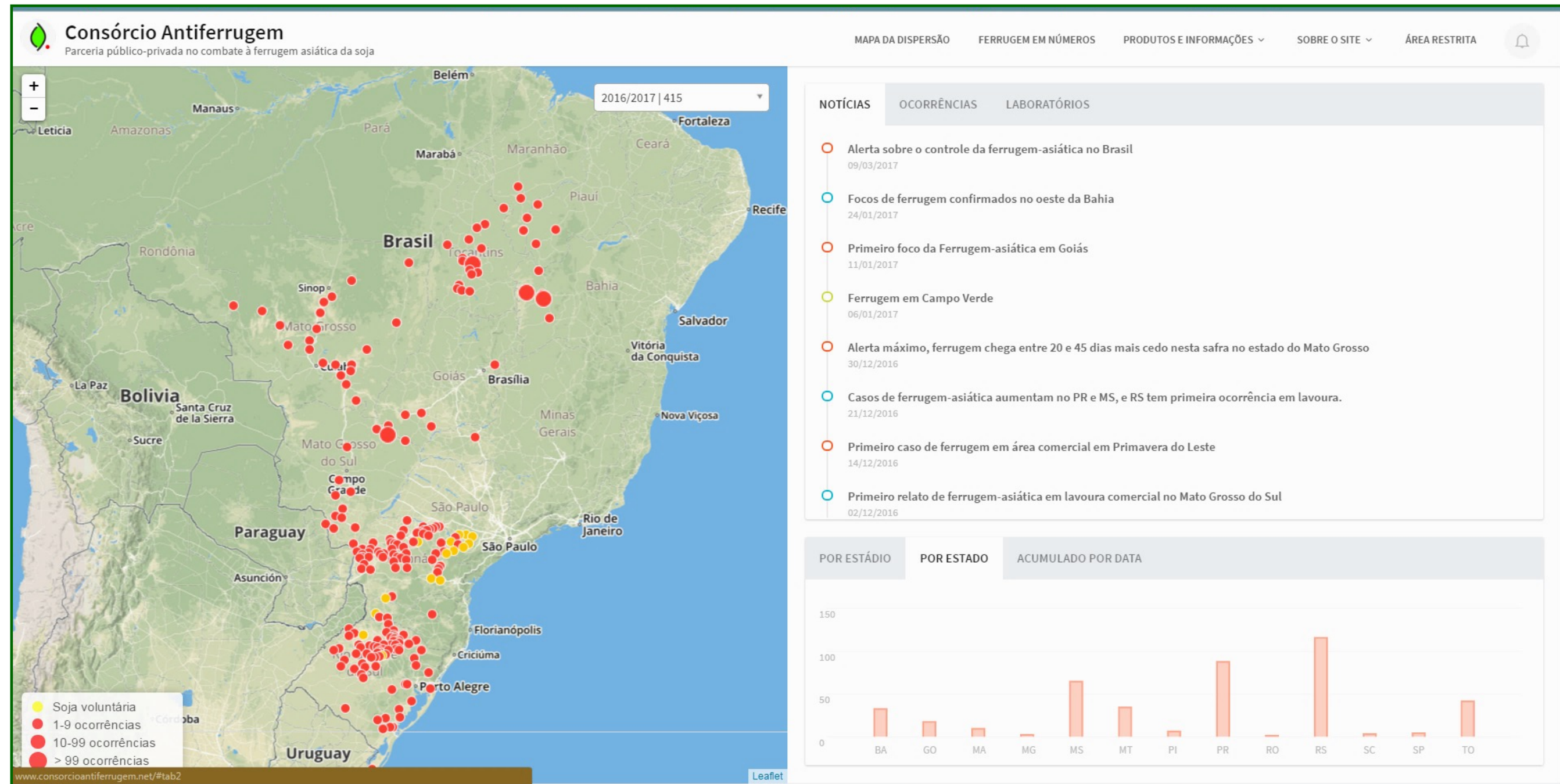
- Regulatory measures
 - Soybean-free period and sowing calendarization
- Escape - early cultivars sown at the beginning of sowing season;
- Genetic resistance;
- Monitoring the disease (favorability);
- Chemical control - fungicides

Soybean crop calendar for most of Center-South Brazil



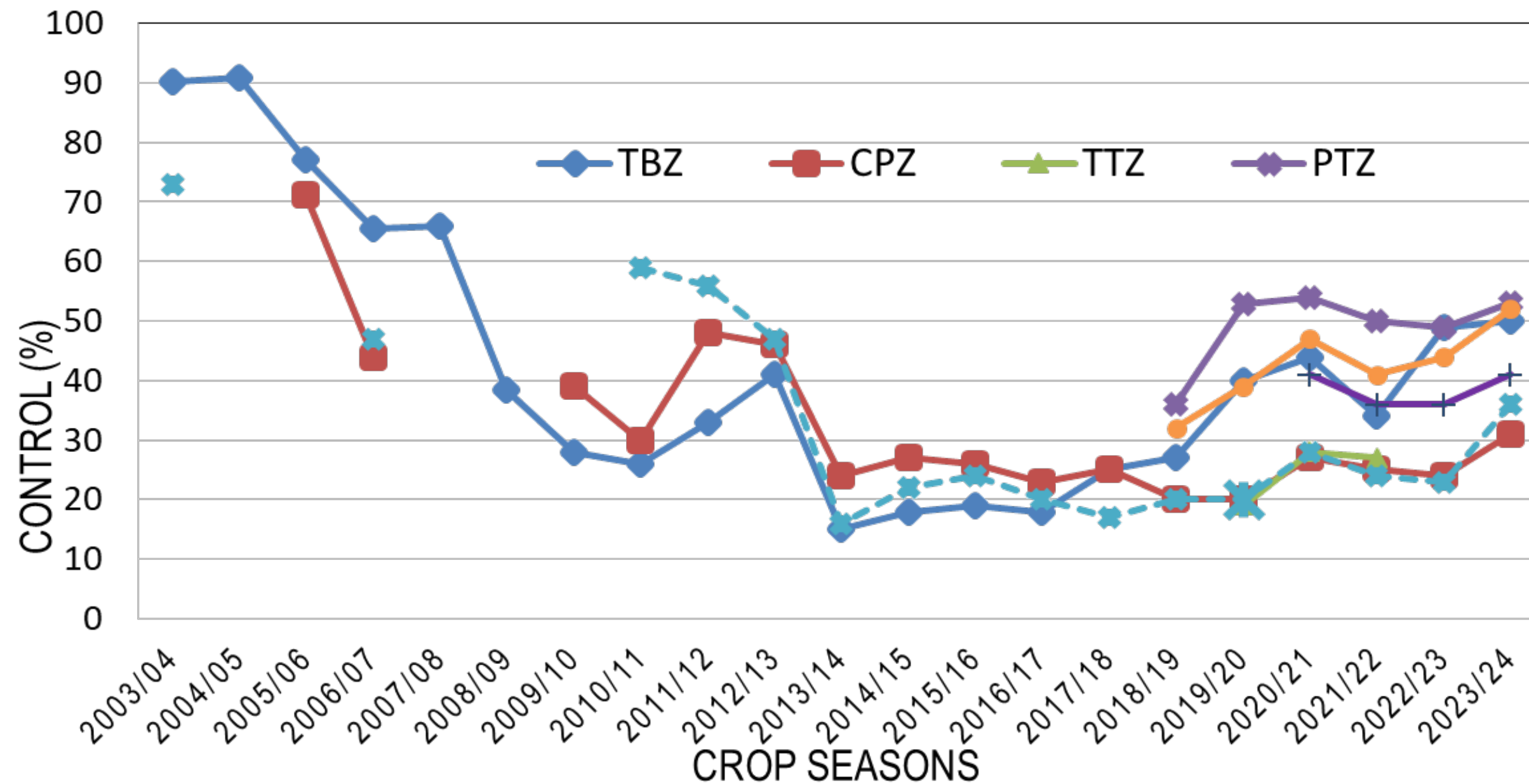
Website

www.consorcioantiferrugem.net



Asian soybean rust: Field trials network

TBZ (tebuconazol), CPZ (ciproconazol), TTZ (tetraconazol) e PTZ (protioconazol) - (IDM)
AZ (azoxistrobina), PCX (picoxistrobina) E MTM (metominostrobin) - (IQe)



Asian soybean rust: Chemical control

- Use commercial mixes:

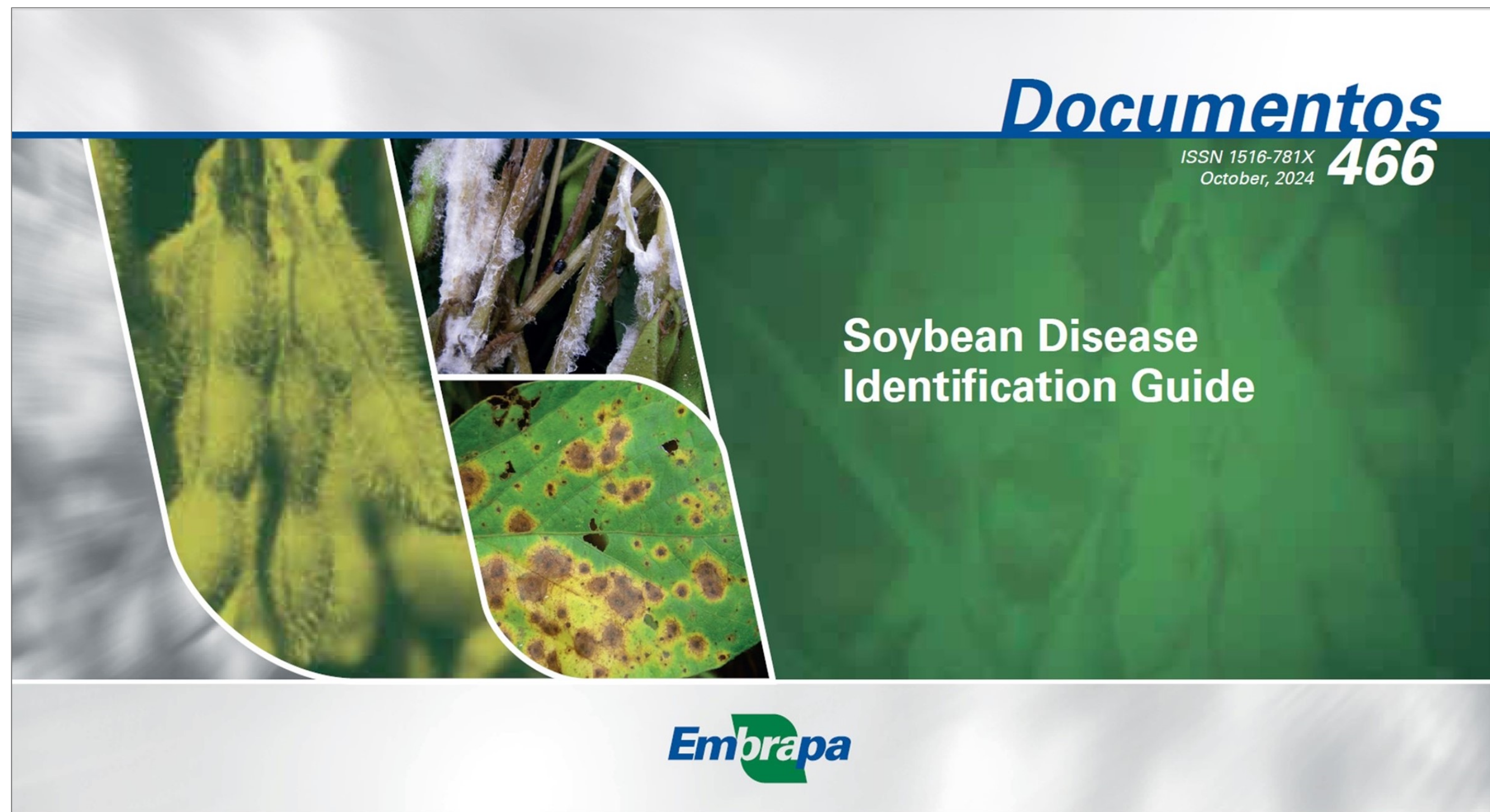
- ✓ Triazoles (DMI) + estrobilurin (Qol)

- ✓ Strobilurin + carboxamide (SDHI)

- ✓ Triazoles + carboxamide

- ✓ Triazoles + strobilurin + carboxamide

*Protective products
(multi-site) mancozeb,
chlorothalonil*



<https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1168245/1/Doc-466-ingles.pdf>

The Neotropical Brown stink bug (*Euschistus heros*) is the most prevalent species



Photo: J.J. Silva



Photo: J.J. Silva

Stink Bugs are currently managed with insecticide mixtures containing neonicotinoids and pyrethroids.

However, increasing resistance to these chemical groups is becoming a significant challenge.

Biological control with macrobiologicals

Parasitoids

Trichogramma pretiosum



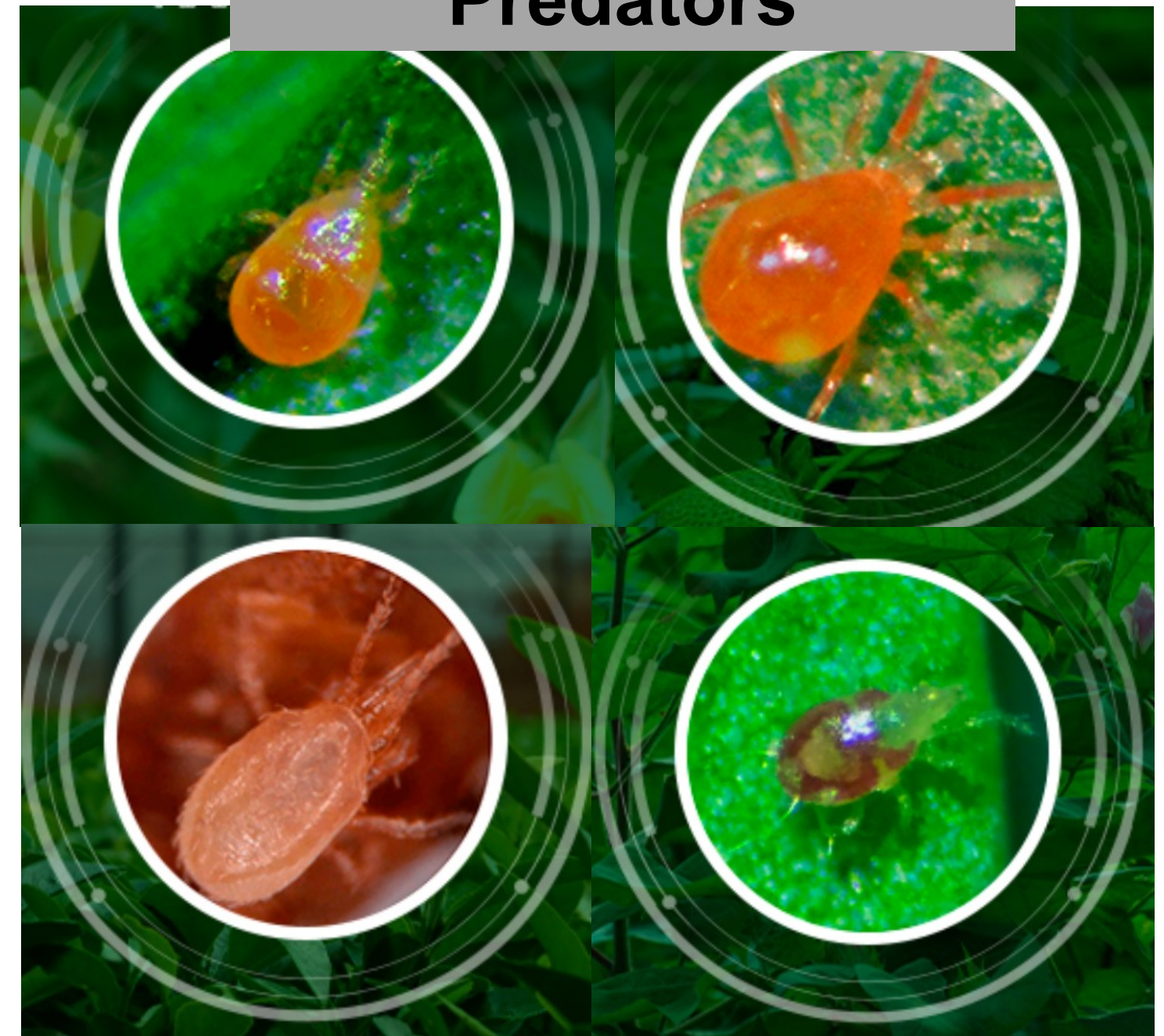
Telenomus podisi



Targets: *Anticarsia gemmatilis*
(soybean caterpillar)
Chrysodeixis includens
(false-measuring caterpillar)

Target: *Euschistus heros*
(brown bug)

Predators



Biological control with microbiologicals

Entomopathogenic fungi

Metarhizium rileyi
M. anisopliae s.l.
M. anisopliae var. *acridum*
Beauveria bassiana s.l.
Cordyceps amoenorozea
C. farinosa
C. fumosorosea
C. tenuipes
C. javanica

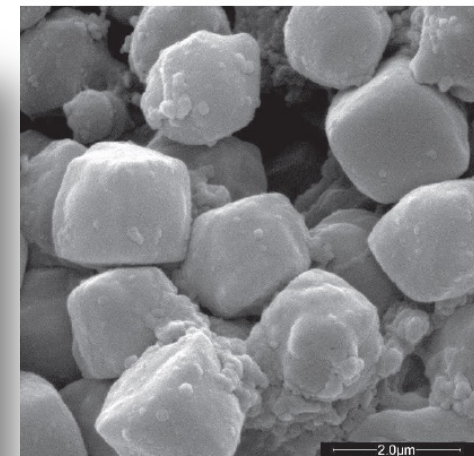


Targets: Bedbugs,
caterpillars, hornworms,
whitefly, etc

Entomopathogenic viruses

New strains for caterpillars:

Chrysodeixis includens nucleopolyhedrovirus
Rachiplusia nu nucleopolyhedrovirus
Helicoverpa armigera nucleopolyhedrovirus
Spodoptera cosmioides nucleopolyhedrovirus
Spodoptera eridania nucleopolyhedrovirus



WEEDS: “RESISTANCE RACE”



TOP FIVE GLYPHOSATE RESISTANT WEED SPECIES



SOURGRASS
Digitaria insularis

18.7 Mha

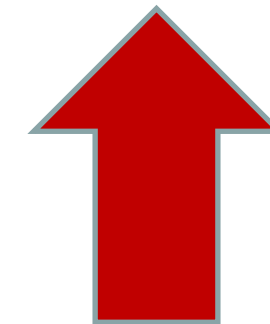
Diclosulam, Trifluralin,
Imazethapyr, s-Metolachlor



PIGWEEED or AMARANTH
Amaranthus sp.

4.2 Mha

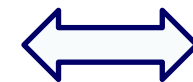
Imazethapyr, 2,4-D,
Dicamba, Fluroxypyr



Horseweed or Hairy fleabane
Conyza sumatrensis, C. bonariensis e C. canadensis

17.5 Mha

2,4-D, Diclosulam, Dicamba,
Diquat, Chlorimuron,
Flumioxazin, Imazapyr



GOOSEGRASS
Eleusine indica

8.6 Mha

Diclosulam, Trifluralin,
Imazethapyr, s-Metolachlor



RYEGRASS *Lolium multiflorum*

4.8 Mha

Paraquat, Diuron,
Glufosinate / + Trifluralin,
Imazethapyr



OTHER IMPORTANT WEED SPECIES



Bengal Dayflower, Tropical Spiderwort, or Indian Dayflower - *Commelina benghalensis*



**Morning glory
*Ipomoea purpurea***



**Shrubby false buttonweed
*Spermacoce verticillata***



**Wild radish or Jointed charlock
*Raphanus raphanistrum***

- *Euphorbia heterophylla* (Wild poinsettia, Mexican fireplan)
- *Cenchrus echinatus* (Southern sandbur ou spiny sandbur)
- *Bidens pilosa* (Black-jack, Beggarticks)
- *Richardia brasiliensis* (Tropical Mexican Clover)
- *Spermacoce latifolia* (Oval-leaf false buttonweed)
- *Tridax procumbens* (coatbuttons ou tridax daisy)
- *Murdania nudiflora* (Nakedstem Dewflower ou Doveweed)
- *Brachiaria plantaginea* (Alexandergrass)
- *Digitaria* sp. (Crabgrass)
- *Chamaesyce hirta* (Garden Spurge), ...

Integrated diseases management measures

- Use of resistant cultivars
- No-till cropping system
- Balanced plant nutrition (K, Cu, Mn, S, Zn)
- Soil management for better root growth
- Crop rotation/succession (with monocotyledons)
- Adequate plant population
- Seed treatment (fungicides and biologicals)
- Good seed quality
- Eliminating hosts and soybean volunteer plants
- Chemical and biological control

Thank you! Dankie!

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MINISTRY OF
AGRICULTURE, LIVESTOCK
AND FOOD SUPPLY