13th Meeting of Agricultural Chief Scientists (MACS)
Session 1: Science and Agriculture
Theme 1: Pathways to food security through science

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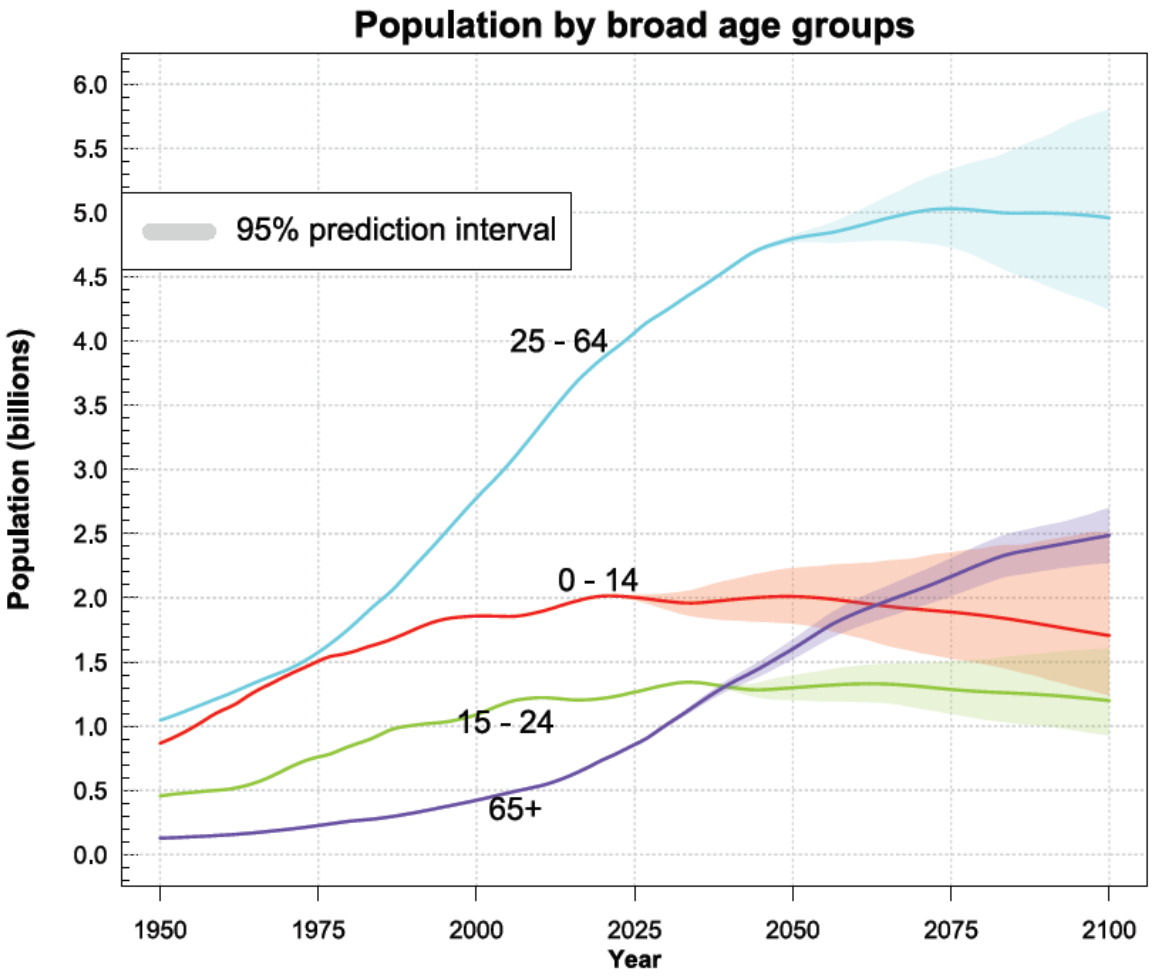
Outline

- 1- Global Population Growth and Critical Contexts
- 2- The Brazilian Ag Science & Innovation System supporting an Ag revolution in a tropical country
- 3- Scientific Trends and Impacts: Biotech and Digital examples
- 4- G20+ Ag International Cooperation
- 5- Final Remarks

1 World Population Growth and Impact on Food Production



2050- ~10 billion inhabitants

"Few" Questions:

- Climate Change (water and heat stress in plants)- resilient agriculture
- Nexus "Food-Water-Energy"
- Food-Nutrition-Health connection
- Increase of relevance of Agriculture and Food Industries
- Economic & Governance systems

https://population.un.org/wpp/Graphs/DemographicProfiles/Line/900

Climatic Emergency- Rio Grande do Sul (RS) State, Brazil- May, 2024

May, 12

- 145 deaths confirmed
- 131 disappeared
- 2 million impacted people
- Impact on agriculture (rice, fruits,..)
- 4 Embrapa's Centre's located in the RS state

Porto Alegre Metropolitan Region, Population: 4.3 million, HDI= 0,762 (high)

2 The Brazilian Agricultural Research System

16 State Research Networks OEPAS

70 Agricultural Universities

The Brazilian Agricultural Research Corporation
43 Embrapa Centers (created 1973)

Private Sector

- Brazil has an active and growing private sector, with national and multinational companies
- More recently Startups- 1,953 AgTechs (2023)

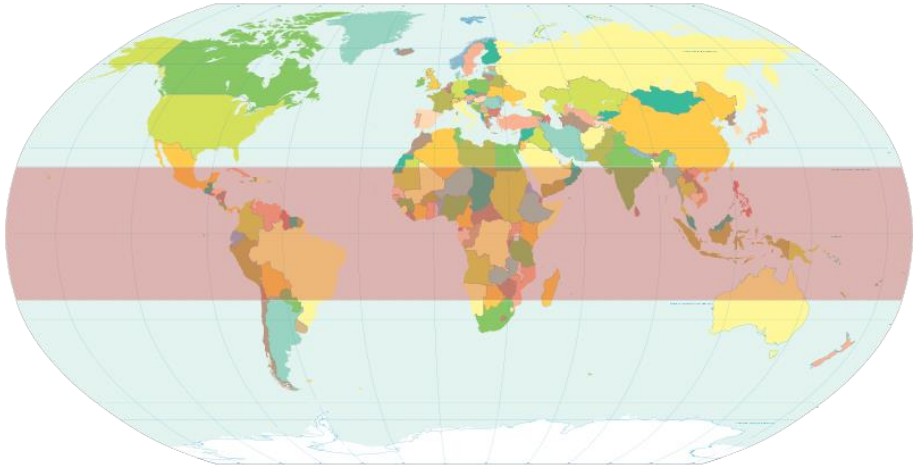
Embrapa- currently 7,680 employees (hiring in 2025)

Investment in qualifications abroad and in different areas of knowledge and professional activities (journalists, for example).

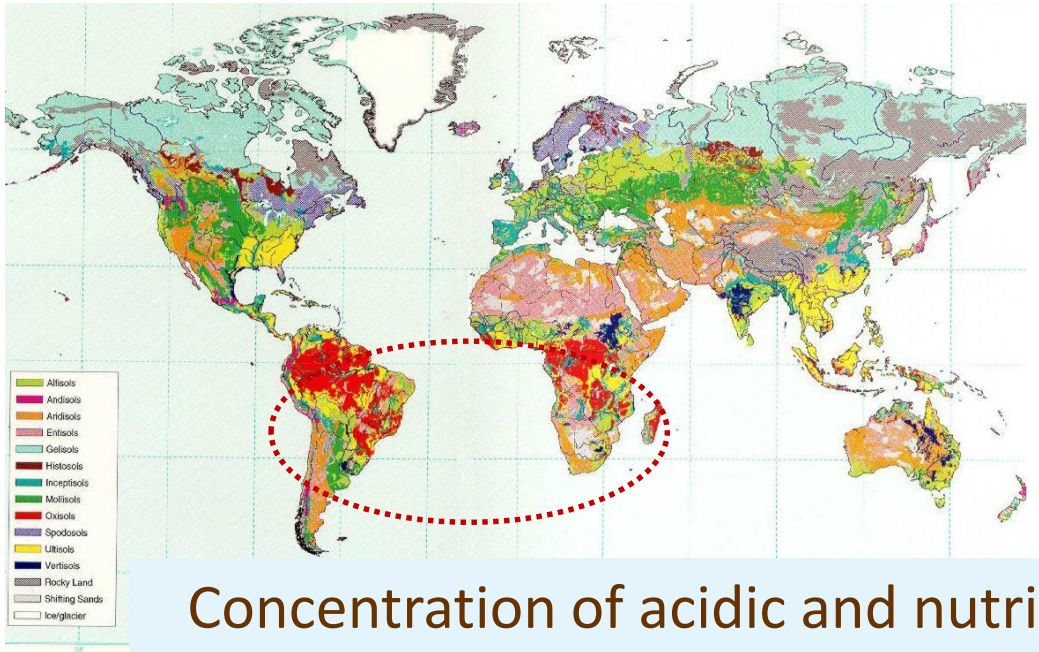
ACADEMIC BACKGROUND*	RESEARCHER	ANALIST	TOTAL	%
AGRONOMY	1345	201	1546	32
BIOLOGY	224	78	302	6
VETERINARY	147	-	147	3
FOREST ENGINEERINGENG	95	-	95	2
HUSBANDRY	88	-	88	2
CHEMISTRY	36	78	114	2
ECONOMY	28	74	102	2
LAW	-	105	105	2
JOURNALISM, PUBLIC RELATIONS (SOCIAL COMMUNICATION)	-	193	193	4
MANAGEMENT	-	272	272	6
ACCOUNTANT	-	166	166	3
OTHERS (PHYSICS, MATERIAL ENGINEERING, ELETRONIC ENGINEERIGNG, MECHANICAL ENGINEERING, CHEMICAL ENGINEERING, FOOD ENGINEERING)	468	1284	1752	36
TOTAL	2431	2451	4882	

*ONLY ACADEMIC BACKGRUND - NOT NECESSARILY MEAN WORK AREA IN EMBRARPA.

Trajectory of Brazilian Agriculture
Challenging Tropical Environments



Most of the Brazilian Territory is Located in the Tropical Belt of the World



Tropical Soils

Acid – 84%

Saline – 2%

Shallow – 7%

Flooded – 16%

No problem – 9%

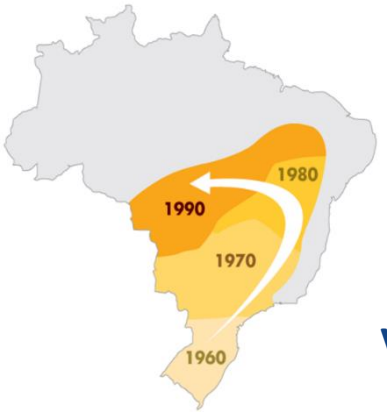
Concentration of acidic and nutrient-poor soils in the tropics

<u>No model to copy</u> - decision to develop a science-based tropical agriculture model for Brazil. In the 70's Brazil was a net food importer

Source : NHQ/NRCS/USDA

Trajectory of Brazilian Agriculture

EXPANSION



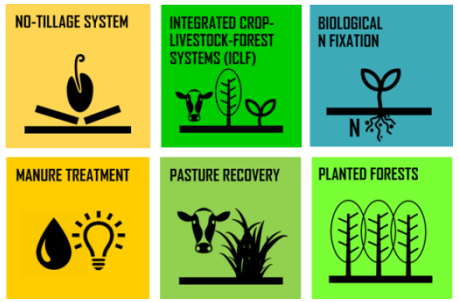
Transformation of acidic and poor soils into fertile soil

SPECIALIZATION

"Tropicalization" of varieties and animals

SUSTAINABILITY

Development of a Sustainable Production Platform



2030...

MULTIFUNCTIONALITY

Agriculture...

- … Brazilian **Low Carbon Agriculture Plan**
- ...Food – Fibers – Energy...
- ...Feed – Nutrition – Health...
- ...Environmental Services – Ecosystem Services...
- ...Biomass – Biomaterials – Green Chemistry...
- ...Biofactories – New Manufacturing Processes...
- ...Microbiome – Bioinputs – Bioprocesses...
- ...Culture – Tradition – Gastronomy – Tourism...

Science-based development

Brazil can have three harvests per year

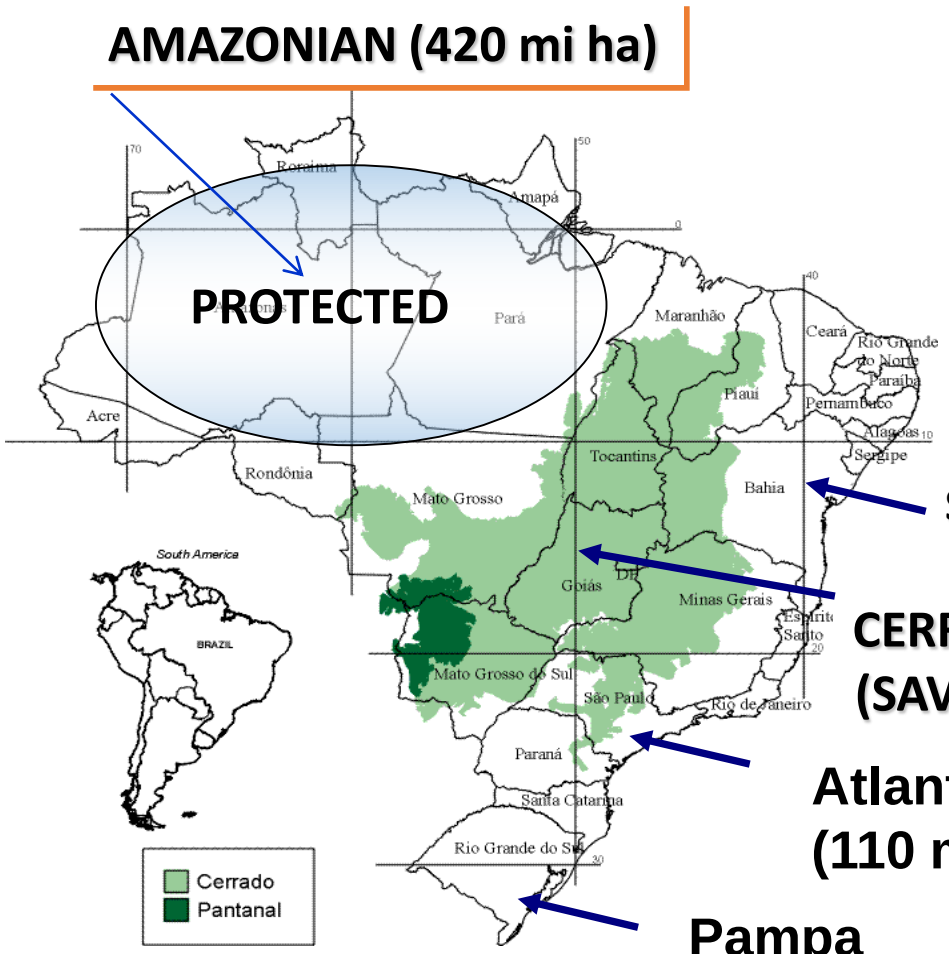
Corn

Pasture

Soybean

October ---------- February ---------- May ---------- September

Brazilian Biomes and Land-Use



Total area	850 M ha
Amazonian and other preservation areas	500 M ha
Potential of Agricultural Land	350 M ha
Today- Grains and perennial	70 M ha (sugarcane- 8 M ha; reforestation- 6 M ha)
Pasture-	190 M ha
Other Areas	90 M ha

Pasture conversion to grains, integrated systems, perennial fruit trees, planted forest, others

Global and Brazilian Food Security Contribution

Sufficient food production to 203 million of inhabitants and exportation of around 300 products to 180 countries (around 20% of total is exported)

322

MILLIONS (
(2022/23)

GRAIN

ONS OF TONS
)

UITS

29.6

MILLIONS O
(2023)

MEAT

OF LITERS

MILK

Economy (2023)

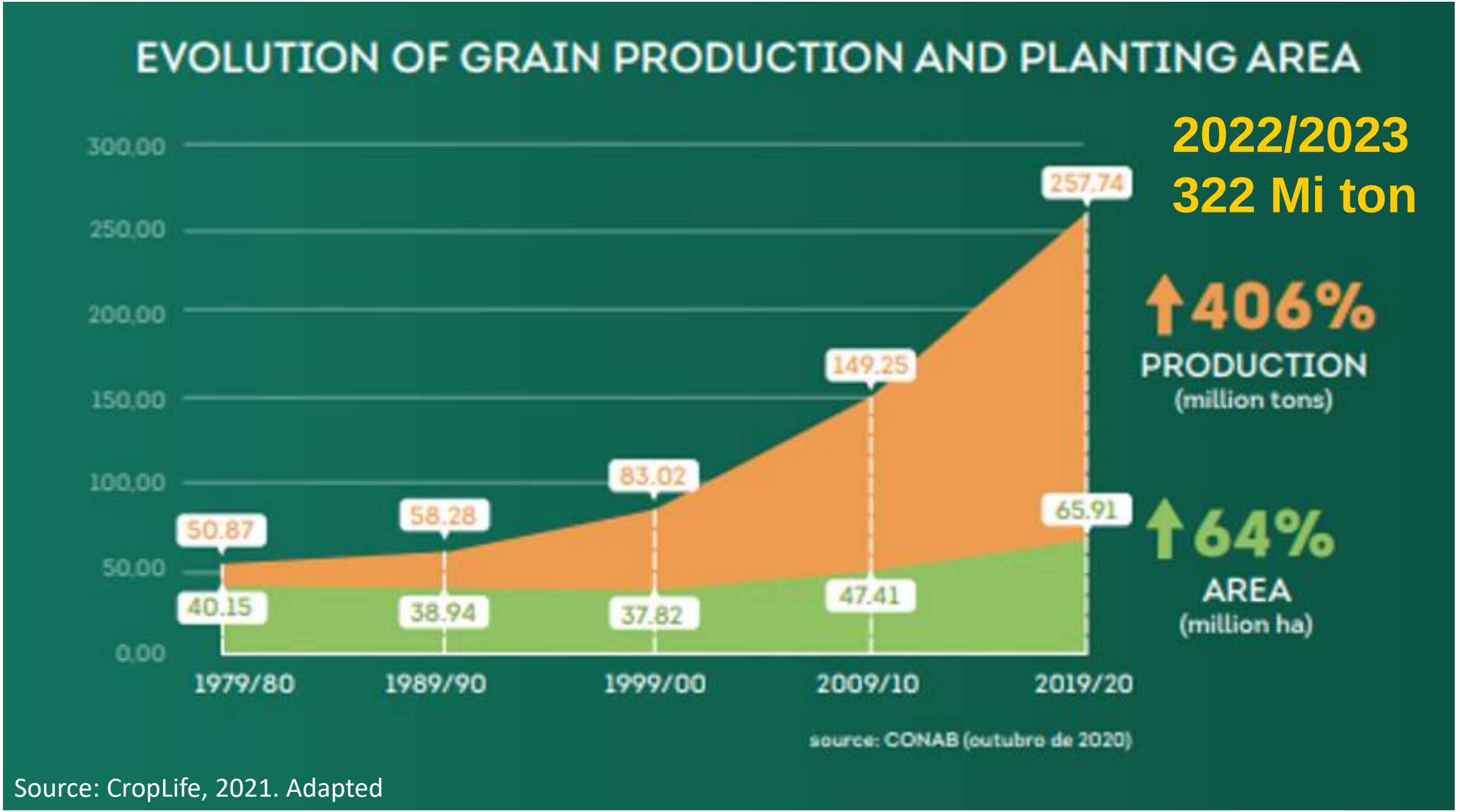
- 24% GDP

(US$ 523 billions)

- 49% exportation

- 27 % of Jobs

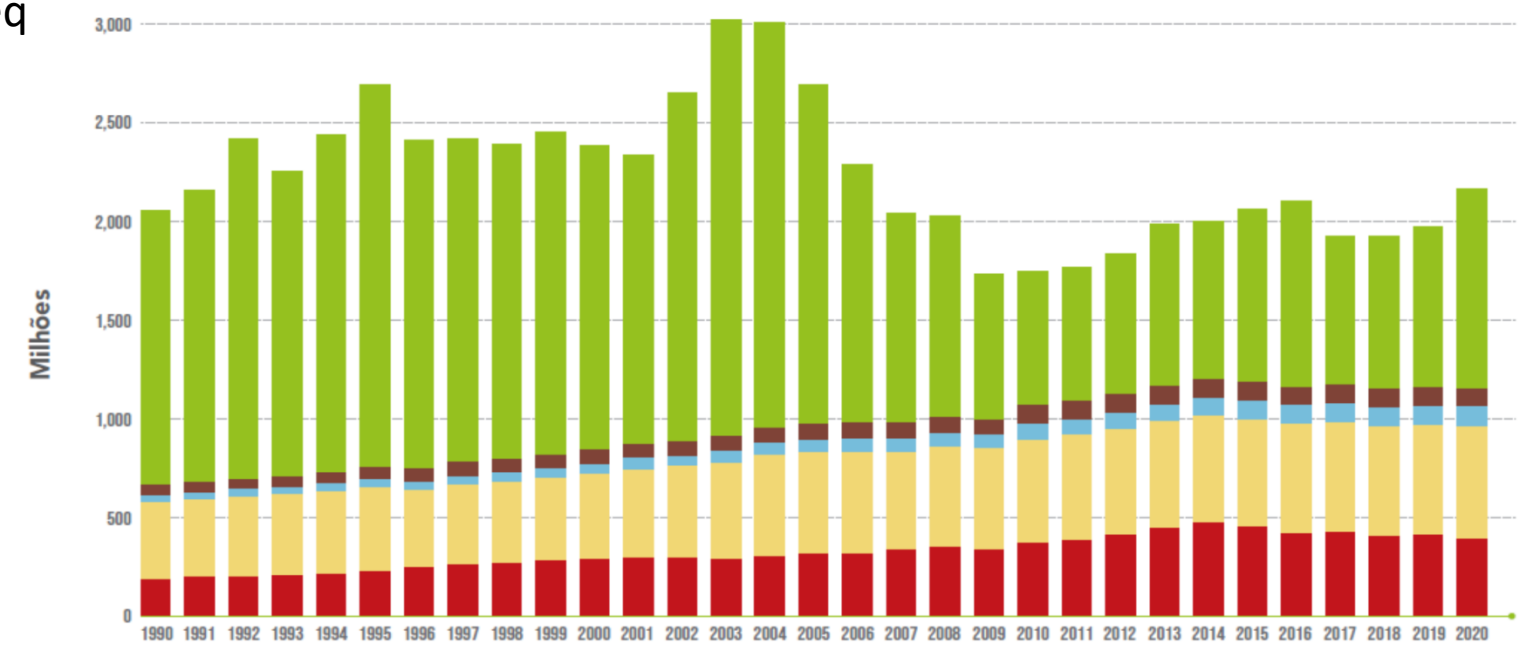
Sources: IBGE, Conab.
Adaptation and update Embrapa



Source: CropLife, 2021. Adapted

Greenhouse Gases Emission- Brazil Period 1990 – 2020

Gt CO_2 eq



Energy

Industrial Processes

Agriculture

Land use changes and forest

Residues

SEEG. Análise Das Emissões Brasileiras De Gases De Efeito Estufa E Suas Implicações Para As Metas De Clima Do Brasil 1970-2020, p. 3, 2021

3 Sequencing and assembly of the reference genome of P. pachyrhizi

International Consortium among public and private companies

JGI MycoCosm
THE FUNGAL GENOMICS RESOURCE

JGI HOME | GENOME PORTAL | MYCOCOSM | PHYCOCOSM | LOGIN

Home • Phakopsora pachyrhizi MG2006 v1.0

SEARCH | BLAST | BROWSE | ANNOTATIONS | MCL CLUSTERS | SYNTENY | DOWNLOAD | INFO | HOME | STATUS | HELP!

Phakopsora pachyrhizi is responsible for the Asian Soybean Rust (ASR) disease and is the major pathogen of soybean. It causes severe losses in almost all soybean-growing areas. Nearly 300 billion tons of the legume are produced annually, and used primarily as feedstock and for bioenergy production. Yield damage caused by ASR can be dramatic (reported cases from 60 percent in the US, to total losses in tropical regions). Today, the use of fungicides is the main way to control this disease. So far, breeding approaches to identify durable and race-independent disease resistant germplasm were unsuccessful. In order to sustainably protect soybean against rust disease in the future, a range of different strategies can be foreseen like chemical or biological product application or plant modification by breeding or trait approaches. In all cases, a better knowledge of the biology of *P. pachyrhizi* could clearly foster disease management programs.

JGI will host the genome sequences of three *P. pachyrhizi* isolates (K8108, MG2006 & PPUFV02) of which one is assembled at chromosome level (PPUFV02). The three genomes will be repeat masked and annotated in the same way facilitating direct comparisons and inferences for the community. This portal summarizes annotations of isolate MG2006 while all three assemblies are available from the download page under JGI Data Utilization Policy.

- ✓ *Three reference genomes (long and short reads / Hi-C)*
- ✓ *The assembled genome size is around 1.05 Gb (Soybean Genome 1.2 Gb) - The biggest genome among the plant pathogens species*
- ✓ *Highly repetitive - (TE invasion) - more than > 90% of genome is similar to transposons / retrotransposons*
- ✓ *High levels of heterozigosity - the 2 nucleis in dicaryo are not similar*

Genome Assembly	
Genome Assembly size (Mbp)	1057
Sequencing read coverage depth	142.8
# of contigs	7465
# of scaffolds	7464
# of scaffolds >= 2Kbp	7464
Scaffold N50	1110
Scaffold L50 (Mbp)	0.22
# of gaps	
% of scaffold length in gaps	0.0%
Three largest Scaffolds (Mbp)	3.05, 2.57, 2.17

YK Gupta, FC Marcelino-Guimarães, C Lorrain, AD Farmer, S Haridas, ... bioRxiv, 2022.06. 13.495685. Nature Communications - Submitted.

INNOVATION

OPEN INNOVATION COOPERATION: LIBS to soil C

Embrapa Instrumentação- Startup Agrorobótica
(since 2015)

AgLIBS- AI: soil C content, soil fertility and texture

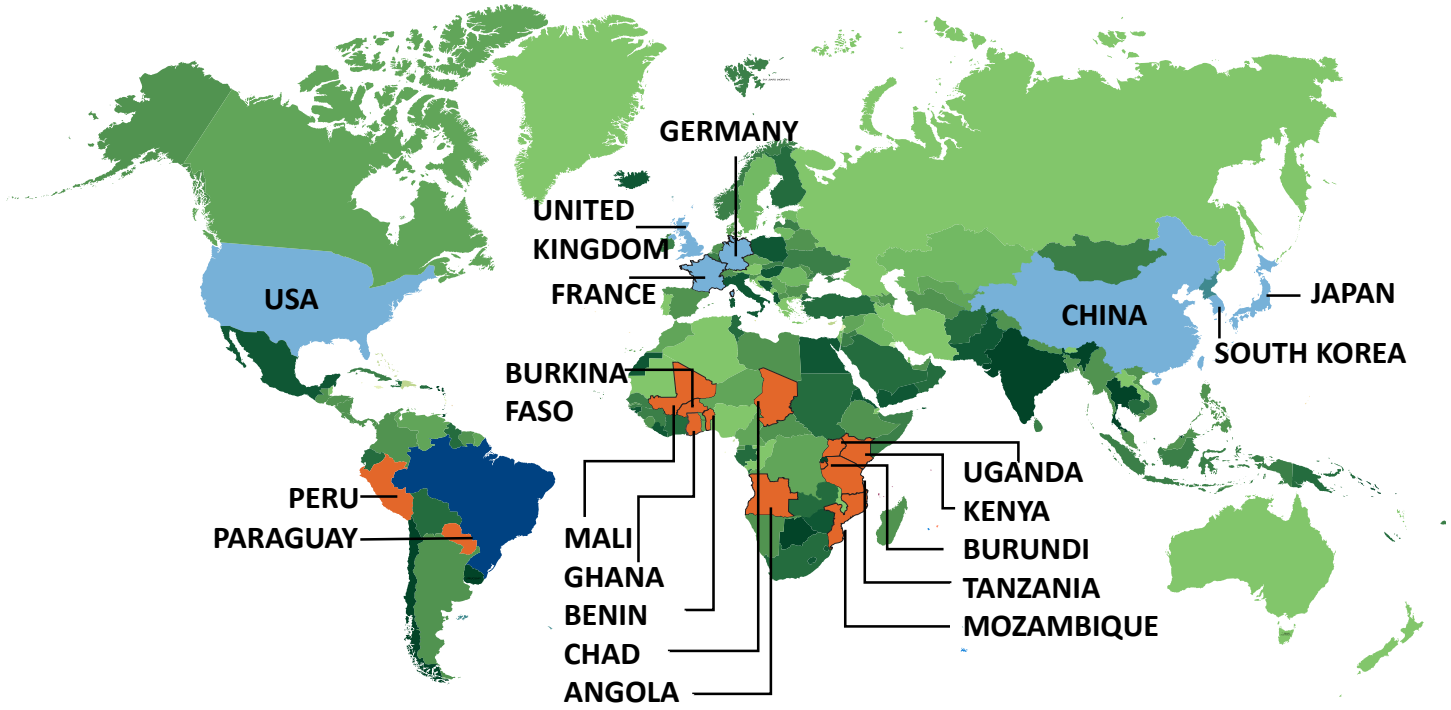
- 1,200 samples/day (10+ times faster than CHN Analyzer)
- Analytical quality with C analysis cost reduction (to facilitate Soil C market)
- Digital data- soil maps

Babos, D. V., ..., Martin-Neto, L. **Milori, Debora**. 2024- Frontiers in Soil Science, DOI 10.3389/fsoil.2023.1242647
PRO CARBON PROJECT COOPERATION WITH BAYER COMPANY (on-farm research)

4 Embrapa's main activity focuses abroad

Embrapa Virtual Labs – LABEX and Projects

(data from 2014, new contexts and possibilities)



TECHNICAL-SCIENTIFIC COOPERATION

TECHNICAL COOPERATION

Long term Storage- Genetic Bank- Embrapa

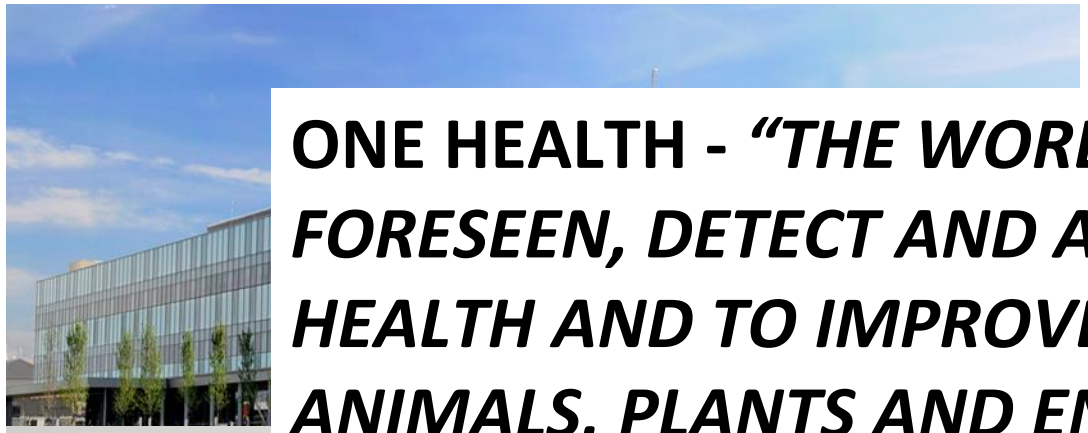
Back-up of all Embrapa's collections

- Located in Brasília- Embrapa Genetic Resources and Biotechnology Centre
- **700.000 samples capacity**
- ALELO- Data Base -vegetal, animal and microorganisms origin samples
- Launched 2014
- Third largest in the World
- Able to genetic material exchange
- **Embrapa is reviewing its breeding programs to priorize food security and resilience to climate change (plant and animal, micoorganisms for bioinputs)**

Embrapa Multiuser Labs

- Multiuser Bioinformatics Laboratory (LMB)
- Multiuser Laboratory of Chemistry of Natural Products (LMQPN)
- National Laboratory of Nanotechnology for Agribusiness (LNNA)
- National Reference Laboratory of Precision Agriculture (Lanapre)
- Multiuser Complex of Livestock Bio efficiency and Sustainability (CMB)
- Multiuser Laboratory of Biosafety for Cattle Farming (Biopec)
- Multiuser Laboratory of Molecular Biology (LMBM)
- Laboratory of Sustainable System Analysis (LASS)
- National Laboratory on Agri-Photonics (LANAF)

Embrapa Labex USA- Animal Health – H1N1 research (2009)
Avian Influenza on Dairy Cows- USA (2024)
ARS/NADC – Ames, Iowa



ONE HEALTH - *"THE WORLD ABLE TO PREVENT, FORESEEN, DETECT AND ANSWER TO THREATS TO HEALTH AND TO IMPROVE HEALTH OF HUMAN, ANIMALS, PLANTS AND ENVIRONMENTH, SUPPORTING SUSTAINABLE DEVELOPMENT"*

Marcus Kehrli- Former Director USDA-ARS-NADC

Janice Zanella- Embrapa Swine and Poultry

5 Final Remarks

- Global Food Security- top mankind priority, however challenges to food production most probable will be bigger than in the past (sustainable solutions). New approaches and scientific tools needed!
- Some topics relevant to international scientific cooperation: global climate change (CC) mitigation and adaptation, zoonosis, food safety, advanced technologies (IT, AI, biotech, nanotech,…), preventive genetic breeding (for anticipation to avoid new plant diseases and plagues), …
- Family and small farms challenges- technological transfer, rural extension, credits, farmers associations, cooperatives,…. – modernization (technologies)
- Role of public ag research? Very much needed mainly due to climate change mitigation and adaptation! So increase in public investments is critical. Improvement in administrative management, partnerships models (public-private), open innovation, international consortium cooperation, facility multiuser, others

Acknowledgments

- Thank you very much for invitation of **Silvia Massruha**, President of Embrapa, and Marcelo Morandi, Coordinator of 13th G20- MACS
- Thank you to several Embrapa's colleagues that shared slides and information
- Thank you all for kind attention!
- A very productive 13th G20-MACS!

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