Developing Transgenic Crops: The Brazilian Success Stories

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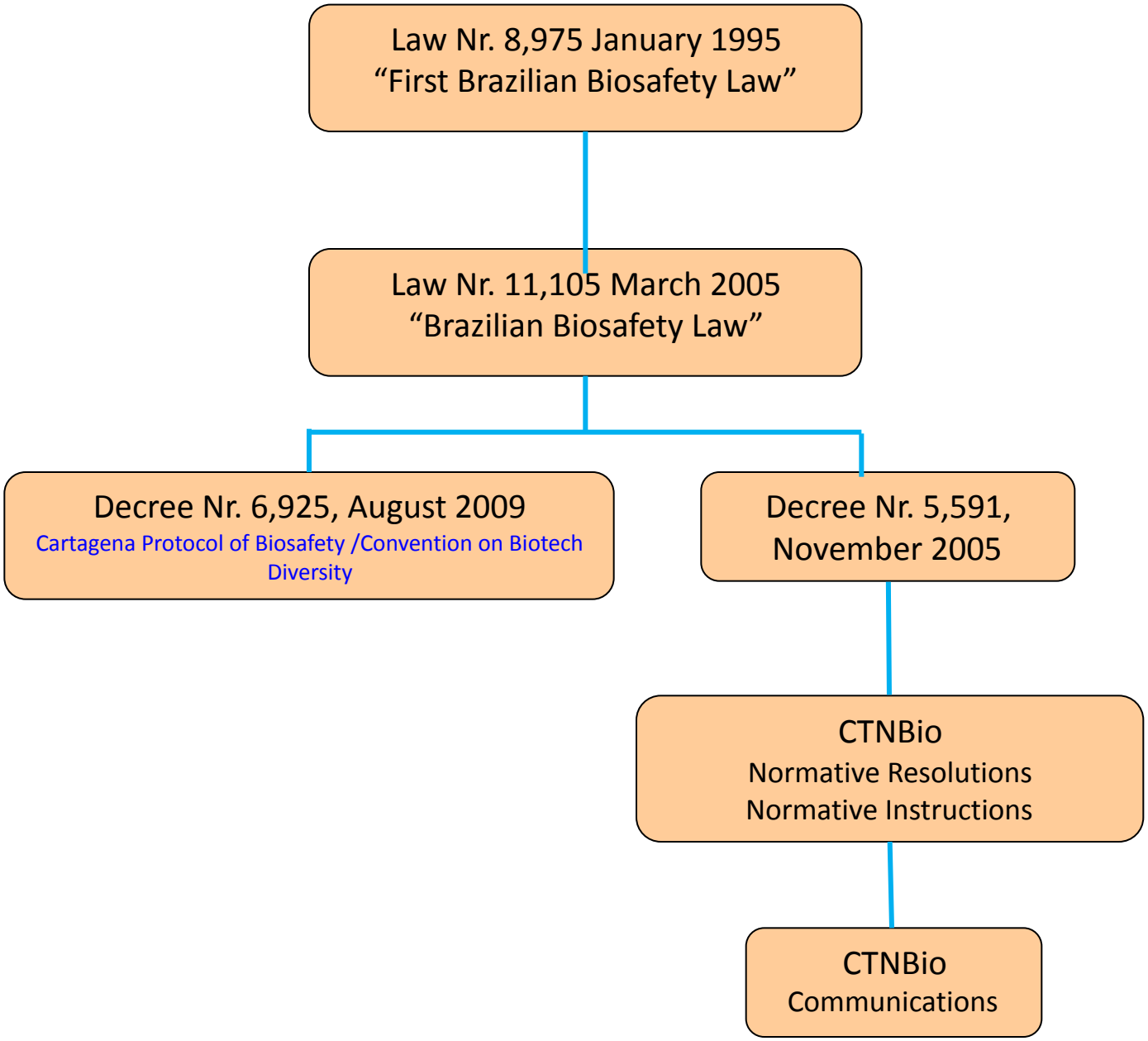
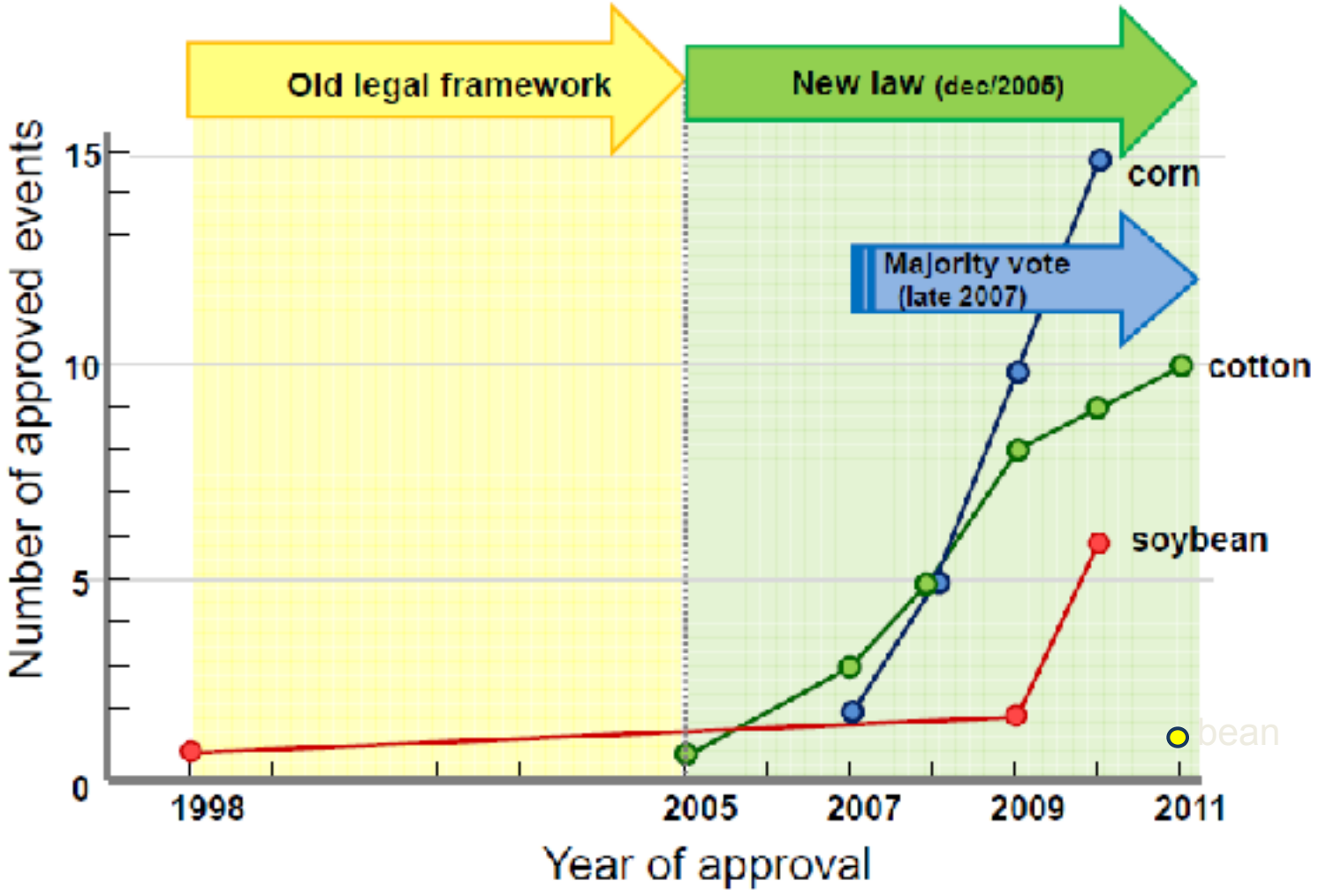
Presented at:
Stakeholder's roundtable on:
Genetically Modified Organisms in Nigeria: Facts and Fiction
Organised by:
The Nigerian Academy of Science
Golden Tulip Essential Airport Hotel
Lagos-Nigeria
15th November 2016

Brazilian Legislation on GMOs



GM Crops Approved in Brazil



Timing is important

Aragao 2011

63 Commercially Released Brazilian GMO's

Milho (20) Corn
T25 – Liberty Link
MON 810 – YieldGard
Bt11
NK 603 – Roundup Ready 2
GA21
TC 1507 – Herculex
MIR162 – Viptera
MON 810 x NK603 – YieldGard/RR2
Bt11 x GA21
MON 89034 – YieldGard VT Pro
TC1507 x NK603
MON 89034 x NK 603 – YieldGard VT Pro
Bt11 x MIR 162 x GA21
MON 88017 – YieldGard VT Rootworm/RR2
MON 89034 x TC 1507 x NK 603
TC1507 x MON 810 x NK 603
TC 1507 x MON 810
MON 89034 x MON 88017
TC1507 x DAS-59122-7
MIR604 e Bt11 x MIR162 x MIR604 x GA21

Feijão (1) Bean
EMBRAPA 5.1

Mosquito (1) Mosquito
OX513A

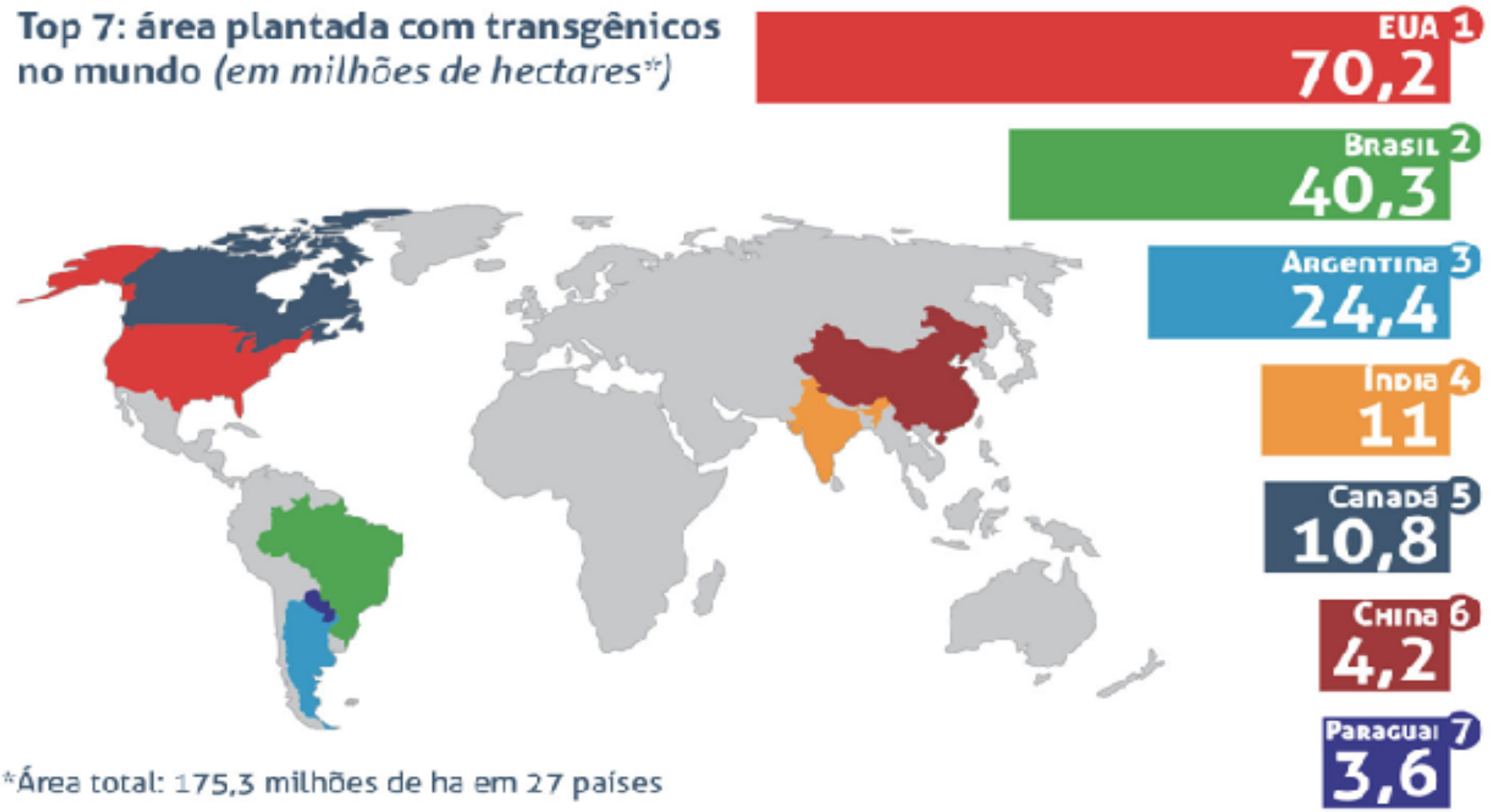
Algodão (12) Cotton
MON 531 – Bollgard I
LLCOTTON25 – Liberty Link
MON 1445 – Roundup Ready
281-24-236/3006-210-23 Widestrike
MON 15985 – Bollgard II
MON 531 x MON 1445
GHB 614 – GlyTol
GHB 119 x T304-40 – TwinLink
MON 88913
GlyTol x TwinLink
GlyTol x Liberty Link
MON 15985 x MON 88913

Soja (5) Soybean
GTS-40-3-2 – Roundup Ready
BPS-CV127-9 – Cultivance
A5547-127 – Liberty Link
A2704-12 – Liberty Link
MON 87701 x MON 89788 – Intacta RR2 PRO™

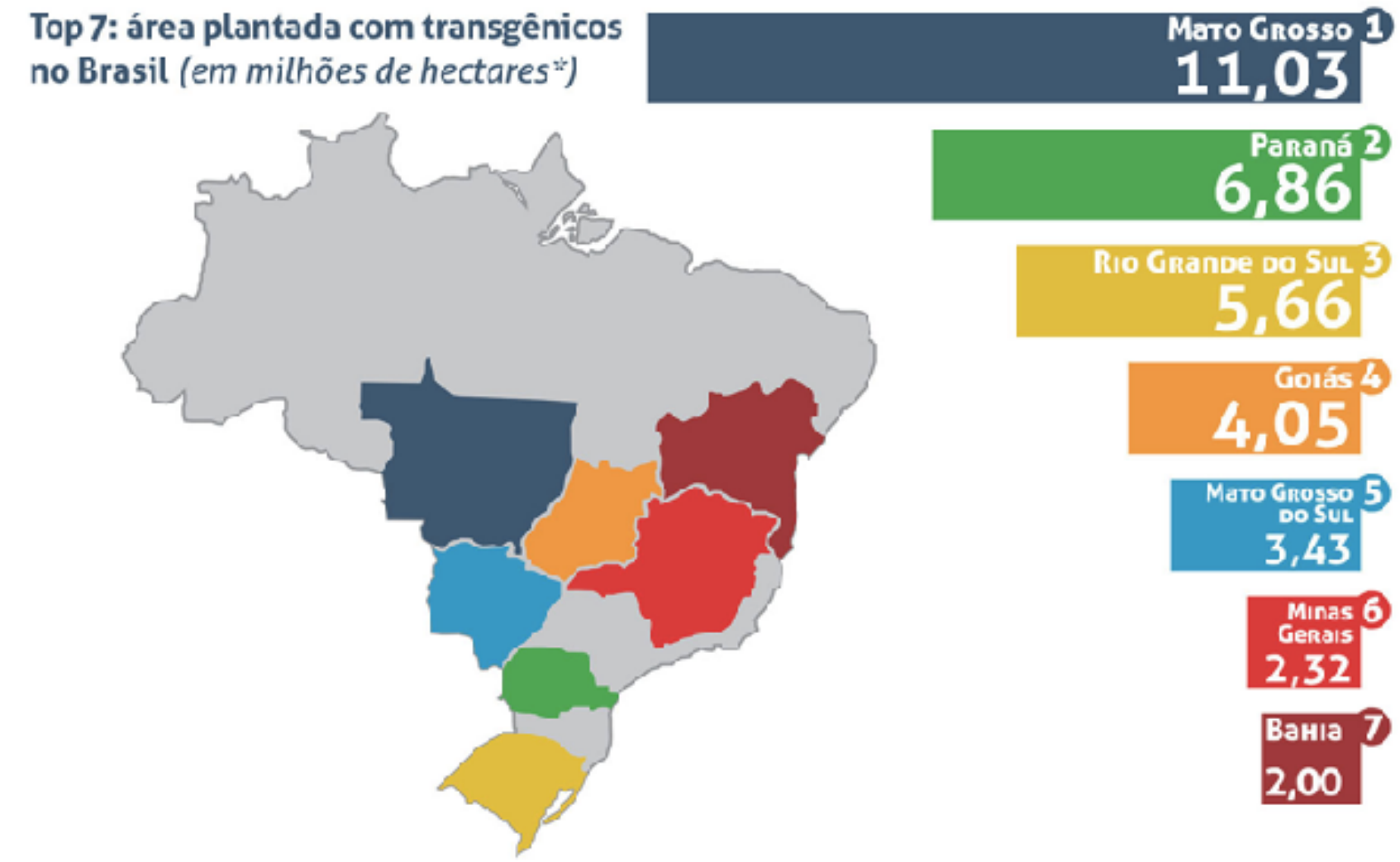
Microorganismo (5)
Levedura – linhagem Y1979
Levedura – linhagem Y5056
Microalga – linhagem S2014
Levedura – linhagem RN1016
Derivado de microalga GM linhagem S2014

Vacina (19) Vaccines
VAXXITEK MD/IBD
[illegible]
SUVAXYN PCV2
PORCILIS CIRCUMVENT
INGELVAC CIRCOFLEX
POULVAC E. COLI
VECTORMUNE FP MG+AE
VECTORMUNE – FP-MG
VECTORMUNE HVT NDV
VECTORMUNE HVT IBD
POULVAC ST
INNOVAX
VECTORMUNE FP-LT
VECTORMUNE FP LT+AE
INNOVAX ND
PROTEQ FLU TE
PROTEQ FLU
PROVAC Circomaster
[illegible]

Global Areas Planted with GM Crops



Areas Planted with GM Crops in Brazil



Commercial Release of GM Events

Number of commercial GM Events - JRC Global Pipeline report		
Crop	**2008 Report**	**2015 Prediction**
Soybean	1	17
Maize	9	24
Rapeseed	4	10
Cotton	12	27
Rice	0	15
Potatoes	0	8
Other	7	23
Total	33	124

NUMBER OF YEARS FROM DISCOVERY OF TRAIT TO FIRST COMMERCIAL SALE (MEAN VALUES)

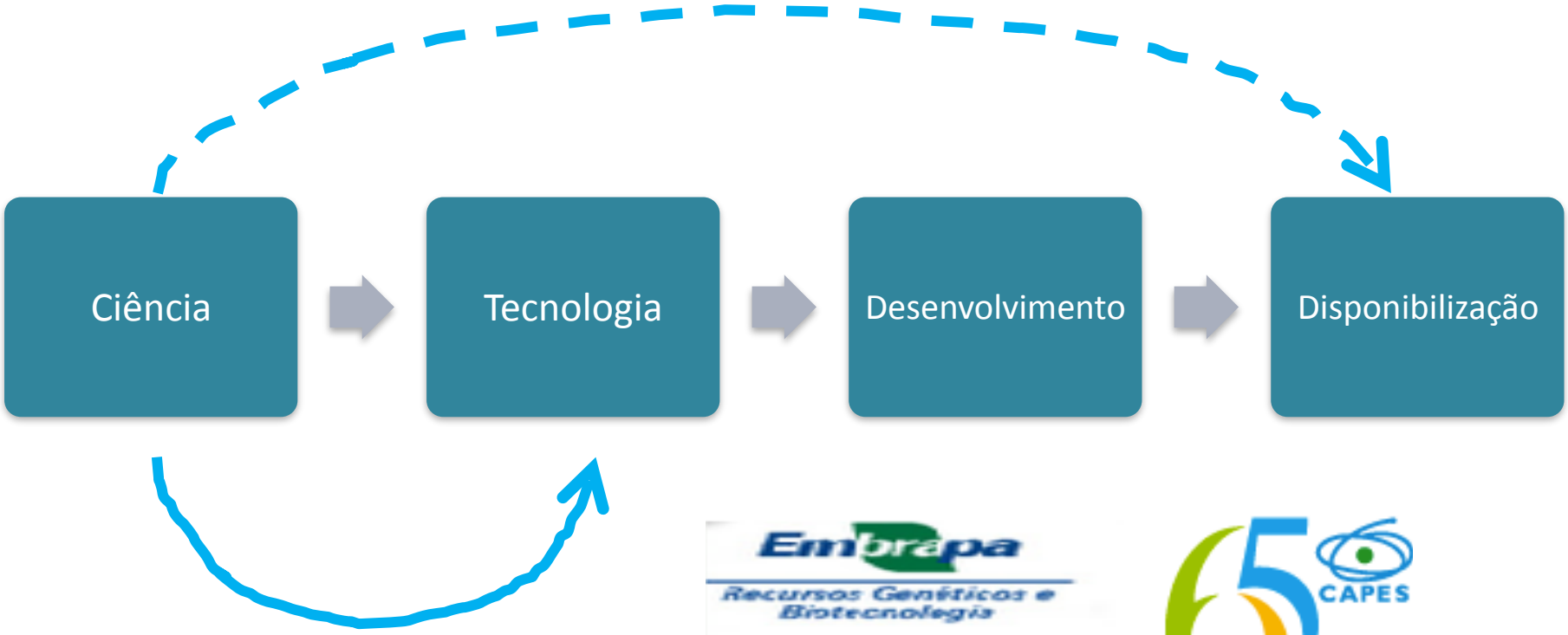
Canola	Corn	Cotton	Soybean	All crops
11.7	12.0	12.7	16.3	13.1

Labeling Law

Decree Nr. 4,680 (April 2003)
Threshold of 1% (species and modification)

Aragao 2011

The Success Stories



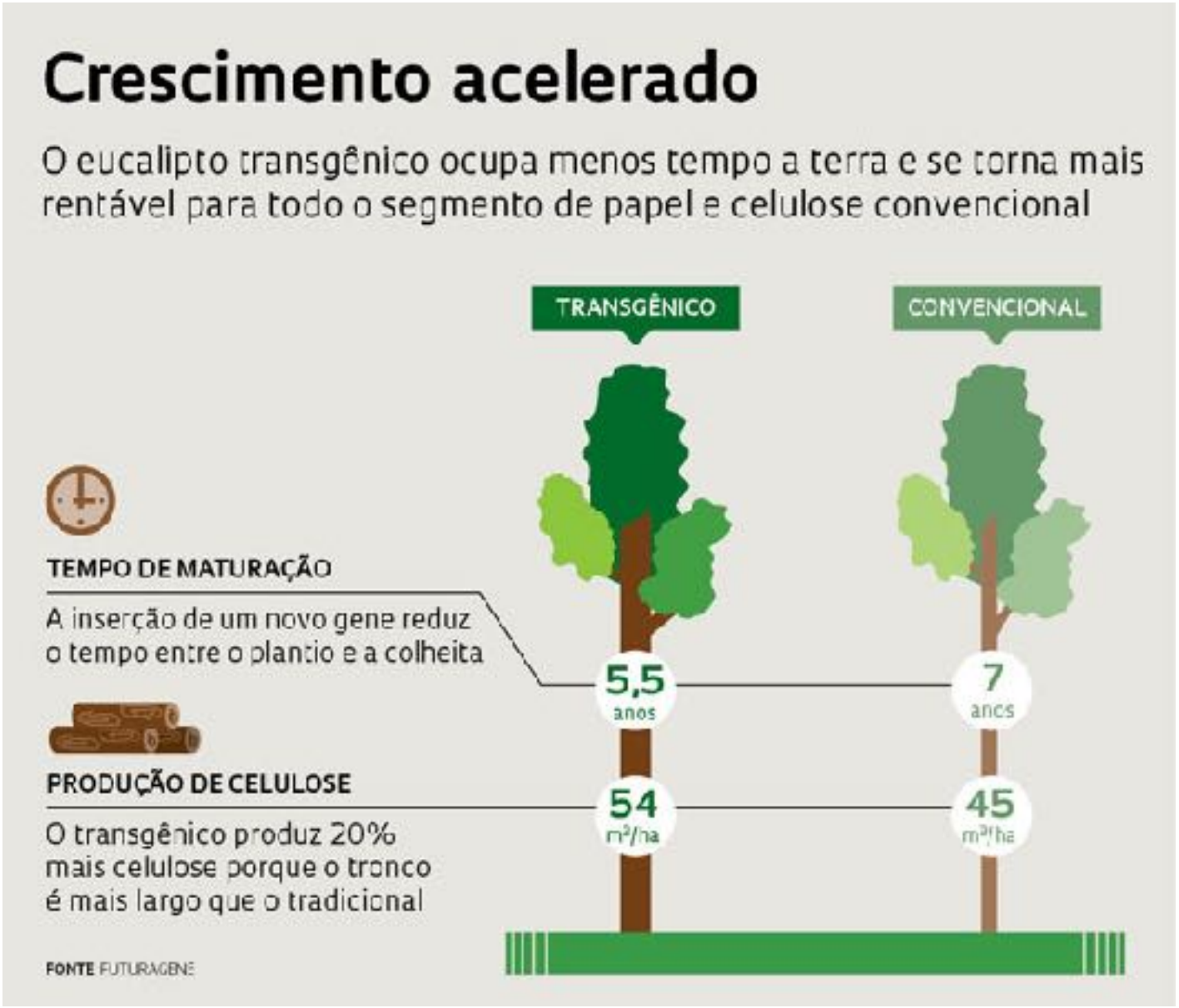
Embrapa Recursos Genéticos e Biotecnologia

65 anos CAPES

CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

Private Sector:
Nestle, Bayer, Syngenta, Dow, Monsanto, BASF etc

1. Transgenic Eucalyptus



2. Embrapa/BASF Cultivance® Soybean

Aragão and Rech

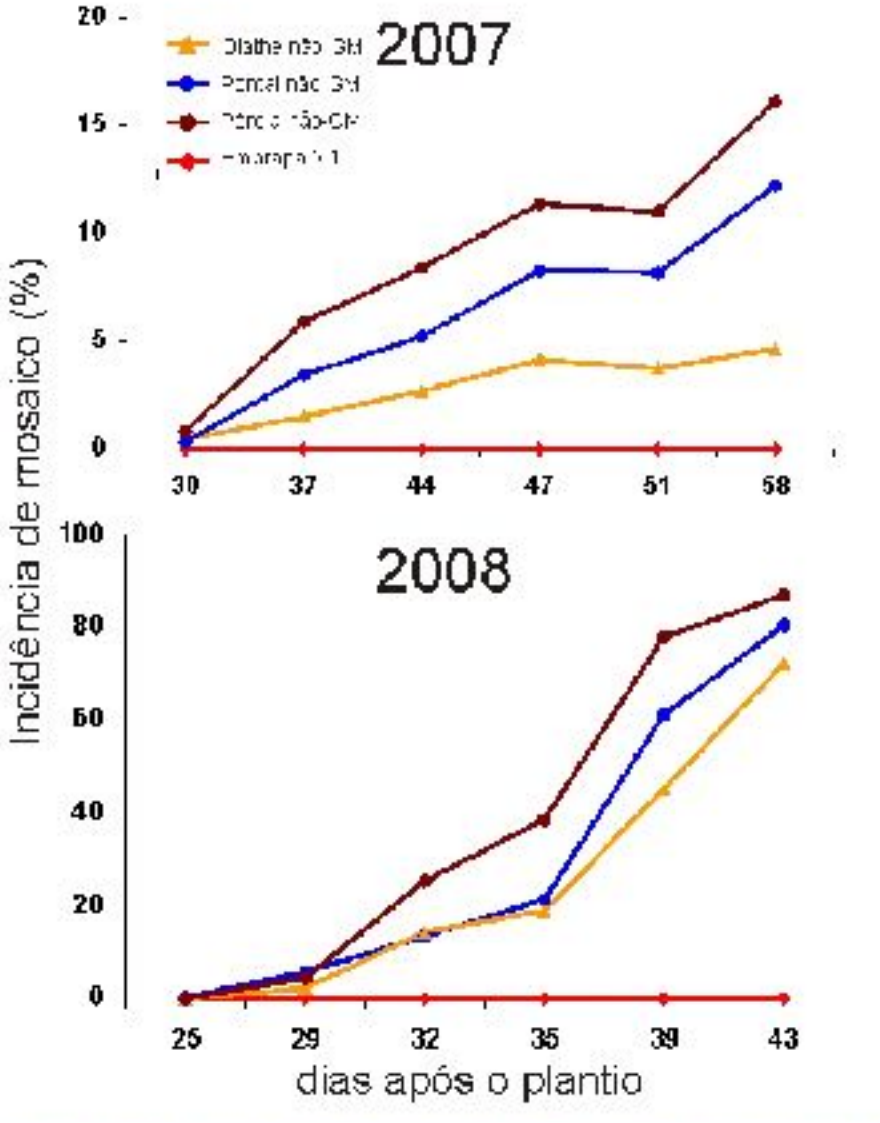
BASF
The Chemical Company

3. Imidazolinone tolerant soybean

Embrapa´s breeding program and biosafety analysis

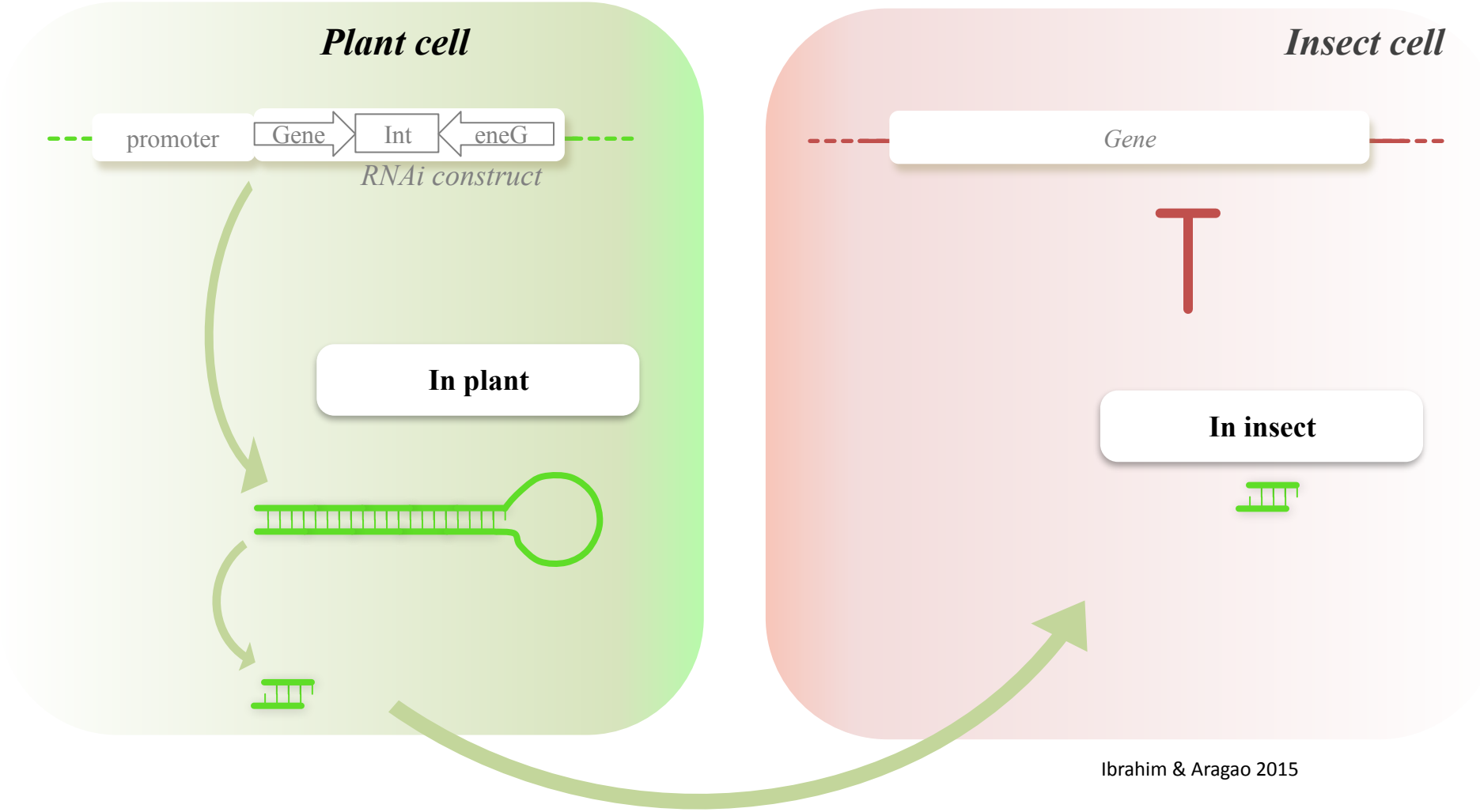
BASF
The Chemical Company

4. Transgenic bean



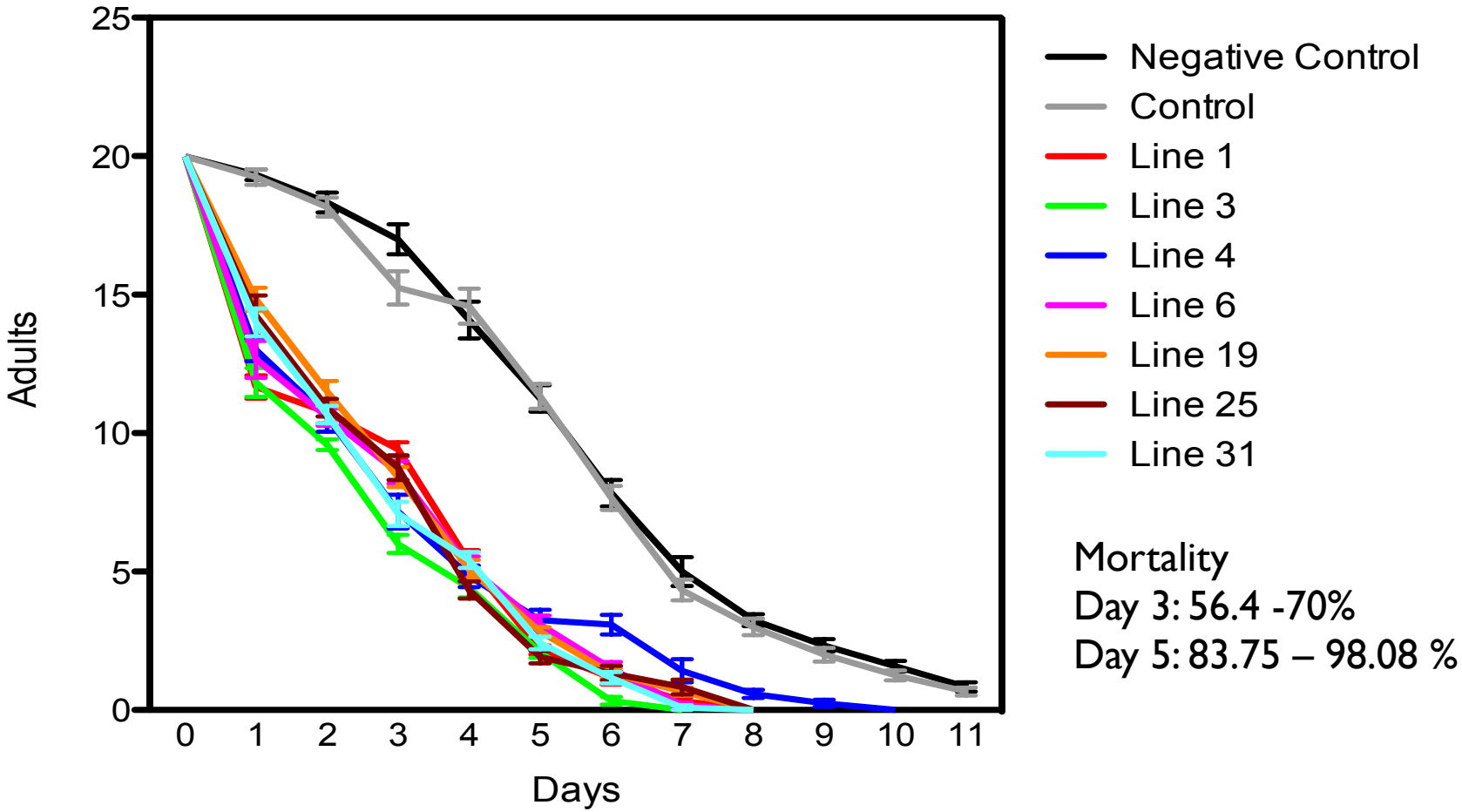
Aragão & Faria, Nature Biotechnology, 27:1086-1088 (2009)

5. RNA interference Technologies



Ibrahim & Aragao 2015

6. Insect Resistant Lettuce

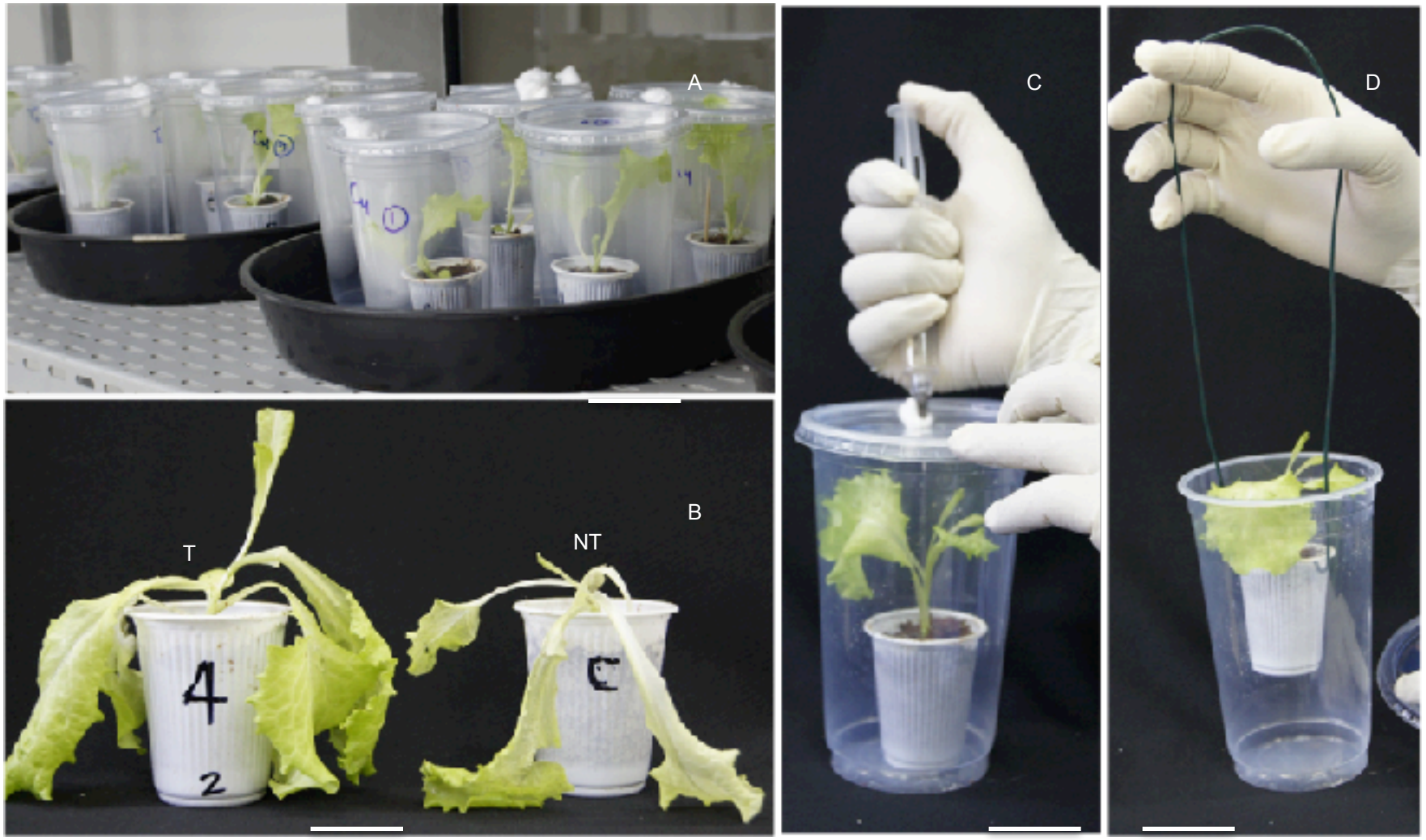


Mortality
Day 3: 56.4 -70%
Day 5: 83.75 – 98.08 %

Toxicity of transgenic lettuce plants producing *v-ATPase* siRNAs against 20 whiteflies

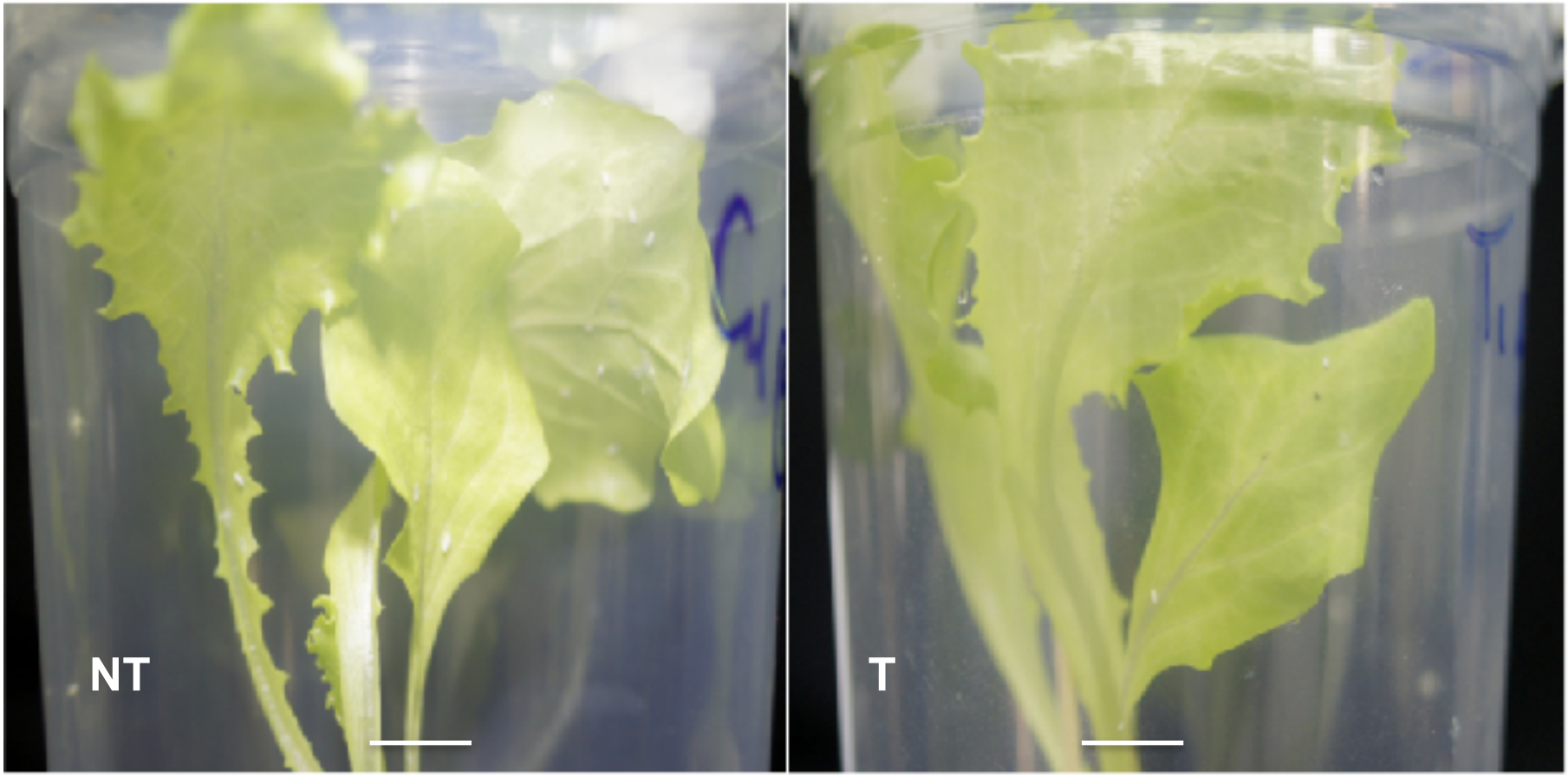
Ibrahim et al., 2016

Plant-insect RNAi



Ibrahim et al., 2016

Plant-insect RNAi



Monitoring the population of whiteflies feeding on non-transgenic (NT) and transgenic (T) lettuce plants. Number of whiteflies on NT than T on day 5 after inoculation with 20 whitelfies. Bar = 1cm

Ibrahim et al., 2016

Our Patent

< Uso exclusivo do INPI >

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Título do Documento: Depósito de Pedido de Patente		Código: FQ001	Versão: 2
		Procedimento: DIRPA-PQ006	

ANEXO: INVENTOR (72) 22:

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6. Telefone: (61) 3107.4180
7. E-mail: bioraz@gmail.com

Brasília-DF, 03 de junho de 2016.

SIMONE SAYURI TSUNEDA

7. Folate Fortified Lettuce

7. Spider silk and interferon producing soybean

8. GM Mosquitoes

Mass production of genetically sterile (OX513A) *Aedes aegypti* for field releases in Brazil

Danilo O. Carvalho[1,4], André B. B. Wilke[2], Derric D. Nimmo[4], Neil Naish[4], Andrew R. McKemey[4], Pam Gray[4], Mauro T. Marrelli[2], Jair F. Virginio[3], Luke Alphey[4] and Margareth L. Capurro[1].

1 Departamento de Parasitologia, Instituto de Ciências Biomédicas, Universidade de São Paulo, BR
2 Departamento de Epidemiologia, Faculdade de Saúde Pública , Universidade de São Paulo, BR
3 Moscamed Brasil, Juazeiro, Bahia, BR
4 Oxitec Ltd., 71a Milton Park, Abingdon, Oxfordshire, UK

9. ABU-EMBRAPA Research

Generation of virus resistant cowpea

Embrapa
Recursos Genéticos e Biotecnologia

Project ID 2970 (418)
Francisco J.L. Aragão[1] and Abdulrazak B. Ibrahim[2]
1. EMBRAPA CENARGEN, Brasilia-Brazil
2. Ahmadu Bello University, Zaria-Nigeria

AHMADU BELLO UNIVERSITY
Zaria-Nigeria.

Objectives

This project was aimed at developing cowpea lines resistant to Cowpea aphid-borne mosaic virus (CABMV) and Cowpea severe mosaic virus (CPSMV) using the technique of RNA interference (RNAi).

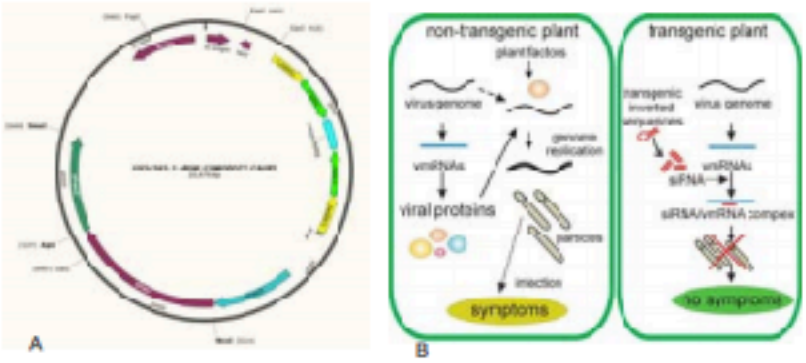

Figure 1. RNAi strategy for silencing viral genes in transgenic plants: A. Transformation vector used to generate GM cowpea, B. Inhibition of viral replication machinery by RNAi

Results and Impacts

- Ten (10) transgenic cowpea lines with transgene that confers resistance to CPSMV and CABMV were generated. Seven of these lines presented milder symptoms when compared to control and three lines presented enhanced resistance to both viruses. Molecular analyses confirmed the presence of small interfering RNA (siRNA) and gene insert in the plants.
- Field experiment was conducted with two lines to evaluate the effectiveness of the resistance to the viruses with natural inoculation under field conditions in the state of Piauí, Brazil. While no virus outbreak was recorded at the time of the trial, the plants demonstrated tolerance to high dosage of imidazolinones.
- Field survey of cowpea varieties susceptible to viruses in the states of Kano, Jigawa, Kaduna and Zamfara States of Nigeria was conducted and CPSMV and CABMV were identified as the major diseases in the regions.
- Undergraduate and postgraduate students from ABU were trained on embryo excision, morphological characterization of cowpea meristem and RNA manipulation from leaves for detection of virus.
- Five researchers from ABU were trained on genetic transformation of cowpea at the Laboratory of Genetic Engineering of EMBRAPA CENARGEN in Brasilia.
- A cowpea transformation system comprising of particle delivery system (PDS) developed by EMBRAPA was installed in ABU, making it the first of its kind in Nigeria.
- The project has greatly impacted in capacity building amongst the scientific community of ABU, given the participation of young Nigerian scientists, who were exposed to the facilities available at Embrapa, and the potential for future collaborations.

Figure 2. Experimental field analysis of transgenic cowpea lines resistant to CPSMV and CABMV. No viral outbreak was recorded at the time of the trial but transgenic lines were highly tolerant to high doses of imidazolinones

Lessons Learned and Bottlenecks

Lessons learned:

Experience in writing grant earning proposal 2. Experience in GM technology 3. Experience in project implementation in general.

Prominent problems we faced during the execution of this project were:

1. Delay due to exportation of the particle delivery system to Nigeria
2. The time frame of 24 months was short.
3. It was only at the end of the project that biosafety law was approved in Nigeria so field trial as done in Brazil couldn't be conducted in Nigeria.

Remarks and Next Steps

- With the availability of the PDS in ABU and the the recent approval of biosafety law in Nigeria, the transformation and field trial experiments conducted in Brazil, will be replicated in the country.
- Using the PDS developed by EMBRAPA scientists, RNAitransgenic technology has been imported to Nigeria, which will ultimately benefit farmers in the country. The equipment is the first of its kind in the country. In the coming years, the facility may be used to transform other important crops in Nigeria and generate lines with improved agronomic traits.

Tobacco, Arabidopsis,

Draught tolerant maize and cowpea

Peanut, Cassava, Tomato, Ferns, Sugarcane

Jatropha, Apple, mosquito etc

SAUDÁVEL
O pesquisador Francisco Aragão, num laboratório na Embrapa. Ele coordenou a criação de arroz transgênico que tem 30% a mais de ácido fólico (Foto: Igo Estrela/ÉPOCA)

GM Crops 2:3, 1-6; July/August/September 2011; © 2011 Landes Bioscience

REVIEW

Genetic engineering in cowpea (*Vigna unguiculata*)

History, status and prospects

Cristiane T. Citadin,[1,2] Abdulrazak B. Ibrahim[1,3] and Francisco J.L. Aragão[1,2,*]

[1]Embrapa Recursos Genéticos e Biotecnologia; [2]Programa de Pós-graduação em Biologia Molecular; Departamento de Biologia Celular; Universidade de Brasília; Brasília, DF, Brazil; [3]Department of Biochemistry; Ahmadu Bello University; Zaria, Nigeria

gation

RESEARCH

Development of Transgenic Cassava Cultivars from Northeastern Brazil

A.B. Ibrahim[1,2], F.F. Heredia[1], C.P. Barbosa[1], T.F. Machado[1] and F.A.P. Campos[1]

Abstract

Following the establishment of a cyclic system of somatic embryogenesis, in excess of 20 independent friable embryogenic callus (FEC) lines originating from different embryogenic cycles were established when fragments of somatic embryos were cultured on GD medium containing 2%

African Journal of Biotechnology Vol. 7 (16), pp. 2780-2787, 18 August, 2008
Available online at http://www.academicjournals.org/AJB
ISSN 1684-5315 © 2008 Academic Journals

Full Length Research Paper

Optimization of somatic embryogenesis and selection regimes for particle bombardment of friable embryogenic callus and somatic cotyledons of cassava (*Manihot esculenta* Crantz)

Ibrahim A.B.[1]*, Heredia F.F.[2], Pinheiro C.B.[2], Aragao F.J.L.[2] and Campos F.A.P.[2]

[1]Department of Biochemistry, Ahmadu Bello University, Zaria, Nigeria.
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[3]Embrapa Recursos Genéticos e Biotecnologia, PqEB W5 Norte, 70770-900, Brasília, DF, Brazil.

Accepted 22 June, 2008

Development of transgenic common bean with agronomic traits

by Thaís M. CIPRIANO[1,2], Abdulrazak B. IBRAHIM[1,3,4,5], Josias C. FARIA[5] and Francisco J. ARAGÃO[1,4,5]*

Capítulo 4

Chapter 5

RNAi-Mediated Resistance to Viruses in Genetically Engineered Plants

Abdulrazak B. Ibrahim and Francisco J.L. Aragão

Abstract

RNA interferente

Francisco J. L. Aragão[1]
Abdulrazak B. Ibrahim[2]
Maria Laine P. Tinoco[3]

Thank you

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