



# Bioinnovations for a Vibrant Cassava Value Chain

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# Cassava in Uganda – a food and industrial crop

- Cassava is a widely grown major staple, food security and income generation crop in Uganda
- Significant potential for commercial use and agro-industrialization – priority commodity under NDP III
- Industrial value chains of great potential – starch, high quality cassava flour (HQCF), ethanol
- Since 2013 production stagnated at c. 3 million tons/year from 5 million 10 years ago





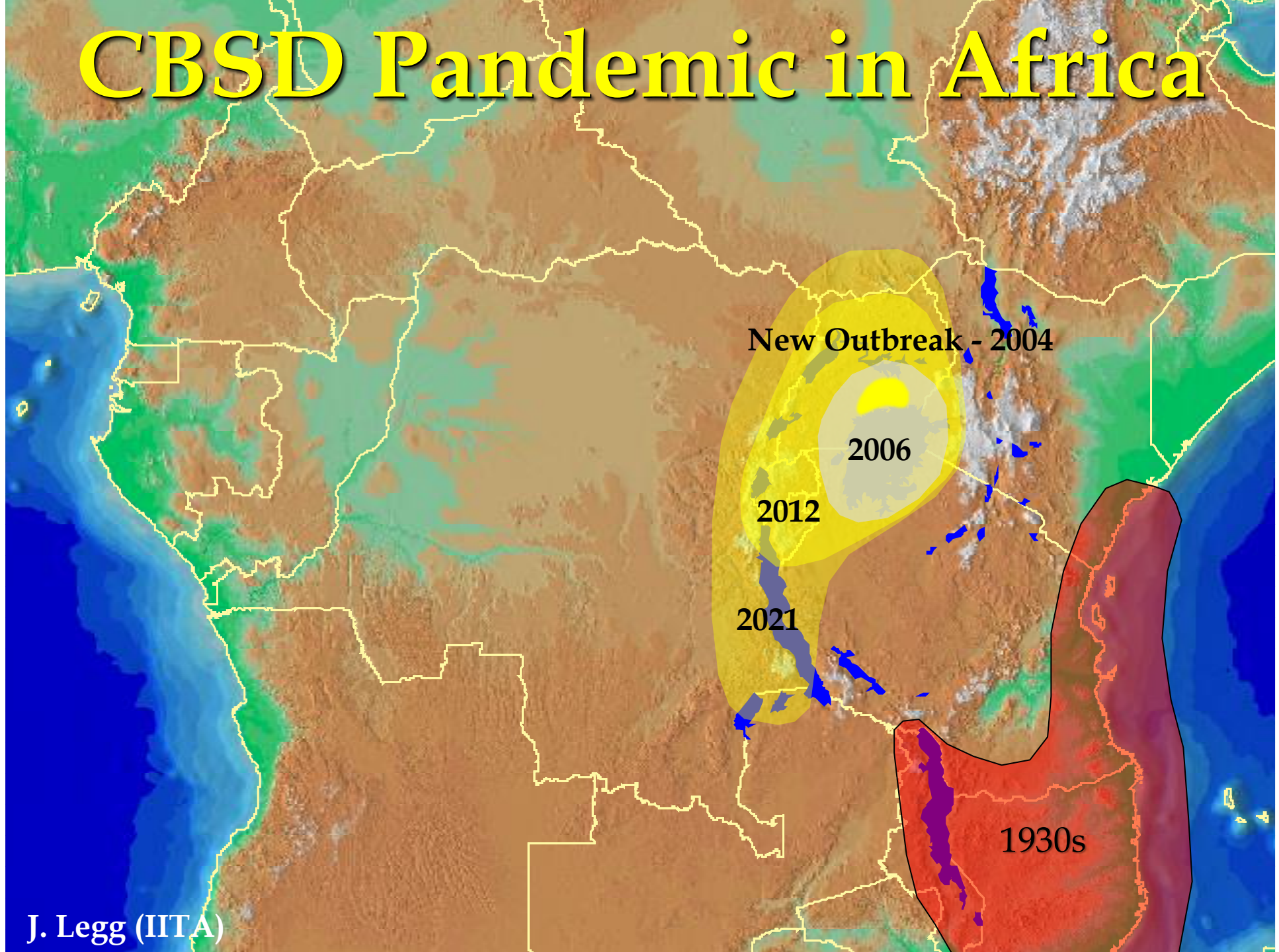
# Cassava brown streak disease pandemic

- 1936 to 2004: CBSD endemic only along coastal eastern Africa
- 2004: outbreaks in Uganda, Kenya, Tanzania around Lake Victoria (losses \$ 750 million, including Malawi by 2015, >\$ 100 million in Uganda annually ).
- Now present in 10 countries, expanding southward and westward with pandemic fronts in Zambia and Democratic Republic of Congo
- Caused by two viruses *Cassava brown streak virus* (CBSV) and *Ugandan cassava brown streak virus* (UCBSV) associated with ‘super-abundance’ of the whitefly insect vector





# CBSD Pandemic in Africa



Non-GM cassava



GM virus resistant cassava



- **Technology:** RNAi-mediated resistance, based on virus sequences integrated into the cassava genome provides resistance to both viruses - CBSV and UCBSV

# Proven RNAi technology used to produce virus resistant crops

- Commonly used to produce virus resistant crops
- DNA from part of the virus integrated into plant genome
- Plant's defenses activated to recognise, target & degrade the viral pathogen

## RNAi virus resistance products commercialised in other crops

Papaya



Plum



Beans

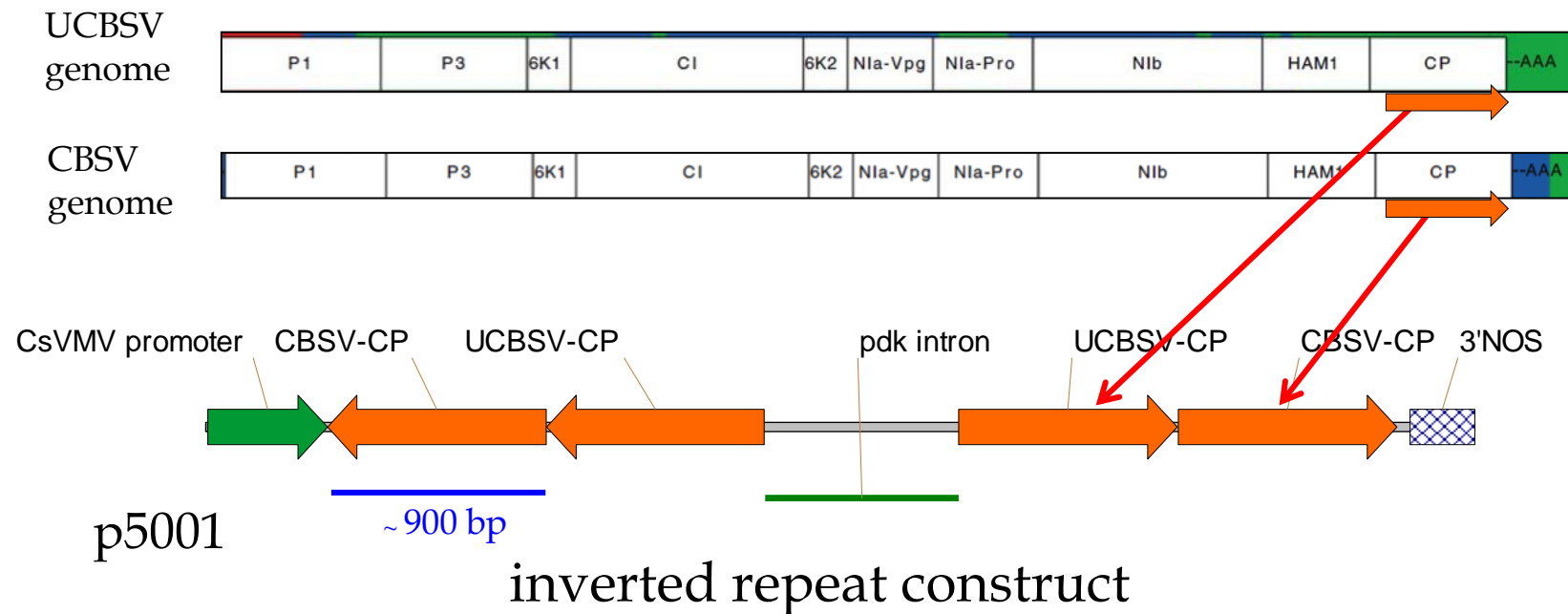


Squash



# RNAi technology imparts resistance to CBSD

- Coat protein (CP) genes of the two causal viruses (*Cassava brown streak virus* - CBSV and *Ugandan cassava brown streak virus* - UCBSV) isolated, fused and used to produce a genetic construct
- Gene engineered to cassava cells, transgenic plants regenerated, evaluated in the greenhouse and field



# VIRCA Plus products demonstrate robust, durable resistance to CBSD

c. 20 fold increase in usable yield

Non GM Cassava



95% loss

VIRCA Plus Cassava



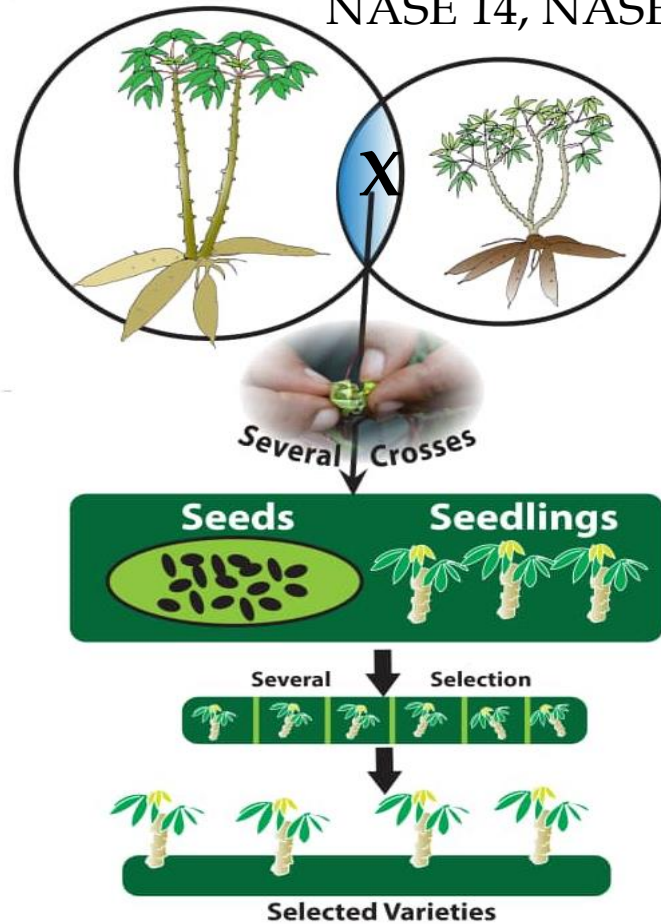
c. < 2% loss

- 2 elite events (**4026 and 4046**) identified and used in product development, and regulatory trials



# Virus resistant lines developed through breeding - have transgenic CBSD resistance and inherent CMD resistance

CMD resistant  
RNAi TME 204 farmer-preferred cvs TME 14,  
NASE 14, NASE 3, NASE 19



c. 11000 seeds produced  
c. 8000 seedlings germinated

# Progeny clones are resistant to CBSD & CMD in the field



Kasese progeny clone  
UGVR1802036



NASE 19 control



# 12 virus resistant and high yielding lines identified

- Product development research completed
- **12** virus resistant lines with high yields and preferred root qualities identified
- Show no CBSD symptoms (0%) or less than 1% incidence with mild severity
- All lines did not show any cassava mosaic disease (CMD) symptoms (0%)

TME 204 wildtype



NASE 14 wildtype



RNAi Event 4046 x TME 14

Event 4040  
X  
TME 14



# Regulatory field trials completed – data on safety



RFT at Kasese, Western Uganda



- Comparative data on the field performance of 2 elite events and non-transgenic conventional varieties
- Food compositional analyses conducted
- Molecular characterization of events
- Draft dossier ready for submission

GM CROPS & FOOD  
2020, VOL. 12, NO. 1, 158–169  
<https://doi.org/10.1080/21645698.2020.1836924>




RESEARCH PAPER

OPEN ACCESS 

## Comparative compositional analysis of cassava brown streak disease resistant 4046 cassava and its non-transgenic parental cultivar

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**Cassava Brown Streak Disease Resistant Event 4046**


Supporting dossier for an application for unrestricted environmental release and use in food and feed of event 4046 cassava

— SUBMITTED TO —  
National Biosecurity Committee  
Uganda National Council for Science & Technology  
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Kampala, Uganda

— SUBMITTED BY —  
National Crops Resources Research Institute  
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REGULATORY DOSSIER NUMBER  
NCR/DPS-19MEVRUG

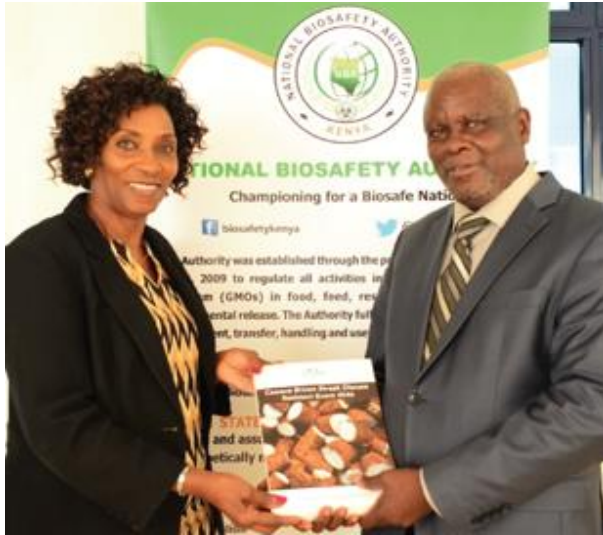
**DRAFT**

  
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# Event 4046 approved by NBA, Kenya – food, feed, environment

Formal submission to  
Kenyan National Biosafety Authority



Public forum June 2020



5100 stakeholders engaged

Approval decision June 2021



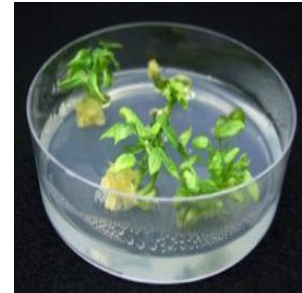
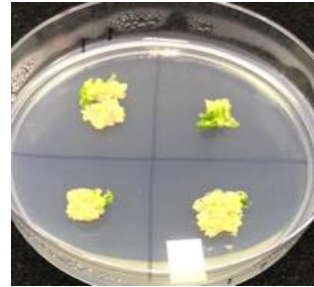
Approved as safe for food, feed and the environment

# Scaling the horizon with emerging tools

- Genome editing
- Tissue culture pipelines and platforms
- Data platforms, next generation sequencing, analytics, modelling and forecasting



*In vitro* flowering



Greenhouse flowering



# Improved seed multiplication rates and systems

MandiPlus - 12 cm

Control - 12 cm



- Enhanced stem germination, vigour, protection from dehydration, fungal and pest attack



MandiPlus 16cm

Control 16cm

MandiPlus 8cm

Control 8cm





# A multidisciplinary team of five country partners



USA



Kenya  
KALRO



Uganda  
NARO



Nigeria  
NRCRI



Rwanda  
RAB

BILL & MELINDA  
GATES *foundation*



Mennonite Economic Development Associates



Communication professionals



**USAID**  
FROM THE AMERICAN PEOPLE



**FEED THE FUTURE**  
The U.S. Government's Global Hunger & Food Security Initiative





# VIRCA Plus

Virus Resistant and Nutritionally  
Enhanced Cassava for Africa



# Thank you

Contact us: <https://naro.go.ug/>

