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CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Cassava Mosaic Disease in Southeast Asia: State of play & the way forward

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10th Starch Innovations ASIA

23rd February 2021

CGIAR

Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
CGIAR is a global research partnership for a food-secure future.

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People consume diverse, nutritious and safe **foods**.

People participate in and benefit from inclusive, innovative and diversified agri-food **markets**.

People sustainably manage farms, forests and **landscapes** that are productive and resilient to climate change.

Communities and institutions sustainably use and safeguard agricultural **biodiversity**.

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Australian Government
Australian Centre for International Agricultural Research

CGIAR RESEARCH PROGRAM ON Roots, Tubers and Bananas

Establishing sustainable solutions to cassava disease in mainland Southeast Asia

CIAT International Center for Tropical Agriculture Since 1967 Science to cultivate change

TTDI

The University Of Queensland AUSTRALIA

Brings together a regional and multidisciplinary team

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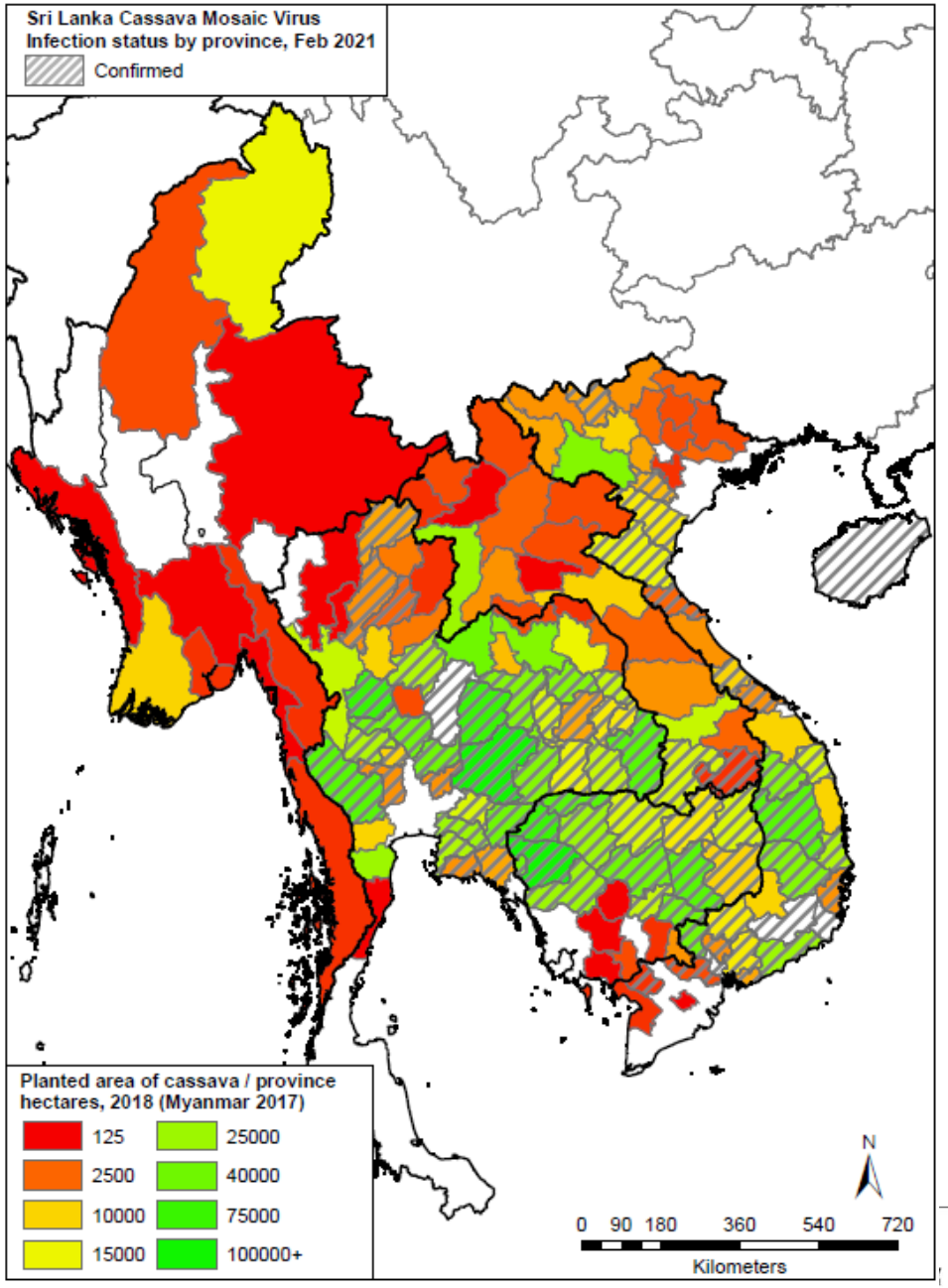
What is the current situation?

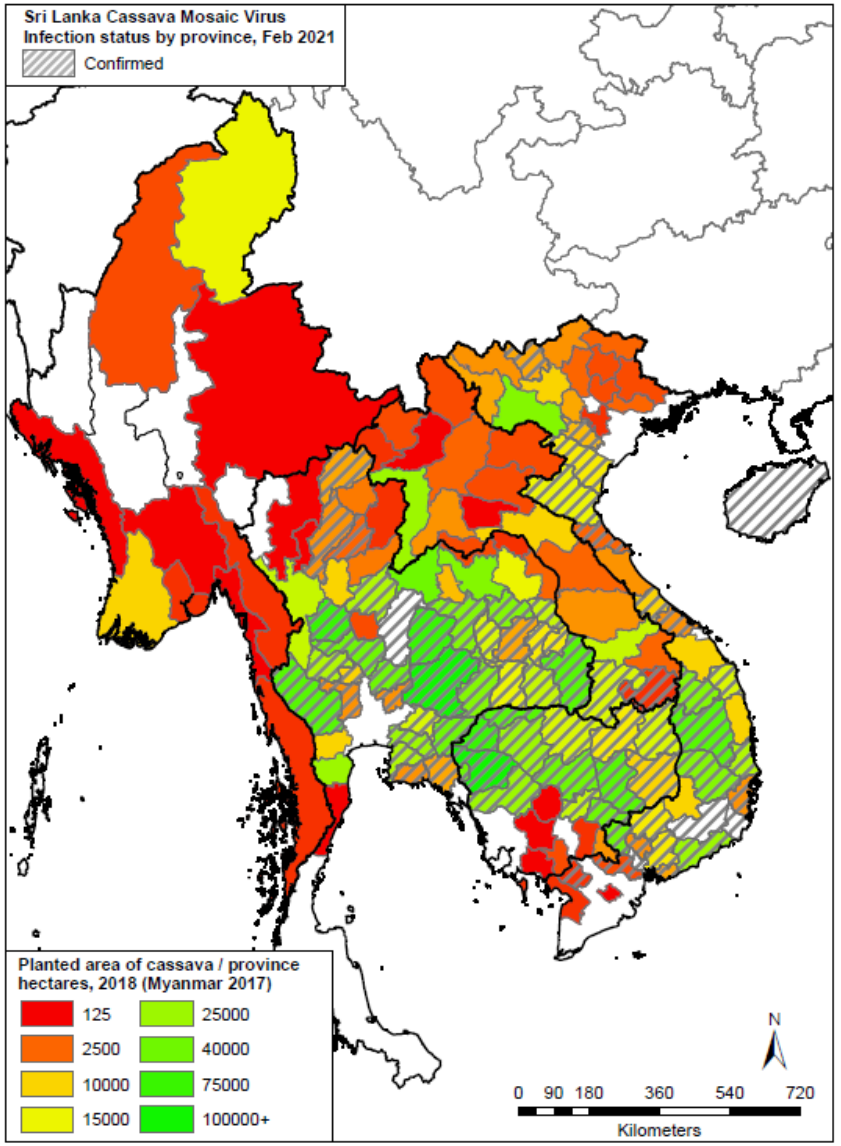
Status of the pandemic

- 6 years after being first reported in Northeast Cambodia, Cassava Mosaic Disease has now been reported in the majority of the main cassava growing provinces in the region.



Status of CMD in Mainland SE Asia

	First reported	Number of provinces	Estimated cassava area	Impacted area
Cambodia	May 2015	14	587,120 ha	~205,500ha*
Vietnam	May 2017	24	471,702 ha	~83,360 ha
Thailand	July 2018	32	1,048,660 ha	~80,785 ha
Lao PDR	July 2020	2	101,490 ha	20-50ha
Myanmar	NA	NA	33,390 ha	NA ?
Total		72	**2,242,380 ha**	**~370,000ha**



17% including the most productive regions

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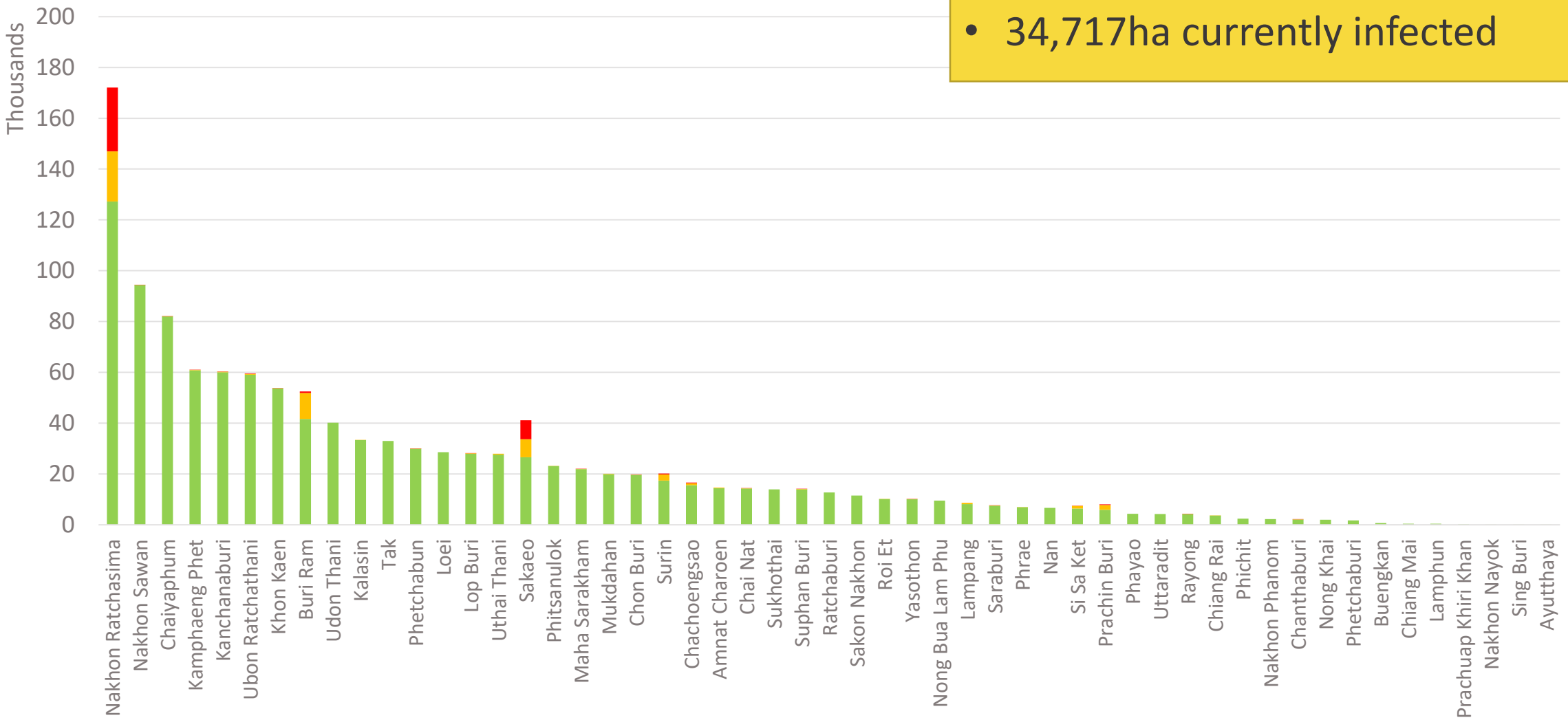
Some perspective - Thailand

- 32 Provinces
- 80,785 ha cumulative infected area
- 34,717ha currently infected



DOA Thailand

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Vietnam perspective

Year	Total planted areas (ha)	Accumulative infected areas (ha)	% infected	#provinces infected
2017	442,850	2,439	1%	2
2018	446,231	40,058	9%	14
2019	467,515	69,954	15%	20
2020	**471,702**	**83,361**	**18%**	**24**
Current standing 19 Feb 2021	306,048	43,050	14%	17

Vietnam Ministry of Agriculture and Rural Development

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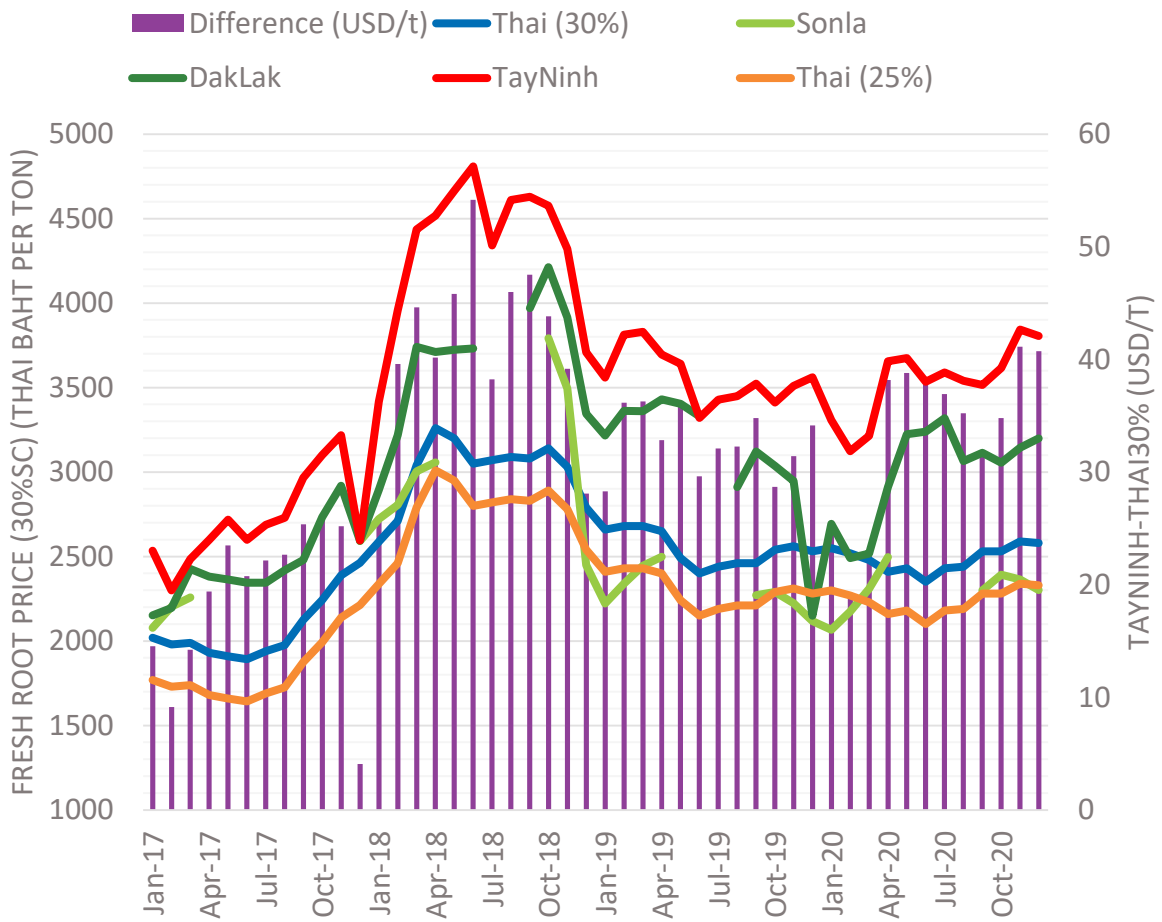
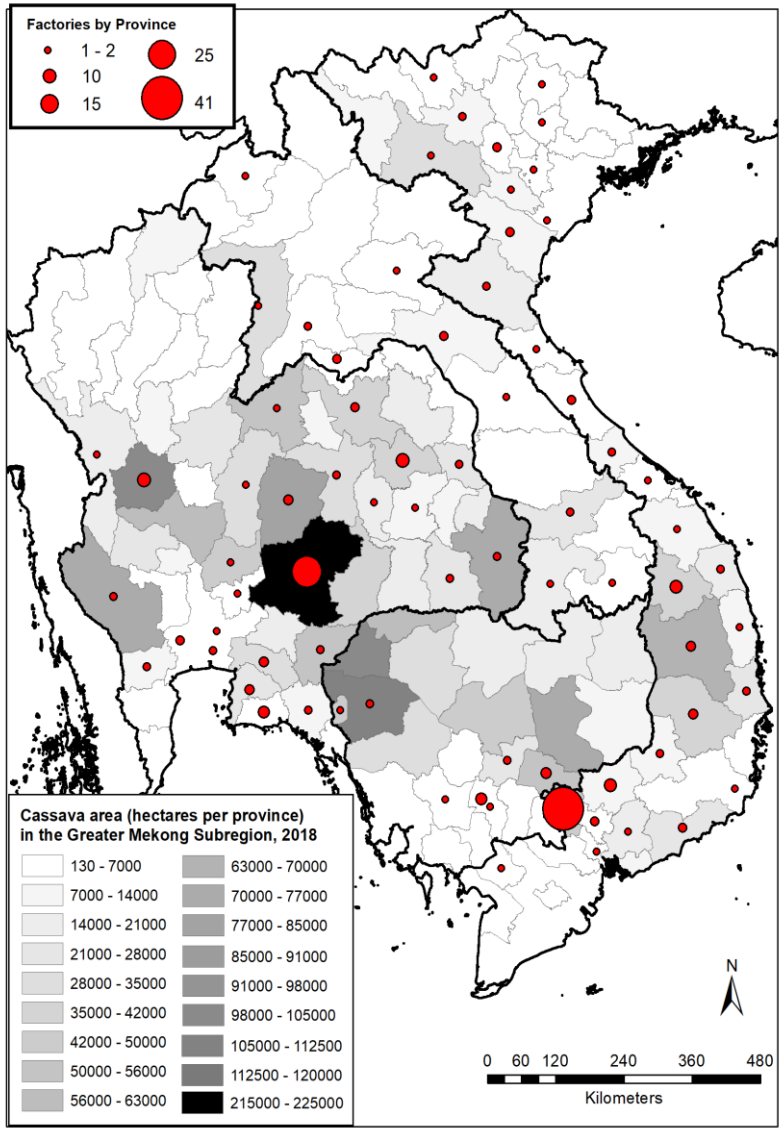
Contributing to root prices





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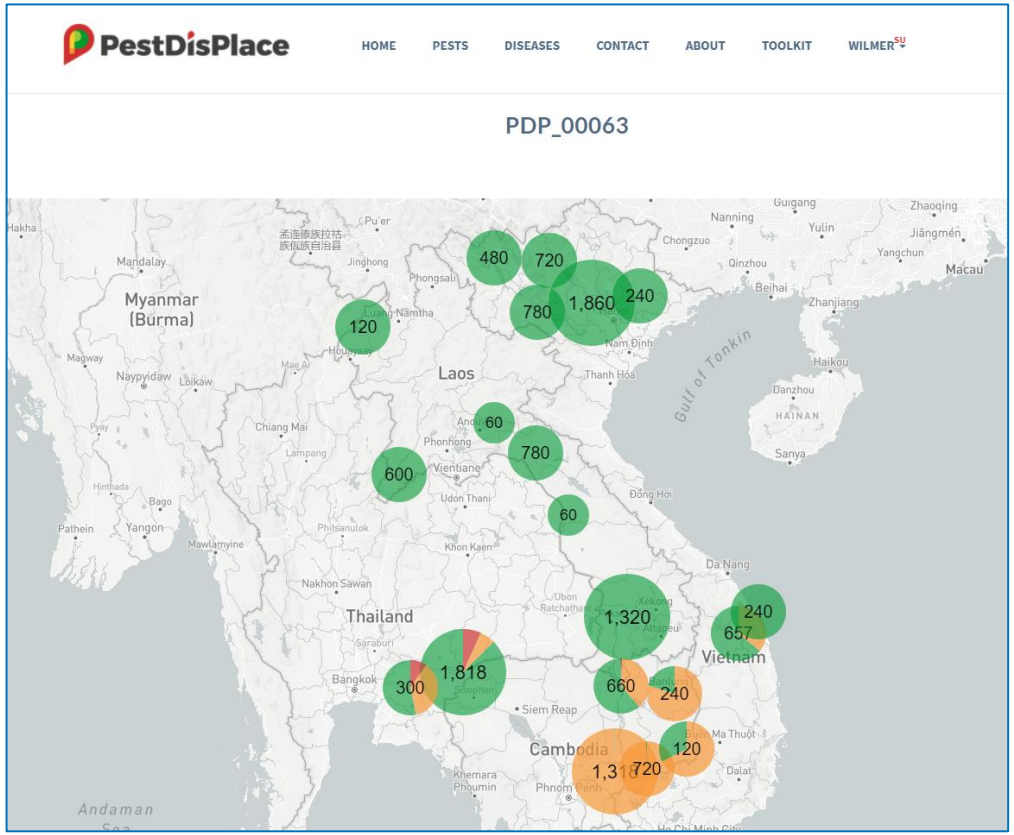
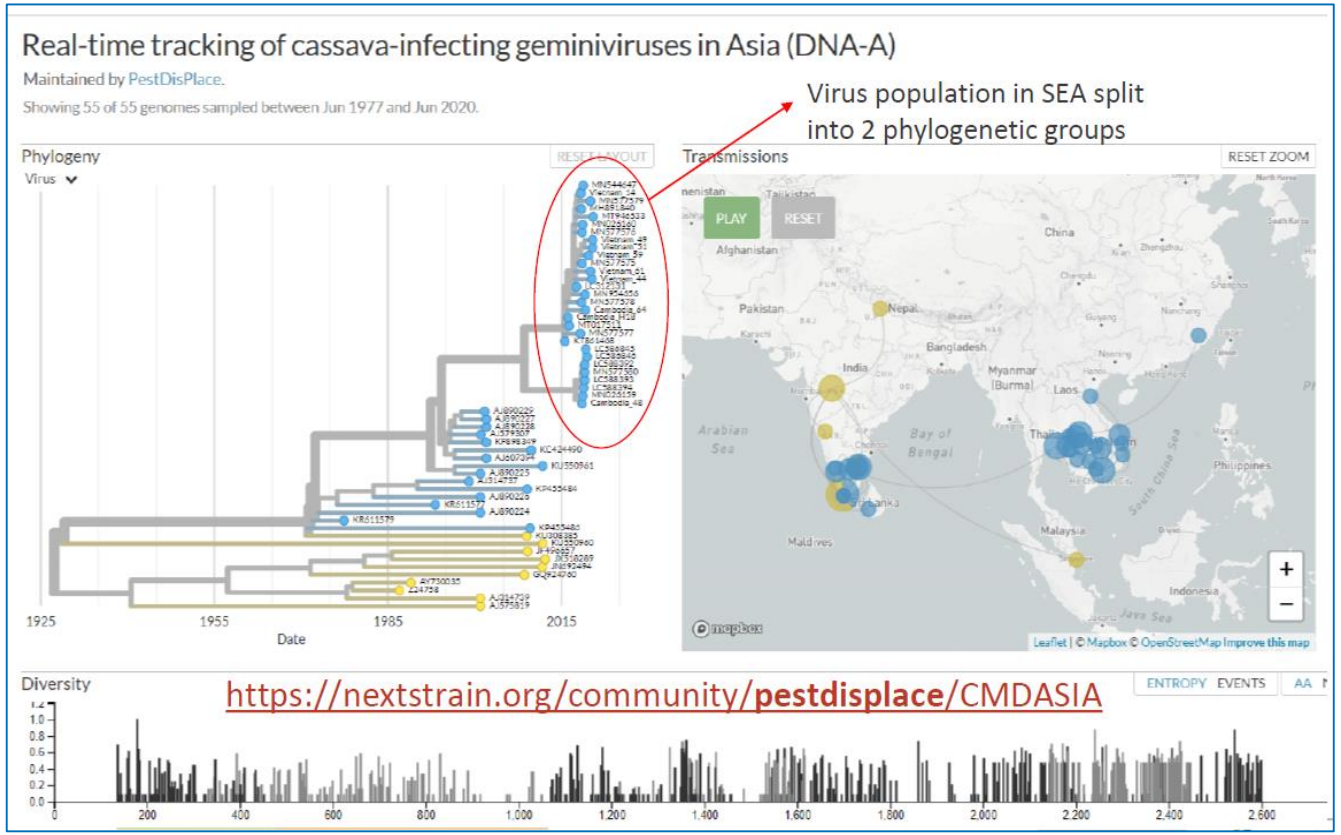
Disease Surveillance with National Plant Protection Departments

Using standard protocols at regional level, in 2020, more than 14,000 field observations for CMD have been collected and analyzed for CMD

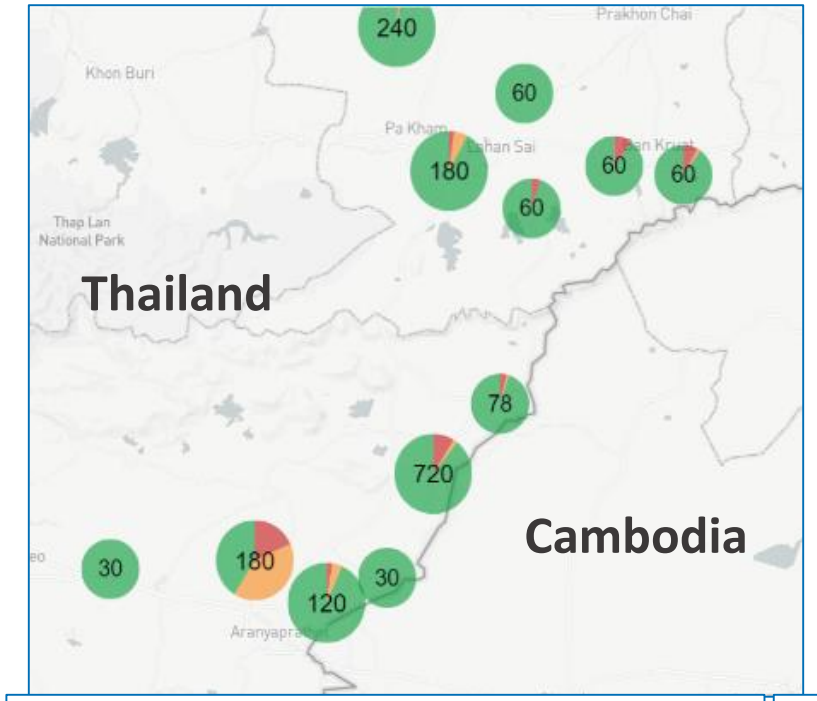


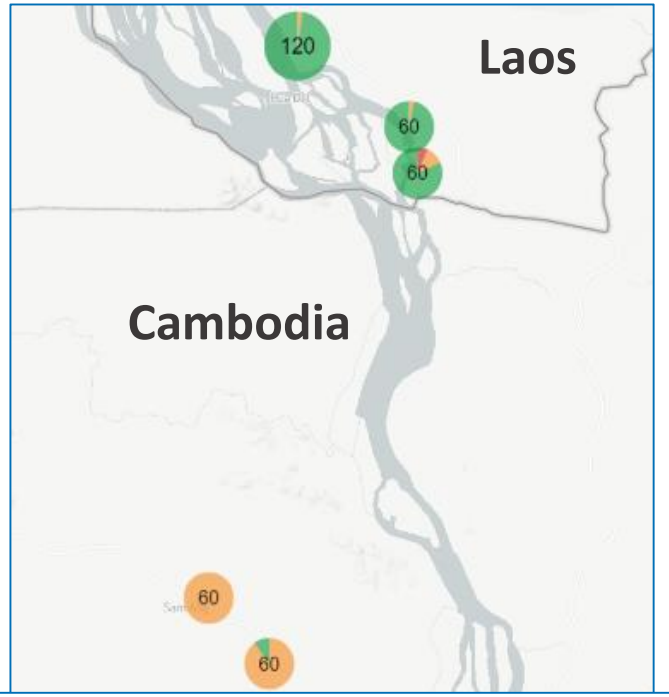
We link field observations to rapid molecular diagnostics and genomic surveillance of SLCMV (using Nanopore and Nextstrain), to track the appearance of new virus strains



Source: https://pestdisplace.org

Harmonized protocols > validation of results > rapid communication





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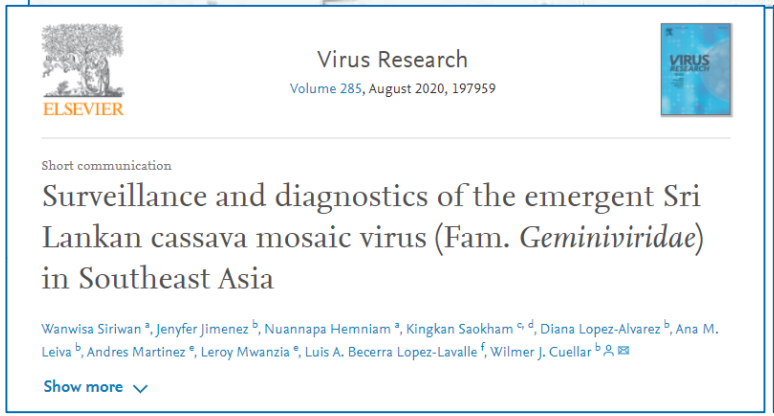

Virus Research

Volume 285, August 2020, 197959

Short communication

Surveillance and diagnostics of the emergent Sri Lankan cassava mosaic virus (Fam. *Geminiviridae*) in Southeast Asia

Wanwisa Siriwan [a], Jenyfer Jimenez [b], Nuannapa Hemniam [a], Kingkan Saokham [c, d], Diana Lopez-Alvarez [b], Ana M. Leiva [b], Andres Martinez [e], Leroy Mwanzia [e], Luis A. Becerra Lopez-Lavalle [f], Wilmer J. Cuellar [b]

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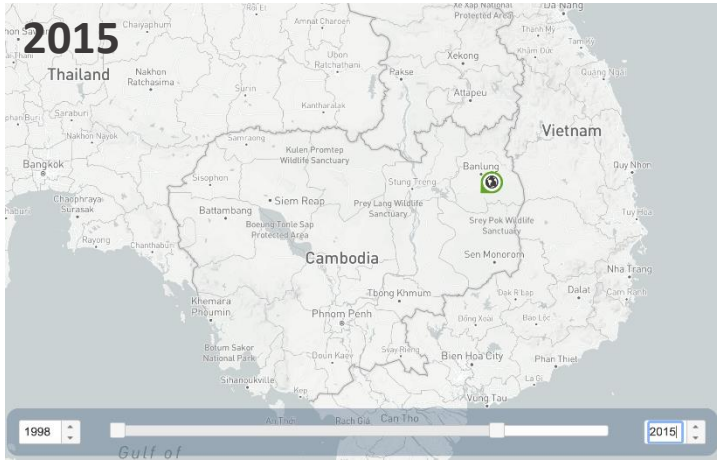
First report of Sri Lankan cassava mosaic virus and Cassava Mosaic Disease in Laos

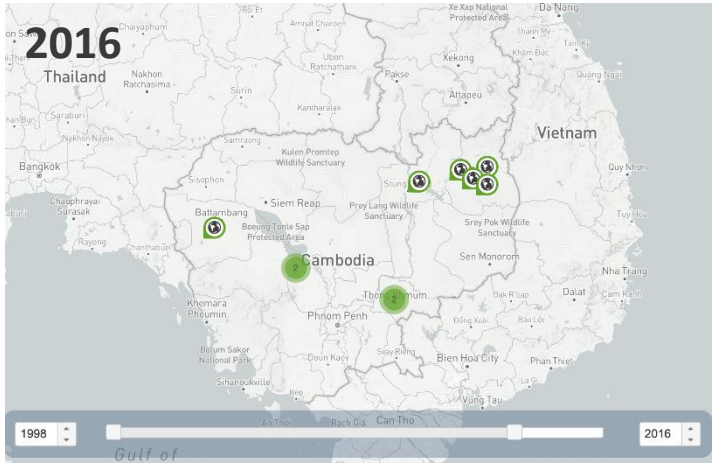
Khonesavane Chittarath, Jenyfer Jimenez, Pinkham Vongphachanh, Ana Maria Leiva, Somkhit Sengsay, Diana Lopez-Alvarez , Touy Bounvilayvong, Derlyn Lourido, Viengvilay Vorlachith, and Wilmer Jose Cuellar

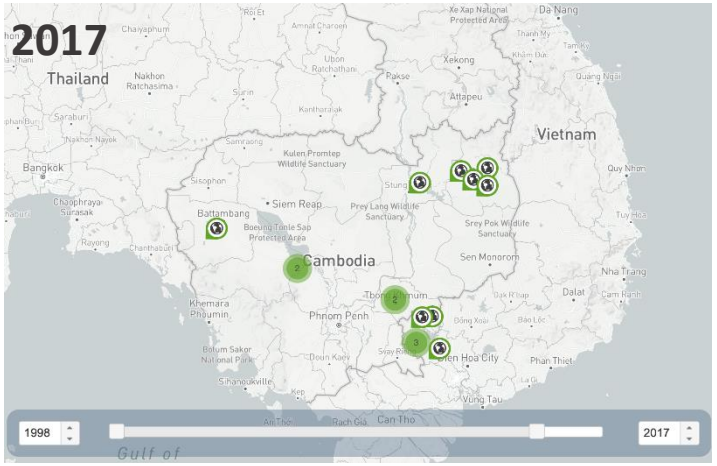
Published Online: 12 Jan 2021 | https://doi.org/10.1094/PDIS-09-20-1868-PDN

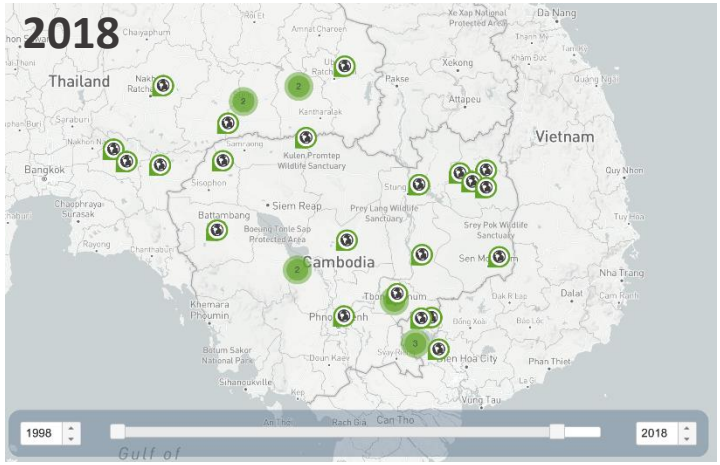
PDF PDF PLUS TOOLS SHARE

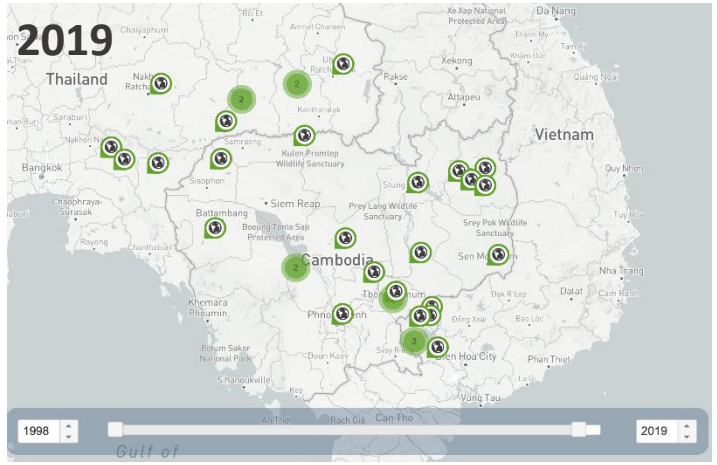
CMD distribution over time and locations for rapid multiplication

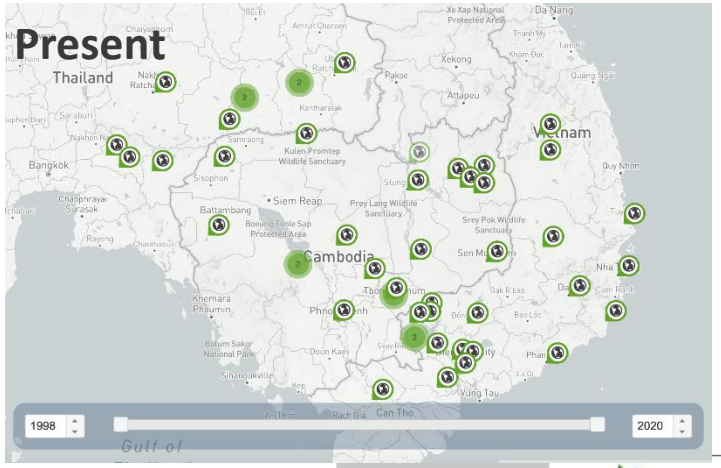












Source: https:www.pestdisplace.org

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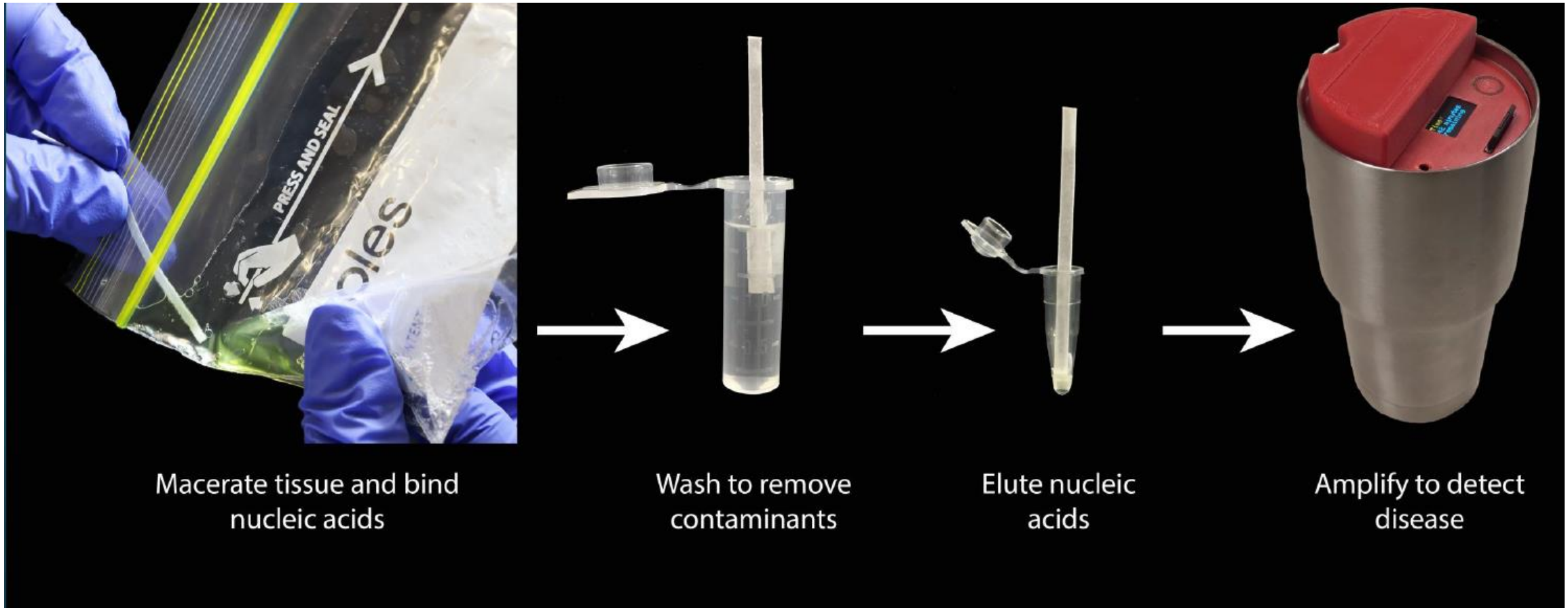
Developing rapid in-field diagnostics

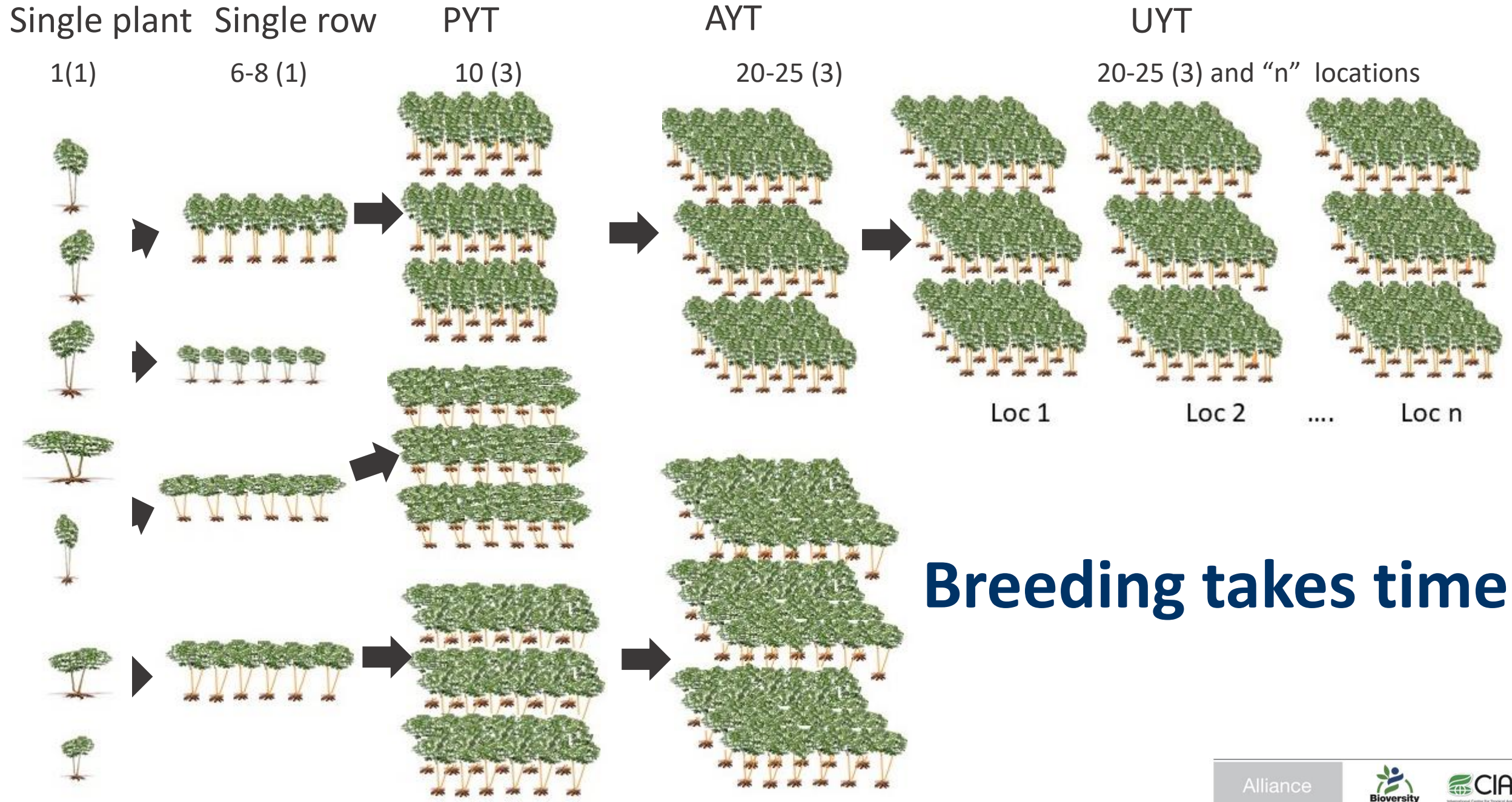
THE UNIVERSITY OF QUEENSLAND
AUSTRALIA



Dr. Michael Mason

Alliance Bioversity International CIAT

Breeding & seed systems



Breeding takes time!

Phased strategy to get resistant varieties into farmers fields as quickly as possible

1. Determine the best existing elite Asian cassava variety for rapid multiplication

2. Evaluate existing resistant varieties and clones from outside Asia.
   Under strict phytosanitary protocol for the movement of genetic material

3. Develop new varieties through conventional breeding with national cassava breeding programs in Thailand and Vietnam

Short-term

Degrees of resistance and susceptibility

1. = No visible symptoms (highly resistant)

2: =mild chlorotic patterns on entire leaflets or mild distortion at base of leaflets, rest of leaflets appearing green and healthy (moderately resistant).

3: = strong mosaic patterns on entire leaf, and narrowing and distortion of lower one-third of leaflets (tolerant)

4: = severe mosaic, distortion of two-thirds of leaflets and general reduction of leaf size (susceptible).

5: = severe mosaic, distortion of four-fifths or more of leaflets, twisted and misshapen leaves (highly susceptible)

Degrees of resistance and susceptibility

1

2

3

4

5 = 4 + stunting

IITA Alliance Bioversity International CIAT

Evaluation of existing Asian elite varieties

Funding support

Australian Centre for International Agricultural Research

Australian Aid

CAVAC Innovation in Agriculture

1. Large variation between existing varieties
2. Timing matters – early infection = lower yield
3. Plants from clean and positive selection planting material produced 2- to 3-fold higher yields than diseased planting material

Current advice: KU50, Rayong72, HB60

Avoid: Rayong11, Variety89, HL-S11, SC8

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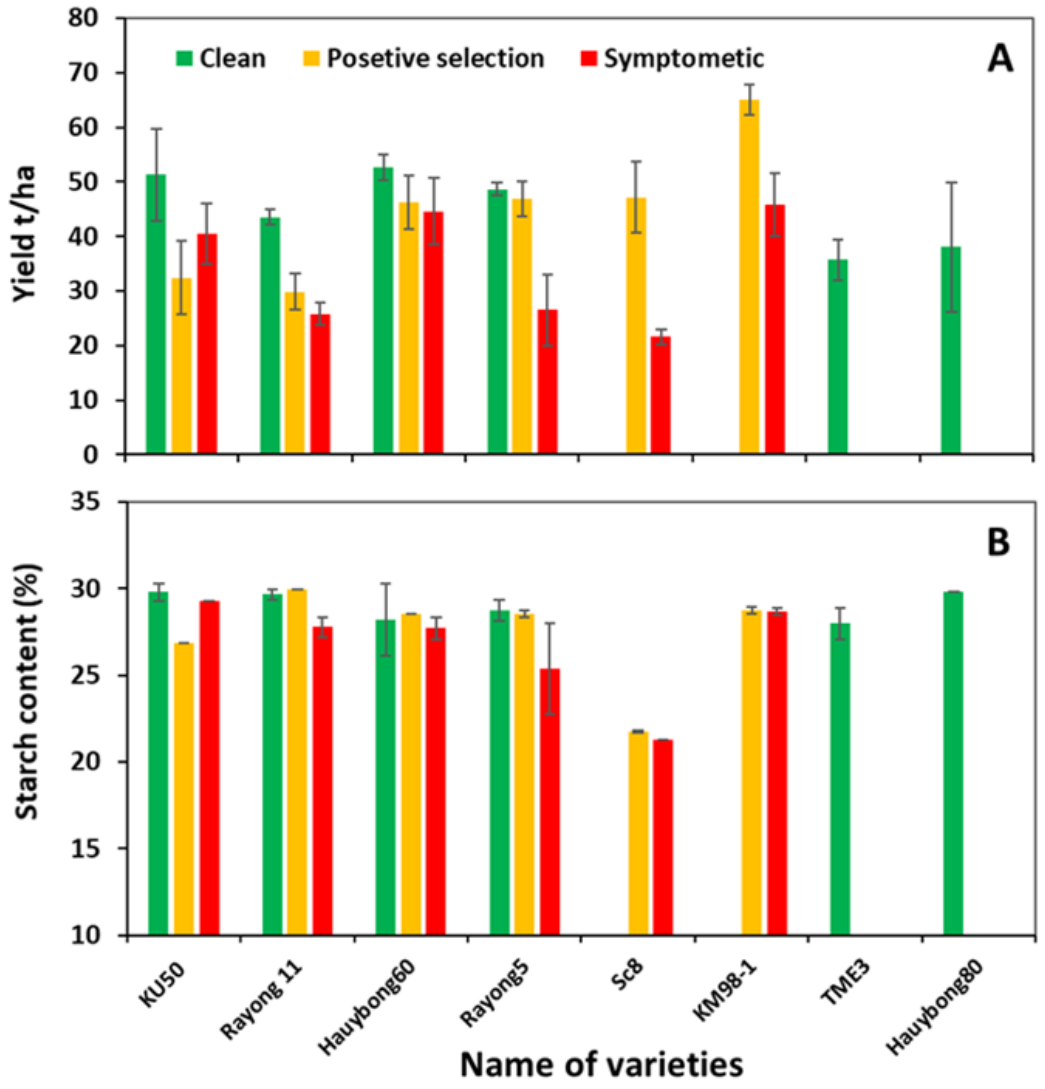
Experimental results from 2020 harvest



1. With **good management** can still achieve 40-50t/ha

2. Plot yield was 1.2- to 2.2-fold higher in plants from clean and/or positive selection planting material than those from symptomatic planting material

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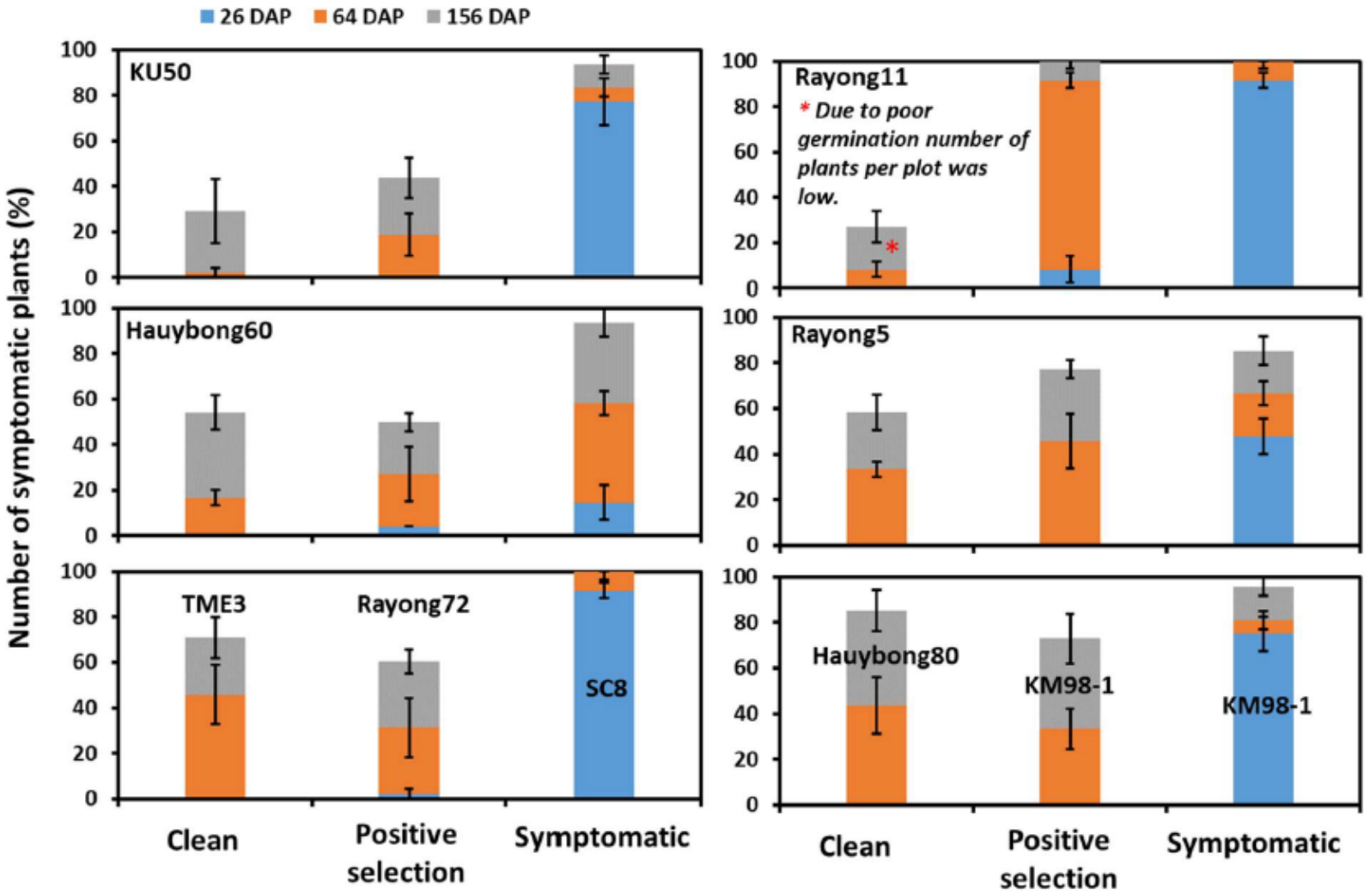
Why do we need a clean seed system?



PCR analysis reveals a large % of asymptomatic infection

Potential for a ‘Trojan horse’ situation

KM419*

Cassava Witches Broom Disease rides again?

Impacting yield, starch content and incomes

Kampong Cham, Cambodia

50.8t/ha @ 30.7 % starch content
= 24 tons of Dried Chips

29.4t/ha @ 25.4 % starch content
= 12 tons Dried Chips

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Medium term

Major Sources of CMD Resistance In South-East Asia

1) 5 IITA clones, all showing high resistance in Tay Ninh;

2) C33, TME3 and other clones from CIAT and IITA

3) 10 resistant varieties from the clones collected in Vietnam

4) 102 CIAT clones containing CMD2 genes according to SSR markers

5) introduced seeds from Hawaii (progenitors from CIAT and IITA)

6) 474 seeds for genomic selection derived from CMD donors at CIAT

Resistant varieties from IITA

- Third season of evaluation in Vietnam
- 2 varieties under consideration of release in 2021 in Vietnam
- Highly resistant to CMD – score 1

- **Harvest in March** (next month)
- Starch content < existing elite varieties

- Also being evaluated by KU-TTDI in Thailand
- In Cambodia and Vietnam ready for evaluation in 2022

Ten Resistant Varieties were identified from ‘local’ varieties

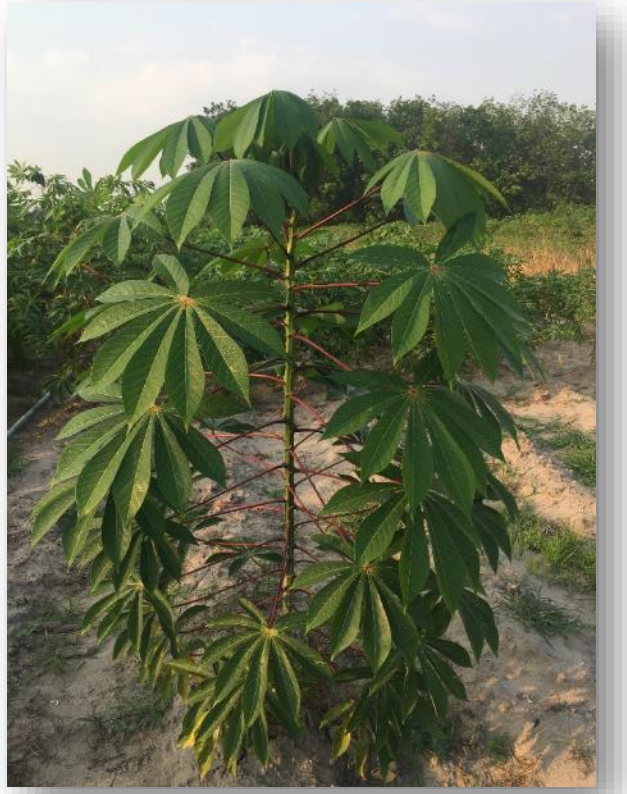
Hanatee

samples	accession_name	6week	3mon	6mon	10mon	germin.	yield_plot
VN19-1432, VN19-1556	PER262/CR63/TAI9	1.1	1.2	1.4	1.4	0.62	15.8
VN19-442	UNK-CI	1.1	1.2	1.3	1.3	1.00	30.0
VN19-1050, VN19-1039	VNM8/KM57	1.0	1.1	1.4	1.5	0.77	15.5
HG2	HG2	1.0	1.2	1.4	1.4	0.68	12.3
VN19-320	UNQ-44	1.0	1.6	1.2	1.5	0.34	26.3
VN19-773	UNQ-115	1.1	1.2	1.3	1.6	0.97	25.8
VN19-1194, VN19-1184	UNK-F	1.1	1.2	1.2	1.7	0.72	24.8
VN19-390	UNK-CH	1.1	1.2	1.5	1.7	0.44	21.5
VN19-2583	UNK-AR	1.2	1.5	1.6	1.9	0.65	11.0
LC1	LC1	1.1	1.4	1.3	1.6	0.75	16.0
	KM140	1.5	1.8	2.3	3.4	0.77	12.4
	KM297	1.6	1.7	1.7	2.5	0.27	17.3
	KM419	1.8	2.2	2.5	2.4	0.89	14.2
	KU50/KM94	1.4	1.4	1.8	2.3	0.61	21.6
	SC8/SC205	1.4	1.5	2.3	3.2	0.34	15.0
	Rayong1	1.5	1.7	1.6	3.0	0.42	17.5
	Rayong60/KM60	1.8	1.9	2.0	3.3	0.58	18.7

**From 2018-2019 yield trial, 4 replications, 5 plants harvested for yield evaluation.*

Local varieties from Vietnam

VN19-442 (GG254)



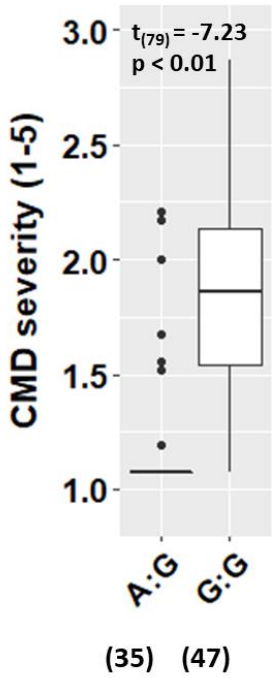
VN19-1556
(HANATEE/PER262/CR63/TAI9)

accession_name	count	CMD_1	CMD_2	Mean	Mother	Father
AR11-12	50	1.0	1.0	1.0	C-243	CW259-43
AR12-11	48	1.0	1.0	1.0	C-33	CW234-2
AR12-57	72	1.0	1.0	1.0	C-33	CW234-2
AR14-2	89	1.0	1.0	1.0	C-33	CW257-10
AR14-3	92	1.0	1.0	1.0	C-33	CW257-10
AR15-6	42	1.0	1.1	1.1	C-33	CW257-12
AR17-18	64	1.0	1.0	1.0	C-33	CW258-17
AR17-23	54	1.0	1.0	1.0	C-33	CW258-17
AR17-3	75	1.0	1.0	1.0	C-33	CW258-17
AR18-1	33	1.0	1.0	1.0	C-377	CW257-12
AR23-1	93	1.0	1.0	1.0	C-39	CW259-43
AR35-1	54	1.0	1.0	1.0	C-243	CW257-10
AR37-103	70	1.0	1.0	1.0	C-33	CW259-42
AR37-38	77	1.0	1.0	1.0	C-33	CW259-42
AR40-19	74	1.0	1.0	1.0	C-39	CW259-42
AR40-3	80	1.0	1.0	1.0	C-39	CW259-42
AR40-5	57	1.0	1.0	1.0	C-39	CW259-42
AR42-3	33	1.0	1.0	1.0	C-413	CW259-42
AR42-4	69	1.0	1.0	1.0	C-413	CW259-42
AR9-12	55	1.0	1.0	1.0	C-243	CW257-12
AR9-14	82	1.0	1.0	1.0	C-243	CW257-12
AR9-48	91	1.0	1.0	1.0	C-243	CW257-12
AR9-63	86	1.0	1.0	1.0	C-243	CW257-12
CR100-2	88	1.0	1.0	1.0	OW181-2	C-377
CR100-5	63	1.0	1.0	1.0	OW181-2	C-377
CR100-9	45	1.0	1.0	1.0	OW181-2	C-377
CR13-8	85	1.0	1.0	1.0	COL1734	C-33
CR24-16	76	1.0	1.0	1.0	CM7951-5	C-18
CR24-3	90	1.0	1.0	1.0	CM7951-5	C-18
CR25-4	89	1.0	1.0	1.0	CM7951-5	C-33
CR27-20	50	1.1	1.0	1.1	CM7951-5	C-243
CR52A-2	78	1.0	1.0	1.0	C-243	SM1219-9
CR52A-4	77	1.1	1.0	1.1	C-243	SM1219-9
CR60B-10	95	1.0	1.0	1.0	C-18	TAI8
CR61A-1	71	1.0	1.0	1.0	TAI8	C-33
IITA-TMS-IBA920057	91	1.0	1.0	1.0		
IITA-TMS-IBA980505	96	1.0	1.0	1.0		
IITA-TMS-IBA980581	57	1.0	1.0	1.0		
TMEB419	83	1.0	1.0	1.0		
S140	52	2.6	2.6	2.6		
KM419	56	2.6	2.8	2.7		
KM94	41	2.8	2.9	2.8		
KM419	39	3.0	2.9	2.9		
KM94	35	3.2	2.7	3.0		
SDA5	52	3.0	2.9	3.0		
KM419	43	3.5	2.7	3.1		
KM140	80	3.2	3.1	3.1		
SDA30	55	3.9	2.9	3.4		

NEW

102 CIAT Clones Containing CMD2 Genes according to SSR markers

43 of 102 clones showed high resistance (No symptoms)
Yield trials were established in Tay Ninh and Dong Nai, in May 2020.



Validate DNA marker

Advanced yield trial harvest in March 2021

Around 12 clones have good plant types.

Some with starch content comparable to existing varieties

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Evaluation of resistant clones from CIAT and IITA in Vietnam

AR42-4

CR25-4

AR18-1

TMEB419

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Resistant vs Non-resistant

Longer term

Major Sources of CMD Resistance In South-East Asia

1) 5 IITA clones, all showing high resistance in Tay Ninh;

2) C33, TME3 and other clones from CIAT and IITA

3) 10 resistant varieties from the clones collected in Vietnam

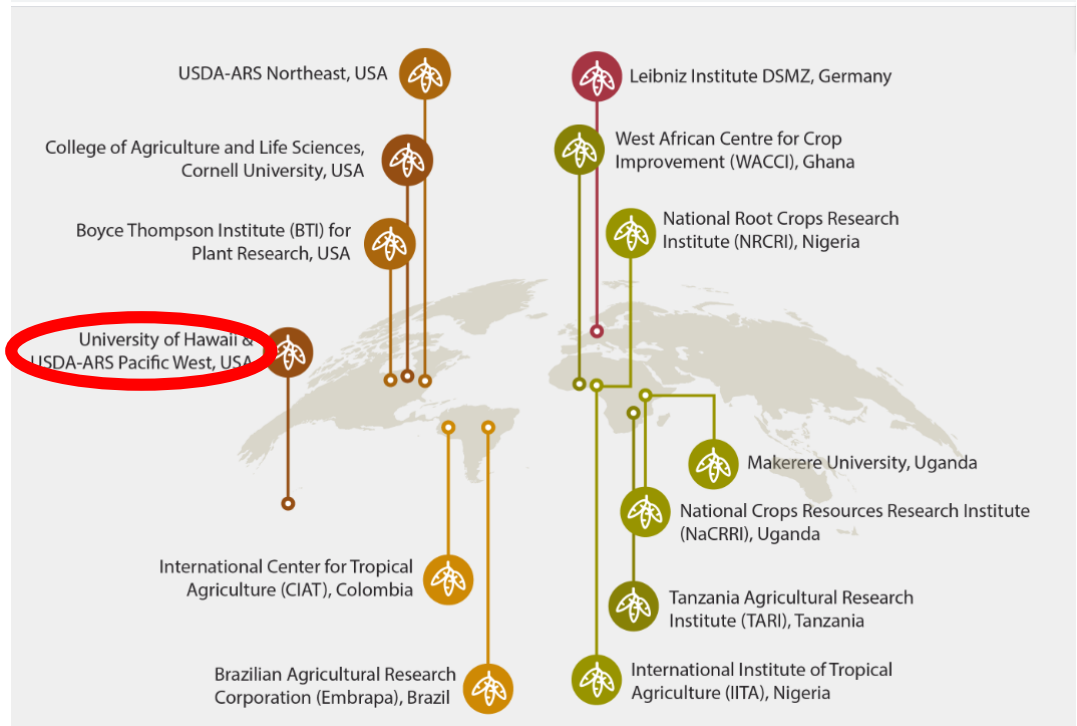
4) 102 CIAT clones containing CMD2 genes according to SSR markers

5) introduced seeds from Hawaii (progenitors from CIAT and IITA)

6) 474 seeds for genomic selection derived from CMD donors at CIAT

NEW Introduced Seeds from Hawaii

	Harvest Year	Cross Type	total seed 26Apr2019
HIL19PK0201	2017	OP	80
HIL19PK0202	2017	OP	210
HIL19PK0203	2017	OP	370
HIL19PK0204	2017	OP	550
HIL19PK0205	2017	OP	525
HIL19PK0206	2017	OP	50
HIL19PK0207	2017	OP	574
HIL19PK0208	2017	OP	102
HIL19PK0209	2017	OP	900
HIL19PK0210	2017	OP	250
HIL19PK0211	2016	OP	39
HIL19PK0212	2016	OP	114
HIL19PK0213	2016	OP	49
HIL19PK0214	2016	OP	87
HIL19PK0215	2016	OP	166
HIL19PK0216	2016	OP	76
HIL19PK0217	2016	OP	21
HIL19PK0218	2016	OP	59
HIL19PK0219	2016	OP	22
HIL19PK0220	2016	OP	36
HIL19PK0221	2016	OP	129
HIL19PK0222	2016	OP	90
HIL19PK0223	2016	OP	38
HIL19PK0224	2016	OP	22
HIL19PK0225	2016	OP	34
HIL19PK0226	2016	OP	156
HIL19PK0227	2016	OP	12
HIL19PK0228	2016	OP	49
HIL19PK0229	2016	OP	110
HIL19PK0230	2016	OP	40
HIL19PK0231	2016	OP	31
Total			4991
			Vietnam



Seed now sent to Thailand, Vietnam and Lao PDR

Maternal	Paternal	CIAT
COL1505	COL1722	12
COL1505	VEN25	12
COL1505	MAL3	12
CR138	MEX2	12
CR138	PER183	12
CUB46	CR138	12
CUB46	CM2766-5	12
GM579-13	SM3134-5	12
MAL3	PER183	12
MAL3	VEN25	12
MEX2	PER496	6
PER496	COL1722	5
SM1127-8	PER496	12
VEN25	PER496	12
C33	HB60	12
C33	SM2828-28	12
C413	SM2828-28	12
GM579-13	C39	10
GM7672-5	SM2828-28	12
GM8868-85	C243	12
GM8868-85	GM10055B-1	12
GM9124-12	GM10054B-1	9
GM9125-5	C243	7
HB60	GM7673-3	12
SM2828-28	C19	12
SM3110-15	C243	5
SM3110-15	GM10055B-1	6
SM3134-5	C19	12
SM3134-5	GM10054B-1	12
SM3137-40	GM10055B-1	12
SM3150-17	GM10055B-1	12
SM3150-17	GM7673-3	12
COL1722	HMC1	12
GM7673-3	SM2834-31	12
VENEZOLANA	C243	12
GM11129-11	SM4517-33	12
GM11129-27	SM4517-33	12
GM11129-27	SM4534-37	12
GM11129-35	GM4883-1	12
GM11194-2	SM4524-28	12
SM4516-40	C243	12
SM4516-40	GM11129-11	12
SM4517-30	GM4883-3	12
SM4524-28	GM10054B-1	12
SM4534-37	GM4781-2	12
SM4534-37	GM4781-2	12

Maternal	Paternal	VNM
CR138	PER183	10
COL1722	CR138	11
COL1505	VEN25	12
MAL3	VEN25	12
GM579-13	SM3134-5	14
COL1505	COL1722	14
CR138	MAL3	14
MAL3	VEN25	14
GM6125-13	SM2828-28	8
SM3150-17	C33	8
SM3134-5	GM10054B-1	12
SM3134-5	C19	12
C33	SM2828-28	12
GM7672-5	SM2828-28	12
SM3110-15	C243	12
SM3134-5	GM10055B-1	12
HB60	GM7673-3	12
GM8868-85	C33	12
C19	HB60	12
C413	HB60	12
HB60	GM10054B-1	12
GM10054B-2	HB60	12
GM7673-3	HB60	12
C243	SM2828-28	12
SM2828-28	C39	12
GM7672-7	SM2828-28	12
GM7671-2	SM3137-40	12
SM3150-17	C19	12
SM3134-5	GM10054B-2	12
SM2828-28	GM10055B-1	12
SM3134-5	C243	12
SM3134-5	GM7673-3	12
C33	HB60	12
COL1505	GM7673-3	14
COL1505	C243	14
CR138	GM10055B-1	14

NEW

CMD Resistance in the Genomic Prediction Population from CIAT

CIAT

AGI, Vietnam

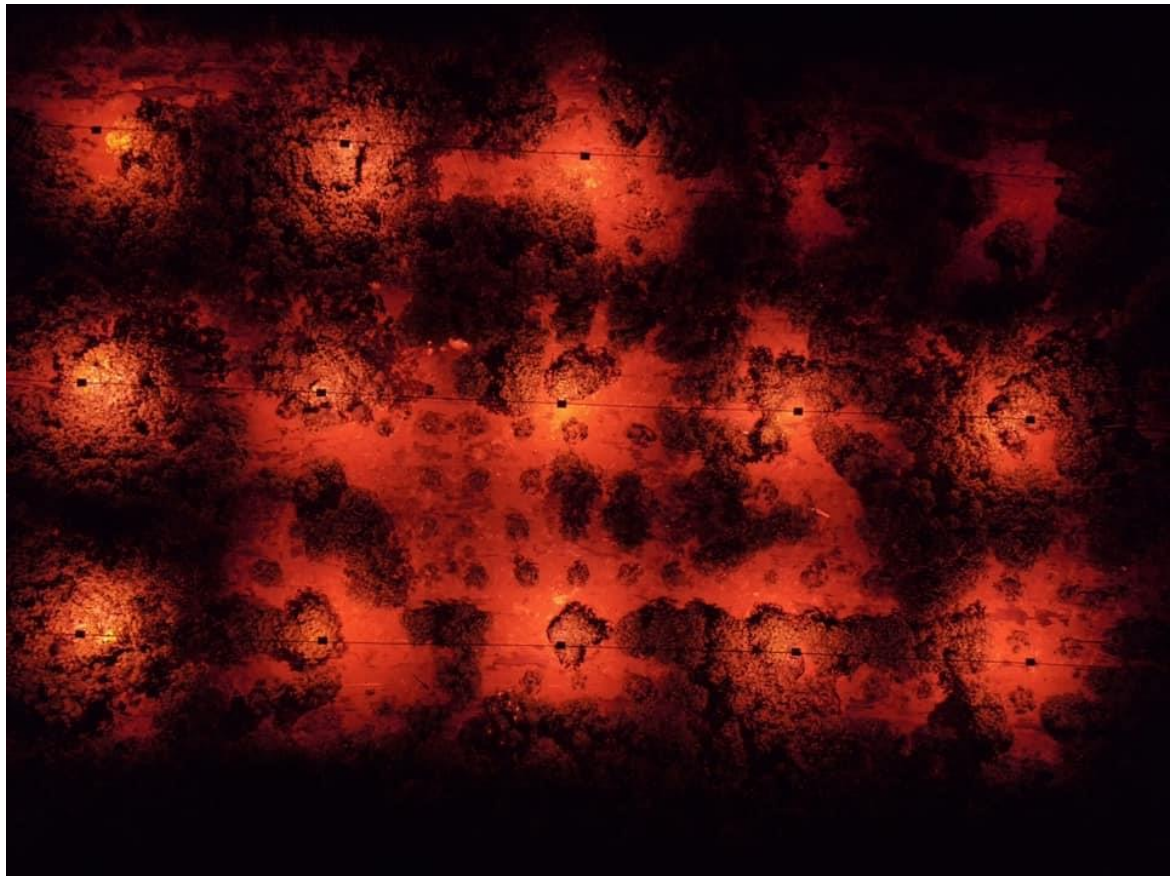
Outcomes:

Genomic prediction models for CMD and agronomic traits

QTL and diagnostic makers

Alliance Bioversity International CIAT

Establish crossing blocks and flower induction (North and Central Highland Vietnam)



Enhancing the cassava seed system

Enhancing the capacity of national tissue culture labs to receive new clones and maintain disease free material

NAFRI, Lao PDR

CARDI, Cambodia

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Establish rapid multiplication tunnels in partnership with private sector partners and local government

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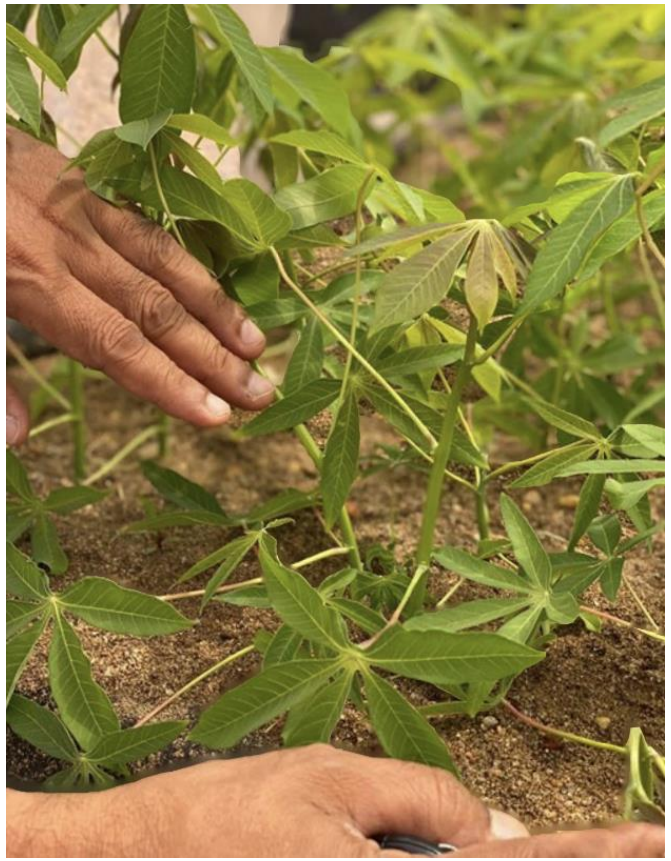
Multiplication rate of 100-125x per year relative to 6-10x using conventional methods



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Transplanting in the field every 2 months (irrigation)

Assessment of yield relative to conventional establishment

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CIAT

Success and sustainability depends on Public-Private partnerships

Long term support and coordination of activities between public and private sector

Within supply chains

- Surveillance and reporting on disease location and sources of clean stems
- Awareness raising of farmers (extension material at collection points)
- Uniform Yield Trials (UYT) for evaluation of clones in different agroecological zones
- Rapid multiplication of disease free and new varieties

Upstream

- Surveillance, including new diseases (CBSD etc.)
- Tissue culture and national genebanks
- Breeding activities of national programs

Partnerships for rapid multiplication have began…

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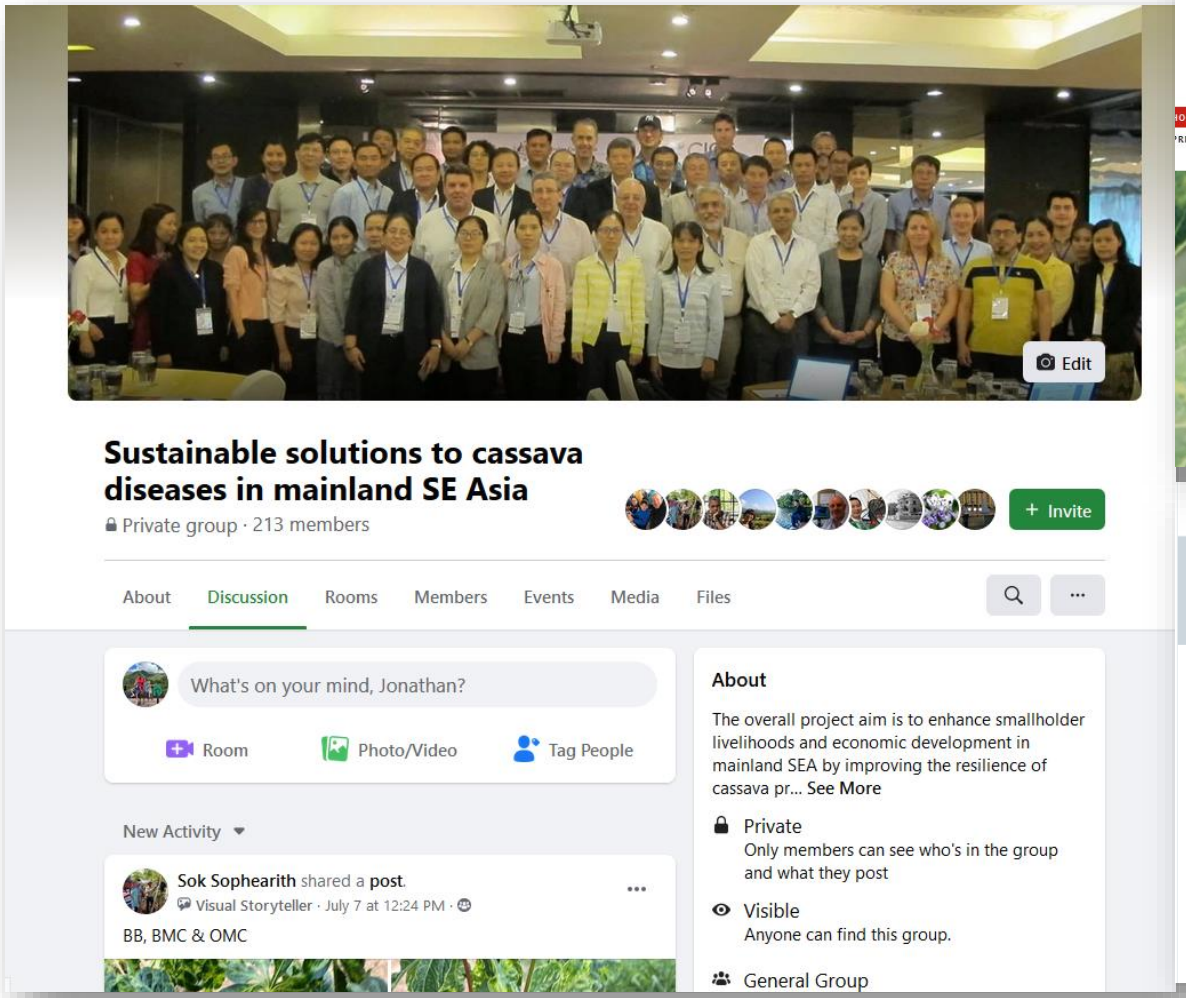
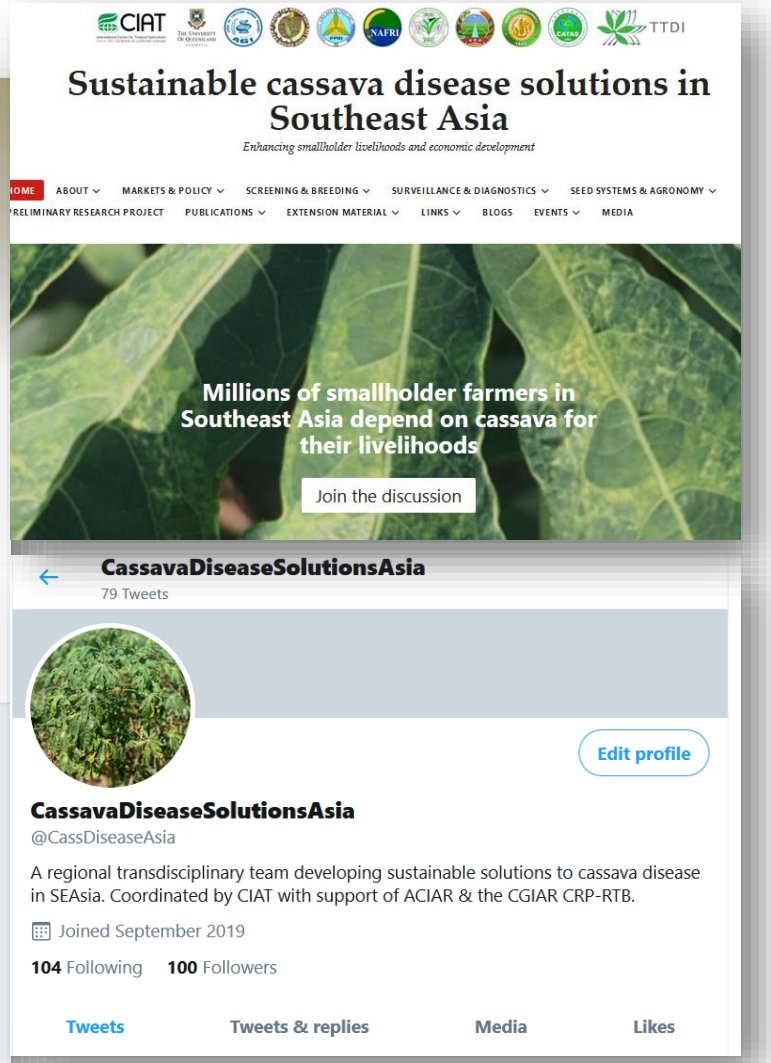
Stay connected to activities and results

https://cassavadiseasesolutionsasia.net/ -





Alliance

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Thank you!

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