

Establishing sustainable solutions to cassava diseases in mainland Southeast Asia

Final Review - Hung Loc Agricultural Research Center (HLARC)

Objective 2:

Enhance the capacity and collaboration between breeding programs in mainland Southeast Asia to develop new product profiles for commercially viable cassava varieties by identifying and incorporating known and novel sources of resistance to Cassava Mosaic Disease (CMD) and Cassava Witches Broom Disease (CWBD) into national breeding programs

Alliance



Report Outline:

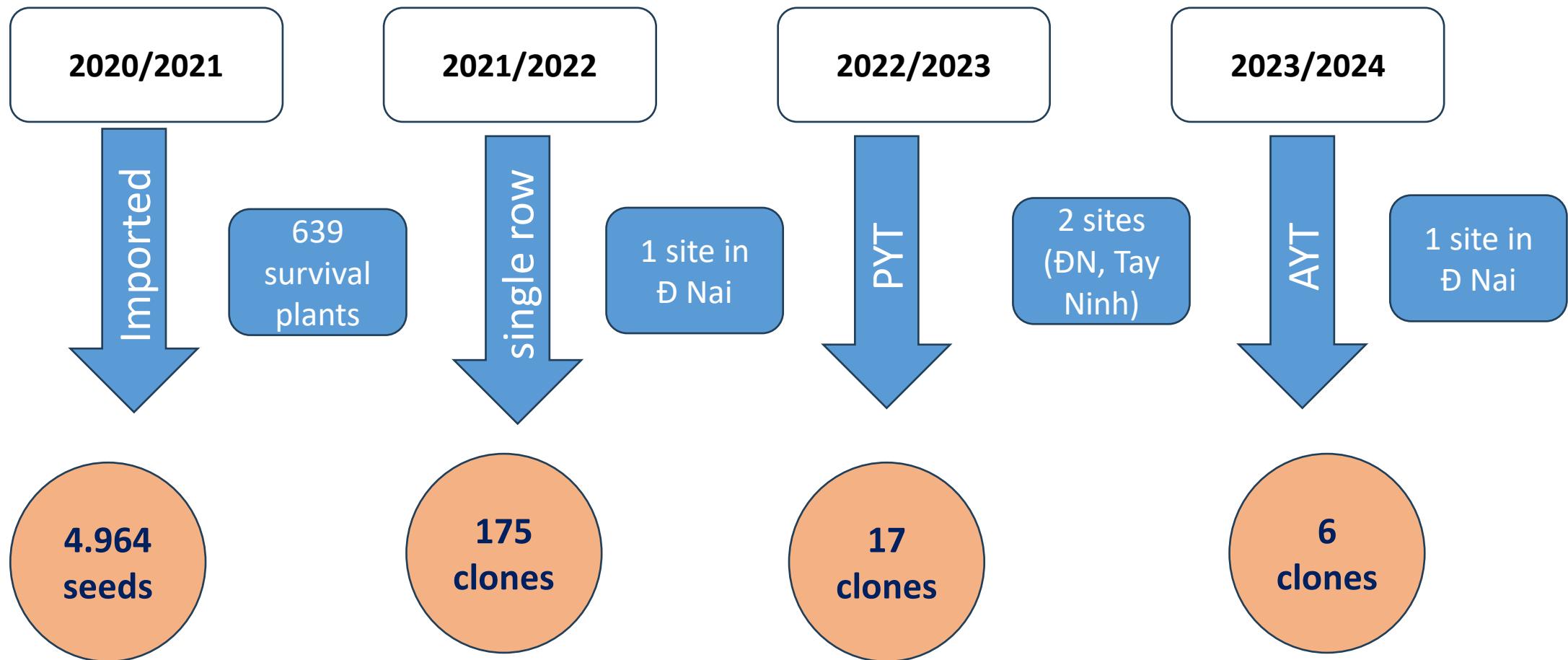
Introduction

- Activity 1: Evaluation of botanical seeds imported from **Hawaii** (NextGen project)
- Activity 2: Multi-environmental evaluation of CMD Resistant clones from **CIAT, IITA and Vietnam local varieties.**

Development

- Activity 3: **Develop CMD resistant varieties** by crossing between Vietnam Elites and CMD resistance varieties with CMD2 marker assisted

Activity 1: Evaluation of botanical seeds imported from Hawaii in 2020-2021



Performance of the Population from Hawaii

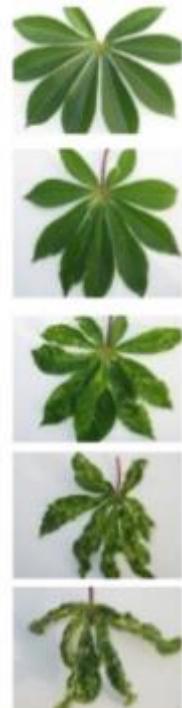
genotype			BLUPs_germination_perc		BLUPs_starch		BLUPs_yield_ha		BLUPs_starch_yield	
	check	advanced	Tai Ninh	Dong Nai	Tai Ninh	Dong Nai	Tai Ninh	Dong Nai	Tai Ninh	Dong Nai
KM505	yes		1.0	1.0	23.8	23.8	28.0	17.0	6.5	4.5
KU50	yes		0.9	0.9	21.6	20.9	28.0	23.4	5.8	5.4
TMEB419	yes		1.0	1.0	16.8	21.3	28.8	26.3	4.7	5.8
VN19-1050	yes		0.9	0.9	11.6	17.2	31.5	14.9	3.4	3.2
IBA980581	yes		0.4	0.4	14.9	13.8	15.3	6.8	2.3	1.1
CR24-16	yes		0.5	0.2	20.3	14.5	9.5	-0.5	2.1	0.3
HLH20-H0016	yes		0.9	0.8	20.8	20.2	32.6	13.2	6.5	3.4
HLH20-H0085	yes		0.9	0.4	20.0	18.9	31.9	7.8	6.2	1.8
HLH20-H0108	yes		0.9	0.8	18.6	15.1	34.1	8.1	6.1	1.7
HLH20-H0022	yes		0.8		22.9		26.2		5.8	
HLH20-H0047	yes		0.9	0.9	17.8	18.6	32.4	21.6	5.7	4.3
HLH20-H0075	yes		0.8	0.4	18.7	16.7	30.8	1.3	5.6	0.8
HLH20-H0135			0.8		18.8		27.0		5.1	
HLH20-H0039	yes		0.9	0.9	12.1	9.0	45.5	28.9	4.8	1.8
HLH20-H0036			0.7	0.3	19.0	16.3	22.7	4.9	4.2	1.1
HLH20-H0038			0.9		17.5		23.5		4.0	
HLH20-H0051			0.5	0.3	18.8	15.7	21.6	5.9	4.0	0.4
HLH20-H0082			0.5	0.0	19.4		11.6	0.0	2.5	0.0
HLH20-H0031			0.6	0.2	19.9	16.6	9.3	0.5	2.2	0.3
HLH20-H0050			0.3	0.4	16.6	13.8	10.7	5.6	1.9	0.7
HLH20-H0065			0.5	0.2	20.4	18.4	5.4	1.6	1.2	0.3
HLH20-H0053			0.1	0.0		16.6		1.7		0.6
HLH20-H0083			0.0	0.1				0.0		0.0



Activity 2: Multi-environmental evaluation of CMD Resistant clones from CIAT, IITA and Vietnam local varieties



Six CMD Resistant Varieties Have Been Released in Vietnam



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)

CIAT
&
IITA

	BLUE – single environment mean						BLUP
	2020_donn	2020_tayn	2021_tayn	2021phuy	2021_quan	CMD_10mon	
KU50	4.0	4.0	3.4	2.3	1.0	3.0	
TMEB419	1.0	1.0	1.4	1.3	1.0	1.1	
CR24-16	1.0	1.0	1.1	1.1	1.0	1.0	
CR13-8	1.0	1.0	1.0	1.0	1.0	1.0	
CR24-3	1.0	1.0	1.0	NA	NA	1.0	
CR52A-2	1.0	1.0	NA	NA	NA	1.0	
AR9-48	1.0	1.0	1.1	1.1	1.0	1.0	
CR52A-4	0.9	0.9	0.9	NA	1.0	0.9	
IBA980581	1.1	1.1	1.0	0.9	1.0	1.0	
IBA972205	1.0	1.0	0.9	1.1	1.0	1.0	
IBA920057	1.1	1.1	1.1	0.9	NA	1.0	
IBA980505	1.0	1.0	NA	1.0	NA	1.0	
HL-511	3.1	3.1	4.1	4.0	NA	3.7	
KM140	2.7	2.7	3.1	3.9	NA	3.5	
KM419	3.7	3.7	3.8	2.8	3.3	3.5	
KM505	2.6	2.6	NA	NA	2.1	2.6	

The clones were sorted based on **starch yield**.

Six CMD Resistant Varieties Have Been Released in Vietnam

		BLUE – single environment mean					BLUP starch_yield (ton/ha)	BLUE – single environment mean					BLUP starch (%)	
		2020_donn	2020_tayn	2021_tayn	2021phuy	2021_quan		2020_donn	2020_tayn	2021_tayn	2021phuy	2021_quan		
CIAT & IITA	KU50	13.3	2.4	11.0	6.4	7.8	8.0	28.4	28.2	27.2	24.1	29.1	27.1	
	HN1	TMEB419	7.6	13.5	10.1	4.4	9.0	7.9	26.8	29.7	25.3	20.0	24.1	24.3
	HN36	CR24-16	5.8	10.2	11.7	3.3	8.0	7.6	27.1	30.9	27.0	22.5	27.2	26.0
		CR13-8	7.0	8.5	9.4	4.4	6.1	7.2	25.9	29.5	25.6	20.8	25.3	24.5
		CR24-3	8.7	7.3	12.7	NA	NA	7.1	22.5	27.7	24.7	NA	NA	22.3
		CR52A-2	8.7	8.9	NA	NA	NA	7.1	23.8	30.7	NA	NA	NA	24.2
	HN97	AR9-48	8.1	6.6	9.6	4.5	8.6	6.7	25.8	25.8	25.9	23.2	25.8	25.4
		CR52A-4	7.2	8.1	9.2	NA	6.5	6.7	26.8	29.6	29.3	NA	26.9	27.1
	HN80	CR27-20	8.9	7.4	8.9	NA	4.6	6.5	25.9	30.4	26.5	NA	26.4	26.3
	HN5	IBA980581	4.7	13.1	8.1	2.6	5.9	6.1	21.0	27.1	20.5	18.0	19.8	20.5
	HN3	IBA972205	5.5	7.7	11.6	3.8	3.1	5.9	21.4	26.1	21.0	12.8	14.2	18.5
		IBA920057	5.5	4.8	10.6	4.1	NA	5.8	22.0	25.8	26.6	19.0	NA	22.8
		IBA980505	4.8	6.1	NA	2.1	NA	5.2	21.4	23.5	NA	14.8	NA	18.9
		HL-511	11.6	1.1	7.0	3.4	NA	5.8	29.0	29.1	27.6	27.1	NA	28.3
		KM140	7.5	6.0	6.4	3.2	NA	5.8	21.3	27.1	23.3	17.9	NA	21.4
		KM419	5.0	3.4	6.5	3.2	5.9	5.7	23.8	30.7	23.8	22.5	23.0	24.7
		KM505	6.4	5.6	NA	NA	6.2	5.3	25.8	31.3	NA	NA	27.9	25.8

The clones were sorted based on starch yield.

Further improvement required: starch stability, plant type, other pest and disease resistance

Multi-environmental evaluation of CMD Resistant clones

- From 2021-2023, CMD Resistant clones were transferred by HARC to partners for evaluation in many other ecological regions.
- The results of evaluation in many regions show that HN1 (TMEB419) is a widely adaptable line with good resistance to CMD and good fresh tuber yield and starch content.
- From 2022 until now, it is reported by stakeholders that area planted with HN1 variety is about 6-7 thousand hectares.
- Many farmers have achieved high economic benefits thanks to propagating HN1.

Activity 3: Develop varieties with CMD resistance

Crossing nursery in Lam Dong – Flower inducing technology



Crossing Nursery 2023

Plot 2 - 2000m2, Lam Dong, Vietnam

- 25 progenitors
 - 10 CMD resistant
 - 15 Elites
- Pair cross block: 2
- Poly cross block: 1
- Plant distance: 1.6m x 2.0m



Activity 3: Crossing Nursery in Lam Dong in 2020-2023

Planting

flowing

Crossing

Harvesting

June

Sept

Oct - Dec

Dec-Feb

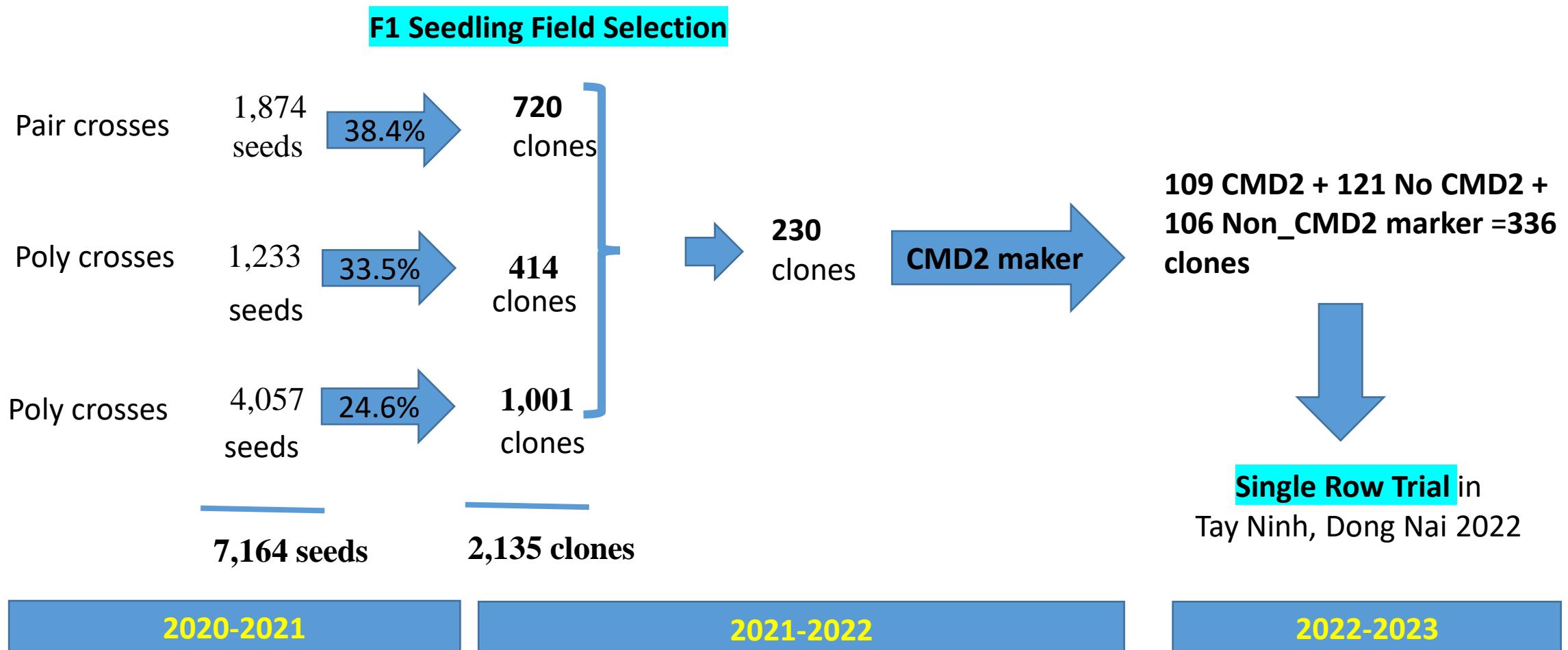


Activity 3: Crossing Nursery in Lam Dong in 2020 - 2023

Item	2020/2021	2022	2023	Total
Progenitors				
CMD resistance (CIAT, IITA)	19	8	7	
Landace, Elite	18	5	14	
Thailand	2	3	3	
Hybrid results				
Full-sibs (seed)	2.194	2.203	5.256	9.653
Half-sib (seed)	8.007	15.246	24.527	47.780
Selfing (seed)			312	312
Managed				
Full-sibs (seed)				
HLARC	2.110	1.556	3.256	6.922
CIAT	320	1.530	2.000	3.850
Half-sib (seed)				
HLARC	5.897	13.476	22.657	42.030
CIAT	1.870	1.770	1.870	5.510
Selfing (seed)				
HLARC				
CIAT			312	312

Activity: Evaluate the seeds harvested from crossing nursery (2021/2022)

Location: Dong Nai



Breeding Populations of Three Cohort of Cycle 1 (2021-2023)

Item	2021	2022	2023
Number seed sowing			
Full-sibs (seed)	1.874	1.556	1.844
Half-sibs (seed)	5.290	3.712	4.040
Germination (%)			
Full-sibs	38.40	55.40	60.85
Half-sibs	26.74	44.80	45.50
Clones to testing CMD maker	<u>230</u>	<u>802</u>	
Full-sibs (clone)	137	303	
Half-sibs (clone)	93	499	
Showing have CMD2	<u>109</u>	<u>318</u>	
Full-sibs (clone)	61	158	
Half-sibs (clone)	48	160	
Single row evaluation clones	336	319	



Single Row Trial in Tây Ninh



Single Row Trial in Dong Nai

**F1C1_V21 of 2021 population
Tay Ninh and Dong Nai, Vietnam**

- 340 clones + 5 checks
- CMD2 marker
- Design: Row column
- Plot: 4 plants x 1 row
- Rep x col x row: 1 x 16 x 23
- Plant distance: 1.0m x 0.8m
- Record data: 1,3,6,9 months after palnting and at harvest by Fieldbook apps on smart phone



The top clones of the cycle 1 and cohort 1 population were selected for further evaluation in two locations

Note: Different performance in two environments

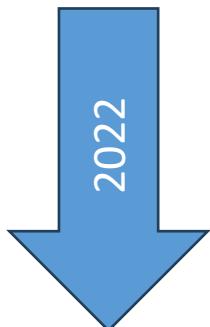
— Severe root rots in Tay Ninh

Genotype	Dong Nai			Tay Ninh		
	CMD_9 m	Yield (ton/ha)	Starch (%)	CMD_9 m	Yield (ton/ha)	Starch (%)
HLF21-0014	1	38.75	27.50	1	7.81	25.70
HLF21-0019	1	60.94	26.50	1	45.31	15.50
HLF21-0022	1	65.63	31.00	1	48.44	21.50
HLH21-0035	1	112.50	25.50	1	25.00	21.50
HLH21-0046	1	43.13	30.50	1	6.25	26.50
HLH21-0066	1	64.06	27.30	1	87.50	30.00
HLH21-0112	1	32.81	24.80	1		
VF21-0250	1	37.50	28.70	1	20.63	
VF21-0255	1	18.75	24.10	1	28.75	33.30
VF21-0264	1	47.81	27.70	1	34.38	19.00
VF21-0267	1	6.25	26.70	1	9.06	
VF21-0289	1	37.50	24.90	1	6.25	
VF21-0292	1	32.81	24.70	1	6.25	
VF21-0315	1	34.38	23.80	1	46.88	19.00
VF21-0343	1	29.69	28.50	1	2.50	19.50
VF21-0348	1	29.69	30.40	1	16.88	
VF21-0359	1	38.13	28.30	1	15.63	
VF21-0360	1	27.50	26.70	1	15.63	24.80
VF21-0364	1	43.44	29.50	1	29.69	
VH21-1503	1	65.00	30.70	1	9.06	21.50
VH21-1505	1	31.56	28.00	1	25.00	
VH21-1506	1	37.50	26.80	1	40.63	31.00
VH21-1513	1	51.25	24.10	1	26.56	
VH21-1516	1	60.31	24.00	1	10.94	
VH21-1519	1	37.50	29.00	1	8.75	
VH21-1521	1	34.38	26.00	1	10.94	
VH21-1537	1	18.75	23.70	1	-	20.50
VH21-1549	1	22.50	28.80	1	28.13	25.50
VH21-1573	1	43.75	23.50	1	17.19	-

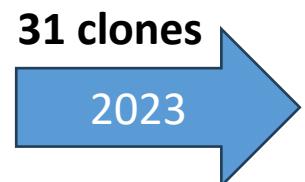
Activity: Preliminary Yield Trial (2023/2024)

Location: Dong Nai, Tay Ninh

Singer Row Trial
(10 months)
4 plants/2 sites/1 rep



Source materials: 109 CMD2 +
121 No CMD2 marker + 106
Asymptomatic = 336 clones



Preliminary Yield Trial
(9-10 months)
10 plants/2 sites/3 rep

109 CMD2:

Selected 23 Clones

121 No CMD2 marker:

Selected 0 Clones

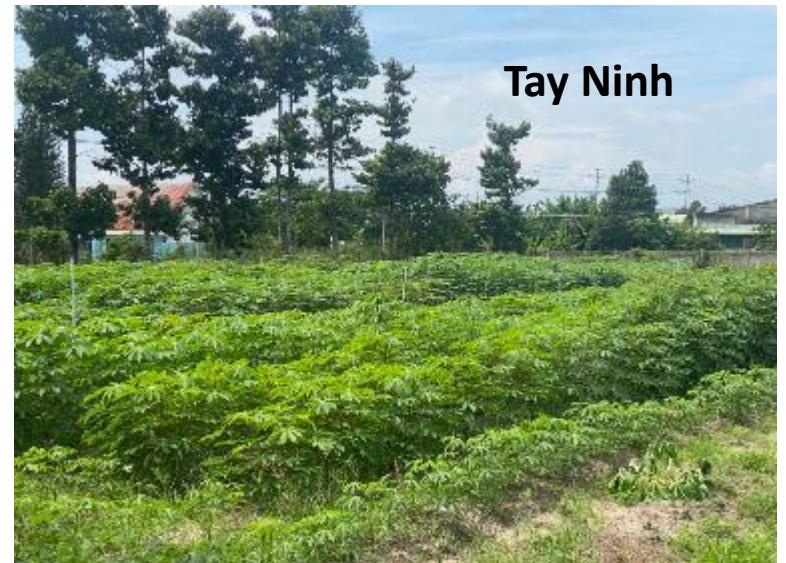
106 Asymptomatic :

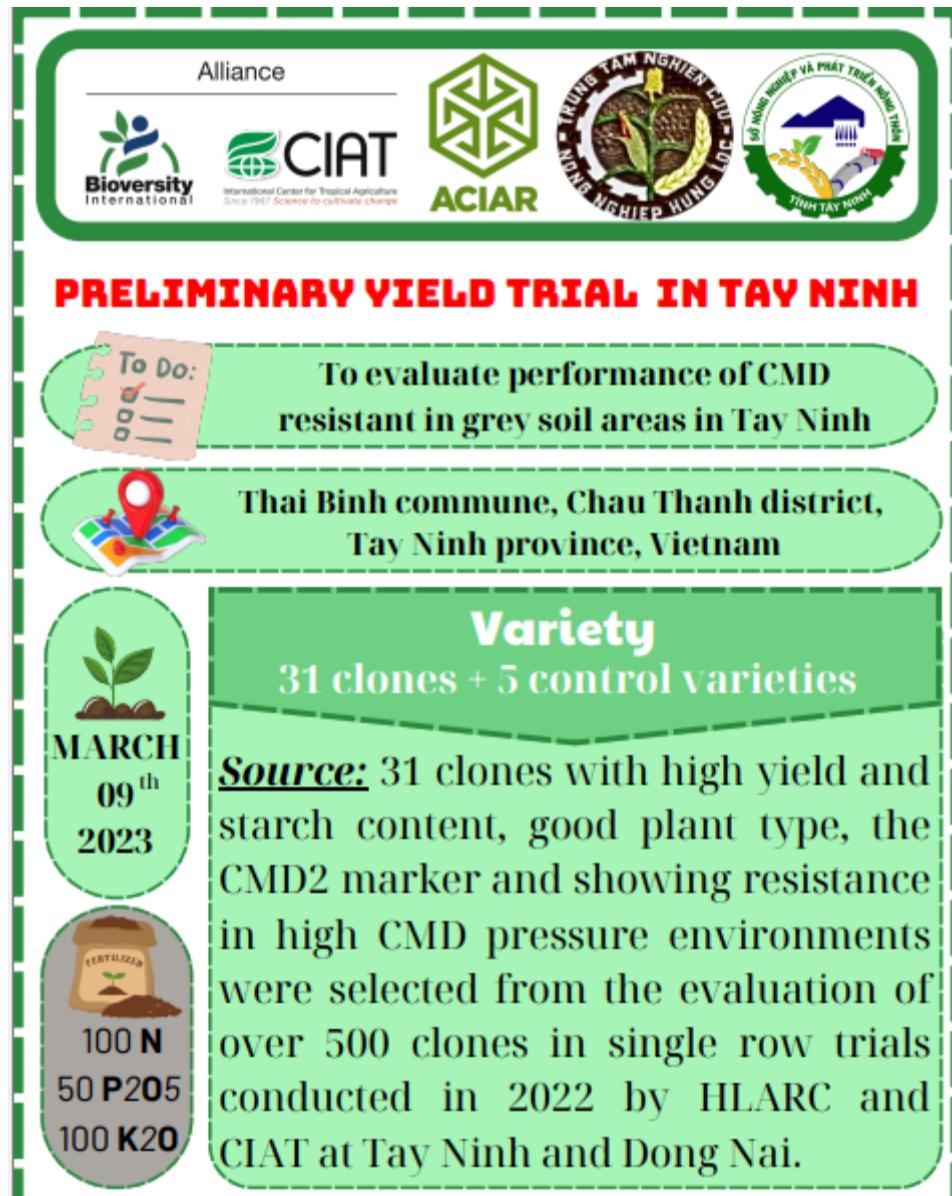
Selected 9 Clones

2022-2023 season

2023-2024 season

31 clones





Design	Density	Plot area	Replication
Row-Column	1 m x 1 m	1 m x 5 m	03
 Uniform with tractor	<p>+ <u>Planting method</u>: Vertical 5 - 6 cm underground and buds facing up</p> <p>+ <u>Stake</u>: 10 - 15 cm (5-8 buds)</p>	<p>← Traits</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> GERMINATION <input checked="" type="checkbox"/> VIGOR <input checked="" type="checkbox"/> CMD; CWBD; CBB; CRR... <input checked="" type="checkbox"/> #MAIN STEMS <input checked="" type="checkbox"/> PLANT HEIGHT <input checked="" type="checkbox"/> HEIGHT OF THE FIRST BRANCH <input checked="" type="checkbox"/> # BRANCHING EVENTS <input checked="" type="checkbox"/> SHAPE OF PLANTS <input checked="" type="checkbox"/> ROOT SHAPE <input checked="" type="checkbox"/> EXTERNAL COLOUR OF STORAGE R... <input checked="" type="checkbox"/> ROOT PULP COLOUR <input checked="" type="checkbox"/> FRESH ROOT YIELDS <input checked="" type="checkbox"/> STARCH CONTENTS <input checked="" type="checkbox"/> #LODGING PLANTS <input checked="" type="checkbox"/> # OF PLANTS HARVESTED <input checked="" type="checkbox"/> picture <input type="checkbox"/> audio <input type="checkbox"/> location 	<p>WEED CONTROL</p> <p>Apply herbicide after planting and hand weeding when weed small.</p> <p></p> <p>At 9-10 months after planting, pull out the plants in effective plots, cut off roots and weigh fresh roots</p> <p></p> <p>At 1, 3, 6, 9 months after planting and at harvest (by Fieldbook apps on Smartphones)</p>

Future Development

1. **Perform the 2nd cycle of breeding** focusing on starch stability, plant type, and resistance to root rot and witches' broom disease;
2. **Increase capacity** in data management and data analysis;
3. **Leverage DNA markers** in variety development;
4. **Enhance collaboration** in disease diagnosis and screening

Thank for your listening !