Agronomic & economic results of improved cassava management in eastern Cambodia: challenges of going to scale

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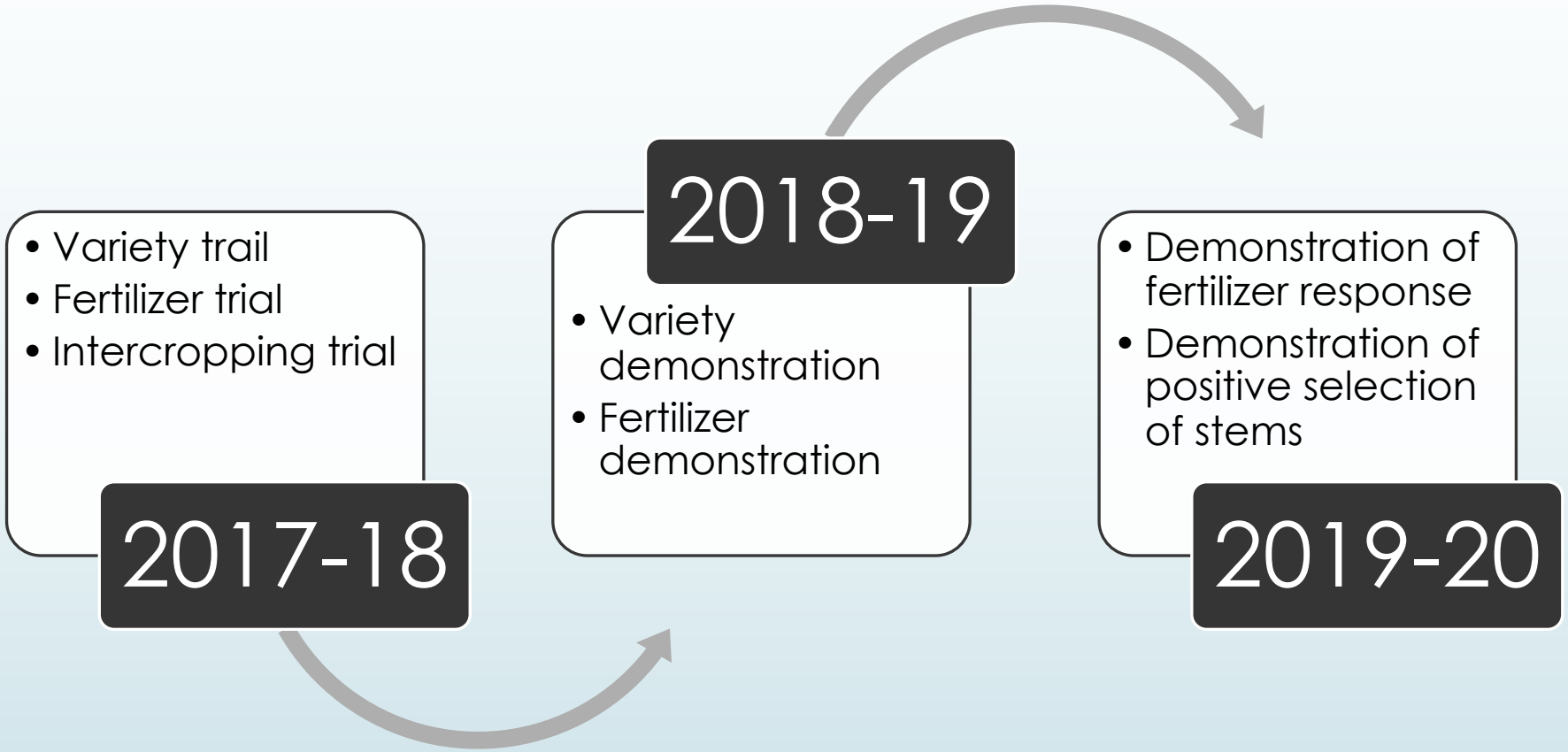
Outline

- Present the results of trials in 2017-18, 2018-19 and 2019-2020
  - Varieties
  - Fertiliser application
  - Varieties vs fertilisers
- Agronomic results
- Economic analysis
- Impact survey results

2015

Timeline of activities



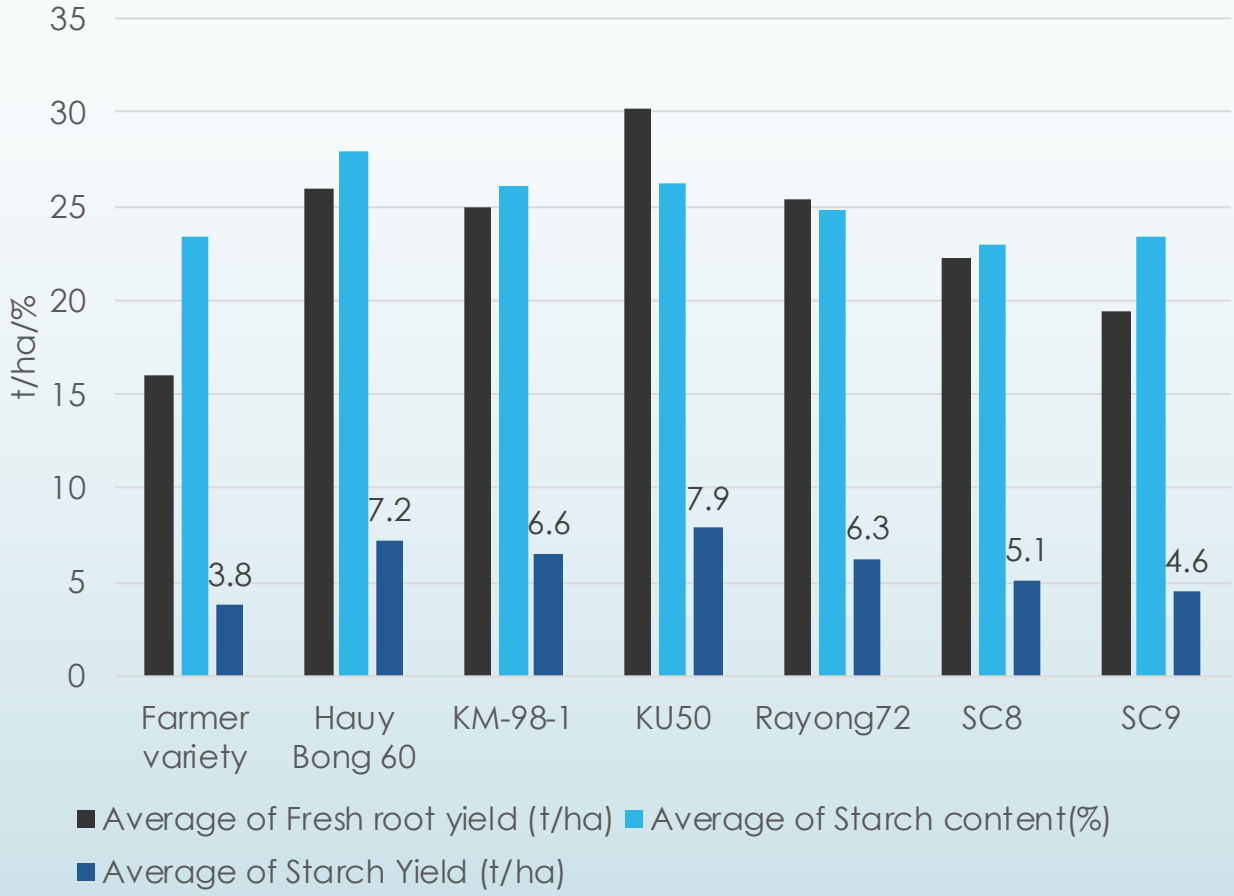
Farmers had no interest in continuing intercropping trials. With CMD arriving this became a major concern of farmers

Variety trial 2017-18

Year 1 results heavily impacted by disease with CMD reaching project Province

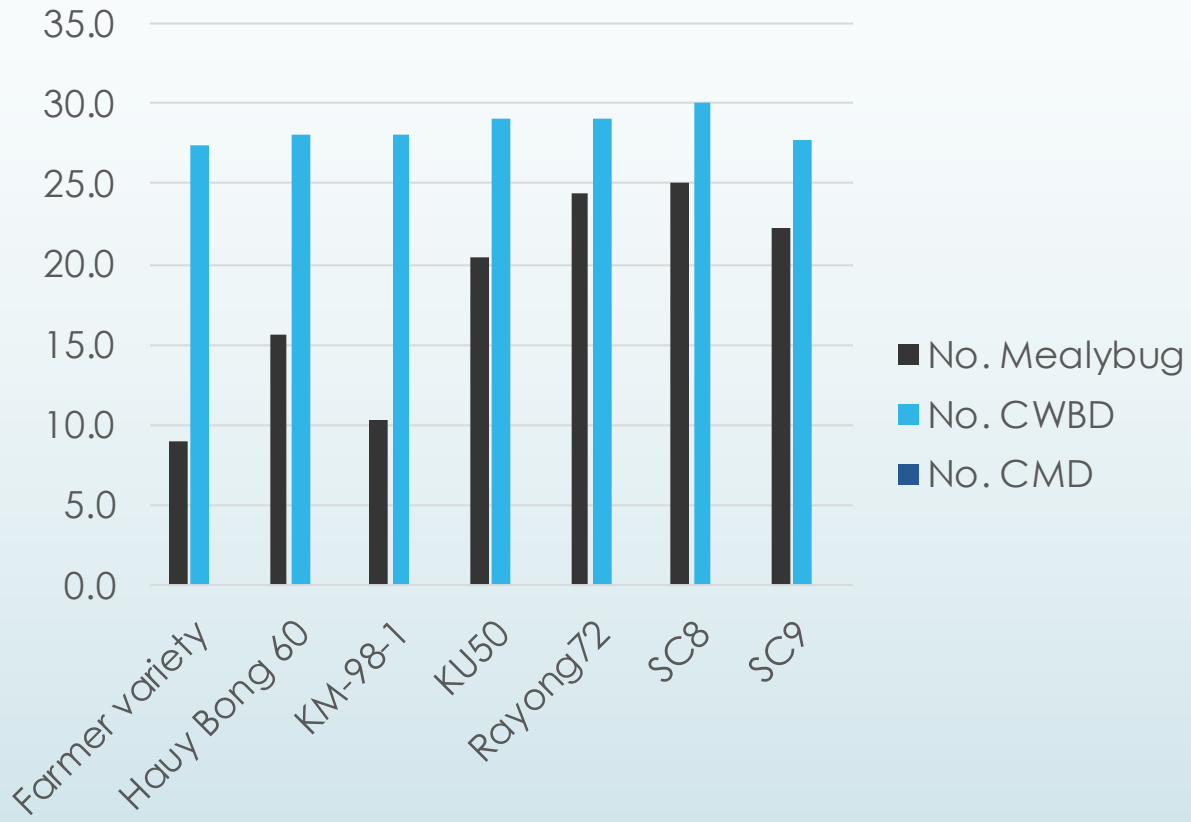
- Problem with farmers harvesting trials early so only 1 site remained for harvest by team.

Variety	Fresh root yield
KU50	30.17 a
Huay Bong 60	25.94 ab
Rayong72	25.41 ab
KM-98-1	24.91 abc
SC8	22.29 abc
SC9	19.44 bc
Farmer variety (likely KM419)	15.97 c



Average number of plants infected by pest and disease at time of harvest in Snuol

- High rate of CWBD across all varieties
- **No CMD observed in 2017-18 season in Snuol trial location.**



High CMD infection rates in Chit Borei

Location 2

	V	rayong_72					R	2	V	Local variety					R	3	V	huay_bong_60				
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6
R1	1	1	0	0	0	0	R1	M	1	1	0	1	1	R1	0	0	0	0	0	0
R2	0	0	0	0	1	0	R2	1	1	1	1	1	0	R2	0	1	0	0	0	0
R3	0	0	0	0	0	0	R3	1	1	1	1	1	1	R3	0	1	0	0	0	0
R4	0	0	0	1	0	0	R4	0	1	1	1	1	1	R4	0	0	1	0	0	0
R5	0	0	0	0	0	0	R5	1	1	0	1	1	1	R5	0	0	0	1	0	0

	V	ku50						V	sc9						V	km98-1				
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6
R1	0	1	0	0	0	0	R1	0	1	0	1	1	0	R1	0	0	0	0	0	0
R2	0	0	1	0	0	0	R2	0	0	0	0	0	1	R2	0	0	0	0	0	0
R3	M	0	0	1	0	1	R3	0	0	0	0	0	0	R3	0	0	0	0	0	0
R4	0	0	0	1	0	0	R4	1	0	0	0	0	0	R4	0	0	0	0	0	0
R5	0	0	0	0	0	0	R5	0	0	0	0	0	0	R5	0	0	0	0	0	0

	V	km98-1						V	rayong_72						V	sc8				
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6
R1	0	0	0	0	1	0	R1	0	0	0	0	0	0	R1	0	0	0	1	1	1
R2	0	0	0	0	0	0	R2	0	0	0	0	0	0	R2	1	0	0	1	1	1
R3	0	M	0	0	0	0	R3	0	0	0	0	0	0	R3	0	0	0	0	1	0
R4	0	0	0	0	0	0	R4	0	0	0	0	0	0	R4	0	1	1	1	1	0
R5	0	0	0	1	0	0	R5	0	0	M	1	0	0	R5	1	1	1	1	0	0

	V	Local variety						V	ku50						V	Local variety				
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6
R1	1	0	1	1	1	0	R1	0	0	0	0	0	0	R1	1	1	1	1	1	1
R2	1	1	1	1	1	1	R2	0	M	0	M	0	0	R2	1	1	1	1	1	0
R3	0	1	1	1	1	1	R3	1	0	0	1	0	0	R3	1	1	1	1	1	1
R4	0	1	1	1	1	1	R4	0	0	0	M	0	0	R4	1	1	1	1	1	M
R5	1	1	1	1	0	1	R5	0	0	0	0	0	0	R5	1	1	1	1	1	1

	V	sc9						V	sc9						V	rayong_72				
	P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6		P1	P2	P3	P4	P5	P6
R1	0	0	0	0	0	1	R1	M	0	1	0	0	1	R1	0	0	0	0	0	0
R2	0	0	0	0	0	0	R2	0	1	M	0	1	0	R2	0	1	0	0	0	0
R3	0	0	1	0	0	0	R3	1	1	1	0	M	0	R3	0	0	0	0	0	0
R4	0	1	0	0	0	0	R4	0	0	0	M	1	1	R4	0	0	0	0	0	0

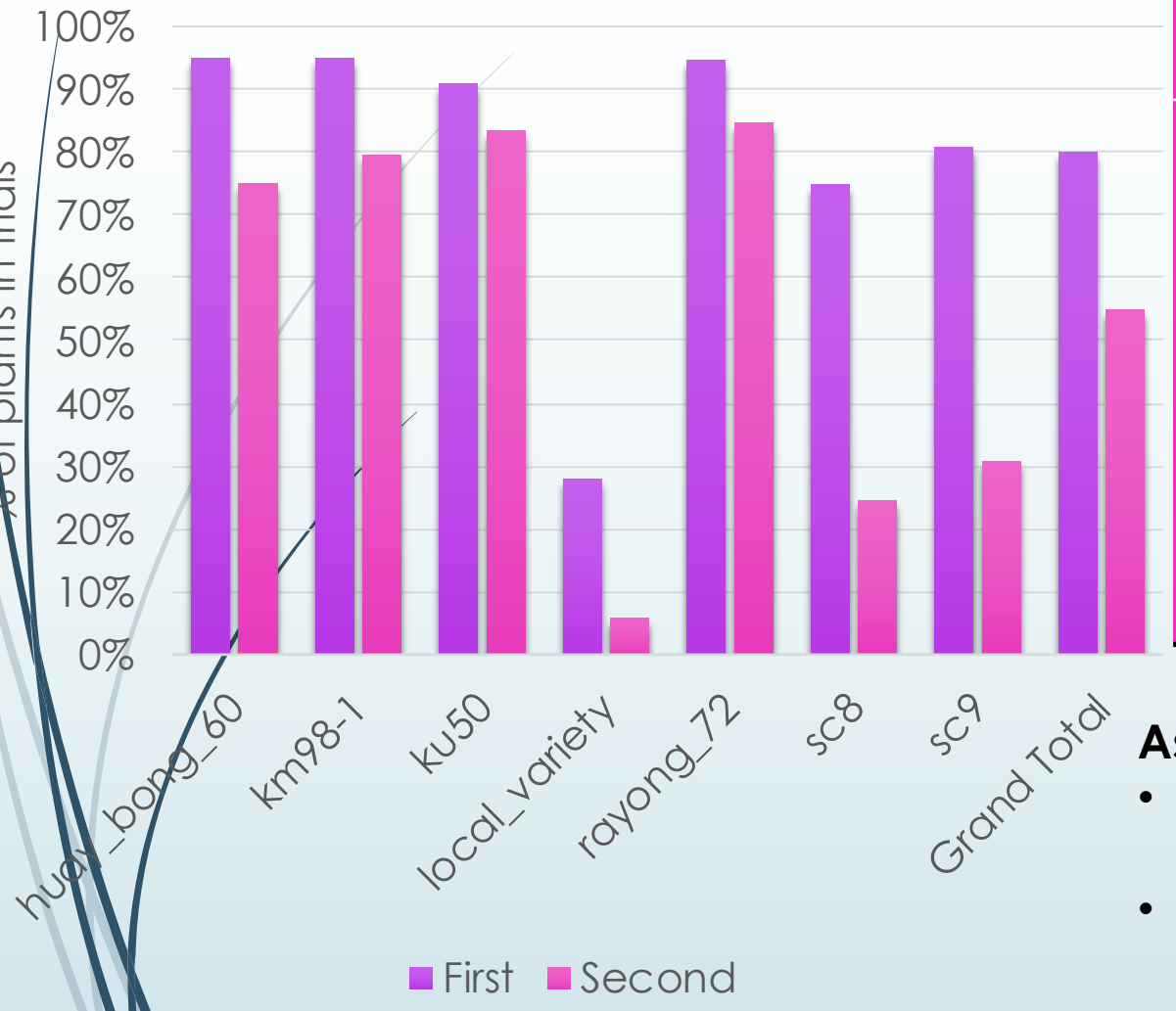
- Farmers own variety is assumed to have been infected prior to establishment with surrounding fields also infected.
  - DNA finger printing showed variety was KM419 officially released in Vietnam in 2013
- Visual inspection of every plant occurred (May 2017)
- Samples collected and sent for PCR analysis
- Second round of visual inspection carried out (Nov 2017)
- No yield data due to farmer harvest

	V	rayong_72									R	1			V	km98-1									R	2			V	huay_bong_60									R	3		
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0
R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	1	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	0
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0

	V	ku50									R	1			V	sc9									R	2			V	km98-1									R	3		
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	M	0	0	0	0	0	0	0	0
R3	0	0	0	0	0	0	0	0	1	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	1	0	R4	0	0	0	0	0	0	0	0	1	0	R4	0	0	0	0	M	0	0	0	1	0
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	1	R5	0	0	0	0	0	0	0	0	0	1	R5	0	0	0	0	0	0	0	0	0	1

	V	km98-1									R	1			V	rayong_72									R	2			V	sc8									R	3		
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0
R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	0
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0

Percentage of plants <u>without</u> visible symptoms



Variety	Infection rate by PCR (%) Location 1	Infection rate by PCR (%) Location 2	Asymptom rate (% of infected) Location 1	Asymptom rate (% of infected) Location 2
Huay Bong 60	6.7	0.0	100	0.0
KM98-1	6.7	5.6	100	100
KU50	0.0	0.0	0.0	0.0
Farmer's Local Variety	76.7	88.9	26.1	20.0
Rayong 72	**43.3**	**61.1**	**84.6**	**81.8**
SC8	16.7	27.8	80.0	60.0
SC9	16.7	66.7	40.0	58.3

Asymptomatic plants

- **SC8/SC9** showed high levels symptoms by November 2017
- **Rayong 72** was still not showing high levels of symptoms by the second inspection despite high levels indicated with PCR

* DNA fingerprinting suggest SC8 and SC9 in the trial were the same variety.

Variety trial 2018-19

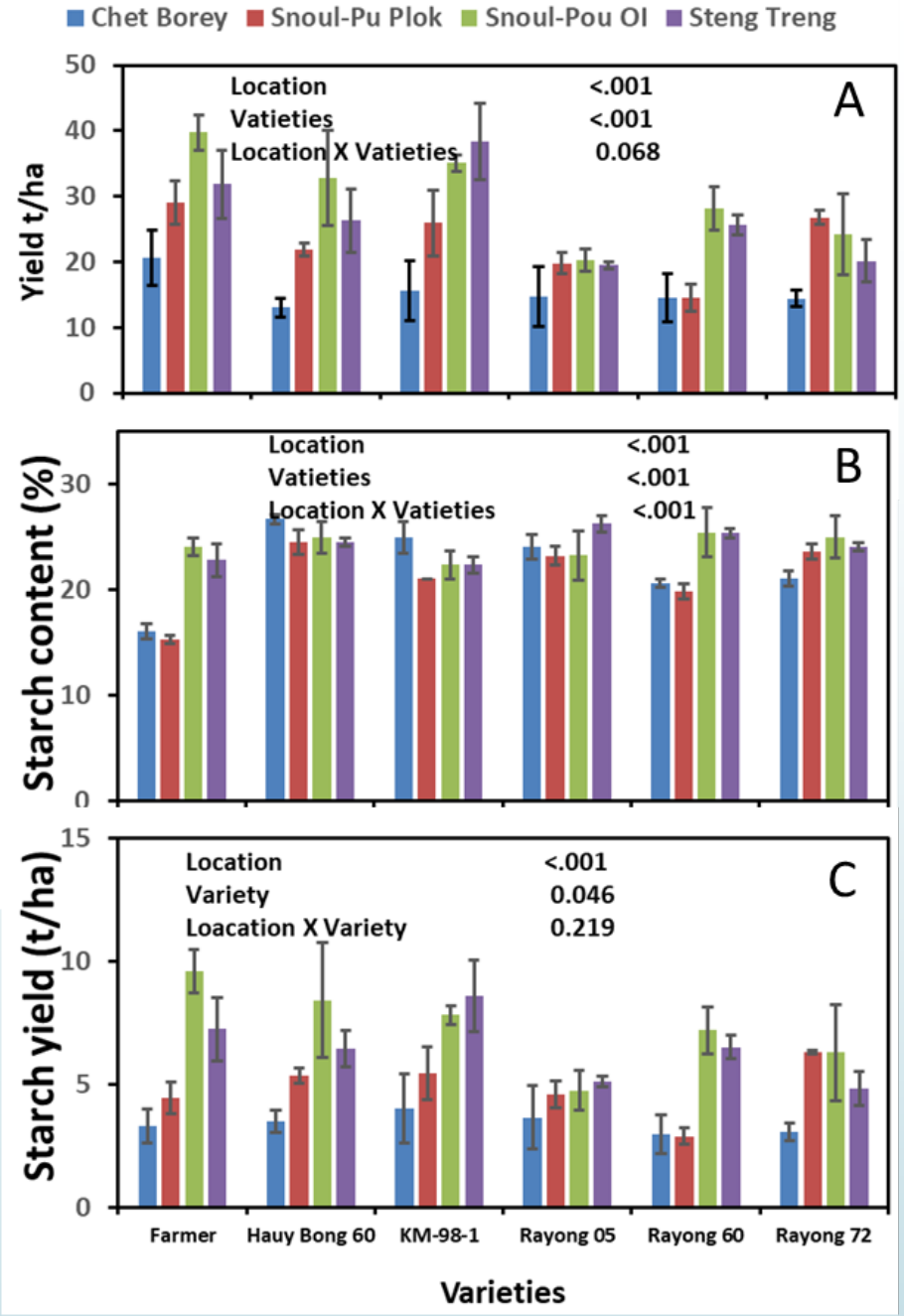

Rayong 72
Local
KM98-1
Rayong 60
Rayong 5
Huaybong60
KM98-1
Rayong 5
Rayong 60
Huaybong60
Local
Rayong 72
Local
Rayong 72
Huaybong60
Rayong 60
KM98-1
Rayong 5


Rayong 72
28.77
Local
24.51
KM98-1
23.74
Rayong 60
16.04
Rayong 5
17.37
Huaybong60
20.83
KM98-1
37.93
Rayong 5
22.67
Rayong 60
15.83
Huaybong60
23.59
Local
28.52
Rayong 72
24.71
Local
36.21
Rayong 72
27.17
Huaybong60
22.01
Rayong 60
12.25
KM98-1
18.48
Rayong 5
19.35

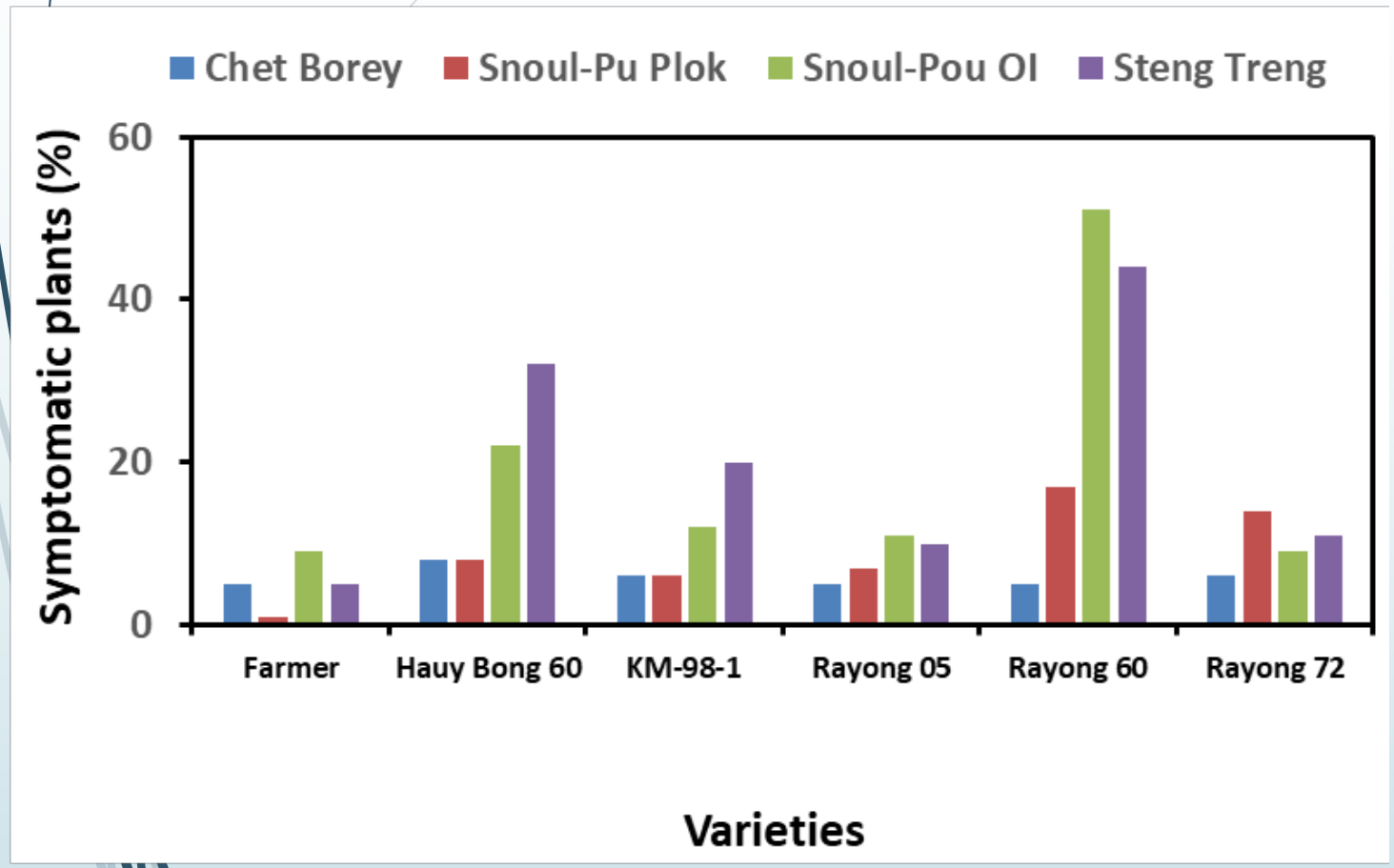

100
90
10
80
20
70
30
60
40
50
NHƠN HÒA

Agronomic results

- Among the varieties across all locations farmer's choice variety yielded highest, ranged from 20.6 to 39.7 t ha^{-1} and Rayong 5 yielded lowest, ranged from 14.8 to 20.2 t ha^{-1}.
- While considering different locations, on an average for all varieties Snoul-(Pou OI) produced highest (i.e. 30 t ha^{-1}) and Chet borey produced the lowest (15 t ha^{-1})
- Starch content was significantly different at variety x location interaction ($p < 0.001$)).
- On an average across all locations starch content of Hauy Bong60 was highest (i.e. 25.2 %) and Farmers' choice variety had the lowest (i.e. 19.6%).
- However, starch yield was not significantly different at variety x location interaction (Fig C).



Observed CMD prior to harvest



- Number of CMD symptomatic plants differed among 6 varieties across **all locations**
- Percentage of CMD symptomatic plants was highest (i.e. 29.3%) for Rayong 60 and lowest for Farmer's choice variety (i.e. 5%).
- Among 4 locations percentage of CMD symptomatic plants were on average highest in trials Snoul-Pou OI and Steng Treng for all the varieties, 20 and 19.3%, respectively.

Conclusion on varieties (2017-2019)

- Ranking of varieties following the criteria of the fresh root yield and starch content came out very different-
  - FRY - Farmer's choice variety came out at the top; however,
  - Starch % the same variety came out at the bottom.
  - Although when ranking was calculated following starch yield farmer's choice variety came out as second precede by variety KM98-1.
  - Ranking on the disease susceptibility (i.e. % of asymptomatic plants), Farmer's choice variety ranked the top and Rayong 60 bottom.
- The current pricing system does not provide incentive for high starch content.
- It is assumed that stems in the trial were CMD free at time of planting. However other results have shown high levels of asymptomatic infection which would produce a different result in the following year.

Fertiliser trials 2017-18

Fertiliser use in NE Cambodia remained low in project villages.

	Kratie		Stung Treng	Total
Name of district	Chit Borei	Snuol	Siem Bok	
Do you apply organic fertiliser to your cassava?	2.97%	1.00%	0.00%	1.29%
Do you apply inorganic fertiliser to your cassava?	**7.92%**	**5.00%**	**4.55%**	**5.79%**
Do you understand what the NPK values mean on the fertiliser you apply?	**1.98%**	**2.00%**	**0.00%**	**1.29%**
Have you ever seen a fertiliser trial on cassava?	22.77%	34.00%	17.27%	24.44%
Are you interested in visiting a fertiliser demonstration trial to see the result on production and returns?	87.13%	91.00%	70.00%	82.32%
Are you interested in conducting a trial on your own land?	75.25%	62.00%	58.18%	64.95%

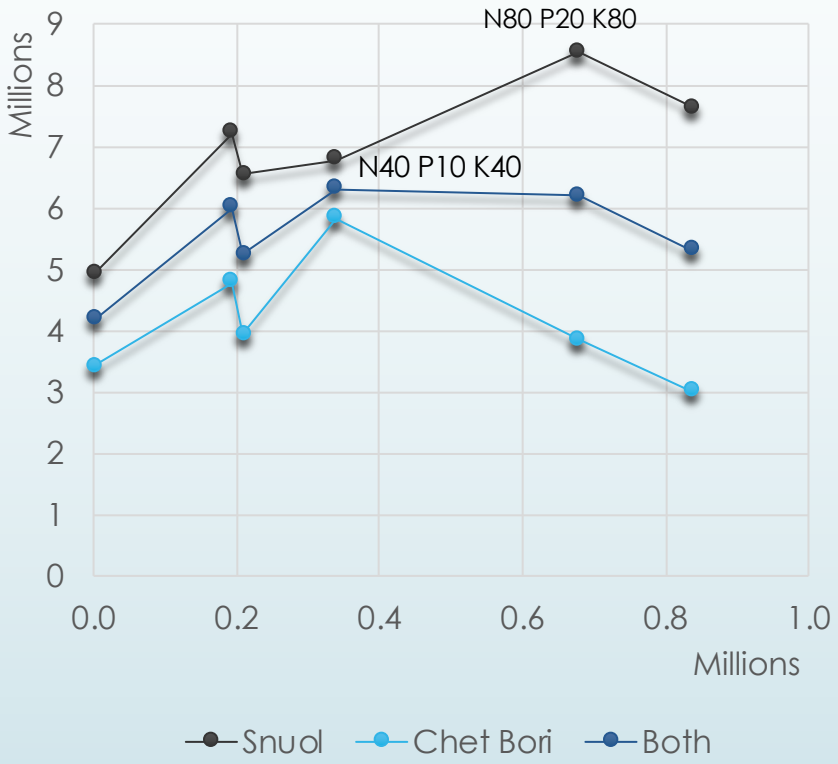
Agronomic results of fertiliser trial

- Root yield was significantly different ($p<0.001$) between two locations.
- However, there was no difference between the treatments in each location due to large variability caused by biotic (root rot, CMD and CWBD) stresses.
- The average fresh root yield was 1.4- to 2.2-fold higher in the Snuol District compared to Chit Borei District.
- The highest yield (26.3 ± 6.7 t ha-1, Snoul) was achieved with highest fertilizer rate.
- In Chit Borei District highest yield was 17.6 ± 1.0 t ha-1 with moderate fertilizer application.
- In general fertilizer application yielded higher fresh root compared to Farmers' practice and without any fertilizer application.

Treatment	Chit Borei (t/ha)	Snoul (t/ha)
Farmer practice*	11.8	19.3
N40 P10 K0	14.2	21.2
N40 P10 K40	17.6	20.3
N40 P10 K40 + CM 5T/ha	11	24.2
N80 P20 K80	12.9	26.3
No fertilizer	9.7	14
Fertilizer	P= 0.172, L.S.D.= 6.31	
Location	P<.001, L.S.D.=3.64	
Fertilizer x Location	P=0.403, L.S.D.=8.92	
*(20:20:15=100kg/ha)		

Net benefits and marginal rate of return analysis

Treatment	Cost of treatment	Snuol	Chit Borei	Both
No fertilizer	0	4,911,667	3,409,259	4,160,463
N40 P10 K0	191,987	7,224,124	4,779,309	6,001,717
Farmer practice (20:20:15=100kg/ha)	210,000	6,545,000	3,925,185	5,235,093
N40 P10 K40	338,661	6,774,117	**5,818,746**	**6,296,43**1
N80 P20 K80	677,322	**8,539,344**	3,853,233	6,196,289
N40 P10 K40 +CM5T/ha	838,661	7,619,672	2,995,135	5,307,404

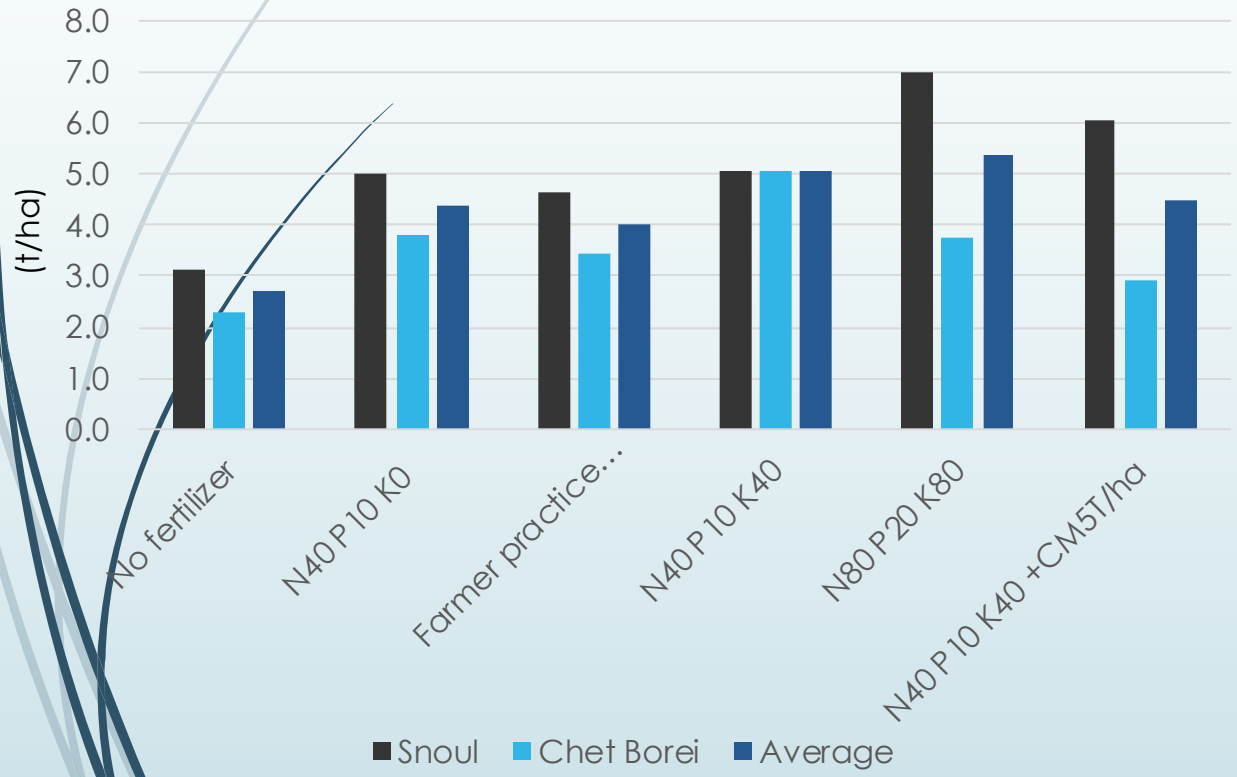


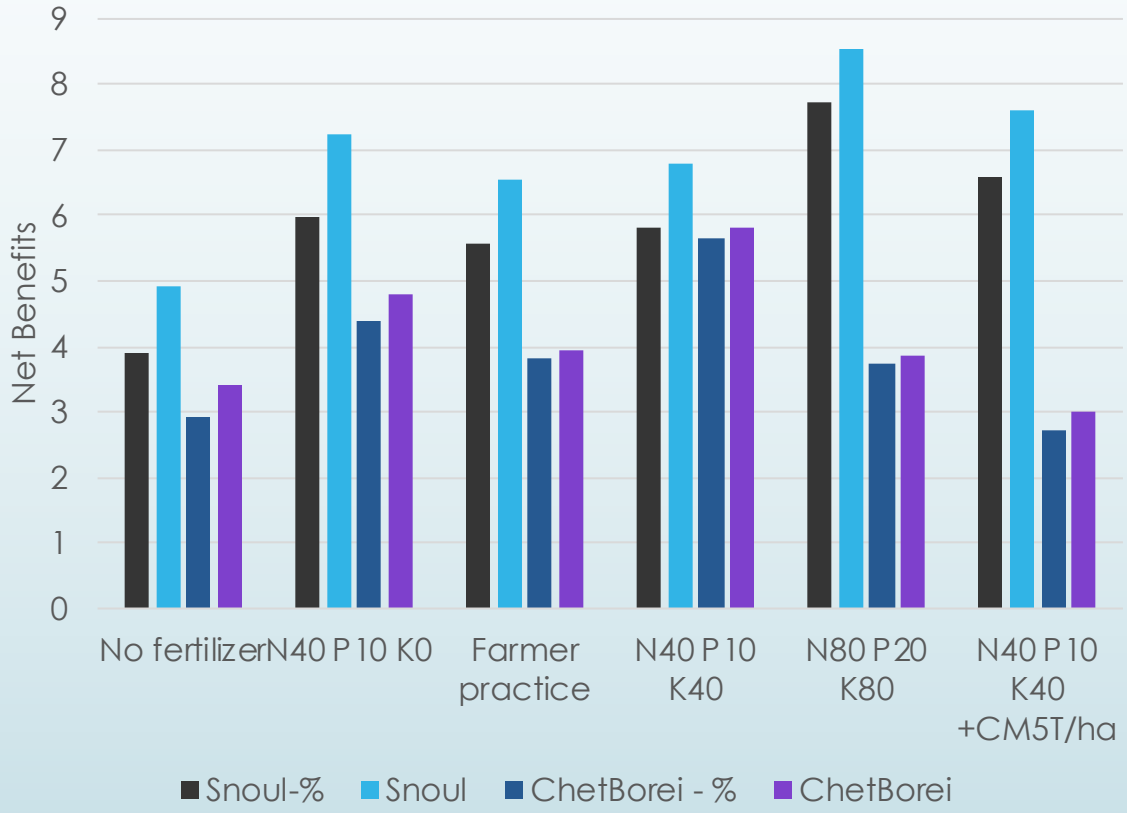
Year 1 conclusion

- Significant uncertainty surrounding fertilizer application when biotic and abiotic stresses are present.
- Given that there was no significant difference between fertilizer rates, the least expensive rate would be recommended, however given it is only one year of result no recommendation can be safely made.
- If average responses are considered, **a $50 USD investment in fertilizer** produced a marginal net benefit (MDB) of over $570 for N40 $P_2O_5$10 K_2O 0. At all probable root prices the MRR would be above 200%.
- An additional $120 USD investment ($170 USD total) required for the high balanced rate produced a MNB of $329 USD equivalent to a MRR of 270%. This would remain above 200% for prices above 280 Riel/kg (analysis done at 350 Riel).
- In Chet Bori District, once again the cheapest rate (N40 P2O510 K2O 0) produced a high MRR (714%), while the additional of potassium (N40 P2O510 K2O 40) also produced a high MRR (709%).

Impact on starch content & starch yield

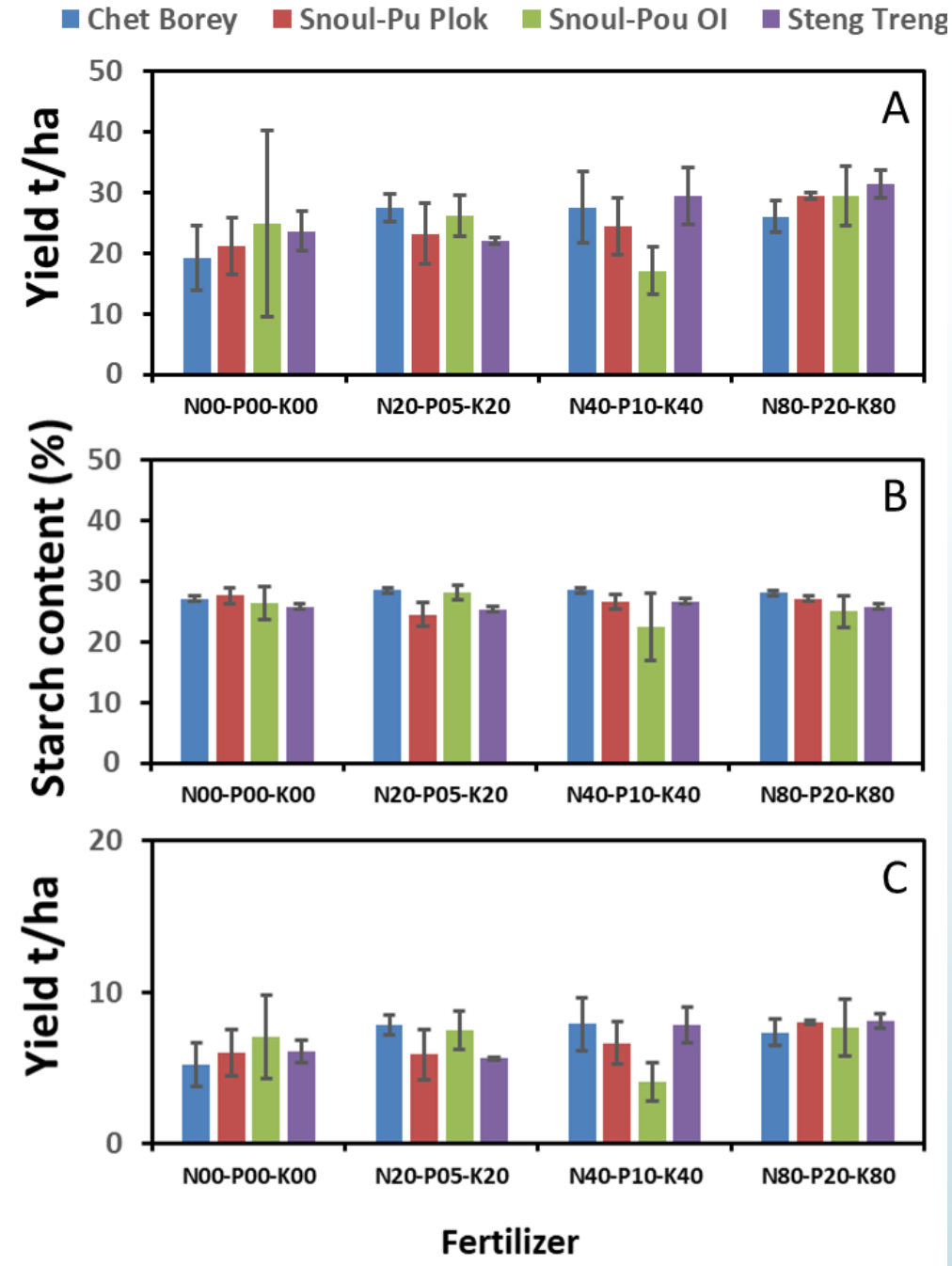
- Application of fertilizer increased starch content in all treatments ranged
- This becomes more important when prices are paid on starch content





Fertiliser trial 2018-19

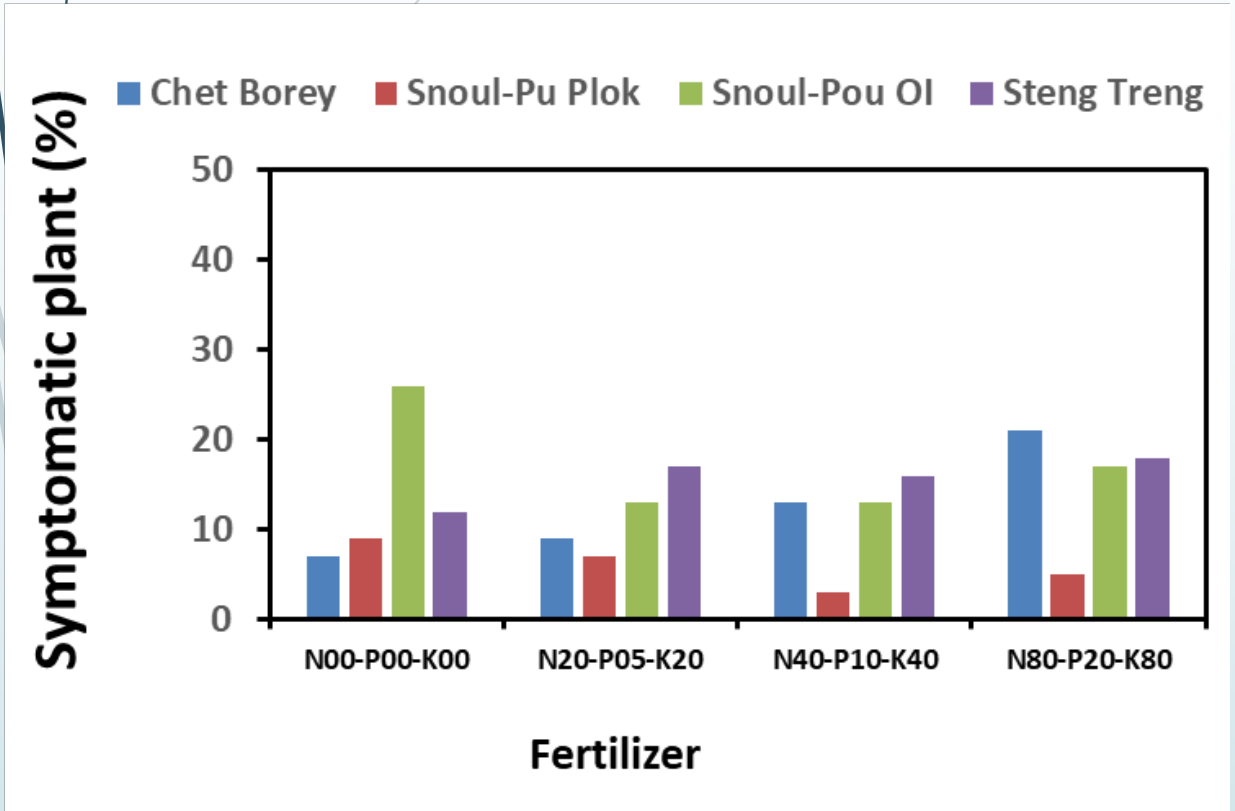

Zero
Medium
Low
High
Low
High
Zero
Medium
High
Zero
Medium
Low



Fertiliser agronomic results

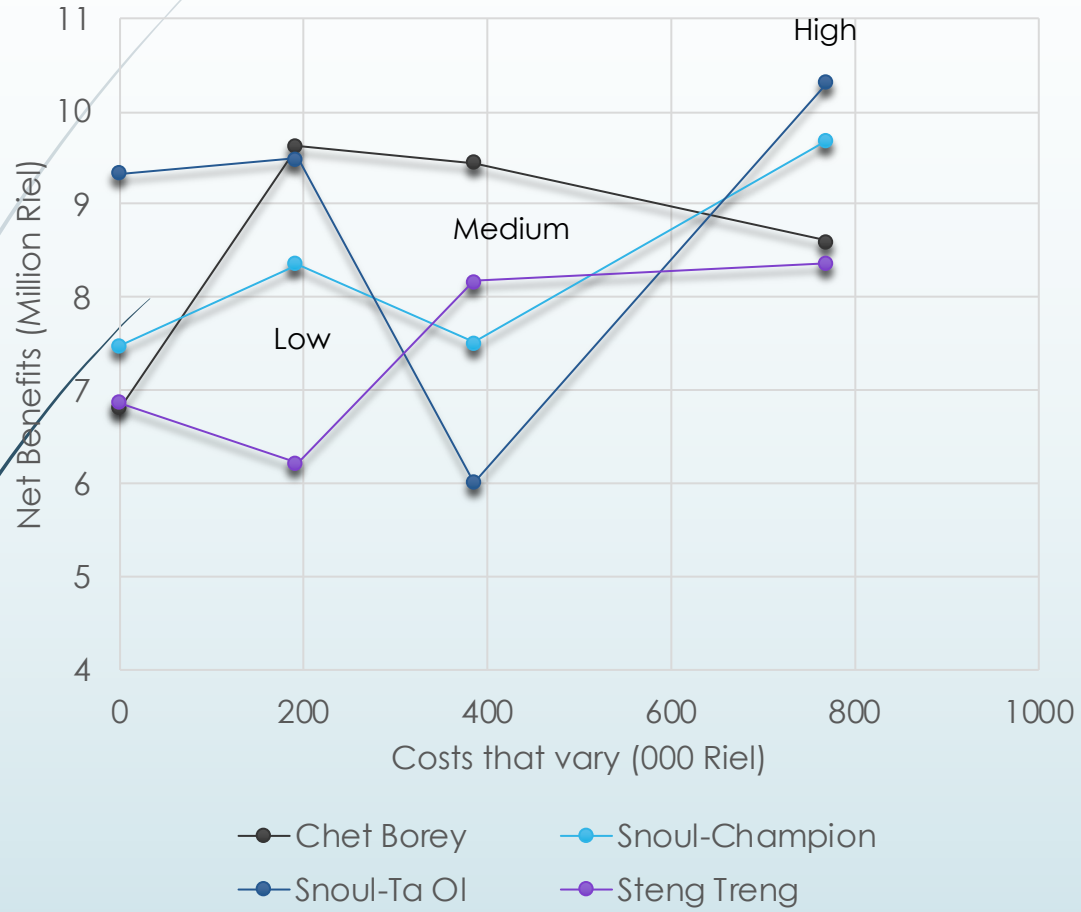
- Fresh root yield was not significantly affected by the location x treatment interaction because fertilisation treatment responded similarly across treatment and location (Fig A).
- However, highest fertilizer treatment (i.e. 80N-P20-K80) produced highest (29 t ha^{-1}) and no fertilizer application produced the lowest (22 t ha^{-1}) fresh root yield on average of all locations which is an increase of yield by 1.3 fold.
- Yield increase by 1.13-fold was observed at minimum fertilizer (20N-P05-K20) application compared to no fertilization on an average of all location.
- Highest yield increase was 1.45-fold at Chit Borey when applied minimum fertilizer (20N-P05-K20) compared to no fertilization.
- Starch content and Starch yield was not significantly affected by the location x treatment interaction (Fig B and C).

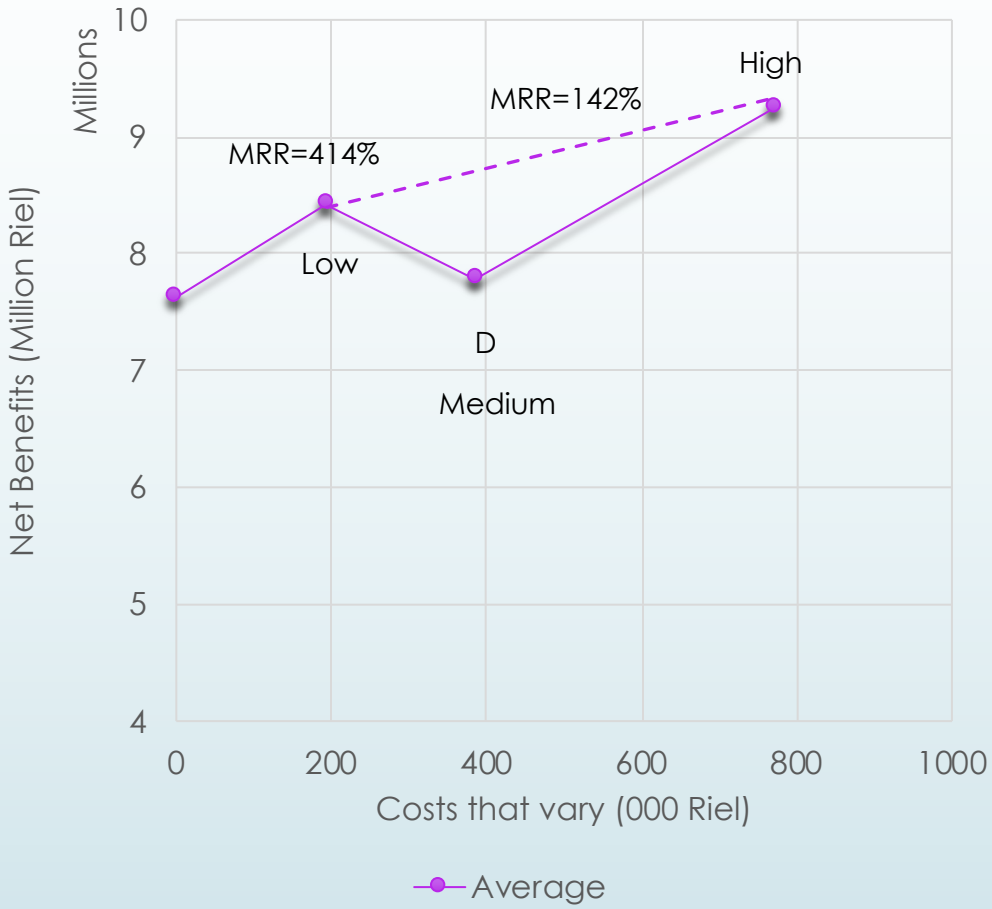
Did fertiliser effect the appearance of CMD symptoms?



- Number of CMD symptomatic plants did not differed when compared across all locations and all fertilizer treatments (ranged ~11 to 15 %)
- There was no clear trend in percentage of symptomatic plants considering different fertilizer treatment.
- Note: this observation confirmed in CAVAC-CIAT-GDA trials in Cambodia (Imran to present)

Economic results (marginal analysis)





Impact of CWBD and CMD on yield

Photo of CAVAC trial

Impact on farmer incomes of price and yield

Snoul District, Kratie

	Root price (Riel/kg)		
Yield (t/ha)	80	240	340
10	-1,265,000	335,000	1,335,000
15	-865,000	1,535,000	3,035,000
20	-465,000	2,735,000	4,735,000

Chet Borei District, Kratie

	Root price (Riel/kg)		
Yield (t/ha)	60	230	360
5	-2,230,000	-1,380,000	-730,000
10	-1,930,000	-230,000	1,070,000
20	-1,330,000	2,070,000	4,670,000
30	-730,000	4,370,000	8,270,000

	Snoul (Champion)		Chet Borei	
	Without fertiliser	With fertiliser	Without fertiliser	With fertiliser
Material costs (A)	1,070,000	1,840,480	1,830,000	2,023,320
Labour costs (B)	755,000	795,000	700,000	740,000
Total costs (A+B = C)	1,825,000	2,635,480	2,530,000	2,763,320
Revenue (D)	7,484,681	10,463,934	6,810,882	9,821,436
Net returns (D-C)	5,659,681	7,828,454	4,280,882	7,058,116
Gross Margin (USD)	1,415	1,957	1,070	1,765
Net returns to household resource (D-A = E)	6,414,681	8,623,454	4,980,882	7,798,116
Labour days (F)	32	34	23	25
Net returns per labour day (E/F)	200,459	253,631	216,560	311,925
Low price scenario				
Revenue	2,138,480	2,989,696	1,945,966	2,806,124
Net returns	313,480	354,216	-584,034	42,804
Gross Margin (USD)	78	89	-146	11
Net returns to household resource	1,068,480	1,149,216	115,966	782,804
Labour days	32	34	23	25
Net returns per labour day	33,390	33,800	5,042	31,312
Net returns per labour day (USD)	8.35	8.45	1.26	7.83

Farmer response during field day

- Variety
  - Yield
  - Good big stakes
- Fertiliser
  - Yield
  - Affordable cost
  - High return

Explaining the economic analysis of fertiliser application

Farmer takes a bundle of his preferred variety

Farm demonstration 2019-20: Positive selection of KU50 & fertilizer

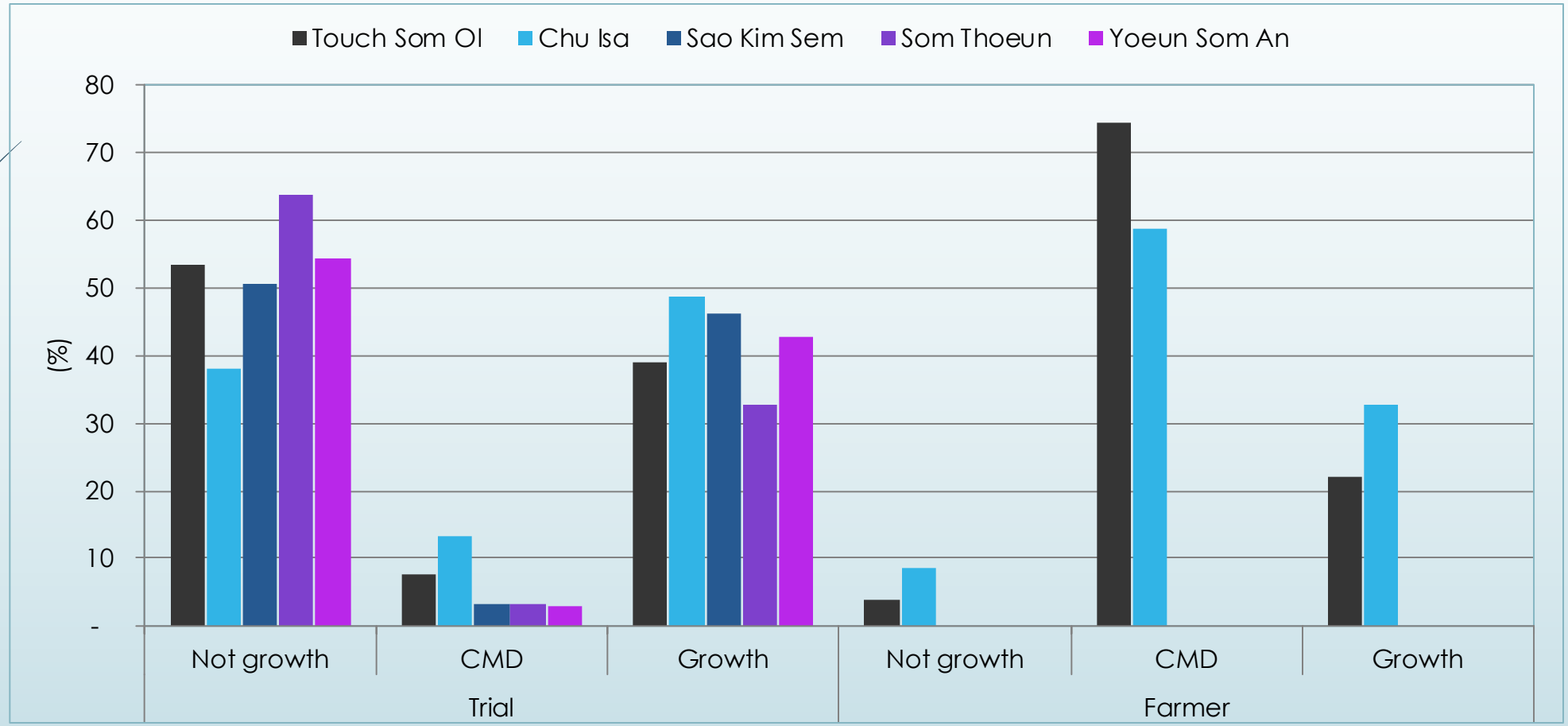
- KU50 compared to farmer's choice variety
- Zero fertilizer and N20-P05-K20
- (Urea: 44 kg/ha; single superphosphate: 16 kg/ha and KCl: 34 kg/ha)
- In Snuol and Chit Borei Districts, Kratie

Variation of farm demonstrations

- Site 1: Flat land, 1 m x 0.75 m, 500 m2 area
- Site 2: Broad bed, 1.6 m x 0.5 m, 390 m2 area (intercropping with cashew nut)
- Site 3: Narrow bed, 1.4 m x 0.6 m, 520 m2 area
- Site 4: Narrow bed, 1.2 m x 0.6 m, 588 m2 area (intercropping with cashew nut)
- Site 5: Narrow bed, 1.2 m x 0.6 m, 470 m2 area

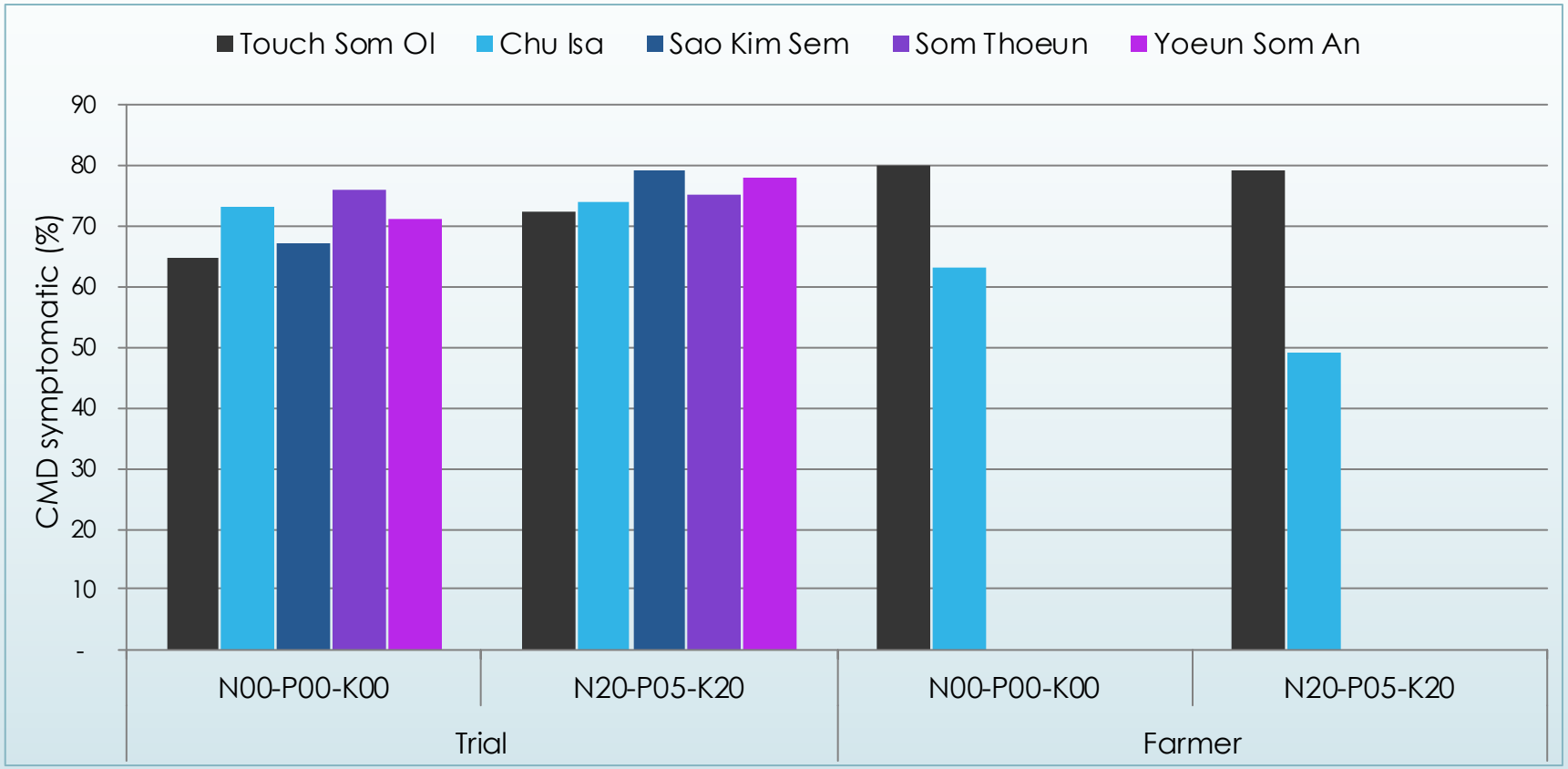
Constraints to crop establishment

- Poor germination due to stem quality and drought
- CMD symptomatic plants



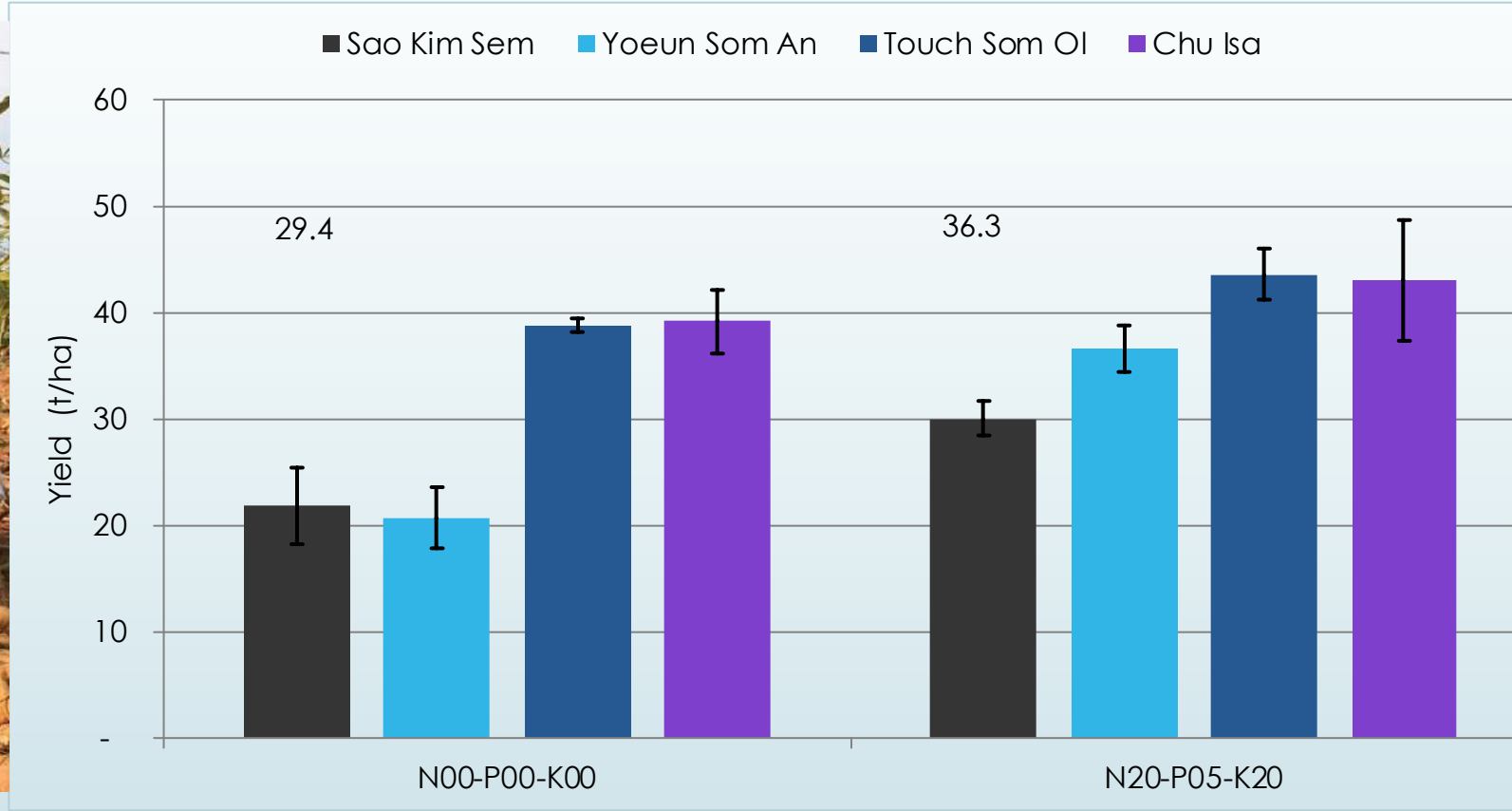
CMD symptomatic on cassava plants

- CMD symptomatic spread whole farm



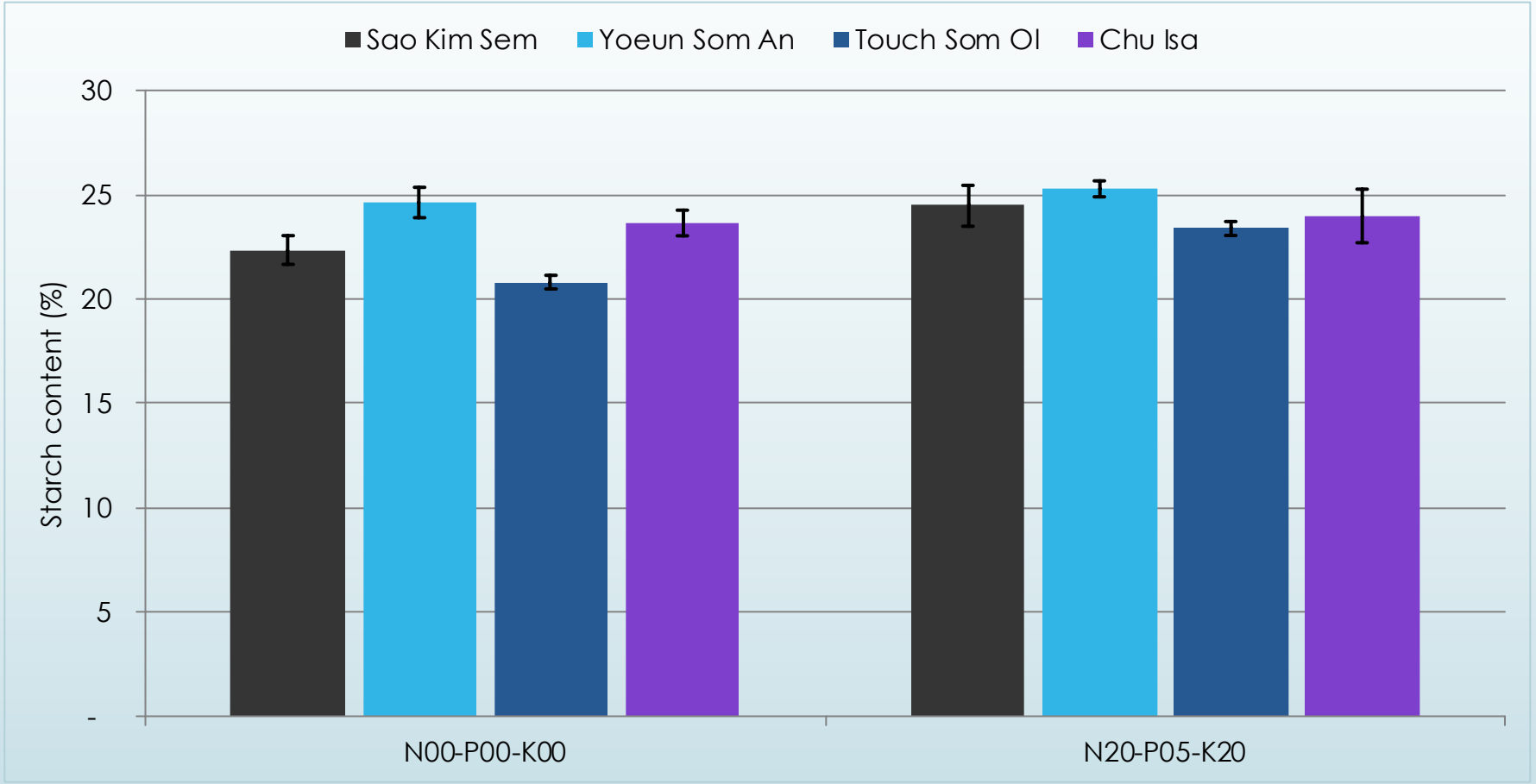
Fresh root yields

- Fresh root yields in Chit Borei $p<0.01$
- Fresh root yields in Snuol $p>0.05$
- Overall yield $p<0.05$



Starch content

- Sao Kim Sem and Touch Som Ol P<0.5
- Overall p<0.5



Economic analysis of 2019-20 demonstration and key point

Revenue and net benefits ('000 KHR)

	Fresh root price (KHR/kg)											
	100 KHR/kg			200 KHR/kg			300 KHR/kg			400 KHR/kg		
Yield Increase	Revenue	Net Benefit	MRR	Revenue	Net Benefit	MRR	Revenue	Net Benefit	MRR	Revenue	Net Benefit	MRR
3.9	390	190	95%	780	580	290%	1,170	970	485%	1,560	1,360	680%
4.9	490	290	145%	980	780	390%	1,470	1,270	635%	1,960	1,760	880%
8.2	820	620	310%	1,640	1,440	720%	2,460	2,260	1130%	3,280	3,080	1540%
15.8	1,580	1,380	690%	3,160	2,960	1480%	4,740	4,540	2270%	6,320	6,120	3060%

- Low balanced fertiliser costs ~ 200,000 KHR/ha ($50 USD)
- If you plant healthy stems the expected response provide very attractive net benefits and rate of return
- Problem: Where can you access healthy planting material in Cambodia?

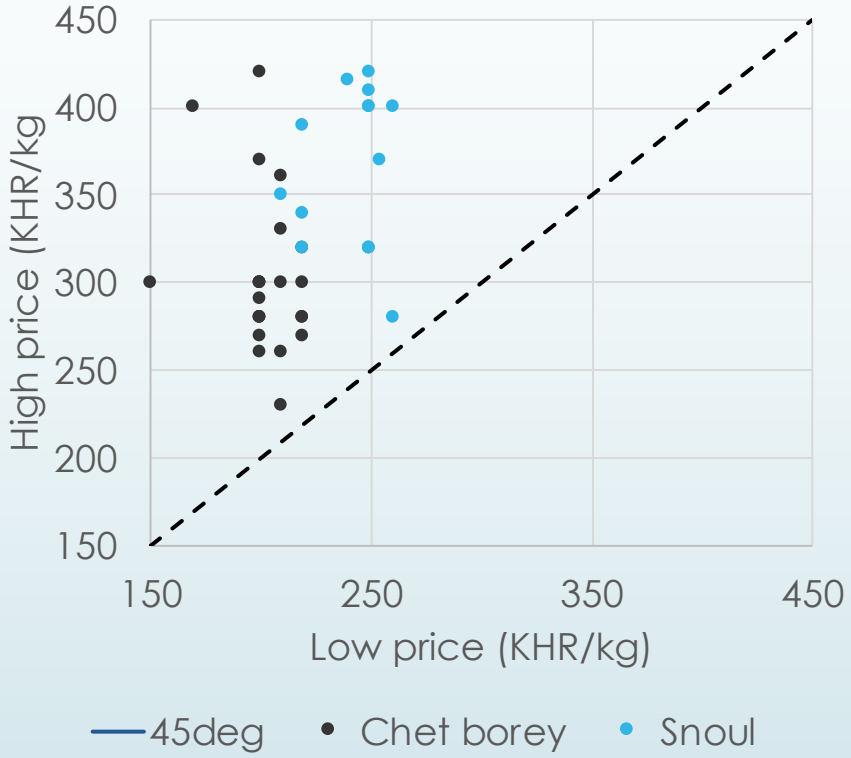
Impact interview: Some preliminary results

Locations and farmers

- Impact survey was conducted in June 2020 in Snuol, Chit Borei districts in Kratie Province and Siembok District in Steung Treng Province.
- Value chain analysis, cassava livelihood study and agronomy trials have been carried out from year 1 to final year in the three districts.
- Total of 39 farmers were interviewed – 12 host trials, 15 field day attendants and 12 other cassava growers noticed field trials.

Cassava production and prices

- Average planted land was 4.8 ha in 2019-20
- Total production was 29 t
- Average yields **very low** – 6.1 t/ha
- Cassava fresh root yield was low in 2019-20 than in 2018-19
- Most received price of fresh cassava root was 250 riel/kg (USD 0.06) with 200 and 320 riel variation in 2019-20



Cassava varieties

- Variety names and sources were Not specifically identified
- Mostly not pay (from previous year or other villagers)
- WTP for stems from zero up to 12,000 riel/bundle ($3/20 stems) of new variety's clean stem
- Farmers trust any agent/organization/institution/authority which has agricultural knowledge for clean stems
- Most of them agreed the project's varieties produced better yields

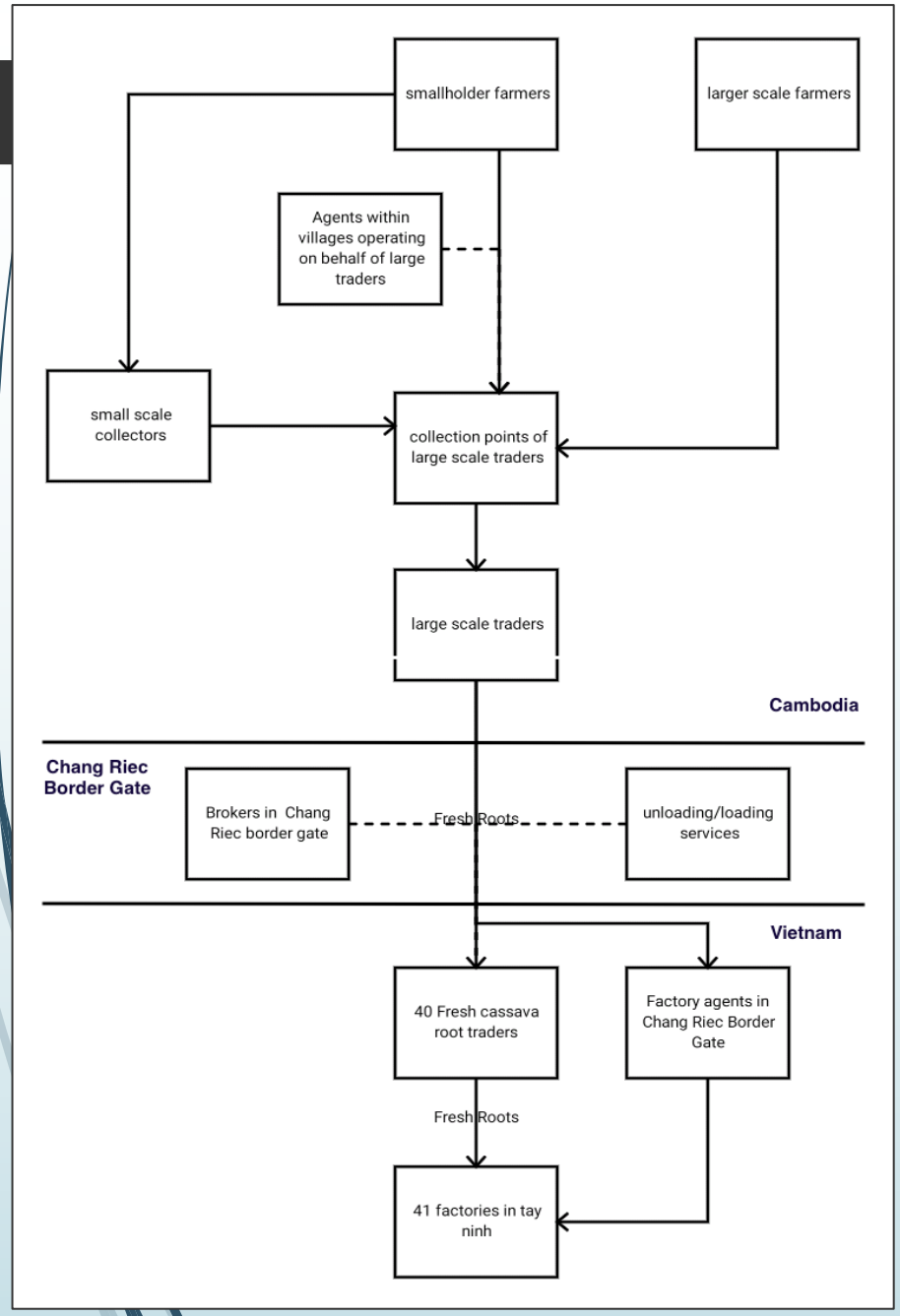
Fertilizer application for cassava cultivation

- Half interviewed farmers used fertilizers for cassava
- Major constraint for purchasing fertilizer was money
- Farmers still have no understanding of N-P-K values
- Typically applying before planting
- Input traders were main source of information
  - potential target for ongoing work on seed system when input supplier also grows cassava

Initial indication of project's impact

- Some practices carried out by host trial farmers
  - Raising bed rather than flat field
  - Planting vertical stem instead of place stem under soil surface
  - Applying fertilizer more effective method (dropping fertilizer next to cassava plants while spreading across field)
  - They are convinced that planting clean stems could avoid diseases
  - Prefer high starch content varieties

Challenges of private sector engagement in Eastern Cambodia

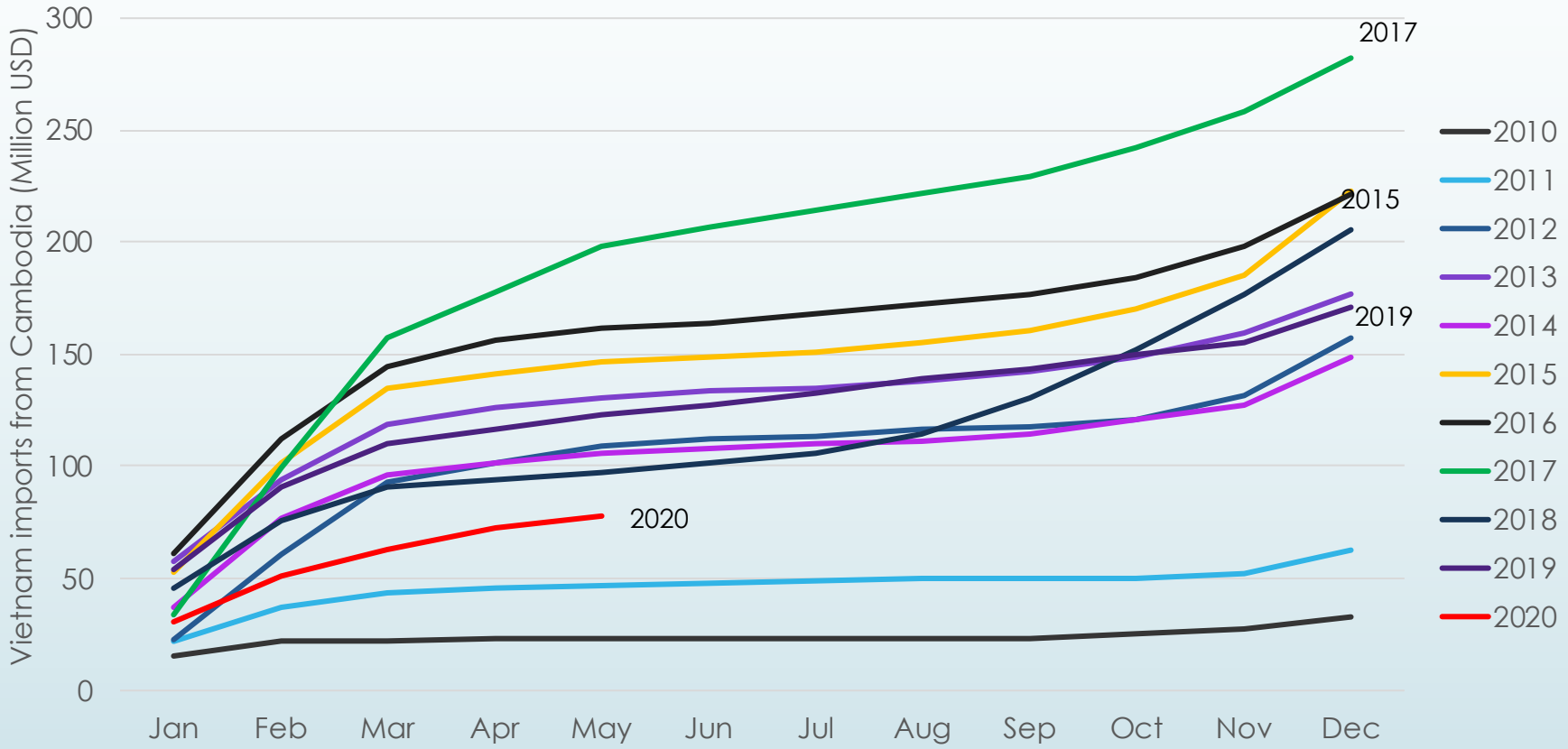


Linked to the Tay Ninh market

- Eastern Provinces dominated by cross border trade to Vietnam
- At start of the project both fresh roots and dried chips were produced.
- Current high prices has pushed the extensive margin for fresh roots further in to Cambodia
- Weak linkages between actors

- New factories were or planned to be established on the Cambodian side of the border – fierce competition for feed stock

Export value to Vietnam decline significantly



Discussion with domestic processors

- New factory in Kratie – Sing Song
- 1,000 t/day capacity
- Uses independent traders
- No agents
- 400 Riel/kg ….but Vietnam had higher price
  - Not enough roots and did not run the factory
- Initially produced some training material
- Limited interest in working with farmers
  - High competition with Vietnamese market

Green Leader

- Green Leader construction province's Snuol district.
- capacity to produce 100,000 tones of tapioca a year
- The company 'plans to spend USD150 million on 10 processing facilities over the next three years.'
- Construction delayed – stopped.

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Business March 15, 2018

Green Leader's factory to break ground next month

Sum Manet / Khmer Times /

A Cambodian farmer collects cassava. KT/Chor Sokunthea

Green Leader Holdings Group Limited, a Hong Kong-based investment holding firm, announced construction of its first cassava-processing factory in Cambodia will begin in April.

The Phnom Penh Post

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Cassava processing factory to open

| Publication date 19 December 2018 | 08:26 ICT

Ministry of Agriculture, Forestry and Fisheries spokesman Srey Vathy says the factory will ensure a stable cassava market for farmers. / Heng Chivoan

Hong Kong-based Green Leader Holdings Group Co Ltd, which announced its first cassava processing factory earlier this year, aims to commence operations by next year, according to Green Leader (Cambodia) Co Ltd CEO Gao Hua.

The company is set to invest a total of $160 million in the cassava industry, which its first broke ground in April in Kratie province. Construction has been delayed, with the factory originally planned to be launched by the end of the year.

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Business March 28, 2019

Green Leader's cassava factory to start production in May

Sum Manet / Khmer Times /

Green Leader's factory groundbreaking was held in April last year. KT/Mai Vireak

Green Leader's $20-million cassava factory will become operational in May, processing up to 130 tonnes of starch per year.

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Business June 8, 2020

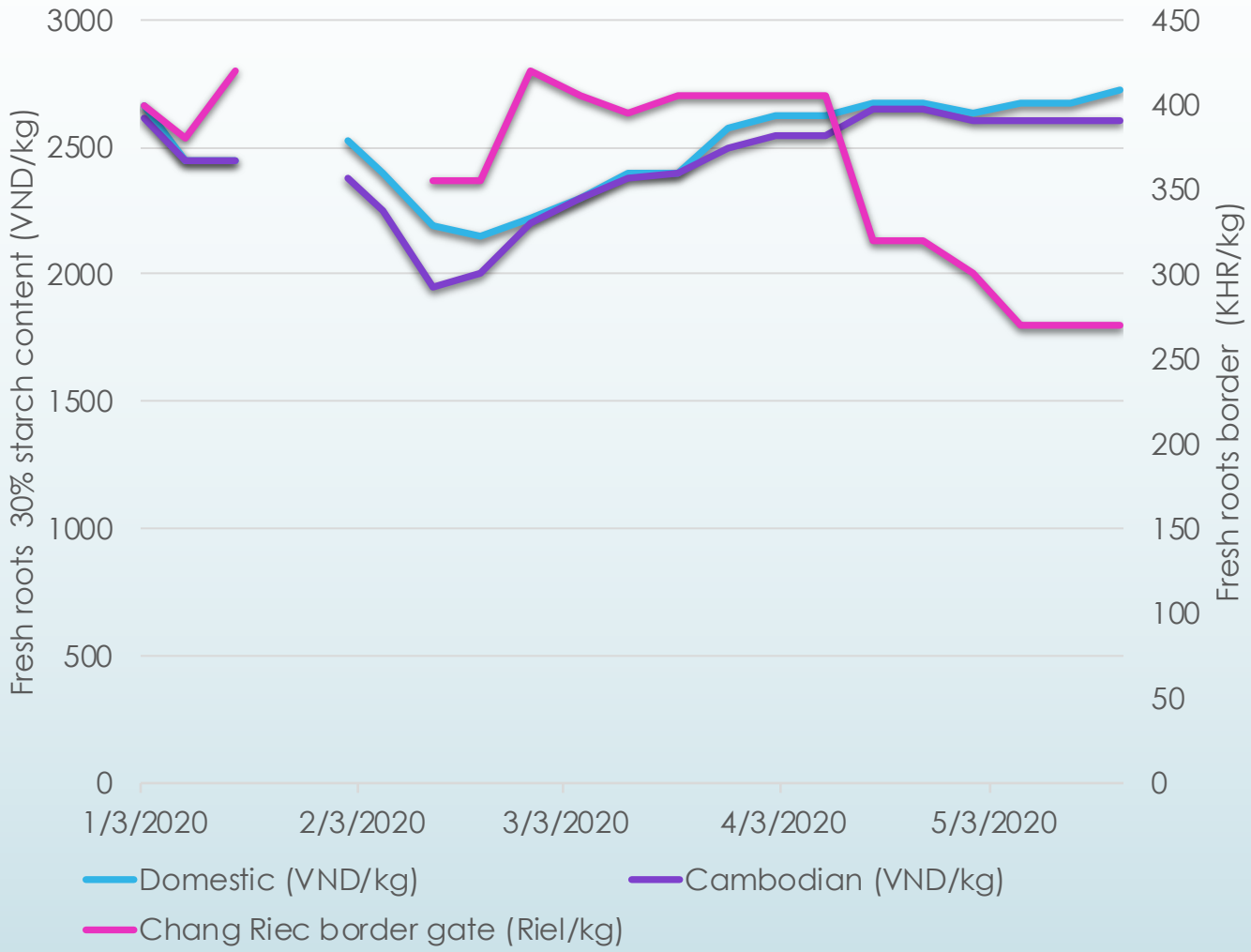
Kratie's first cassava processing factory delayed over high costs

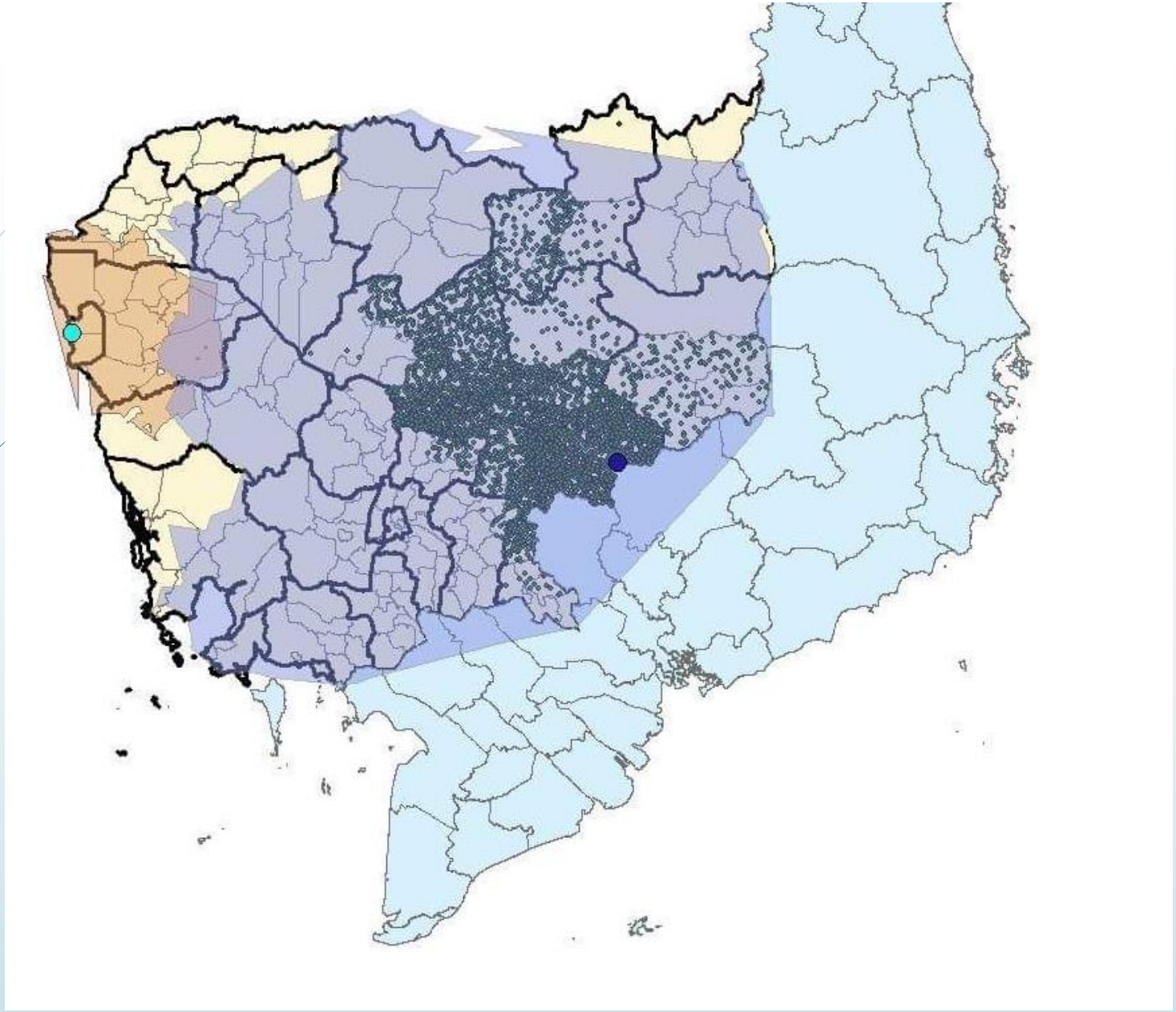
Som Sareth / Khmer Times /

A local farmer sorts cassava, the second largest agricultural crop in Cambodia after rice. KT/Chor Sokunthea

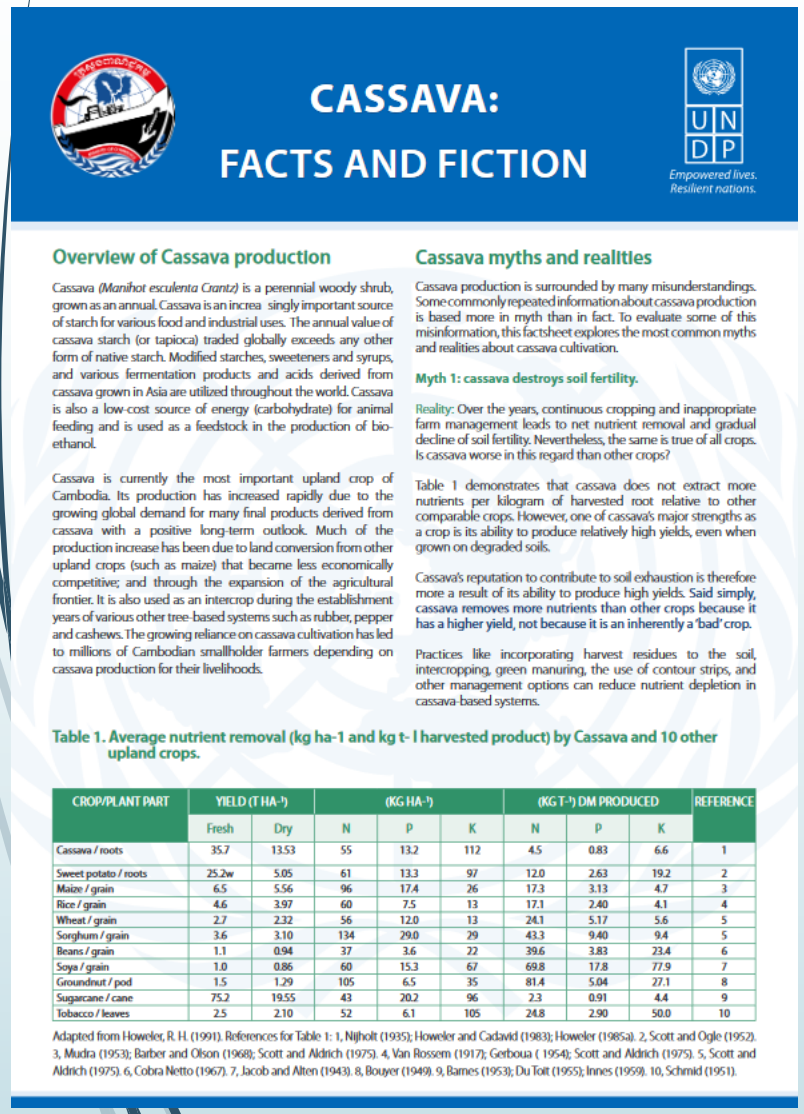
The cassava processing factory invested in by Hong Kong-based Green Leader Holdings Group Co Ltd in Kratie province has been put on hold because of the high cost of production, according to the Minister of Agriculture Forestry, and Fisheries Veng Sakhon.

Excess capacity in Tay Ninh means strong competition for feedstock





National Cassava Policy Development input



CASSAVA:

FACTS AND FICTION

UNDP

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Overview of Cassava production

Cassava *(Manihot esculenta Crantz)* is a perennial woody shrub, grown as an annual. Cassava is an increa singly important source of starch for various food and industrial uses. The annual value of cassava starch (or tapioca) traded globally exceeds any other form of native starch. Modified starches, sweeteners and syrups, and various fermentation products and acids derived from cassava grown in Asia are utilized throughout the world. Cassava is also a low-cost source of energy (carbohydrate) for animal feeding and is used as a feedstock in the production of bio-ethanol.

Cassava is currently the most important upland crop of Cambodia. Its production has increased rapidly due to the growing global demand for many final products derived from cassava with a positive long-term outlook. Much of the production increase has been due to land conversion from other upland crops (such as maize) that became less economically competitive; and through the expansion of the agricultural frontier. It is also used as an intercrop during the establishment years of various other tree-based systems such as rubber, pepper and cashews. The growing reliance on cassava cultivation has led to millions of Cambodian smallholder farmers depending on cassava production for their livelihoods.

Cassava myths and realities

Cassava production is surrounded by many misunderstandings. Some commonly repeated information about cassava production is based more in myth than in fact. To evaluate some of this misinformation, this factsheet explores the most common myths and realities about cassava cultivation.

Myth 1: cassava destroys soil fertility.

Reality: Over the years, continuous cropping and inappropriate farm management leads to net nutrient removal and gradual decline of soil fertility. Nevertheless, the same is true of all crops. Is cassava worse in this regard than other crops?

Table 1 demonstrates that cassava does not extract more nutrients per kilogram of harvested root relative to other comparable crops. However, one of cassava's major strengths as a crop is its ability to produce relatively high yields, even when grown on degraded soils.

Cassava's reputation to contribute to soil exhaustion is therefore more a result of its ability to produce high yields. Said simply, cassava removes more nutrients than other crops because it has a higher yield, not because it is an inherently a 'bad' crop.

Practices like incorporating harvest residues to the soil, intercropping, green manuring, the use of contour strips, and other management options can reduce nutrient depletion in cassava-based systems.

Table 1. Average nutrient removal (kg ha-1 and kg t- l harvested product) by Cassava and 10 other upland crops.

CROP/PLANT PART	YIELD (T HA-1)		(KG HA-1)			(KG T-1) DM PRODUCED			REFERENCE
	Fresh	Dry	N	P	K	N	P	K	
Cassava / roots	35.7	13.53	55	13.2	112	4.5	0.83	6.6	1
Sweet potato / roots	25.2w	5.05	61	13.3	97	12.0	2.63	19.2	2
Maize / grain	6.5	5.56	96	17.4	26	17.3	3.13	4.7	3
Rice / grain	4.6	3.97	60	7.5	13	17.1	2.40	4.1	4
Wheat / grain	2.7	2.32	56	12.0	13	24.1	5.17	5.6	5
Sorghum / grain	3.6	3.10	134	29.0	29	43.3	9.40	9.4	5
Beans / grain	1.1	0.94	37	3.6	22	39.6	3.83	23.4	6
Soya / grain	1.0	0.86	60	15.3	67	69.8	17.8	77.9	7
Groundnut / pod	1.5	1.29	105	6.5	35	81.4	5.04	27.1	8
Sugarcane / cane	75.2	19.55	43	20.2	96	2.3	0.91	4.4	9
Tobacco / leaves	2.5	2.10	52	6.1	105	24.8	2.90	50.0	10

Adapted from Howeler, R. H. (1991). References for Table 1: 1, Nijholt (1935); Howeler and Cadavid (1983); Howeler (1985a). 2, Scott and Ogle (1952). 3, Mudra (1953); Barber and Olson (1968); Scott and Aldrich (1975). 4, Van Rossem (1917); Gerboua (1954); Scott and Aldrich (1975). 5, Scott and Aldrich (1975). 6, Cobra Netto (1967). 7, Jacob and Alten (1943). 8, Bouyer (1949). 9, Barnes (1953); Du Toit (1955); Innes (1959). 10, Schmid (1951).

1. Establish a **Cambodian Cassava Research and Development Coordination entity**;
2. Promote sustainable and resilient **cassava-based farming systems and livelihoods** avoiding interventions that focus on cassava in isolation of other components of a farming system;
3. Invest in **cassava breeding and coordinate variety evaluation** with industry stakeholders;
4. Develop **viable seed systems and business models** to promote the use of healthy planting material;
5. Develop and promote **robust fertilizer management recommendations** and flexible strategies for different agro-ecological regions of Cambodia;
6. Invest in and coordinate the **monitoring, surveillance and reporting of pest and disease** and promote appropriate management practices;
7. Develop **cassava-based cropping system options** suitable for different agro-economic regions of Cambodia; and
8. Invest in ongoing **development of mechanization technologies** that enable viable contracting models, address rising labour shortages, and enable the implementation of conservation agriculture practices

Next users in Cambodia using research output

The material produced by the ACIAR Value Chains Project provided the most comprehensive data set and analysis available and the Facebook site also gave timely updates for on trade and prices, disease management and field trials. As a Policy Officer largely operating at the national level, the interactions with the ACIAR Program provided opportunities to visit the field with an expert team and to learn a great deal about practical aspects of cassava production and disease management. In addition, the Facebook site provided regular updates on progress with field trials, brief statements of the results and a great deal of information relating to trade and prices. This was a valued source of information for me and for others at FAO Cambodia.

Iean Russell
Senior Policy Officer
FAO-EU FIRST Programme
Cambodia

Thanks you