Australian Government
Australian Centre for International Agricultural Research

NAFRI

Agronomic and economic results of improved cassava management

IS THERE AN INCENTIVE AT THE FARM LEVEL?

Alliance

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The University Of Queensland
AUSTRALIA

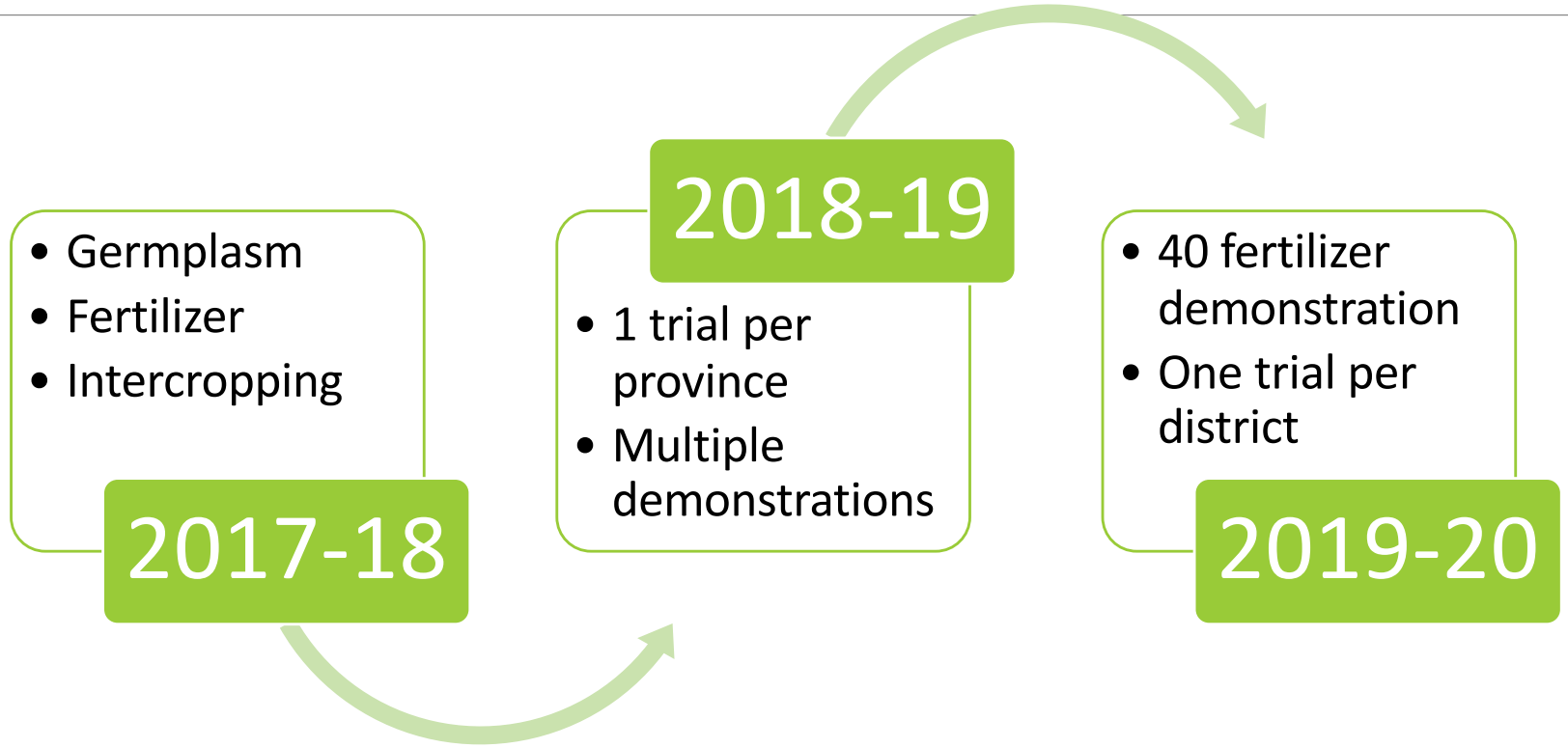
Bioversity International

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

Outline

1. Timeline and strategy
2. Variety evaluation
3. Improve fertiliser utilisation
4. Disease management
5. Soil management

Timeline


2017-18
• Germplasm
• Fertilizer
• Intercropping
2018-19
• 1 trial per province
• Multiple demonstrations
2019-20
• 40 fertilizer demonstration
• One trial per district

Variety

IDENTIFYING PREFERRED VARIETIES OF FARMERS AND PROCESSORS FOR MULTIPLICATION AND DISTRIBUTION

Variety assessment in Year 1 (2017-18)

Fresh root yield (t ha^{-1}) of 7 Cassava varieties in 3 Districts

Variety	Kenethao	Paklai	Viengthong
KM140	28.3	22.7	19.8
KM21-12	21.5	25.3	10.7
KU50	24.7	23.8	11.8
Local	23.9	28.8	15.1
Rayong 11	**28.3**	**28.2**	**21.3**
Rayong 72	22.3	30.1	17.1
Rayong 9	27	25.1	14.5

	Fresh Root yield	Starch content	Starch yield
	(t ha^{-1})	(% fresh root weight)	(t ha^{-1})
Rayong 11	**25.91_{a}**	**30.67_{a}**	**7.9_{a}**
KM140	23.59_{ab}	23.54_{bcd}	5.5_{b}
Rayong 72	23.19_{ab}	23.60_{bcd}	5.6_{ab}
Local	22.58_{ab}	25.57_{bc}	5.7_{ab}
Rayong 9	22.19_{ab}	26.70_{b}	6.3_{ab}
KU50	20.12_{ab}	21.65_{d}	4.7_{b}
KM21-12	19.16_{b}	22.76_{cd}	4.7_{b}

Rayong 11

Rayong 72

Farm gate prices do not consider starch content which encourage varieties not necessarily the preference of starch processing sector

Evaluation of varieties for direct consumption

(opportunistic activity requested by farmers in Viengthong)

No	Treatment	Root yield (t/ha)	% starch content
1	KM140	9.8	21
2	Local *	6.5	19
3	NARC61	7.8	22

No	Treatment	Female			Male		
		Not good	Good	very good	Not good	Good	very good
1	KM140	2	1	7	2	4	7
2	Local	3	5	2	4	6	3
3	NARC61	5	4	1	5	4	4

Loss of traditional eating varieties from the landscape

* Not known with variety farmers were growing

DNA fingerprinting of collection

The Lao Cassava Collection that includes eating varieties and landraces has become heavily infected with CWBD

DNA fingerprinting identified several unique clones in need of conservation (not in genebank in CIAT or in Vietnam adoption study)

Capacity building of tissue culture lab is ongoing

Recommend survey and collection within Laos before landraces are lost.

Outcome of variety work

1. Begin to distribute Rayong11 for farmer evaluation in 2018-2019, especially in areas with CWBD
2. Import Rayong11 from TTDI to Cambodia for testing against CMD – highly susceptible to SLCMD
3. Re-consider future distribution…. KU50 shows good resistance to CMD = ?
   - New clones are arriving for evaluation in new ACIAR project
4. Industry interested in promoting varieties with high starch content and resistant to disease.

Fertiliser utilisation for higher productivity

WHAT AND HOW MUCH TO ADD

Baseline: Almost zero adoption of fertiliser in sites in Lao PDR

	Bolikhan	Kenthao	Paklai	Viengthong	Total
Do you apply organic fertiliser to your cassava?	1.1%	0.0%	0.0%	0.0%	0.3%
Do you apply inorganic fertiliser to your cassava?	1.1%	0.0%	0.0%	0.0%	0.3%
Do you understand what the NPK values mean on the fertiliser you apply?	1.1%	1.1%	1.1%	0.0%	0.8%
Have you ever seen a fertiliser trial on cassava?	6.7%	4.4%	3.3%	3.3%	4.4%
Are you interested in visiting a fertiliser demonstration trial to see the result on production and returns?	53.3%	41.1%	52.2%	56.7%	50.8%
Are you interested in conducting a trial on your own land?	47.8%	44.4%	48.9%	53.3%	48.6%

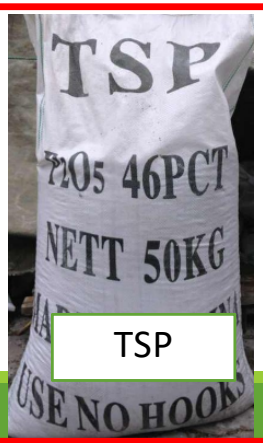
Y1 Fertiliser treatments x 2 varieties (2017-18)

Treatment	Actual fertilizer application (kg ha^{-1})			
	Urea (46-0-0)	TSP (00-42-00)	KCL	Manure
Control (00N-00P-00K)	-	-	-	-
NP low rate without K (40N-10P-0K)	87.00	54.60	-	-
Balanced NPK low rate (40N-10P-40K)	87.00	54.60	80.30	-
Balanced NPK low rate (40N-10P-40K)+Manure (5 t/ha)	87.00	54.60	80.30	5,000
Available fertilizer in local market (15-15-15) at 40N-40P_2O_5-40K_2O	266.65			-
Balanced NPK high rate (80 N-20P-80K)	173.90	109.10	160.60	-

Commonly used on rice and available in markets

Compound

Urea



TSP

KCL

Difficult to obtain in local markets

CWBD symptoms worse in zero treatment

Fresh root yield (t ha^{-1}) Average of three districts

	Fertilizer					
Variety	**P0**	**P1**	**P2**	**P3**	**P4**	**P5**
KU 50	17.2	18.8	18.6	21.4	19.7	23.7
Rayong 11	18.1	22.3	25.1	27.9	23.9	28.2

Variety	P<.001	L.S.D.= 2.51
Fertilizer	P=0.005	L.S.D.= 4.34
Variety x Fertilizer	P=0.808	L.S.D= 6.14

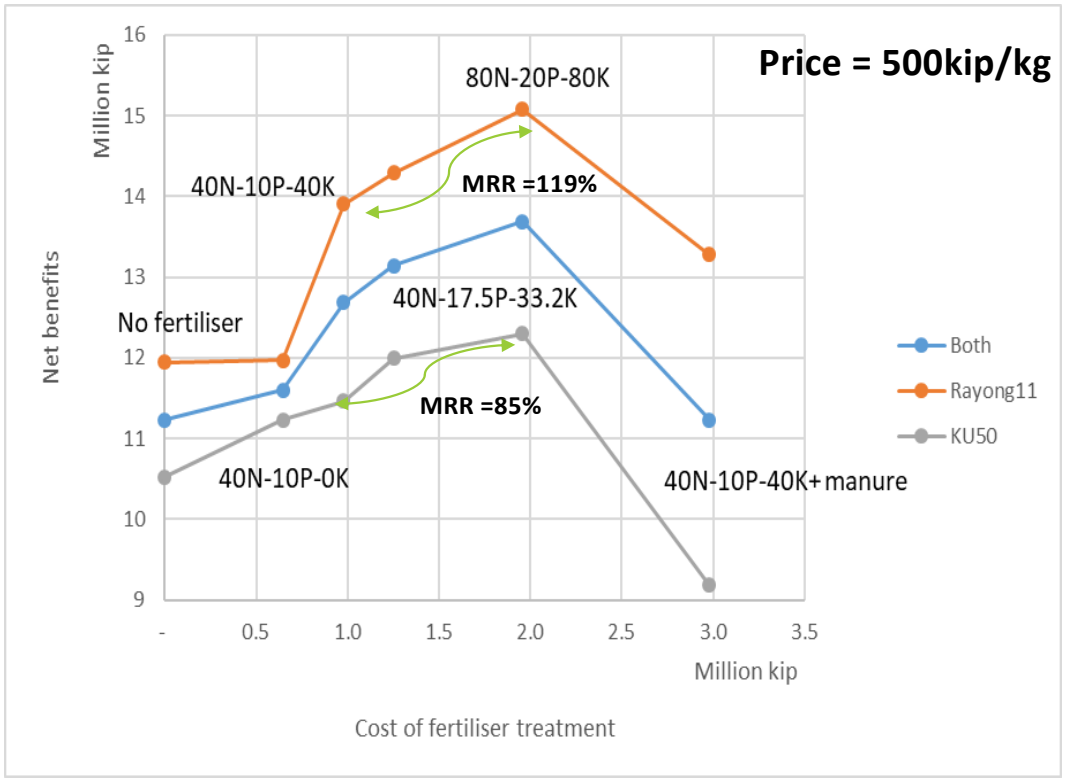
P0 No fertilizer, **P1** 40N-10P-0K, **P2** 40N-10P-40K, **P3** 40N-10P-40K + Manure (5t/ha), **P4** N-P-K (15-15-15), **P5** 80N-40P-80K

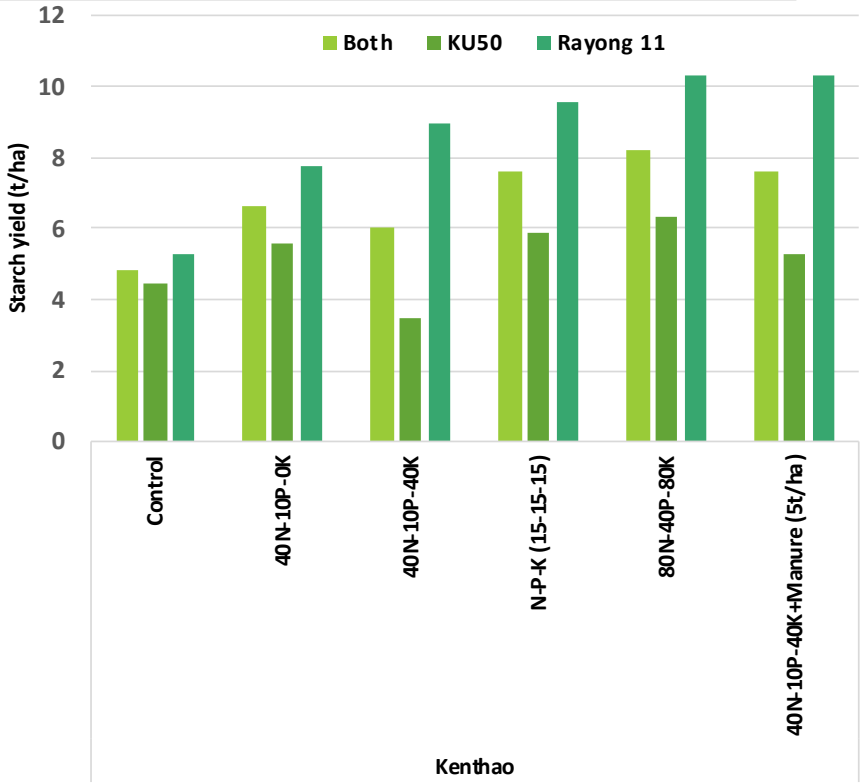
Starch content (%) of KU 50 and Rayong 11 while applied different fertilizer rate

District	Variety	P0	P1	P2	P3	P4	P5
Kenethao	**KU 50**	21.04	23.55	13.90	21.55	22.12	22.25
	Rayong 11	21.99	30.84	29.97	31.72	30.83	30.34
Paklai	**KU 50**	24.32	21.55	21.57	22.21	22.96	24.20
	Rayong 11	30.44	31.22	30.89	28.05	31.40	26.57
Viengthong	**KU 50**	24.70	19.33	14.65	21.54	20.98	19.53
	Rayong 11	28.21	27.75	27.25	29.51	29.51	24.71

P0 No fertilizer, P1 40N-10P-0K, P2 40N-10P-40K, P3 40N-10P-40K + Manure (5t/ha), P4 N-P-K (15-15-15), P5 80N-40P-80K

Kenthao District example of marginal rate of return (MRR)





Year 2 Results of replicated trials (2018-19)

Fertilizer	Fresh root yield (t ha^{-1})		Starch content (%)	
(ordered by cost)	Xayaboury	Bolikhamxay	Xayaboury	Bolikhamxay
no fertilizer	20.3 ± 5.3	7.3 ± 1.4	30.4	27.7
NPK (40-20-40)	34.2 ± 1.5	12.4 ± 0.1	29.2	29.7
(15-5-30) 300kg ha^{-1}	36.5 ± 2.3	9.1 ± 0.7	30.7	28.4
NPK (80-20-80)	32.2 ± 5.2	10.3 ± 1.2	30.1	28.3
Location	P<0.001			
Treatment	P=0.005			
Location X Treatment	P=0.064			

Economic analysis of 2018-19 trial

			Xayabouli		Bolikhamxai	
	Treatment	**Cost**	**Net Benefits**	**MRR**	**Net Benefits**	**MRR**
	Control (No fertiliser)	0	10,156,944		3,662,500	0
	N:P2O5:K2O (40-20-40)	814,157	16,287,232	753%	**5,401,120**	**214%**
	N:P2O5:K2O (15-5-30): 300 Kg/ha = (45-15-90)	**1,320,000**	**16,950,833**	**131%**	3,216,806	D
	N:P2O5:K2O (80-20-80)	1,401,172	14,709,939	D	3,761,328	D

Root rot cause low yields and a reduction in net benefits

Fertiliser demonstration

Agronomic results of demonstrations

Commercially available NPK (15-5-30) 300 kg ha^{-1}

District	Fresh root yield (t ha^{-1})		Starch content (%)	
	No Fertilizer	With Fertilizer	No Fertilizer	With Fertilizer
Kenethao	**24.8** ± 2.7	**36.8** ± 2.3	**28.6** ± 2.8	**25.9** ± 2.2
Paklai	**25.0** ± 2.4	**33.5** ± 2.1	**24.0** ± 5.2	**24.9** ± 3.9
Viengthong	**26.4** ± 2.6	**29.7** ± 2.4	**29.1** ± 0.2	**30.9** ± 1.3
Bolikan	**12.3** ± 1.5	**21.1** ± 2.1	**25.1** ± 1.7	**27.5** ± 2.3
Location	P <0.001, l.s.d. 3.93			
Treatment	P <0.001, l.s.d. 2.78			
Location X Treatment	P=0.169, l.s.d. 5.56			

Economic results of demonstrations

District	Paklai	Kenthao	Bolikan	Viengthong
Yield without fertiliser (t/ha)	27.8	24.8	12.3	26.4
Yield with fertiliser (t/ha)	37.2	36.8	21.1	29.7
Difference (t/ha)	9.5	12.0	8.8	3.3
Current price (kip/kg)	540	540	540	500
Cost fertiliser (kip/ha)	1,320,000	1,320,000	1,320,000	1,320,000
Current cassava root price				
Marginal Net Benefits (kip/ha)	3,785,333	5,140,667	3,428,240	313,796
MRR (%)	286.8%	389.4%	259.7%	23.8%
Low cassava root price: 300 kip per ton				
Marginal Net Benefits (kip/ha)	1,516,296	2,269,259	1,317,911	- 339,722
MRR (%)	114.9%	171.9%	99.8%	-25.7%

Enterprise budget

	Without fertiliser	With fertiliser
Material costs (A)	1,600,000	2,920,000
Labour costs (B)	6,420,000	6,660,000
Total costs (A+B = C)	8,020,000	9,580,000
Revenue (D)	16,114,691	21,598,198
Net returns (D-C)	8,094,691	12,018,198
Net returns to household resource (D-A = E)	14,514,691	18,678,198
Labour days (F)	152	158
Net returns per labour day (E/F)	95,491	118,216
Low price scenario		
Revenue	8,335,185	11,171,481
Net returns	315,185	1,591,481
Net returns to household resource	6,735,185	8,251,481
Labour days	152	158
Net returns per labour day	44,310	52,225

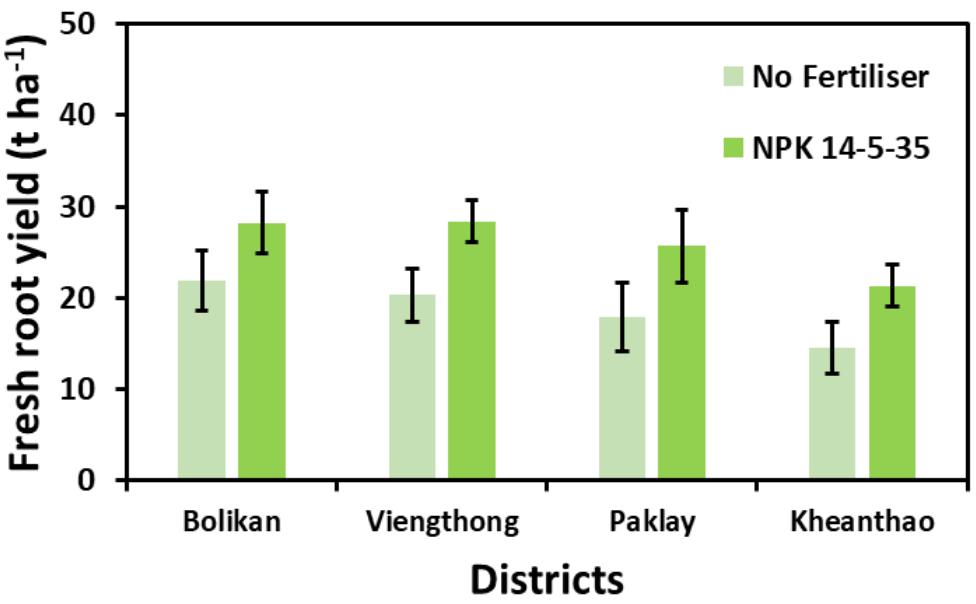
Comparison of commercially available fertilizer and single nutrient application (2019-2020)

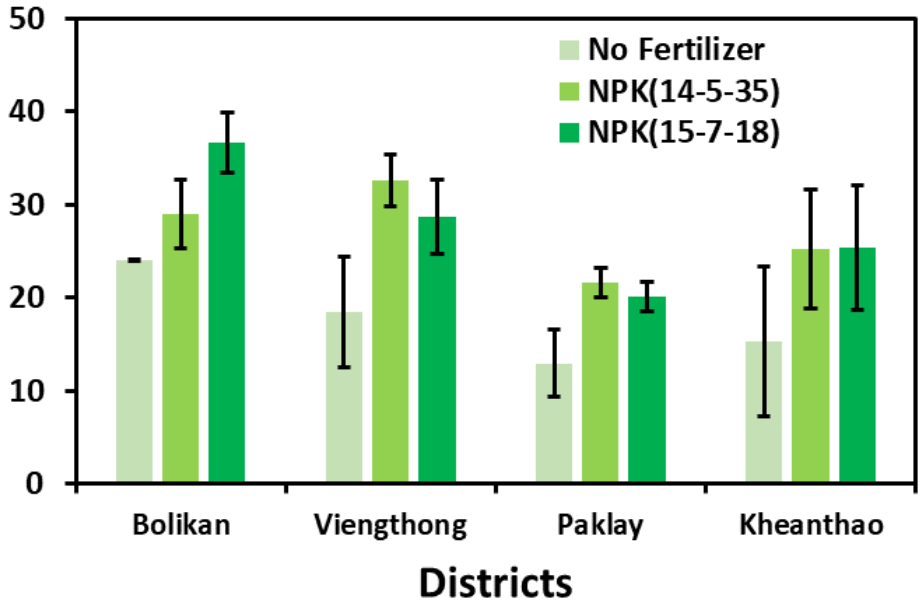
Fertilizer	Cost of fertilizer (LAK ha^{-1})	Fresh root yield (t ha^{-1})		Starch content (%)	
	Prices may vary in local market	Paklai	Viengthong	Paklai	Viengthong
P0 (No fertiliser)	0	**6.1**[a] ± 0.53	**10.3**[a] ± 1.91	23	23
P1 N:P_2O_5:K_2O (14-5-35)	1,653,000	**10.4**[b] ± 0.63	**27.6**[b] ± 1.17	24	**29**
P2 N:P_2O_5:K_2O (15-7-18)	1,444,200	**9.5**[b] ± 0.39	**23.7**[b] ± 5.40	22	26
P3 N:P_2O_5:K_2O (40-10-40)	1,080,265	**10.8**[b] ± 1.97	**27.9**[b] ± 1.88	24	26
P4 N:P_2O_5:K_2O (80-20-80)	2,160,530	**11.5**[b] ± 2.08	**24.2**[b] ± 4.69	22	**30**
Location	**P<0.001, l.s.d. 3.62**				
Treatment	**P=0.004, l.s.d. 5.72**				
Location X Treatment	**P=0.150, l.s.d. 8.09**				

No Significant difference in yield between fertilizers treatment. If results is consistent cheapest option recommended

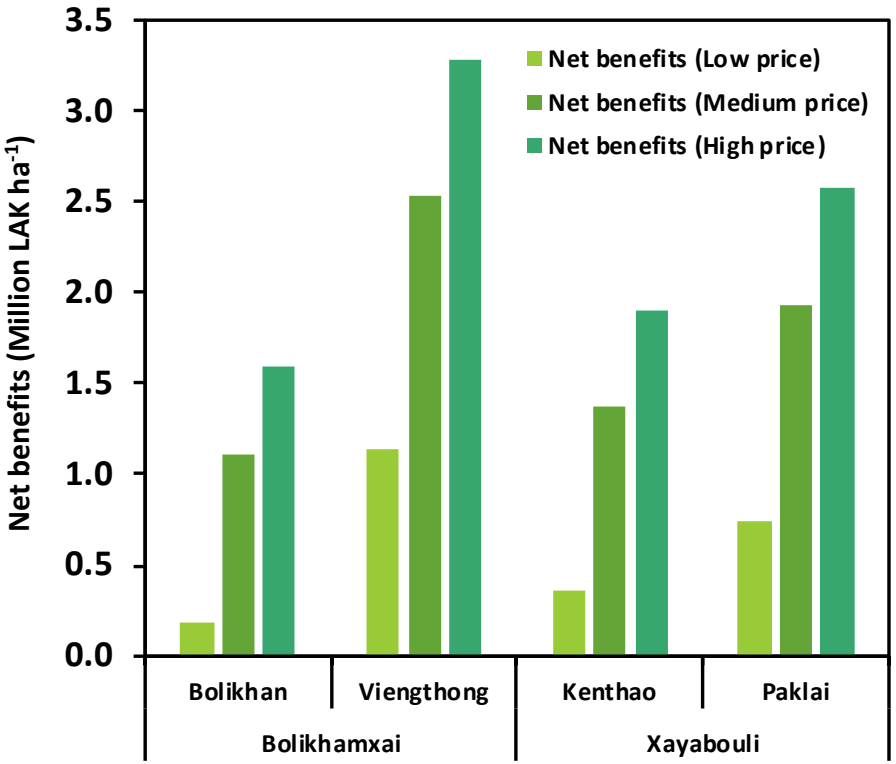
Demonstrations of commercially available fertilizer

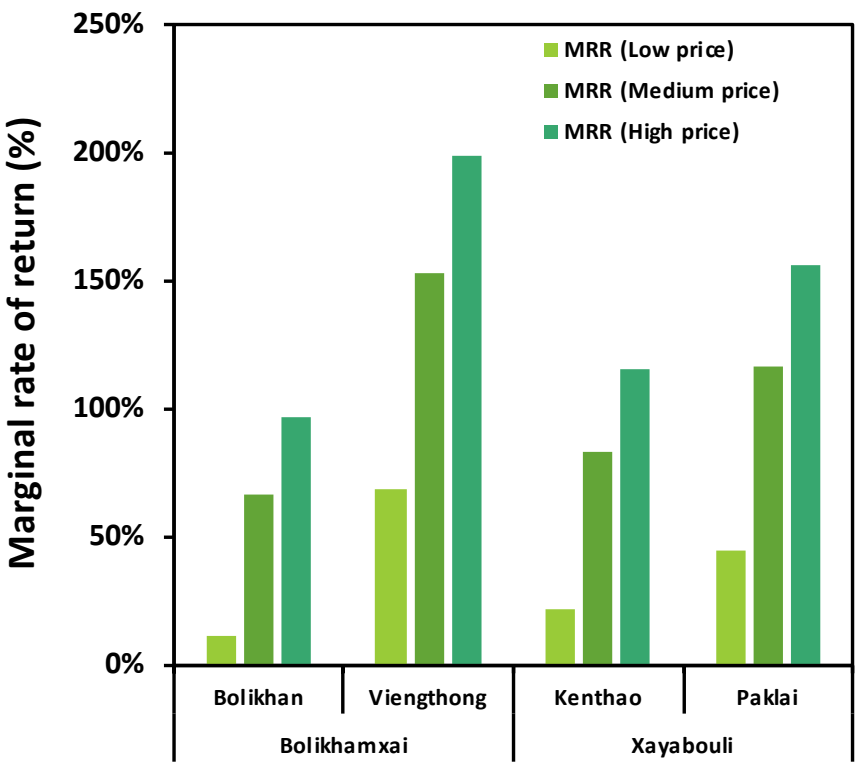
40 un-replicated larger area demonstrations in farmers fields under farmer management



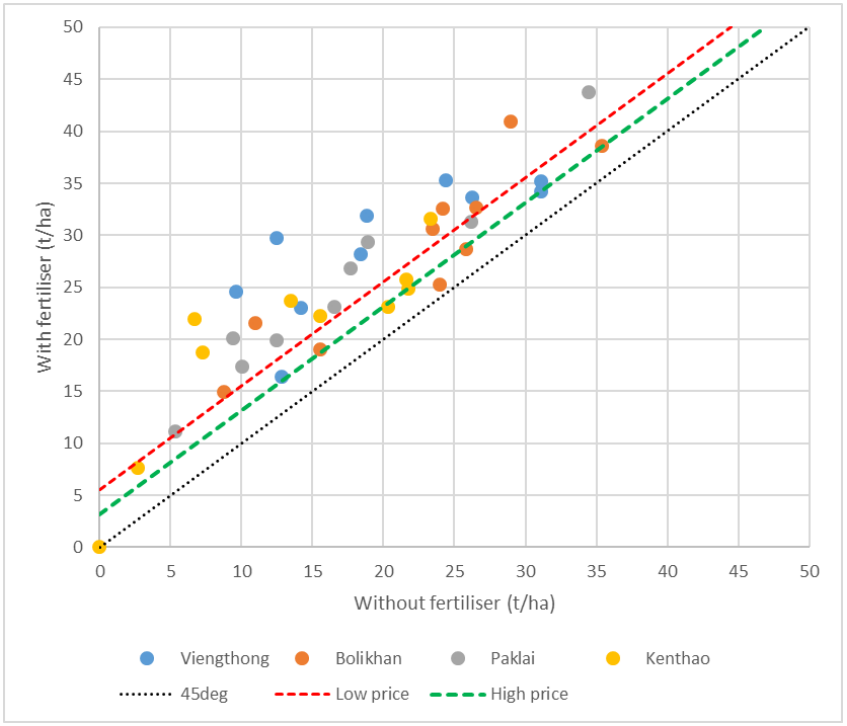


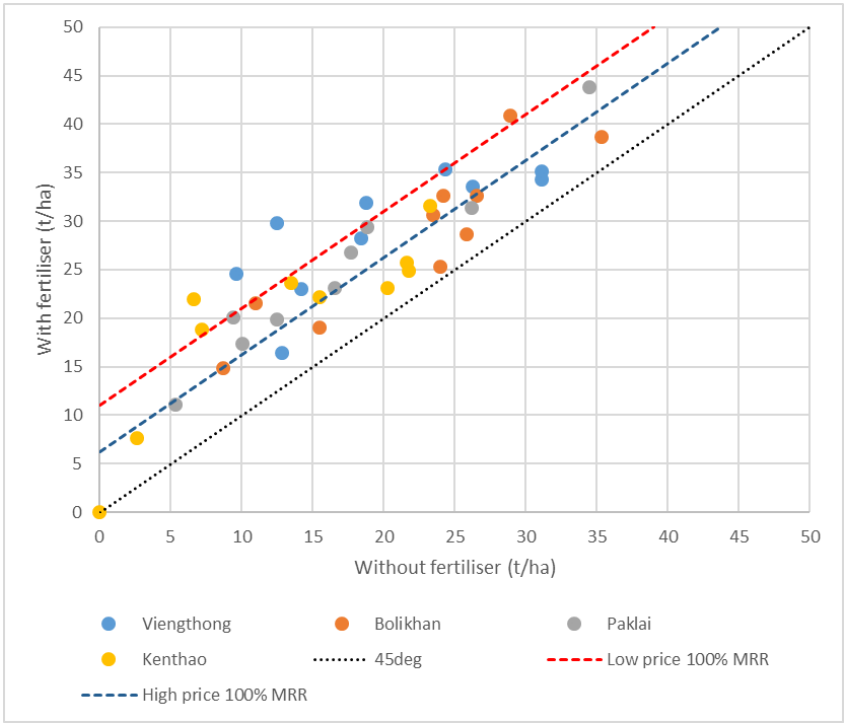
Average net benefits & rate of return





What is an attractive rate of return?



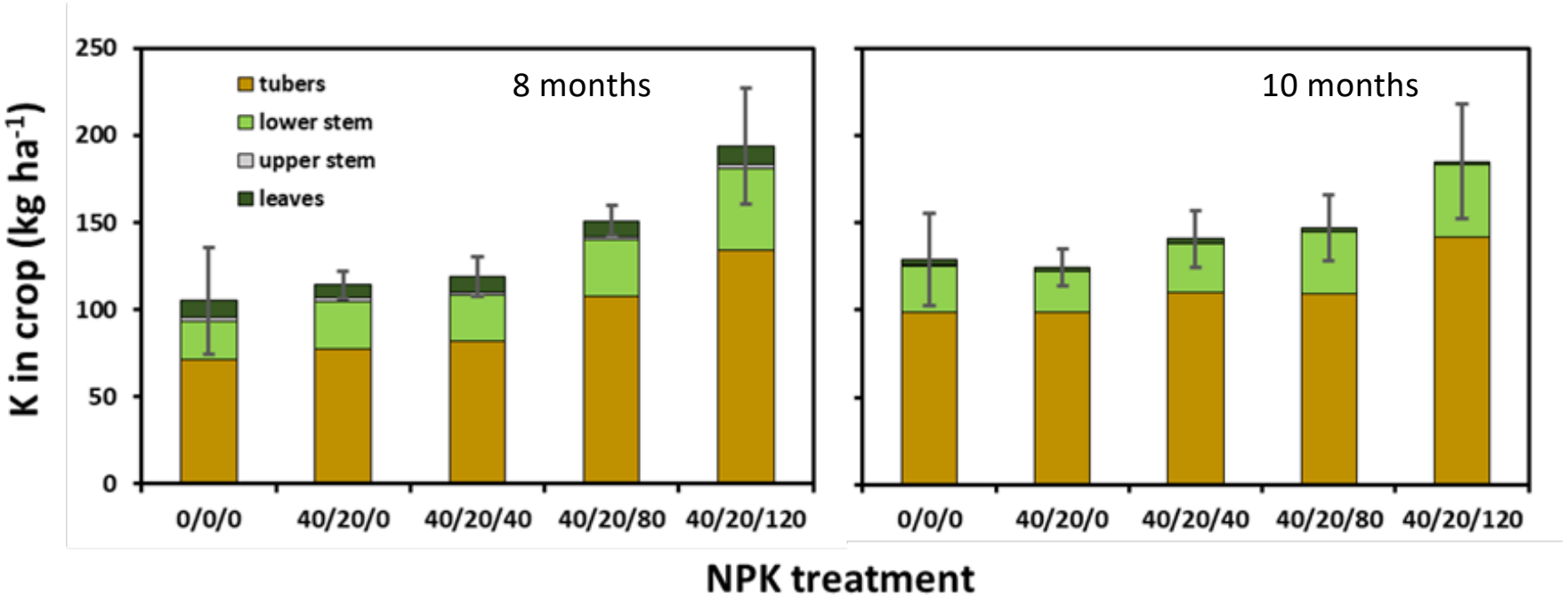


100% rule of thumb for farmers with limited experience with fertiliser used

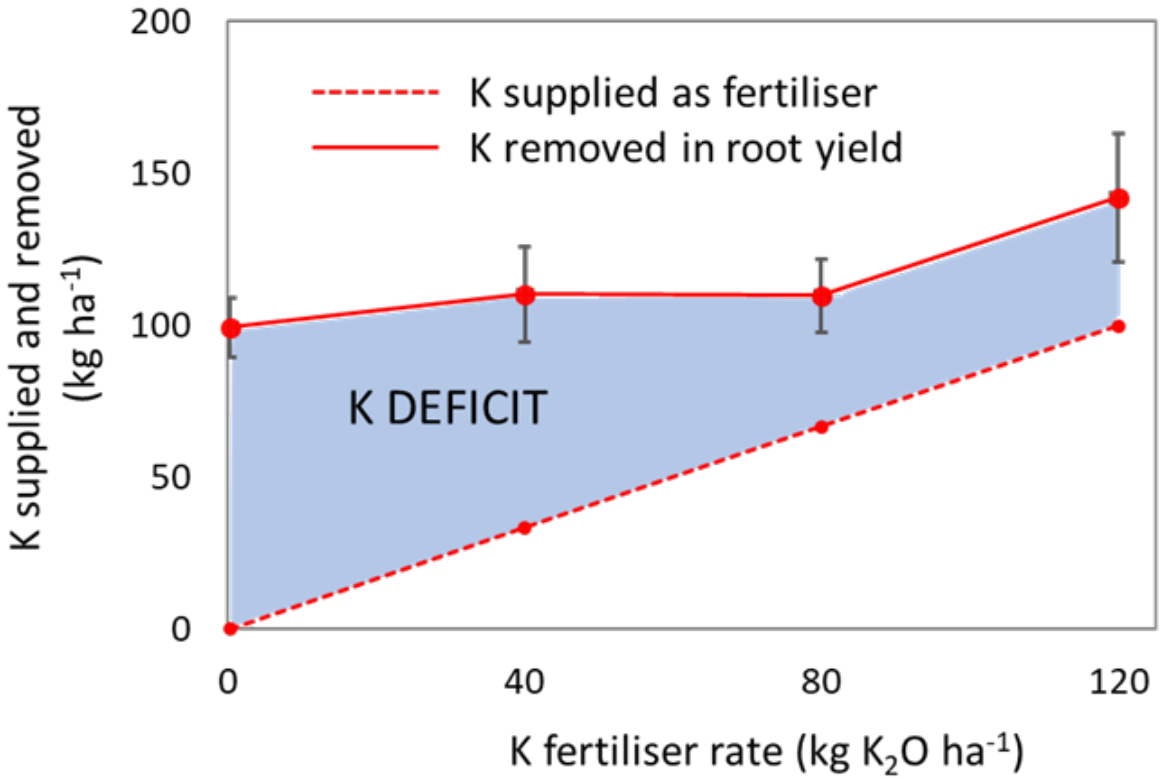
Soil management

HOW MUCH NUTRIENT REMOVED WITH HARVEST

Harvesting removes a significant amount of K



K removal was higher than K supplied



- Important implications for policy markers & industry promoting (or exploiting) the organic cassava starch segment of the market.
- Most organic fertility management option address Nitrogen but not Potassium.

Pest and disease

Differential impact of CWBD by variety

KU50

Rayong 11

Extension of basic information

How to identify CWBD in the field

How to identify CWBD in stem

Importance of rouging infected plants

Varieties that are less susceptible

Impact

Many farmers report getting CWBD under control

Q: Who has CWBD in their field??

Training of DAFO and farmers

Conclusion

1. Selecting well adapted **varieties** can have significant impact on farmer incomes (typically only through yield as prices not paid on starch content in most situations);
2. And processors profitability (amount of roots available x starch content that impacts efficiency).
3. Variety recommendations can not cannot be separated from disease situation which is creating greater incentive for industry to engage in the seed system.
4. **Fertiliser** on average provides good economic returns at the plot level, however can not be separated from other management – weeding, pest and disease.
5. Simple extension messages can regarding disease management can have a large impact on getting of top of disease before situation becomes too bad that no clean stems exist.
6. Intercropping and many soil management activities face considerable hurdles in terms of labour productivity
7. At the field level – many of the activities indicate an incentive for adoption using an economic lens. However, more constraints will be discussed in next presentation before likely to see widespread scaling by private sector actors.