

Cassava seed systems and implications for human vectoring of CMV

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Seed system R&D areas

Seed technologies & production pipelines

- Differential management
- Rapid multiplication techniques
- Pipeline design

Seed policies and regulation

- Seed laws
- Quality Declared Seed (QDS)
- Internal control procedures

Seed storage and post-harvest treatment

- Storage practices
- Stake treatments

Seed system economics and value chains

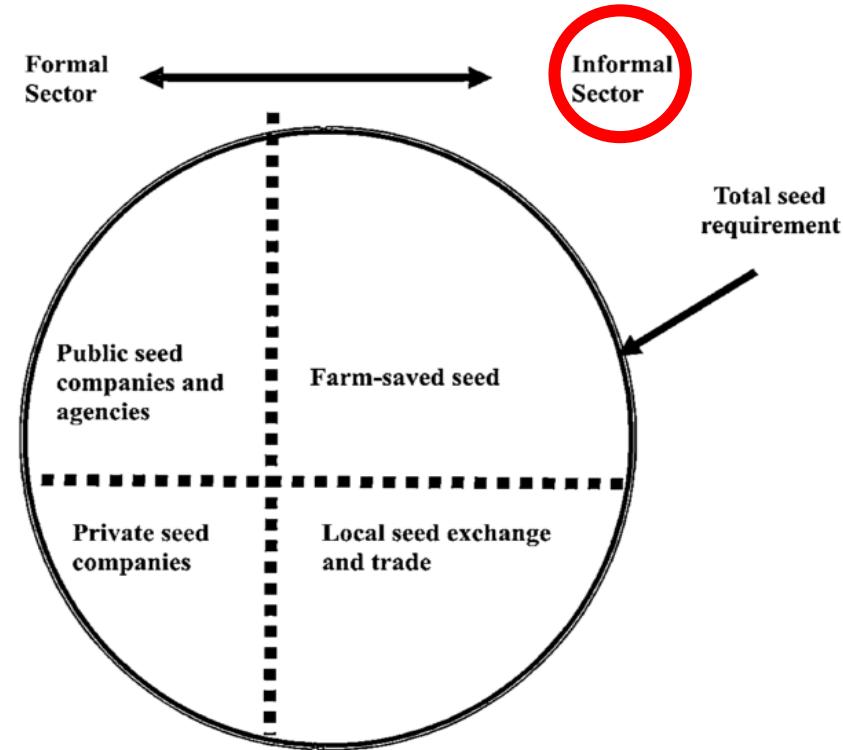
- Feasibility, including willingness to pay
- Business models
- Network analysis (flows)
- Characterization (including farmer practices)

Seed health and quality

- Degeneration trials
- Diagnoses and indexing
- Certification and thresholds
- Purity, vigor

Seed systems research

Seed systems: what and why?



- Characterize sources, sinks, mechanisms, and ultimately networks of planting material exchange
- Analyze the structure and characteristics of these networks & constituents, identify key points for interventions (phytosanitary, agrobiodiversity, genetic/varietal, information networks, etc.)



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Seed systems research

	Informal Seed Systems	Quality Declared seed System	Formal Seed Systems
Certification	N.A.	Group-based	Seed law
Producers	Small to big farmers	Farmer groups, companies	Farmer groups, companies
Seed health	Poor to high	Acceptable	High
Production pipeline	N.A.	Applied and adapted	Stage-wise (in-vitro, pre-basic, basic, certified)
Main value chain actors	Traders	Associations	Companies
Use of advanced technologies	Low	Modest	Potentially high
Cost	Low	Modest	Modest to high



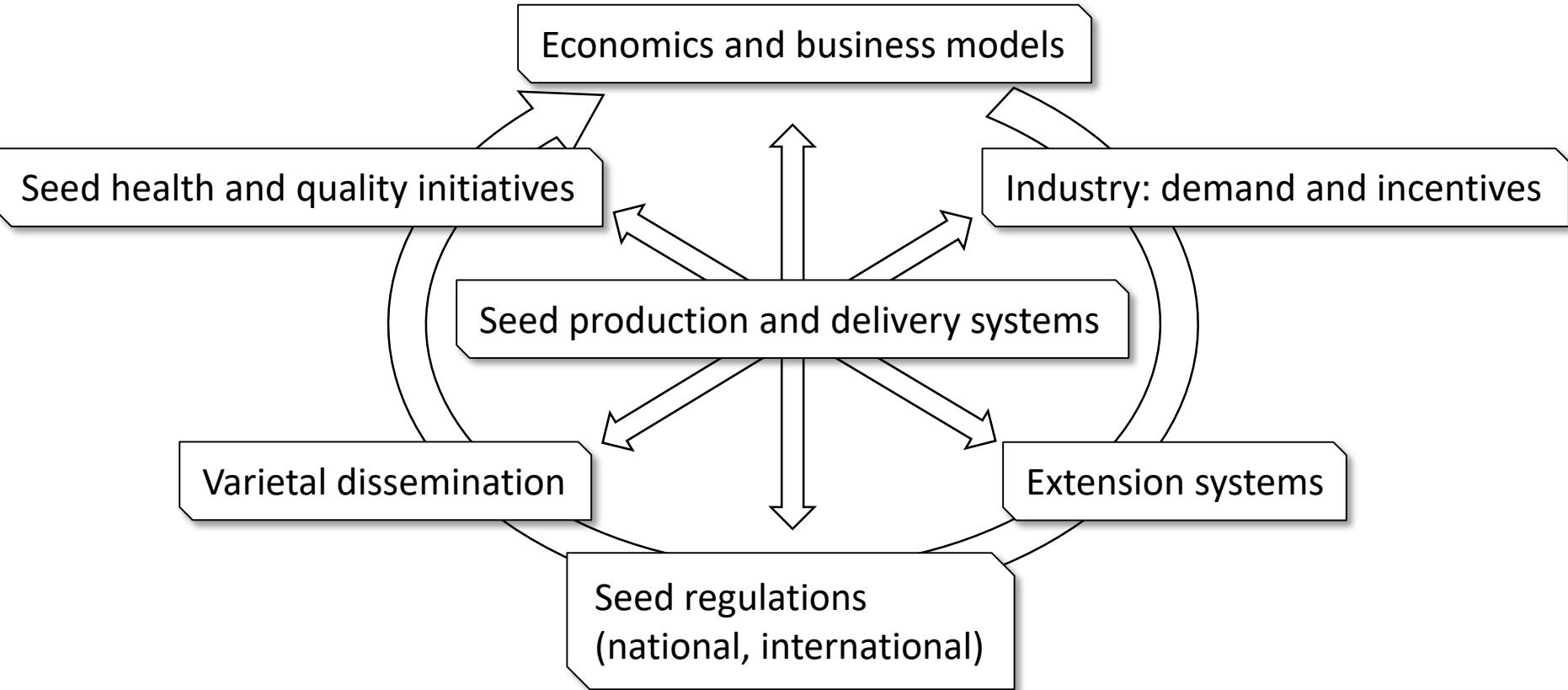
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Seed systems: interacting components



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Seed systems research

Selected cassava viral & phytoplasma diseases

Cassava Mosaic Disease (mult.)



Cassava Frogskin Disease

Cassava Brown Streak Disease

Cassava Green Mottle

Cassava Witches' Broom

Antholysis

Superelongation disease

Cassava Vein Mosaic Disease

Cassava symptomless infections (mult. viruses)



... a host of bacterial, fungal, arthropod pests transmitted by stem cuttings



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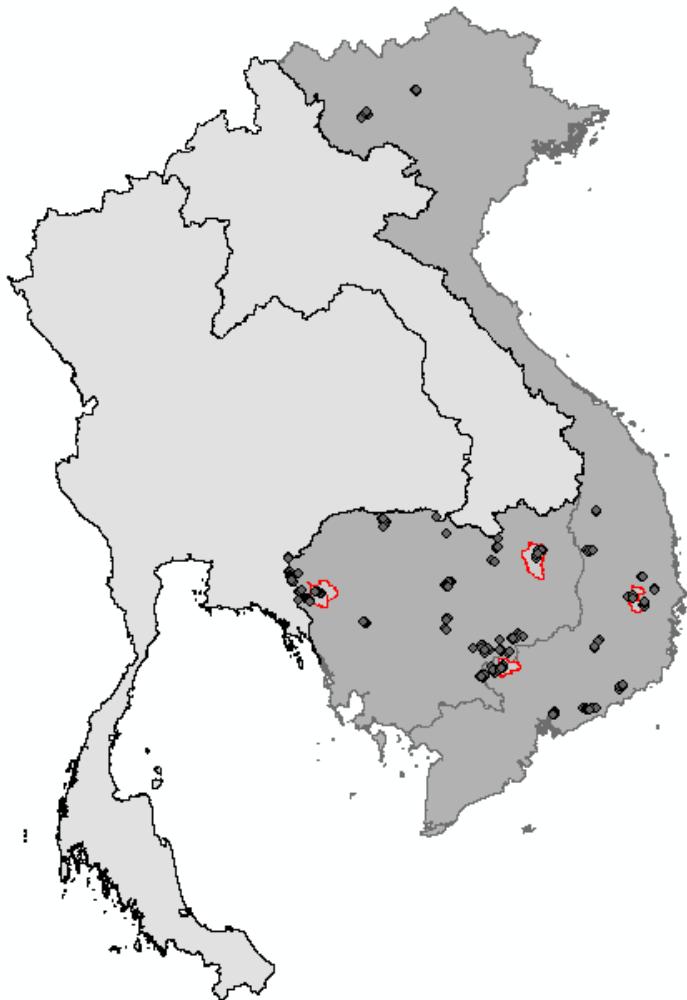
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National surveys

Country	District
K (KH)	1 Anlong Veaeng
	2 Malai
	3 Sala Krau
	4 Pailin
	5 Kamrieng
	6 Phnum Proek
	7 Rattanak mondul
	8 Kravanh
	9 Koun Mom
	10 Steung Treng
	11 Snoul
	12 Dambae
	13 Memot
	14 Romeas Haek
	15 Sandan
	16 Baray



Country	District
V (VN)	1 Thuan Chau
	2 Van Yen
	3 Chu Prong
	4 Mad Lak
	5 Eak Lak (Eaker?)
	6 Dak Glong
	7 Sa Thay
	8 Krong Pa
	9 Song Hin
	10 Bac Binh
	11 Ham Tan
	12 Tan Bien
	13 Tan Chau
	14 Ham Thuan Nam
	15 Long Thanh

Survey Team

VN: Plant Protection Research Institute (PPRI)
 & Plant Protection Department (PPD)

KH: General Directorate of Agriculture (GDA)
 & Provincial Department of Agriculture (PDA)

National survey results

	Cambodia	range	Vietnam	range
Sample size	240		206	
# districts surveyed	16		15	
Gender (M/F)	F-50 M-190		F-49 M-157	
Total farm size (ha)	6.37 (± 9.0)	0.1-100	2.0 (± 2.5)	0.2-30
Land planted to cassava (ha)	3.89 (± 5.6)	0.1-45	1.4 (± 1.3)	0.03-7
# of years growing cassava	6.33 (± 5.0)	1-24	12.8 (± 9.5)	1-40
Importance of cassava to total income (%)	52.5 (± 23.3)	5-100	49 (± 24.2)	1-100

	Cambodia	Vietnam
Regular use of fertilizer on cassava	Y-34 N-206	Y-141 N-52 (13 did not answer)
Number experiencing pest/disease problems in their cassava field	Y-181 N-59	Y-94 N-107 (5 did not answer)
Use of pesticide on the cassava field	N-187 Y-53	N-184 Y-22

In-depth survey results

Ratanak Kiri

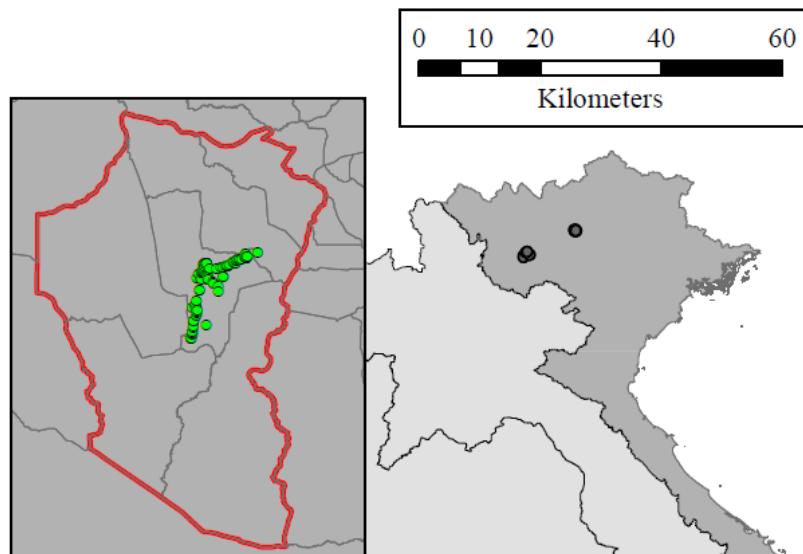
Koun Mom dist.

N=100

47% Female

yrs experience: 3.2

Cassava 2017? 81%



Đăk Lăk

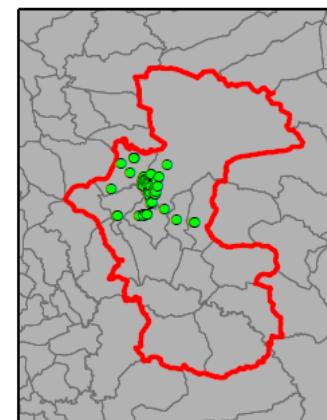
Ea Kar dist.

N=94

49% Female

yrs experience: 7.6

Cassava 2017? 87%



Battambang

Rotanak Mondol,

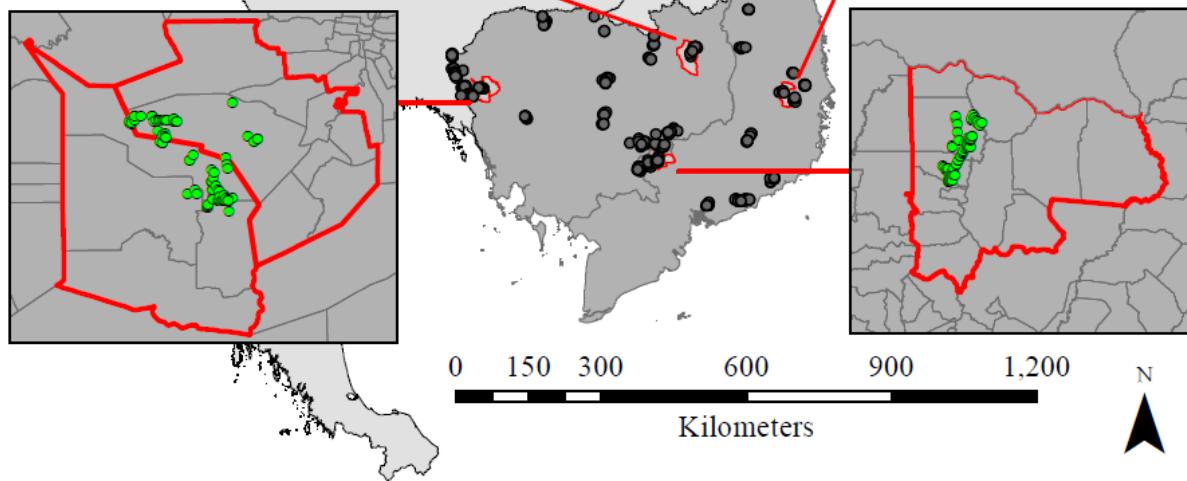
Banan dist.

N=100

26% Female

yrs experience: 2.7

Cassava 2017? 95%



Tây Ninh

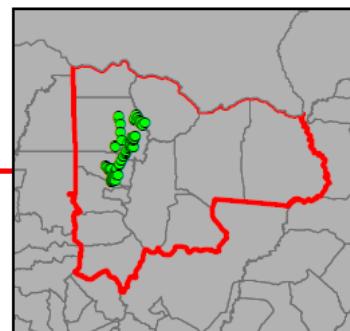
Tân Châu dist.

N=100

10% Female

yrs experience: 10.3

Cassava 2017? 88%



Results – Stake exchange

End use of cassava roots (%)

	Cambodia	Vietnam
Sold to factory	0.4	42.2
Sold to trader	41.3	52.9
Sold to collection point	54.6	8.3
Eaten domestically	0.0	0.0
Did not answer	4.2	0.0

Who makes decisions in the household regarding cassava? (%)

	Battambang	Ratanakiri	Tay Ninh	Dak Lak
Male head	21	15	73	34
Female head	9	5	9	35
Decision is made together	70	67	1	30
Other		11	7	
Did not answer		2	10	1



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Results – Stake exchange

Who did you exchange stakes with in 2016?

Source	National				Subnational-established sites				Subnational-expansion sites			
	Cambodia		Vietnam		Battambang		Tay Ninh		Ratanakiri		Dak Lak	
	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.
Acquaintance (within community)	26.2	82.3	19.7	77.9	27.1	94.7	23.8	20.7	21.8	90.7	5.2	84.5
Acquaintance (outside community)	3.9		4.3	1.0	4.2		1.9		2.0	1.9		
Local market	0.5		0.4		2.5				0.7			
Agroinput dealer			6.0									
Starch factory	0.5										3.1	
Community collection point		17.7		12.5		5.3	12.4	10.3		5.6		14.1
Community group							1.0			1.9		
Trader (with truck)	18.1		3.0	8.7	2.5		26.7	69.0	1.4		3.1	1.4
Municipality / district office			1.3									1.0
Government research organization												1.0
Other farmer (non-acquaintance)	3.4		1.3				1.9					
Own stock	47.2		64.1		63.6		32.4		74.1		86.5	
Total N transactions	381	130	234	104	118	38	105	29	147	54	96	71
Sample N (individuals)	240		206		100		100		100		94	



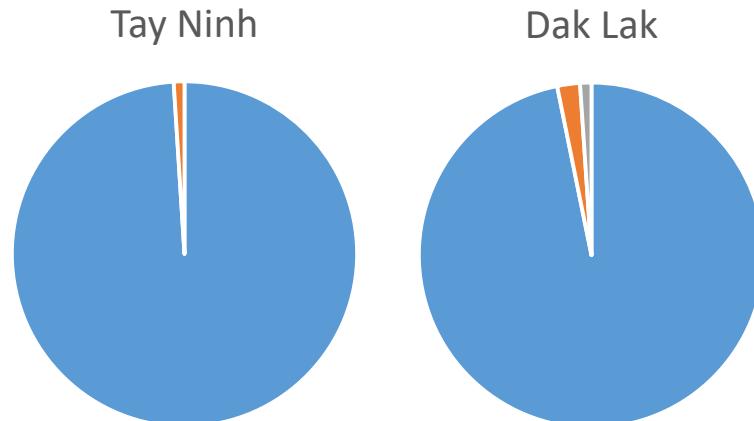
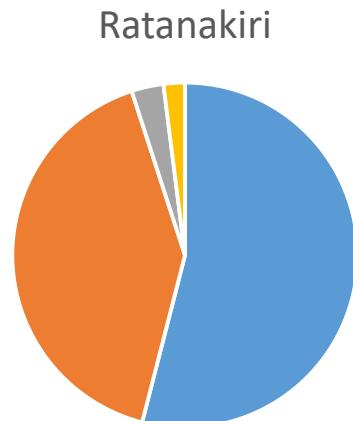
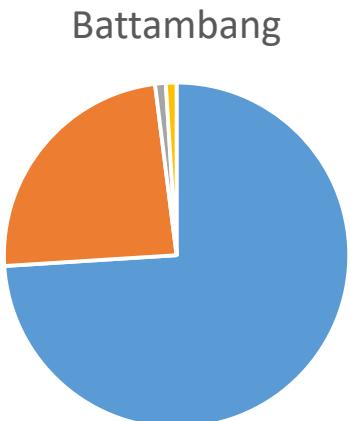
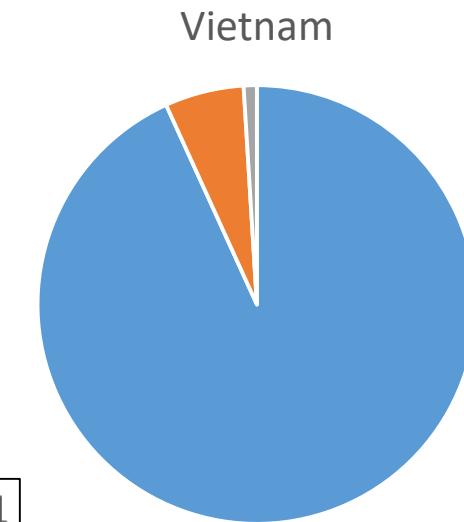
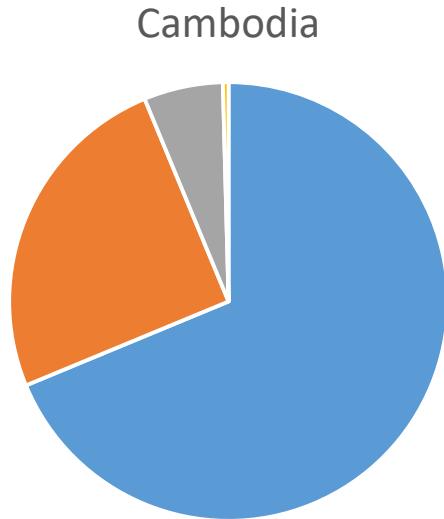
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Results – Number of varieties



Results – Method of stake exchange

How did this exchange happen?

Method of exchange	Cambodia		Vietnam		Battambang		Tay Ninh		Ratanakiri		Dak Lak	
	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.	Ac.	Prov.
Save own stocks	47.2		65.0		63.6		32.4		74.1		86.5	
Exchange/barter	0.3	1.5	6.8	45.2			1.0			3.7		
Gift (friends/neighbours/relatives)	10.0	61.5	12.8	33.7	5.9	42.1	11.4	21.4	17.0	53.7	5.2	91.5
Purchase	42.5	36.2	15.4	21.2	30.5	57.9	55.2	78.6	8.8	40.7	6.3	7.0
Voucher/coupon			0.8									
Seed Loan										1.9	1.0	
Money credit											1.0	1.4



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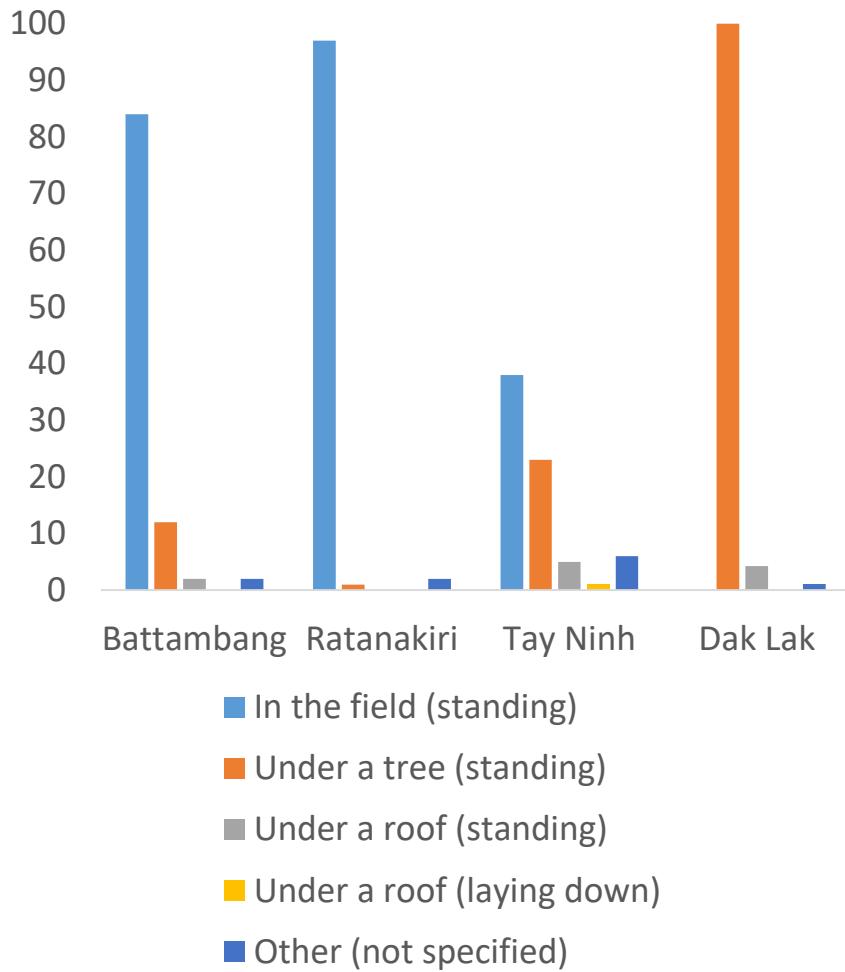
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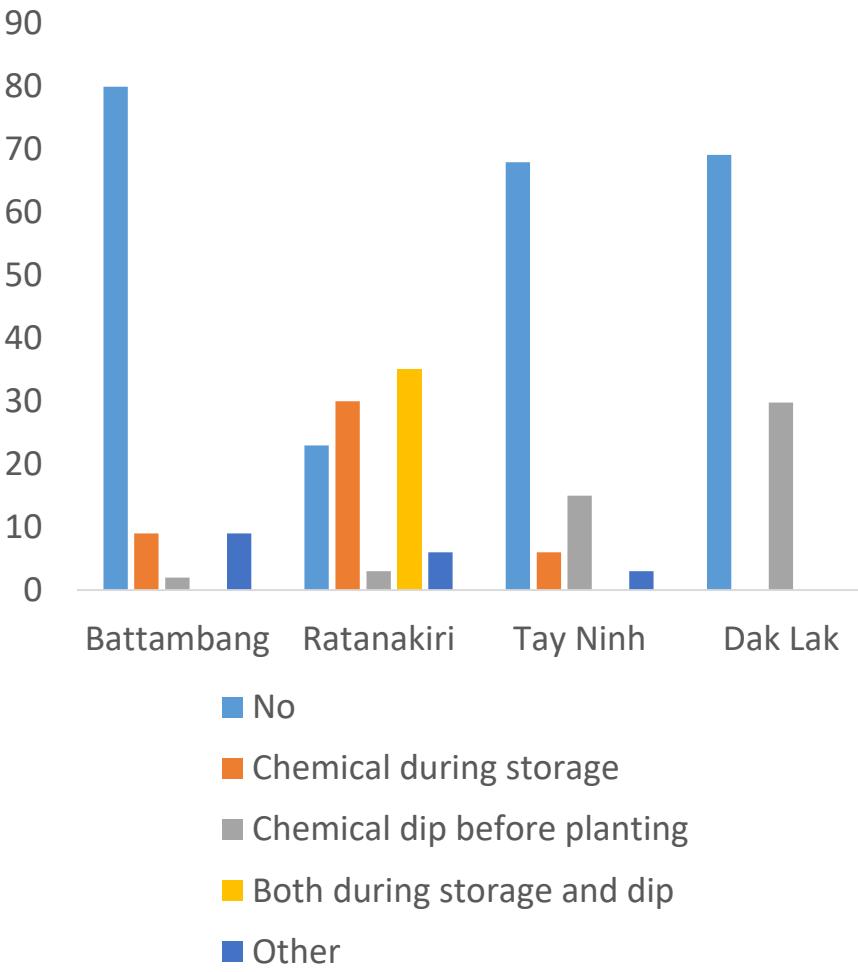


Seed storage

How do you store stakes? (%)



Do you treat stakes during storage? (%)



Geography of stake trading

Where did the stakes move from/to?

Source	National			
	Cambodia		Vietnam	
	Ac.	Prov.	Ac.	Prov.
Own field	47.0		63.7	
Other field – same commune	24.1	90.8	26.1	86.5
Other commune – same district	3.7	1.5	1.7	
Other district – same province	2.4	3.8	2.6	1.9
Other province – same country	2.4	3.1	4.7	
Other country	19.9			
Unknown		0.8		11.5



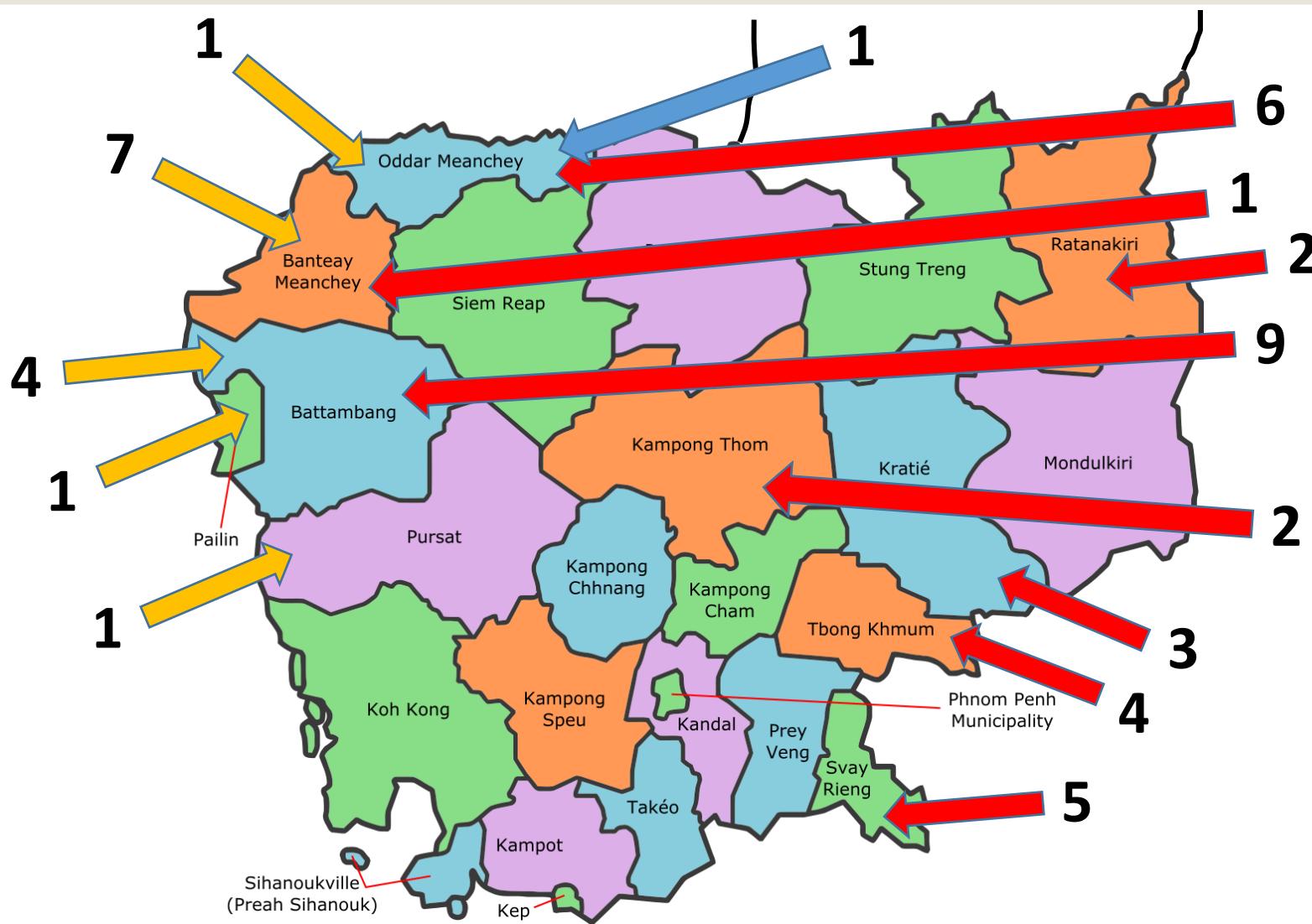
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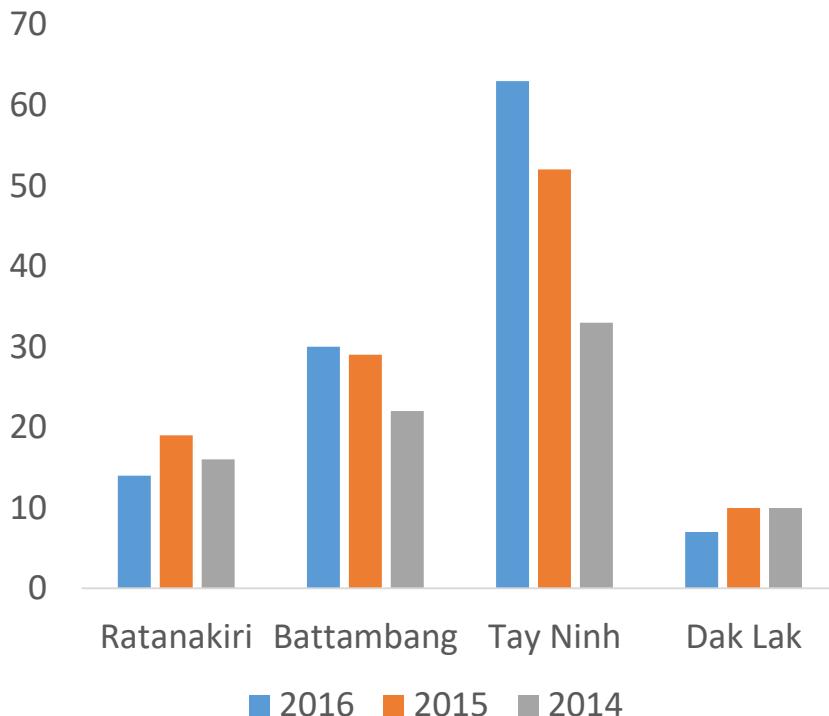


International trading

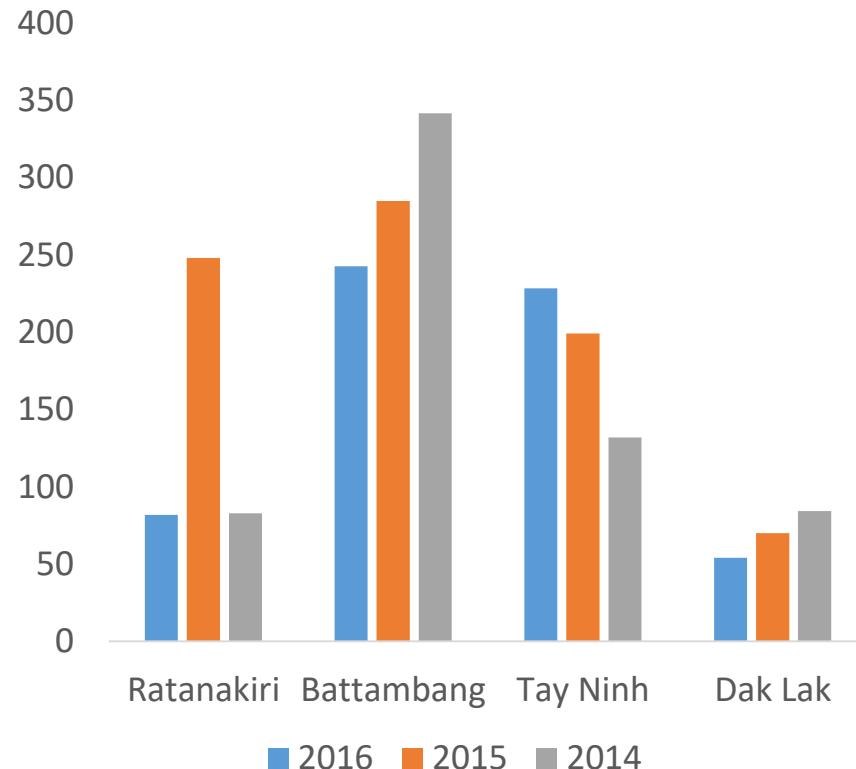


Seed trade - Purchasing

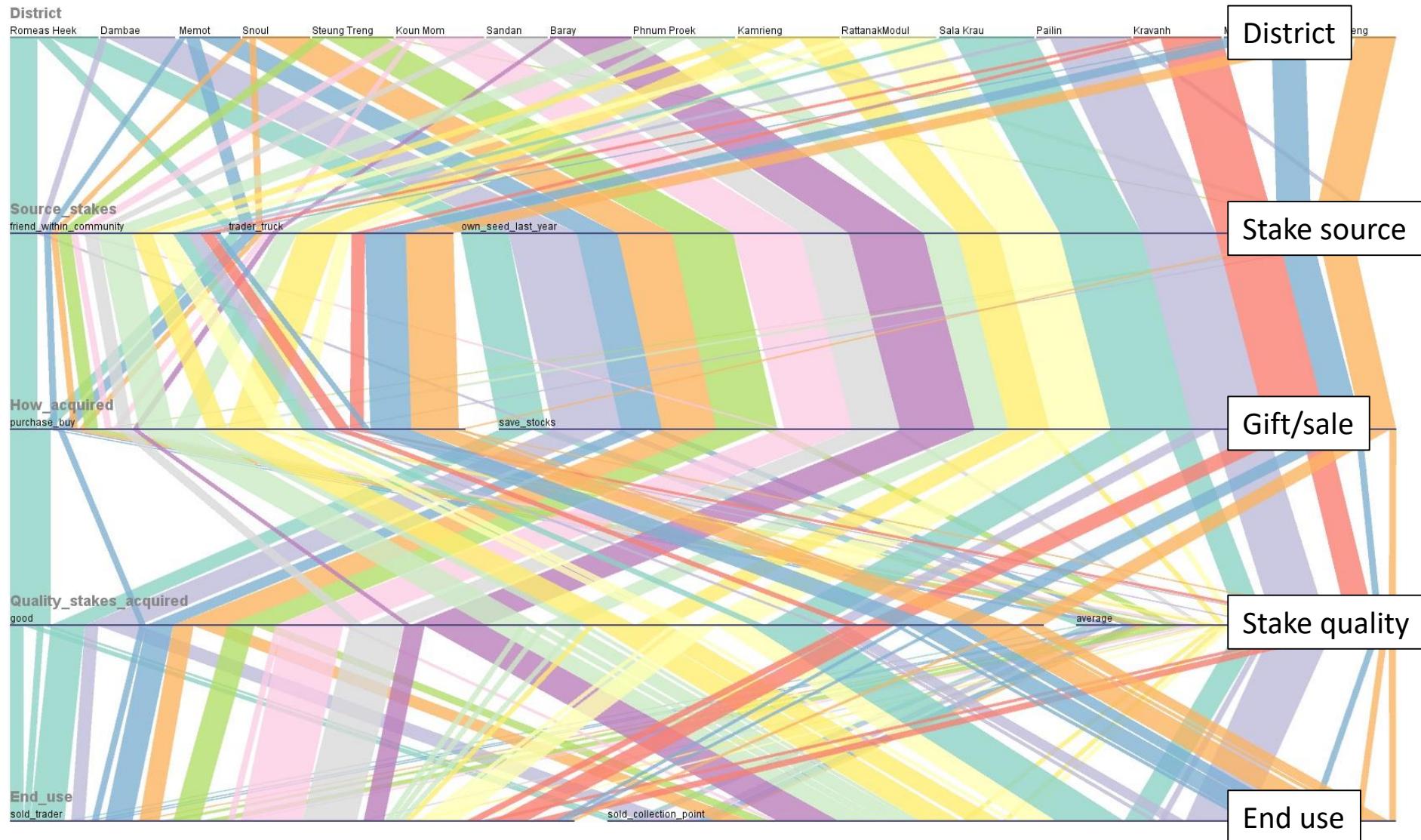
Percentage of respondents buying stakes (%)



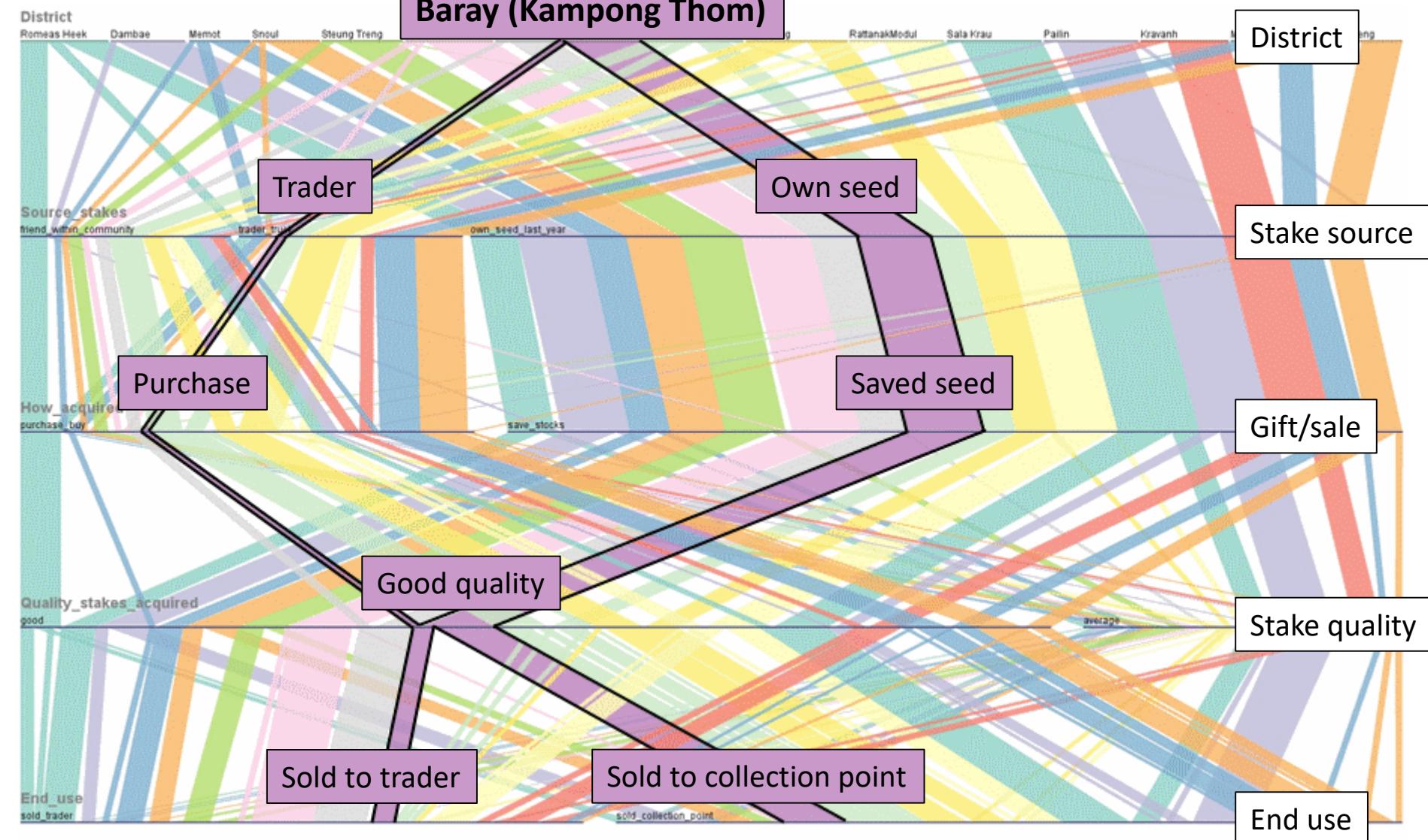
Price paid for stakes (USD)



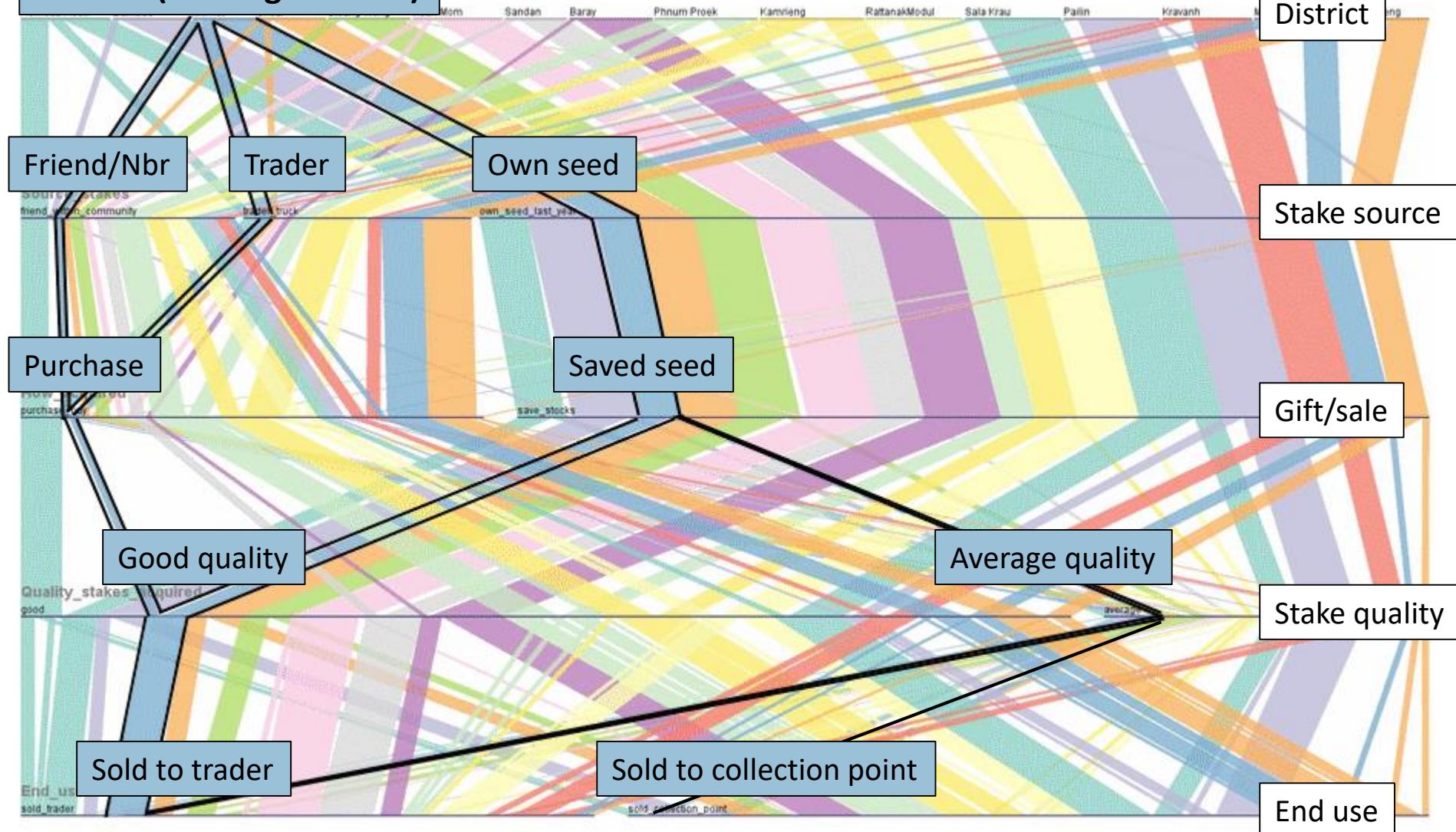
Parallel coordinate plots



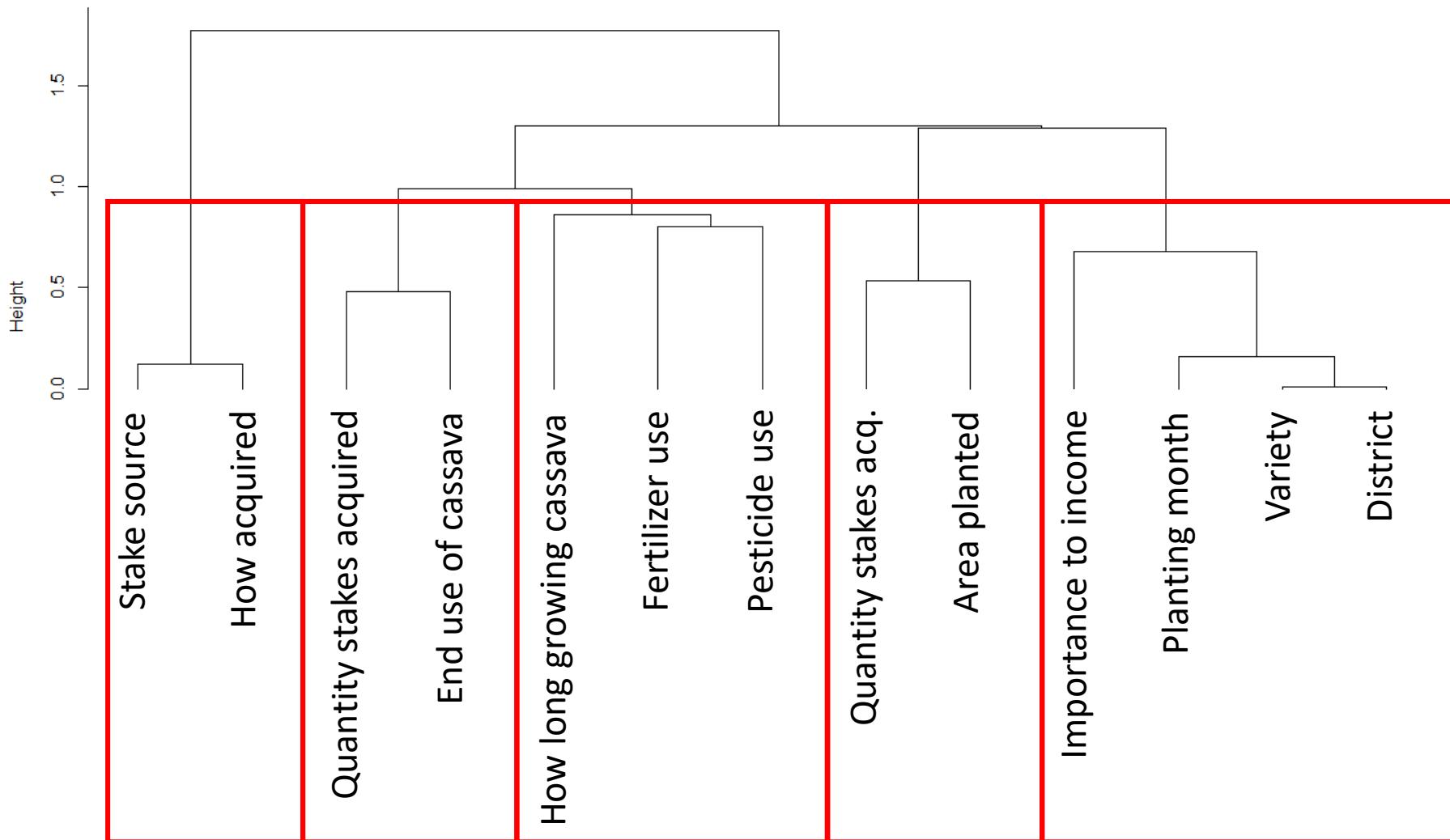
Baray (Kampong Thom)



Memot (Tboung Khmum)



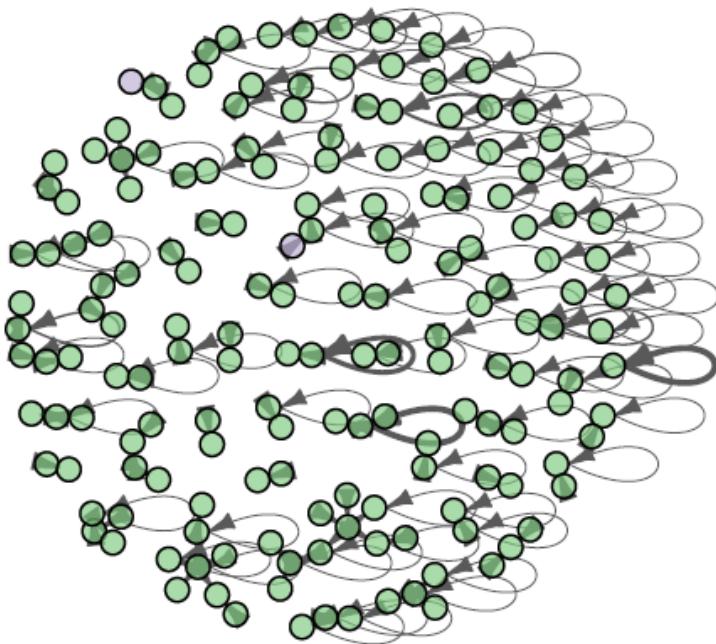
Clustering variables – National survey



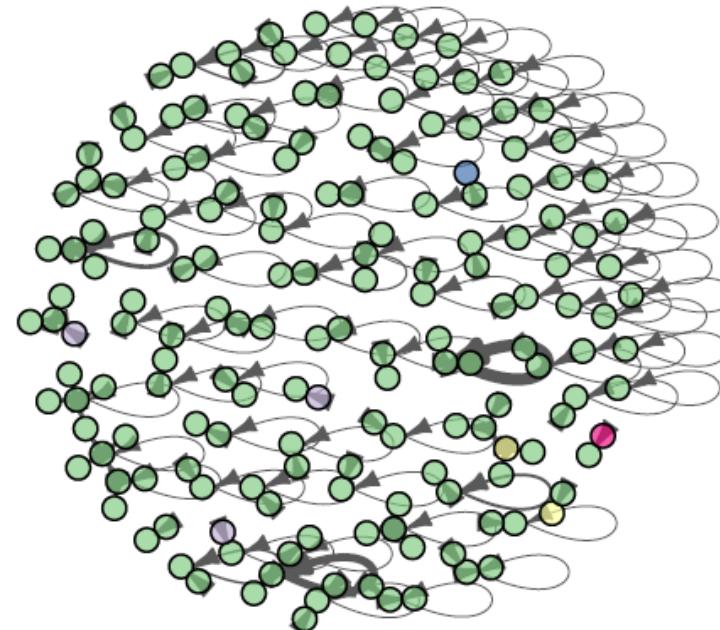
Seed networks in action

'Expansion sites'

Ratanakiri



Dak Lak



- Farmer
- Trader
- Collection point
- Starch Factory

- Government office
- Government research center
- Market



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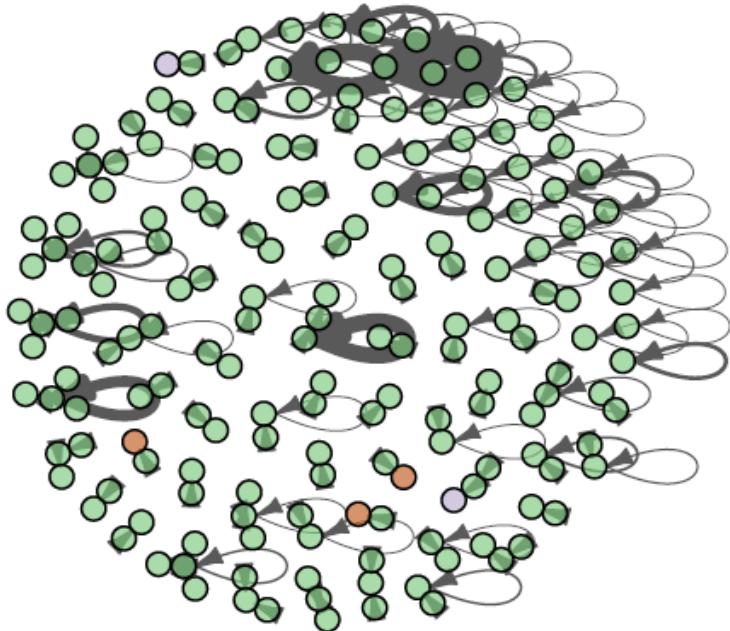
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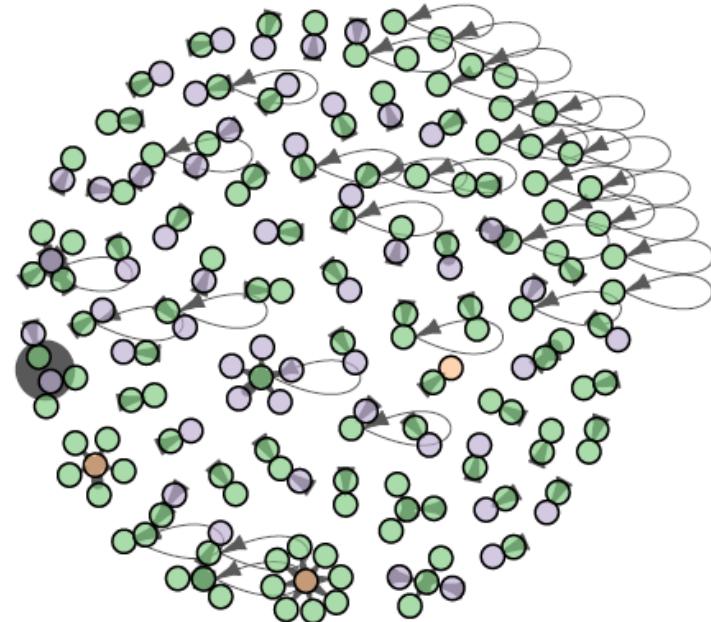
Seed networks in action

'Established sites'

Battambang



Tay Ninh



- Farmer
- Trader
- Collection point
- Starch Factory

- Government office
- Government research center
- Market



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Seed networks in action

● Farmer

● Trader

● Collection point

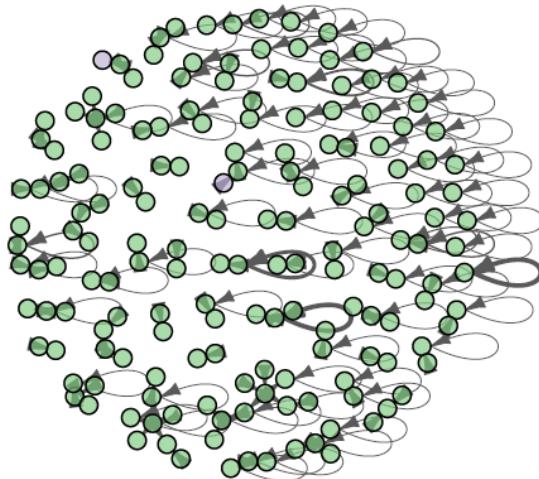
● Starch Factory

● Government office

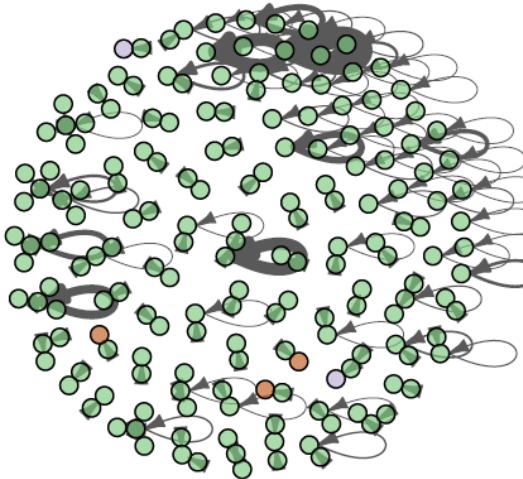
● Government research center

● Market

Ratanakiri

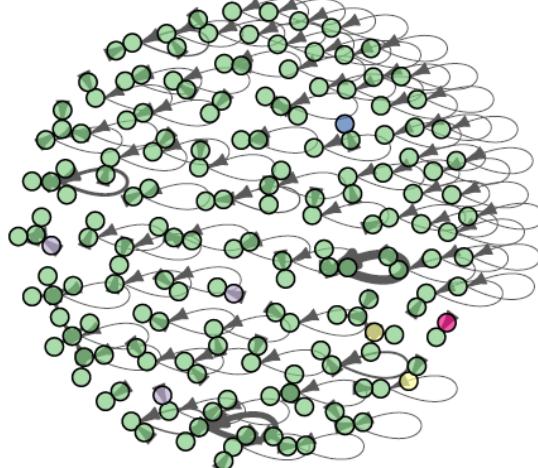


Battambang

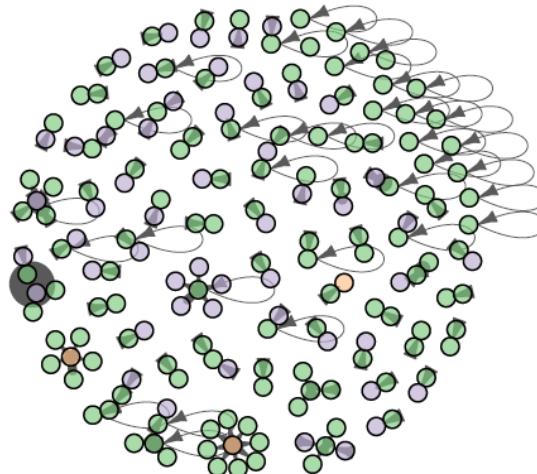


Cambodia

Dak Lak



Tay Ninh

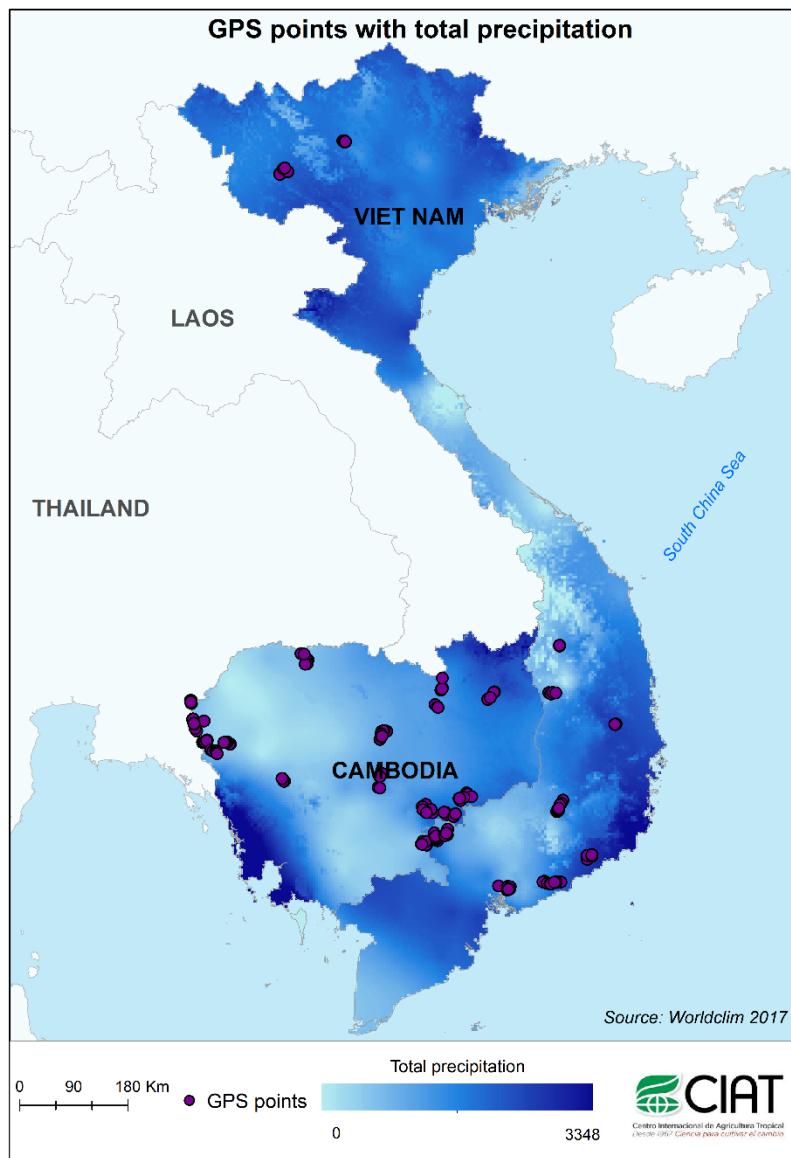
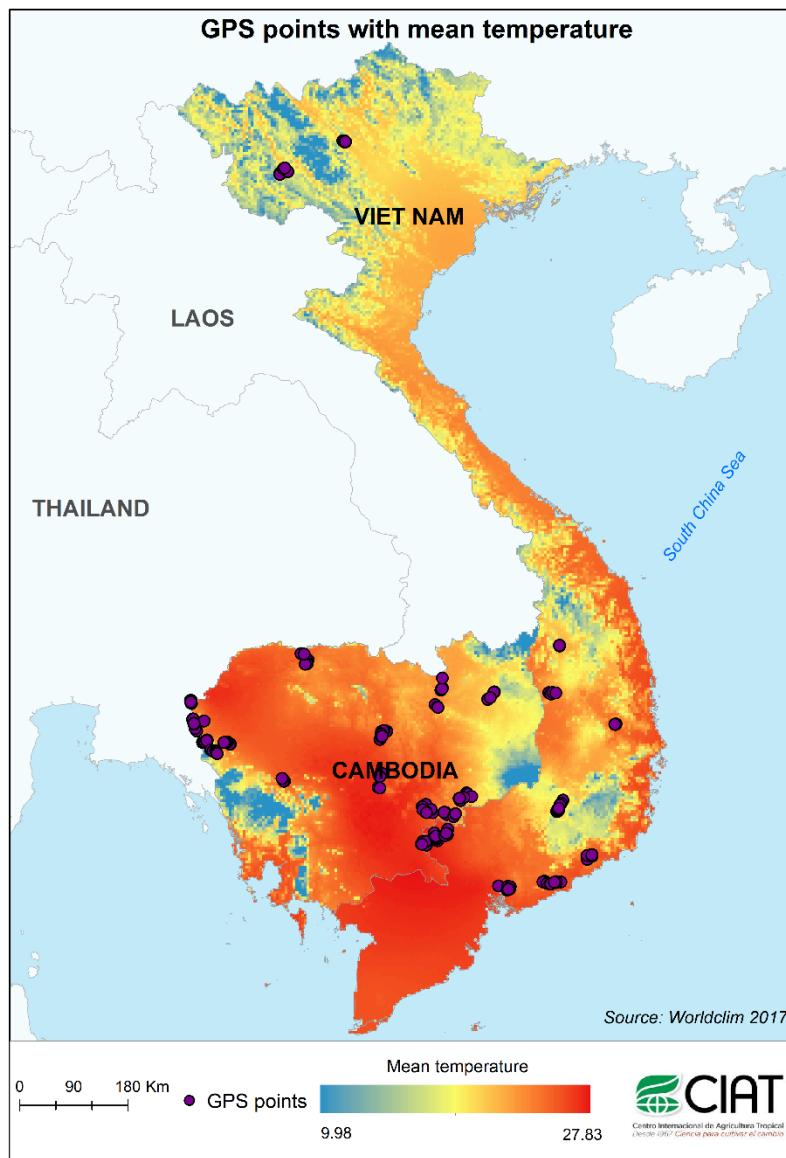


Vietnam

Expansion

Established

Effect of climate and seasonality



(Map from Than Nguyen, CIAT)

Implications for CMV

- In Vietnam and Cambodia's dense production districts, the landscape is essentially contiguous cassava fields
- A high degree of stake sharing within communities, and trader-mediated links to distant communities make the landscape highly suitable for pest/disease
- Low varietal diversity in Vietnam and extensive reliance on buy and trade in Tay Ninh are also risk factors
- International stake movement a reality – but some types of farmers and settings are more at risk than others



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Trader surveys

- Trader activity variable from site to site
- Many traders in some locations... but farmers had difficulty providing contact information

Farmer surveys completed:

Ratanakiri – 1, Battambang – 0

Dak Lak - 7, Tay Ninh – 12

- All stakes traded to Dak Lak originated in Tay Ninh
- All traders mix stakes when they have more than 1 source
- Traders served between 10-120 farmers
 - Those from Tay Ninh served 15-20, those from Dak Lak served larger numbers
- Given their critical status in the cassava seed system, a survey initiative dedicated to traders should be a next step



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Notes for group discussion

- ❑ The whole value chain of stake supply should be mapped from farm to farm, especially for international trade
- ❑ Cassava has the advantage of flexible harvest time... can this be used to give Cambodian farmers more independence from purchasing stakes?
- ❑ Differences in seasonality likely to also drive exchange patterns



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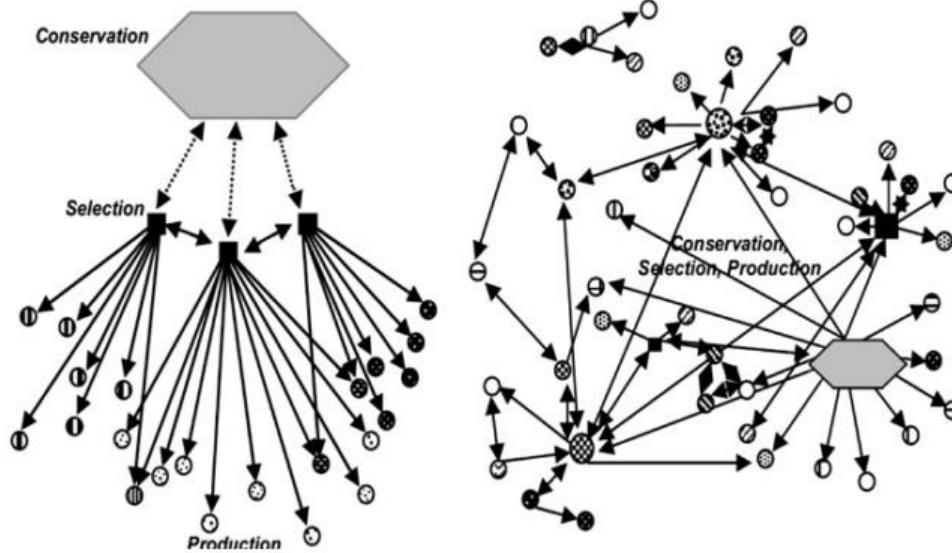
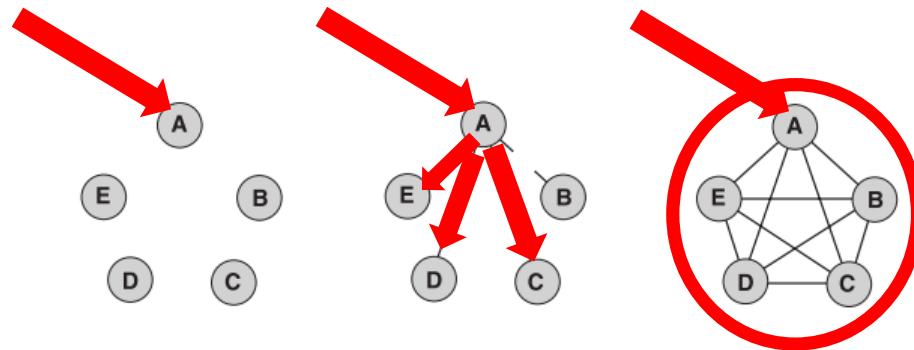
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A CGIAR Research Center

Network Analysis

- How do seeds move?
- What does this tell us?



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Country	Vietnam	Cambodia
Key stakeholders	<ul style="list-style-type: none"> • National level: Ministry of Agriculture and Rural Development (MARD) • Provincial level: Department of Agricultural and Rural Development (DARD) • District level: Sub-MARD • Department of Crop Production (DCP): seed quality control of commercial seed (public and private). • National Centre for Variety Evaluation and Seed Certification (NCVESC): organizes testing of new varieties and conducts seed quality certification of crop seeds. • Department of Plant Protection (PPD): managing pests and diseases of crops, monitoring health of imported seeds, and seed pathology issues. • New varieties issued from: MARD, the Ministry of Education and Training (MET), and private seed companies. 	<ul style="list-style-type: none"> • National level: Ministry of Agriculture, Forestry and Fisheries (MAFF) and General directorate of agriculture (GDA). • The Cambodian Agricultural Research and Development Institute (CARDI) • Both MAFF and GDA are responsible for the implementation of seed law including the development of related articles. • The ownership rights of new seeds are being certified by MIME after all technical tests are completed and officially approved by MAFF. • For seed from abroad, MAFF will be responsible for seed tests • Registration of seed companies is done by the Ministry of Commerce • Registration of seed associations is done by the Ministry of Interior • Registration of community seed based organizations is done by MAFF. • No official seed laboratory in Cambodia

Country	Vietnam	Cambodia
Key legislation	<ul style="list-style-type: none"> • Seed Ordinance (2004) • Ordinance on Plant Varieties (2004) • Law on intellectual property (no. 50/2005/QH11) • Amendment of Intellectual Property Law (2009) • Decree No. 07/CP (1996) • Decree No. 88/2010/ND-CP • Decree No. 187/2013/ND-CP • Decision-35/2008 (MARD); to legalize and stimulate any farmer individuals, farmers' groups, clubs and cooperatives who and which can do breeding, selection, seed production for household use and seed exchange and supply in the market. • Joined UPOV (1991 act) in 2006 • Circular No. 11/2013/TT-BNNPTNT Issued by MARD & notified UPOV – applies the legislation governing breeders' rights of Viet Nam to 21 vegetatively propagated crops, including Manihot esculenta Crantz (No. 16 on the list). 	<ul style="list-style-type: none"> • Law on seed management and plant breeder's rights (2008). • Sub-decree 69; identified as Legal Framework for Agricultural Materials and Products • Sub-decree 15 on phytosanitary inspection • Sub-decree 118 assigned responsibilities for seed management to the GDA under the MAFF. • Cambodia is in contact with UPOV for development of seed laws, but Cambodia is not yet a signatory of the convention

Country	Vietnam	Cambodia
Seed certification classes	<ul style="list-style-type: none"> • Local seed: existed in a locality for a long time and a rather stable manner, with properties and features which are distinctive from others' and may be passed to the following generation. • Breeder seed (author's seed): the author(s) has/have selected, crossbred or taken from the gene fund with stable heredity. • Foundation seed: has been produced from the breed seed strictly in line with the process for foundation seed production and with the quality up to the standards stipulated by the State so that it may be further multiplied. • Certified seed (commercial seed): one of the last generation of foundation seed, used for large-scale production but not kept as seed. 	<ul style="list-style-type: none"> • Breeder seed: produced by plant breeders using NS in a single panicle/progeny selection approach. • Foundation seed: most closely controlled class and grown from seed supplied by the breeder or owner of the variety. • Registered seed: grown from foundation seed and is a multiplication class of seed that has standards that are less strict than Foundation class. • Certified class or commercial seed: progeny of Registered seed and uses standards less stringent than Registered seed.