CASSAVA PROGRAM DISCUSSION PAPERS

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Smallholder Farmer Use and Sources of Cassava Varieties - Implications for Private Sector Involvement in Technology Dissemination[1]

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Introduction

The recent boom in the global market for cassava has created livelihood opportunities for many smallholders in Southeast Asia. Research over many years by public agencies has generated an abundance of technologies that could enhance the productivity and sustainability of these cassava producers. While national government policies have not prioritised the dissemination of these technologies, we hypothesise that, in particular contexts, private-sector value-chain actors have incentives to invest in the promotion of suitable varieties, fertiliser regimes, pest control methods, and other production practices. In other contexts, however, there is little incentive for private-sector involvement, and support from public-sector or non-government actors will be required.

In this paper we examine the varieties of cassava used by smallholder cassava farmers across sites in Indonesia, Vietnam, Laos and Cambodia based on the results of an extensive household survey conducted in 2017. We also examine the sources of both exchanged and purchased planting materials. We combine these with the results of variety trials conducted across 7 sites between 2016 and 2018 to propose potential business models for private sector involvement in development and dissemination of improved varieties across the sites.

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[1] This series ***Cassava Program Discussion Papers*** presents results of the Australian Centre for International Agricultural Research (ACIAR) supported projects ASEM /2014/053 *Developing cassava production and marketing systems to enhance smallholder livelihoods in Cambodia and Lao PDR* and AGB/2012/078 *Developing value-chain linkages to improve smallholder cassava production systems in Vietnam and Indonesia*

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Household Survey Locations

Household surveys in **Sikka, Indonesia** were conducted across four communes, Kangae and Kewa Pante in the lowlands and Koting and Nita in the uplands. As a result of relatively small sample sizes across communes much of the survey data is analysed between lowland communes with a total of 60 households and upland communes with 54 households.

Table 1: Households by Survey locations – Sikka, Indonesia

Communes	Number of household surveys	Region	Total
Kangae	59	Lowland	60
Kewa Pante	1		
Koting	16	Upland	54
Nita	38		
Total	**114**	**Total**	**114**

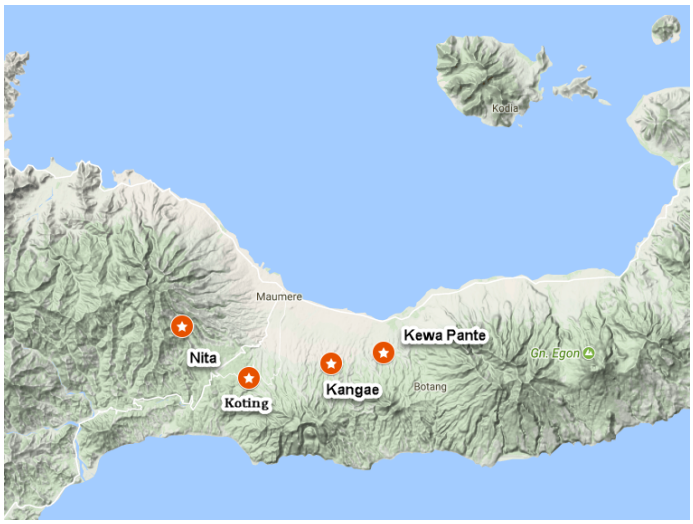

Figure 1: Survey Sites, Sikka, Indonesia

In **North Sumatra**, **Indonesia** household surveys were conducted in four districts, Papak Bharat, Pematang Siantar, Simalungun and Toba Samosir, with the majority of surveys (over 80%) conducted in Simalungun. The total usable sample size included 138 households.

Table 2: Households by Survey locations – North Sumatra, Indonesia

Districts	Number of household surveys
Simalungun	111
Toba Samosir	17
Pematang Siantar	9
Pakpak Bharat	1
Total	**138**

Figure 2: Survey Sites, North Sumatra, Indonesia

Field research was undertaken in four communes in **Dak Lak, Vietnam**. These included Ea Sar and Ea So communes in Ea Kar District and Yang Kang (Dang Kang) and Cu Kty Communes in Krong Bong District. Ea Kar and Krong Bong districts were chosen for field research as they will be key locations of project activities moving forward.

Table 3: Households by Survey locations – Dak Lak, Vietnam

Communes	Number of household surveys
Cu Kty	63
Dang Kang	62
Ea Sar	65
Ea So	63
Total	**253**

Figure 3: Survey Sites, Dak Lak, Vietnam

In **Son La**, household surveys were undertaken in Chieng Chan, Na Ot, Pung Tra and Bo Muoi communes. In each commune, 32 households were surveyed in each of the two selected villages. In each commune the choice of villages was made in order to have one mid-land village close to the commune center and one more highland village far from the commune center. Within each village respondents were selected randomly amongst households producing cassava.

Table 4: Households by Survey locations – Son La, Vietnam

Communes	Number of household surveys
Bo Muoi	65
Chieng Chan	64
Na Ot	64
Pung Tra	64
Total	**257**

Figure 4: Survey Sites, Son La, Vietnam

In **Cambodia**, household surveys were undertaken in Kratie and Stung Treng provinces. Within Kratie the interviews were conducted in Snuol and Chitr Borie districts, and within Stung Treng they were conducted in Siem Bouk District. The useable sample was more or less divided evenly across the surveyed districts.

Table 5: Households by Survey locations – Cambodia

Districts	Number of household surveys
Chitr Borie	101
Siem Bouk	110
Snuol	100
Total	**311**

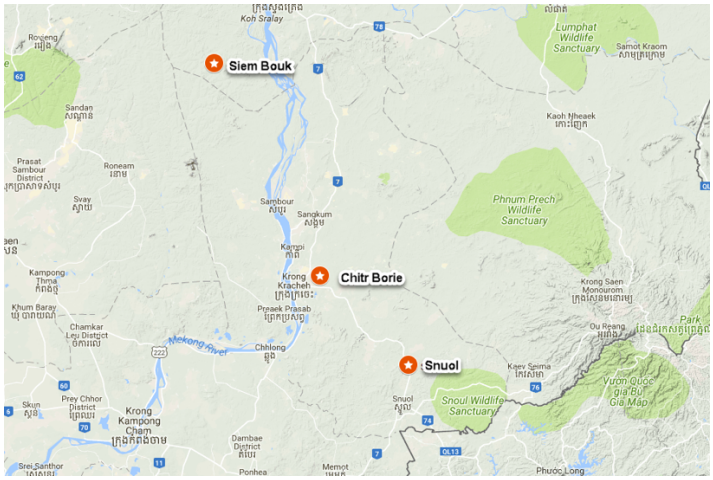

Figure 5: Survey Sites, Cambodia

In **Laos**, the household surveys were undertaken in Bolikhamxay and Sayabouly provinces. Within Bolikhamxay the interviews were conducted in Bolikhan and Viengthong districts and within Sayabouly it was conducted in Kenthao and Paklai districts. A total of 360 households were surveyed across the four districts.

Table 6: Households by Survey locations – Laos

Districts	Number of household surveys
Bolikhan	90
Kenthao	90
Paklai	90
Viengthong	90
Total	**360**

Note: For the purposes of this report the analysis of the collected survey data are conducted separately for the two provinces within Laos.

Figure 6: Survey Sites, Laos

Household Survey Results on Variety use and sources

Number of cassava varieties grown

Up to five different varieties of cassava are reported to be grown by farmers at the time of the survey across the seven survey sites. While there are only a handful of farmers with three or more varieties, a majority of farmers across all survey sites claim to be growing a single variety. Over 90% of farmers in Dak Lak, Sayabouly, Bolikhamxay, North Sumatra and Sikka have only one cassava variety while 23% in Son La and 31% in Cambodia have two varieties (Table 7).

Table 7: Proportion of farmers (%) growing various numbers of varieties, by site

Number of varieties grown	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
1	96.67%	95.00%	76.00%	97.83%	94.21%	91.89%	64.33%
2	3.33%	3.89%	23.20%	1.63%	4.96%	7.21%	31.33%
3	0.00%	1.11%	0.80%	0.00%	0.83%	0.90%	3.67%
4	0.00%	0.00%	0.00%	0.54%	0.00%	0.00%	0.33%
5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.33%

Sweet vs. bitter varieties

In most of the survey sites, bitter varieties of cassava, which are primarily for commercial purposes are more popular. Over 90% of farmers in Cambodia and the Laotian sites and over 70% in the Vietnamese sites claim to be growing the bitter varieties. The dominance of bitter varieties however is not the case for sites in Indonesia with only about 47% growing them in North Sumatra while no farmers report growing them in Sikka. In Sikka, 100% of farmers claim to be growing the sweet cassava variety (Table 8).

Table 8: Proportion of farmers (%) growing sweet and bitter varieties, by site

Type of Variety	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
Bitter	97.4%	92.30%	72.84%	73.20%	46.61%	0%	95.58%
Sweet	0.00%	5.13%	47.37%	0.80%	55.12%	100%	3.60%

Commonly adopted cassava varieties

There are many varieties that have been adopted by farmers across the survey regions. It is quite possible that the same variety is known by different names across different regions while in other cases the farmers may not have accurate information regarding the exact variety they are growing. This section provides details of the cassava varieties that have been adopted in the survey sites along with characteristics and opinions related to the adoption of these varieties.

Dak Lak:

In Dak Lak, the three most popular cassava varieties being adopted are the 'high yielding variety' which is adopted by 47% of farmers followed by the 'local variety'(adopted by 16% of farmers) and 'km94 variety' (adopted by 5% of farmers). As shown in Table 9, over 30% of farmers are not aware of the variety that is currently planted in their fields.

Table 9: Proportion of farmers (%) growing various cassava varieties, Dak Lak

Cassava Variety Name	Percent
High Yielding	47.18%
Local Variety	16.41%
km94	5.13%
Other	0.51%
Don't know	30.77%
Total Responses	**195**

Figure 7 shows the year each of the three major cassava varieties were first adopted by farmers in Dak Lak. The high yielding varieties were the earliest cassava varieties that were introduced starting the early 1990s up until the initial years of the new millennia. It was only in 2002 and 2003 that the local variety and km94 were also introduced. The adoption of all three varieties steadily increased until they peaked in the year 2012. While the rate of adoption of the high yielding variety has been retained to some extent over the years, the popularity of the other two have dropped significantly.

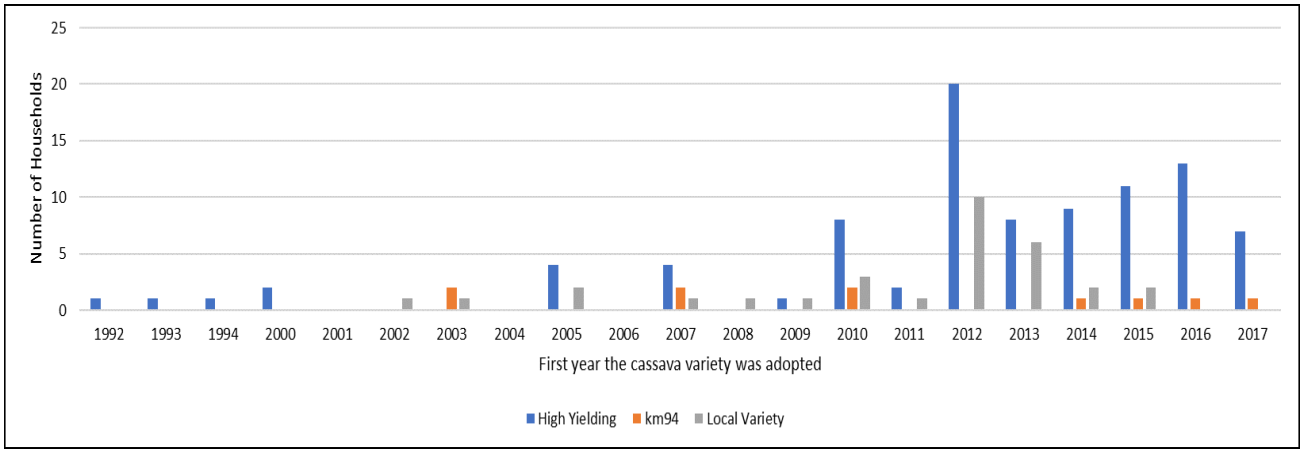

Figure 7: First year for adoption of cassava variety, Dak Lak

The primary source of planting material when planting cassava for the very first time is usually through friends, neighbours or relatives within the community itself. While this is the most popular source of planting material for growers of the high yielding and local varieties, for adopters of km94, the dominant source is the cassava factory (Table 10).

Table 10: Source of Planting Material for the first plantation, Dak Lak

Source	High yielding	km94	Local variety
Friend/ Neighbour/ Relative Within the Community	61.54%	10.00%	68.75%
Cassava Factory	20.88%	70.00%	25.00%
Friend/ Neighbour/ Relative Outside the Community	5.49%	10.00%	6.25%
Other	12.09%	10.00%	0.00%
Total Responses	**91**	**10**	**32**

Once farmers have a cassava variety planted in their fields, most of them depend upon their own farms for gathering planting materials for subsequent seasons. When asked about the source of planting material in the current season, a majority of farmers pointed to their own farms. Over 94% of farmers adopting the local variety sourced planting materials from their own farms while this proportion was slightly lower at about 80% for farmers adopting the high yielding variety and km94 variety. The second most popular source of planting material was from friends, neighbours and relatives living within the community followed by the cassava factory (Table 11).

Table 11: Source of Planting Material for planting cassava in the current season, Dak Lak

Source	High yielding	km94	Local variety
Own Material	80.85%	80.00%	94.12%
Friend/ Neighbour/ Relative Within the Community	10.64%	0.00%	5.88%
Other	8.51%	20.00%	0.00%
Total Responses	**94**	**10**	**34**

The primary purpose for growing cassava for adopters of all three cassava varieties is to sell them fresh. This is the purpose for all farmers planting the high yielding variety, as well as over 90% of those planting the km94 and local varieties. However, selling them as dry chip is also stated as the primary purpose by about 9% of km94 adopters and 3% of local variety adopters. It seems none of the farmers grow cassava with the intention of using them primarily for consumption within the household or for feeding their livestock.

Once a particular type of cassava variety is planted, most farmers seem to retain their production levels of the adopted variety. Over 90% of farmers growing the local variety indicate no change in production levels in the last five years, while this was relatively lower at 78% for adopters of the high yielding variety and even lower at 70% for those growing the km94 variety. The remaining 30% of farmers growing the km94 variety indicated that their production had decreased in the past five years. A decrease in production was also expressed by 17% of farmers growing the high yielding variety and about 6% of farmers growing the local variety. Only a handful of farmers from Dak Lak revealed an increase in cassava production for any of the varieties grown in the last five years.

The majority of cassava farmers in Dak Lak only grow a single variety of cassava, which is why the chosen cassava variety takes up at least 90% of the land area designated to planting cassava. For growers of the local variety, 100% of their land is claimed to be used for planting this particular variety, while this proportion is slightly lower for growers of the high

yielding variety where only 95% claim to be planting them exclusively. The remaining 5% of farmers growing the high yielding variety claim to only be using 50% or less of their land designated to growing this specific cassava variety. The growers of km94 on the other hand only had 70% of farmers utilizing the entire land designated to cassava plantation. The remining 30% used between 50 and 80% of their cassava lands for growing this variety.

The desirable and undesirable characteristics of the cassava crop vary across the different adopted varieties. For the local variety the most desirable characteristic was related to the plant type which was stated by over 81% of farmers growing this variety. A distant second was stated as the high yielding dry matter produced by the variety, followed by starch content and its ability to store for a long time. The plant type was also revealed as the most preferred attribute of the km94 by 40% of farmers growing this variety. In fact, the very attributes preferred by adopters of the local variety were also revealed to be the ones preferred about km94, however an additional feature of km94 was revealed to be its resistance to pest and diseases by over 13% of farmers growing this variety. Furthermore a handful of farmers also preferred the fact that the km94 variety was easy to harvest as they could be more easily uprooted.

High yielding dry matter was regarded as the most important attribute of the high yielding variety with almost 40% of farmers growing this variety pointing towards this attribute. In addition to the preference for plant types, its resistance to pests and diseases and starch content, a handful also claimed to prefer the fact that this variety matured earlier. A few farmers adopting the high yielding variety also seemed to appreciate the ease with which the plant could be uprooted making the harvest process easier. Another preferred feature of this variety was the fact that the plants did not grow very tall (Table 12).

Table 12: Preferred attributes of adopted cassava variety, Dak Lak

What is liked about the variety	**High yielding**	**km94**	**Local variety**
Starch Content	7.50%	13.33%	3.70%
Early Maturing	5.83%	0.00%	0.00%
High yielding dry matter	40.83%	26.67%	11.11%
Plant Types	24.17%	40.00%	81.48%
Root Colour	1.67%	0.00%	0.00%
Fast Cooking	0.83%	0.00%	0.00%
Taste	1.67%	0.00%	0.00%
Resistant to Pest and Diseases	15.00%	13.33%	0.00%
Stores Long	2.50%	6.67%	3.70%
Total Responses	**120**	**15**	**27**

The most undesirable characteristic of the local variety was regarded to be its low yield by over 43% of farmers growing this variety, which was followed by its unstable starch and the fact that it was susceptible to pest and diseases. Despite a handful of farmers indicating the resistance to pest and diseases as a preferred attribute of the km94, 57% of farmers believed its susceptibility to pest and disease to be a significant weakness of km94. Another 43% also pointed to the starch content of km94 as an undesirable attribute. For the high yielding variety the unstable starch was the most commonly stated attribute that was

deemed undesirable followed by its low yield and susceptibility to pests and diseases (Table 13).

Table 13: Undesired attributes of adopted cassava variety, Dak Lak

What is not liked about the variety	High yielding	km94	Local variety
Starch Content	10.31%	42.86%	1.64%
Late maturing	2.06%	0.00%	1.64%
Low Yield	25.77%	0.00%	42.62%
Unstable starch	38.14%	0.00%	32.79%
Susceptible to pest and diseases	22.68%	57.14%	18.03%
Branchy	1.03%	0.00%	3.28%
Total Responses	**97**	**7**	**61**

Son La:

The most popular varieties being grown by farmers in Son La include the high yielding variety which is adopted by almost 56% of farmers, followed by the local variety which is adopted by 44% of farmers (Table 14).

Table 14: Proportion of farmers (%) growing various cassava varieties, Son La

Cassava variety name	Percent
High yielding	55.63%
Local	44.37%
Total Responses	**311**

Figure 8 shows the year each cassava variety was first adopted by farmers in Son La. The earliest cassava varieties that were introduced in the 1990s or earlier comprised only of the local variety. The early 2000s saw the gradual introduction of the high yielding variety, and although the local variety was more popular with its adoption peaking in the year 2007, the high yielding variety has proven to be more popular with its adoption rate increasing significantly since 2012.

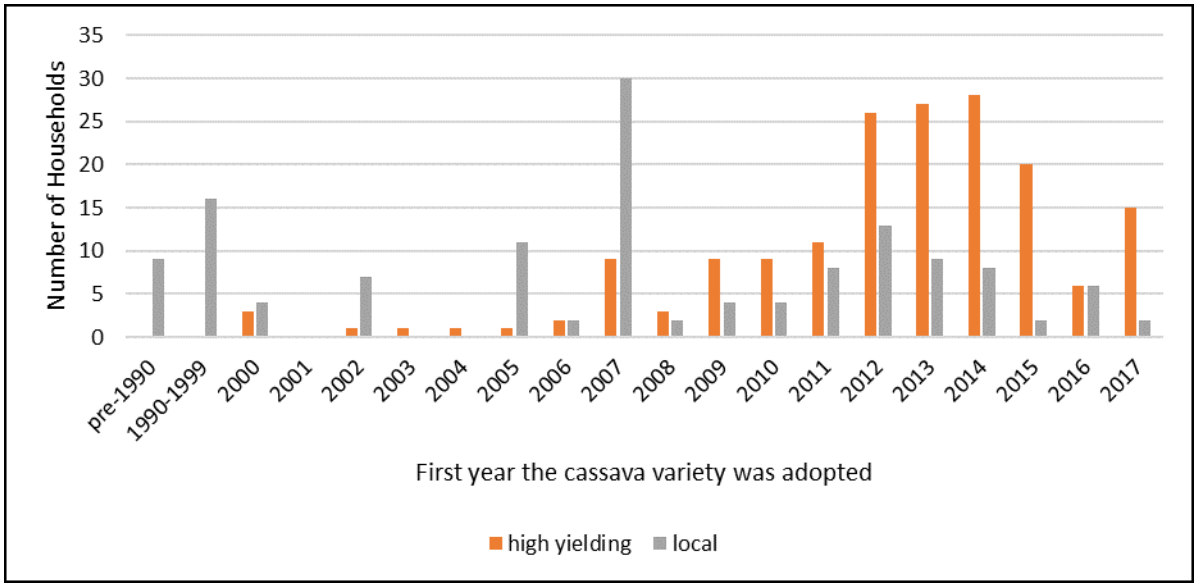

Figure 8: First year for adoption of cassava variety, Son La

The primary source of planting material when planting cassava for the very first time is usually from friends, neighbours and relatives within the community itself. While over 58% of adopters of the high yielding variety claim to have obtained their planting materials from within the community over 27% also claim to have received them from outside the community. Some of the popular sources for the remaining farmers was either the cassava factory or even cassava traders within the village. As for the adopters of the local variety, almost 85% sourced their planting material from within the community itself while about 12% received them from outside the community (Table 15).

Table 15: Source of Planting Material for the first plantation, Son La

First Time	**High yielding**	**Local variety**
Friend/ Neighbour/ Relative Outside the Community	27.17%	11.59%
Friend/ Neighbour/ Relative Within the Community	58.38%	84.78%
Cassava Factory	5.78%	0.72%
Other	8.67%	2.90%
Total Responses	**173**	**138**

Once farmers have a cassava variety planted in their fields, most of them depend upon their own farms for gathering planting materials for subsequent seasons. When asked about the source of planting material in the current season, a majority of farmers pointed to their own farms. Over 94% of farmers adopting the local variety sourced planting materials from their own farms while this proportion was slightly lower at about 86% for farmers adopting the high yielding variety. The second most popular source of planting material for farmers adopting both varieties was from friends, neighbours and relatives living within the community followed by the cassava factory (Table 16). A handful of farmers adopting the high yielding variety also sourced them from the cassava factory.

Table 16: Source of Planting Material for planting cassava in the current season, Son La

This Season	High yielding	Local variety
Own Material	86.19%	94.33%
Friend/ Neighbour/ Relative Within the Community	7.18%	4.96%
Cassava Factory	2.76%	0.00%
Other	3.87%	0.71%
Total Responses	**181**	**141**

Similar to farmers in Dak Lak, the primary purpose for growing cassava for a majority Son La farmers adopting the high yielding variety and half of those adopting the local variety was to sell them fresh. However unlike Dak Lak, Son La farmers seemed to have a diverse range of uses for their cassava. Almost 45% of farmers growing the local variety and 11% growing the high yielding variety planted them primarily to feed their livestock. Selling them as dry chips was the third most popular use for farmers adopting both varieties. Additionally, there were a handful that indicated consumption within the household as a primary purpose, which in some cases were in the form of a home brew.

Unlike the case in Dak Lak the level of production of both varieties seem to be changing for farmers in the last five years. Production levels have been maintained by 43% of farmers adopting the high yielding variety and 33% adopting the local variety. However over 50% of farmers growing the local variety indicated a reduction in the production of this variety in the last five years. In the case of the high yielding variety, there seemed to be an even split across farmers increasing and decreasing their production of the high yielding variety in the last five years.

Contrary to under 3% of Dak Lak farmers growing more than one variety of cassava, this proportion was much higher at 24% for Son La farmers. As a result it was relatively less common for farmers to exclusively plant only one variety on their lands designated for growing cassava. Only about 63% of farmers adopting the high yielding variety exclusively planted this variety exclusively while the proportion was much lower for adopters of the local variety with only about 55% doing the same.

The attribute revealed as the most preferred of both varieties was the high yielding dry matter which was stated by 55% of farmers adopting the high yielding variety and 24% adopting the local variety (Table 17). For the local variety adopters this attribute was closely followed by its ability to resist pest and diseases, its superior taste and plant types. As for the high yielding variety some of the preferred attributes stated included their preference for its root colour along with its ability to mature early and store for longer periods of time. An additional attribute that was preferred by adopters of both varieties was the fact that they could both be fed to their livestock. Some farmers claimed that the entire plant including the root, stem and leaves could be utilized as feedstock. Less effort required to uproot the plant made it easier to harvest both the varieties while some claim they can be processed faster as drying takes less time. The superiority of the local variety over the high yielding variety as revealed by some related to its reduced bitterness which was a preferred attribute for human consumption.

Table 17: Preferred attributes of adopted cassava variety, Son La

What is liked about the variety	High Yielding	Local variety
Starch Content	3.93%	0.65%
Early maturing	8.73%	7.19%
High yielding dry matter	55.46%	24.18%
Plant types	8.30%	17.65%
Root colour	10.04%	1.31%
Fast cooking	0.00%	9.80%
Taste	0.44%	18.95%
Resistant to pest and diseases	4.80%	19.61%
Stores long	8.30%	0.65%
Total Responses	**229**	**153**

For both the local and high yielding varieties, farmers revealed similar characteristics as being undesirable. The most undesirable characteristic was regarded as the low yield by almost 66% of high yield variety adopters and about 60% of local variety adopters. This was followed by the fact that both the varieties were branchy and they were susceptible to diseases (Table 18). Some additional highlighted weaknesses of the high yielding variety related to the concern that they reduced fertility of the soil and degraded it quickly. Some farmers were also indicated that cattle were not able to eat raw cassava and could lead to food poisoning if they did. This concern related to food poisoning resulting from livestock eating raw cassava was also raised by farmers adopting the local variety.

Table 18: Undesired attributes of adopted cassava variety, Son La

What is not liked about the variety	High Yielding	Local variety
Starch Content	0.00%	1.92%
Late maturing	0.00%	5.77%
Low Yield	65.79%	59.62%
Susceptible to pest and diseases	15.79%	7.69%
Branchy	18.42%	25.00%
Total Responses	**38**	**52**

Sayabouly:

Relative to the Vietnamese sites in Sayabouly we find a wider range of cassava varieties being adopted by farmers. The most popular varieties being grown include the FR variety which is adopted by over 41% of farmers, followed by Eloup, Ab ah and Rayong varieties. About 12% of farmers are found to be growing varieties other than those listed above (Table 19).

Table 19: Proportion of farmers (%) growing various cassava varieties, Sayabouly

Cassava Variety Name	Percent
FR	41.32%
Eloup	15.57%
Ab ah	13.77%
Rayong	7.19%
Other	11.98%
Don't Know	10.18%
Total Responses	**167**

Figure 9 shows the year each of the four major cassava varieties were first adopted by farmers in Sayabouly. It wasn't until the years 2006 and 2007 that the first cassava varieties namely Rayong and FR were introduced in this region. The year 2011 saw the introduction of the Ab ah variety followed by the Eloup variety in 2012. The adoption of all varieties, particularly the FR variety escalated between 2012 and 2016.. While the rate of adoption of all four varieties were still relatively high by 2016, there seems to have been a sudden drop in their adoption since 2017. It is quite possible that the adoption of cassava has reached a point of saturation.

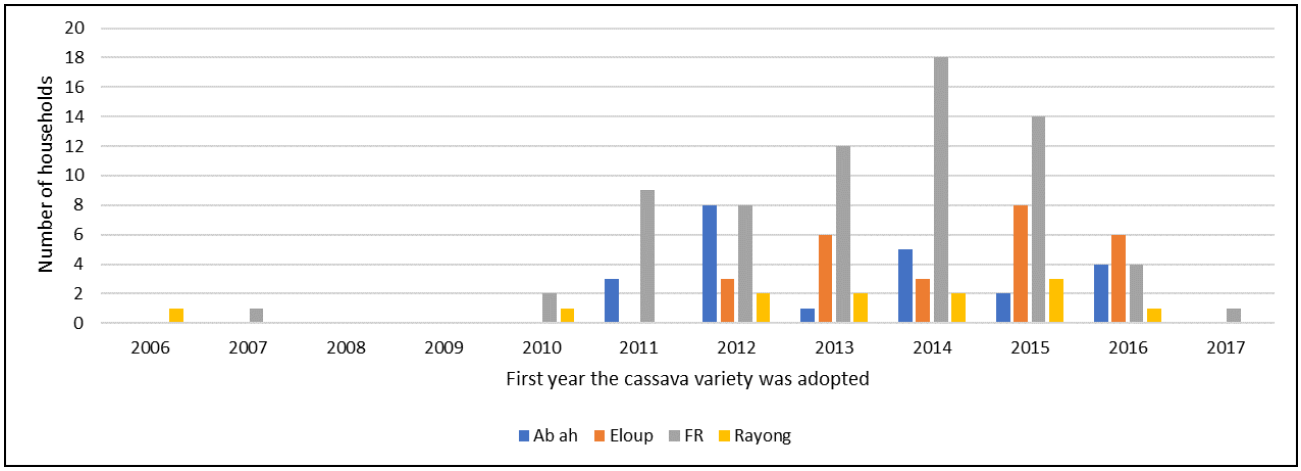

Figure 9: First year for adoption of cassava variety, Sayabouly

The primary source of planting material when planting cassava for the very first time is usually from friends, neighbours and relatives within the community itself. The second most popular source of planting material is from friends and relatives outside the community followed by cassava traders at collection points. Collection points are particularly a popular source for farmers adopting the Eloup variety where up to 20% claim to be have received planting material from this source when planting for the very first time. As for adopters of Rayong, a quarter of them claim to have received them from traders within the village (Table 20).

Table 20: Source of Planting Material for the first plantation, Sayabouly

First Time	Ab ah	Eloup	FR	Rayong
Friend/ Neighbour / Relative within the Community	63.64%	65.38%	59.42%	50.00%
Friend/ Neighbour / Relative Outside the Community	31.82%	0.00%	14.49%	25.00%
Cassava Trader at Collection Point	4.55%	19.23%	10.14%	0.00%
Local market	0.00%	0.00%	2.90%	0.00%
Trader in village	0.00%	3.85%	5.80%	25.00%
Other	0.00%	11.54%	7.25%	0.00%
Total Responses	**22**	**26**	**69**	**12**

Farmers primarily depend upon their own farms for planting material for subsequent seasons after having obtained them from various sources when planting the first time. This was the case for over 90% of Eloup and FR variety adopters while 100% of farmers adopting the Ab ah and Rayong varieties claimed to have sourced their planting materials from within their own farms (Table 21).

Table 21: Source of Planting Material this season, Sayabouly

This Season	Ab ah	Eloup	FR	Rayong
Own Material	100.00%	92.59%	97.10%	100.00%
Cassava Trader at Collection Point	0.00%	3.70%	0.00%	0.00%
Cassava Trader in Village	0.00%	3.70%	0.00%	0.00%
Friend/ Neighbour/ Relative Within the Community	0.00%	0.00%	2.90%	0.00%
Total	**23**	**27**	**69**	**12**

Farmers in Sayabouly, regardless of the variety of cassava being grown planted them exclusively for selling them fresh. None of the farmers seemed to be using cassava for any other purpose.

The change in the level of production in the last five years vary across farmers adopting the different varieties. The level of production seems to have stabilized for a majority of farmers growing the Eloup, FR and Rayong varieties. The highest increase in production of over 46% was reported by farmers growing the Eloup variety while none of the Rayong variety adopters experience any such increase. An increase in production was also reported by 39% of Ab ah variety adopters and a quarter of FR adopters.

Regardless of the variety adopted, farmers generally utilize most of their land designated to growing cassava (between 70 and 85%) to that particular variety. This is because over 96% of farmers in Sayabouly only grow a single variety. Farmers growing multiple varieties tend to divide up their land in various ways but a relatively popular method seems to be adopting an even split especially for those adopting the Rayong variety.

High yielding dry matter was revealed as a desirable attribute by about a third of farmers regardless of which of the five cassava varieties they were adopting. The most popular characteristic of the Ab ah variety as claimed by over 40% of farmers adopting this variety was the plant types followed by its ability to mature earlier as revealed by a further 21% of

farmers (Table 22). These two characteristics were also favoured by farmers adopting the Eloup variety with over 20% revealing their preference for each of these attributes. For FR and Rayong varieties, apart from their high yielding dry matter, it was their root colour, starch content and their ability to mature early that seemed to be most preferred by farmers adopting them.

Table 22: Preferred attributes of adopted cassava variety, Sayabouly

What is liked about the variety	Ab ah	Eloup	FR	Rayong
Starch Content	0.00%	0.00%	18.99%	20.83%
Early maturing	21.43%	20.69%	18.99%	16.67%
High yielding dry matter	35.71%	34.48%	27.85%	29.17%
Plant types	40.48%	20.69%	3.80%	0.00%
Root colour	0.00%	10.34%	24.05%	25.00%
Fast cooking	0.00%	0.00%	2.53%	0.00%
Taste	0.00%	0.00%	1.27%	8.33%
Resistant to pest and diseases	0.00%	13.79%	2.53%	0.00%
Stores long	2.38%	0.00%	0.00%	0.00%
Total Responses	**42**	**29**	**79**	**24**

Susceptibility to pests and diseases was regarded as a key weakness of several of the adopted varieties. Low yield was also considered a notable limitation of several adopted varieties with as many as 63% adopting the Eloup variety and 43% adopting the FR variety regarding this feature to be a key weakness.

Table 23: Undesired attributes of adopted cassava variety, Sayabouly

What is not liked about the variety	Ab ah	Eloup	FR	Rayong
Late maturing	16.67%	0.00%	0.00%	0.00%
Low Yield	16.67%	62.50%	43.33%	0.00%
Susceptible to pest and diseases	61.11%	37.50%	43.33%	100.00%
Branchy	5.56%	0.00%	13.33%	0.00%
Total Responses	**18**	**8**	**30**	**1**

Bolikhamxay:

The most popular varieties being grown in Bolikhamxay include the Rayong variety which is adopted by almost 26% of farmers, followed by the Green variety which also has slightly less adopters. Over 30% of farmers are found to be growing varieties other than those listed above (Table 24).

Table 24: Proportion of farmers (%) growing various cassava varieties, Bolikhamxay

Cassava Variety Name	Percent
Rayong	25.97%
Green	23.38%
Other	30.52%
Don't Know	20.13%
Total Responses	**154**

Figure 10 shows the year each of the two major cassava varieties were first adopted by farmers in Bolikhamxay. It should be noted that these two cassava varieties represent only about 50% of all surveyed farmers in Bolikhamxay as 30% claim to be growing other less popular varieties and over 20% are not aware of the varieties they are growing.

It wasn't until the year 2006 that the first cassava varieties were introduced in this region when Rayong was the sole variety adopted until 2009. The year 2010 saw the introduction of the Green variety. The adoption of both varieties but more so the Green variety escalated then onwards peaking in the years 2014 and 2015. While the rate of adoption of both varieties were still relatively high until 2016, there seems to have been a sudden drop in the adoption of these varieties in 2017. It is quite possible that the adoption of cassava has reached a point of saturation.

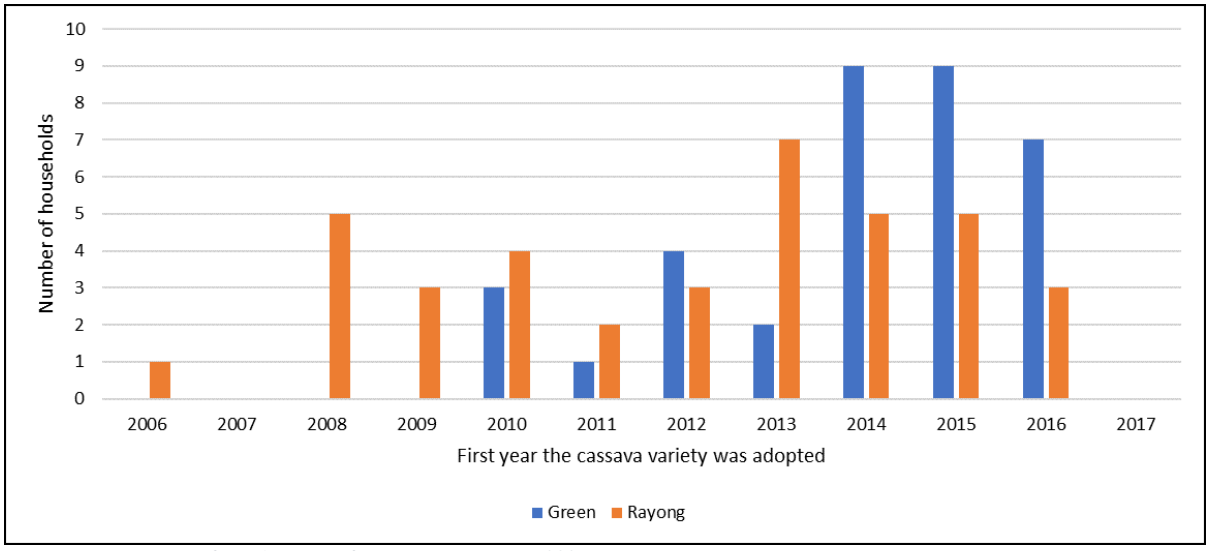

Figure 10: First year for adoption of cassava variety, Bolikhamxay

The primary source of planting material when planting cassava for the very first time is usually from friends, neighbours and relatives within the community itself. This source which is cited by between 50-60% of respondents is followed by 'friends and relatives outside the community' and 'cassava traders at collection points'. Collection points are particularly a popular source of planting materials for farmers adopting the Rayong variety where over 27% claim to be have received planting material from this source when planting for the very first time (Table 25).

Table 25: Source of Planting Material for the first plantation, Bolikhamxay

First Time	Green	Rayong
Friend/ Neighbour / Relative within the Community	61.11%	50.00%
Cassava Trader at Collection Point	5.56%	27.50%
Local market	11.11%	0.00%
Friend/ Neighbour / Relative Outside the Community	13.89%	10.00%
Regional market	2.78%	0.00%
Trader in Village	0.00%	5.00%
Other	5.56%	7.50%
Total Responses	**36**	**40**

Farmers primarily depend upon their own farms for planting materials for subsequent seasons after having obtained them from various sources when plating the very first time. There are however a handful of farmers that claim to have obtained their planting materials from friends and relatives both inside and outside the community for planting in the current season (Table 26).

Table 26: Source of Planting Material this season, Bolikhamxay

This Season	Green	Rayong
Own Material	86.11%	82.93%
Friend/ Neighbour/ Relative Outside the Community	2.78%	4.88%
Cassava Trader in Village	0.00%	2.44%
Friend/ Neighbour/ Relative Within the Community	11.11%	9.76%
Total	**36**	**41**

The primary purpose for growing cassava for adopters of the Rayong variety was to sell them fresh. This was cited by almost 70% of Rayong variety adopters and about 47% of Green variety adopters. Selling them as dry chip was slightly more popular for the Green variety adopters with 50% indicating dry chip sales as the primary purpose for growing cassava. About 28% of Rayong variety growers were also involved in selling their cassava as dry chips.

The level of production seems to have stabilized for a majority of farmers growing both the Green and Rayong varieties. About 13% of Rayong variety adopters however revealed decreased cassava production in the last five years.

Regardless of the variety adopted, farmers generally utilize most of their land designated to growing cassava to that particular variety. This is because over 92% of farmers in Bolikhamxay only grow a single variety.

High yielding dry matter was revealed as a desirable attribute by about a third of farmers regardless of which of the five cassava variety was being adopting. About 34% of the Green variety adopters regarded the starch content to be a desired characteristic of this variety while half as many (17%) believed the same to be true for the Rayong variety. The colour of the root and plant types were also regarded as desired attributes by adopters of both of

these varieties. Furthermore, the ability to mature early was regarded as a preferred characteristic of the Rayong variety by 12% of Rayong variety adopters.

Table 27: Preferred attributes of adopted cassava variety, Bolikhamxay

What is liked about the variety	Green	Rayong
High yielding dry matter	35.29%	34.15%
Starch Content	33.82%	17.07%
Plant types	7.35%	17.07%
Root colour	17.65%	7.32%
Early maturing	2.94%	12.20%
Resistant to pest and diseases	1.47%	7.32%
Stores long	1.47%	4.88%
Total Responses	**68**	**41**

Susceptibility to pests and diseases was regarded as the primary weakness of the Rayong variety while this weakness was reported by less than 5% of the Green variety adopters. On the other hand weaknesses related to late maturing, starch content and instability of starch were regarded weaknesses of the Green variety while no such complaints were made about the Rayong variety. 'Low yield' was a common complaint from adopters of both varieties with over a quarter of farmers reporting this to be a notable weakness.

Table 28: Undesired attributes of adopted cassava variety, Bolikhamxay

What is not liked about the variety	Green	Rayong
Low Yield	27.27%	26.32%
Susceptible to pest and diseases	4.55%	47.37%
Starch Content	22.73%	0.00%
Late maturing	13.64%	0.00%
Unstable starch	18.18%	0.00%
Branchy	9.09%	21.05%
processing quality	4.55%	5.26%
Total Responses	**22**	**19**

Cambodia:

In Cambodia, the two most popular varieties being adopted are the 'Truoy svay (Malay) variety' which is adopted by almost 52% of farmers followed by the 'Truoy sor variety' which is adopted by over 27% of farmers. As shown in Table 29, over 20% of farmers are also involved in growing other less common varieties.

Table 29: Proportion of farmers (%) growing various cassava varieties, Cambodia

Variety	Frequency	Percent
Truoy svay (Malay)	221	51.88%
Truoy sor	117	27.46%
Other	88	20.66%
Total Responses	**426**	**100.00%**

Both of the popular cassava varieties seem to have been introduced together in the late 1990s although Truoy svay (Malay) gained more popularity in the initial years after their introduction. While its popularity in recent years have declined to some degree there has been a surge in the popularity of Truoy sor starting 2014 (Figure 11).

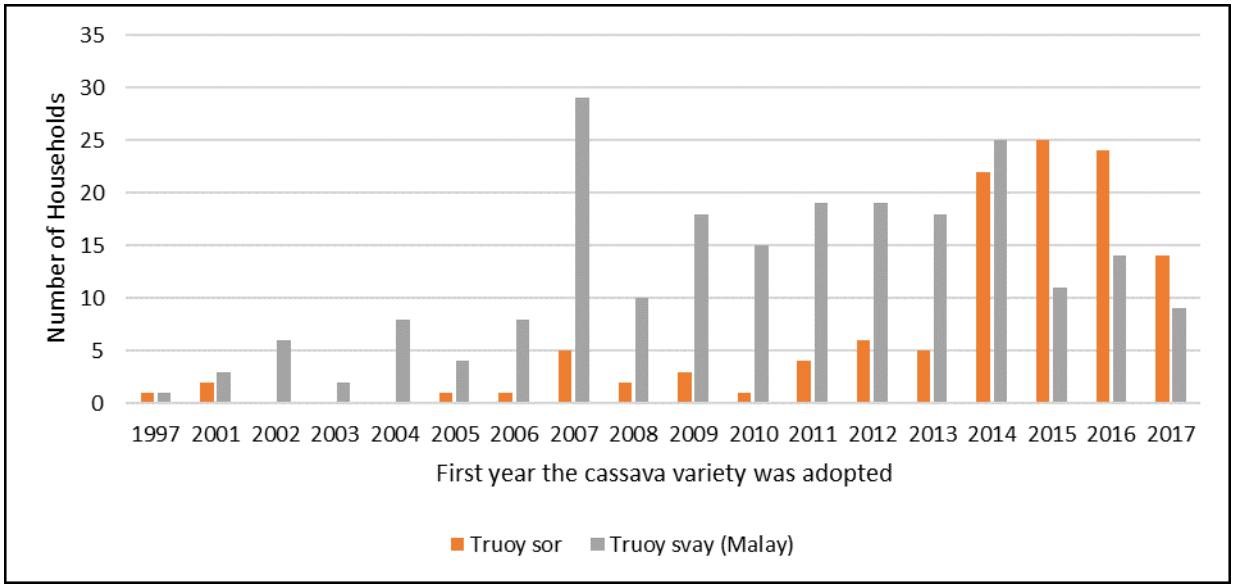

Figure 11: First year for adoption of cassava variety, Cambodia

The primary source of planting material when planting cassava for the very first time is usually from friends, neighbours and relatives within the community itself. The second most popular source of planting material is from cassava traders in the village followed by friends and relatives outside the community. Cassava traders at collection points also seem to be a relatively popular source for obtaining planting materials by a handful of farmers adopting the Truoy sor variety (Table 30).

Table 30: Source of Planting Material for the first plantation, Cambodia

First Time	Truoy sor	Truoy svay (Malay)
Friend/ Neighbour/ Relative Within the Community	42.86%	51.90%
Cassava Trader in Village	32.54%	20.68%
Friend/ Neighbour/ Relative Outside the Community	8.73%	14.77%
Cassava Trader at Collection Point	8.73%	3.38%
Other	7.14%	9.28%
Total Responses	**126**	**237**

Between 80 and 90% of farmers claim to have sourced planting materials from their own farm for planning cassava in the current season. A handful of farmers also indicate sourcing their planting materials from friends, family and neighbours within the community (Table 31).

Table 31: Source of Planting Material this season, Cambodia

This Season	Truoy sor	Truoy svay (Malay)
Own Material	81.97%	91.34%
Friend/ Neighbour/ Relative Within the Community	13.11%	5.63%
Other	4.92%	3.03%
Total Responses	**122**	**231**

Both popular varieties of cassava adopted by farmers in Cambodia seem to have the exact same purpose where about three quarters claim to sell fresh cassava while the remaining plan on selling them as dry chips.

A majority of farmers adopting either variety seem to have retained their level of production in the last five years. About 20% adopting either variety claim to have reduced production while twice as many adopting the Truoy Sor variety report having increased production in the last five years compared to their counterparts adopting the Truoy svay variety.

Fewer than 65% of cassava farmers grow a single cassava variety. As a result slightly less than 50% of farmers growing the Truoy svay variety report using 100% of their land designated land for growing this variety. This proportion is even lower for growers of the Truoy sor variety where only 36% claim to be growing the variety on 100% of their land designated to growing cassava. About a third of farmers growing either variety use only 50% of their cassava designated lands for growing that particular cassava variety.

High yielding dry matter was revealed as a desirable attribute by about 40% of farmers regardless of which cassava variety they were adopting. A popular characteristic of the Truoy sor variety as claimed by over 30% of farmers adopting this variety was its starch content followed by the plant types as revealed by a further 16% of farmers. The starch content was also revealed as a popular attribute of the Truoy svay variety as revealed by 27% of farmers adopting this variety followed by its resistance to pest and diseases, which was revealed by a further 18% of farmers (Table 32). Some farmers also claim that both Truoy sor and Truoy svay varieties are easy to harvest as they are easy to uproot. A further preferred characteristic of the Truoy svay variety as revealed by some of its adopters is that it is resistant to both flooding and drought conditions.

Table 32: Preferred attributes of adopted cassava variety, Cambodia

What is liked about the variety	Truoy sor	Truoy svay (Malay)
High yielding dry matter	39.29%	43.43%
Starch Content	30.36%	26.94%
Resistant to pest and diseases	8.33%	18.18%
Plant types	16.07%	4.04%
Other	5.95%	7.41%
Total Responses	**168**	**297**

Both Truoy sor and Truoy svay varieties have been regarded as being susceptible to pest and diseases. In addition to this weakness, over 15% of farmers adopting the Truoy sor variety also claimed that it produces low yields with a further 11% pointing towards its unstable starch. 23% of farmers adopting the Truoy svay variety regard the branchy structure of this variety to be a weakness with a further 18% indicating that it produces low yields (Table 33). While some farmers adopting either of these varieties have stated that they are easy to harvest, others have regarded this not to be the case. On the contrary, a few farmers, particularly those adopting the Truoy sor variety have complained about the additional challenges involved in harvesting them.

Table 33: Undesired attributes of adopted cassava variety, Cambodia

What is not liked about the variety	Truoy sor	Truoy svay (Malay)
Susceptible to pest and diseases	56.25%	34.01%
Branchy	7.81%	23.35%
Low Yield	15.63%	17.77%
Starch Content	3.13%	10.15%
Late maturing	6.25%	6.60%
Unstable starch	10.94%	8.12%
Total Responses	**64**	**197**

North Sumatra:

In North Sumatra, the most popular variety being adopted is Malaysia which is adopted by half of the surveyed farmers. Adira and Lampung are the other two popular varieties each of which has an adoption rate of 12%. As shown in Table 34over 25% of farmers are also involved in growing other less popular varieties.

Table 34: Proportion of farmers (%) growing various cassava varieties, North Sumatra

Variety Name	Percent
Malaysia	50.00%
Adira	12.31%
Lampung	12.31%
Other	25.38%
Total Responses	**130**

About 50% of farmers adopting each of the varieties do not specifically remember when they started growing the particular variety and simply claim to have been growing it as long as they can remember. It should be noted that the graph below (Figure 12) only constitutes of responses where respondents were able to accurately recall the year they first adopted the variety.

The first variety introduced in North Sumatra is Lampung which was first adopted in 2001. However the adoption of this variety seems to have been intermittent and furthermore unable to gain much popularity over the years. The adoption of Adira seems to have also achieved a similar fate although it was only introduced a few years later in 2006. The variety Malaysia seems to have been preferred by a majority of farmers with a rigorous adoption rate since its relatively early introduction in 2002.

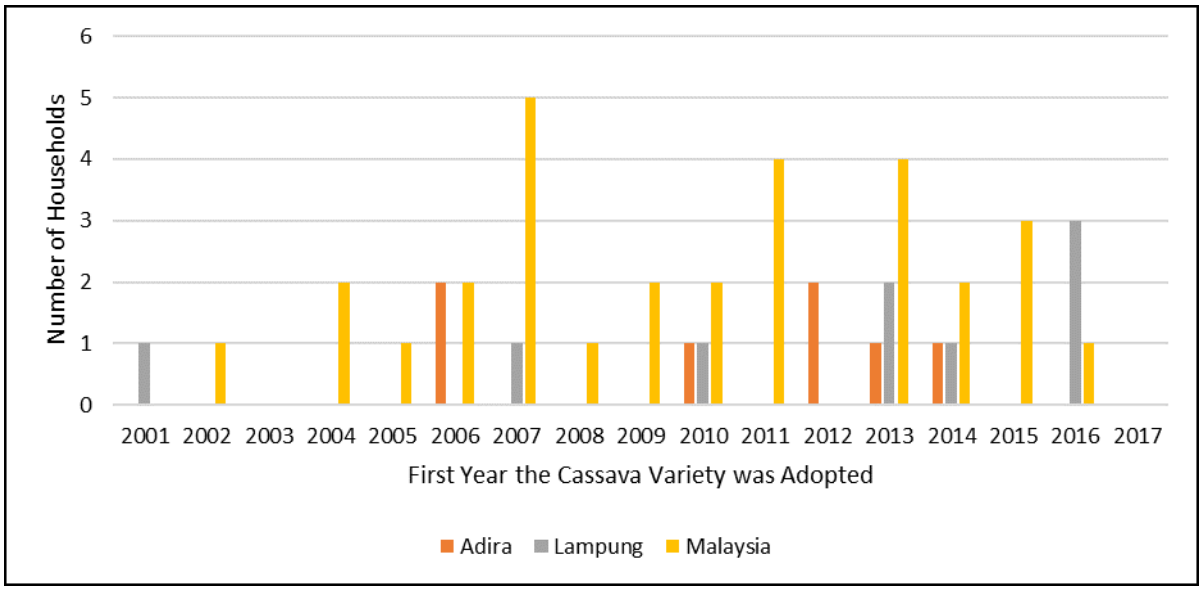

Figure 12: First year for adoption of cassava variety, North Sumatra

The primary source of planting material when planting cassava for the very first time is usually from friends, neighbours and relatives within the community itself regardless of the variety adopted. Cassava traders at collection points was regarded as a popular source by adopters of Lampung and Malaysia while those adopting Adira also seemed to source their planting materials more often from the cassava factory (Table 35).

Table 35: Source of Planting Material for the first plantation, North Sumatra

First Time	**Adira**	**Lampung**	**Malaysia**
Cassava Factory	18.75%	0.00%	4.62%
Cassava Trader at Collection Point	6.25%	26.67%	16.92%
Friend/ Neighbour/ Relative Outside the Community	12.50%	0.00%	7.69%
Government Research Office	0.00%	0.00%	1.54%
Cassava Trader in Village	0.00%	6.67%	1.54%
Friend/ Neighbour/ Relative Within the Community	56.25%	60.00%	64.62%
Other	6.25%	6.67%	3.08%
Total	**16**	**15**	**65**

For the current season the planting materials were generally sourced by farmers from their own fields. While this was the primary source for 81% of farmers adopting the Adira variety and 90% of farmers adopting the Malaysia variety, only 44% of Lampung variety adopters claimed to be utilizing their own material. Of the Lampung variety adopters, 22% still depended upon friends, neighbors and family members within the community, another 17% claimed to source them from cassava traders at collection points and an additional 17% from other less popular sources (Table 36).

Table 36: Source of Planting Material this season, North Sumatra

This Season	Adira	Lampung	Malaysia
Cassava Trader at Collection Point	0.00%	16.67%	6.56%
Friend/ Neighbour/ Relative Within the Community	12.50%	22.22%	1.64%
Own Material	81.25%	44.44%	90.16%
Other	6.25%	16.67%	1.64%
Total	**16**	**18**	**61**

The most common purpose of growing cassava for adopters of all three varieties is reported to be for selling them fresh. While this was only purpose for those growing the Lampung variety, a small group of farmers growing the other two varieties also planted them for household consumption or to sell as dry chips.

Over the last five years it was more common for farmers to have retained the same level of cassava production. While this was mostly the case for those growing the Malaysia variety with over 76% claiming to have maintained their production levels, it was relatively lower for Lampung and Adira adopters. For Adira and Lampung adopters, up to a third claim to have decreased their levels of production while almost 13% of Adira adopters have increased production over the last five years.

With almost 95% of farmers growing only one cassava variety, it was quite common to find farmers planting only their chosen variety in their entire farmland designated for growing cassava. This was particularly the case for adopters of Adira and Lampung where over 90% of farmers planted 100% of their lands designated for cassava with the chosen variety. While this was also generally the case for farmers planting the Adira variety, almost 20% of farmers adopting this variety refrained from exclusively planting only this variety on their farmland.

High yielding dry matter was revealed as a desirable attribute by about 45% of farmers regardless of which cassava variety they were adopting, although this was more often the case for Adira adopters and relatively less often the case for Malaysia adopters. Another popular characteristic of the Adira variety was regarded as its starch content as claimed by almost 18% of farmers adopting this variety. The taste along with its ability to mature early was regarded as an attractive attribute of the Lampung variety by 19% and 14% (respectively) farmers adopting this variety. Finally, for those adopting the Malaysia variety, it was the plant types, taste and root colour that was generally regarded as a preferred attribute (Table 37).

Table 37: Preferred attributes of adopted cassava variety, North Sumatra

What is liked about the variety	Adira	Lampung	Malaysia
Starch Content	17.86%	0.00%	5.47%
Early maturing	0.00%	14.29%	5.47%
High yielding dry matter	53.57%	47.62%	36.72%
Plant types	10.71%	9.52%	16.41%
Root colour	7.14%	0.00%	11.72%
Fast cooking	0.00%	4.76%	3.13%
Taste	3.57%	19.05%	14.06%
Resistant to pest and diseases	7.14%	4.76%	6.25%
Stores long	0.00%	0.00%	0.78%
Total Responses	**28**	**21**	**128**

The attribute proclaimed as the least attractive for the Lampung variety was its branchy structure as pointed out by 58% of those adopting this variety. The low yield and late maturing nature were also regarded as undesirable by a handful of farmers. These two attributes were also regarded as being undesirable by 33% and 31% of Malaysia variety adopters respectively. The most undesirable attribute stated by most farmers adopting the Adira variety was its unstable starch followed by low yield, and branchy structure.

Table 38: Undesired attributes of adopted cassava variety, North Sumatra

What is not liked about the variety	Adira	Lampung	Malaysia
Starch Content	7%	0%	5%
Late maturing	14%	17%	31%
Low Yield	21%	17%	33%
Unstable starch	29%	0%	14%
Susceptible to pest and diseases	7%	8%	5%
Branchy	21%	58%	9%
Processing quality	0%	0%	3%
Total Responses	**14**	**12**	**58**

Sikka:

In Sikka, the most popular variety being adopted is Kuning which is adopted by almost 83% of surveyed farmers. 12% of farmers are found to be adopting the Putih variety with a further 5% adopting other less popular varieties (Table 39).

Table 39: Proportion of farmers (%) growing various cassava varieties, Sikka

Variety Name	Percent
Kuning	82.64%
Putih	12.40%
Other	4.96%
Total Responses	**121**

Unfortunately, most of the farmers were not able to accurately recall the first time they adopted the cassava varieties they were currently planting. A majority simply indicated that they had the varieties planted on their lands for as long as they could remember.
Most farmers, regardless of the adopted variety claim to have sourced the planting material from friends, neighbours and family within the community when planting for the very first time.

Table 40: Source of Planting Material for the first plantation, Sikka

First Time	Kuning	Putih
Friend/ Neighbour/ Relative Outside the Community	1.01%	0.00%
Regional Market	1.01%	0.00%
Friend/ Neighbour/ Relative Within the Community	87.88%	93.33%
Non Government Organization	1.01%	0.00%
Other	9.09%	6.67%
Total	**99**	**15**

It was common for farmers to source planting materials from their own fields to grow cassava in the current season. While their own fields were the most popular source for a majority of farmers, almost 18% of Putih adopters and 9% of Kuning adopters also claim to have source them from friends, neighbours and family members within the community.

Table 41: Source of Planting Material this season, Sikka

This Season	Kuning	Putih
Friend/ Neighbour/ Relative Outside the Community	3.03%	0.00%
Friend/ Neighbour/ Relative Within the Community	9.09%	17.65%
Own Material	86.87%	82.35%
Other	1.01%	0.00%
Total	**99**	**17**

The primary purpose of growing cassava in most of the survey sites in this study was to sell them fresh. While 29% of Kuning adopters and 26% of Putih adopters claim this to be the primary purpose of their cassava crop, a significant portion of farmers in Sikka grow them for their own consumption. 45% of Kuning adopters and 65% of Putih adopters report own consumption as the primary reason for growing cassava. For Kuning adopters feeding them to livestock is also a key purpose with over 25% indicating this as a reason for growing cassava. Production levels of cassava have been maintained in the last five years by a majority of farmers regardless of which variety they are adopting. While a handful of farmers claim to have reduced their production, hardly anyone has increased them in the last five years. Contrary to most other surveyed sites, it was also less common to have the entire area designated to cassava planted with just one variety of cassava. Although up to 92% of farmers only plant one cassava variety, only 40% of Kuning variety adopters and as low as 7% of Putih variety adopters claim to be exclusively planting the variety on their lands designated for cassava. Despite the high proportion of single variety adopters, it is

surprising to see a wide distribution in terms of the proportion of land used for planting cassava.

As household consumption is a primary reason for growing cassava for a majority of Sikka farmers, it is natural that the taste of cassava is of high importance. As such adopters of both variety claim 'taste' to be a desirable attribute of their chosen varieties. However the taste is more often regarded as a preferred characteristic by Kuning adopters (over 47%) compared to Putih adopters (27%). 23% of Kuning adopters and 22% of Putih adopters also regard root colour to be a preferred characteristic of their chosen varieties. The high yielding dry matter is regarded as a desirable characteristic by 10% of Kuning adopters and 16% of Putih adopters. An additional 16% of Putih adopters also point to its fast cooking nature to be a preferred attribute.

Table 42: Preferred attributes of adopted cassava variety, Sikka

What is liked about the variety	**Kuning**	**Putih**
Starch Content	3.19%	5.41%
Early maturing	6.91%	8.11%
High yielding dry matter	10.11%	16.22%
Plant types	1.60%	5.41%
Root colour	23.40%	21.62%
Fast cooking	5.85%	16.22%
Taste	47.34%	27.03%
Resistant to pest and diseases	0.00%	0.00%
Stores long	1.60%	0.00%
Total Responses	**188**	**37**

From the responses provided by Kuning and Putih adopters, it appears that both varieties contain similar characteristics that are undesired by farmers. Both varieties are regarded as being susceptible to pest and diseases, produce a low yield, are late maturing, and have a branchy structure (Table 43).

Table 43: Undesired attributes of adopted cassava variety, Sikka

What is not liked about the variety	**Kuning**	**Putih**
Starch Content	0.00%	8.00%
Late maturing	22.38%	28.00%
Low Yield	23.08%	20.00%
Unstable starch	0.70%	0.00%
Susceptible to pest and diseases	35.66%	24.00%
Branchy	16.78%	20.00%
Processing quality	1.40%	0.00%
Total Responses	**143**	**25**

Planting Materials:

Source of Planting Material:

Proportion of planting material sourced from own field, exchanged or purchased:

For the multiple varieties of cassava that are planted, farmers depend upon various sources for planting materials when adopting them the first time. However after the first plantation farmers seem to prefer obtaining planting materials from their own farms for subsequent plantations. A majority of farmers report having sourced planting materials from their own farms for the current season. Beyond the farm, the second most common source of planting material is by exchanging them with other individuals who are generally neighbouring farmers, friends, or relatives. Up to 10% of farmers in Dak Lak and Cambodia claim to have obtained their planting material for the current season this way. Purchasing new planting material was generally reported as the least common option with no farmers having purchased them in Sayabouly and Son La. However 8% of farmers in Cambodia, and about 6% in Dak Lak and North Sumatra claim to have purchased new planting materials in the last year (Table 44).

Table 44: Proportion of planting material (%) obtained from different sources, by site

Source	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
Own Field	91.27%	95.94%	93.24%	83.79%	89.17%	96.56%	81.97%
Exchanged	8.73%	3.44%	6.76%	9.23%	5.41%	0.23%	10.02%
Purchased	0.00%	0.63%	0.00%	6.61%	5.41%	3.21%	8.02%
Total Respondents	**165**	**160**	**204**	**248**	**109**	**109**	**309**

In developing this table, if the total for any farmer did not equal 100% (across Own field, exchanged and purchased), they were dropped.

Own field as the source of planting material:

In the event that farmers decided to source planting materials from their own field, it is important to know whether any management changes are necessary compared to when they do not plan to source planting materials from their fields. None of the farmers in Dak Lak, Sayabouly, North Sumatra or Sikka claimed to be using different management techniques when securing cassava from their own fields. Different management techniques were only adopted by about 14% of farmers in Bolikhamxay, however this proportion was as high as 20% for farmers in Cambodia and Son La (Table 45).

Table 45: Proportion of farmers adopting different management practices when sourcing planting material from own field, by site

	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
No	100.00%	86.11%	79.38%	100.00%	100.00%	100.00%	81.03%
Yes	0.00%	13.89%	20.62%	0.00%	0.00%	0.00%	18.97%
Total Respondents	**180**	**180**	**257**	**251**	**135**	**112**	**311**

Farmers who claim to manage the field differently when securing cassava from their own fields provided details on how the management practices were different. In Son La, farmers generally removed the root and the top ends, bundled them and then kept them separate in the field. Some left them covered in the soil while others covered them to protect from the sun by applying soil on them, leaving them under a tree, or placing them in a shaded area. Farmers in Cambodia had a very different approach where they claim to apply herbicides and pesticides in addition to fertilizers to these areas.

Storage of Planting Materials:

As sourcing planting materials from one's own field is the most popular method of obtaining them, it is important that the planting materials are adequately stored. Storing methods vary significantly across the survey sites as can be seen in Table 46. The most common storage method for farmers in Cambodia, Sayabouly, Bolikhamxay, Son La and North Sumatra is to leave them standing in the field. The preferred method of farmers in Sikka and Dak Lak is to store them in the shade under a tree. Laying the planting material down on the field is another popular method of storage practiced by 31% of farmers in North Sumatra and about 10% in Cambodia and Son La.

Table 46:Storage of planting materials, by site

	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
In the field (laying down)	0.00%	0.00%	10.12%	0.00%	31.06%	0.90%	9.42%
In the field (standing)	92.57%	70.39%	68.87%	30.17%	50.00%	44.14%	85.39%
In the shade (under a tree)	4.57%	27.37%	10.89%	68.18%	12.88%	49.55%	1.62%
On the roof	0.00%	0.00%	0.39%	0.00%	0.76%	0.00%	1.62%
Other	2.86%	2.23%	9.73%	1.65%	5.30%	5.41%	1.95%
Total Responses	**175**	**179**	**257**	**242**	**132**	**111**	**308**

Timing of planting material selection:

For the new season, planting materials are generally selected after cassava has been harvested. This is especially the case for Dak Lak, Cambodia, North Sumatra and Sikka where over 85% of farmers select the new year's planting material after harvest. The proportion of farmers selecting planting materials after harvest is lower for Son La at under 68% and even lower for Bolikhamxay and Sayabouly at 45% and 39% respectively (Table 47). The remaining farmers claim to make such selections before the harvest is made.

Table 47: Selection of the subsequent year's planting material, by site.

	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
After Harvest	39.44%	45.25%	67.58%	99.59%	87.31%	88.29%	92.72%
Before harvest	60.56%	54.75%	32.42%	0.41%	12.69%	11.71%	7.28%
Total Respondents	**180**	**179**	**256**	**244**	**134**	**111**	**302**

Household member responsible for selecting planting material:

Across the surveyed sites it was generally the male household head that was responsible for selecting planting materials. The was particularly the case in the Indonesian sites of North Sumatra and Sikka where over 70% of households claimed this responsibility to be carried out by the male household head. The selection of good quality planting material is of key importance and requires good level of skill and experience, which is why it is generally the head of the household with most experience that undertakes this task. In Son La however only 40% of male household heads were tasked with making such selections. Across all surveyed sites, the female household head or the spouse of the household head was designated this responsibility in 20-30% of households. Generally only 10% of less households assigned this responsibility to sons or daughters in the family (Table 48).

Table 48:: Household member responsible for making selection of planting material, by site.

Household Member	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
Male head of household	57.08%	58.55%	40.00%	65.40%	72.30%	73.81%	55.28%
Female head of household or spouse	28.77%	32.05%	34.65%	29.66%	20.27%	21.43%	34.40%
Son	9.43%	6.84%	13.49%	3.42%	7.43%	2.38%	7.57%
Daughter	4.72%	2.56%	11.86%	1.52%	0.00%	2.38%	2.75%
Total Responses	**212**	**234**	**430**	**263**	**148**	**126**	**436**

Key characteristics for selecting planting material:

When selecting planting materials for the new season, farmers tend to pay attention to several key characteristics. These characteristics identified by farmers seem more or less comparable across surveyed sites. 'Close nodes' are regarded as the most important attribute by 36% of farmers in Dak Lak followed by 'normal, good looking stems' and 'disease free stems' (Table 49). Farmers in Son La regarded 'big stems' as a key feature for making selections of planting materials. In addition to 'big stems' which was identified by 27% of Son La farmers, 'normal, good looking stems' and the existence of 'many nodes' were also ranked high with 18% and 12% of farmers reporting them to be of key importance respectively. An additional 10% regarded 'close nodes' and a further 9% indicated the level of freshness of the stems as key characteristics when making planting material selections (Table 50). For Indonesian farmers 'short internodes' was regarded as the most important characteristic by almost 28% of farmers. This was followed by the planting material having a 'good stem' as regarded by 21% of farmers, without any 'disease or pests' by another 21% and the materials having 'big stems' by 12% of farmers as key features (Table 51). While the level of importance of the top attributes seem to vary across the surveyed sites, the characteristics regarded as being most important were generally quite similar especially when considering the top five to seven attributes.

Table 49: Characteristics preferred by farmers (%) when selecting planting material, Dak Lak

Characteristics	**Percent**
Close nodes	35.58%
Normal, good looking stems	27.37%
Disease free stems	18.74%
Equal nodes	4.00%
Many nodes	3.37%
Big stem	2.53%
Other	8.05%
Total Responses	**475**

Table 50: Characteristics preferred by farmers (%) when selecting planting material, Son La

Characteristics	**Percent**
Big Stem	27.45%
normal, good looking stems	18.14%
many nodes	11.76%
close nodes	9.64%
fresh stems/ white inside	9.15%
firm and strong stems	7.52%
big nodes	2.94%
Straight Stems	2.78%
disease free stems	2.45%
Other	8.17%
Total Responses	**612**

Table 51: Characteristics preferred by farmers (%) when selecting planting material, Cambodia

Characteristics	**Percent**
Short internode	**27.80%**
good stem	**21.04%**
No disease or pests	**20.66%**
Big Stem	**11.58%**
Many eyes	**5.41%**
Long stem	**3.86%**
Old/mature stem	**3.67%**
Fresh/ fresh stem	**3.28%**
Good eyes	**1.54%**
Big eyes	**0.77%**
Big root	**0.39%**
Total Responses	**518**

Planting material sourced from beyond own field:

As discussed above, planting materials are generally sourced from within the farm by a majority of farmers although there are certain situations where they are obtained from

sources outside the farm. Farmers seem to depend upon sources outside the farm in extreme circumstances or when a new variety is to be planted. In Sikka almost 92% of farmers claim to have never looked for planting materials outside the farm, while this proportion is also quite high for Sayabouly, Bolikhamxay and North Sumatra at 74%, 80% and 72% respectively (Table 52). In Cambodia almost 38% of farmers report having sourced planting materials from outside their fields in the last five years while 8% claim to have done this twice. Farmers from the survey sites in Vietnam seemed to be more amenable to sourcing planting materials outside the farm with about 45% in both Son la and Dak Lak claiming to have obtained their planting materials from outside the farm at least once in the last five years.

Table 52: Number of times planting materials were sourced from outside own farm in the last five years, by site

	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
Once	25.14%	19.10%	44.53%	45.85%	17.91%	4.55%	37.54%
Twice	1.12%	1.12%	8.59%	8.30%	3.73%	0.91%	8.09%
Three Times	0.00%	0.01%	1.56%	1.58%	1.49%	1.82%	2.27%
Four Times	0.00%	0.00%	0.39%	0.79%	2.24%	0.00%	1.94%
Every year	0.00%	0.01%	1.17%	10.28%	2.99%	0.91%	1.94%
Never	73.74%	79.76%	43.75%	33.20%	71.64%	91.82%	48.22%
Total Respondents	**179**	**178**	**256**	**253**	**134**	**110**	**309**

Motive for purchasing planting material

The primary reason for resorting to the markets to purchase planting material by a majority of farmers is when they first decide to plant cassava in their farm. Of the farmers that had purchased planting material, this was the primary reason for up to 73% of farmers in Sayabouly, 70% in Bolikhamxay, 60% in North Sumatra, and 42% in Sikka. A key reason for purchasing planting material for farmers in Son La (47% of farmers) was when a new variety was available while for Dak Lak (41% of farmers) it was when farmers believed that their existing planting material was of sub optimal quality. Further reasons included instances when farmers lost their own stake which was a common reason for farmers in Son La with almost 47% citing this reason. About 15% of farmers in Dak Lak and Cambodia also claim to have purchased planting material as a result of disease or pest problems with their previous crop (Table 53). Most of the farmers citing 'other' as their reason for making the purchase in fact indicated not having purchased planting material at all and instead received them for free from family, friends or neighbours.

Table 53: Reason for purchasing planting materials, by site

Reason for Purchase	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
When first began farming cassava	73.47%	69.89%	20.67%	21.76%	59.62%	41.94%	25.38%
When a new variety was available	2.04%	1.08%	46.67%	18.65%	1.92%	0.00%	4.62%
When own stakes were lost	0.00%	4.30%	2.67%	26.42%	1.92%	16.13%	32.31%
When own planting material is not of good quality	0.00%	0.00%	4.67%	40.93%	9.62%	3.23%	23.85%
When I have a disease or pest problem in previous year	0.00%	0.00%	2.67%	15.03%	0.00%	0.00%	15.00%
On a regular basis to improve seed stock	0.00%	0.00%	0.00%	2.07%	0.00%	0.00%	1.92%
Other	24.49%	24.73%	43.33%	26.94%	28.85%	41.94%	16.92%
Total Responses	**98**	**93**	**150**	**193**	**52**	**31**	**260**

Number of people farmers purchased, sold, or exchanged planting material from within the last 5 years:

Farmers claim to have purchased planting materials from as many as 10 different suppliers in the last five years, although this was only for a handful of farmers. Of those that purchased planting materials, a majority of farmers across all survey regions claim to have purchased them from only one seller. This was the case for almost 36% of farmers from Cambodia, 29% from Bolikhamxay, 26% from Dak Lak, 17% from Sikka, and 14% from North Sumatra. Son La had the least number of farmers purchasing planting material; as such only 8% were involved in purchasing them from a single seller. Farmers from Cambodia seemed to be most amenable towards purchasing planting materials with over 14% claiming to have purchased them from two sellers. Purchasing from two sellers was also reported by a handful of farmers from the Indonesian sites. (Table 54).

Table 54: Proportion of farmers (%) purchasing planting materials by number of people purchased from, by site

Number of people purchased from	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
0	41.09%	70.53%	90.57%	67.20%	77.59%	82.86%	42.27%
1	9.82%	29.45%	8.02%	25.60%	13.79%	17.14%	36.08%
2	1.09%	0.01%	0.94%	3.20%	3.45%	0.00%	14.43%
3	0.73%	0.00%	0.00%	1.20%	1.72%	0.00%	5.50%
4	0.00%	0.00%	0.00%	0.40%	0.00%	0.00%	0.69%
5	0.00%	0.00%	0.00%	2.00%	0.00%	0.00%	0.69%
6	0.00%	0.00%	0.47%	0.00%	0.00%	0.00%	0.00%
7	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
8	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
9	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
10	0.36%	0.00%	0.00%	0.40%	3.45%	0.00%	0.34%
Total Respondents	**275**	**129**	**212**	**250**	**58**	**35**	**291**

Apart from North Sumatra, farmers in other survey sites were generally not involved in selling planting materials. In North Sumatra however up to 25% reported having sold planting materials to at least one other buyer. For the other survey sites, only a few claim to have been involved in selling them to one or more farmers. A handful of farmers in Sayabouly, Son La, and Cambodia claim to have sold them to 10 or more farmers, but this is a rare case where presumably the farmer is actively involved in the business of selling planting materials.

Table 55: Proportion of farmers (%) selling planting materials by number of people sold to, by site

Number of people sold to	Sayabouly	Bolikhamxay	Son La	Dak Lak	N Sumatra	Sikka	Cambodia
0	89.04%	92.97%	99.04%	98.40%	70.00%	97.06%	82.01%
1	0.00%	2.34%	0.48%	0.00%	25.00%	2.94%	3.81%
2	1.37%	0.78%	0.00%	0.40%	3.33%	0.00%	5.54%
3	2.74%	0.78%	0.00%	0.00%	0.00%	0.00%	3.46%
4	2.74%	0.78%	0.00%	0.00%	1.67%	0.00%	0.69%
5	1.37%	1.56%	0.00%	1.20%	0.00%	0.00%	3.46%
6	0.68%	0.00%	0.00%	0.00%	0.00%	0.00%	0.35%
7	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
8	0.00%	0.78%	0.00%	0.00%	0.00%	0.00%	0.00%
9	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
10	0.68%	0.00%	0.48%	0.00%	0.00%	0.00%	0.35%
Greater than 10	1.37%	0.00%	0.00%	0.00%	0.00%	0.00%	0.35%
Total Respondents	**146**	**128**	**208**	**250**	**60**	**34**	**289**

Number of people exchanging plating materials within last 5 years:

As discussed earlier, receiving planting materials from neighbouring farmers in an exchange is a more popular method of gaining access to planting materials in relation to purchasing them. While some farmers (particularly in Bolikhamxay and Cambodia) claim to have exchanged planting materials with as many as 15 different farmers in the last five years, this was only reported by a handful. A majority of farmers across all surveyed regions exchanged them from only one other farmer. This was the case for 38% of farmers in both Laotian sites, 34% in Son La, 24% in Dak Lak and 16% in Cambodia. In the Indonesian sites this proportion was relatively low with only between 6 and 7% reporting any such exchange. Farmers in Cambodia were relatively more open to receiving planting materials from multiple farmers with 20% and 16% claiming to have received them from two and three farmers respectively. This was also the case for the Vietnamese sites where 18% and 11% of Son La farmers claim to have received them from two and three other farmers respectively. In Dak Lak over 10% claim to have received planting materials from five other farmers (Table 56).
Most farmers claim to source planting materials from their own farms once the crop is well established on their farms. Hence a majority of farmers reporting any exchange in the last five years are likely to be those planting the cassava variety for the first time.

Table 56: Proportion of farmers (%) exchanging planting materials by number of people exchanged with (receive only), by site

Number of people exchanged from (received from)	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
0	37.85%	48.28%	30.20%	48.40%	76.67%	93.94%	40.55%
1	38.42%	37.93%	33.88%	24.00%	6.67%	6.06%	15.81%
2	10.73%	3.45%	17.55%	8.00%	3.33%	0.00%	20.27%
3	6.78%	1.38%	11.43%	7.20%	5.00%	0.00%	15.81%
4	2.26%	3.45%	2.04%	0.80%	5.00%	0.00%	3.44%
5	3.39%	2.76%	2.04%	10.40%	1.67%	0.00%	2.75%
6	0.56%	0.00%	0.82%	0.80%	0.00%	0.00%	0.34%
7	0.00%	0.00%	0.41%	0.00%	0.00%	0.00%	0.00%
8	0.00%	0.69%	0.41%	0.00%	0.00%	0.00%	0.00%
9	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
10	0.00%	1.38%	1.22%	0.40%	1.67%	0.00%	0.69%
11	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
12	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
13	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
14	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
15	0.00%	0.69%	0.00%	0.00%	0.00%	0.00%	0.34%
Total Respondents	**177**	**145**	**245**	**250**	**60**	**33**	**291**

The frequency of exchanges made with other farmers with the aim of giving planting materials to other farmers seemed to vary from the nature of exchanges made for gaining access to them. Unlike the situation where farmers were involved in receiving planting materials, it was more likely that farmers engaged with more than one other farmer when giving them away. In Cambodia while only 6% gave planting materials to one other farmer, 19% gave them to 2 farmers and 18% to three farmers. In Son La while only 2% gave planting materials to one other farmer 13% gave them to 2 farmers and 10% to 3 farmers. Moreover, another 10% claim to have given them to 10 farmers with an additional 9% to more than 10 farmers (Table 57). In general farmers claim to report giving planting materials to more farmers than they receive from.

Table 57:Proportion of farmers (%) exchanging planting materials by number of people exchanged with (give only), by site

Number of people exchanged from (given to)	Sayabouly	Bolikhamxay	Son La	Dak Lak	N Sumatra	Sikka	Cambodia
0	65.36%	55.38%	39.58%	76.49%	81.36%	96.97%	38.75%
1	7.84%	5.38%	2.08%	1.99%	5.08%	0.00%	6.23%
2	7.19%	6.92%	12.50%	3.59%	0.00%	0.00%	18.69%
3	3.92%	11.54%	9.58%	3.19%	5.08%	0.00%	18.34%
4	1.31%	3.08%	5.00%	0.40%	5.08%	0.00%	6.57%
5	5.88%	5.38%	7.92%	7.97%	1.69%	3.03%	8.30%
6	1.31%	1.54%	3.33%	1.59%	0.00%	0.00%	0.35%
7	0.65%	0.77%	0.00%	0.00%	0.00%	0.00%	0.00%
8	0.00%	1.54%	0.83%	0.00%	0.00%	0.00%	0.69%
9	0.00%	0.77%	0.00%	0.00%	0.00%	0.00%	0.00%
10	3.92%	4.62%	10.42%	3.98%	1.69%	0.00%	1.38%
Greater than 10	2.61%	3.08%	8.75%	0.80%	0.00%	0.00%	0.69%
Total	**153**	**130**	**240**	**251**	**59**	**33**	**289**

Assessment of quality of purchased or exchanged material:

Farmers generally seem to assess the quality of purchased or exchanged materials based upon attributes they prefer to see in planting materials as discussed above. However, the assessment also seems to be influenced by their existing crop which is used as a reference for making comparisons.

The most important factor for farmers in Son La when assessing the quality of purchased or exchanged materials is the size of the stem. 34% of the responses pointed to the importance given to big stems when making such assessments. About 19% also claimed to compare the planting material with what they currently have (Table 58). Attributes related to the stem as well as nodes such as the number of nodes, durability of the stems, etc. as discussed earlier were all regarded as being relevant when making such assessments.

Most of the farmers in Cambodia assess the quality of purchased planting material by evaluating characteristics of the stem. A good stem is preferred by over 60% of respondents while 13% prioritize the existence of any pests or diseases; and another 11% place an emphasis on how short the internodes are (Table 59).

Table 58:Assessment of quality of purchased or exchanged materials, Son La

Characteristics	Percent
big stem	34.38%
compare with existing	18.75%
good nodes	12.50%
many nodes	12.50%
good stems	12.50%
sturdy stem	6.25%
big roots	3.13%
Total Responses	**32**

Table 59: Assessment of quality of purchased or exchanged materials, Cambodia

Characteristics	Percent
Good Stem	60.12%
no pest or disease	13.29%
short internode	10.98%
Big Stem	4.62%
Lot of eyes	4.05%
Fresh	2.89%
long stem	2.31%
mature	1.73%
Total Responses	**173**

Problems with purchased planting materials

While a majority of farmers indicate no problems with purchased planting materials, almost 23% of farmers in Cambodia claim to have experienced some problems (Table 60). The problems experienced by Cambodian farmers almost exclusively relate to pests and diseases. Mealy bugs, mites and witches broom were some of the issues that were reported by the farmers. Problems are also reported by over 11% of farmers in Sikka and almost 7% of farmers in North Sumatra who had purchased them.
For the two sites in Vietnam, the proportion of farmers reporting a problem with their purchased planting material was about 5% for Dak Lak and 3% for Son La. In Dak Lak and Son La, a key complaint was related to the lack of freshness of the planting material where some of the purchased material appeared to be dried out or even dead in some cases. In Dak Lak other reported complaints were related to plants that were damaged or those that were infested with mealy bugs or mites. Farmers in Laos on the other hand hardly reported having any problems with purchased planting materials.

Table 60: Proportion of farmers (%) experiencing problems with planting material, by site

	Sayabouly	Bolikhamxay	Son La	Dak Lak	North Sumatra	Sikka	Cambodia
Problems	0.00%	1.78%	3.20%	5.22%	6.90%	11.43%	22.62%
No Problems	100.00%	98.22%	96.80%	94.78%	93.10%	88.57%	77.38%

Last year a new variety was made available:

From the charts in the previous sections we can see that there is significant lag between the first time a specific variety is first adopted in a particular region and the years it is eventually adopted by the rest of the farmers. While some farmers may prefer to reduce their risks by avoiding prompt adoption of a newly introduced variety and instead prefer to wait and assess them, the lag in adoption may also be a result of inefficient transfer of information within the same village.

The charts below (Figure 13 - Figure 18) present the opinions of farmers regarding the last time a new variety was made available in their village in each of the survey sites (except for Sikka where valid data was unavailable). The stated years vary quite significantly across farmers even within the same survey site. This variation is likely a result of the level of dissimilarities in motivation for sourcing new varieties but also the lack of efficient flow of information.

While there are several farmers that indicate a new variety having been made available in the current year, for a majority, this date is up to five years ago. It is unclear whether it is the case that most farmers are not aware of newer varieties that have been introduced, or whether there have been no new varieties made available in recent years and certain farmers are only recently coming to realize these varieties that were introduced much earlier.

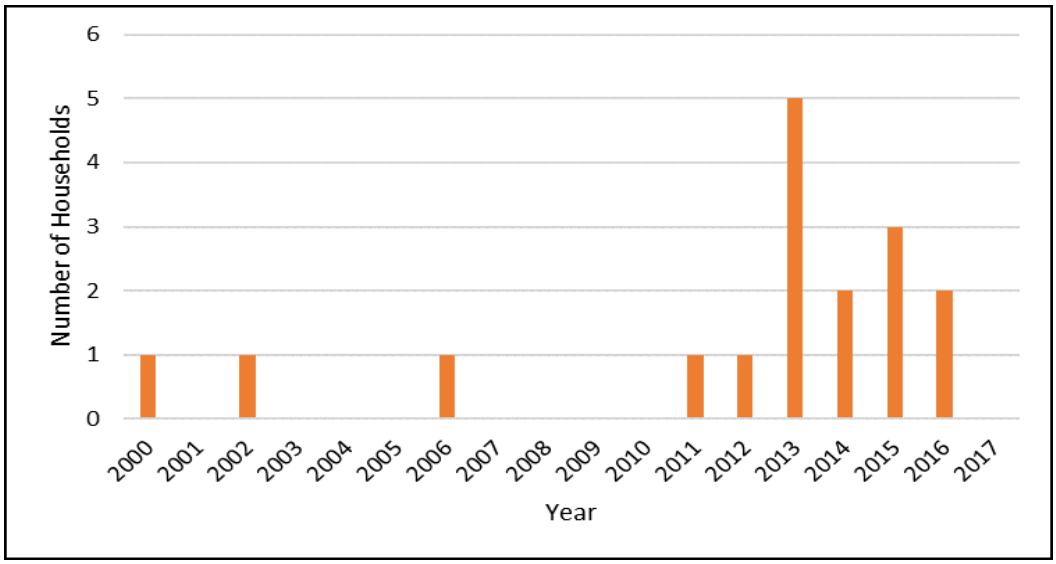

Figure 13: Number of farmers indicating the last year a new variety became available, Sayabouly

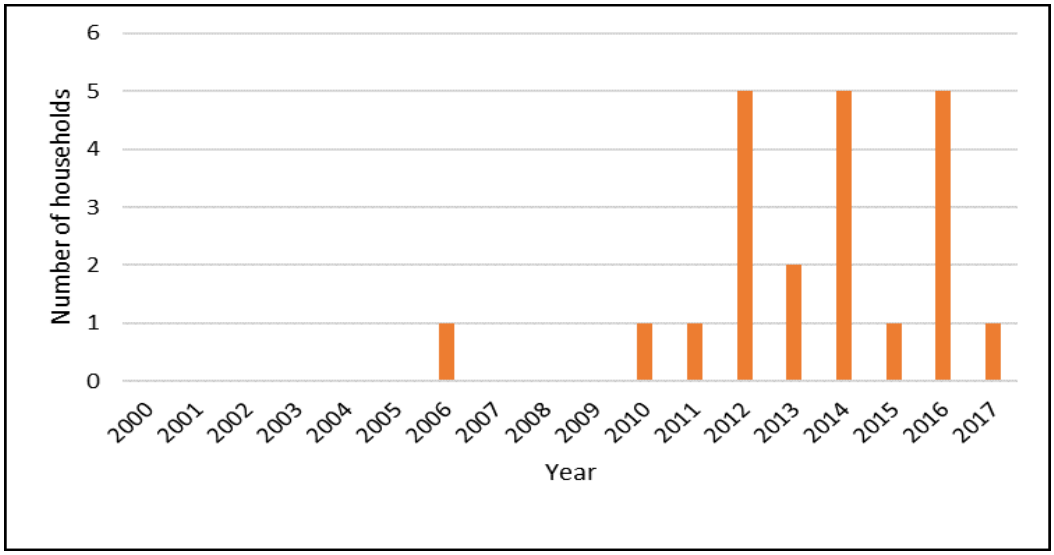

Figure 14: Number of farmers indicating the last year a new variety became available, Bolikhamxay

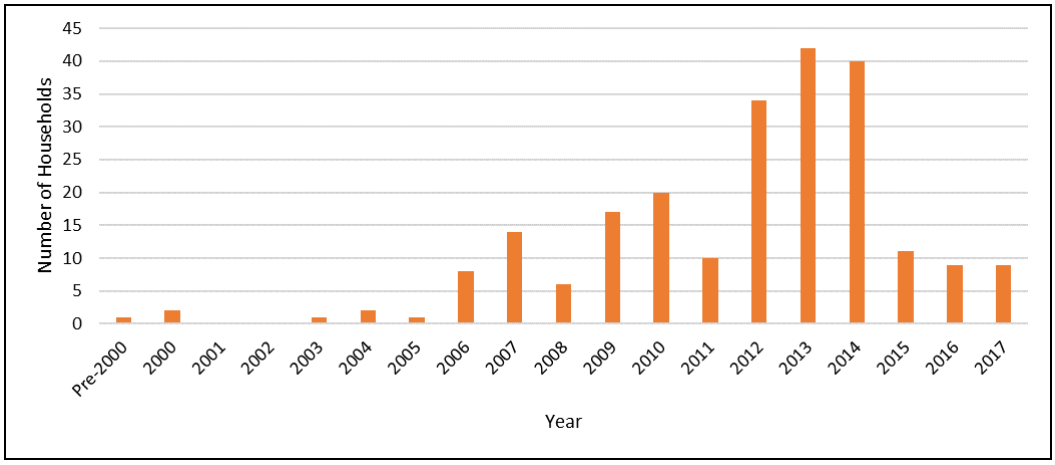

Figure 15: Number of farmers indicating the last year a new variety became available, Son La

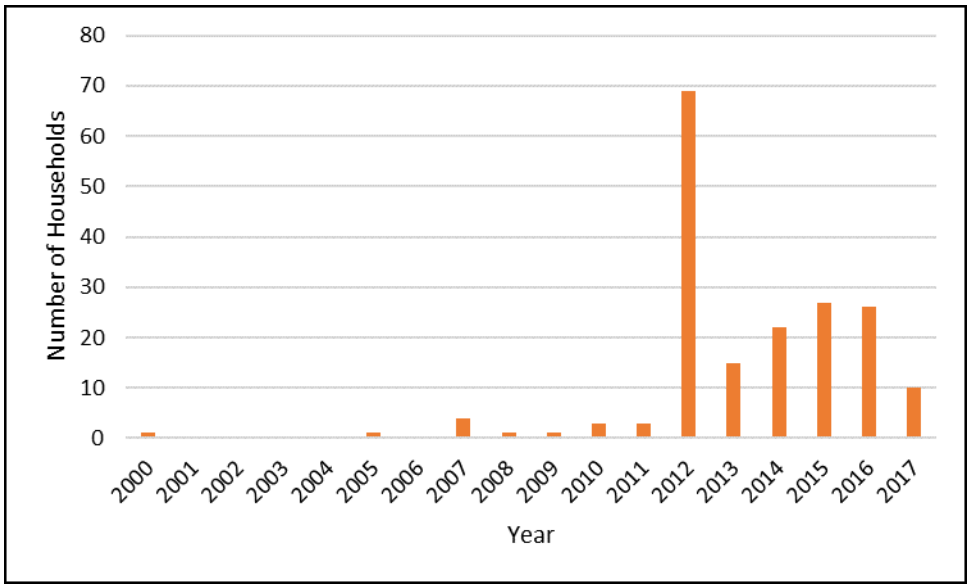

Figure 16: Number of farmers indicating the last year a new variety became available, Dak Lak

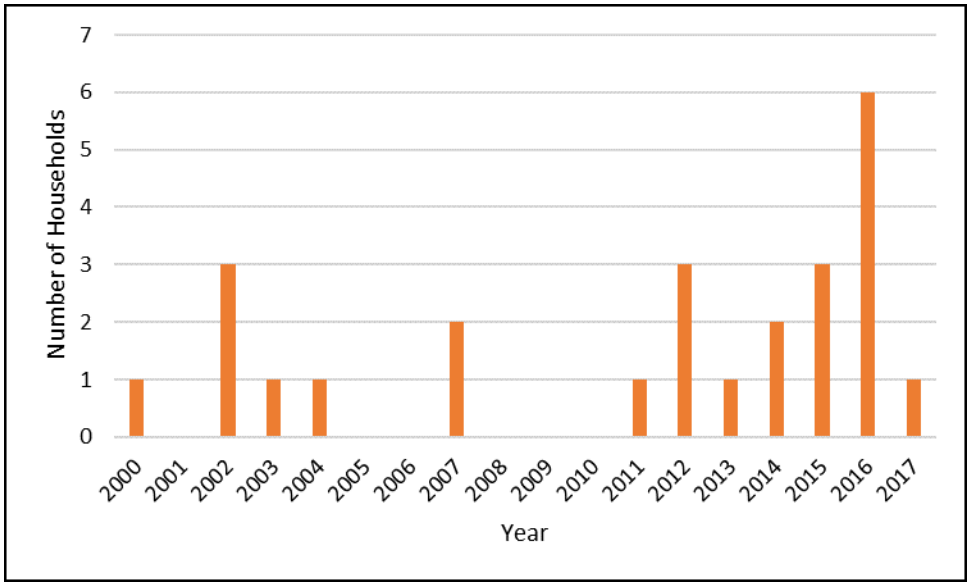

Figure 17: Number of farmers indicating the last year a new variety became available, North Sumatra

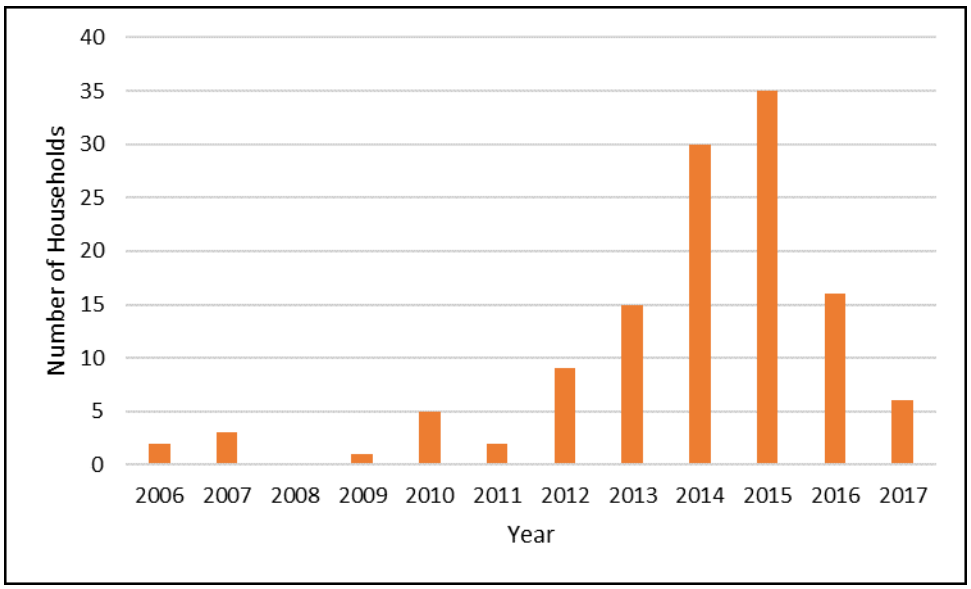

Figure 18: Number of farmers indicating the last year a new variety became available, Cambodia

Method of access to new varieties

Farmers across all surveyed sites generally obtain new varieties of cassava for free by exchanging them with friends and family or neighbouring farmers. Farmers are generally known to be risk averse and do not prefer to adopt new varieties without evidence of positive results in their neighbouring farms.

Farmers in Son La seem the most inclined to get cassava varieties for free from neighbouring farmers, friends, and family. In Cambodia the most popular source of new varieties is through traders followed by neighboring farmers and the provincial department of agriculture (Table 62). While only a handful of farmers in Cambodia claim to purchase new cassava varieties, this was relatively common in Son La with over 22% claiming to purchase them (Table 61). The cassava factory is a popular source of new varieties in Dak Lak with almost 28% relying on this source for new varieties. However it is not clear whether

the varieties are provided for free or require some payment. Over 12% of farmers in Dak Lak also depend obtain new varieties of cassava from their village leader or other village staff members.

Table 61:Proportion of farmers (%) getting new varieties from various sources, Son La

Source	**Frequency**
Friends Neighbours and Relatives	69.34%
Purchase it	22.26%
Village Leader	3.28%
Other	5.11%
Total Responses	**274**

Table 62:Proportion of farmers (%) getting new varieties from various sources, Dak Lak

Source	**Frequency**
Friends Neighbours and Relatives	39.85%
Cassava Factory	27.97%
Village Leader/ Village Staff	12.26%
Purchase it	8.43%
Trader	5.75%
Other	3.07%
Extension workers/ agriculture staff	1.53%
Farmers union	1.15%
Total Responses	**261**

Table 63: Proportion of farmers (%) getting new varieties from various sources, Cambodia

Source	**Frequency**
Traders	37.50%
Other Farmers	27.50%
Provincial Department of Agriculture	20.00%
Agricultural Projects	5.50%
NGO	5.00%
Village Head	2.50%
market	2.00%
Total Responses	**200**

2017 Variety Trial Results

Vietnam

A total of 11 high yielding cassava varieties were evaluated in 2 provinces, Dak Lak and Son La.

In Dak Lak, trials were conducted in 3 locations in two different soil types (i.e. Ferrasol and Acrisol) with following verities- KM140, KM505, KM419, HLS10 and HLS11. In Son La, trials were conducted in 2 locations with following varieties- 13Sa05, BK, Sa21-12, and Sắn dù. In Both provinces variety KM94 and Rayong 9 were common in all trials.

In Dak Lak, fresh root yield was significantly affected by treatment (i.e. farmers' practice, 100 kg phosphorous fertilizer + 300kg NKP (15-5-20) and MARD recommend practice, 90N-60P_2O_5-90K_2O with 1000 kg ha^{-1} bio fertilizer) X variety interaction ($P < 0.001$) (Table 1). Fresh root yield was ranged from 24.8 (Rayong 9) to 31.2 (KM419) t ha^{-1} when grown as farmers practice and 28.5 (Rayong 9) to 36.8 (KM419) as MARD practice. Soil type also significantly affected fresh root yield ($P < 0.001$). Fresh root yield on an average across all location was 1.4-fold higher in Ferrasol compared to Acrisol. Starch content in the varieties were significantly different ($P < 0.001$) and ranges from 27.5% (variety KM505) to 30.8% (variety HLS11).

In Son La, fresh root yield was significantly different among different varieties ($P < 0.001$) (Table 2). On average fresh root yield ranges from 13.1 (variety Sa21-12) to 23.7 (variety 13Sa05) t ha^{-1}. There was variation in starch content among the varieties ranges from 27.7 to 30%.

Indonesia

A total of 7 high yielding cassava varieties (i.e. sweet variety-Tambak Udang, and bitter varieties-Faroka, UB ½, UB 14772, Gajah, Malang 6 and Aldira) were evaluated and compared with two local sweet varieties (i.e. Sika Putih and Sika Kuning) in Sikka. Due to exceptionally dry season, cassava could not grow well (~30% of each plot was affected) and there was heavy presence of mealy bugs. However, the fresh root yield was calculated from individual plant measurements (means of 6 to 9 plants/plots). Fresh root yield of high yielding varieties ranged from 31.2 to 45.7 t ha^{-1} which was 1.2 to 1.7-fold higher compared to local varieties.

Cambodia

Six high yielding cassava varieties (Rayong 72, KU50, Huay Bong 60, KM-98-1, SC912 and SC8A) along with farmers' variety were evaluated. Four on-farm demonstrations were conducted in 2 Districts (i.e. Snoul and Chet Borei) in 2017 to show optimum cultivation practices (sowing method, timely weeding and fertilizer application) and expand the use of new technologies among growers. However, we managed to get data from only one trail due to premature harvest by farmers' as root price was higher compared to previous years. Data from Snoul District demonstrated that varieties differed significantly in fresh root yield ($P < 0.05$). Among the cassava varieties KU 50 produced the highest fresh root yield (30.2 t ha^{-1}) and farmers' variety was the lowest (16.0 t ha^{-1}). In this trail all the plots were infected by CWBD and infested by mealy bug. Presumably all the plants were equally effected by the pest and disease.

Varieties differed significantly ($P < 0.05$) in starch content. Highest starch content was achieved by Rayong 72 (i.e. 28 %) and the lowest was 23% for SC9.

The trials carried out in Chet Borei District were infected with cassava mosaic disease (CMD) prior to the premature harvest by the owner. The farmers own planting material was unknown to be infected at the time of planting, as was much of the cassava fields in the

village. DNA fingerprinting revealed that the farmers own variety was KM419. Visual assessment and PRC analysis was conducted on the trial showing some varieties highly susceptible to the disease (eg. SC8) and others having a high percentage of asymptomatic plants (eg. Rayong 72). The experiment is being repeated on station to have more control and closer monitoring.

Laos

Six high yielding cassava varieties (Rayong 9, Rayong 11, Rayong 72, KU50, KM-21-12, KM 140) along with farmers' variety were evaluated. Four on-farm demonstrations were conducted in 4 Districts (i.e. Paklai, Kenthao, Viengthong and Bolikhan) in 2017 to show optimum cultivation practices (sowing method, timely weeding and fertilizer application) and expand the use of new technologies among growers. However, we managed to get data from three trails due to premature harvest by farmer from Bolikhan District as root price was higher compared to previous years. Data from three Districts demonstrated that varieties did not differed significantly in fresh root yield ($P=0.064$). However, location (i.e. Paklai, Kenthao and Viengthong) had significant ($p<0.001$) effect on root yield.

On an average Paklai District demonstrated highest and Viengthong lowest yield. Among the cassava varieties Rayong 11 produced the highest fresh root yield (25.9 t ha^{-1}, average from three Districts) and KM-21-12 yielded the lowest (19.2 t ha^{-1}). In these three trials farmers' variety yielded 22.6 t ha^{-1}. In these trails all plots were infected by CWBD. Visual inspection of the trials showed that different varieties were impacted by CWBD differently. Rayong 11 for example showed less symptomatic plants – contributing to the higher average yields.

Varieties differed significantly ($P < 0.05$) in starch content. Highest starch content was achieved by Rayong 11 (i.e. 31 %) and the lowest was 22% for KU 50 (again influenced by CWBD). Factories didn't pay based on starch content in most locations, however wide variations is likely to see changes based on starch yield rather than fresh root weight.

Implications for Business Models for Technology Dissemination

There is a high incentive for farmers and processors to understand how different varieties perform in local supply zones particularly under pest and disease pressure.

The impact of disease on farmer yields and overall feedstock supplies are considerable. This goes beyond fresh weight yields with starch yields declining as a result of CWBD which are likely to impact starch recovery and profitability of processors.

In value chains where there is a central processor or stronger value chain links (Paklai, Viengthong, Bolikhan), demonstrating these risks and providing extension information and training to processors and agents for dispersal through the network of traders should provide benefits to farmers, with the processor also capture the benefits of enhanced feedstock (or avoid the potential future losses).

In value chains that are more dispersed with multiple actors and less exclusivity of any benefits generated at the farm level (Kratie, Kenthao), individual value chain actors are more difficult to identify with incentive to scale technologies. In Kenthao there is an association of processors who may provide an entry point. In Kratie there are new value chain actors entering into the market who the project will target going forward.

A primary source of clean material to introduce important given that the project trials became infected with CMD in Cambodia and CWBD in Laos. More work is required to understand the biology and economics around establishing and maintaining clean material.

The main priority for intervention expressed by farmers in Son La was new varieties of cassava. Farmer priorities were varieties with; (i) higher yield than the current varieties planted in Son La; (ii) resistance to disease, and in particular resistance to Witches Broom; (iii) frost tolerance; (iv) early or late harvesting in order to gain better market price; and (v) good root quality.

Engagement and dissemination		Adoption	
Value chain characteristics Factory has incentive for introduction of varieties but lacks links to rest of value chain. Large traders have links, but little incentive	Value Chain Actor advantage √	Community learnability √	Community advantage √
Technology learnability √	Technology advantage √	Technology learnability √	Technology advantage √

Figure 19: Engagement, Dissemination and Adoption profile of new varieties in Son La

The main entry point/partner for an intervention introducing improved varieties in the cassava value chain in Son La could be the Mai Son Starch Factory. There is a significant incentive for the starch factory to promote higher yielding varieties leading to higher raw material supply in order to more effectively use the increased capacity resulting from the investments in productive capacity made since the takeover by FOCOCEV. The technology characteristics of new varieties and the community characteristics in Son La mean that the potential peak adoption level of new varieties by farmers in Son La is relatively high.

As shown in Figure 19, while FOCOCEV have a strong incentive to support the dissemination and adoption of new varieties, they lack strong long-term links though the value chain. Larger traders supplying the factory have strong upstream links in the value chain back to farmers, but have little incentive to promote higher yielding varieties.

In order to facilitate engagement of traders and widespread dissemination of varieties, larger scale traders and associated small traders at commune level need to be incentivised to participate. Incentives could include subsidising the sale of stakes to larger traders and supporting large traders and commune level traders to multiply planting material for sale to farmers. Initial technical support could come from the project, but financial support for subsidising planting material should come from the factory.

The main entry point/partner for intervention in the value chain in Dak Lak could be the DAKFOCAM Company through their factories in Ea Kar and Krong Bong. DAKFOCAM has an incentive to support farmers to increase the quality/starch content of fresh roots supplied to the factory and to balance supply levels over a longer growing/harvesting season. Interventions could make use of the existing linkages of DAKFOCAM with the small trader/farmer group networks in Ea Kar and through linkages with farmers taking credit from the Krong Bong factory.

Engagement and dissemination		Adoption	
Value chain characteristics √ Factory has incentive for introduction of varieties and has relatively strong links with farmer groups and farmers who take credit from the factory	Value Chain Actor advantage √	Community learnability √	Community advantage √
Technology learnability √	Technology advantage √	Technology learnability √	Technology advantage √

Figure 20: Engagement, Dissemination and Adoption profile of new varieties in Dak Lak

The main entry point/partners for intervention in variety dissemination in Xayabouly could be the Khampai Chip Factory, Mailivanh Chip factory and the Luon Chip factory located around Kenethao town. There are incentives for the chip processors/traders to support the introduction of improved varieties with better quality and for increased information flows and coordination in order to avoid periods of over- and under-supply.

Engagement and dissemination		Adoption	
Value chain characteristics √ Factory and traders have an incentive for introduction of varieties and has relatively strong links with farmer groups through traders	Value Chain Actor advantage √	Community learnability √	Community advantage √
Technology learnability √	Technology advantage √	Technology learnability √	Technology advantage √

Figure 21: Engagement, Dissemination and Adoption profile of new varieties in Xayabouly

A potential entry point/partner for project interventions in Bolikhan district is the Vasana trading company. Although the company is located in Paksan town, they have expressed an interest in partnering, especially in supporting with land for trials and the dissemination of improved technologies for smallholder chip production. Vasana has an incentive to support the adoption of improved varieties and the dissemination of improved technologies for

smallholder chip production as the company could potentially secure larger quantities of chips for export and balance periods of over and under supply.

Engagement and dissemination		Adoption	
Value chain characteristics √	Value Chain Actor advantage √	Community learnability √	Community advantage √
Technology learnability √	Technology advantage √	Technology learnability √	Technology advantage Need to increase availability of low-cost technologies

Figure 22: Engagement, Dissemination and Adoption profile of smallholder chip processing in Bolikhamxay

While the engagement and dissemination incentives are high, the potential level of adoption of improved smallholder chip processing is currently low due to the high costs and low availability of the technology. One of the key investments in facilitation of the adoption of fertiliser for cassava production will be developing a network of local level fabricators to produce low cost chipping equipment at the local level.

In Sikka, There are significant public-good incentives to control mealybug, which is in evidence in many fields. If mealybug becomes more widespread in Sikka it has the potential to devastate the cassava crop and have a serious impact on smallholder livelihoods. The private incentive to control mealybug is relatively low, due to the presence of significant externalities (treating one field is not useful if other farmers do not also treat). In the absence of a sizable private sector in the cassava sector, there is a case for the involvement of DINAS and local and international NGOs who have a strong incentive to control pests and disease in order to ensure smallholder livelihoods and food security in the uplands of Sikka.

In terms of developing a more commercialized/industrial cassava production system with higher yielding bitter varieties of cassava it is not realistic or desirable to develop such a system within the existing upland production systems. The current systems provide a diversified source of livelihood for upland farmers and help to minimize risk and increase the sustainability of production. Other interventions would potentially have much more significant positive impact for upland farmers – some introduction of higher yielding sweet cassava varieties, pre-emptive control of mealybug and a step by step process of replacing the older (15-20 years) less productive cashew and cacao trees for example.
An appropriate partner for project interventions in upland areas of Sikka may well be a local or international NGO with a focus on sustainable livelihood improvements. Local and international NGOs have a strong incentive to promote higher yielding sweet varieties of cassava as it is a key component of smallholder livelihoods and food security in the uplands of Sikka.

In Sikka, commercialized/industrialized cassava production (especially of improved bitter varieties) should be considered as quite a separate commodity/production system/value chain to the existing sweet cassava systems. The approach taken in this instance could be to support the development of a distinct system in the lowland areas on the north coast near Maumere, which currently have a “maize plus” intercropping system (maize plus cassava/pigeon pea). There may well be potential to increase farmer livelihoods in this zone through changed

intercropping systems based on improved, higher yielding cassava varieties and improved fertiliser practices.

The main constraint to the sustainable development of cassava in this zone is the lack of any sizable processing industry. The very limited demand on Flores for starch (estimated at less than 2 tons per month) means that any starch or dried chip factory set up will need to be oriented towards "export" of product to Java rather than the Flores market. This implies that the factory must be competitive with factories in Java and other parts of Indonesia. In turn this means that the factory must be of a sufficient scale to be cost-effective and hence will require significant investment and expertise. Whilst several private sector entities have expressed interest in investing, it remains to be seen what form this will take and when/if it would come about.

Engagement and dissemination		Adoption	
Value chain characteristics √ Farmer groups have strong incentives and relatively strong links with members	Value Chain Actor advantage Lack of working capital to invest in dissemination	Community learnability √	Community advantage √
Technology learnability √	Technology advantage √	Technology learnability √	Technology advantage Need to develop appropriate fertiliser formulation for local conditions

Figure 23: Engagement, Dissemination and Adoption profile of new bitter cassava varieties and fertilizer practices in lowland Sikka

The main entry point/partner for intervention in the value chain in North Sumatra could be the PT Bumi Sari factory and associated agents. PT Bumi Sari has an incentive to support farmers to increase the quality/starch content of fresh roots supplied to the factory and to balance supply levels over a longer growing/harvesting season. Interventions could make use of the existing linkages of PT Bumi Sari and agents with the associated traders being incentivized through taking on the role of multiplying planting material for sale to farmers.

Engagement and dissemination		Adoption	
Value chain characteristics √ Factory has incentive for introduction of varieties and has relatively strong links through agents and associated traders.	Value Chain Actor advantage √	Community learnability √	Community advantage √
Technology learnability √	Technology advantage √	Technology learnability √	Technology advantage √

Figure 24: Engagement, Dissemination and Adoption profile of new varieties in North Sumatra

If the new starch factory begins operating in Kratie then that may be a good focal point to work with, in addition to working with traders who currently export to Vietnam and will start to work with the new starch factory. The starch factory would have an incentive to develop strong relationships in order to secure supply of input material for new starch factory.