Australian Government
Australian Centre for International Agricultural Research

Annual report

project	**Short Research Activity:** Developing an emergency response and long term management strategy for Cassava Mosaic Virus in Cambodia and Vietnam
project number	AGB/2016/032
period of report	August 1 2016 till July 30 2017 (Phase 1, pre-amendment)
date due	30-09-2017
date submitted	03-10-2017
prepared by	Stef de Haan, CIAT Nami Minato, CIAT Erik Delaquis, CIAT
co-authors/ contributors/ collaborators	Jonathan Newby, CIAT
approved by	

Contents

1 Progress summary

The Sri Lanka strain of Cassava mosaic disease (SLCMD) was first reported from one single, isolated plantation in eastern Cambodia in December 2015. Since the first official publication of this information in an article by Wang et al. (2016)[1] in March 2016, a great deal has happened to gain intelligence about the new biotic threat and its possible control measures. The Short Research Activity "*Developing and emergency response and long term management strategy for Cassava Mosaic Virus in Cambodia and Vietnam*" facilitated the completion of large-scale surveys covering the major cassava production districts of both Vietnam and Cambodia (table 1). Activities at these sites included systematic plant tissue collection for molecular-based virus detection, surveys evaluating patterns of exchange of planting materials, and collection of whitefly vectors for biotyping. In addition, detailed surveys were conducted at 2 sites in each country, representing well-established production areas and newer expansion areas. In each of these 4 sites (figure 1), 100 additional surveys were conducted in order to obtain more detailed, fine-scale information about factors influencing seed exchanges, types, volumes, and distances of seed flows, and issues related to quality of planting materials, pest and disease, and management practices. In parallel activities were undertaken to propose evidence-based options for eradication and control of the disease in dialogue with national institutional in Cambodia and Vietnam.

Within a relatively short period the SRA was able to provide some novel and essential information for orchestrating an adequate emergency response and mid to long term management strategies. Highlights in terms of results and foreseen outputs include:

- At the time of the study SLCMD was not detected at any of the evaluated sites in Vietnam, indicating that border control and prevention of stake imports into the country could be a possible control measure;
- At the time of the study SLCMD was isolated 70 km from the initial point of detection. Geographical distribution of the disease in Cambodia was relatively limited, thus suggesting that eradication of infection hotspots may still have been a viable route to extinguish the disease.
- At least one quarter of plants testing positive for SLCMV infection didn't show clear symptoms, indicating that, contrary to the case in African strains of the virus, spread through visually healthy looking plants is a possibility. This finding aggravates the situation and limits options of control through roughing or positive selection at the farm-level.
- At the time of the study, farmers in Cambodia were found to be purchasing stakes from Vietnam, Thailand, and Laos. Although self-saved seed and acquaintances within the community were the most important sources of stake acquisition for Cambodian farmers, this long-distance, cross-border trade links local trade networks to distant areas.
- Subregional district-level seed networks are highly distinct. Seed distribution networks in Ratanakiri, the province where SLCMD was first reported, are largely farmer-to-farmer based with seed acquisition flows staying within the province. Therefore the risk of intensive anthropogenic spread of SLCMD from Ratanakiri to other provinces is relatively lower than in other regions.

[1] http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-10-15-1228-PDN

- Traders are key actors in stake provisioning beyond the community level. Future studies on the informal seed sector should target traders so that lessons can be drawn on possible linkages to upgraded or clean seed system interventions.
- Two draft manuscripts were prepared for submission to peer reviewed journals. The manuscripts will be submitted for publication in October 2017.
- A poster was prepared for the ACIAR North-West Vietnam Research Symposium to be held on 23 & 24 November in Hanoi, Vietnam.

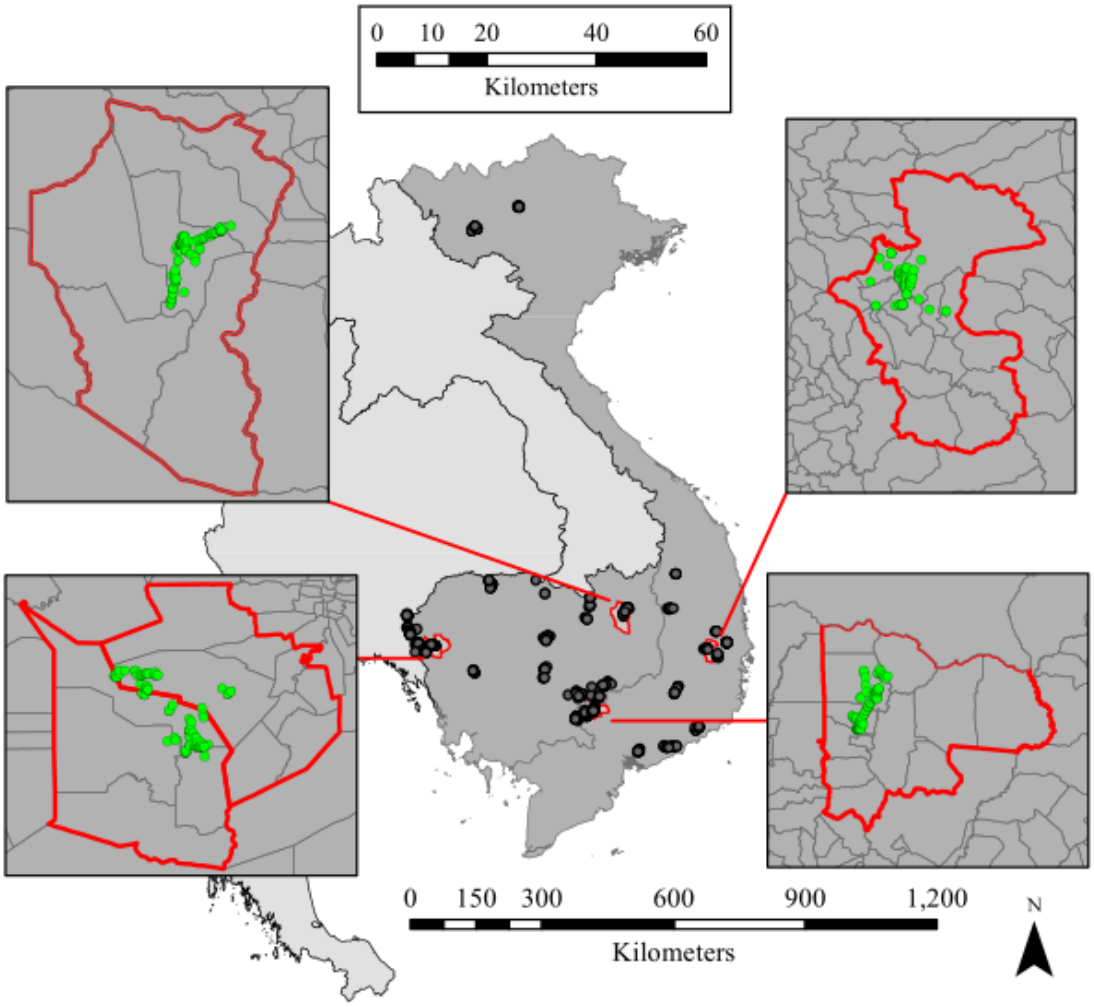
Results from our 2016 cropping season 2-country survey indicate that SLCMD had spread, but was still only detected within a limited geographical range within an area of predominant influx of stakes. These results suggested that, with the right biocontrol package, the disease could possibly still be eradicated. However, since the conclusion of our monitoring activities there have been many new reports of symptomatic plants throughout Cambodia, and importantly also in Tay Ninh, Vietnam. This finding is troubling indeed given the status of Tay Ninh as Vietnam's major production province, and as a major stake provider to many other regions of both Vietnam and Cambodia. Many of these reports were not backed-up by PCR analysis, but on a purely symptomatic basis it seems highly likely that both the range and rate of spread have accelerated beyond the option of early control and eradication. Therefore, future interventions will have to consider the short- to long term options. Specific recommendations include:

- Establishment of national coordination platforms (technical SLCMD working groups).
- Implementation of a scheme with a clear incentive system for eradication and replacement of SLCMD infected cassava fields.
- Implementation of quarantine restricting movement of SLCMD infected planting materials.
- Implementation of capacity building, awareness raising, and extension activities for SLCMD.
- Development of an integrated disease management plan for SLCMD.
- Set-up a system for near-real-time intelligence of SLCMD presence and incidence.
- Development of clean seed systems for the provision of quality cassava stakes.
- Socioeconomic feasibility analyses of clean seed production pipelines for feeding into new and existing seed supply networks.
- Set-up a network of degeneration trials with common varieties to elucidate economic impact.
- Initiation of a SLCMD resistance breeding program with focus on mainland Southeast Asia.

Table 1. Locations of SLCMD and seed system survey sites in Vietnam and Cambodia.

Vietnam		**Cambodia**	
Province	**District**	**Province**	**District**
Gia Lai	Chu Prong	Oddar Meancheay	Anlong Veaeng
Dak Lak	Madrak	Banteay Meanchey	Malai
Dak Lak	Eaklak	Pailin	Sala Krau
Dak Nong	Dak G'long	Pailin	Pailin
Binh Tuan	Bac Binh	Battambang	Kamrieng
Dong Nai	Long Tham	Battambang	Phnum Proek
Son La	Thuan Chau	Battambang	Rattanak mondul
Kon Tum	Sa Thay	Pursat	Kravanh
Yen Bai	Van Yen	Ratanakiri	Koun Mom
Gia Lai	Krong Pa	Steung Treng	Steung Treng
Phu Yen	Song Hinh	Kratie	Snoul
Tay Ninh	Chau Thanh	Tbong Khmun	Dambae
Binh Thuan	Ham Tan	Tbong Khmun	Memot
Tay Ninh	Tan Bien	Svay rieng	Romeas Haek
Tay Ninh	Tan Chau	Kampong Thom	Sandan
		Kampong Thom	Baray

Figure 1. Location of survey sites in Vietnam and Cambodia. Black symbols indicate the locations of sampling sites of the national survey. Green symbols on the inset maps indicate the locations of the 4 subnational surveys (clockwise from bottom left: Battambang, Ratanakiri, Dak Lak, Tay Ninh). The inset scale bar applies to all inset maps.



2 Achievements against project activities and outputs/milestones

Objective 1: To generate an accurate, baseline diagnosis (including map) of the current geographical distribution of SLCMD in Cambodia and Vietnam (including measures of field-level incidence and severity) and baseline information on the insect / anthropogenic vectors involved in SLCMD spread

No	Activity	Outputs/ milestones	Compl. date	Comments
1.1	Organize a multi-stakeholder workshop on emerging cassava plant health threats, with involvement of national actors (Cambodia: GDA, CARDI; Vietnam: PPD, PPRI) and representatives of ongoing, international cooperation programs on crop health (e.g., CRC Biosecurity project, CAVAC II, UWA) to share current knowledge and plan collaboration during the implementation of the SRA.	(a.) Plant and insect sampling protocols and farmer survey strategies were discussed and validated; (b) Target districts for large-scale plant and whitefly sampling were presented and adjusted according to expert knowledge; (c) Seed system survey methods were discussed and the tools validated; (d) Lead responsibilities and involvement in sub-components were divided among the project stakeholders in both Vietnam and Cambodia; (e) Initial work plan was developed and priorities were agreed upon.	Sept, 6, 2016	The actual involvement of partners changed once activities started to be implemented, based on real capacity to deliver in a short timeframe or within the possibilities of the budget
1.2	Develop a survey and sampling protocol following a customized sampling design that fully takes into account planting area per province and growth stage of the crop.	(a) Protocol developed and validated, (b) survey team collected: young leaf tissues, pictures of whole-plant and apex, whitefly population counts, whitefly bodies of nymphs and adults, and seed trading information at the household-level	Nov. 01, 2016	Based on 2014 cassava production data, 15 districts per country were selected to survey SLCMV occurrence and incidence in both countries. In Cambodia, Koun Mom district in Ratanakiri province was added as it was where the disease was first reported
1.3	Train a survey team in Vietnam and Cambodia (including government plant health officers) in the implementation of the standardized baseline diagnostics surveys & plant / insect sampling / coding, including field testing	(a) field survey training was conducted in (i) Hung Loc station in Dong Nai province, Vietnam and (ii) Phnom Penh & Dambae district, Tboung Khmum province, Cambodia.	Nov. 2016	3 survey teams in Vietnam (for Northern/Central/Southern region) and 2 in Cambodia (for Western / Eastern region) were organized. In total 6 governmental partners (3 / country)

1.4	Implement the baseline diagnostics surveys and conduct extensive plant / insect sampling in both countries	(a) Baseline survey for both seed systems and SLCMD covered 446 households (240 Cambodia / 206 Vietnam); (b) Samples collected for a total of 419 fields and 6,480 plants (15 fields per district, 16 plant samples per field)	Nov. and Dec. 2016 (survey) June 2017 (PCR)	The surveys were conducted by the national partner teams, including PPD, PPRI and IAS in Vietnam and RUA, GDA and PDA in Cambodia
1.5	Conduct centralized data entry and data cleaning of the completed diagnostics surveys.	(a) Data Entry and quality control for regional seed systems and diagnostics survey completed, (b) Translations, data entry and quality control for the zoom-in seed system surveys completed	May - June 2017	A MSc. intern from Wageningen University helped with data entry, organization and cleaning
1.6	Conduct centralized disease diagnosis on cassava leaf and insect samples, using existing protocols (serological and nucleic-acid based)	(a) SLCMD PCR-based diagnosis conducted at CATAS, China for a total of 6,480 plant samples, (b) Biotype identification of whitefly samples were completed with expert taxonomist in Thailand covering all districts and 35.7% of the fields	June 2017 (PCR)	We extracted total DNA from all the samples using a modified CTAB method and ran PCR-based diagnostics detecting the *AC1* gene of SLCMV. Given the large amount of samples and the limited capacity in Cambodian and Vietnam for processing an agreement was signed with CATAS, China.
1.7	Conduct statistical analysis, generate maps and draft a working paper on the baseline situation of the SLCMD geographical incidence, severity / incidence, and direction of spread, as well as disease vectoring	(a) Write-shop for drafting manuscripts of two journal articles (one on virus geographical distribution, and another on seed systems analysis) held 18-23th June, (b) submission of manuscripts foreseen for October 2017	June-Sept 2017	A collaboration with experts on network analysis from the University of Florida was established. This will likely result in another publication elaborating scenario analysis.

PC = partner country, A = Australia

Objective 2: To generate broad-level awareness of the risks posed by SLCMD and to build critical capacity among multiple stakeholders, including researchers, plant protection officers and extension agents, to deal with disease

No	**Activity**	**Outputs/ milestones**	**Completion date**	**Comments**
2.1	Develop a highly didactical information-extension package on SLCMD, its symptoms and management for public or private sector actors.	Ongoing (2017)	N.A.	This activity will be carried forward to the extension phase of the SRA (Y2); Progress was made on 1 poster and 1 basic recommendation sheet for SLCMD recognition and on-farm management options

2.2	Organize a technical training for plant health researchers and authorities on sampling protocols, laboratory-based diagnostics and recommended post-baseline-diagnostics surveillance.	(a) Technical training on sampling protocols provided in Vietnam for PPD, PPRI and IAS (2016), (b) Technical training on sampling protocols provided in Cambodia for RUA, GDA and PDA (2016), (c) Post-baseline diagnostics recommendations provided in Cambodia and Vietnam to RUA, GDA, PDA, PPD, PPRI and IAS (2017)	Sep. - Nov. 2016 July 2017	Formal technical training was provided during dedicated events and backstopping a numerous meetings dealing with the disease outbreak situation. A laboratory-based diagnostic training will be provided during the extension phase of the SRA (Y2)
2.3	Elaborate a focused strategy document for sector-wide sensitizing with actions, research needs, or targeted biosecurity measures, based on the baseline diagnostics data to devise SLCMD management / mitigation plans for the short, mid- and long-term.	(a) Short-/Mid-/Long-term strategies were discussed and proposed in the group work with national partners in a result-sharing workshop in Cambodia, on 19th July, (b) most of these strategies are incorporated into the national cassava strategy under development by UNDP and GDA in Cambodia (see section 8 on problems / opportunities for an overview of strategies).	19th July	In Cambodia the proposed strategies are incorporated into the national cassava strategy. In Vietnam progress is made at the level of MARD, yet buy-in from the starch factories via VICAAS is yet to be assured
2.4	Organize a multi-stakeholder closing workshop, with involvement of government officials, plant health authorities and private sector actors to share the project's finding and present / discuss the strategy document.	(a) A results-sharing workshop for to share key findings, implications and discuss short- / mid- / long-term strategies for mitigation SLCMD held in Phnom Penh in July 2017	19th July	High-level participation was achieved and recommendations taken forward by national institutions

PC = partner country, A = Australia

3 Impacts

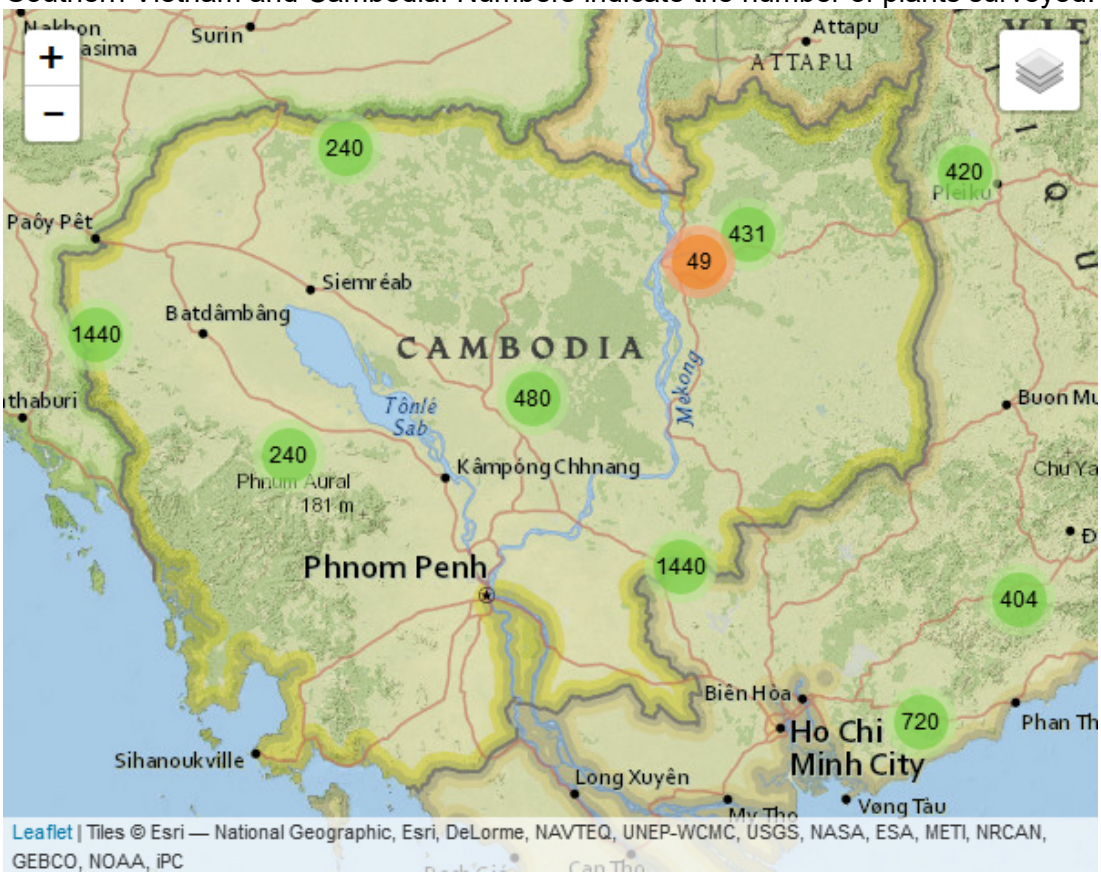
3.1 Scientific impacts

3.1.1 SLCMV spread and incidence in Vietnam and Cambodia

For virus diagnostics leaf sample collection was conducted in tandem with survey activities, covering a total of 419 fields and 6,480 plants (15 fields per district, 16 plant samples per field). We extracted total DNA from all of the samples using a modified CTAB method, and ran PCR-based diagnostics detecting the *AC1* gene of SLCMV.

In the 2016 planting season we found nine SLCMV-infected fields, which were restricted to Ratanakiri and Stung Treng provinces of Eastern Cambodia, while no infection was detected from any other sites (Figure 2). In the Ratanakiri province, where the disease had been reported in 2015, the virus occurrence was 13.3%, whereas in Stung Treng province, next to Ratanakiri, seven fields (46.6%) were infected, and four of those fields had within-field SLCMV incidences higher than 40%. The most distant infected field was approximately 70 km away from the first reporting site of 2015, indicating that the virus had already spread at least this distance by the 2016 cropping season.

Figure 2. Distribution of clustered SLCMV-infected (orange) and non-infected (green) plants in Southern Vietnam and Cambodia. Numbers indicate the number of plants surveyed.



From the surveillance in Cambodia, we found plants showing SLCMD symptoms both systemically and non-systemically (limited to upper leaves) in one field, indicating that the virus infected plant showing mosaic only on upper leaves might have been a result of insect vectoring. We also found SLCMV-infected plants exhibiting typical symptoms of cassava witches' broom disease, suggesting

the occurrence of multiple diseases in one plant. Interestingly, from Ratanakiri and Stung treng provinces, over 25% of SLCMV-infected cassava plants did not show typical visual symptoms of SLCMD. Non-symptomatic infection has not been reported commonly in other cassava mosaic diseases, and this finding raises the possibility that, unlike African cassava mosaic virus, SLCMD may be able to spread asymptomatically on Southeast Asian varieties.

Box 1. Key messages for 2016 distribution, spread, and incidence of SLCMD

1. At the time of the study, **no SLCMD-infected fields were detected in Vietnam[2]**, indicating that border control and prevention of stake imports into the country could be a possible control measure;
2. At the time of the study, **SLCMD had spread *at least* 70 km from the initial point of detection**. The geographical distribution of the detected disease in Cambodia was relatively limited, suggesting that eradication of infection hotspots was still a viable route to extinguish the disease.
3. At least one quarter of the plants infected didn't show clear symptoms of SLCMV, indicating that **spread through movement of asymptomatic, healthy looking plants and stakes is likely**. This finding aggravates the situation, and limits options for control through simple roughing or positive selection at the farm-level.

3.1.2 Seed systems and anthropogenic spread

The results of the 2-country survey showed that seed flows were heterogeneous, and depended greatly on contextual factors. Farmers in Vietnam (N=206) always used stakes produced in their own country, and more frequently acquired rather than provided stakes: 234 versus 104 transactions registered, respectively. In Vietnam, the most important sources of stakes acquisition, in order of importance, were: (i) own seed stocks, (ii) acquaintances within the community, and (iii) agroinput dealers. The most important sinks for provision in Vietnam were: (i) acquaintances within the community, (ii) agroinput dealers, and (iii) traders. Conversely, in Cambodia the import of seed from neighboring countries was relatively common, with stake acquisitions registered from Thailand, Vietnam, and in a single instance, Laos. Stakes from Vietnam in particular were transported deep into Cambodia, covering larger distances than would normally be predicted for bulky, vegetatively propagated seed. This is largely due to the nature of the Cambodian cassava value chain, which involves long transport routes for root products; an existing channel that is easily exploited to effectuate stake transport. Farmers in Cambodia also tended to be involved in more acquisition transactions than provisions. This is important as it demonstrates Cambodia's status as a sink rather than a source of seeds. This reality, due in part to environmental conditions (many areas of Cambodia experience a 3-month dry season, pushing the limits of storage for viable cassava stakes), means that Cambodia is at increased risk of phytosanitary contamination than its more self-sufficient neighbors. In Cambodia, the most common sources of stakes acquisition, in order of importance, were: (i) own seed stocks, (ii) acquaintances within the community, and (iii) traders. The most important sinks for provision in Cambodia were: (i) acquaintances within the community, and (ii) community collection points. The prevalence of traders in Vietnamese systems contrasts with the high level of interaction with community collection points in Cambodia. Figure 3 also shows variability for exchange methods.

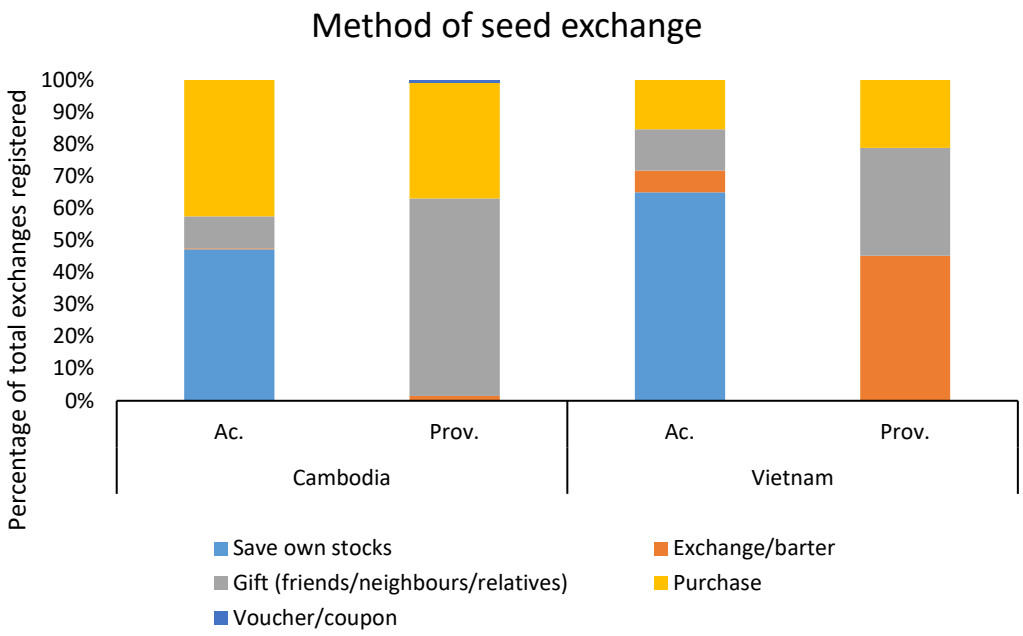


Figure 3. 100% stacked chart of stake exchange methods from the National surveys. 'Ac.' indicates seed acquisition, 'Prov.' indicates seed provision to others.

The zoom-in surveys allowed for a much higher level of resolution in terms of actors, mechanisms and sub-national dynamics. A comparison of seed networks in 2016 in Ratanakiri (expansion site in Cambodia) and Tay Ninh (established site in Vietnam) makes this very clear (Figures 4 and 5). In Ratanakiri, most exchanges were farmer-to-farmer, with traders mostly involved in seed acquisition. The 100 interviews conducted in Ratanakiri identified only a single trader in the community. Conversely, in Tay Ninh, a highly commercial production area, over 30 trader-mediated transactions were recorded, with dozens of traders in the area. Seed networks here are active and seed provision through trade networks have a large national and cross-border character. In other words, the Ratanakiri network is more inwards centered, while the Tay Ninh network reaches widely beyond the district's borders. In a sense, this is a positive finding for the possible spread of SLCMD infected materials from Ratanakiri, which does not seem to be a major source of stake export, reducing the risk of spread compared to the situation in Tay Ninh. Farmers in Tay Ninh were integrated into a highly organized trader network, with an exchange system unique in this study. Farmers indicated receiving stakes from a trader on a yearly basis, an exchange founded on the expectation that the farmer would respond in-kind by selling their next year's crop (both roots and stakes) to the same trader. These were not formal agreements, but rather informal contracts founded on sociocultural expectations from both parties. In both countries a number of inter-provincial trades were identified, with the major difference being that in Vietnam these were strictly trader-mediated transactions. Trader-mediated exchange also led to more instances in Vietnam in which the geographical origin of the stakes was unknown to the farmer.

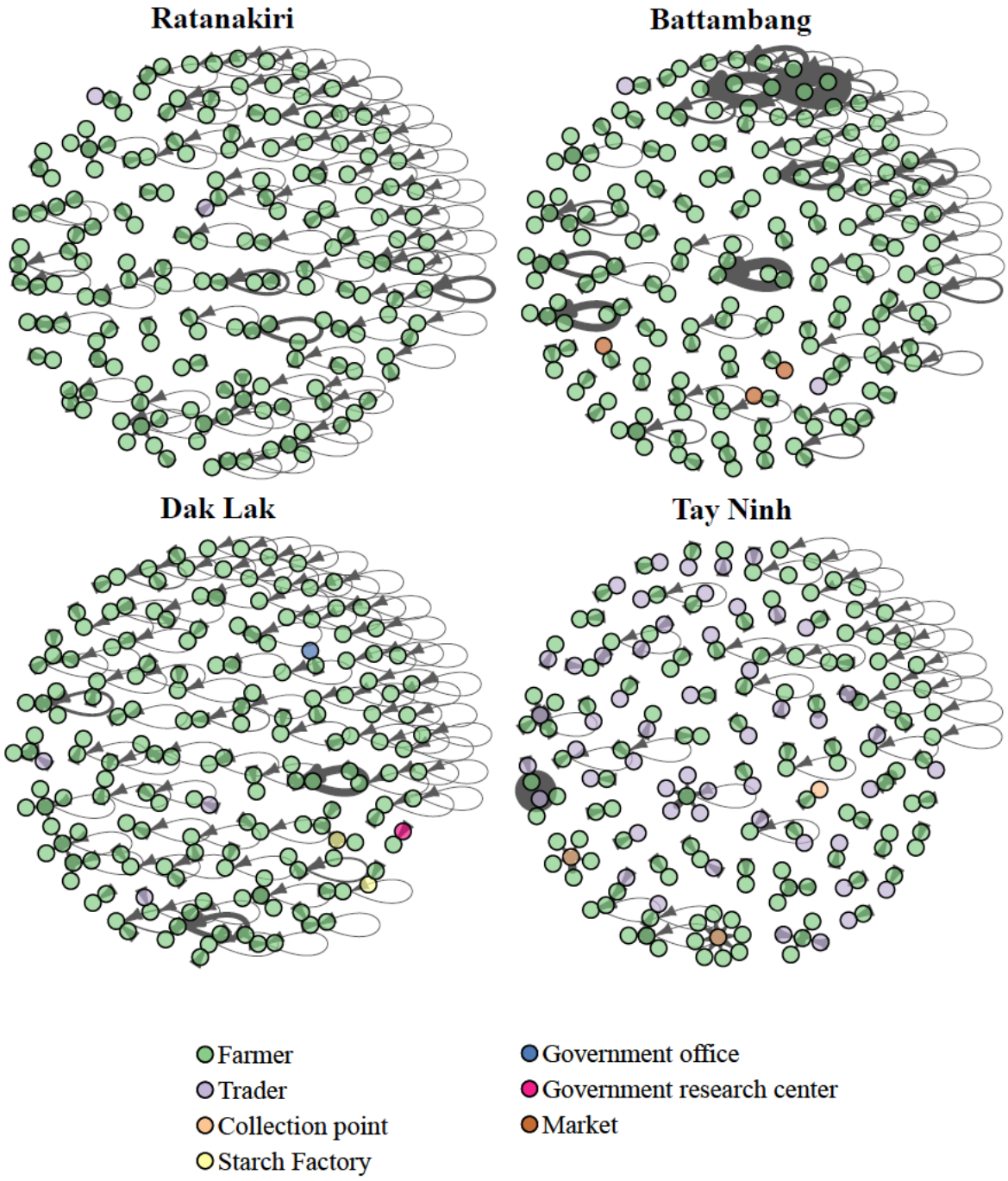


Figure 4. Network representations of stake provisioning in 4 'zoom-in' sites of Cambodia and Vietnam in 2016. Arrows indicate directionality of exchange, while line weight indicates relative volume. Node color denotes type of actor involved in exchange (see legend). Self-loops indicate provision from the farmer's own stocks from the previous year.

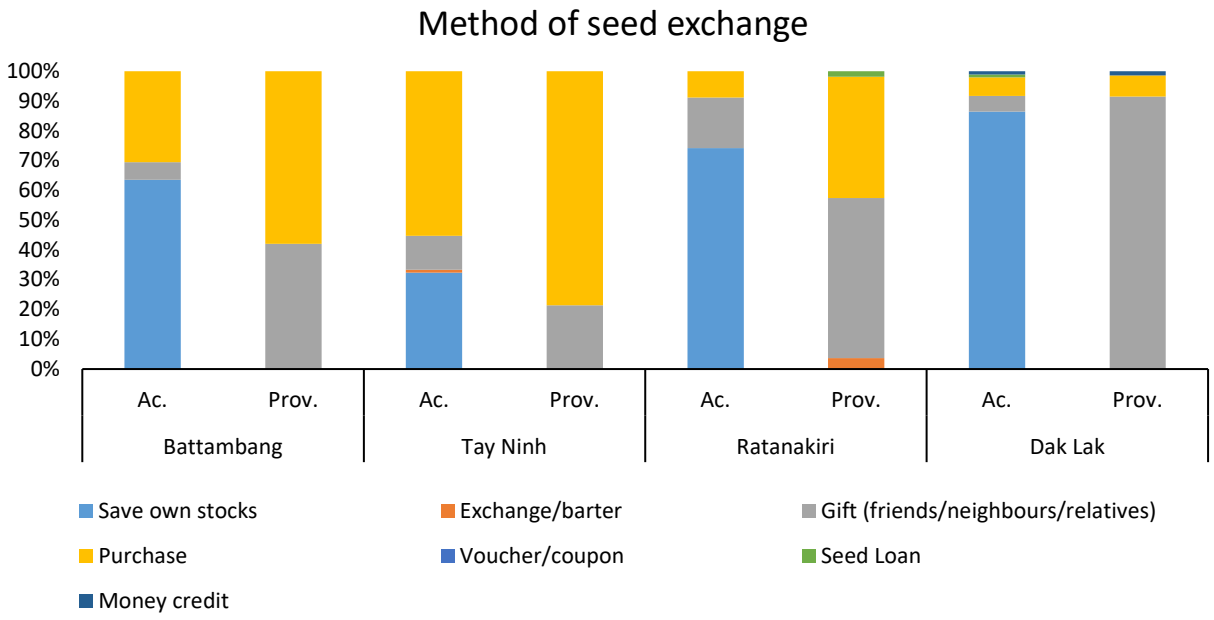


Figure 5. 100% stacked chart of methods of seed exchange in zoom-in surveys. 'Ac.' indicates seed acquisition, 'Prov.' indicates seed provision to others.

The production landscapes of the sites interviewed very much indicated a 'cassava countryside'. Overall 94-100% of respondents indicated that their production field was adjacent to at least one other cassava field, and despite low cassava prices in 2016, between 81 and 95% of respondents indicated that they would continue to grow cassava the next season. These findings suggest a context suitable for whitefly-mediated transmission of the virus. In 3 of 4 in-depth survey sites a majority of respondents indicated losses of viable stakes during storage, with losses averaging 28% of stored seed. The percentage of respondents buying new stakes in 2016 varied from 7 and 14 percent in the expansion sites (Dak Lak and Ratanakiri) to 30 and 63 percent in the established sites (Batambang and Tay Ninh; Figure 6). In the same year, respondents also reported paying higher prices for stakes in the established sites than in the newer ones. These results demonstrate that despite the prevalence of self-provisioning of stakes, a significant amount of respondents source stakes from outside their farm, and suggest the potential for clean seed schemes to make possible impacts in local seed networks.

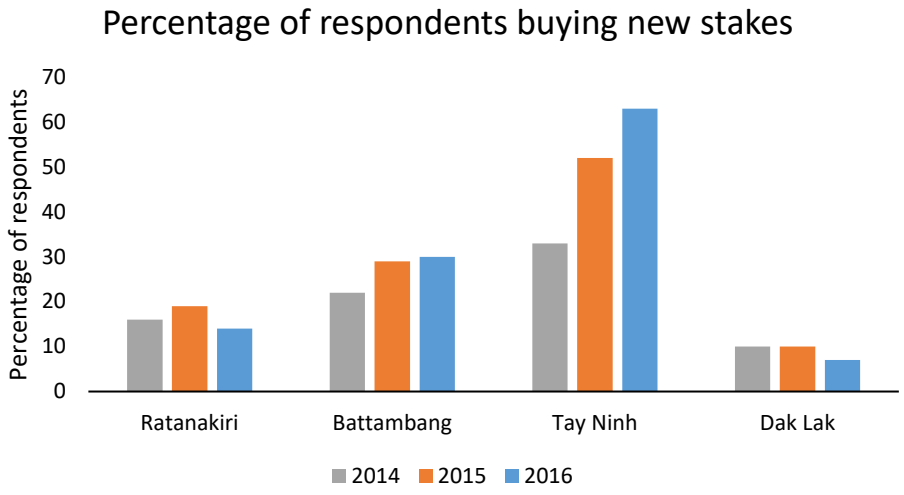


Figure 6. Percentage of respondents reporting buying stakes in the last 3 production seasons.

Box 2. Key messages as far as the 2016 cassava seed networks and likely anthropogenic spread of SLCMD are concerned

1. At the time of the study, farmers in Cambodia were found to purchase stakes from Vietnam, Thailand, and Laos. **Cross-border trade of seed penetrates deep into Cambodia**, even though self-saved seed and acquaintances within the community were more important sources of stake acquisition for Cambodian farmers.
2. Subregional district-level seed networks are highly distinct between districts. Seed networks in Ratanakiri, the province where SLCMD was first reported, are largely farmer-to-farmer based with seed acquisition flows staying within the province. Therefore **the risk of intensive anthropogenic spread of SLCMD from Ratanakiri to other provinces is relatively low.**
3. **Traders are key actors in stake provisioning beyond the community level.** Future studies on the informal seed sector should specifically target traders to better understand their networks so that lessons can be drawn on possible linkages to upgraded or clean seed interventions.
4. **Farmers already pay significant amounts of money, with regular frequency, to replenish their seed stocks**. This finding has important implications for potential phytosanitary or varietal interventions deploying through existing seed networks.

3.1.3 Whitefly biotyping

A total of 150 whitefly samples of different life stages of *Bemisia tabaci* whiteflies were collected and subjected to PCR-based genotyping and comparison with a global biotype base. Results show that 149 out of 150 samples belonged to the biotype AsiaII1 (also see annex 5). Only one sample belonged to the AsiaII6 biotype. This result is an important first step towards further intelligence concerning the insect-mediated spread of SLCMD. One biotype is predominant, but more research remains to be done on its ability to spread SLCMD, and the population dynamics of the insect in relation to the phenology of the cassava crop and the nature of its surrounding landscape.

3.2 Capacity impacts

A series of hands-on trainings were organized (see section 4 on capacity building) and also on-the-job learning through co-implementation of activities led to capacity development.

Photo A. Workshop on findings and recommendations for the project "Developing and emergency response and long term management strategy for cassava mosaic virus in Cambodia and Vietnam (July 19, 2017)

Table 2: Main short, medium and long-term options put forward and prioritized by key stakeholders for the management of SLCMD in Cambodia (results-sharing workshop Phnom Penh, July 19, 2017)

Time frame	Action proposed	Proposed actors involved
Short term	Restrict movement of planting materials from infected zones	PDAFF and local authorities
	While the current market price of cassava is not attractive try and advise farmers to temporarily change to other crops	PDAFF
	Establish country-level task force or working group to share information, progress and plan for coordinated actions. This task force is to meet every 3 months minimally	MAFF, FAO, GDA, CIAT
	Awareness raising among relevant actors, including farmers, private sector and provincial authorities	CIAT, MAFF, PDAFF, NGO's and private sector
	Ministerial Declaration (guidelines on the management of SLCMD)	MAFF, GDA, PDAFF, DoA
	Short training on the management of SLCMD to PDAFF and DoA	CIAT, GDA, FAO
	Organize awareness raising meetings to local authorities (commune, councils) and extension materials for farmers	GDA, PDAFF
	Develop extension materials (leaflets, videos, posters, apps, etc.)	GDA, FAO
	Conduct regular surveillance of disease presence and spread	GDA, PDAFF
	Develop and advocate for a compensation policy for smallholders	GDA
Medium term	Establish and promote a global information platform to facilitate access to and sharing of information	CIAT, MAFF in Cambodia and MARD in Vietnam
	Map disease incidence levels at the landscape level (geospatial fine-grained mapping)	CIAT, MAFF in Cambodia and MARD in Vietnam
	Implement quarantine measures	GDA, MPPO, FAO regional office
	Develop a platform for international coordination and co-operation that provides systematic capacities for learning and adaptation, including on improving clean seed systems and resistance breeding	FAO regional office, CIAT, GDA in Cambodia, and MARD Vietnam
	Promotion if intercropping and crop diversification strategies	MAFF Cambodia
	Clean seed system development to provide an influx and regular supply of stakes	CIAT, CARDI and UBB (Cambodia), Hung Loc (Vietnam), Private sector
	Test, develop and promote integrated disease management options	GDA (Cambodia), FAO
	Implement extension and agricultural advisory on SLCMD management	GDA (Cambodia), private sector
	Upgrade and improve the national capacity to deal with (new) invasive diseases	MAFF (Cambodia), FAO
Long term	Development of CMD resistant varieties	CIAT, Asian Cassava Breeders Network, CARDI (Cambodia), AGI (Vietnam)

3.3 Community impacts

In 12 months of implementation this SRA has been able to bring forward some important evidence in terms of the nature, spread, and management of SLCMD. A core strategy has been discussed with partners and experts on how to deal with the disease (see section 8 of this report). As a next step, the strategy need to be implemented to trigger on-the-ground impact.

3.3.1 Economic impacts

Like other, closely-related cassava mosaic viruses, it is anticipated that SLCMD will have an impact on yield, and therefore also on the economic performance of the cassava crop in Southeast Asia. Furthermore, the development of clean seed systems will require an economic rationale based on willingness to pay, and real demand. We also hope that our SRA activities will inform preventative measures by the respective governments involved, and thereby help to mitigate economic losses. Our current findings do not yet have the benefit of data on yield or economic impacts due to this disease.

3.3.2 Social impacts

The main social impact to date has been at the level of stakeholder engagement. Both in Vietnam and Cambodia, the SRA team has been actively participating in country-level coordination meetings. This has contributed to better information sharing and synergy, even though the main recommendation of forming country-level task forces remains to be implemented (see sections 3.2 and 8). CIAT has contributed to many high-level political activities to better inform authorities or the realities of this phytosanitary emergency. Cumulatively, this has led to several actions at the highest level both in Vietnam and Cambodia.

To give an example, in April, 2017 Dr. Nguyễn Văn Liêm, the director of the Vietnamese Academy of Agricultural Sciences (VAAS) directed a letter to the Vice Minister of Agriculture Dr. Lê Quốc Doanh from the Ministry of Agriculture and Rural Development (MARD) with the following recommendations:

"*Based on the complex situation and risk of spreading the disease to Vietnam, PPRI would like to propose the following methods: (i) Strengthen plant quarantine at border gates between Vietnam and Cambodia, Vietnam and Laos, (ii) Do not transport, trade or exchange cassava between Vietnam and Cambodia, Vietnam and Laos. MARD should allocate budget for some following important activities: (i) Investigate, do survey and collect samples of cassava and white flies in Vietnam's cassava planting areas, (ii) Apply molecular techniques to inspect and detect the presence of pathogenic viruses on samples of cassava and white flies collected, (iii) Localize and eliminate disease hotspots before it spreads and caused more outbreaks*."

In September, 2017, the Cambodian Ministry of Agriculture, Forestry and Fisheries (MAFF) released an announcement on the outbreak and prevention of SLCMD in Cambodia to all national cassava stakeholders. The letter requests projects and initiatives to coordinate closely with the General Directorate of Agriculture (GDA) of MAFF. The announcement was signed by Minister of MAFF (see Annex 3).

3.4 Communication and dissemination activities

The SRA team has participated in numerous events in Vietnam and Cambodia to share results, including workshops organized by JICA, GIZ, FAO, and other agencies not directly involved in the research. The two first manuscripts generated from these activities are nearing submission to a peer reviewed journal and we foresee publication late 2017 or early 2018. A poster was developed for the ACIAR North-West Vietnam Research Symposium to be held on 23 & 24 November in Hanoi, Vietnam. These activities will help to bring more widespread academic and political interest to the issue. Furthermore, the SRA team has been working on producing more applied communication materials for extension and awareness raising, which will be finished during the second phase of the SRA (year 2).

4 Training activities

During the first phase of the SRA (2016-2017), several training activities were organized to enhance the capacity of partners in sampling methods, and to co-prioritize possible control measures based on the main project results (see Table 3). To implement standardized survey protocols, field survey trainings were conducted in (i) Hung Loc station in Dong Nai province, Vietnam and (ii) Phnom Penh & Dambae district, Tboung Khmum province, Cambodia. Three survey teams in Vietnam (for Northern/Central/Southern region) and two in Cambodia (for Western/Eastern region) were trained. These methods and the skills they entail, although modified for specific application under the current project, reflect a robust methodology which can be re-applied in future monitoring scenarios.

Table 3: Overview of training events held in year of the SRA

Date	Training	Organizations	Number of Participants
Sept. 2016	Field survey training in Vietnam	Plant Protection Institute, Plant Protection Department, Institute of Agricultural Sciences	12
Nov. 7-10 2016	Field survey training in Cambodia (see annex 5)	General Department of Agriculture, Provincial Department of Agriculture	6
Mar. 1-3 2017	In-depth seed system survey training (Tay Ninh province, Tan Chau, Vietnam)	Institute Agricultural Sciences, Hung Loc research station	3
Mar. 5-7 2017	In-depth seed system survey training (Battambang province, Rattanak Mondul district, Cambodia)	Battambang University	4
March 9-11 2017	In-depth seed system survey training (Ratanakiri province, Koun Mom district, Cambodia)	Royal University of Cambodia	9
March 16-18 2017	In-depth seed system survey training (Dak lak province)	Tay Nguyen University	5

Photo B. Finding a survey route in the training workshop.

Photo C. Practice in interviewing for quick seed system survey.

Photo D. Plant sample collection.

Photo E. Seed systems interview.

5 Intellectual property

No intellectual property was derived on any of the research conducted in the SRA. All the data generated is open access and available as per the CGIAR Open Access and Data Management Policy (https://cgspace.cgiar.org/handle/10947/4488). The datasets pertaining to the two manuscripts that are about to be submitted will be also be published as data papers.

6 Variations to future activities

The new activities are planned as foreseen in the extension of the SRA, specifically variation 1. The following objectives and activities were added:

Activity 1.8 Develop georeferenced global database (utilised by multiple stakeholders) that keeps accurate spatial and temporal dynamics of invading pathogen populations with the dynamics and intensity of a surveillance system.

Objective 3. Enhance diagnostic capacity of national partners utilising existing technology, evaluate improved diagnostic technologies utilising NGS technology and the feasibity of different short-term control measures

Activity 3.1 Provide hands-on capacity building on PCR-based, virus sequence analysis and field diagnostics that can be applied by national partners and different primer options such that national programs can also contribute autonomously to surveillance and study the effects of control and/or further spread and evolution of the disease.

Activity 3.2 Evaluate Next Generation Sequencing (NGS) applied to diagnostics to track the occurrence of other cassava-infecting viruses in symptomatic and asymptomatic plants

Activity 3.3 Conduct a feasibility study of different practical and more advanced options (isolation, QDS, etc.) to support ongoing surveillance, diagnostics, and multiplication of clean materials through private-public partnerships. This activity will be conducted in conjunction with AGB/2012/078 and ASEM/2014/053.

7 Variations to personnel

Generally all went as planned. A major role in implementation was played by young CIAT staff, particularly Nami Minato and Erik Delaquis, who very effectively coordinated the field work on the ground with national partners. CIAT-Asia's senior entomologist (Dr. Kris Wyckhuys) has recently left the centre, leaving a gap in terms of the project's capacity to deal with insect vectors and agroecological linkages. During the extension phase we will make sure that this gap is filled by involving other experts.

8 Problems and opportunities

Challenges have arisen during the course of project implementation, including at the technical, organizational and institutional levels. Yet, this is to be expected when dealing with a new and potentially devastating disease for a regionally important economic cash crop. Technical challenges specifically related to the in-country capacity to deal with PCR analysis for large amounts of samples within a short timeframe. This turned out to be difficult to solve without major investments in capacity development and capital investment. After exploring a range of options, we decided to work with the laboratory of CATAS, the Chinese Academy of Tropical Agricultural Sciences, to process and analyse samples. Organizational challenges were basically related to the national partner's expectations and the need to handle and cluster over 6000 plant samples from 2 countries. These challenges were of a practical nature and fairly easily overcome. The main challenge for sustainability, outreach, and impact relates to the need for a multisector, interdisciplinary, and collective effort. Many new and scattered initiatives using a vast range of approaches have popped up in response to the presence of SLCMD in Cambodia. The uncoordinated nature and lack of central control in this process has meant that information sharing and complementary investments have not been optimal.

A clear opportunity thus resides in the need for leadership in collective action to deal with the complex problem of SLCMD spread and incidence. While it is a problem that different actors have not nearly been working together on in a coordinated matter, this is an opportunity for the involved countries to show leadership and capacity to collaborate in forming a coherent response. For example, in Cambodia it has been proposed at several occasions to form a task force or working group to bring different actors together. This is needed, but CIAT is probably not the optimal institution to lead this. National governmental institutions, such as MAFF, GDA, and MARD or organizations such as FAO have mandates that position them effectively in such a regard. These institutions can be the 'neutral brokers' to bring people together, eventually through a governance structure such as a steering committee.

CIAT, through participation in multi-stakeholder workshops and consultations with a wider range of experts (including those working on the African strain of CMD), was able to compile a range of strategies that can help to deal with the SLCMD disease outbreak. The strategies outlined below offer opportunities for collective action, innovation, and investment.

<u>Short term strategy:</u>

- Establishment of a **national coordination platform** (technical working group) to facilitate, coordinate and streamline information, program investments and interventions.
- Implementation of a scheme with a clear incentive system for farmer-level **eradication and replacement**. Government work with farmers in the worst affected areas to burn all top growth and stumps during the 2017 upcoming harvest, with the guarantee that farmers will be either provided with clean planting materia,l or be compensated financially.
- Implementation of **quarantine measures** that restrict the movement of infected planting materials out of infected areas, and stimulate the use of clean planting materials in regions that are currently disease-free. Ideally quarantine would address cross-border stake movement, national stake movement from infected areas, declaration of clean production areas and farmer seed lots coming from these areas.
- Implementation of **capacity building, awareness raising, and extension**, including the development of adequate communication materials. This must happen at all levels (from technicians to farmers), and be linked to an **integrated disease management plan** that takes into account applied options for control.
- Set up a system for **near-real-time intelligence of disease** presence and incidence. This could be though an open platform able to handle large volumes of data (including imagery),

and different types of observations from symptom recognition to PCR-based diagnosis, and then to quickly inform users.

Mid term strategy:

- Development of **clean seed systems** for the provision of quality, clean cassava stakes. This would include pipeline management from in-vitro to open field multiplication, business development, and different levels of engagement from farmer seed, quality declared seed (QDS), and formally certified seed. Physical isolation and seed management can be implemented at higher elevations, where whiteflies do not occur.
- Set up a **network of degeneration trials** with popular varieties and susceptible / resistant checks to determine degeneration rates, yield, and economic impacts of SLCMD infections. This is an important unknown, and essential to promote viable seed businesses.

Long term strategy:

- Initiation of a **SLCMD resistance breeding program,** with a focus on mainland Southeast Asia and its variety ideotypes. Different options exist, ranging from classical breeding using known sources of resistance, transgenic approaches, and clonal / candidate variety testing schemes using existing materials from CTCRI India. The Asian Cassava Breeders Network or ACB-Net could play a logical facilitating role in this activity.

9 Budget

See financial report provided by CIAT for details.

Annex 1: Seed Systems Survey (zoom-in, farmers)

INDIVIDUAL FARMER DETAILED INTERVIEW

Oral previous informed consent:

We are here to conduct a study about cassava production in the region. We would like to ask you a series of questions which will take approximately 45 minutes of your time. Your opinion is very important to us. Participation is voluntary, and if you are not willing or able to participate, please let us know. Your records will be kept confidential, and no personally identifiable information will be released to anyone (government or other). Your name is recorded only so we can contact you again if necessary. In the final report your name will be removed and your identity kept private. This research seeks to study the movement of plant materials to protect cassava growers from seed-borne diseases. In the eventual case that serious diseases may be discovered, government agencies may take approved actions in the region based on these findings. In such cases they will do so in accordance with existing local regulations. You may withdraw from this survey at any time, or refuse to answer specific questions. You reserve the right to request a summary of the results of the survey after the study is complete. Thank you for your participation.

Please complete the questionnaire by interviewing the male or female head of the household.

Please give currency amounts in Cambodian Riel/Vietnam Dong; use the conversion rate 1 Thai Baht = 120 Cambodian Riel

For multiple choice questions please select the letter for **ALL** answers that apply.

a) 1. RESPONDENT INFORMATION

1.1 Questionnaire # _____
1.2 Enumerator _____
1.3 Date of interview_____
1.4 Name of household head _____
1.5 Male (✓) _____ or Female (✓) _____
1.6 Commune _____
1.7 District _____
1.8 Province _____
1.9 Latitude GPS _____ / Longitude GPS _____
1.10 Interview location
- ☐ Home
- ☐ Field
- ☐ Community meeting area
- ☐ Other (specify)_____

1.11 Telephone number _____

b) 2. HOUSEHOLD AND SEED USE OVERVIEW

2.1 Number of people living in your household

Adults (over 16) _____ Youth (under 16) _____

2.2 How many household members are involved in full-time farming activities? _____

2.3 What is the total size of your farm (all cropped land)? Total area _____ hectares

2.4 How much of this area is planted with cassava (in 2016)? A. _____ hectares, B. _____ No. of plots, C. _____ total number of varieties.

2.5 How long have you been growing cassava? _____ years

2.6 Is a neighboring field (immediately next to your property) also growing cassava? (Y / N) _____

2.7 Do you plan to continue growing cassava next year? (Y / N) _____

2.8 Why or why not? _____

2.9 **Varietal portfolio.** Please fill all the following information you can from each of the varieties you currently grow.

#	Variety (name)	Where did it first come from? (ex. Commune, province, as precise as possible)	Obtained from (source CODES)	Person / place name	First acquired by (see codes below)	Year of initial acquisition	Quantity initially obtained	
							(# of bundles)	# of stakes / bundle
1								
2								
3								
4								
5								

Sources of seed: CODES	First acquired: CODES
1) Friend / neighbor / relative within the community 2) Friend / relative from outside the community 3) Local rural market 4) Regional rural market 5) Agroinput dealer (also providing chemicals) 6) Cassava / starch factory 7) Collection point in the village 8) Community group 9) Trader (those with truck) 10) Government extension agency 11) Municipality, district office (government) 12) Government research organization 13) International NGO / development organization 14) National NGO / development organization 15) Other farmer I don't know personally 16) Other (specify)	A= exchange/barter B= gift (friend/neighbor/relatives) C= purchase/buy) D= vouchers/coupons E= seed loan F= money credit G= other (specify)

c) 3. AVAILABILITY / SUPPLY

3.1 2016 Seed acquisitions. Please fill the table below. Use one row for <u>each transaction</u> (sourcing of stakes) you have used for <u>this year's</u> planting.

#	**Source of stakes** (See codes below; please list all that apply to you)	**How acquired** (See codes below)	**Quantity**		**Quality of stakes** G=good A=avg P=poor	**If paid for, price per bundle**	**Use these again next season?** Y= Yes N= No	**Where did it come from?** (location)	**Obtained from** (name of person, market, or source)	**Variety** (name)
			(# of bundles)	# stakes /bundle						
1										
2										
3										
4										
5										

Sources of seed: CODES
1) Friend / neighbor / relative within the community
2) Friend / relative from outside the community
3) Local rural market
4) Regional rural market
5) Agroinput dealer (also providing chemicals)
6) Cassava / starch factory
7) Collection point in the village
8) Community group
9) Trader (those with truck)
10) Government extension agency
11) Municipality, district office (government)
12) Government research organization
13) International NGO / development organization
14) National NGO / development organization
15) Other farmer I don't know personally
16) Own seed stock from last year

How acquired: CODES
A= save/own stocks
B= exchange/barter
C= gift (friend/neighbor/relatives)
D= purchase/buy)
E= vouchers/coupons
F= seed loan
G= money credit
H= other (specify)

3.2 2016 Season Provisions. Please fill the table below. Use one row for <u>each transaction</u> (provision of stakes) you have provided to others / third parties using material from your own 2015 planting. If none, mark an X in the first row.

#	**Receiver of stakes** (See codes below; please list all that apply to you)	**Where are they located?** (Precise location)	**What is the name of the person you provided to?**	**How provided** (See codes below; please enter all that apply to you)	**Quantity**		**If paid for, price per bundle**	**Quality of stakes** G=good A=avg P=poor	**First time or repeated transaction?** 1 = first 2 = repeated	**Variety** (name)
					# bundles	# stakes / bundle				
1										
2										
3										
4										
5										

Sink of seed: CODES
1) friend/neighbor/relative
2) local market
3) agro-input dealer/factory
4) community group
5) government
6) NGO /FAO
7) other farmers (I don't know personally)
8) other (specify)
9) trader

How provided: CODES
A= exchange/barter
B= gift (friend/neighbor/relatives)
C= sell
D= vouchers/coupons
E= seed loan
F= money credit
G= other (specify)

3.3 In which cases have you used planting material from outside your own farm?
a) Only once when first began farming cassava
b) When a new variety was available
c) When own stakes were lost (drought, flood, etc.)
d) When own stakes lost vigor (degeneration)
e) On a regular basis to improve seed stock
f) Other _____

3.4 In normal conditions, how often do you source stakes from outside your farm?
a) Never
b) Every year
c) Every 2-3 years
d) Every 3+ years

3.5 Under typical / normal circumstances, from how many different sources do you get stakes during the year you acquire planting material?
a) Only 1
b) Two
c) Three
d) Four
e) More than four
f) Does not apply to me

3.6 Under typical / normal circumstances, during years when you purchase stakes, how much of the total cassava area you grow is planted with the new stakes.
a) <25%
b) 50%
c) 75%
d) 100%
e) Does not apply to me

3.7 Are you satisfied with the stake sources available to you?
a) Satisfied
b) Somewhat satisfied
c) Not satisfied

3.8 Why or why not?
_____

3.9 For your particular situation, what are the most important sources of seed stakes (rank 1, 2, 3, with 1 being the most important) and which ones do you consider most trustworthy (rank 1, 2, 3 from most to least trustworthy)?

Source	**Importance Rank / importance (1,2,3)**	**Trustworthy Rank / importance (1,2,3)**
1. Friend / neighbor / relative from within the community		
2. Friend / relative from outside the community		
3. Local rural market		
4. Regional rural market		
5. Regional urban market		
6. Agroinput dealer (also providing chemicals)		

7. Cassava / starch factory		
8. Collection point/silo		
9. Trader (those with truck)		
10. Community group		
11. Government extension agency		
12. Municipality, district office (government)		
13. Government research organization		
14. International NGO / development organization		
15. National NGO / development organization		
16. Other farmer I don't know personally		
17. Others		

3.10 How do you contact stake traders?

a) I don't contact stake traders
b) Trader is in the community
c) Trader visits seasonally
d) Family or friend (personal relationship)
e) Telephone with trader (relationship already established)
f) Other _____

3.11 What other services do traders provide to you?

a) Purchase fresh roots
b) Purchase chips
c) Provide credit
d) Sell agro-chemicals
e) Other _____

3.12 Are you satisfied with your relationship with traders?

a) I have no contact with stake traders
b) Yes
c) Sometimes
d) No

3.13 If not, why? _____

3.14 Please list the traders you bought/sold with in 2016 (If no trader interaction, mark an X)

#	Name	Location	Telephone #
1			
2			
3			
4			

3.15 In this last season, did you have any losses of seed that was stored?

a) No
b) Yes

3.16 If yes, what % was lost? _____ %

3.17 Was this more or less than in past years?

a) Less
b) More

c) Same
d) Does not apply to me

3.18 If yes, what was the cause of loss (previous season only)?

_____

3.19 In the last 5 years, have you ever received /obtained a new cassava variety?
a) No
b) Yes

d) 4. QUALITY

4.1 Have you ever participated in a training which discussed cassava seed quality? If yes, with whom?
a) No I have not
b) Yes, with an NGO
c) Yes, with a government project
d) Yes, with a commercial group (for example agribusiness dealer, cassava processing factory)

4.2 When you select your stakes from your own planting, how do you decide on whether the stakes are good to use as next year's planting material (Note you can circle more than one)?
a) I just keep everything / all stakes for planting next season (no particular practice)
b) I discard stakes that are too weak (small, thin, few buds) (Negative selection based on morphological traits)
c) I discard unhealthy-looking stakes with visible pest / disease symptoms (Negative selection based on phytosanitary traits)
d) I only select stakes that are vigorous (long, erect, thick, many buds) (Positive selection based on morphological traits)
e) I select healthy-looking stakes without visible pest / disease symptoms (Positive selection based on phytosanitary traits)

4.3 How do you usually store stakes before planting?
a) In the field (standing)
b) Under a tree (standing)
c) Under a roof (standing)
d) Under a roof (laying down)
e) Other _____

4.4 Do you treat your stakes during storage and before planting?
a) No
b) Yes, chemical during storage
c) Yes, stake dip just before planting
d) Other _____

4.5 If yes, which product(s) do you use?

_____
_____

4.6 Do you consider the way you store seed to be adequate?
a) Yes
b) No

4.7 What quality indicators do you consider when selecting stakes? In other words, how do you decide a stake is good yes or no? Please list the things you look for from most important to least (ex. Number of buds, length of stakes, width of stakes, clean bark, presence of insects, freshness of stakes, etc.)

1 _____
2 _____
3 _____
4 _____
5 _____

4.8 Do you treat plants or plots that you will use as next year's planting material differently?

a) No, all plants and plots are treated the same (stakes are selected from the bulk)
b) Yes, I plant a separate plot for next year's planting materials and provide it with special care
c) Yes, I earmark the plants that I will use for next year's planting materials and provide them with special care

4.9 If YES to question 4.8 what differential treatment do you give the plots / plants?

a) Different within-field spacing / planting distance
b) Different cropping area (isolated / higher altitude)
c) Different soils (i.e. new or fertile soils)
d) Different / better care for pest and diseases (more careful)
e) Different / better fertilizers to stimulate growth
f) Other_____

4.10 Do you note that the production of cassava changes if you keep on planting the same materials year after year?

a) Production does not change
b) Production goes down
c) Production goes up
d) I do not notice

4.11 Do you use pesticides (Y / N)? If yes, which ones?

_____

4.12 Have you seen any pests or diseases on your cassava this year? If yes, what symptoms have you noticed?

_____
_____
_____
_____

4.13 In your opinion, which problems most affect cassava planting materials in your area? Please rank with 1 being the most important. You do not need to rank all the options, only the ones you believe play a role.

__Pests
__Disease
__Soil quality
__Weather
__Excessive sprouting
__Lack of proper storage
__Price
__Availability

4.14 When you acquire stakes, how do you assure the quality is decent?

a) I don't know / no way to know
b) I travel and go and see the source where the stakes are produced
c) I trust the provider
d) I check the quality of the stakes visually when acquiring
e) I get assurances from the provider

f) I do not buy stakes

4.15 If you answered E to question 4.14, what kind of assurances do the providers provide?

a) They will buy my production
b) They show a certificate
c) They know the source of the stakes
d) Other _____

4.16 Who makes decisions for the household on acquiring stakes?

a) Male head of household
b) Female head of household
c) Decision is made together
d) Other_____

4.17 Please fill the below calendar by checking (X) the months that apply for each activity

Cassava stakes	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Selling												
Buying												
Planting												
Harvesting												

4.18 Have you ever heard of Vietnam / Cambodia's seed law and what it proposes?

a) Yes
b) No

4.19 Have you ever heard of certified planting materials and what it entails?

e) Yes
f) No

4.20 If the market would offer certified seed, that is seed with a label or certificate that says its quality is guaranteed, would you trust and buy it?

a) No
b) Yes
c) Yes, but only if _____

g) 5. AFFORDABILITY / PROFITABILITY

5.1 Do you believe that poor seed quality reduces your final cassava yield?

a) No reduction
b) Small reduction
c) Some reduction
d) High reduction
e) Not sure

5.2 What is the average cost of cassava stakes in your area in a normal year? _____ Cambodian Riel / Vietnam Dong per bundle, _____ = number of stakes per bundle.

5.3 Importance of cassava to total income? ____ (%)

5.4 How much money (in Cambodian Riel/Vietnam Dong) have you spent on cassava stakes in the last 3 years?

2016: _____
2015: _____

2014: _____

5.5 How did your income from cassava this past season compare to previous years?
a) Lower than previous years
b) Same as previous years
c) Higher than previous years

5.6 How willing would you be to pay for stakes of higher quality?
a) Not willing
b) Somewhat interested
c) Very interested
d) Depends on available funds
e) Not sure/undecided
f) Priority to spend on something else

5.7 If willing, what is the highest price you would pay for guaranteed good quality stakes? _____ Cambodian Riel / Vietnam Dong per bundle

h) 6. INFORMATION SOURCES

6.1 From which sources do you get your information about new varieties?

Type	**Name of person/organization**
a) Friends/relatives/neighbors	
b) Traders	
c) Government extension	
d) NGO/project	
e) Media (internet/radio/pamphlets)	
f) I have not heard about any new varieties	

6.2 Have you ever accessed the internet to look for information about cassava health?
a) Yes
b) No

6.3 If yes, what did you use to access the internet?
a) Computer (personal)
b) Computer (outside home)
c) Smartphone/tablet

6.4 Did you find any useful information, and if so where?
a) No
b) Yes, on government website
c) Yes, on NGO website (name) _____
d) Yes, on social media
e) Yes, other_____

6.5 Where did you get information about cassava health this year? Put an X in the first row if you got no information

#	**Source of information** (CODES)	**Name of person or organization**	**Type of information received** (Disease management, variety information, soil fertility, etc.)	**Source type** (CODES)	**Location of info source** (Commune, province, be as precise as possible)	**Level of trust in this information source** (1 lowest, 4 highest)
1						

2						
3						
4						
5						

Sources of information: CODES	**Source type: CODES:**
1) Friend / neighbor / relative within the community 2) Friend / relative from outside the community 3) Local rural market (please name) 4) Regional rural market (please name) 5) Agroinput dealer (also providing chemicals) 6) Cassava / starch factory 7) Collection point in the village 8) Community group 9) Trader (those with truck) 10) Government extension agency 11) Municipality, district office (government) 12) Government research organization 13) International NGO / development organization 14) National NGO / development organization 15) Other farmer I don't know personally 16) Media (Print, TV, radio, internet, etc.)	1) Personal communication 2) Printed document 3) Radio 4) Internet 5) Government extension officer - training 6) NGO-training 7) TV

6.6 Have you heard anything about Cassava Mosaic Virus Disease? If so, where did you hear it from?

Type	**Name of person/organization**
a) Friends/relatives/neighbors	
b) Traders	
c) Government extension	
d) NGO/project	
e) Media (internet/radio/pamphlets)	
f) I have not heard about CMVD from anyone	

Annex 2: Protocol PCR-based white-fly taxonomy

Whitefly DNA Extraction-Chelex 100

Chelex 5% Solution Preparation

5g of Chelex 100 sodium from (50-100 mesh) in 100 ml of autoclaved distilled water.

DNA Extraction

1. Place one single insect of whitefly using the pipette in a 0.2 ml Eppendorf tube containing from 30 to 50 µl of Chelex 5% solution.
2. Smash the insect in the solution using a smasher.
3. Vortex the tube for a few seconds.
4. Centrifuge for a few seconds (Spin).
5. Incubate at 56˚C for 15 minutes.
6. Vortex the tube for a few seconds.
7. Centrifuge for a few seconds (Spin).
8. Incubate at 99˚C for 8 minutes.
9. Centrifuge for 5 minutes at 13.000 rpm.

Reference

WALSH P, METZGER D, HIGUCHI R. Chelex-100 as a medium for sample extraction of DNA for pcr-bases typing from forensic material. Biotechniques v.10, p.506-513, 1991.

PCR conditions are: a 23 µl PCR reactions

	Volume (μl)
1. Template	3.0
2. Master mix	12.5
3. Bt-forward	1.0
4. Bt-reverse	1.0
5. water	4.5
Total	23

Polymerase Chain Reaction (PCR)

PCR reactions heated at 94°C for 2 min followed by 35 cycles

Denaturation	94 °C	20	sec
Annealing	60 °C	30	sec
Extension	72 °C	1	min
Final extension	72 °C	10	min

Primer name sequence (5' to 3')

Bt-forward TGRTTTTTTGGTCATCCRGAAGT

Bt-reverse TTTACTGCACTTTCTGCC

Reference

Shatters, Jr., R.G. C. A. Powell, **L. M. Boykin**, H. Liansheng, and C. L. McKenzie. 2009. Improved DNA Barcoding Method for *Bemisia tabaci* and Related Aleyrodidae: Development of Universal and *Bemisia tabaci* Biotype-Specific Mitochondrial Cytochrome c Oxidase I Polymerase Chain Reaction Primers. Journal of Economic Entomology 102(2): 750-758.
http://ddr.nal.usda.gov/bitstream/10113/29041/1/IND44197972.pdf

Annex 3: Announcement on the outbreak and prevention of SLCMD in Cambodia from MAFF

ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

លេខ ៧៥៥ កសក.សជណ

សេចក្តីជូនដំណឹង
ស្តីពី
ការបង្ការ និងទប់ស្កាត់ការរាតត្បាតនៃជំងឺម៉ូសាអ៊ិក
(Cassava Mosaic Disease - CMD) **នៅលើដំណាំដំឡូងមី**

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ សូមជូនដំណឹងដល់បណ្តាក្រុមហ៊ុន អាជីវករ អ្នកនាំចូល និងផ្គត់ផ្គង់ចែកចាយពូជដំណាំដំឡូងមី ជាពិសេសបងប្អូនប្រជាកសិករដែលដាំដំឡូងមីទាំងអស់នៅក្នុងព្រះរាជាណាចក្រកម្ពុជាឱ្យបានជ្រាបថា ជំងឺម៉ូសាអ៊ិក (Cassava Mosaic Disease-CMD) ជាប្រភេទជំងឺដ៏កាចសាហាវមួយរាតត្បាតលើដំណាំដំឡូងមី ដែលបង្កឡើងដោយវីរុសជីមីនី (*Gimini virus*)។ តាមរបាយការណ៍របស់អ្នកជំនាញការអន្តរជាតិនានា ទិន្នផលរបស់ដំណាំដំឡូងមីនៅបណ្តាប្រទេសមួយចំនួនក្នុងទ្វីបអាហ្វ្រិក ប្រទេសឥណ្ឌា និងប្រទេសស្រីលង្កា ដែលទទួលរងការរាតត្បាតពីជំងឺនេះ បានធ្លាក់ចុះរហូតដល់៨០ភាគរយ។ ការរាតត្បាតនៃជំងឺវីរុសថ្មីនេះ បើមិនត្រូវបានគ្រប់គ្រងដោយប្រសិទ្ធភាពទេនោះ ពិតជានឹងបង្កផលប៉ះពាល់យ៉ាងធ្ងន់ធ្ងរចំពោះផលិតកម្មដំណាំដំឡូងមី និងការនាំចេញផលិតផលដំឡូងមីទៅកាន់ទីផ្សារអន្តរជាតិនៅក្នុងពេលខាងមុខជាក់ជាមិនខាន។ មកទល់ពេលបច្ចុប្បន្ននេះ ពុំទាន់មានថ្នាំកសិកម្មដែលមានប្រសិទ្ធភាពអាចកម្ចាត់ជំងឺម៉ូសាអ៊ិកនេះបាននៅឡើយទេ។

រោគសញ្ញារបស់ជំងឺម៉ូសាអ៊ិក គឺដំឡូងមីមានស្លឹករួញ មានចំណុចតូចៗជាច្រើនពណ៌លឿង ឬស្លែកនៅលើផ្ទៃស្លឹក និងដើមក្រិនលូតលាស់ខ្សោយជាងធម្មតា។ ជំងឺនេះឆ្លងដោយការប្រើប្រាស់ពូជដែលមានជំងឺស្រាប់ ហើយដែលត្រូវចម្លងទៅចម្ការដំណាំដំឡូងមីដទៃទៀតតាមរយៈរុយពណ៌ស (White fly) ដោយការជញ្ជូនរបស់វា។

ក្នុងគោលបំណងដើម្បីទប់ស្កាត់ការរីករាលដាលនៃជំងឺខាងលើ ធានានិរន្តរភាពនៃផលិតកម្ម និងការនាំចេញផលិតផលដំឡូងមី ឆ្លើយតបទៅនឹងលក្ខខណ្ឌតម្រូវអនាម័យ និងភូតគាមអនាម័យនៃប្រទេសនាំចូល ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ សូមណែនាំដល់គ្រប់អង្គភាពពាក់ព័ន្ធក្រោមឱវាទ មន្ទីរកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ រាជធានី-ខេត្ត បណ្តាក្រុមហ៊ុន អាជីវករអ្នកនាំចូល និងផ្គត់ផ្គង់ចែកចាយពូជដំណាំដំឡូងមី ព្រមទាំងបងប្អូនប្រជាកសិករដែលដាំដំណាំដំឡូងមីទាំងអស់ ចូលរួមសហការអនុវត្តនូវវិធានការមួយចំនួនដូចខាងក្រោម៖

១- សមត្ថកិច្ចជំនាញអនាម័យ និងភូតគាមអនាម័យនៃអគ្គនាយកដ្ឋានកសិកម្ម ត្រូវសហការជាមួយមន្ទីរកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ រាជធានី-ខេត្តដែលទទួលរងការឆ្លងជំងឺ ដើម្បីបន្តការស្រាវជ្រាវ ពិនិត្យ តាមដាន និងវាយតម្លៃសភាពការណ៍នៃការឆ្លងជំងឺនេះ និងអនុវត្តវិធានការភូតគាមអនាម័យពាក់ព័ន្ធ ដើម្បីកម្ចាត់ និងទប់ស្កាត់ការឆ្លងនៃជំងឺនេះទៅបណ្តាតំបន់ ឬបណ្តាខេត្តផ្សេងទៀតទូទាំងព្រះរាជាណាចក្រកម្ពុជា។

២- មិនអនុញ្ញាតឱ្យលើកពូជដំឡូងមីចេញពីតំបន់ដែលរងការឆ្លងជំងឺ យកទៅដាំដុះក្នុងទីកន្លែងដទៃទៀតក្នុងខេត្ត និងតាមបណ្តារាជធានី-ខេត្តដទៃទៀតក្នុងព្រះរាជាណាចក្រកម្ពុជាជាដាច់ខាត។

N° 200 Preah Norodom Blvd, Sangkat Tonle Basak, Khan Chamkarmon, Phnom Penh, Cambodia
Phone: (023) 726 128 / 726 129, Fax: (855) 23-217 320

៣- ចំពោះចម្ការដែលសង្ស័យថាបានទទួលរងនូវជំងឺនេះ ត្រូវផ្អាកដាំដំណាំដំឡូងមីមួយរដូវទៅរដូវក្រោយដោយដាំដំណាំផ្សេងជំនួសវិញដូចជា ដំណាំសណ្តែកសៀង ពោត...ដើម្បីកាត់ផ្តាច់ប្រភពជំងឺ។

៤- រាល់ការនាំចូលពូជដំណាំដំឡូងមី ក៏ដូចជាពូជដំណាំផ្សេងៗទៀត ត្រូវសុំការអនុញ្ញាតជាមុនពីអគ្គនាយកដ្ឋានកសិកម្ម នៃក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ (ប្រការ៤នៃប្រកាសលេខ៣៤៦ប្រក.កសក ចុះថ្ងៃទី១០ ខែឧសភា ឆ្នាំ២០១០ ស្តីពីនីតិវិធីនៃការត្រួតពិនិត្យភូតគាមអនាម័យ) ដើម្បីសមត្ថកិច្ចជំនាញអនាម័យ និងភូតគាមអនាម័យ នៃអគ្គនាយកដ្ឋានកសិកម្មមានលទ្ធភាពគ្រប់គ្រងហានិភ័យនៃការនាំចូលតាមបែបបទបច្ចេកទេស ជាពិសេសការនាំចូលពូជដំឡូងមីពីប្រទេសជិតខាង។

៥- រាល់ការធ្វើរបាយការណ៍ ឬផ្សព្វផ្សាយព័ត៌មានអំពីការរាតត្បាតនៃសត្វល្អិតចង្រៃ ជំងឺ និងស្មៅចង្រៃភូតគាម-អនាម័យទៅក្រៅប្រទេស ត្រូវមានការយល់ព្រមពីអគ្គនាយកដ្ឋានកសិកម្ម នៃក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ។

៦- មន្ទីរកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ រាជធានី-ខេត្ត និងស្រុក-ខណ្ឌ ត្រូវយកចិត្តទុកដាក់ចុះត្រួតពិនិត្យ និងជំរុញបងប្អូនប្រជាកសិករចុះពិនិត្យចម្ការដំឡូងមីជាប្រចាំ ហើយនៅពេលឃើញមានរោគសញ្ញាសង្ស័យដូចរៀបរាប់ខាងលើ ត្រូវចាត់វិធានការទប់ស្កាត់ឱ្យបានទាន់ពេលវេលា និងរាយការណ៍មកអគ្គនាយកដ្ឋានកសិកម្មជាបន្ទាន់។

ទទួលបានសេចក្តីជូនដំណឹងនេះ គ្រប់អង្គភាពពាក់ព័ន្ធក្រោមឱវាទក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ មន្ទីរកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ រាជធានី-ខេត្ត បណ្តាក្រុមហ៊ុន អាជីវករ អ្នកនាំចូល និងផ្គត់ផ្គង់ចែកចាយពូជដំណាំដំឡូងមីទាំងអស់ ត្រូវអនុវត្តឱ្យមានប្រសិទ្ធភាព ដោយស្មារតីទទួលខុសត្រូវខ្ពស់ ចាប់ពីថ្ងៃចុះហត្ថលេខាតទៅ។

រាជធានីភ្នំពេញ ថ្ងៃទី ០៥ ខែ កញ្ញា ឆ្នាំ២០១៧

រដ្ឋមន្ត្រី

ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

វេង សាខុន

កន្លែងទទួល:

-ទីស្តីការគណៈរដ្ឋមន្ត្រី
-ក្រសួងសេដ្ឋកិច្ចនិងហិរញ្ញវត្ថុ
-ក្រសួងពាណិជ្ជកម្ម
-ខុទ្ទកាល័យសម្តេចតេជោនាយករដ្ឋមន្ត្រី
-ខុទ្ទកាល័យសម្តេច ឯកឧត្តម លោកជំទាវ ឧបនាយករដ្ឋមន្ត្រី
-គ្រប់សាលារាជធានី ខេត្ត
-គ្រប់អង្គភាពក្រោមឱវាទក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ
-ឯកសារ កាលប្បវត្តិ

Annex 5: Summary Report (Cambodia Field Survey Training)

A. Logistics

Date: 7-10th November 2016
Location: Phnom Penh (7,-8th) and Dambae district, Tboung Khmum province (8-10th)

Participants:

	Team	Name	Affiliation
Team Leader	Eastern	Sreymom Tep	DoIC, GDA
	Eastern	Sereyrath Sorn	DoIC, GDA
	Western	Somhoun Not	DoIC, GDA
	Eastern	Savoeun Dok	PDAFF Tboung Khmum
Team Leader	Western	Thorngun Ieng	PDAFF Tboung Khmum
	Western	Chhorvorn Phal	Independent consultant
		Sophearith Sok	CIAT-Asia
		Nami Minato	CIAT-Asia

B. Activities and Notes

Day 1: Training for sampling of cassava leaf & whitefly
Team & Route arrangement: two teams with three people for Eastern & Western provinces each.

Team Eastern
Who: Sreymom Tep (Leader; GDA), Sereyrath Sorn (GDA), Savoeun Dok (PDA)
When: start on 17th November 2016
Route: Dambae, Tboung Khmum (Field Training)> Romeas Haek, Svay Rieng, Memot, Tboung Khmum, Snoul, Kratie, Steung Treng, Steung Tren, Koun Mom, Ratanakiri, Baray, Kampong Thom, Sandan, Kampong Thom

Team Western
Who: Thorngun Ieng (Leader; PDA), Somhoun Not (GDA), Phal Chhorvorn (freelance)
When: start on 17th November 2016
Route: Anlong Veaeng, Oddar Meancheay, Malai, Banteay Meancheay, Phnum Proek, Battambang, Kamrieng, Battambang, Sala Krau, Pailin, Pailin, Pailin> Rattanak Mondul, Battambang> Kravanh, Prusat

Checking the protocol and distributing materials

- Presentation with Khmer translation and Khmer version of short survey protocol were provided.
- Each team leader (Sreymom and Thorngun) received 2 tablets and 1 powerbank, signed the document. We confirmed that teams need to give them back to CIAT once after completing survey for data collection.
- Teams also received protocols, 2 magnifiers, 7 field sheet books, 1 aspirator, 1 hole-puncher, ziplock bags for 8 districts, eppendorf tubes for 8 districts, 7 parmanent markers. Some paper napkin and slilica gel for initial survey were handed over.

Day 2: Training for quick seed systems survey

Checking quick seed systems survey questionnaire**.** Khmer version of questionnaire was provided, and survey teams have made some modifications/agreements as follows:

- If they acquire bundles/stakes from trucks, the farmer will estimate the quantity.
- Option e) Others (specify) was added. For instance when they have less rain in planting season & much rain in harvesting season, it would be specified.
- Option e) Others (specify) was added. E.g. Sold to one person but the farmer doesn't know where his/her cassava goes.
- All participants are paired and every pair practiced an actual interview each other/ with CIAT staff.

Day 3 & 4: Field survey training in Tboung Khmum province

- To link between fields & households, first we visited a commune office.
- Survey teams have done the sample collection in four fields and the interview in four households.

C. Main outcomes from the training workshop

- The survey team members, their schedule and routes were fully agreed among participants.
- Whole cassava plant and insect sampling protocols are demonstrated and practiced in four plots in Dambae district, Tboung Khmum province.
- Quick seed systems survey was conducted in four households in Dambae, Tboung Khmum. In the questionnaire, some modifications were made in Khmer version.

Annex 5: Results Biotyping Whitefly

The consolidated results of genotyping of 150 samples of *Bemisia tabaci* whitefly, as collected from cassava fields throughout Vietnam and Cambodia. The results from molecular analyses using the genius 10.2.2 program and molecular identification *Bemisia tabaci* species support by http.//www.whiteflybase.org. Table of whitefly samples: assignment to *Bemisia tabaci* species, host plants, locations, side and collection stage.

Sample name	Species	Host	Location	side	stage of insect
ID 1	AsiaII1	Cassava	Memot	F1-A	Adults
ID 2	AsiaII1	Cassava	Memot	F4-A	Adults
ID 3	AsiaII1	Cassava	Memot	F7-A	Adults
ID 4	AsiaII1	Cassava	Memot	F10-A	Adults
ID 5	AsiaII1	Cassava	Memot	F13-A	Adults
ID 6	AsiaII1	Cassava	Samdan	F1-A	Adults
ID 7	AsiaII1	Cassava	Samdan	F4-A	Adults
ID 8	AsiaII1	Cassava	Samdan	F7-A	Adults
ID 9	AsiaII1	Cassava	Samdan	F10-A	Adults
ID 10	AsiaII1	Cassava	Samdan	F13-A	Adults
ID 11	AsiaII1	Cassava	Thuan Chau	F5-A	Adults
ID 12	AsiaII1	Cassava	Thuan Chau	F5-B	Pupa
ID 13	AsiaII1	Cassava	Thuan Chau	F7-B	Pupa
ID 14	AsiaII1	Cassava	Thuan Chau	F10-A	Adults
ID 15	AsiaII1	Cassava	Thuan Chau	F10-B	Pupa
ID 16	AsiaII1	Cassava	Thuan Chau	F13-A	Adults
ID 17	AsiaII1	Cassava	Thuan Chau	F13-B	Pupa
ID 18	AsiaII1	Cassava	Thuan Chau	F15-A	Adults
ID 19	AsiaII1	Cassava	Thuan Chau	F15-B	Pupa
ID 20	AsiaII1	Cassava	Long Thanh	F1-B	Adults
ID 21	AsiaII1	Cassava	Long Thanh	F2-A	Adults
ID 22	AsiaII1	Cassava	Long Thanh	F3-B	Adults
ID 23	AsiaII1	Cassava	Long Thanh	F4-A	Adults
ID 24	AsiaII1	Cassava	Long Thanh	F5-B	Adults
ID 25	AsiaII1	Cassava	Bac Binh	F7-A	Adults
ID 26	AsiaII1	Cassava	Bac Binh	F7-B	Adults
ID 27	AsiaII1	Cassava	Bac Binh	F10-A	Adults
ID 28	AsiaII1	Cassava	Bac Binh	F10-B	Adults
ID 29	AsiaII1	Cassava	Bac Binh	F13-A	Adults
ID 30	AsiaII1	Cassava	Bac Binh	F13-B	Adults
ID 31	AsiaII1	Cassava	Dambae	F4-A	Adults
ID 32	AsiaII1	Cassava	Dambae	F7-A	Adults
ID 33	AsiaII1	Cassava	Romeas Haek	F4-A	Adults
ID 34	AsiaII1	Cassava	Dambae	F13-A	Adults
ID 35	AsiaII1	Cassava	Koun Mom	F7-A	Adults
ID 36	AsiaII1	Cassava	Koun Mom	F10-A	Adults
ID 37	AsiaII1	Cassava	Ham Thuan Nam	F4-B	Adults
ID 38	AsiaII1	Cassava	Snoul	F1-A	Adults
ID 39	AsiaII1	Cassava	Snoul	F13-A	Adults
ID 40	AsiaII1	Cassava	Snoul	F10-A	Adults
ID 41	AsiaII1	Cassava	Romeas Haek	F4-A	Adults
ID 42	AsiaII1	Cassava	Romeas Haek	F4-B	Adults
ID 43	AsiaII1	Cassava	Romeas Haek	F7-A	Adults
ID 44	AsiaII1	Cassava	Romeas Haek	F10-A	Adults
ID 45	AsiaII1	Cassava	Steung Treng	F1-A	Adults
ID 46	AsiaII1	Cassava	Romeas Haek	F1-A	Adults
ID 47	AsiaII1	Cassava	Steung Treng	F13-A	Adults
ID 48	AsiaII1	Cassava	Baray	F1-A	Adults
ID 49	AsiaII1	Cassava	Baray	F13-A	Adults
ID 50	AsiaII1	Cassava	Baray	F7-A	Adults

ID 51	AsiaII1	Cassava	Krong Pa	F1-A	Adults
ID 52	AsiaII1	Cassava	Krong Pa	F4-A	Adults
ID 53	AsiaII1	Cassava	Krong Pa	F7-A	Adults
ID 54	AsiaII1	Cassava	Krong Pa	F10-A	Adults
ID 55	AsiaII1	Cassava	Krong Pa	F13-A	Adults
ID 56	AsiaII1	Cassava	Sa Thay	F1-A	Adults
ID 57	AsiaII1	Cassava	Sa Thay	F4-A	Adults
ID 58	AsiaII1	Cassava	Sa Thay	F7-B	Pupa
ID 59	AsiaII1	Cassava	Sa Thay	F10-B	Adults
ID 60	AsiaII1	Cassava	Sa Thay	F7-A	Adults
ID 61	AsiaII1	Cassava	Chu Prong	F1-A	Adults
ID 62	AsiaII1	Cassava	Chu Prong	F1-B	Pupa
ID 63	AsiaII1	Cassava	Chu Prong	F4-A	Adults
ID 64	AsiaII1	Cassava	Chu Prong	F10-A	Adults
ID 65	AsiaII1	Cassava	Chu Prong	F7-A	Adults
ID 66	AsiaII1	Cassava	Sa Thay	F13-A	Adults
ID 67	AsiaII1	Cassava	Dak G'long	F10-A	Adults
ID 68	AsiaII1	Cassava	Dak G'long	F7-A	Adults
ID 69	AsiaII1	Cassava	Dak G'long	F10-B	Pupa
ID 70	AsiaII1	Cassava	Dak G'long	F13-A	Adults
ID 71	AsiaII1	Cassava	Van Yen	F1-A	Adults
ID 72	AsiaII1	Cassava	Sala Krau	F7-A	Adults
ID 73	AsiaII1	Cassava	Sala Krau	F10-A	Adults
ID 74	AsiaII1	Cassava	Sala Krau	F13-A	Adults
ID 75	AsiaII6	Cassava	Malai	F1-A	Adults
ID 76	AsiaII1	Cassava	Malai	F4-A	Adults
ID 77	AsiaII1	Cassava	Malai	F13-A	Adults
ID 78	AsiaII1	Cassava	Pailin	F1-A	Adults
ID 79	AsiaII1	Cassava	Anlong Veaeng	F1-A	Adults
ID 80	AsiaII1	Cassava	Anlong Veaeng	F4-A	Adults
ID 81	AsiaII1	Cassava	Anlong Veaeng	F10-A	Adults
ID 82	AsiaII1	Cassava	Bac Binh	F4-B	Adults
ID 83	AsiaII1	Cassava	Kamrieng	F1-A	Adults
ID 84	AsiaII1	Cassava	Tan Chau	F13-B	Adults
ID 85	AsiaII1	Cassava	Kamrieng	F7-A	Adults
ID 86	AsiaII1	Cassava	Kamrieng	F10-A	Adults
ID 87	AsiaII1	Cassava	Kamrieng	F13-A	Adults
ID 88	AsiaII1	Cassava	Kravanh	F1-A	Adults
ID 89	AsiaII1	Cassava	Kravanh	F4-A	Adults
ID 90	AsiaII1	Cassava	Kravanh	F7-A	Adults
ID 91	AsiaII1	Cassava	Kravanh	F10-A	Adults
ID 92	AsiaII1	Cassava	Baray	F10-A	Adults
ID 93	AsiaII1	Cassava	Van Yen	F1-A	Pupa
ID 94	AsiaII1	Cassava	Van Yen	F4-B	Pupa
ID 95	AsiaII1	Cassava	Van Yen	F7-A	Adults
ID 96	AsiaII1	Cassava	Van Yen	F7-B	Pupa
ID 97	AsiaII1	Cassava	Van Yen	F10-A	Adults
ID 98	AsiaII1	Cassava	Van Yen	F10-B	Pupa
ID 99	AsiaII1	Cassava	Van Yen	F13-A	Adults
ID 100	AsiaII1	Cassava	Van Yen	F13-B	Pupa
ID 101	AsiaII1	Cassava	Van Yen	F1-B	Pupa
ID 102	AsiaII1	Cassava	Van Yen	F4-A	Adults
ID 103	AsiaII1	Cassava	Tan Bien	F1-B	Adults
ID 104	AsiaII1	Cassava	Tan Bien	F4-A	Adults
ID 105	AsiaII1	Cassava	Tan Bien	F4-B	Adults
ID 106	AsiaII1	Cassava	Ham Thuan Nam	F1-A	Adults
ID 107	AsiaII1	Cassava	Ham Thuan Nam	F4-A	Adults
ID 108	AsiaII1	Cassava	Bac Binh	F1-A	Adults
ID 109	AsiaII1	Cassava	Huyen M'Drak	F13-A	Adults
ID 110	AsiaII1	Cassava	Huyen M'Drak	F13-B	Pupa
ID 111	AsiaII1	Cassava	Bac Binh	F4-A	Adults
ID 112	AsiaII1	Cassava	Ham Tan	F7-A	Adults
ID 113	AsiaII1	Cassava	Ham Tan	F10-A	Adults

ID 114	AsiaII1	Cassava	Ham Tan	F13-A	Adults
ID 115	AsiaII1	Cassava	Long Thanh	F1-A	Adults
ID 116	AsiaII1	Cassava	Long Thanh	F2-B	Adults
ID 117	AsiaII1	Cassava	Long Thanh	F3-A	Adults
ID 118	AsiaII1	Cassava	Long Thanh	F5-A	Adults
ID 119	AsiaII1	Cassava	Tan Chau	F7-A	Adults
ID 120	AsiaII1	Cassava	Tan Chau	F10-B	Adults
ID 121	AsiaII1	Cassava	Huyen Eakar	F1-A	Adults
ID 122	AsiaII1	Cassava	Huyen Eakar	F1-B	Pupa
ID 123	AsiaII1	Cassava	Huyen Eakar	F4-A	Adults
ID 124	AsiaII1	Cassava	Chu Prong	F13-A	Adults
ID 125	AsiaII1	Cassava	Huyen Eakar	F7-A	Adults
ID 126	AsiaII1	Cassava	Dak G'long	F7-B	Pupa
ID 127	AsiaII1	Cassava	Huyen Eakar	F10-A	Adults
ID 128	AsiaII1	Cassava	Huyen Eakar	F10-B	Pupa
ID 129	AsiaII1	Cassava	Huyen Eakar	F13-A	Adults
ID 130	AsiaII1	Cassava	Huyen Eakar	F13-B	Pupa
ID 131	AsiaII1	Cassava	Tan Chau	F1-A	Adults
ID 132	AsiaII1	Cassava	Tan Chau	F1-B	Adults
ID 133	AsiaII1	Cassava	Tan Chau	F4-A	Adults
ID 134	AsiaII1	Cassava	Tan Chau	F13-A	Adults
ID 135	AsiaII1	Cassava	Ham Thuan Nam	F7-A	Adults
ID 136	AsiaII1	Cassava	Ham Thuan Nam	F7-B	Adults
ID 137	AsiaII1	Cassava	Ham Thuan Nam	F10-A	Adults
ID 138	AsiaII1	Cassava	Ham Thuan Nam	F10-B	Adults
ID 139	AsiaII1	Cassava	Ham Thuan Nam	F13-A	Adults
ID 140	AsiaII1	Cassava	Ham Thuan Nam	F13-B	Adults
ID 141	AsiaII1	Cassava	Ham Tan	F1-A	Adults
ID 142	AsiaII1	Cassava	Ham Tan	F1-B	Adults
ID 143	AsiaII1	Cassava	Ham Tan	F4-A	Adults
ID 144	AsiaII1	Cassava	Ham Tan	F4-B	Adults
ID 145	AsiaII1	Cassava	Tan Bien	F7-A	Adults
ID 146	AsiaII1	Cassava	Tan Bien	F7-B	Adults
ID 147	AsiaII1	Cassava	Tan Bien	F10-A	Adults
ID 148	AsiaII1	Cassava	Tan Bien	F10-B	Adults
ID 149	AsiaII1	Cassava	Tan Bien	F13-A	Adults
ID 150	AsiaII1	Cassava	Tan Bien	F13-B	Adults