## Summary

In 2016, the first publication of the cassava mosaic disease (CMD) was published, reporting the unequivocal identification of the Sri Lankan cassava mosaic virus as responsible for CMD symptoms in the Northeast of Cambodia as early as 2015, although it is not known if the disease appeared first in this location and country. Since that date, several surveys have been conducted in Cambodia, Vietnam and Thailand, and as of mid 2018, the disease was present in 6 provinces in Cambodia and 10 in Vietnam, and now 3 provinces in Thailand. There is no CMD case yet reported in Laos. In 3 years, the disease reports extended from a single plantation in Cambodia to an estimated 10% of the surfaces cultivated in the whole region. Therefore, the impact is still limited but expanding quickly. The disease is transmitted in two ways: by the natural whitefly vector (presumably *Bemisia tabaci*, Aleyrodidae) and by the cassava cuttings. There is no transmission through the roots nor the seeds. There is a very active cassava stake trade between several provinces of Cambodia and between Cambodia and Vietnam or Thailand. Although there is clearly insect transmission occurring, it is believed that currently the disease is mostly spread through cuttings. Considering the importance of cassava in the region (>55 million tons/year and >$10 billion business), urgent action is needed to stop the spread and put CMD under control. To this effect, the Global Cassava Partnership of the 21st Century (GCP21) and the International Center for Tropical Agriculture (CIAT), with additional funding from the Australian Centre for International Agricultural Research (ACIAR), organized a regional workshop on 18–20 September 2018, in Phnom Penh, Cambodia, aiming at establishing a unique regional plan of control of CMD in Cambodia. The workshop gathered 75 people belonging to international organizations, officers from the Ministries of Agriculture and Commerce of the four countries, donor representatives and communication experts. The outcome of the workshop is a list of recommendations in four different topics: Policy, Market Engagement, and Communication; Surveillance and Diagnostics; Virus-free Seed Multiplication; and Testing and Breeding Resistant Material (www.gcp21.org/meetings2018.html). This report provides the complete list of recommendations and also outlines the urgent need to put in place an immediate CMD Emergency Plan. The current proposal is a concept note briefly illustrating the Emergency Plan for fundraising purposes.
### Development of a two-year Emergency CMD Control Plan in Mainland Southeast Asia (SEA)

There is urgency! The cassava mosaic disease (CMD)-infected surfaces are expanding every day, and it is imperative to respond immediately. Therefore, representatives of the four countries (Cambodia, Lao PDR, Thailand and Vietnam) and members of international organizations are proposing to develop an Emergency Plan. The primary goal of this plan is to put in place an organization to deal with the full implementation of the plan and to initiate all the actions without delay. We believe that the necessary funding can be found in a very short period of time to allow the development of the emergency plan. Essentially, the emergency plan would cover the first two years of the full CMD control plan (www.gcp21.org/meetings2018.html), and it is formulated into five sections.

### 1. Regional & national coordination mechanism

- Coordination at various levels is required for a regional project. First, it is necessary to exchange information at the highest level (Ministers of Agriculture), and it would be more effective if one of the Ministers (e.g., Cambodia) were the champion of all of them. This would boost the overall regional plan and allow a much better coordination at subsequent levels.
- Establishment of a steering committee (senior scientists, SEA senior government officials, private sector representatives...) to advise/guide the implementation of the overall plan of action. National and regional steering committees (with champions) might complement and relay the information to guide coordination mechanisms.
- Representation of policy makers, research institutions, private sector, donors, UN agencies, NGOs, civil society organizations, farmer organizations.
- Building off existing technical platforms at regional (Asian breeders network) and national level (MAF-WGA).
- Sharing information on CMD Prevalence and Economic Impact.
- Promoting Cross Project Coordination/Complementarity to address CMD at national and regional level.

### 2. CMD awareness & mitigation extension

- In Southeast Asia, cassava is grown by over 8 million farmers. A large number of these smallholder farmers grows cassava on marginal upland soils and in fragile environments, where manure and fertilizer are not commonly applied. A recent outbreak of CMD has exposed these farmers’ livelihoods at risk. Farmers are unfamiliar with the disease symptoms and the impact on the crop productivity.
- A combination of symptoms such as whole plant stunted growth, as well as mosaic, deformed, twisted and smaller leaves can be visible at any stage of the life cycle of a CMD-infected cassava plant. Furthermore, the cassava variety, virus isolate, age of the plant at the time of infection, and mode of infection (i.e. through diseased stakes or through whiteflies) can limit root and starch production. Thus, an awareness campaign regarding the new disease (i.e. CMD) and a mitigation strategy are a must to protect the farmers.
- To build awareness about CMD and its control measures among cassava farmers, traders, local government and factory owners, the strategies below can be followed to stop the disease from spreading and safeguard farmers’ livelihoods:

#### a. Disseminate information through media outlets

- Develop an information pack about CMD to disseminate through different media (e.g. posters, newspaper, radio, TV); and information about potential monetary loss in current circumstances and projection.
- Information about clean seed source with contact information in the respective country language.
- Information on how to replace infected stakes (i.e. negative and positive selection; and government compensation package).

#### b. Training about pest and disease (i.e. whitefly and CMD)

- Organise training for district extension officers, researchers, agriculture officers.
- On-farm demonstration during growing season and during harvest.
- Conduct farmers and stakeholders participatory variety evaluation and soil management practices.
- Provide information about the source of CMD-free planting material.

#### c. Seed certification

- Identify farmers and/or traders willing to multiply healthier cassava stakes and engage the private sector to be proactive in this process by investing.

#### d. Demonstrate model agronomic practices

- On-farm hygiene practices:
  - Identify and destroy symptomatic plants
  - Select healthy plants for next planting season
  - Timely weeding
- Monitor soil fertility/nutrient status: Application of balance fertilizer (organic and inorganic).
- Crop rotation (e.g. upland cereals, legumes and short-duration fruits).
- Farmer participatory variety evaluation and soil management practices.
3. **CMD Surveillance & Diagnostics of disease-free planting material**

**Delivering rapid surveillance strategies for CMD outbreak mitigation**

- Generate and update maps with “confirmed/suspected/non-infected” data.
- Identify and collate existing data from Cambodia, Laos, Thailand and Vietnam in main cassava-producing regions.
- Implement surveillance: annual disease monitoring.

**Harmonized/standardized protocols for field sampling and lab testing**

- Inventory of existing methods.
- Regional workshop to agree on SOPs for field sampling & lab testing.
- Update protocols with new diagnostics technologies as they come online.
- Regional training courses for field sampling (identification of sampling zones, sampling procedures, etc.).
- Regional training courses for laboratory (nucleic acid extraction, DNA amplification and analysis, etc.).

**Evaluate new rapid, cheap technologies for field diagnostics**

- Identify sensitive, rapid, cheap technologies and information that should feed the platform, e.g. portable field molecular diagnostic systems. AI-based smartphone apps, e.g. Nuru.

4. **Propagation and distribution of disease-free planting material**

Based on current disease status, develop sources and sinks of planting material, define potential zones for transport cost and hinterland analysis for different regions – which can potentially link to different sites. Spatial analysis of potential supply zones in different times of the year.

**a. Pre-epidemic sites (northern Vietnam, Laos, central Thailand)**

- Promote self-sufficiency plans and restriction of movement into these sites.
- Develop demand through advertising for the supply of surplus disease-free material.
- Identify intermediaries that can consolidate within disease-free areas and market areas.
- Optimize cropping system to supply a combination of roots and stems (change density, fertilizer, management, harvesting time).

**b. Hyper-epidemic sites (eastern Cambodia, Central Highlands)**

- Develop strategy for expansion of clean front identifying priority regions.
- Develop redistribution hubs based on value chain and political context for coordination to avoid re-infection, involvement of government for transitioning to private model once coordination becomes less important. Potential for involvement of associations.
- Where single or separated supply zones for processors, engage factories and agents for redistribution. No movement of planting material outside hyper-epidemic sites.
- Simple diagnostics for multipliers for planting and maintaining clean material – quality declaration.
- Develop business models for multiplication in isolation sites.

5. **Varietal testing and breeding for CMD resistance**

- Determine the variety composition through DNA fingerprinting to draw a cassava genetic landscape in the region before the epidemic changes completely the situation.
- Safe and coordinated introduction of sources of resistance available in Africa and India.

- Create a CMD-resistant germplasm list with sources from CIAT, the International Institute of Tropical Agriculture (IITA) and India
- Introduce CMD-resistant germplasm to Thailand and Vietnam. Cambodia will receive resistant germplasm through Thailand during the evaluation phase.
- Complete quarantine procedures as required.
- Set up two SAH laboratories in Thailand and one in Vietnam.
- Rapid multiplication of germplasm for testing using SAH.
- Rescue local varieties in the affected regions before they are lost to CMD infection. Assessing varietal performance of local varieties (multi-location trials), CIAT-, IITA- and CTCRI-Hybrids.
- Pre-increase those materials that show good level of CMD tolerance and comparable levels of starch production using the SAH system or comparable platform.
- CIAT to recruit a local breeder to coordinate varietal development efforts.
In addition, a number of peripheral businesses are benefiting from dry chips of cassava being exported from the region, but starch is mostly produced, principally in Thailand and Vietnam, representing another income in the region estimated at $4-8b/Y. Cassava production in the region has been dominated by Thailand, but has been tremendously boosted since 2000 and 2006 by the production of Vietnam and Cambodia, respectively. The increase in production is the conjunction of the increase in surface planted (5%/y) and the increase in average yield in each country (1.5%/y).

Potential CMD impact

Cassava viruses are very serious diseases and in Africa where these diseases are most prevalent today, more than one hundred years after the first description of CMD, the disease is still not under complete control and causes major losses every year. By all means, the CMD outbreak should be put under control the soonest possible before it runs out of control. The sooner a plan of control is developed and put in place, the more chances we have to control the disease. The task is big because knowledge, organizations and regulations are not well developed in this large region, and there is no sanitary control in place for the traded cassava stakes.

Where is CMD in the world?

CMD is a generic name to indicate a virus infection causing mosaic. Until recently, CMD was only present in Africa and in the Indian subcontinent. CMD is the disease caused by ssDNA viruses belonging to the family Geminiviridae and transmitted by whiteflies and through the infected plant material. In Africa, CMD is caused by 11 different species of geminiviruses out of which ACMV (African cassava mosaic virus) and EACMV (East African cassava mosaic virus) are the most important widespread and destructive viruses. In the Indian subcontinent, CMD is caused by the Indian cassava mosaic virus-ICMV and Sri Lankan cassava mosaic virus-SLCMV. All these viruses are endemic in each region, meaning that they were locally present in host reservoir plants and invaded cassava over time. No virus importation was recorded in these continents. CMD in Southeast Asia is attributed to SLCMV and presumably has been imported from the Indian subcontinent.

What is the impact of CMD viruses on cassava?

Losses due to viral diseases are very difficult to assess because it is the combination of the nature of the virus, the impact on each infected plant, the frequency of infected plants in each field and the mode of infection. After decades of evaluation work, experts agreed that in Africa losses could be estimated to an overall 30% of the production. The impact of CMD through cuttings (70%) is much more damaging than through whiteflies (40%).

A 30% impact would cost billions to farmers, to the industry and to the countries. A 30% impact in SEA would represent huge losses, firstly to the farmers and secondly to the industry and all the people involved in its business. Farmers will have a net loss of production that can vary in space and time, but a 30% would be considered as a minimal loss in locations where the disease would be prevalent.

Cumulative effect with the cassava witches broom disease (CWBD)

For several years, CWBD has been prevalent in many places in the region. It is well established that a positive selection of disease-free cuttings is capable of controlling CWBD, but it is also clear that CMD can super-infect CWBD infected plants, worsening the phytosanitary situation.

Domino effect with other issues such as price, competition.

Furthermore, the number one problem for the industry is the amount of cassava produced to keep the factories running at 100%. A production loss at the farmer level will automatically impact the industry. The spread of CMD in the region could impact further its competitiveness, playing a domino effect in the production and putting the cassava processing industry at higher risks.

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