Developing value-chain linkages to improve smallholder cassava production systems in Vietnam and Indonesia

Date: July 2020

Progress towards completion of project AGB/2012/078

This report gives a brief overview of the progress towards completion of project AGB/2012/078 as of July 2020. The activities and outputs of the project are presented in a table for each of the three Objectives, and comments are provided regarding the progress towards completion of each output. A summary of key outputs, achievements and challenges is also given for each objective.

Objective 1: Assess opportunities and constraints for smallholder production and marketing of cassava within different value chains

no.	activity	outputs/ milestones	completion date	Comments
1.1	Review cassava production, use and trade, and main substitutes in production and final markets	Annual update on cassava production, trade and utilisation in target countries and the region	Annually	A database with updated information on regional and global cassava markets have been maintained through the duration of the project using an ACIAR blog and via facebook updates. Results of the analysis have also been presented at various workshops and conferences annually while also relaying them to the AESM project and to the Agricultural Master Class series in Myanmar. A interactive webpage is under development with co-funding from RTB to continue to make data collected available
1.2	Conduct training in value-chain methodologies, economic analysis and gender analysis	Training material developed for use within the region Training report	June 2016	Practical value chain training was conducted with key stakeholders in Malang, Indonesia to map key value chains in target provinces in Indonesia. Similar training activities were conducted in Vietnam for mapping value chains in Son La and Dak Lak.
1.3	Assess cassava value chains in each site, including primary and supporting actors and local policy environment, and where feasible conduct initial mapping of value chains of potential intercrops.	Map cassava VC including actors, processes, flows of information Geographical representation of production and information flow is different VC and production settings Report on gender norms within the value-chain in different sites	October 2016	**Vietnam:** Value Chain assessments including key informant interviews were conducted in Son La and Dak Lak Provinces in Vietnam. **Indonesia:** Similar assessments were also conducted in Indonesia in Sikka Regency and North Sumatra The results of the value chain assessments have been presented in various workshops and international conferences.
1.4	Conduct farm surveys to find current production practices, market linkages, sources of information, risks, and	Establish baseline for current practices, perceptions, aspirations and opportunities.	July 2017-June 2019	**Vietnam:** Focus groups and household surveys were conducted in Son La and Dak Lak with a total of 256 household surveys completed in each province. **Indonesia:** Focus groups and household surveys were conducted in Sikka and Simalungun

	constraints to adoption	Data to be gender disaggregated.		Regency in North Sumatra. A total of 140 surveys in North Sumatra and 114 surveys in Sikka were undertaken. **Presentations** The results of the household surveys have been presented in various workshops and international conferences.
1.5	Evaluate project impacts on knowledge, attitudes, skills, aspirations, and practices of farmers and other actors	Evaluate changes in KASA of farmers and VC actors Assess the impact of learning alliances and dialogues of raising the profile of cassava in policy development	Nov 2019 – March 2020	**Indonesia:** In East Nusa Tenggara, impact surveys were conducted with 25 farmers in Sikka and 13 farmers in Boru. Impact surveys were also conducted in North Sumatra with 70 farmers in 2 locations. **Vietnam:** Impact Assessment Surveys have been undertaken with farmers in Son La and Dak Lak during May and June 2020.

VC = Value chain, KASA = Knowledge, Attitudes, Skills and Aspirations

1.1 Review cassava production, use and trade, and main substitutes in production and final markets

Since the commencement of project activities, developments in the regional and global cassava markets have been monitored and shared communicated to stakeholders. A database has been created to monitor price and trade flows utilising published data, online national databases, and industry contacts.

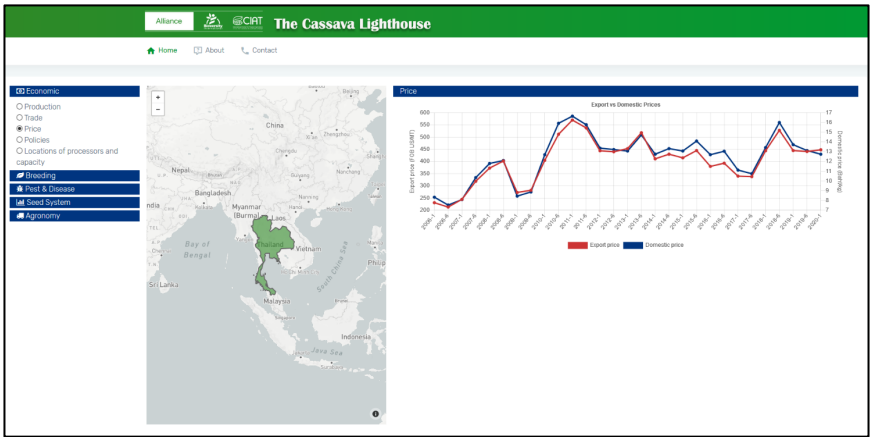
Results from an analysis of the collected information have been presented in a number of workshops, conferences, as well as through the web via blogs and social media.
The updated database has been maintained and summary information has been made available through the program website (www.cassavavaluechains.net), as well as through Facebook updates. Other direct outlets for information sharing have included presentations at local and national stakeholder workshops, research symposia and research and industry conferences including the World Roots and Tuber congress, Starch World , CIAT Cassava Retreat, Agribusiness Master Class, North-West Vietnam Research Symposium, Mid-term review/research symposium (Vientiane, 2018), GCP21 IVth International Cassava Conference (Contonou, Benin, 2018), NAFRI 20th Anniversary Symposium (2019), the regional research symposium (North Sumatra, 2019), national workshop in Indonesia (2019) and provincial stakeholder workshops in Vietnam and Indonesia (2020).

Presentations were also made to research and industry partners in Vietnam and Indonesia during the inception meetings (Malang, Son La, Dak Lak- 2016) and field visits. Given the importance of the Vietnam market to Laos and Cambodia the information collected in AGB has also been used to inform the AESM project during the AESM meetings (Vientiane, Phnom Penh; 2017) and contribute to the Agricultural Master Class series in Myanmar in 2018 and the Agribusiness Insights Webinar Series in 2020[1].

[1] *https://youtu.be/3IDkuB_x2Cg*

The importance of freight and logistic costs became apparent and collaboration has been initiated with the ACIAR and DFAT funded "Transit" Research group at CSIRO.

The data collected during the project is being transferred to an online platform managed by CIAT called "The Cassava Lighthouse". This aims to become the most comprehensive sight offering access to data, analysis, and monitoring market and policy developments. It will continue to be associated and supported by AGB/2018172 and also link to Pest and Disease Monitoring (PestDisPlace[2]).



1.2 Conduct training in value-chain methodologies, economic analysis and gender analysis

Value chain training programs were held in Malang in August 2016 and in Son La and Dak Lak in September 2016 where participants learned about basic principles of value chain analysis and were also involved in conducting a preliminary value chain mapping exercise. This formed the foundation for site selection of key production and value chains for more detailed analysis in the field. In Indonesia an invitation was extended to the agricultural economic staff of several non-project partner universities in Malang and the local university in Maumere. A key feature of the value-chain training was the involvement of government and private sector partners. This enabled the collection of useful information and better planning for the field work. It also helped build the relationship between the research team and our government and private sector stakeholders which were critical to the subsequent strong relationships developed. Another feature was the emphasis on gender and social inclusion.

Ms Hanh, Mr Dat, and Mr Ngoc from the cassava project team in Tay Nguyen University participated in gender training conducted by the Gender SRA in Hanoi between December 12th and 14th, 2017. Participants learnt not only gender and social lens and tools to explore these, but also facilitation skills.

1.3 Assess cassava value chains in each site

Staff from partner organizations in Indonesia conducted value chain analyses in Sikka Regency (NTT) and North Sumatra in August and October of 2016 respectively. Similar value chain analyses were conducted by NOMAFSI in Son La and Tay Nguyen University (TNU) in Dak Lak in September 2016.

[2] *https://pestdisplace.org/diseases/cassava*

In all sites, information was gathered from value chain actors through face-to-face interviews using a standardized questionnaire. Value chain actors interviewed included large and medium scale starch and dried chip processors, small-scale collectors and assemblers, medium scale traders, and larger scale traders and brokers.

The questionnaire included topics on the overall value chain as well as technical details as listed below:

- Purchasing
- Sales
- Cost Structure
- Access to and provision of credit
- Access to information and training
- Cassava Varieties
- Fertilizer use
- Land Preparation
- Soil Conservation
- Pest and Disease Management
- Weed control

The survey was undertaken electronically, using the Commcare app loaded onto Android tablets. The results of the value chain analyses have been presented in the International Conference on Root and Tuber Crops for Food Security in Malang (2017), the North-West Vietnam Research Symposium (2017), the MTR/Research Symposium in Vientiane (2018), the NAFRI 20th Anniversary Symposium, Laos, (2019), the mid-term review/ research symposium (Vientiane; January 2018) and have also been included in Country Profile papers and in a series of Project Working Papers (available at www.cassavavaluechains.net).

1.4 Conduct farm surveys

In conjunction with the value chain analyses, focus group discussions were conducted with small groups of between 10 and 15 farmers across all selected sites. Some activities were conducted as a single group, others in mixed gender groups, and some by gender groups. The key topics discussed were:

- Key village information (village chief and committee)
- Listing of all livelihood activities (agricultural, non-farm, off-farm, migration)
- Ranking of relative importance of activities for food security, cash income, labour utilisation (smaller groups by gender)
- History of cassava production and marketing in the village and other key events
- Seasonal calendars (smaller mixed gender groups)
- Cassava production enterprise budgets (smaller mixed gender groups)
- Mapping of the cassava value chain (smaller mixed gender groups)
- Discussion of production and marketing problems (smaller groups by gender)
    - Ranking of these problems

- Discussion on potential solutions and interventions (smaller groups by gender)
    - Ranking of these solutions

Baseline household surveys to determine current farm-household types, livelihood activities, production practices, market linkages, decision-making, and constraints to adoption of improved practices were developed and implemented in conjunction with partners in Vietnam and Indonesia. Surveys were translated into Vietnamese and Indonesian and loaded onto electronic tablets running the Commcare app.

Training on the household survey and the use of electronic tablets for surveys was undertaken for the Vietnamese survey teams in Hanoi (for survey in Son La) and Dak Lak in April 2017. Pre-testing was also undertaken in both provinces at that time to build the practical experience of the survey teams and to identify any potential challenges with the electronic surveys. Household surveys commenced in mid-June 2017 in Dak Lak and Son La and were completed in August 2017. A total of 256 households were interviewed in each province, based on a sample size of 32 households per village, two villages per commune, two communes per district, and two districts per province.

Training on the household survey and the use of electronic tablets for surveys was undertaken for the Indonesian survey team in Malang in April 2017. Pre-testing was also undertaken close to Malang. Household surveys were completed in North Sumatra during May 2017, with a total of 140 surveys undertaken for the province. With sharp declines in cassava prices many farmers were known to be considering switching to alternative crops, making the process more challenging. Household surveys in NTT were undertaken in August 2017 with a total of 114 completed surveys for the province.

Data from the household surveys in Vietnam and Indonesia were collated and cleaned prior to conducting both country specific as well as cross-cutting analysis. The results of the surveys have been presented at the International Tropical Agriculture Conference in Brisbane (November 2017), the North-West Vietnam Research Symposium (2017), the MTR/Research Symposium in Vientiane (2018), GCP21 IVth International Cassava Conference, Contonou, Benin (2018), the NAFRI 20th Anniversary Symposium, Laos, (2019) and have also been included in Country Profile papers and in a series of Project Working Papers (available at www.cassavavaluechains.net). Data has been made available to other research groups and has led to subsequent publications and informed planning within CIATs cassava program.

Gender and Social Inclusion Case Studies: In-depth interviews were conducted in Son La and Dak Lak Province with 64 ethnic minority men and women focusing on social and gender dimensions of the production process and their relationships with other value chain actors. The villages for gender and social inclusion case studies were selected based on cassava production and socioeconomic status. We included two contrasting villages from each commune to see how socio-economic status and proximity to a main road influenced the ways men and women engaged in cassava production. For Dang Kang commune however, we only selected one big village as there were no contrasting villages in the same commune. Based upon the advice provided by the village leader, interviewees were selected ensuring inclusion of participants from all major ethnic groups, genders and socio-economic backgrounds.

Information on field sites and interviewees - Gender and Social Inclusion Case Studies

Date	Provinces	Districts	Communes	Villages Total hh	Socio-economic status and ethnicity of interviewees	Interviewees	
						M	F
16-23 April	Sơn La	Mai Sơn	Nà Ớt (productivity the lowest in Son La)	Há Xét 70hh	Better-off, Poor Thai, Xinh-Mun	6	6
				Hủa Kẹt 28hh	Very poor Khơ mú	12	12
12-20 May		Thuận Châu	Bó Mười	Sót 50hh	Better-off Thai	12	12
				Nà Viềng 116hh	Poor, remote Thai	12	12
29 May-9 June	Dắk Lắk	Ea Kar	Ea Sar	Thôn 3 105hh	Better-off Tay	9	9
				Ear Sar 106hh	Poor, remote Ede	4	4
7-8, 26-30 June		Dang Kang	Krong Bong (Near a factory)	Curpam 120hh	Better-off & Poor mix, Ede	9	9

1.5 Evaluate project impacts

During the harvests of the final year's field trials and demonstrations (October 2019 – March 2020), follow-up interviews were conducted to evaluate how the project interventions had increased the knowledge, attitudes, skills, and aspirations (KASA) and led to changed practices of farmers and other actors within the different value chains.

In East Nusa Tenggara impact surveys were conducted with 25 farmers in Sikka and 13 farmers in Boru that participated in the project and adopted recommended technologies. The surveys also included 5 farmers in Sikka and 4 farmers in Boru that had not adopted project related technologies.
Similarly in North Sumatra impact surveys were conducted with 75 that participated in the project and adopted recommended technologies.

In Vietnam a similar process was conducted in both Sonla and Dak Lak Province to document farmer and private sector reactions, changes in KASA, and any changes in behaviour or practices. In general the project raised awareness of the technologies demonstrated. Those that required small changes (planting technic) have resulted in changed practices. However, when the new technology required additional labour or capital the change has been less immediate and there remains a need for ongoing demonstrations established in partnership between local government and private sector.

It was acknowledged that the project had brought these stakeholders together and opportunities to work together were beginning to emerge. However, this remains a facilitated process rather than something that will occur in the absence of some external catalyst. Scaling beyond initial project communes is likely to depend on some external actor being the 'honest broker' in developing these relationships and identifying opportunities.

Objective 2: Increase the adoption of improved and sustainable cassava technologies by strengthening linkages between primary value-chain actors (farmers, traders, processors) and with support actors (researchers, government agencies).

no.	activity	outputs/ milestones	completion date	comments
2.1	Conduct training in improved cassava practices, demonstration trials, and participatory research methods	Assessment of existing capacity (human, financial) of public and private actors in cassava technologies and extension methods Increased technical capacity of both public and private sector actors	December 2017	**Vietnam** Training programs related to improved cassava cultivation practices were provided to 400 farmers in several districts within Dak Lak. Extension staff in multiple cassava factories were also subject to training on cassava management and relevant technologies. Additionally field-day meetings were organized with district extension staff and farmers to discuss topics related to spacing and fertilization as well as intercropping techniques. In Son La, training programs to farmers and commune extension officials were provided on agrobiology and planting techniques, weeding techniques, and pest control techniques. **Indonesia** Demonstration trials were established in Sikka and North Sumatra with the support from local cassava value-chain stakeholders. A workshop was held for developing training material for farmers on topics including cassava agronomy and nutrient management, new varieties, pest and disease management, and small-scale processing. Training sessions were also held for farmers in both Sikka and North Sumatra on silage making from cassava leaves were
2.2	Conduct participatory variety selection with farmers with varying levels of outside support from research institutions	Establishment and monitoring of different variety demonstration M&E of farmer participation in the different production and value-chain settings	Yr2, Yr3 and Yr4	Germplasm evaluation, Soil management trails and agronomic practice experiments/trials were conducted in consultation (and in some cases active participations) with stake holders and farmers in Vietnam and in Indonesia. In **Vietnam**, nine fertiliser combinations (4 in Son La and 5 in Dak Lak) were evaluated against farmers' practice and/or without fertiliser application. Market available fertiliser combinations (i.e. NPK 12:5:10 or 5-10-3 or 15:5:20) were also experimented. Single nutrient applications (i.e. 40N-10P-40K or 60N-15P-60K) came out to be profitable. Different soil management options, legume (i.e. different leguminous crops) intercropping, grass strip and cassava residues from previous year were

				experimented. Intercropping with legumes was the preferred options for soil management (i.e. soil nutrient status) and had been scaled up; however, concern of scarcity of farm labour has been raised by stake holders. In **Indonesia**, a total of 15 high yielding varieties (i.e. sweet and bitter) were evaluated during in project districts of East Nusa Tenggara and North Sumatra. A total of 16 different fertiliser combinations were experimented along with some manure application. Medium rage fertiliser application (i.e. 45N: $45P_2O_5$ $115K_2O$ kg ha^{-1}) turned out to produce higher yield in all districts with different varieties in North Sumatra. In East Nusa Tenggara, root yield was influenced by both N and K application. As cassava roots are being removed from the field as harvest product, a balance of N and K fertiliser application is highly recommended. Options for diversifying cropping systems were experimented to make sure the availability of cassava roots for stakes holders. Intercropping with different crops were experimented. Maize intercropping came out to be popular as farm income increase in such systems in East Nusa Tenggara. However, in North Sumatra, different high value crop also experimented.
2.3	Identify opportunities for on-farm improvement and commercial production of clean planting material	Report on the demand for clean planting material in different settings Report on the costs of different 'seed systems' Develop business models for different settings reported	Jan 2017 Jan 2017 Jan 2018	Initial demand, incentives and potential entry points were evaluated as part of the value chain analysis. Farmers and value chain actors actively participated in harvest field days in Sikka, North Sumatra, Dak Lak and Son La and discussed relative merits of trialled improved varieties. In East Nusa Tenggara and North Sumatra workshops were held on 'Cassava development based on business models'

			July 2018-June 2019	
2.4	Investigate opportunities to communicate information on pest and disease management to farmers through value-chain actors	Agreed plan for participation of value-chain actors in communication activities Report submitted	Ongoing	Initial demand, incentives and potential entry points were evaluated as part of the value chain analysis. Farmers, value chain actors and government staff actively participated in harvest field days in Sikka, North Sumatra, Dak Lak and Son La and discussed pest and disease control methods.
2.5	Conduct participatory evaluation of soil management practices (including intercropping)	Assessment of adoptability of improved soil management practices	January 2018	Done (detail see activity 2.2)
2.6	Evaluate opportunities for value-chain actors to promote adoption of appropriate fertiliser regimes	Agreed plan for participation of value-chain actors in communication activities	Annually	Initial demand, incentives and potential entry points have been evaluated as part of the value chain analysis. Farmers and value chain actors actively participated in harvest field days in Sikka, North Sumatra, Dak Lak and Son La and discussed relative merits of improved soil fertility management. In Son La, support has been provided to farmers expressing interest on separate application of N, P and K fertilizers. Trials have also been conducted to examine longer harvest periods and to identify optimal planting densities related to cassava. In Dak Lak a total of three farmer field-day meetings were organized where discussions involved appropriate planting methods, fertilizer application and selection of optimal intercrops.

2.1 Conduct training in improved cassava practices, demonstration trials, and participatory research methods

Vietnam:

TNU, Ea Kar and Krong Bong agriculture and Rural Development Offices and district extension stations provided training on improved cassava cultivation practices to 200 farmers in 4 communes in Ea Kar and Krong Bong districts in March, 2017. The training was carried out in conjunction with the Ea Kar cassava starch processing factory and Dang Kang (Krong Bong) starch processing factory. At the request of M'Drak district, the same training course was provided to 200 farmers in M'Drak district with the training cost covered by the district's budget in April, 2017. The training was carried out in conjunction with the Khanh Duong starch factory in M'Drak district.

In Dak Lak, TNU provided advice and training on cassava management practices and technology for extension staff of five factories in Ea kar, Krong Bong, Cu M'gar districts in 2019. Additionally three farmer field-day meetings were organized with participation from crops, pest and disease sub-department of Dak Lak (10 staff), district extension station, and a total of 50 farmers. Discussion topics included: Spacing and fertilization practices applicable for HLS11, HLS11 intercropped with 4 types of beans, and KM419 intercropped with 4 type of beans. A total of 30 farmers in Cu'Mgar district have bought HLS11 from HLRC for the season 2018/2019 occupying a total of 20 hectares in Cu'Mgar district (non-project site).

A program for training farmers and local extension officers was also developed in Son La with collaboration from Son La DARD. The first training session in cassava agrobiology and planting techniques were attended by 73 farmers and commune extension officials. In April 2019 NOMAFSI and Son La Dard were also involved in hosting training sessions on weeding and pest control techniques for farmers and commune extension officials in April and June of 2019 respectively (Further details on the training programs including power point slides from the first training session can be found in http://cassavavaluechains.net/vietnamese/).

Indonesia:

In Indonesia, UB and ILETRI staff provided practical training to government and private sector partners including DINAS staff, local university staff, cassava trading agents and traders responsible for managing trials. Demonstration trials were established in Sikka (Flores) and Siantar (North Sumatra) with support from local cassava value-chain stakeholders. In June 2017, a two-day workshop was held to develop training material for farmers. Topics covered cassava varieties, planting materials preparation, agronomic aspect of cassava growing (include cropping system), soil management (tillage requirement, fertilization and soil conservation), pest and diseases management and simple technology for cassava processing.

Additional training by ILETRI-UB was provided during the harvest field days in Maumere and North Sumatra in late 2017. This covered topics on cassava agronomy and nutrient management, new varieties, pest and disease management, and small-scale processing. The training participants included farmers, traders, agents and factory staff. The partner institutions also drew on additional staff not directly involved in the project. The training was also attended by local government officials and attracted coverage in local media.

A training on 'making silage from cassava leaves' was conducted on 15 March 2019. The motivation for the training was the scarcity of animal feed faced by farmers during the dry seasion (kemarau) in East Nusa Tenggara. On the other hand during the wet season there is excessive amounts of animal feed available (including cassava leaves). Hence preserving the excess feed material for the dry season would help alleviate the problem related to limited feed supply for East Nusa Tenggara farmers. A total of 20 farmers from Tebuk village, Maumere and about 15 students from the Faculty of Agriculture, University of Nusa Nipa (UNIPA) Maumere participated in the training session which was delivered by Dr. Marjuki. In North Sumatra a similar training on silage making from cassava leaves was also conducted on the 15th of March 2019 where a total of twenty five participated in the training session which was delivered by Prof. Titiek Islami.

2.2 Activity: Conduct participatory variety selection with farmers with varying levels of outside support from research institutions.

Improved technology (i.e. sowing method, timely weeding and fertiliser application) and high yielding varieties were disseminated among farmers in different provinces of Vietnam and Indonesia. The aim was to expand the use of new technologies among growers with varying levels of support from private institutions. An overview of the experimental trials carried out during the length of the project listed below. Details of trial protocols and results can be found in each of the separate annual reports.

Vietnam

The focused project districts were Thuan Chau (communes Bó Muoi and Pung Tra) and Mai Son (communes Chieng Chan and Na Ot) of Son La and KrongBong and Eakar of Dak Lak province. Experiments, trials and demonstrations were carried out in these communes unless stated otherwise. First batch of experiments and/or trials were established during 2017-18 cropping season and followed till end of the project (i.e. 2019-20 season). In most cases, replicated plot trials were carried out at the start of the project then followed on to big plot demonstrations. Throughout the project different stakeholders were consulted and/or involved in establishing the trails and disseminating results.

Germplasm evaluation: A total of 13 varieties were evaluated in Vietnam in two provinces. Variety Rayong9 and KM94 was common in all evaluation trails. During 2017-2018 season, Sa21-12, BK, 13sa05 and La Tre (Local variety) were evaluated in Son La**.** The trial was conducted in 5 replicates with NPK at 60N-15P-60K kg ha^{-1}.
In Dak Lak, HLS10, HLS11, KM 419, KM140, KM505 were evaluated in two different types of soils (i.e. Acrisol and Ferrasol) and with two types of practices (i.e. Framers' practice and MARD recommended practice). For Farmers' practice, 100kg phosphorous fertilizer and 250kg NPK (15-5-20) ha^{-1} and for MARD recommended 90 kg N - 60 Kg P_2O_5 - 90 kg K_2O + 1 t ha^{-1} bio fertilizer was applied in three replicates.
Following up on the result of 2017-2018 season, same varsities were evaluated in big blocks (150 m^2) on Farmers' field in same communes in Son La in 2018-19 and in 2019-20 season. As cassava mosaic disease (CMD) spreading in the region since 2017, during 2019-20 season, at Eatu commune, Buon Ma Thuot City of Dak Lak province, an experiment was carried out to evaluate 21 new CIAT clones (i.e. elite lines) compared with popular varieties KM419 and KM94. The experiment was harvested after 10 months at the end of 2019. The experiment was established, managed and monitored by TNU and in collaboration with Centre for Crops Seeds and Animal Breeds.

During 2019-20 season three varieties, HLS11, HlS12 and HLS14, were evaluated to find out tolerance to CMD and Cassava Witches Broom disease (CWBD) at IaRve commune, Easup District, Daklak; where ~10% of planting area was CMD infected by 1st week of February 2020. There were two treatments, farmers' practices (planting density 0.6 m x 0.6 m and fertilizer 250 kg NPK 15:5:20 ha^{-1}) and recommended practice (planting density 0.8 m x 0.8 m and fertilizer 90 kg N ha^{-1} 60 kg P_2O_5 ha^{-1}, 90 kg K_2O ha^{-1} and 1 t bio fertilizer ha^{-1}). Experiment was conducted in big plots 2000 m^2.

Effect of fertiliser application: In Son La, four treatments were evaluated compared with no fertilizer application during 2017-18 and in 2018-19 season. P_0-No fertilizer; P_1-300 kg ha^{-1} NPK (5:10:3); P_2, 600 kg ha^{-1} NPK (5:10:3); P_3, 40N -10P-40K + 80 kg K_2O; P_4, fertilizer deep placement, 40N-10P-40K + 80 kg K_2O. After evaluating the results, during 2019-20 season following fertiliser rates were compared- T_0 no fertilizer, T_1 NPK (5-10-3) 300 kg

ha^{-1} basal application, T_2 NPK (12:5:10) 300 kg ha^{-1} basal application, T_3: 40N-10P-40K (i.e. 87 kg Urea, 142 kg Superphosphate, 80 kg KCl), T_4: 60N-15P-60K (i.e. 130 kg Urea 213 kg Superphosphate, 120 kg KCl, Lam Thao factory, Phu Tho province, Vietnam). T_1 and T_2 was applied at planting and for T_3 and T_4 all Phosphorous was applied at planting with $1/3^{rd}$ of N and K, rest of N and K was top dressed in two application 45 and 75 days after planting.

Soil management: In Son La different intercrops and soil management techniques were evaluated and compared with sole cassava cropping. In the experiment cassava variety KM94 was intercropped with peanut (*Arachis hypogaea*), cowpeas (*Vigna unguiculata*), mung bean (*Vigna ratiata*), grass Ghinea (*Panicum.maximum*) strips and contour lines of cassava stake residue compared with sole cassava during 2017-18 and 2018-19 season.
In Dak Lak soil management experiment was first established during 2018-19 season. HLS11 and KM419 were evaluated to find benefit of intercropping with four different legumes, mung bean (*Vigna ratiata*), red bean (*Vigna angularis*), cow pea (*Vigna unguiculata*) and pea nuts (*Arachis hypogaea*) and compared with sole cropping. Evaluating previous season results, peanuts was intercropped with cassava variety HLS11 and compared with sole cropped cassava on big plots (2000 m^2) without any replicates. Cassava was fertilised with 90 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1}, 90 kg K_2O ha^{-1} and 1 t bio fertilizer ha^{-1} and applied at each plant. Cassava was planted in two different densities 1.0 m x 1.0 m (10,000 plant ha^{-1}) and 1.0 m x 0.8 m (12,500 plant ha^{-1}). However, sole crop cassava was planted at density 0.8m x 0.8m (15,625 plants ha^{-1}). For peanuts there were two treatments, fertilized (400 kg lime powder ($CaCO_3$) ha^{-1}, 75kg Urea ha^{-1}, 150kg Super phosphorous ha^{-1}, 100kg KCL ha^{-1} and 1 t bio fertilizer ha^{-1}) and unfertilized to quantify yield benefit of the intercropping and fertilizer.

Density and fertiliser: During 2017-18 season variety KM94 and during 2018-19 season Variety HLS11 was evaluated in experiments in different combinations of fertilisers (N, P and K) and planting densities. Five fertilizer treatments (P_0, No fertilizer; P_1, 90N-60P_2O_5-90K_2O; P_2, 99N-66P_2O_5-99K_2O; P_3, 108N-72P_2O_5-108K_2O; P_4, 117N-78P_2O_5-117K_2O) were compared with Farmers' practice (P_5,100kg Phosphorous fertilizer + 250kg NPK (15-5-20) kg ha^{-1}). The trails were conducted in two different soil types (i.e. Ferrasol and Acrisol), with three different planting densities, 15,625, 12,500 and 10,000 Plants ha^{-1} in two different soil types in Dak Lak.

During 2018-19 season, four planting densities were evaluated with variety KM94 order to find the most appropriate (i.e. poor fertile soils and low-investment-capacity farmers). The treatments were as follows: M_1 (0.8m X 0.6m, 20,800 plant ha^{-1}), M_2 (0.8m X 0.8m, 15,600 plant ha^{-1}), M_3 (0.8m X 1.0m, 12,500 plant ha^{-1}), M_4 (1.0m X 1.0m, 10,000 plant ha^{-1}) in Son La. Following year same experiment was conducted in large plots (i.e.160 m^2).

Extending the cassava harvest window: Two popular varieties, KM94 and La Tre, were evaluated for fresh root yield and starch content during harvests in off season (i.e. from May to September) to ensure availability of cassava roots during off season. 60N-15P-60K fertilizer was used as describes above for fertilizer trial. A total of 10 harvest were done over a period of 20 months. First harvest was after 10 months of growth (i.e. normal practiced harvest) was in December 2018, following that 9 more harvests was carried out during 2019, January, March, April, May, June, July, August, September and December. This trial was designed based on the feedbacks from Son La starch factory to operate until September instead of April as currently.

Indonesia

The focused project districts were Sikka Regency of East Nusa Tenggara province and Siantar and Simalungun districts of North Sumatra. Experiments, trials and demonstrations were carried out in these provinces unless stated otherwise. First batch of experiments and/or trials were established during end of 2016 cropping season. Monitoring of different variety demonstration and evaluation of farmer participation in the different production and value-chain settings were completed during 2018-2019 and the final set of on-farm trials was carried out during 2019-2020.

Germplasm evaluation: At the start of the project during 2016 season, in Sikka regency, 8 varieties (four sweet varieties- local Sika Putih and Sika Kuning; and introduced Mentefa and Tambah, four bitter introduced varieties- Faroka, UB ½, UB4772, Gajah) were evaluated. During 2017 season, two more bitter introduced varieties, Malang6 and Aldira were also included. The varieties imported to the region was also evaluated in farmers' fields. In the experiment, 300 kg Urea (46% N); 150 kg SP_{36} (36% P_2O_5); 100 kg KCl (50% K_2O) ha^{-1} fertiliser was used. Considering the performance of the imported varieties, in other locations-e.g. Hokeng, Larantuka district, demonstration was organized in 2018 season.
In North Sumatra, during 2016 season 12 varieties, UB½, UB4472, Adira1, Malang4, Cecek Ijo, Faroka, Gajab, Ketan, Kaspro, Malaysia, Adira4, Cikaret were evaluated.

Effect of fertiliser application: During 2018 season, in East Nusa Tenggara fertilizer trial were conducted to determine the optimum rate of Nitrogen and Potassium. The experimental treatments were-Nitrogen rate (N0: 0 kg N; N1: 45 kg N ha^{-1}; N2: 90 kg N ha^{-1}; N3: 180 kg N ha^{-1}) and -Potassium rate (K0: 0 kg K_2O; K1: 25 kg ha^{-1} K_2O; K1: 50 kg K_20 ha^{-1}; N3: 100 kg K_20 ha^{-1}). The treatment combinations were: N0K0, N1K0, N2K0, N3K0, N1K0, N1K1, N1K2, N1K3, N2K0, N2K1, N2K2, N2K3, N3K0, N3K1, N3K2, N3K3. The experiment was arranged in randomized block design with three replications. All treatments were applied with 100 kg ha^{-1} Super Phosphate 36 (36% P_2O_5).

In North Sumatra fertilizer trials were carried out in Siantar at an experimental field belonging to PT. Bumi Sari Prima. Strip plot design with three replications was used. The treatment structure of this fertilizer application trial was 7 different fertiliser treatments (Farmers' practice-200 kg Phonska ha^{-1}, Phonska 200 kg + 125 kg Urea + 125 kg KCl ha^{-1}, Phonska 200 kg + 5 t manure ha^{-1}, Manure 10 t ha^{-1}, Phonska 200 kg + 25 kg Urea + 50 kg KCl ha^{-1}, Applied 100 kg Urea + 100 kg SP-36 ha^{-1}, 200 kg Urea + 100 kg SP-36 ha^{-1}) with two cassava varieties (Malang4 and Malaysia) during 2017 season (Annual report 2017). After reviewing the results, following season (i.e. 2018) five different fertiliser combinations, 300 kg Phonska ha^{-1}, Phonska 300 kg + 100 kg Urea ha^{-1}, Phonska 300 kg + 100 kg KCl ha^{-1}, Phonska 400 kg ha^{-1}, Animaldunk 10 t ha^{-1}. In this on-farm experiments evaluating the results of germplasm evaluation, following varieties (Malang4, Dacon (i.e. sister line of Rayong72) Huaybong60 and Faroka were evaluated at 5 sites [i.e. Sinasak, Tapian Dolok (Mr. Muchlis's land), Tanjung Tonga, Siantar (Turisno's land), and Siantar (Factory land)-2 experiments, Sipasung (Factory Land)].

Diversifying cropping systems: The intercropping other crops with cassava was experimented as cassava price was dropping. There was an interest in these experiments from the starch industry as to ensure farmers continue to grow cassava rather than shifting into other crops due to movement of cassava price.
Intercrop trials in Sikka was carried out during 2017, 2018 and 2019 seasons. First season there was six intercrop treatments (cassava plus maize (local system), cassava plus maize (introduced system), cassava plus peanut, cassava plus mungbean, cassava plus soybean) in

4 replicates (Annual Report 2018). Following seasons, the technology was demonstrated among the farmers.
In North Sumatra, intercropping experiment was with two types of cassava, grafted (i.e. root of Faroka and stem from *Manihot glasiovii*) and normal, with peanuts and peanuts followed by mungbeans during 2017. Following year (i.e. 2018), cassava monocrop was compared with intercropping with maize, with upland rice, with legumes (i.e. soybean, peanuts and cow pea). After reviewing the results of 2017 experiments in Sikka regency and North Sumatra, 2019 season intercropping cassava with maize and upland rice was demonstrated.

Reducing HCN content of Malang4: Experiment was conducted for reducing HCN content of Malang6 cassava variety. In the previous experiment Malang4 variety yielded more than 50 t ha^{-1}. This is significantly higher than other introduced or local varieties grown by East Nusa Tenggara farmers. However, with its high HCN content, this variety is not suitable for human consumption. Lab tests were conducted by 20 students from East Nusa Tenggara to reduce HCN content in this variety using NaCl and $NaHCO_3$.

Results

Vietnam

During the project participatory germplasm evaluation was the focus at the start and a total of 11 high yielding varieties were evaluated in different soil types and also in different agroecological zones. Experiments and demonstrations were repeated to validate the findings. Furthermore, as the disease (i.e. CMD and CWBD) was spreading in the region, 21 elite lines imported from CIAT-HQ were evaluated. Summary of the results and recommendations as follows.

Germplasm evaluation: A total of 11 high yielding cassava varieties were evaluated in 2 provinces, Dak Lak and Son La.
In Dak Lak, trials were conducted in 3 locations in two different soil types (i.e. Ferrasol and Acrisol). Fresh root yield was significantly affected by treatment X variety interaction ($P < 0.001$) and also soil type significantly affected fresh root yield ($P < 0.001$) (Annual report 2017). MARD practice yield higher compared to farmers' practice in all locations. Furthermore, on an average across all location fresh root yield was 1.4-fold higher in Ferrasol compared to Acrisol. Rayong9 and KM419 performed better compared to other varieties. Starch content in the varieties were significantly different ($P < 0.001$) and ranges from 27.5% (variety KM505) to 30.8% (variety HLS11).

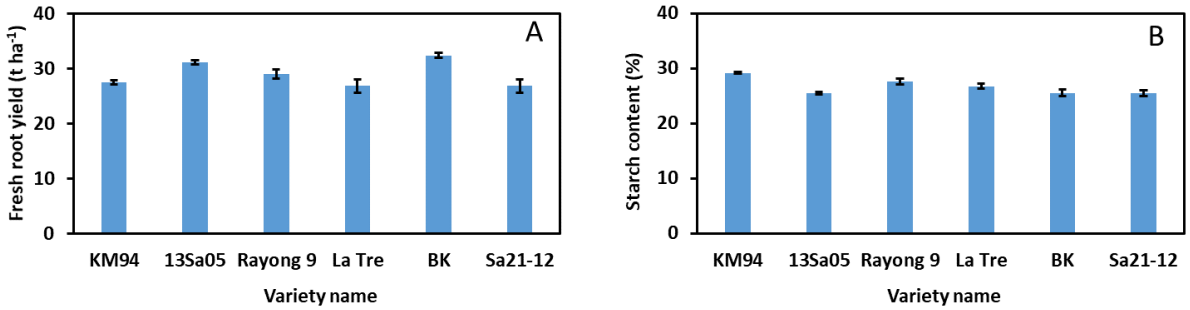


Figure 2.2.1 Fresh root yield (A) and Starch content (B) of cassava variety 13Sa0, Rayong 9, BK, 5Sa21-12, KM94 and La Tre grown Chieng Ban commune in Mai Son district. During 2019 season.

In Son La, fresh root yield was significantly different among different varieties ($P < 0.001$) (Annual report 2017). On average fresh root yield ranges from 13.1 (variety Sa21-12) to 23.7

(variety 13Sa05) t ha^{-1}. There was variation in starch content among the varieties and ranges between 27.7 to 30%.

During 2018 season follow up trial was established on big plots with same six varieties in Fresh root yield of 6 verities significantly differed by the interaction variety X location (Annual Report 2018). New variety 13Sa05 yielded highest (23.8 t ha^{-1}) followed by Rayong9 20.6 t ha^{-1} BK900 20.2 t ha^{-1} in Pung Tra commune. However, all these three varieties performed poorly in Chieng Chan commune where yield were ranged between 15.5 to 12 t ha^{-1}. Popular variety KM94 and La Tre produced similarly in both locations (Annual report 2018). As there was very different result was observed for different variety, during 2019 season six varieties were evaluated again in big plots. New variety 13Sa05 yielded 31.1 t ha^{-1} followed by Rayong9 29.0 t ha^{-1}, however, variety BK produced marginally higher (32.4 t ha^{-1}). Popular variety KM94 produced lower yield (27.5 t ha^{-1}); however, starch content was highest (29.2%). In this experiment higher yielding varieties produced lower starch content ranging between 25.4 to 27.5 % (Fig 2.2.1A).

To evaluate different cultivation practice to reduce disease severity, project recommended treatment showed less disease symptoms, higher fresh root yield and starch content over farmer's practice (Annual report 2019). In general, presence of symptomatic plants was very low (i.e. ranges between 0.09 to 0.5%) for CMD. There was no presence of CWBD in the experiment. Among the varieties, HLS14 came out the best considering all the parameters in the experiment (Annual report 2019).
One farmer and an ethanol factory engaged in multiplication of planting material of three cassava varieties during 2019 season (Annual report 2020). HLS11 had 95% CMD symptomatic plants in factory operated field; and HLS12 and HLS14 had 4 and 3% CMD symptomatic plants. HLS11 had reputation to be highly susceptible to CMD, however, in the multiplication block symptoms were mild. There was no CWBD symptomatic plants any of these fields. PCR results from asymptomatic plants from diseased field did not show presence of virus that cause CMD (Annual report 2020).

Demonstration for effect of fertilizer application: A total of 7 demonstrations were conducted in 2 provinces, Dak Lak and Son La.
In Dak Lak, five different fertiliser treatments were tested in two different soil types, fertiliser treatment X planting density interaction was not significant for fresh root yield (Annual report 2018). Fresh root yield ranges from 19.2 to 45.4 t ha^{-1} across all treatment and locations. Furthermore, fresh root yield on an average 1.3-fold higher in Ferrasol compared to Acrisol. Fertilizer treatment X planting density interaction was not significant for starch content (P=0.935). Starch content ranges from 28.5 to 31.2% across all treatment and locations. Medium rate fertilizer application, 108N-72P_2O_5-108K_2O, resulted in highest starch content (31.4 %) when planted at 12,500 Plants ha^{-1}. Similar result was observed during following year (Annual report 2019). Highest yield (37 t ha^{-1}) was achieved at medium density (12,500 plant ha^{-1}) and medium fertilizer application (90N-60P_2O_5-90K_2O + 1 t bio-fertilizer per ha^{-1}). Lowest yield (12 t ha^{-1}) was from treatment lowest density with no fertiliser. In Púng Tra of Son La province highest yield was also obtained with 12,500 plant ha^{-1}. However, Chiềng Chăn, highest yield (i.e. 25 t ha^{-1}) was achieved with highest density (20,000 plant ha^{-1}) (Annual report 2019). Large plot demonstrations during 2019 season also confirm previous results (Annual report 2020).

Application of fertilizer increased yield by 1.4-fold to 2.7-fold (i.e. averaged with all treatment) in demonstrations in Dak Lak (Annual report 2018). In Son La, fertilizer treatment X location interaction was significant (P<0.001) (Annual report 2018) as fertilizer responded

differently in different locations. Across all locations, without fertiliser treatment produced lowest yield (17.8 t ha^{-1}) and 600 kg ha^{-1} NPK (5:10:3) produced the highest (19.8 t ha^{-1}). However, in following season, fresh root yield was not significantly (P=0.008) affected by interaction of location X fertiliser as cassava responded similarly to fertilizer treatment in all locations. Considering all three locations on an average root yield increased by 1.7-fold to 2.0-fold compared to without fertiliser treatment (Annual report 2019).

Soil management: A total of 4 demonstrations of intercropping of cassava were conducted in 4 locations in Son La province.
Fresh root yield was not affected by intercropping as there was no significant interaction between intercrop X locations (Annual report 2018, 2019, 2020). However, in all trials 10 to 16% higher fresh root yield was obtained when intercropped with legumes (i.e. mung bean or red beans) compared to sole crop cassava. Legume crops received 80 kg ha^{-1} [NPK (5-10-3)], presumably, have contributed to the increased yield in cassava. Residues of cassava also demonstrated similar yield increase as shown for legume intercropped, can be attributed to the leaching of nutrients from the residues. No effect of Grass-contours on the yield of cassava was found.
In Dak Lak during 2019 season, cassava was intercropped with pea nuts and enhanced cassava yield was obtained compared to sole crop (Annual report 2020). Sole cropped cassava yielded 31.8 t ha^{-1}. Intercropping increased cassava yield ranged between 2.1 to 6.7 t ha^{-1}. Highest yield increased (6.7 t ha^{-1}) when cassava was grown at 10,000 plant ha^{-1} and peanut was fertilized. However, unfertilized pea nuts also enhanced cassava yield by 3.6 t ha^{-1} suggest that an extra 3.3 t ha^{-1} of cassava was achieved by the extra fertilizer that was added to pea nuts that, presumably, was also abetted to cassava. Fertilization to peanuts also boosted yield by 1.3-fold for peanuts. Sole cassava was planted at higher density compared to other treatment may have some influence on the yield.
Higher density of plants in the sole cropped cassava showed greater removal of nutrients. At the end of the experiment, soil analysis demonstrated marginal decline of all nutrients when cassava was grown as sole crop at 15,625 plant ha^{-1} density by contrast all other treatments add and/or remain the same for all nutrients (Annual report 2020). Similar results were also observed in other demonstrations when cassava was grown in higher density during the project.

Extending the cassava harvest window: To extend the harvest window to supply cassava fresh root to factories most of the year, cassava crop was grown for extended period (Annual report 2020). As the duration of the crop increased, fresh root yield of cassava also increased (Fig 2.2.3A). Highest yield was achieved at 20 months of growth for both varieties (i.e. La Tre and KM94). Yield penalty (2 to 4 t ha^{-1}) was observed during harvest in rainy season (i.e. April to June) compared to harvest at optimum crop duration (i.e. 10 to 12 months growth).

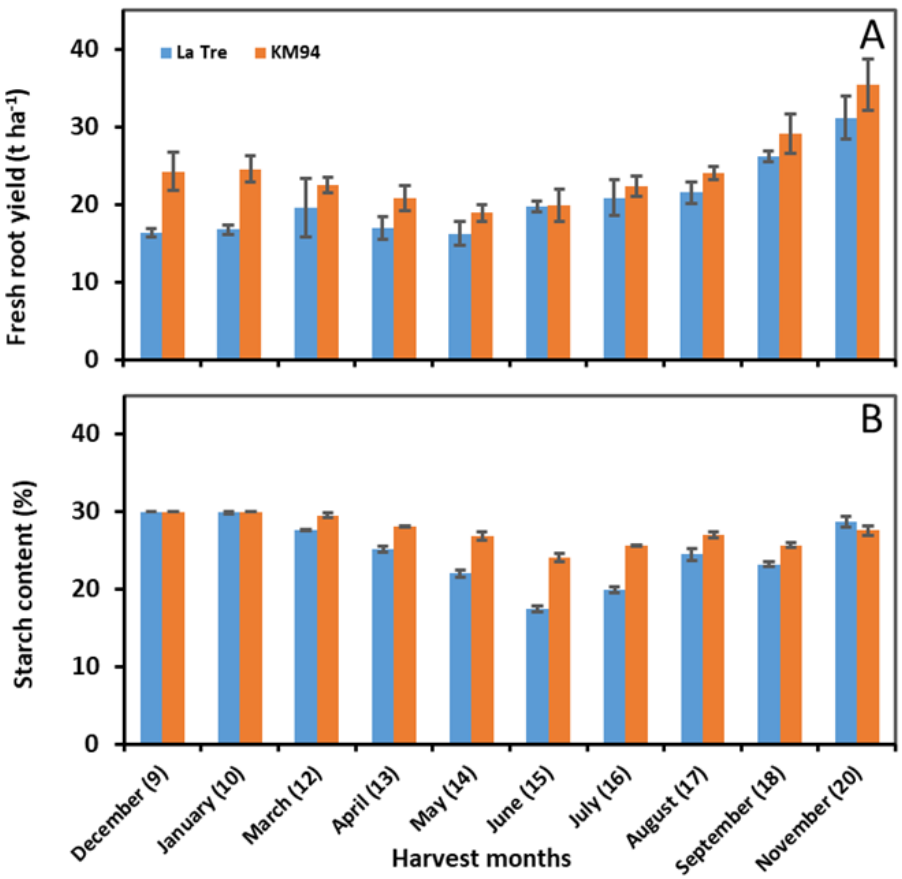


Figure 2.2.3: Fresh root yield (A) and Starch content (B) of cassava variety La Tre and KM94 at different harvest date (duration of crop in month). Crop was planted at the same time in April of the previous year (i.e. 2018). Means are followed by standard errors (n = 3).

Starch content decline as the crop growth period increased (Fig 2.2.3B). Highest starch content (i.e. 30%) was observed for both varieties after 9 and 10 months of growth. During rainy season, the starch content was lowest for both varieties. At the end of the experiment after 20 months, the starch content was 27.6% and 28.6% for KM94 and La Tre, respectively. Starch content of KM94 marginally higher compared to La Tre when considered the whole experiment duration of 20 months.

Indonesia

Germplasm evaluation: A total of 15 high yielding varieties were evaluated during in project districts.

In Sikka regency the results of the introduced varieties were promising compared to the local varieties (i.e. Sika Putih and Sika Kuning) (Table 2.2.1, Annual report 2017). Similarly, introduced varieties, Malang4, UB1/2, UB4472, Adira1, Faroka) also performed well in North Sumatra (Annual report 2017). Farmers' responded positively to introduced varieties and like the following varieties Gajah, Tambak Udang, UB ½, Malang6, Faroka. During 2018 season, in both regions, Sikka Regency and North Sumatra, varietal demonstrations were conducted with farmer's participations (Annual Report 2018, 2019).

Table 2.2.1. Cassava fresh root yield of 15 varieties at germplasm evaluation experiments at Sikka Regency during 2017 season and Siantar, North Sumatra during 2016.

Varieties	Sikka regency				Siantar
	Experimental field		Farmers' field		Experimental field
	Mealy Bugs (%)	Yield (t ha^{-1})	Mealy Bugs (%)	Yield (t ha^{-1})	Yield (t ha^{-1})
Sika Putih (L,S)	20	25.7	n.a.	n.a.	-
Sika Kuning (L,S)	25	26.6	n.a.	n.a.	-
Adria1 (I,B)	41	31.2	100	29.4	36.3
Adria4	-	-	-	-	27.4
Tambak Udang (I,S)	65	32.5	100	28.2	-
Faroka (I,B)	50	36.8	100	34.7	41.7
Cikaret	-	-	-	-	26.0
UB1/2	52	34.8	100	34.2	38.7
UB4472 (I,B)	39	33.6	100	35.7	35.8
Gajah (I,B)	35	45.7	n.a.	n.a.	31.5
Malang6 (I,B)	54	38.5	100	35.2	-
Malang4	-	-	-	-	49.8
Malaysia	-	-	-	-	41.0
Ketan	-	-	-	-	20.6
Kaspro	-	-	-	-	27.8

L=local variety, S=sweet variety, I=introduced, B=bitter, n.a.=not available.

During 2018 season, there was demonstrations in different areas (Annual report 2019) and the yield was consistently higher for project introduced technology compared to local technologies (Table 2.2.2). In 2017, the adoption of Malang4 variety were in 4 sub-districts of North Sumatra and average yield was 39.0 t ha^{-1} (Annual Report 2018).

Table 2.2.2 Root fresh yield of four introduced varieties in demonstrations in different part of project area.

Variety	Root yield (t ha^{-1})	
	East Nusa Tenggara	North Sumatra
Malang4	53.1	30.6
Faroka	46.4	26.3
Tambak Udang	40.9	34.0
Gajah	48.7	37.0
Local	32.4	16.2

Demonstration for effect of fertilizer application: Cassava and maize yield was significantly increased by fertiliser application in East Nusa Tenggara (Table 2.2.3). Cassava yield increase was between 3- to 5-fold depending on the fertiliser combination. Maize yield was influenced by nitrogen application only. However, cassava yield, was influenced by N and K application.

Table 2.2.3 Effect of Nitrogen (N) and Potassium (K) application on the yield of maize and cassava in intercropping system in East Nusa Tenggara.

Nutrient (kg ha^{-1})		Crop yield (t ha^{-1})	
K_20	N	Maize	Cassava
0	0	1.75	7.2
	45	2.9	13.42
	90	4.01	22.61
	180	4.42	36.79
25	0	1.7	8.78
	45	2.85	13.28
	90	4.53	25.32
	180	4.68	33.94
50	0	1.87	10.42
	45	3.22	14.78
	90	4.45	25.72
	180	4.27	33.19
100	0	1.91	10.91
	45	2.87	17.2
	90	4.58	25.72
	180	4.58	32.64

In North Sumatra, during 2017 season fertiliser experiment result was not conclusive. Fertilizer treatment X variety interaction was not significant for fresh root yield (Annual Report 2018). However, fresh root yield on an average 1.3-fold higher for Malang4 compared to Malaysia. Following year (i.e. 2018 season), with a little modification, 5 different fertiliser treatment was experimented on farmers' field in five locations (Table 2.2.4). Across all site, fertiliser with higher K application (45N: 45 P_2O_5 115 K_2O kg ha^{-1}) yielded highest. In another experiment, where maize was intercropped with cassava also same fertilizer combination yielded highest (Annual Report 2019).

Table 2.2.4 Cassava tuber yield in response to five fertiliser combinations in 5 different sites in North Sumatra during 2018 season. Four different varieties were used in the experiments on farmers' field.

Treatments (NPK)/ Districts	Tuber yield (t ha^{-1})				
	[a]Sinaksak	[a]Tanjung Tonga	[b]Siantar	[c]Siantar	[d]Sipasung
*45N: 45P_2O_5 : 45 K_2O kg ha^{-1}	31.7	36.7	23.2	19.8	36.6
90N: 45P_2O_5 : 45 K_2O kg ha^{-1}	31.3	36.9	23.9	21.2	37.6
45N: 45 P_2O_5 115 K_2O kg ha^{-1}	47.1	44.2	28.2	26.3	43.7
60N: 60P_2O_5 : 60K_2O kg ha^{-1}	30.4	37.8	24.8	22.7	38.4
Organic manure 10 t ha^{-1}	30.4	36.0	24.8	23.6	36.7

*Farmers' practice, Varities-[a]Malang4, [b]Dacon, [c]Hoybong60, [d]Faroka

Diversifying cropping systems: Cassava yield was highest in monoculture practice (Annual Report 2018). In all intercropping practice cassava yield was lower (between 10 to 27.1 t ha^{-1}) as the planting density was adjusted (low). However, when calculated Land Equivalent Ratio (LER) the yield of intercrop system was higher in all treatment and the highest (LER 1.78) was for cassava with maize intercropping with higher density (Annual Report 2018). Following season, demonstration of the effect of fertilizer application on yield of maize and cassava-maize intercropping was carried out in East Nusa Tenggara (Annual Report 2019). Farm productivity was increased significantly due to intercropping and fertiliser application

as yield for both crops increased (i.e. for maize up to 2.6- and for cassava 2.8-fold compared to sole croping; Annual report 2019).

HCN content in Malang4: Experiment demonstrated that HCN content in Cassava (Malang4 variety) can be lowered by submerged the tuber in Sodium chloride or in sodium bicarbonate solution (Annual Report 2020). HCN in un-treated tuber was 114.23 mg kg^{-1}. and with different treatment combination it reduced to 44.6 mg kg^{-1}. The HCN content is considered as safe for consumption is about 50 mg kg^{-1} or less; for example, HCN content of sweet variety Tambak Udang is much lower (i.e.26.7 mg kg^{-1}) (Annual Report 2020).

2.3 Identify opportunities for on-farm improvement and commercial production of clean planting material

Initial demand, incentives and potential entry points were evaluated as part of value chain analysis. Farmers and value chain actors actively participated in harvest field days in Sikka, North Sumatra, Dak Lak and Son La and discussed relative merits of trialled improved varieties.

In Dak Lak in 2018-2019, efforts were made towards the establishment of a clean planting production and distribution model with a farmer-businessman, but this did not succeed as the farmer was too busy with other activities and could not see immediate benefits from clean planting material production and distribution.

In North Sumatra considerable achievements have been made in the dispersal of the variety Malang4 through the value chain. Malang4 is an open pollinated variety formally released by ILETRI in 2001. It is one of the varieties grown in East Java, but new to North Sumatra. In 2015-16 the variety was selected by farmers and traders at the first participatory evaluation conducted by the project with Bumi Sari. In 2016-17 25 farmer/traders received planting material and trialling the variety in other areas in the supply zone. In 2018-19 more farmers (around 60) will have received Malang4 from the trader/farmers with the main agents providing a key player in moving material through the value chain. The project purchased stems for 500IDR/stem (5-8 stakes/stem) that were provided free of charge to the next round of farmers. Shipment of stems from Java to North Sumatra is relatively expensive. It is recommended that the rapid multiplication technology being developed in AGB/2018/172 be transferred to North Sumatra for primary multiplication with Bumi Sari and the main agents.

In the absence of disease pressure, and low frequency of new varieties being released the industry led seed system may prove to be a one-off mechanism to achieve rapid dispersal. However, if the production area continues to contract and expand based on relative prices there may be some opportunities for the system to be maintained. With Bumi Sari continuing to support the primary evaluation of new technologies there should be opportunities for CIAT to work with ILETRI-UB to evaluate new clones and begin planning for emergency responses if/when disease presents itself. The reported presence of ‘Huay Bong’ varieties in North Sumatra indicates that the private sector has recently transferred material from Thailand to Sumatra. This is a very high risk activity, and every effort should be develop a domestic seed system from in-vitro movement between countries and rapid multiplication in core cassava regions.

In NTT, the project has tested both sweet and bitter varieties in some core locations. After the field day in 2017 the 25 farmers received ‘new’ varieties for evaluation on their own land. Due to the limited quantity of planting material produced by the initial trial, additional

stems were sent from East Java to facilitate high numbers of farmer involvement (6000 stems including Gajah, Malang 4, Faroka, and Tambak Udang). The project team has also developed a relationship with the Agricultural High School at Hogeng, Larantuka District. The project is conducting a variety trial at Hogeng with students and staff from the school involved. Small-scale industry managers have also been involved in this activity.

The importance of clean planting material and rapid multiplication and dispersal is likely to become an increasingly high priority in Dak Lak. CMD has not formally been announced in the central Highlands, but seed system studies have shown that planting material has been purchased from Tay Ninh, the main hotspot of the disease in Vietnam. Furthermore, the Central Highland borders the areas of infection in Cambodia. New clones from CIAT have been sent to two locations in the Central Highlands. The first is managed by TNU and the second has been funded and managed by one of the ethanol producers. The importance of industry coordination around surveillance and clean seed systems appears to be an important entry point for activities under objective 3.

2.4 Investigate opportunities to communicate information on pest and disease management to farmers through value-chain actors

Initial demand, incentives and potential entry points evaluated as part of value chain analysis. Farmers, value chain actors and government staff actively participated in harvest field days in Sikka, North Sumatra, Dak Lak and Son La and discussed pest and disease control methods.

Addressing pests is likely to become an important part of activities in Sikka given that cassava mealybug was observed during the value-chain assessments and focus groups. Researchers working on a national mealybug monitoring effort visited the site and the project team communicated their findings with them. Extension information exists on this topic in Bahasa Indonesia which was previously developed by CIAT.

Cassava witches broom disease (CWBD) is currently present in Dak Lak with cassava mosaic disease (CMD) having a high likelihood of arriving in the near future. Extension material for witches broom is currently available in Vietnamese with some previous efforts made to show videos at the processing factory under the CIAT IFAD Emerging Pests and Diseases of Cassava Project. Given that the household survey showed around 50% of farmers selling through traders rather than directly to the factories, additional approaches need to be developed to ensure the message scales through the value chain. A farmer-to-farmer DVD is being considered to be developed for CWBD that will be translated into all the major languages with incentives for industry to provide them to farmers Activities under this objective are closely linked to the seed system objective above.

2.6 Evaluate opportunities for value-chain actors to promote adoption of appropriate fertiliser regimes

Initial demand, incentives and potential entry points were evaluated as part of value chain analysis. Farmers and value chain actors actively participated in harvest field days in Sikka, North Sumatra, Dak Lak and Son La and discussed relative merits of improved soil fertility management.

Cassava grown as part of the trial on fertilizers was harvested in January and February of 2019. Fertilizer trials tested five fertilizer treatments in order to identify optimal types and rates of fertilizer application to achieve high fresh root yields and starch content as well as high economic returns. Soil management trials with the aim of identifying intercrops varieties and soil management techniques that were able to deliver improved economic returns and soil erosion control were also conducted.

During the field days farmers expressed interested in applying separate N, P and K fertilizers and thus support was provided to some farmers for employing this fertilization application method.

In addition, trials were also conducted on planting density and harvest times. These two trials were planned based upon the opinion of farmers and cassava companies during the 2017 field days. Both cassava farmers and cassava companies expressed a preference for longer cassava harvest periods which would allow farmers to more easily sell cassava roots while also permitting cassava processors to operate for extended periods during the year. The trials on planting density were conducted to identify suitable planting density for farmers to apply in Son La (normally farmers plant cassava at 0.6m x 0.6m while the recommended area is 1.0 m x 1.0 m).

In Dak Lak three farmer field-day meetings were organized with participation from crops and pest and disease sub-department of Dak Lak (included about 10 staff members), district extension station staff and 50 farmers. Discussion topics included: Spacing and fertilization practices applicable to HLS11 variety, HLS11 variety intercropped with four types of beans, and KM419 intercropped with four types of beans.

Objective 3: Develop policy recommendation and facilitate learning alliances for the development of a sustainable cassava industry and improvement in rural livelihoods through improved agribusiness arrangements

no.	activity	outputs/ milestones	completion date	comments
3.1	Review government planning and policy procedures	Working paper on local planning and policy constraints	Not completed as there were numerous existing reviews	A review of existing secondary information in both Vietnam and Indonesia revealed that there are numerous existing reviews of agricultural and rural development policies which are directly relevant to cassava (including Vietnam Food Security Policy Review undertaken by ACIAR in 2017 and a review of maize and agriculture related policies undertaken by project SMCN/2014/049 in 2018). It was decided that rather than replicate these existing documents in another report, that the project would concentrate on dialogue with stakeholders at local level on local policy settings impacting on cassava value chains. Frequent discussion have been held with stakeholders on this topic.
3.2	Facilitate stakeholder dialogues in each case-study region to identify incentives, problems, and solutions	Dialogues conducted and reported	Throughout project	Dialogues with stakeholders were conducted at the inception meetings in Son La and Dak Lak. Stakeholder meetings with participation of the private sector and provincial government have been held since in Son La and Dak Lak. Additional private sector and local government stakeholder engagements have been conducted at field days around harvest of trials across all sites in Vietnam and Indonesia. In East Nusa Tenggara, a workshop was held on “Cassava development

				in East Nusa Tenggara based on business model" between the 14th and 15th of March 2019 In North Sumatra, a workshop on "Cassava development in North Sumatra based on business model" was conducted on 21-22 November 2018 Provincial Stakeholder meetings and discussions in Vietnam have been held in May and July 2020.
3.3	Facilitate and evaluate a learning alliance between key stakeholders	Meetings of key stakeholders held in each country	National level policy meetings for discussion	National Policy Meeting held in Indonesia in March 2020 National stakeholder meeting to be held in Vietnam in September 2020 in conjunction with AGB/2018/172.
3.4	Develop evidence-based policy briefs on agribusiness models for improving cassava-based livelihoods	Policy briefs produced and distributed	Policy Briefs developed from July 2019 National level policy meetings for discussion in Indonesia in March 2020	Policy briefs on fertiliser use, varieties, stakeholder linkages and pests and disease prepared for Indonesia in both English and Bahasa Indonesia and discussed with stakeholders. A stakeholder brief on project results in Son La has been developed by NOMAFSI and will be discussed with stakeholders.
3.5	Facilitate a Southeast Asian workshop on opportunities to support smallholder livelihoods and improve cassava value chains	Workshop held and reported Workshop proceedings	Regional Symposium Jan 2018 Regional Symposium July 2019 Final Meeting and review July 2020	Two regional workshops/symposia done, final review in July 2020.

3.1 Review of national policies

A review of existing secondary information in both Vietnam and Indonesia revealed that there are numerous existing reviews of agricultural and rural development policies which are directly relevant to cassava (including Vietnam Food Security Policy Review undertaken by ACIAR in 2017 and a review of maize and agriculture related policies undertaken by project SMCN/2014/049 in 2018). It was decided that rather than replicate these existing documents in another report, that the project would concentrate on dialogue with stakeholders at local level on local policy settings impacting on cassava value chains. Frequent discussion have been held with stakeholders on this topic.

Vietnam

Preliminary discussion on local government policies and priorities were conducted during the inception meetings in each site. DARD and the People's committee outlined the views and perception on cassava and priorities for the project. There are limited direct policies at the national level, besides some unenforceable targets – including the national level of cassava and minimum prices.

Indonesia
Similar to Vietnam there are few national level policies around cassava and the crop is largely impacted by policies in the substitute commodities. In Sikka there are some local policies around diet diversification. In North Sumatra there is limited government support and regulation of the cassava sector. Various policies impact the processing and logistics in both countries.

3.2 Facilitate stakeholder dialogues in each case-study region

Vietnam
First stakeholder dialogs were conducted at the inception meetings in Son La and Dak Lak. This meetings included participation by researchers (including those outside the project), DARD officials, MOST, Provincial Peoples Council, and cassava processing industry. By involving government and private sector actors in the value-chain training and assessments, these actors also had the opportunity to interact with groups of men and women farmers in the target districts. Farmers, government and private sector value chain actors participated in the harvest and assessment of the 2017 trials in both Son La and Dak Lak. The project also presented papers and posters at the North-West Vietnam Research Symposium in Hanoi in November 2017.
A stakeholder meeting was held in Dak Lak on 30th March 2018, with the participation of private sector and provincial government. A stakeholder meeting was held in Son La on 5th July 2018, with the participation of private sector and provincial government.

At the national scale, the arrival of CMD in Vietnam and the importance of industry and government coordination in response has brought forward the need for national level meetings in association with other projects. The project results will provide useful inputs into these discussions highlighting the importance of cassava for the poorest households in the uplands of Vietnam and how different approaches for extension utilizing the value chain need to be developed based on the location.

The results have already been used in communicating the urgent need for action at several international forums. Project team members participated in the workshop “Solutions for CMD prevention and control in Daklak” organized by the National Extension Centre in October 2018 and provided experiment results from 2017/2018.

During 2018-2019, three farmer’s field-day meetings were organized with participation from crops and pest and disease sub-department of Daklak (10 staff), district extension station and 50 farmers in Dak Lak. Discussion topics included: Spacing and fertilization practices applicable for HLS11, HLS11 intercropped with four types of beans, and KM419 intercropped with four type of beans.

Further provincial meetings and discussions with stakeholders in Vietnam have been held in Son La (May 2020) and Dak Lak (July 2020).

Indonesia
Strong stakeholder relations have been formed in North Sumatra during repeated field visits. The project team travelled with the Director of Bumi Sari and one of the key cassava trading-agents. Meetings were held at Bumi Sari with the largest agents who coordinate with traders to supply the factory. The group (research +private sector) also met with BPTP to discuss the project and their priorities and capacity. Stakeholders were also

invited to the harvest of multiplication trials in North Sumatra and the harvest of variety, intercrop and fertilizer trials in North Sumatra in September 2017.

Team members continued to liaise with both public and private sector actors with higher frequency as more results became available. In Sikka, there has been strong engagement with the local DINAS who managed the trials with the support from an enthusiastic private sector actor. There has also been engagement with the Nusa Tenggara Association (NTA), an NGO that may have interest in scaling innovations into the areas in works. There have also been cross-site visits of private sector actors from Sikka to North Sumatra. The project supported and presented papers at an International Workshop of root and Tuber crops in October 2017 in Malang. The project team also met with representatives of ICFORD in Bogor on June 5th, 2018 to update about project progress and to explore government priorities around cassava research.

In North Sumatra, a workshop on "Cassava development in North Sumatra based on business model" was conducted on 21-22 November 2018 at "Horison" hotel, Pematang Siantar, North Sumatra. The workshop was attended by 40 participants from government officials (District Agricultural Service), Researchers form University and Research Institute, Extension Services, Cassava trader and industries, and farmers. The workshop was aimed at collecting information from various cassava stakeholder industries for the development of cassava in North Sumatra.

The workshop was inaugurated by Prof. Wani Hadi Utomo, as the team coordinator. Presentations were made by two key speakers, namely: 1) Director of Legumes and Tuber Crops from the Ministry of Agriculture who presented a paper entitled "Cassava Development Policy in Indonesia", delivered by Dr. Yuliantoro Baliadi (Head of ILETRI), and 2) Head of the North Sumatra Province Food Crops and Horticulture Office, who presented a paper entitled "Policies on the development of Cassava in North Sumatra", delivered by Dr. Unedo Koko Nababan. This was followed by a presentation on the topic of "Farming system, processing, marketing, farmers respons, and opportunities for developing cassava in North Sumatera" by Mrs. Rully Krisdiana. Mr. YudiWidodo presented "The results of agronomic research as a basis for the initial policy of developing North Sumatra" and finally Dr. Kartika Noerwijati presented "The results of adoption of Malang 4 variety in North Sumatra"

In East Nusa Tenggara, a workshop was held on "Cassava development in East Nusa Tenggara based on business model" between the 14th and 15th of March 2019 at "Sylvia" hotel, Maumere, East Nusa Tenggara. The workshop was attended by 40 participants including government officials (District Agricultural Service), Researchers form University and Research Institutes, Extension Services, Cassava trader and industries, and farmers (see appendix 1 for a list of participants). The workshop was aimed at collecting information from various cassava stake holder industries for developing cassava in East Nusa Tenggara. The workshop was inaugurated by the Bupati of Sikka District, East Nusa Tenggara Province. The head of East Nusa Tenggara BPTP (Balai Pengkajian Technology Pertanian) provided an overview of the policy and strategy of tuber crops in East Nusa Tenggara, Mr. Tomy Jare (Trader/Industry) discussed cassava trading measures in East Nusa Tenggara, Mr. Erwin (University Tribhuwana Tunggadewi, Malang) provided details on the results of agronomic trials in East Nusa Tenggara, and Dr. Suhartini (University of Brawijaya, Malang) provided some insights on the socio-economic conditions of cassava farmers in East Nusa Tenggara. The second day of the workshop a visit was made by the participants to a fertilizer experiment site and also to some farmer fields where the methods had been adopted.

The mid-term review/research symposium held in Vientiane enabled dialogues between private sector, government and research stakeholders to take place. Stakeholder dialogues with the participation of government, private sector and research actors from Indonesia, Vietnam, Laos, Cambodia and Myanmar continued in the regional research symposium held in North Sumatra in July 2019.

3.3 Facilitate and evaluate a learning alliance between key stakeholders

Indonesia

A National level policy dialogue was held in March 2020. This event was supported by the project in association with the Indonesia Cassava Society (ICS) and the Directorate General of Food Crop. The meeting included representatives from (1) Ministry of Agriculture (Ditjen TP, BB Biogen, Balitkabi, BKP); (2) the Ministry of Cooperatives and SMEs; (3) LIPI; (4) Regional Agricultural Service; (5) Academics (UNEJ, ITB, UB); (6) Communities; (7) Industries; and (8) Small and Medium Enterprises[3].

The outcomes include submission to the Minister of Agriculture and the President of the Republic of Indonesia to have cassava considered one of the strategic crops for Indonesia; prioritising research; development of national cassava seed system; establish demonstration; enhanced coordination between farmers and processors; addressing price fluctuations; developing standards for cassava starch and MOCAF; support domestic utilisation and promote exports; promote consumption as food; preparing for new diseases and strengthening cooperation between all relevant stakeholders.

The general conclusion is that the timing is very good for lifting the profile of cassava within the Indonesian Government and efforts should be made to maintain coordination in the future.

Vietnam

There have been several national level meetings and discussion during the project life supported by different organisation – largely in response to cassava disease. The project has contributed to these discussion highlighting the economic and livelihood importance of cassava based on the results of the household survey and market assessments.

A final National Policy Dialogue was planned for early 2020 subsequent to the Province level meetings. However was postponed due to COVID travel restrictions impacting the former meetings. Given the focus on cassava disease and seed systems in ongoing cassava ACIAR activities in Vietnam, it was decided to postpone and combine with the meeting planned for AGB/2018/172 later in 2020. This will also provide an opportunity for results of the first year of disease resistance screening to be presented.

3.4 Develop evidence-based policy briefs on agribusiness models for improving cassava-based livelihoods

As much of the discussion and many of the recommendations in the briefs relate to the private sector the briefs have been produced as Stakeholder Briefs, rather than Policy Briefs. The stakeholder briefs summarise issues, findings and key policy recommendations

[3] *Agenda, paticipants and presentations are online at: http://cassavavaluechains.net/indonesia-2/*

related to major topics under the project. The intended audience for the briefs is national level policymakers, Local Government and extension centres and private sector stakeholders.
Four Stakeholder briefs have been prepared for Indonesia and discussed with stakeholders. The briefs are available in both Bahasa Indonesia and in English and can be downloaded from the project website. The briefs for Indonesia are:

1. Fertilizer use in the Cassava Sector in Indonesia
2. Varieties in the Cassava Sector in Indonesia
3. Pests and Diseases in the Cassava Sector in Indonesia
4. Developing Stakeholder Linkages in the Cassava Sector in Indonesia

A stakeholder brief for Son La has been produced, covering general project results and providing recommendations for various stakeholder groups. This is available in Vietnames and in English and reflects the contents of discussions at the stakeholder workshop in Son La in May 2020. Further discussions around these topics are planned with stakeholders up until the completion of the project.

3.5 Facilitate a Southeast Asian workshop on opportunities to support smallholder livelihoods and improve cassava value chains

In July 2019 a Regional Workshop was held in North Sumatra bring together research team, government staff and private sector partners from each of the project sites. The topics covered included the agronomic and economic analysis of trials and demonstrations as well as presentations on the value chain and stakeholder engagement. Several panels discussion were facilitated.
The Proceedings from the Symposium are being published by ACIAR.

The final project meeting was planned for Dak Lak in the Central Highlands of Vietnam. It was proposed to follow a similar process with industry and government partners from project sites coming together. Unfortunately this was cancelled due to COVID.

July 2020 in the one year anniversary of the event in North Sumatra and two year anniversary of the mid-term review and research symposium in Vientiane. It is clearly evident from following Facebook posts that these two event created strong networks and friendships between different actors in the value chain and between the 5 countries (Vietnam, Indonesia, Lao PDR, Cambodia and Myanmar). It is hoped that these networks can be maintained and research and development results and idea shared throughout southeast Asia.