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Cassava value chains and livelihoods in South-East Asia

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ACIAR PROCEEDINGS

Cassava value chains and livelihoods in South-East Asia

A regional research symposium held at Pematang Siantar, North Sumatra, Indonesia, 1–5 July 2019

Jonathan Newby, Dominic Smith, Rob Cramb, Erik Delaquis and Lava Yadav (Editors)

ACIAR

2020

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Cover: Cassava farmer in Tboung Khmum province in central Cambodia. For some smallholder farmers, cassava contributes 50% or more to their household income. In South-East Asia, cassava is an important staple food, but it is also grown for industrial starch production, animal feed and biofuels. Photo: ACIAR

Foreword

In supporting resource-poor smallholder farmers, the focus of agricultural research and development is often on crops that can provide valuable nutrition for families, as well as an income if sold into local value chains. Agricultural technologies and practices that lead to better productivity and sustainability in such crops may directly improve food security. However, it is important not to oversimplify the diverse income streams that are available to smallholder farmers.

Cassava is an important staple food in many parts of the world, but, in South-East Asia, it is also grown for industrial starch production, animal feed and biofuels. It is an attractive crop for farmers with limited access to irrigation and other inputs, and can survive in areas and conditions that may be marginal for other crops.

Cassava plantings are estimated to cover more than 3.5 million hectares in South-East Asia, and cassava starch makes up an increasingly large proportion of the global starch market (compared with potato, wheat, corn or other starches). For Vietnam, cassava exports were valued at more than US$1 billion in 2017. However, smallholder farmers must deal with large fluctuations in the price they receive for their cassava roots. For some smallholder farmers, cassava contributes 50% or more to their household income, so global market trends and shocks can lead to price uncertainty for farmers and directly impact their livelihood.

The Australian Centre for International Agricultural Research (ACIAR), in partnership with research organisations in Australia and overseas, has been supporting multifaceted research on cassava for more than 10 years. At the farm level, we have invested in research to improve the sustainability of cassava production, investigate climate change impacts, practices for basic fertiliser use, and pest management. But research beyond the farm gate along the value chain is also required.

Ensuring that smallholder famers are sufficiently linked to input and output markets is important, but bringing cassava traders, processors and starch factories across many countries into the research agenda helps to improve sustainability for any commodity. Through our investment in the Cassava Value Chain and Livelihood Program, we have built an environment where diverse participants across the cassava industry can discuss challenges, as evidenced by the many different perspectives in this publication.

Andrew Campbell
Chief Executive Officer, ACIAR

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Acronyms and abbreviations

Term	Description
ACIAR	Australian Centre for International Agricultural Research
CaO	calcium oxide
K_2O	potassium oxide
KCl	potassium chloride
ENT	East Nusa Tenggara province (Indonesia)
NPK	nitrogen-phosphorus-potassium
P_2O_5	phosphorus pentoxide
PCR	polymerase chain reaction

Units

Unit	Definition
cm	centimetre
g	gram
ha	hectare
₭	Lao kip
kg	kilogram
km^2	square kilometre
Ks	Myanmar kyat
m	metre
m^2	square metre
mm	millimetre
Rp	Indonesian rupiah
t	tonne

Preface

The ACIAR Cassava Value Chain and Livelihood Program consists of two interlinked projects implemented by the University of Queensland in partnership with the International Center for Tropical Agriculture (CIAT) and national partners across South-East Asia. The projects, running between 2016 and 2020 are:

- Developing cassava production and marketing systems to enhance smallholder livelihoods in Cambodia and Lao PDR (ASEM/2014/053)
- Developing value-chain linkages to enhance the adoption of profitable and sustainable cassava production systems in Vietnam and Indonesia (AGB/2012/078).

The program analyses the socioeconomic conditions under which improved technology and market booms in commercial crops such as cassava can be harnessed to increase the profitability and sustainability of smallholder farming systems in mainland South-East Asia. This will contribute to poverty reduction.

There are considerable opportunities to increase the productivity, profitability and sustainability of the cassava industry through better value-chain linkages between smallholders and industry actors that can deliver the dual objectives of industry development and economic growth, and livelihood security and poverty reduction. This requires that core value-chain actors are well linked, that they have strong connections to supporting networks and services, and that the institutional framework creates an environment conducive to smallholder development.

One of the key features of the Cassava Value Chain and Livelihood Program has been knowledge and information sharing between the public and private sectors, researchers and the development sector across Vietnam, Indonesia, Laos, Cambodia and Myanmar. This information sharing has been most visible as a result of international events convened by the program. The first of these, in conjunction with the midterm review of the program, was in Vientiane in January 2018. After the success of the first research meeting, program participants agreed to convene an international research symposium in July 2019 in Siantar, North Sumatra, Indonesia.

More than 50 participants—encompassing the private sector, governments, researchers and development specialists, from across the region and Australia—attended the symposium. Participants shared information on agronomic and socioeconomic aspects of the cassava industry and exchanged ideas between countries. These proceedings collect the presentations and discussions from the symposium and serve as a record of the positive and fruitful interactions between the participants.

The presentations from the symposium can be downloaded from the project website at cassavavaluechains.net/research-symposium-2019.

Introduction and international context

1 Overview of ACIAR cassava projects and the workshop

Dominic Smith
University of Queensland, Australia

The two ACIAR projects cover a wide geographic range, and disparate value chains, policies, priorities and production systems. Key activities completed include:

- value-chain training, interviews with value-chain actors and group interviews with farmers in 2016
- implementation of household baseline surveys in 2017
- field trials to test varieties, fertiliser rates and intercropping from 2016 until July 2019, with the final season of trials in 2019–20.

Involvement of starch factories and other private-sector partners throughout the projects has been an exceptionally strong point. Information sharing has been equally important, through a Facebook group, workshops and sharing of the midterm review results. Student involvement has been strong and continues this year, with students from the University of Queensland, Tay Nguyen University, the University of Brawijaya, the National University of Laos and Universitas Nusa Nipa.

The program structure for this meeting will be:

1. overview
2. agronomic results and analysis
3. engagement with the private sector and government for scaling out
4. challenges and planning for the remaining 18 months of the project.

I would like to thank all the actors—research, government and private sector—and we look forward to a productive meeting.

2 Cassava policies and priorities in Indonesia

Hardiyanto
Indonesian Center for Food Crop Research and Development

Indonesia is the third-largest global cassava producer behind Nigeria and Thailand. Cassava is not currently a priority commodity as designated by the Ministry of Agriculture, which has selected three priority commodities based on achieving food self-sufficiency. However, looking forward to the end of Indonesia's current strategic outlook for food security (2045), cassava will likely become a priority crop. According to official statistics for 2015, Indonesia harvested 949,916 ha of cassava, producing 21.8 million tonnes (t) valued at about 21.8 trillion rupiah.

The major production zones in Indonesia are Lampung, Central Java, East Java, East Nusa Tenggara and North Sumatra. The most widely distributed variety is Malang 4. The total harvested area has decreased over the past 5 years, but yields and total production have increased. Most (55%) of Indonesian cassava production is destined for direct consumption. Despite steadily rising total production over the past 5 years, imports of tapioca have increased.

The objectives of national cassava policy are to:

- increase production
- develop agribusiness and the private sector
- support food diversification
- increase access to capital/credit through government assistance, the food and energy security credit scheme, and microfinance and other sources
- improve commodity trading—that is, increase traded volumes.

Working with farmer groups is an integral part of government strategy. The use of existing farmer group structures is important for meeting strategic objectives. A cassava development group should be formed within each farmer group, and responsibility for managing cassava activities, finance and events should be delegated to particular individuals in the group.

Research and development activities are key to achieving the cassava strategy. The Directorate General of Food Crops, through the Indonesian Legumes and Tuber Crops Research Institute in Malang, ensures the provision of certified, high-quality—in terms of both variety and phytosanitary aspects—cassava planting material. Work is continuing on the development of the national cassava-processing sector to increase local markets. Significant work is also needed to select nonbitter cassava varieties for producing snack food.

3 Global cassava market update

Jonathan Newby
International Center for Tropical Agriculture, Laos
Cù Thị Lê Thuy
International Center for Tropical Agriculture, Vietnam

The framework of the ACIAR cassava research program embraces multiple scales, from global to local, and attempts to unpack interactions across them (Figure 3.1). This presentation deals with global markets and the impact of external policies that affect farm economics and the incentives for different value actors to scale innovations to farmers in their supply zone.

On the demand side, the market outlook for cassava in Asia needs to be considered in the context of substitutes in different applications. There are markets where:

- cassava chips compete with other sources of carbohydrate for processing animal feed or ethanol (e.g. maize, sorghum, wheat, molasses)
- cassava starch competes largely on price with substitutes such as maize and potato starch
- the functional properties of cassava starch are desired (e.g. frozen food, gluten-free products).

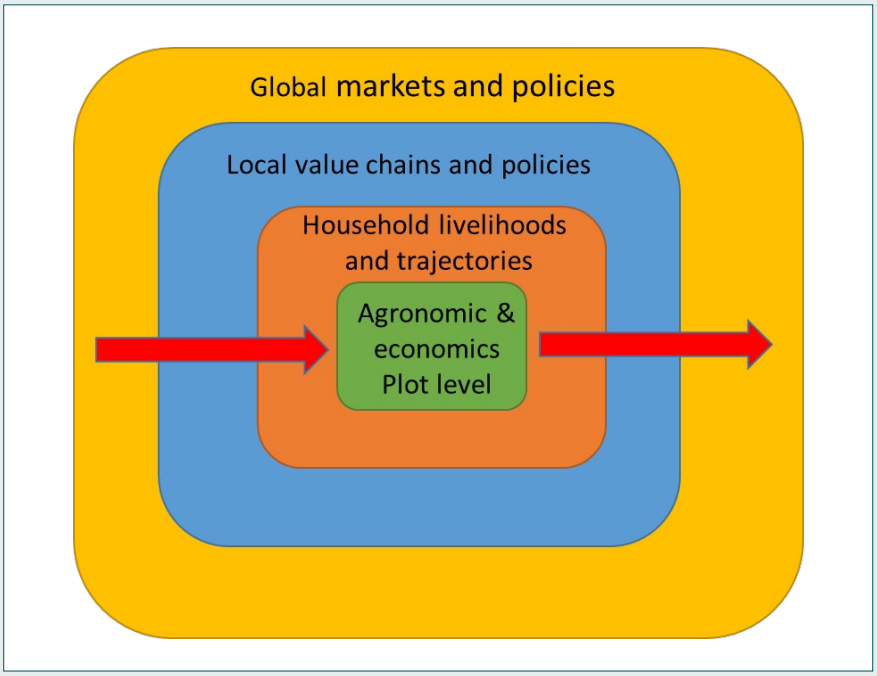


Figure 3.1 Conceptual framework of the project that works across scales

On the supply side, the outlook depends on the relative competitiveness of cassava against other land uses in the context of different trends and shocks. This is a function of:

- the price of cassava relative to other commodities that can be produced in the same agroecological zones (e.g. maize, sugarcane, coffee, rubber)
- changes in production costs, particularly changing labour costs and the ease of mechanisation.

Cassava supply will also be affected by long-term climate trends, floods and droughts, changes in land suitability and land degradation, and the impact of pests and diseases. The spread of cassava mosaic disease (CMD) is currently the biggest threat to cassava supply. Positive virus assays have been reported from Vietnam, Cambodia and Thailand. Although not yet reported in Laos and Myanmar, it is likely that infected planting material has been (or will be) imported from other countries, or that whitefly will transmit CMD across the border.

National statistics on planted area, yield and production do not necessarily give an accurate picture of changes in supply. Changes are descriptive of past trends, but the data do not become available soon enough for timely analysis. Hence, we are left explaining changes after the fact, except possibly Thailand, which has more efficient recording and updating by industry associations. In Thailand, area, yield and production increased in 2018 from 2017 (Table 3.1). However, Thai imports of chips and fresh roots from Cambodia declined from US$282 million in 2017 to US$201 million in 2018, and from Laos they declined from US$83 million to US$68 million.

China has the majority share of the global cassava market; hence, changes within China can affect demand for cassava in the South-East Asian countries producing it. For example, price support for maize in China led to increased demand for cassava imports because cassava could be substituted as a source of starch or carbohydrate. After price support policies were removed in 2016, a large stockpile of maize remained. Because maize was a cheaper source of carbohydrate than cassava, demand for cassava dropped. However, maize can now be used to produce biofuel, which will reduce China's demand for cassava chips in the short to medium term.

The arrival of fall armyworm (*Spodoptera frugiperda*) in China in January 2019 is likely to affect maize supply and increase prices. However, the spread of African swine fever in China and Vietnam is affecting demand for animal feed in the short term, and hence the prices of sources of carbohydrates such as cassava.

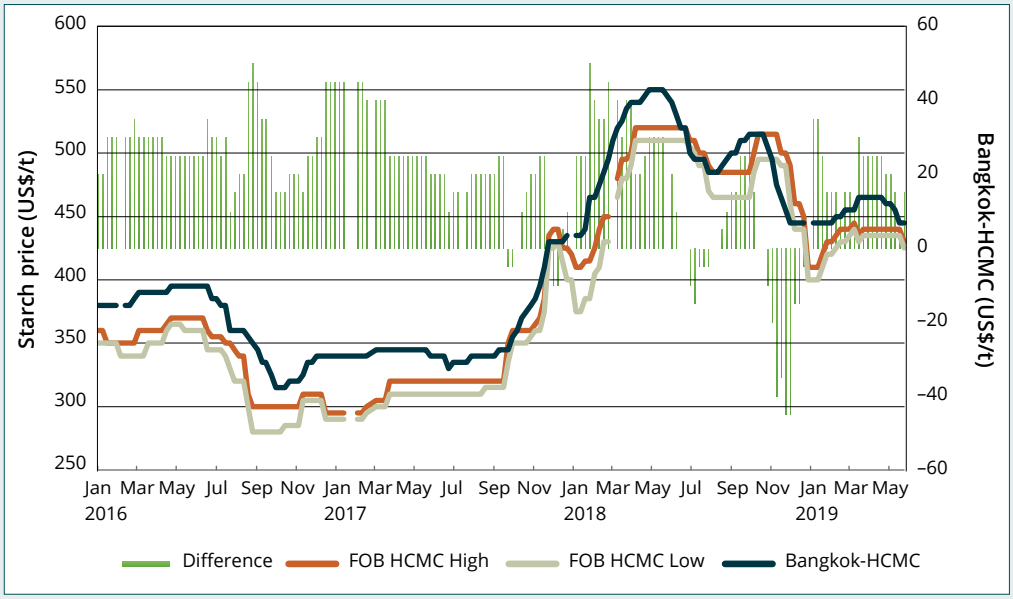
Within South-East Asia, cassava starch exports from Thailand and Vietnam continue to grow in value, while there has been a significant decline in chip exports, reflecting a changing market structure. Since the first quarter of 2018, Thai starch has been cheaper than starch produced in Vietnam and Indonesia (Figure 3.2), but more expensive than cornstarch from the United States. Hence, Indonesian imports of cornstarch and syrups have increased.

In Vietnam, there is increasing competition for fresh cassava roots because of reduced supply as a result of CMD. This demand has extended into Cambodia to take advantage of an earlier harvest. Many factories report that they rely on Cambodia for 70–80% of their feedstock. However, this cuts into the supply of chips and undermines the viability of new factories in Cambodia, which struggle to compete for roots at higher prices, with established processors in Vietnam.

Table 3.1 Cassava area, yield and production in South-East Asia, 2016–18

	Area (ha)			Production (t)			Yield (t/ha)		
Country	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**	**2016**	**2017**	**2018**
Thailand	1,427,168	1,284,021	1,344,792	30,557,857	27,875,464	29,974,636[a]	21.4	21.7	22.3
Indonesia	822,744	772,975	792,952	20,260,675	19,053,748	19,341,233	24.6	24.6	24.4
Vietnam	569,233	532,501	513,021	10,909,800	10,267,568	9,847,074	19.2	19.3	19.2
Cambodia[b]	684,070	613,912	652,235	14,820,249	13,817,261	13,750,076	21.7	22.5	21.1
Laos	75,810	70,930	71,010	2,410,000	2,277,050	2,279,030	31.8	32.1	32.1
Myanmar	36,625	34,718	31,278	433,378	405,404	376,663	11.8	11.7	12.0
Philippines	229,769	234,540	227,644	2,755,146	2,806,668	2,723,033	12.0	12.0	12.0
Total	**3,845,419**	**3,543,597**	**3,632,932**	**82,147,105**	**76,503,163**	**78,291,745**	**21.4**	**21.6**	**21.6**

a Thailand production was decreased by 8% because of the effects of climate on yields.
b Data provided by the General Directorate of Agriculture.
Source: FAOStats unless specified



FOB = free on board; HCMC = Ho Chi Minh City

Figure 3.2 Price differential between Thai and Vietnam starch price

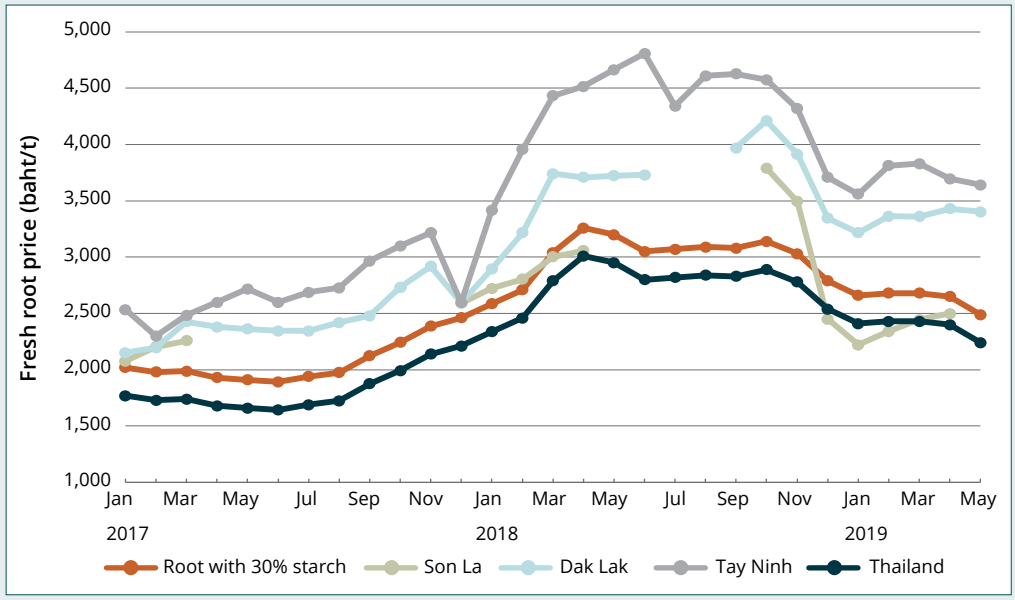


Figure 3.3 Price of cassava fresh roots in Vietnam and Thailand

The Myanmar starch price has risen since the first quarter of 2018, closing the gap with the Thai price. Across the region, cassava remains a very expensive feedstock for biofuel applications, posing a significant challenge to existing and proposed bioethanol enterprises.

Overall, the supply and demand of cassava and cassava-based products are uncertain for 2020. The interaction of supply and demand for these intermediate products ultimately affects the price smallholder farmers receive for their cassava roots. This not only affects household incomes in the short term, but contributes to uncertainty about the benefits and risks of adopting new practices promoted by the project. Although the outlook suggests tight supplies of fresh roots, processors who can easily substitute other feedstocks may begin to do so if prices remain high relative to maize for an extended time.

4 Panel discussion with private sector actors in the cassava value chain

Chaired by **Jonathan Newby**
International Center for Tropical Agriculture, Laos

Questions from the chair

Ngô Quang Tuấn, FOCOCEV, Son La, Vietnam

Q: Your company has recently increased capacity, and there are also new factories opening in Son La. How do you see the supply and demand for roots changing in Son La for the next few seasons?

A: Thank you for the opportunity to participate in this workshop. Son La is in the north-east of Vietnam. According to the official statistics, this year 35,000 ha of cassava is planted—but in reality it is 40,000 ha or beyond already, bolstered by declining maize prices and rising cassava prices. In 2019 this trend will continue. However, yields are still quite low at roughly 14 t/ha (provincial average). Our factory capacity has gone up to 200 t/day of fresh roots, while another factory that just started operating last year is at 250 t/day. Production remains higher than factory capacity, but there is a trade-off with chip traders facilitating access to markets outside the province. There are three main competing crops in Son La: cassava, sugarcane and maize. Provincial authorities are working to designate production zones around factories to facilitate meeting operational demands. Around 6,000 ha would be needed to meet factory production capacity, and only two or three factories are currently active in Son La. Factories need varieties suited to producing high starch yields in the north-west Vietnam production zone. In addition, encouraging farmers to maintain cassava production requires price stability. Last year this was possible, as the cassava price was higher than the maize and sugarcane prices. Some localised droughts in April–May threatened yields for 2019, but there have been no early surveys to attempt to quantify this, so the results at harvest time are still in question.

Q: How are the new policies from China (which the Ministry of Agriculture and Rural Development considers to be tantamount to trade barriers) impacting the way you run your business?

A: Since November 2018, we have faced various changes to starch export regulations. Stricter land border gate regulations ask for packaging clearly stating origins, quality reports and processing dates for traded starch. In addition, they insist that all starch processors wishing to export to China must be registered with the Vietnamese Government, and then in turn with Chinese customs authorities. Since 1 April 2019, the value-added tax for official export across land or sea borders has been reduced from 16% to 13%. In August 2019, a meeting is planned with the 14 factories of our corporation to develop a unified strategy for dealing with the Chinese changes.

Sirait Herawati, Bumi Sari Prima Starch Factory, North Sumatra, Indonesia

Q: Supply has lowered and you are running at less than half capacity. Has the supply recovered from the area decline of 2015–16, and how do you see the forecast for your factory?

A: One of the major reasons for the decline was that farmers felt cassava was a nutrient-depleting crop and they needed to think about their soil quality and the sustainability of production. A second reason was a shift to maize because the growth period is shorter, and the price increased due to the restrictions on maize imports by the Indonesian Government. This boosted prices to about US40 cents per kilogram (compared with about 10 cents for cassava). Bumi Sari remains optimistic that supplies to the company will rebound in the next 1–2 years. We benefit from a loyal network of farmers and traders who continue to grow cassava, and are pursuing attempts to persuade other farmers to join this network.

Q: How have the prospects of starch production changed in North Sumatra in the past 2 years? Is the Indonesian starch market very closely linked to Thailand's?

A: Thailand is the role model our company follows. Tapioca in Thailand has a higher starch content (30%) than Bumi Sari (25%). We feel that we cannot compete in the same markets. However, we export to Taiwan, a separate market that is based on consistent demand and shielded somewhat from global price swings.

Dang Cong Nguyen, Vice-President, Dai Viet Ethanol Factory, Dak Lak, Vietnam

Q: The Vietnamese Government has a strong bioethanol policy, but factories have faced challenges. How do you see the outlook for cassava as a feedstock for ethanol production?

A: First of all, thank you for the opportunity to participate in this workshop. In Vietnam there are currently six factories producing bioethanol, and there are Vietnamese policies in five cities mandating E5 gasoline use. However, consumers remain sceptical and the policy has remained restricted to the five cities. Our processing capacity is 50 million litres per year. As feedstock we can use cassava fresh roots, cassava chips and molasses in our conversion process. Our processing lines can handle 800–850 t/day of cassava fresh roots, 400–410 t/day of chips and 600–650 t/day of molasses. In the past 2 years, a high cassava starch price due to competition from starch factories has forced us to use more molasses. Among the three materials, the easiest to use is cassava chips (for both processing technologies and wastewater management). In the future, the main ingredients for ethanol processing will continue to be cassava chips and fresh roots. Dai Viet is the only one of the six factories that has the processing and wastewater technologies to use molasses. However, this still requires outsourcing another waste management company to do the final processing. Cassava is the optimal material for processing, but this requires cheap roots.

Q: Dai Viet grows their own root supply. How important is this for dealing with price fluctuations in cassava rootstock?

A: In the past 2 years the high root and chip price has led us to further increase cassava production. We now have 4,000–5,000 ha to grow cassava. If factory processors cannot access enough cheap roots on the market, growing their own cassava is the best option.

Somsay Didouangdeth, Owner, DDD Chip Factory, Bolikhamxai, Laos

Q: How do you see the outlook in Bolikhamxai for dry chip production?

A: In 2018–19, the Government of Lao PDR developed a master plan supporting this company to expand cassava production in five provinces in southern Laos. This is a good omen for my company.

Q: How are the new quarantine measures impacting the cost of exporting chips to Thailand? How does it impact the price of roots?

A: There is no problem with quarantine at the Thai border due to agreements in the Association of Southeast Asian Nations for open trade.

Questions from the floor

Q. Tin Maung Aye: Are you concerned about soil degradation, and do you have plans to support varieties for farmers?

A. Ngô Quang Tuấn: In Son La, cassava is mainly planted on sloping land. My company was involved in the project with the Northern Mountainous Agriculture and Forestry Science Institute, the International Center for Tropical Agriculture and the National Root Crop Research Centre to trial soil conservation practices—for example, the use of vetiver grass strips and legume intercropping. So far the results of these experiments are encouraging, especially the grass strips. They can reduce erosion while maintaining yields and starch. In the future, our factories will expand the use of the results from these experiments, and work on training farmers in our catchments to implement such practices. We would also like to test new varieties to ensure that the varieties we use are adapted to their ecological zones.

A. Dang Cong Nguyen: In Dak Lak, the land conditions are not as steep as in Son La, but our 4,000–5,000-ha cassava area will also use residues to produce biofertilisers—initially for use in our own production zone. Regarding the cassava price: to produce 1 litre of ethanol we need 5 kg of fresh roots or 2.5 kg of dry chips. The price should be less than 2,000 Vietnamese dong per kilogram of roots and 4,000 Vietnamese dong per kilogram of chips to be profitable.

Q. Yudi Widodo: In Vietnam, the ethanol factory often has cassava shortages and needs molasses. Indonesia has a lot of land—why not invest to build a factory here?

A. Dang Cong Nguyen: Great idea, very good opportunity—provided that the Government of Indonesia facilitates the process we will happily invest.

Q. Nguyen Bach Mai: Question for Bumi Sari. In the field visits I asked about the policy for checking starch content. I am curious why the factory does not check starch content. All factories in Vietnam check starch content, which helps traders and farmers think about managing and increasing starch content on the supply side. In the future, what will you do to promote increased starch content?

A. Sirait Herawati: Starch content is manually checked. Our target is 20–25%. If the starch content is lower than this, we will contact the farmer/trader and negotiate a price reduction based on 'bad quality'. In the future, we want high-quality starch like Thailand, and we will reach it by investing in new varieties. We are therefore especially grateful to be involved in this project. We emphasise the importance of keeping strong relationships with the farmers, some of whom are multigenerational suppliers to Bumi Sari.

Agronomic and economic analysis

5 Fertilisation of cassava in Siantar and Simalungun districts, North Sumatra

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Indonesian Legumes and Tuber Crops Research Institute, Indonesia
Kartika Nurwijati
Indonesian Legumes and Tuber Crops Research Institute, Indonesia
Wani Hadi Utomo
University of Brawijaya, Indonesia

Introduction

In North Sumatra, cassava is planted mainly as a commercial crop. Although planted with traditional technology, the yield of cassava in North Sumatra is higher than the national mean or the yield in other provinces. One reason for this is that farmers plant cassava closer together (100 cm × 60 cm or 80 cm × 60 cm). Farmers hardly fertilise their cassava or, if they do, they use improper fertilisers. However, with its high total yield, cassava is a crop that removes a high quantity of nutrients from the soil. Therefore, without the correct use of fertilisers, planting cassava would speed up soil degradation. The experiment discussed here aimed to investigate the fertiliser requirements of cassava in Siantar and Simalungun, North Sumatra. The experiment was also intended to demonstrate to farmers the importance of using fertiliser for cassava.

Methods

The experiment was conducted on farmers' fields and was managed by farmers. The project team helped with setting up the experiment and providing materials. Five farmers conducted fertiliser experiments in a cassava monoculture system, and one farmer conducted an experiment in a cassava plus maize intercropping system (Table 5.1).

Table 5.1 Location of experiments

Location	Owner of field	Cropping system	Cassava variety
1 Sinasak, Tapian Dolok	Muchlis	Monoculture	Malang 4
2 Tanjung Tonga, Siantar	Turisno	Monoculture	Malang 4
3 Tanjung Pinggir	Factory	Monoculture	Dacon
4 Tanjung Pinggir	Factory	Monoculture	Huabuong
5 Sipayung	Factory	Monoculture	Faroka
6 Tiga Dolok	Ibu Sirait	Cassava + maize	Malang 4

Farmers typically apply 300 kg/ha of Phonska (15-15-15 nitrogen-phosphorus-potassium [NPK]); this was used as the control treatment. The suggested improvements were:

- increasing the nitrogen by increasing the Phonska to 400 kg/ha
- increasing the nitrogen only by adding 100 kg/ha of urea (45 kg N)
- increasing the potassium only by adding 100 kg/ha of KCl (50 kg K_2O)
- applying 10 t/ha organic manure.

The complete set of treatments is in Table 5.2.

The treatments were arranged in a randomised block design with four replicates. Planting was done on 28–29 November 2017. Cassava was planted with a spacing of 1.0 m × 1.0 m on a plot size of 5.0 m × 7.0 m. For the intercropping system at Tiga Dolok, cassava was planted with a spacing of 1.25 m × 1.0 m and maize was planted with a spacing of 0.75 m × 0.25 m. There were two rows of maize between each pair of cassava rows, with a spacing of 0.25 m within the row. The maize used was Syngenta NK212.

Fertiliser was applied in three equal doses at 1 week, 8 weeks and 12 weeks (or after harvesting the maize for the intercropping experiment). The maize was harvested in April 2018, and the cassava was harvested in September 2018. Twenty farmers attended the field day conducted during the harvesting of maize.

Results

Table 5.3 shows that substantially increasing the potassium dose from the farmers' practice (treatment 4) significantly increased yield at all locations. However, increasing the nitrogen dose did not significantly affect yield, even with the small additional dose of potassium in treatment 2, except in location 4 (Tanjong Pinggir planted with the Huabong variety). Fertilising with 10 t/ha of manure did not significantly affect yield compared with farmer practice, except in location 4 where it gave the same yield as treatments 2 and 3 with increased nitrogen.

The results from the intercropping trial are in Table 5.4. Increasing nitrogen or potassium, or both, did not significantly increase maize yield. Cassava yield, on the other hand, increased significantly by increasing nitrogen and/or potassium (treatments 2, 3 and 4). Treatment 4, with only potassium added to the usual farmer practice, gave the highest yield at 41 t/ha but this was not significantly different from treatments 2 and 3. The manure treatment did not result in yields significantly different from the usual farmer practice.

Table 5.2 Experimental treatments

Treatment	Fertiliser applied per ha	Nutrients per ha
1	300 kg Phonska (farmer practice)	45 kg N + 45 kg P_2O_5 + 45 kg K_2O
2	400 kg Phonska	60 kg N + 60 kg P_2O_5 + 60 kg K_2O
3	300 kg Phonska + 100 kg urea	90 kg N + 45 kg P_2O_5 + 45 kg K_2O
4	300 kg Phonska + 100 kg KCl	45 kg N + 45 kg P_2O_5 + 95 kg K_2O
5	10 tonnes organic manure	Not ascertained

K_2O = potassium oxide; KCl = potassium chloride; N = nitrogen; P_2O_5 = phosphorus pentoxide

Table 5.3 Mean yield of monocropped cassava from fertiliser trials in North Sumatra

Treatment	Location (t/ha)				
	1	2	3	4	5
1 Farmer practice (300 kg/ha Phonska)	31.72[b]	36.67[b]	23.17[b]	19.80[c]	36.55[b]
2 400 kg/ha Phonska	30.37[b]	37.80[b]	24.75[ab]	22.72[b]	38.35[b]
3 300 kg/ha Phonska + 100 kg/ha urea	31.72[b]	36.90[b]	23.85[b]	21.15[bc]	37.35[b]
4 300 kg/ha Phonska + 100 kg/ha KCl	47.10[a]	44.20[a]	28.20[a]	26.32[a]	43.65[a]
5 10 t/ha manure	30.30[b]	36.00[b]	24.75[ab]	23.62[ab]	36.67[b]
LSD 5%	4.08	2.67	3.84	2.78	1.95
CV %	8.53	4.53	10.00	7.95	3.29

CV = coefficient of variation; KCl = potassium chloride; LSD = least significant difference
Note: Means with same letter in same column are not significantly different at the 5% level.

Table 5.4 Mean yield of maize and cassava from intercropping fertiliser trial at Tiga Dolok, North Sumatra

Treatment	Yield (t/ha)		Revenue (Rp × 10^3 per ha)		
	Maize	Cassava	Maize	Cassava	Total
1 Farmer practice (300 kg/ha Phonska)	6.84	22.57[b]	23,256	28,212	51,468
2 400 kg/ha Phonska	6.93	37.35[a]	23,562	46,687	70,249
3 300 kg/ha Phonska + 100 kg/ha urea	7.20	34.30[a]	24,480	42,875	67,355
4 300 kg/ha Phonska + 100 kg/ha KCl	7.17	41.05[a]	24,378	51.312	75.690
5 10 t/ha manure	6.66	32.30[ab]	22,644	40,375	63,019
LSD 5%	ns	11.5	na	na	na
CV %	5.49	21.98	na	na	na

CV = coefficient of variation; KCl = potassium chloride; LSD = least significant difference; na = not applicable; ns = not significant; Rp = Indonesian rupiah
Notes:
1. Means with same letter in same column are not significantly different at the 5% level.
2. Price of maize = Rp3,400/kg. Price of cassava = Rp1,250/kg.
3. Yield of maize monoculture = 6.73 t/ha.

Discussion and conclusion

The results indicate that the sites in Siantar and Simalungun districts in North Sumatra are highly responsive to increased potassium fertiliser. In both monocropped and intercropped systems, cassava showed a significant response to increased potassium, but only in the cassava plus maize system did cassava also show a response to nitrogen. However, manure cannot compete with inorganic fertiliser in terms of performance over a single year experiment because of the much slower nutrient release.

During the field day at Tiga Dolok, all participating farmers showed interest in the intercropping system. They now understand that planting cassava in between their maize did not influence maize yield. They expressed willingness to practise this system in their farms and to try other crops to intercrop with cassava.

Clarifications in response to questions

North Sumatra is primarily a commercial cassava production zone. The 2017 survey results suggested that 95% of farmers applied inorganic fertilisers. A fertiliser subsidy scheme is in place, encouraging the use of Phonska (15-15-15), urea and potassium chloride. The subsidy halves the price of a bag of fertiliser to 160,000 Indonesian rupiah. Manure acquired from a goat farm for our trial incurred significant shipping and application costs due to the high bulk and weight.

6 Adoption of cassava varieties in North Sumatra

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Introduction

North Sumatra is one of the centres of cassava production in Indonesia. Based on data from the Indonesian Statistics Agency, the average yield of cassava in North Sumatra is around 30 t/ha. Although this yield is quite high, it is lower than the potential yield, which can reach 50 t/ha. Reconnaissance and household surveys conducted in 2016 and 2017 showed that farmers used only local cassava varieties. Varietal trials in 2016 showed that some gave a higher tuber yield than the local varieties. Malang 4 had the highest average yield (49.83 t/ha) among the 12 varieties tested. Farmers who participated in field days also preferred Malang 4 in terms of its branching, ease of harvest, tuber size, tuber type, plant height and starch content. Therefore, Malang 4 was chosen to be distributed to traders and farmers as part of varietal testing and adoption activities. The aim of this study was to conduct varietal testing to evaluate the yield potential and limitations of Malang 4 at the farm level.

Methods and design

Malang 4 was provided to farmers to plant in their own fields. Cultivation (land preparation, plant spacing, fertilising, weeding) was done according to the farmers' practices. After harvesting, farmers handed over 50% of their cassava stems to the project to be distributed to other farmers. The project paid 500 Indonesian rupiah per stem (which can be used for up to five cuttings). The project helped with cuttings, fertilisers and herbicides, and supervised the farmers to ensure that the work was done correctly.

In 2016–17, Malang 4 was planted by 26 farmers who were located in four subdistricts of Simalungun Regency and one subdistrict of Toba Samosir Regency. Each farmer planted Malang 4 on an area of 0.2–0.3 ha. In 2017–18, the number of participating farmers increased to 51, in Simalungun Regency (three subdistricts), Toba Samosir Regency (one subdistrict) and Deli Serdang Regency (two subdistricts). More farmers were willing to participate but there were not enough cuttings.

To measure the yield, the project team sampled 16 farmers' fields randomly. These 16 farmers were also asked about their problems and opinions regarding planting Malang 4 and to compare the yield with that from the previous year.

Results

The total land area for adoption of Malang 4 in 2016–17 was 4.68 ha, increasing in 2017–18 to 8.22 ha. The target of 60 farmers could not be achieved because stem cuttings from some adopters in 2017 could not be harvested because of drought.

The measured yields of Malang 4 varied widely between farms due to differences in cultivation techniques (planting method, spacing, fertiliser use) and weather conditions. The spacing used by farmers practising monoculture planting included 0.8 m × 0.8 m, 1 m × 0.6 m, 1 m × 0.7 m, 1 m × 1 m and 1.2 m × 1 m. The spacing used by one farmer practising intercropping was 1.5 m × 0.8 m. The tuber yield ranged from 30 t/ha to 51 t/ha (Table 6.1).

Based on the recall of the selected farmers, the tuber yields of Malang 4 were mostly higher than the previous season with a different variety (Figure 6.1). In two cases, farmers previously using the Malaysia variety reported no difference with Malang 4. The six farmers in Uluan who had quantitative estimates for the previous season's yield with Adira 4 indicated substantial yield increases of between 11 and 23 t/ha with Malang 4.

However, because North Sumatra has a continuously wet climate, cultivation of Malang 4 encounters the problem of tuber rot, especially in Simalungun Regency. One participating farmer estimated the occurrence of tuber rot at 15%. So far, cassava farmers in North Sumatra have not used ridging, which could reduce the risk of tuber rot. Some farmers not in the sample experienced crop failure due to drought, especially farmers who planted in January 2018. Some of these could not harvest at all, while others obtained very poor yields.

Discussion and conclusion

Studies in 2016–17 showed that farmers used only local varieties. However, when tested, Malang 4 had a much higher yield than local varieties, averaging 50 t/ha.

Figure 6.1 Performance of Malang 4 variety in Pak Muklis's farm in the 2018–19 planting season

Table 6.1 Tuber yield of Malang 4 in 16 farms in North Sumatra, 2017–18

No.	Name of farmer	Subdistrict	Yield (t/ha)	Previous year	
				Variety	Yield previously
1	Pak Mukhlis	Tapian Dolok	30.40	Malaysia	Same
2	Pak RasmenPurba	Tapian Dolok	33.06	Malaysia	Lower
3	Dewi Pangaribuan	Tapian Dolok	29.57	Malaysia	Same
4	Lumongga Siallagan	Siantar Martoba	33.45	Malaysia	Lower
5	Edison Pasaribu	Tapian Dolok	30.00	Malaysia	Same
7	Bu Sirait	Dolok Panribuan	34.75	Ubi Roti Lampung	na
8	Pak Naryo	Dolok Merlawan	44.02	Ubi Roti Lampung	na
9	Pak Parmin	Dolok Merlawan	38.10[a]	Ubi Roti Lampung	30 t/ha
10	Marolop Sitorus	Uluan, Toba Samosir	51.00	Adira 4	40 t/ha, 12 months
11	Marata Sirait	Uluan, Toba Samosir	42.50	Adira 4	37.5 t/ha, 12 months
12	Afnita Sianturi	Uluan, Toba Samosir	44.50	Adira 4	25 t/ha, 12 months
13	Rihard Sitorus	Uluan, Toba Samosir	48.00	Adira 4	25 t/ha, 12 months
14	Jenti M Manik	Uluan, Toba Samosir	50.50	Adira 4	30 t/ha, 12 months
16	Anita Manurung	Uluan, Toba Samosir	48.00	Adira 4	25 t/ha, 12 months

na = not available
a In addition, there was a maize intercrop (Lampung variety), yielding 3.50 t/ha.

After project farmers introduced Malang 4, 51 farmers planted it by 2017–18 across a total of 8.22 ha. The main factor limiting more rapid uptake was the lack of availability of stakes. The yield of Malang 4 obtained by the 16 selected farmers varied widely, from 30 t/ha to 50 t/ha, due to the diversity of cultivation techniques, fertiliser and weather. However, in almost all cases Malang 4 gave a higher yield than the local varieties planted in the previous year; in no case was a lower yield reported. However, root rot poses a potential risk. Ridging or improved drainage could help to reduce these losses if adopted in North Sumatra. To avoid the problem of drought, planting activities for the 2019–20 season will begin around July–August 2019.

Questions from the floor

Q. Chanphasouk Tanthaphone: Can you please explain a little bit more about the fertiliser subsidy. What is the Indonesian situation?

A. Yudi Widodo: We need to make a breakthrough in fertiliser access for farmers, but the price needs to be evaluated. Our currently subsidised fertilisers are not appropriate for cassava.

A. Jonathan Newby: In our trials, the economic margins are still positive with or without the subsidy. However, the subsidy is distorting the use of fertiliser and encouraging the use of inappropriate blends for cassava. This is what we should be focusing on, and why we need to find ways to influence regional policy.

7 Cassava agronomy research in Dak Lak, Vietnam

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Introduction

Current cassava yields in Dak Lak are low and have been in decline. This is because of reasons such as soil erosion and the increase in new pests, which especially affect the high-yielding varieties. Therefore, this report focuses on trials conducted in 2018 and 2019 with various cassava varieties, planting densities, quantity and type of fertilisers, and intercropping methods to assess best agronomic practices. Trials in 2017 identifed that HLS11 and KM419 were the superior varieties and were used in the current experiments.

Planting density and fertiliser trials

The first set of trials relating to planting densities and fertiliser application were conducted in Chukty Commune in 2018–19. These experiments involved three density treatments:

- M1—(1.0 m × 1.0 m) = 10,000 plants/ha
- M2—(1.0 m × 0.8 m) = 12,500 plants/ha (control)
- M3—(0.8 m × 0.8 m) = 15,625 plants/ha.

The trials also included six fertiliser treatments:

- P0—no fertiliser
- P1—250 kg nitrogen-phosphorus-potassium at 15-5-20 + 100 kg Van Dien phosphorus fertiliser
- P2—81 kg nitrogen + 54 kg P_2O_5 + 81 kg K_2O (10% reduction from P3)
- P3—90 kg nitrogen + 60 kg P_2O_5 + 90 kg K_2O (control)
- P4—90 kg nitrogen + 60 kg P_2O_5 + 90 kg K_2O (control) + 1 tonne (t) biofertiliser
- P5—108 kg nitrogen + 72 kg P_2O_5+ 108 kg K_2O (20% increase on P3).

Yields were the highest (averaging 26 t/ha) when planting at a density of 12,500 plants/ha. With regards to fertiliser application, results showed that P4 produced the highest average yields at 34.55 t/ha, followed closely by a yield of 33.68 t/ha with P5. An economic analysis showed that profits were highest when adopting these density and fertiliser combinations.

Intercropping trials

The second set of trials, conducted in Krongbong, examined intercropping. The five treatments were:

- CT1—HLS11/KM419 monocropped
- CT2—HLS11/KM419 plus red bean
- CT3—HLS11/KM419 plus cowpea
- CT4—HLS11/KM419 plus mungbean
- CT5—HLS11/KM419 plus peanuts.

For all of the treatments, planting density was 10,000 plants/ha (1.0 m × 1.0 m spacing). The fertiliser applied to cassava followed the Ministery of Agriculture and Rural Development standard, which was 90 kg N + 60 kg P_2O_5 + 90 kg K_2O (195 kg urea + 400 kg phosphorus + 150 kg potassium fertiliser). Each plant received 19.5 g urea + 40 g phosphorus + 15 g potassium. Fertiliser application per hectare for the legumes was 1 t biofertiliser + 400 CaO + 75 kg urea + 150 kg phosphorus + 100 kg KCl. Each plot was 40 m^2 with ridges to avoid waterlogging. Each ridge consisted of three cassava rows. Two rows of legumes were planted between rows of cassava, with 30 cm × 20 cm spacing between legumes.

The trials showed that higher yields and greater profits were generally attained for treatments where cassava was intercropped with red bean, cowpea and peanuts.

Evaluation of clones

Finally, 21 elite cassava clones received from the International Center for Tropical Agriculture were evaluated. From these assessments, the most promising varieties were found to be B5-39 and C2-10, with mean root yields of 139.92 t/ha and 157.50 t/ha, respectively. However, these yields are relatively high as they are based on small sample sizes.

Questions from the floor

Q. Jonathan Newby: I am very interested to know the response of the farmers to intercropping. Have the results changed the minds of those farmers hesitant because of labour shortages?

A. Nguyen Van Minh: In Dak Lak, farmers really do not want to do intercropping. Cassava is only the fourth or fifth crop in importance for the province, behind the likes of coffee, cacao, fruit trees and durian. Intercropping is labour-intensive. Both scientists and farmers acknowledge that soil indicators are improved by the practice, but farmers do not feel that it is worth it economically for a low-value crop.

Q. Kyaw Thura: In Myanmar, we are growing one row on one ridge, but I see that in Vietnam it is two rows on one ridge. Why is this and which spacing is used? Do you use horizontal planting or vertical planting?

A. Nguyen Van Minh: Usually if the land is good with adequate drainage, we do not make ridges. Our area is a little waterlogged, so we use ridges with three rows because the 1 m × 1 m spacing is convenient for tractors. We then put two rows of legumes in between. There is about 20 cm between legumes within a row, although that depends on the legume species. Horizontal planting is used for ridge cultivation.

Q. Rod Lefroy: Usually intercropping incurs a yield penalty, which is compensated by the intercrop. In your results, the yield of cassava actually increased. Is this because of the legume nitrogen, or what is the explanation?

A. Nguyen Van Minh: We supply fertiliser to the legume intercrop, so incidental uptake by cassava is a possibility. We also leave the legume residues on the field to increase nitrogen and organic matter content.

A. Tin Maung Aye: Weed competition is also a possibility—the intercrop may suppress weeds.

Q. Rod Lefroy: You mentioned clean seed production by an ethanol company. What is the method, and how do you know they are clean?

A. Cù Thi Lê Thuy: It is simple open-field stake multiplication. Cassava witches' broom (CWB) disease is the most serious disease issue in Dak Lak; cassava mosaic disease is present but not yet very widespread. There is a low whitefly population in the area, advanced clones are still performing quite well and HLS11 is resistant to CWB disease. Cleaning is through insecticides, rouging and careful monitoring. Initially we are not doing any PCR-based detection; we are only doing visual symptom identification and positive selection.

8 Research for development of sustainable farming techniques for cassava in Son La province, Vietnam

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Introduction

Son La province has the largest area of cassava in the northern mountainous region of Vietnam (32,000 ha) with an annual total production of about 376,000 t. Cassava was one of the main food crops in the region, but nowadays it has become an important cash crop, especially for the resource-poor farmers. Although cassava contributes a small share of total household income, it has significant value for the livelihoods and economic development of poor farming households.

There are advantages for developing the cassava industry in Son La, such as suitable climate and soil conditions, market demand and farmers' traditional knowledge. Nevertheless, with a changing end use from food to industrial starch and feed processing, locally developed varieties are no longer appropriate. In addition, due to conventional farming practices on slopes, cassava production is now facing increasingly serious problems of soil erosion, reduced yield and low economic benefits.

In this context, under ACIAR project AGB/078/2012, we have been implementing activities to validate and promote the adoption of some sustainable farming practices towards a sustainable and inclusive value chain for cassava in Son La. The field experiments started in 2017 and were planned for three successive cropping seasons. Therefore, to produce final conclusions and recommendations, we need to wait for one more harvest, which will be completed in February 2020.

Activities and methods

The trials were conducted in two communes (Bo Muoi and Pung Tra) in Thuan Chau district and two communes (Chieng Chan and Na Ot) in Mai Sơn district. These sites were selected as they represent most of the cassava production conditions in the province. In each of these communes, more than 70% of households grow cassava, typically over 0.3–0.9 ha on steep slopes (up

to 65°) where soil erosion is perceived as a serious problem. The trials included:

- a variety trial, which evaluted four new varieties (Sa21-12, Rayong 9, BK and 13Sa05) using two locally popular ones for control (KM94 and La Tre), to identify new high-yielding varieties appropriate for local conditions so that farmers could have more choice
- a fertiliser trial, which tested five fertiliser treatments, to find the best and most economic fertiliser rate to achieve and maintain high cassava fresh root yield and starch content with adequate profitability
- a soil management trial, to study different intercrops and soil management techniques, to find effective options for improving economic benefit and controlling soil erosion
- a density trial that tested four plant spacings, to find the most appropriate spacing for local conditions (low fertility soils and lack of investment capacity). The trial was designed based on the feedback from farmers
- a harvest staggering trial, to evaluate the performance of the two locally popular varieties (KM94 and La Tre) when harvested in the off-season. This trial was designed based on the feedback from the Son La Starch Factory that they need supplies to keep operating until September instead of April as currently done.

All the trials were conducted on farmers' fields. Farmers participated in cassava cultivation and management activities under researchers' guidance and with logistic support from local extension staff and officials. Field days were organised at suitable times during each cropping season for all stakeholders to evaluate the treatments and provide feedback.

Results

The results to date of the first four of these trials are summarised here.

With regard to varieties, when pests did not affect the trials, two out of the four new varieties (BK and 13Sa05) performed well and yielded higher than the controls. The increase in yield was between 14% and 76%, depending on the variety, the control and the growing conditions (sites, fertilisers, levels).

In general, with the same cost spent for fertilisers, using separate nitrogen, phosphorus and potassium (N, P, K) fertilisers, brought higher economic benefits due to higher yields of cassava than with the mixed NPK fertilisers. When fertilised with separate fertilisers at the level of 40 kg/ha N, 10 kg/ha P, 40 kg/ha K, divided into three applications (one basal and two top dressings), KM94 yielded around 20 t/ha. Higher levels of fertiliser (60 kg/ha N, 15 kg/ha P, 60 kg/ha K) gave the highest yield but lower profit.

Deep fertiliser placement appeared unsuitable for cassava in Son La, perhaps due to drought conditions and the steep slopes. Nevertheless, the impact of fertiliser level depends on the land condition (slope, fertility) and application method (only basal application, or with one or two top dressings). In Bo Muoi commune, for example, where the fertiliser trial was established on flat land right after maize and cowpea, the high level of fertiliser (600 kg/ha of NPK applied basally and 150 kg/ha as top dressing) did not affect cassava yield. This was likely due to the soil still being rich in nutrients from previous crops and crop residues.

All five soil management practices tested (intercropping with mungbean, black cowpea and peanut; grass contours; and cassava residues on the contour) did not

reduce the yield of cassava. Mungbean had a very low survival rate; shortly after germination most mungbean plants died, presumably because the local soil or climatic conditions are not suitable for this crop. Local farmers also mentioned that they had tried to grow mungbean in the area but never succeeded. Intercropping with cowpea and peanut brought higher gross and net returns, because of the additional income from legumes. Grass-contour strips reduced net income, net return per workday and net income per unit expenditure because of increased material costs required for grass planting in the first year and subsequent management expenses without any additional income. Using grass as feed was not efficient in our trial due to the high labour requirement for harvesting and carrying the grass a long distance from the field to the homestead for cattle or fish culture. Cassava residues on the contour had no impact on cassava growth and yield, and significantly reduced the amount of soil eroded. However, the short duration of the trial means that an accurate estimation of the longer-term impact on soil erosion is not possible.

With regard to plant density, in the local conditions, for KM94, the density of 12,500 plants/ha (1 m × 0.8 m spacing) brought the highest net return per hectare and per workday. On steep slopes—normally with poor soils—12,500 plants/ha also gave the highest cassava yield among the four densities tested. On flat lands, normally with more fertile soils, the highest three densities (12,500, 15,600 and 20,800) had the same yield, but the increase in density incurred increased cost.

Conclusion

So far, we can make the following provisional conclusions, subject to confirmation when the last harvest is completed in March 2020.

Two new varieties—13Sa05 and BK—are suitable and should be promoted for large-scale production in Son La. Using separate N, P and K fertilisers is better economically than using mixed NPK (5-10-3) fertilisers. Applications of 40 kg/ha N, 10 kg/ha P, 40 kg/ha K or 60 kg/ha N, 15 kg/ha P, 60 kg/ha K applied in one basal dressing and two top dressings gives the highest economic benefit. A planting density of 12,500 plants/ha (1.0 m × 0.8 m) is most suitable for the dominant local conditions of infertile, sloping lands and low investment capacity. Intercropping with cowpea or peanut increases the overall yield and economic benefit, while using cassava residues on the contour significantly prevents soil erosion and is preferred by farmers.

Questions from the floor

Comment. Nguyen Van Minh: Most farmers are not using fertilisers or are using the wrong formulas. Our recommendations are based on a target a yield of 30 t/ha because of the low current yields (13 t/ha) and the low capacity for investment in inputs.

Q. Rod Lefroy: You have said that increasing density also increases costs because of the extra costs for planting materials and labour. But do you get a labour saving because of reductions in weed pressure and associated weeding labour? Is there a compensation effect there?

A. Nguyen Van Minh: There is not much difference in terms of weeding labour because in Son La farmers only do two weedings per season. They usually do this before the canopy has closed, so it ends up not making much difference, but it does mean that weeding is a more delicate task for the farmer due to the tighter spacing.

Q. Phan Sophanara: How do you control fertiliser application in experiments on sloping land, since fertiliser leaches downhill with the rain?

A. Nguyen Van Minh: We have not yet done any soil analysis after the treatments in the soil fertility experiments. However, I prefer cowpea for its fast growth and early soil cover. In terms of grass strips and using cassava residues, it can improve soil fertility but the major benefit is in erosion reduction. In terms of fertiliser treatments on sloping land, instead of using random blocks, we use large plots to minimise spillover. We also encourage people to apply fertiliser in split applications. Fertiliser is applied in a pocket system and planting is horizontal.

Q. Neng Por: At what age did you harvest all the field trials? I have seen a lot of intercropping, which is reasonable from a scientific point of view, but I see it as very challenging to work with farmers since the intercrop choice is not only agronomic. It is economic, based on income from the intercrop components.

A. Nguyen Van Minh: Markets are different for each crop—peanut, cowpea and other legumes have different local markets.

9 Agronomic and economic research activities in Cambodia

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This presentation reports on the results of cassava trials conducted between 2017 and 2019. The trials involved experiments with cassava varieties, fertiliser application and intercropping with food crops.

Variety trials

The trials for evaluating cassava varieties conducted in 2017–18 came across some hurdles as a result of high cassava prices. The high prices motivated farmers to harvest early and sell the roots for higher profits. This resulted in losing seven of the eight field sites. Stakes have also been stolen from our experimental plots, reflecting the high levels of demand for stems Cambodia is experiencing.

The varieties trialled included KU50, Hauy Bong 60, Rayong 72, KM-98-1 SC8 and SC9, and the variety used by the farmer (likely KM419). In 2017–18, the fresh root yields of all evaluated varieties were higher than the farmer's.

Among the varieties trialled in 2018–19 across all locations, the farmer's choice variety yielded highest, ranging from 20.6 to 39.7 t/ha, and Rayong 5 yielded lowest, ranging from 14.8 to 20.2 t/ha. Across the different locations, highest yields were achieved in Snoul for all varieties at 30 t/ha, while they were lowest in Chet Borei at 15 t/ha. Starch content was significantly different across varieties and locations. On average, the starch content of Huay Bong 60 was highest (25.2%) and the farmers' choice variety was lowest (19.6%) across all locations. However, such variations across varieties and locations were not seen for starch yields.

High pest and disease infestations were found, particularly cassava witches' broom (CWB) disease, which was prevalent across all varieties. Cassava mosaic disease (CMD) was not observed in the 2017–18 season in Snoul. However, the farmers' own varieties had high CMD infection rates in Chit Borei. CMD was an early and dramatic event in the field trials, which changed the direction of the research focus.

The incidence of plants with CMD was highest for Rayong 60 (29.3%) and lowest for the farmer's choice variety (5%). The proportion of plants with CMD symptoms was in general highest in trials conducted in Snoul (Pou Ol) (20.0%) and Steng Treng (19.3%) for all varieties.

Overall, the farmers' choice variety was generally ranked high for starch yield, while it was ranked lowest for starch content. Ranking based on disease susceptibility put the farmer's choice variety at the top, with Rayong 60 at the bottom.

Fertiliser trials

In the selected project villages across north-east Cambodia, fertiliser use has remained quite low, which motivated the fertiliser trials in 2017–18. The yield varied significantly across the fertiliser trial sites, with the average fresh root yield 1.4–2.2 times higher in Snoul district than in Chit Borei district. However, differences were not pronounced across treatments within the same site. This is likely due to stresses resulting from root rot, CMD and CWB disease. Nevertheless, fertiliser application in general produced higher yields than no fertiliser application.

In the presence of significant biotic and abiotic stresses, the yield response to different fertiliser levels is uncertain. As such, the best fertiliser application is related to the cost of fertiliser. Based on the results, on average, a US$50 investment in fertiliser produced a marginal net benefit of more than US$570 for 40 kg/ha N, 10 kg/ha P_2O_5, and 0 kg/ha K_2O. For all probable root prices, the marginal rate of return was more than 200%. Similar to Snoul, in Chet Borei district, the cheapest treatment (40-10-0 kg/ha) produced a high marginal rate of return (714%), with additional levels of potassium (40 kg/ha N, 10 kg/ha P_2O_5, 40 kg/ha K_2O) also producing a high marginal rate of return (709%). The application of fertiliser was found to result in significant increases in starch yields. Hence, it would make more economic sense to carefully choose and apply fertilisers if premiums for cassava were based on starch content more than starch yield.

Similar to the fertiliser trials in 2017–18, those conducted in 2018–19 did not result in significantly different fresh root yields across treatments and locations. However, root yield was found to be correlated with fertiliser use. Also, the number of plants infected with CMD did not vary across the different experimental treatments.

Conclusion

There appears to be a high demand for good-quality cassava stakes. Preferences are for high-yielding varieties with short root peduncles and long stakes. A preference has also been observed for the lowest suitable fertiliser rates. This is due to the low capacity of farmers to invest in inputs and their increasing debt levels. Hence, it seems unlikely that farmers will be able to apply the recommended fertiliser rates. Furthermore, some farmers seem to be shifting away from cassava to tree crops, such as cashew and mango, which are considered to be more profitable.

Questions from the floor

Q. Tin Maung Aye: Cassava farmers are shifting to cashew and mango. What is the motivator?

A. Chea Sareth: Mungbean and peanut have no market. These are commercial farmers who want a cash income from their cultivation activities. Therefore, when thinking of diversification, tree crops are becoming more attractive. Cashew nuts sell for US$2/kg. Black pepper is also attractive, but the investment cost is quite high. However, if the cassava price goes back to 4,000 riel per kg, as it was at its peak, farmers have no problem chopping down cashew trees.

Q. Rod Lefroy: Are those low fertiliser treatments really the best option?

A. Chea Sareth: Compared with no fertiliser, the economics of this low level of fertiliser use are favourable.

A. Jonathan Newby: We should not be promoting the highest yields possible—what we need is high return to capital. CMD is also changing the dynamics as clean stems give a good return, but if replanted when infected, this leads to large losses.

10 Cassava planting method trials in north-west Cambodia—yield and economic analyses

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Farmers in north-west Cambodia use different methods to plant cassava than their counterparts in eastern Cambodia. This study investigates the effect that planting method has on yield and profitability of cassava, and the potential for more sustainable farming methods in this region. The study forms part of ACIAR project ASEM/2013/003.

An experiment was conducted at two on-farm sites in the neighbouring north-west provinces of Battambang (Samlout district) and Pailin over 2 years, with a third year of research currently underway. Soil preparation following the farmers' practice of ploughing, and hilling-up was compared with minimum till (ploughed, no hills, flat) and no till (not ploughed but sprayed, and flat). Furthermore, a split plot was incorporated, comparing vertical and horizontal stake placement.

At Samlout in 2017–18, the hilled-up treatments had the highest yields (18–22 t/ha, $P < 0.05$), regardless of stake placement, compared with the minimum-till and no-till treatments (5–8 t/ha). Similar results were obtained in 2018–19 at that site, where the hilled-up vertical-stake treatment had significantly higher yields (22 t/ha, $P < 0.05$) than all other treatments (<15 t/ha). However, no-till treatments on soil under previously conventionally managed plots take time to have an effect—more time than a 2-year analysis will reveal.

Results were less conclusive at Pailin, although yields were generally higher. There were no significant differences among treatments in 2017–18. In 2018–19, the hilled-up horizontal-stake treatment yielded almost twice as much as the no-till horizontal-stake treatment, and all treatments except for no-till vertical and minimum-till horizontal were significantly different to no-till horizontal ($P < 0.05$). Thus, hilled-up treatments again outperformed the other treatments.

Hilled-up treatments also provided the highest gross margin returns at both sites in 2017–18, yet, in the 2018–19 harvest, no treatments gave positive returns due to low yields (in this context, 17 t/ha is what is needed to break even) and a lower commodity value than the previous season. Labour costs were fully factored into the budgets and were very high in this remote site, which affected farmers differently.

This study raises questions about the sustainability of cassava with the high break-even yields that are required to make a profit. Cassava yields were

fairly low in the region. Poor stake quality was an issue, causing patchy field plots. The weed seedbank is highly developed due to poor agricultural practices over past years. Further research into rainfall infiltration, soil run-off and sediment loss will investigate the environmental cost attributed to these farming practices.

Questions from the floor

Q. Rod Lefroy: What is the benefit of the hilling? It is drainage, compaction, etc.?

A. Stephanie Montgomery: Good question! Anecdotally, germination is slower on compacted soils despite higher soil moisture. This could be a result of structure more than drainage. Farmer rationale is certainly drainage.

11 Planting time of cassava in north-west Cambodia

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Planting time for cassava varies considerably between eastern and north-eastern Cambodia. Most farmers in eastern Cambodia plant cassava in May–June, later than in the north-west, where planting is usually in March–April (though farmers have shifted to planting almost year-round). As part of ACIAR project ASEM/2013/003, research was conducted for 2 years in Battambang (Samlout district) and Pailin provinces, which have the largest cassava farming areas in the country.

The research objective was to determine if there are viable alternative months for planting in the north-west, and to compare no-tillage versus conventional planting on hills. Over 2 years of research trials in both sites, three planting times (April, May and June) were combined with ploughing and hilling-up (farmers' practice) and no-till planting, as described in the previous presentation. Stake supply was an issue—prices varied and we needed to buy from two separate sources. Plants were counted 1 month after planting to determine the germination rate, then again at harvest to check for plant population effects. All harvesting occurred at the same time, despite the staggered planting.

At Samlout in 2017–18, both hilling-up and no-till practices planted in June and hilling-up planted in May produced higher yields (35–38 t/ha) than either practice in April (18–24 t/ha). At the same site in 2018–19, results showed that both conventional and no-till planting in May and June produced significantly higher yield (28–34 t/ha) than planting in April (14–23 t/ha).

The site at Pailin in 2017–18 resulted in no significant difference in yields between any of the treatments. In 2018–19 at Pailin, both hilling-up and no-till planting in April and May yielded significantly more (22–27 t/ha) than planting in June (7–9 t/ha). This is the opposite of Samlout.

At the Samlout site in 2017–18, hilling-up and no-till planting in May and June provided higher gross margin than planting in April. In 2018–19, all treatments resulted in negative returns due to low yield, poor-quality planting material and the high cost of weed control. As previously mentioned, hand weeding is the biggest problem due to the associated high labour cost.

At the Pailin site in 2017–18, hilling-up and no-till planting in May and June provided higher gross margins than planting in April. In 2018–19, all treatments resulted in negative

returns due to low yield and the high cost of weed control.

To improve cassava yield and sustain its production, farmers should manage the soil nutrients, plant in alternative months, and use good planting materials and weed control measures.

12 Susceptibility and yield impact of cassava mosaic disease on cassava varieties in Cambodia

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The prevalence of cassava mosaic disease (CMD) has been on the increase in Cambodia and has been negatively affecting more areas of cassava than in previous years. This study assessed variations in cassava resistance to CMD, the effect of fertiliser use, and yields of different varieties.

The study was conducted at two sites. The varieties tested were KU50, Rayong 5, Rayong 11, SC8, Huay Bong 60 and KM98-1. Measurements were taken at different time intervals (60, 150, and 270 days after planting) to assess symptoms of CMD (see Figure 12.1).

The incidence of CMD was highest at site 2 (50–100%). Across the two sites, while the number of plants showing symptoms of CMD increased with time, using fertiliser had no effect on the severity of the disease. At site 1, cassava yields were highest for SC8 for both treatments (fertiliser and no fertiliser). However, at site 2, KM 98-1 produced highest yields followed by KU50 and SC8. On the other hand, Rayong 11 produced lowest yields in both treatments and in both sites.

A clear trend was observed where plants demonstrating symptoms at an early stage of development (i.e. 60 days after planting) produced reduced levels of fresh root yield compared with plants that first showed symptoms at a later stage of development (i.e. 270 days after planting) or no symptoms until harvest. The starch yield for plants with symptoms at 60 days after planting was, on average, 1.5–2.2 kg/plant, while those that only showed symptoms at 270 days after planting or were asymptomatic produced between 2.5 and 3.8 kg/plant.

The results from this trial were compared with those conducted by the Cambodian Agricultural Research and Development Institute in Kratie and Stung Treng. Here, the average yields were found to be highest for the farmer variety[1] at 46.4 t/ha, while the average for all other varieties was 31.6 t/ha. However, using infected planting material from traders at Snoul Ta Ol reduced the yield to an average of 18.5 ± 2.7 t/ha. Significant losses can be avoided if farmers are more careful and manage to keep their planting material clean.

1 DNA fingerprinting revealed that the farmer's variety in one location was KM101. For other locations no genetic match was found in the International Center for Tropical Agriculture genebank or library; however, the varieties were sampled in the Vietnamese adoption study.

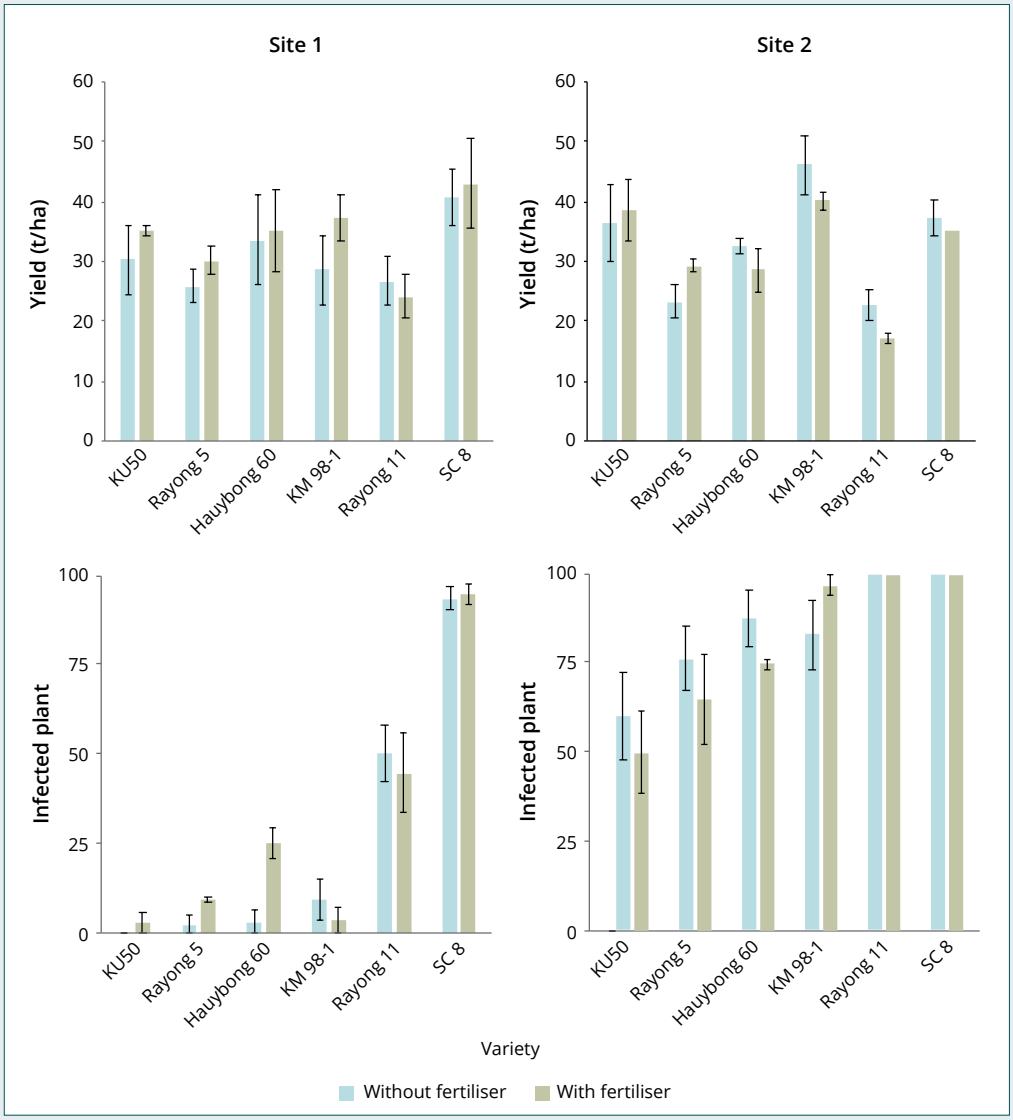

Figure 12.1 Incidence of cassava mosaic disease symptoms and yields of six cassava varieties with and without fertiliser at two sites in Cambodia

Questions from the floor

Q. Syaiful Bahri Panjaitan: How do you know that your starting material is clean? And how do you assure cleanliness if you have contaminated soil?

A. Sophearith Sok: For varieties like KU50, we were able to get material from unaffected areas. For local varieties, we relied on absence of visual symptoms. In addition, CMD is not transmitted by soil—only by whiteflies and planting materials.

A. Jonathan Newby: We are not sure that every single stake was uninfected. However, we do know from the PCR results that at least some of them were uninfected.

Q. Nguyen Bach Mai: The yield results from some of the infected varieties are still fairly high. How about the starch content?

A. Sophearith Sok: Starch contents of the elite selections are still in the normal range—around 25%. Farmer varieties gave the lowest starch contents. Average root yield for all varieties was 31.6 t/ha.

Q. Soytavanh Mienmany: You mentioned clean Thai materials. Can farmers access these materials and are they willing to pay for them?

A. Sophearith Sok: No, buying from the Thai Tapioca Development Institute requires phytosanitary certificates on both sides.

A. Jonathan Newby: Farmers are already paying US$3 per bundle for stems. If there were clean materials available in the country, people would buy them.

Q. Tin Maung Aye: Did the planting material come from mother plants of the same age?

A. Sophearith Sok: In some cases, it was not possible to know completely the exact age of the mother plants. However, this year we are replanting with our own materials and the ages will be synchronised.

13 Agronomic and economic results of improved cassava management in Laos

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This paper presents results of cassava variety and fertiliser response trials conducted in 2017–18 and 2018–19. The variety trials were conducted with seven varieties (KM140, KM21-12, KU50, Local, Rayong 11, Rayong 72 and Rayong 9) across three sites in Kenethao and Paklai districts in Xayabouy, and Viengthong district in Bolikhamxai.

Fresh root yields and starch content varied across the three sites. On average, Rayong 11 produced the best yields overall, while KM21-12 had the lowest yields. It should be noted that farm-gate prices do not reflect starch content and are primarily based on the overall weight of the roots.

As the local population consumes cassava, especially in Viengthong, which is deficient in rice, the optimal varieties for direct human consumption were also assessed. KM140 is the preferred variety and also gives relatively high root yields. Regarding new varieties, the 42 new clones introduced into Laos by the International Center for Tropical Agriculture in 2018–19 have passed the National Agriculture and Forestry Research Institute's initial screening and are being trialled. Preliminary yield trials are underway with five clones in 2019–20, with the rest planned to be trialled across multiple locations in 2020–21.

The fertiliser trials conducted were crucial, given the minimal adoption of fertilisers by Lao farmers. A survey conducted in 2017 revealed almost zero use of fertiliser, whether organic or inorganic. Despite the lack of use of fertilisers, there was a promising response from respondents regarding their interest in visiting a fertiliser demonstration trial or even conducting a trial on their own farms. The fertiliser trials conducted in 2017–18 included six treatments, including a zero control and two cassava varieties (Table 13.1). The fertilisers included both commonly used brands that were being used on rice crops and readily available in local markets, as well as those that were difficult to obtain.

Overall, fresh root and starch yields were higher in Kenthao than in the other two sites. Susceptibility to cassava witches' broom (CWB) disease also differed across varieties—Rayong 11 appears to

Table 13.1 Fertiliser trials in Laos, 2017–18

Treatment	Fertiliser application (kg/ha)				
	Urea (46-0-0)	TSP (00-42-00)	KCl	Manure	Local (15-15-15)
Control (0-0-0)	0	0	0	0	0
Low NP without K (40-10-0)	87.00	54.60	0	0	0
Low balanced NPK (40-10-40)	87.00	54.60	80.30	0	0
Low balanced NPK (40-10-40) + manure	87.00	54.60	80.30	5,000	0
Locally available mix (40-40-40)	0	0	0	0	266.65
High balanced NPK (80-20-80)	173.90	109.10	160.60	0	0

KCl = potassium chloride; NPK = nitrogen-phosphorus-potassium; TSP = triple super phosphate

be more resistant to CWB disease. CWB disease was also found on plants regardless of whether they were fertilised.

For 2017–18, net benefits were maximised when using 80N-20P-80K (high balanced) across all three varieties in Kenethao and Paklai. On the other hand, maximum net benefits in Viengthong were realised for the 40N-10P-40K (low balanced) fertiliser treatment.

Fertiliser trials in 2018–19 were conducted across two sites in Xayaboury and Bolikhamxai. There were four treatments across each of these sites, including a control (no fertiliser) treatment. In Xayabouri, highest net benefits were obtained for the 45-15-90 kg/ha treatment, while in Bolikhamxai net benefits were maximised using 40N-20P-40K kg/ha treatment. In addition, root rot was found to decrease yields and therefore reduce net benefits across both sites.

Simpler fertiliser trails were also conducted for demonstration purposes in Kenethao, Paklai, Viengthong and Bolikan. The treatments were simply a control treatment with no fertilisers and a fertiliser treatment. The fertiliser used was the commercially available NPK (15-5-30) at 300 kg/ha. The marginal rates of return were quite high, particularly for Kenethao when using the current price of cassava roots (Lao kip [₭]500–540/kg). Using fertiliser makes economic sense even at lower root prices (₭300/kg), except for farmers in Viengthong where the cost of fertiliser outweighs the returns.

In general, fertilisers have good potential to improve cassava yields in Laos but are difficult to access in many locations.

Questions from the floor

Q. Rod Lefroy: You mentioned getting farmers to identify CWB disease by symptoms. Has anyone looked at whether farmers select plants further away from symptomatic plants, or do they happily select asymptomatic plants immediately next to symptomatic ones?

A. Laothao Youabee: Farmers simply look for healthy plants.

Comment. Jonathan Newby: We now know from DNA fingerprinting that NARC61

from Laos is similar to an Indonesian variety. This exchange is interesting to note.

Q. U Thant Lwin Oo: According to our previous discussions, roots and chips are both important in Laos. Which varieties are best for chip production in Laos?

A. Laothao Youabee: Rayong 11 is preferable for chips because of the high starting starch content.

A. Tin Maung Aye: In reality, high-starch cassava does not necessarily make good chips. When you dry high-starch varieties they can turn grey, so Thai chip producers prefer 20–25% starch content for chips.

14 Agronomic and economic analysis in Myanmar

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Introduction

In Myanmar, cassava can grow on a wide range of soils under rainfed upland conditions where other food crops (such as rice and pulses) cannot be produced. Cassava is a cash crop that is relatively undemanding in terms of inputs (e.g. fertilisers, water, labour) compared with other key crops. Though cassava is a relatively neglected crop in the country, the impact of cassava in the Ayeyarwady region has been immense and many smallholder farmers here prefer to grow cassava, especially in the uplands. In recent years, the cassava area has markedly increased (34,700 ha in 2017–18) due to high market demand, while the average yield of cassava (14.8 t/ha in 2017–18) has been declining due to lack of high-yielding varieties and appropriate agronomic practices (DOA 2018). Dissemination of improved varieties and adoption of good agronomic practices could help farmers to grow cassava in a sustainable and profitable way (Aye 2017; Howeler & Aye 2014).

Methods and design

The Ayeyarwady is Myanmar's most populated region with about 6.32 million people, about 88% of which are in rural areas. It has a tropical climate with three seasons—a hot season, a rainy season and a cold, dry season. The mean annual precipitation is about 3,000 mm with 82% average relative humidity. This region covers a total area of 35,964 km^2 and consists of six districts with 26 townships. After consultations with regional Department of Agriculture officers and village leaders, three townships (Hinthada, Lemyethna and Kyonpyaw) were selected in the major cassava-growing districts of Pathein and Hinthada for the cassava value-chain study (Figure 14.1).

Three types of cassava demonstration trials were conducted in the 2018–19 growing season:

- planting methods
- balanced fertiliser application
- multiplication of good planting materials.

Results

The five farmer trials of planting methods and balanced fertiliser application used the Malaysia variety and were harvested 8 months after planting. Fresh root yield and starch content (%) were measured. The trials of planting methods showed that the ridge method produced higher yields (average root yield 26 t/ha) than the traditional mounding method

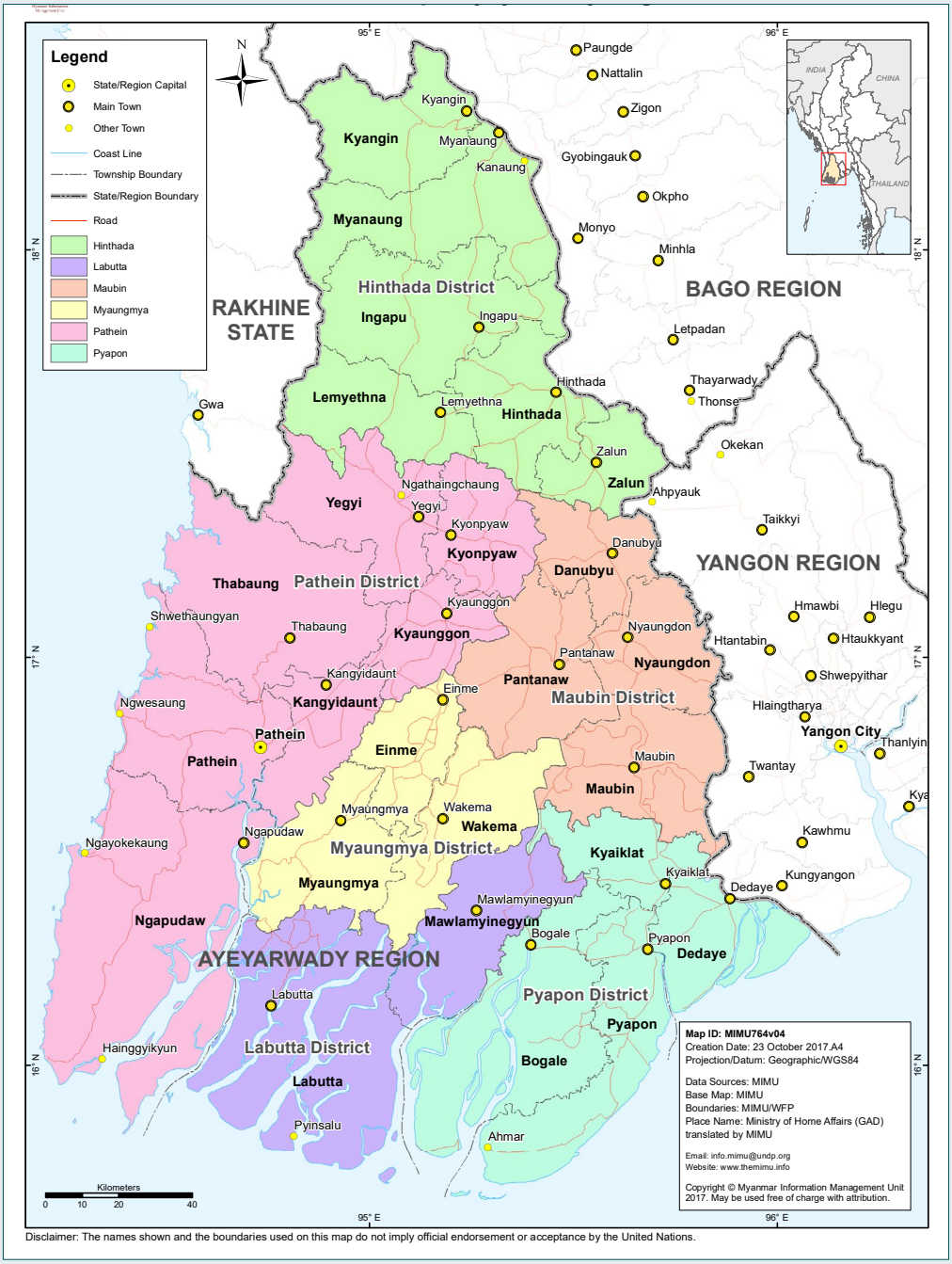

Figure 14.1 Location of study townships in Ayeyarwady region, Myanmar

(average root yield 23 t/ha), although the root yields varied among the five farmer plots with the same method. On average, the ridge method had lower production costs and thus more net income (Myanmar kyat [Ks] 463,000/ha) than the mounding method.

The fertiliser trials indicated that all fertiliser treatments significantly increased root yields and starch content relative to the control with no fertiliser (Table 14.1). The balanced fertiliser application with high levels of nitrogen-phosphorus-potassium (NPK) gave the highest yield (29 t/ha) and highest starch content (32%). The difference between this and the low NPK treatments with and without farmyard manure (FYM) was not significant, but all treatments gave significantly higher yields and starch content than the farmer practice of only applying urea.

The costs and returns of the fertiliser treatments based on mean yields are in Table 14.2. All treatments gave a good return over costs when compared with the zero fertiliser control. Table 14.3 shows that the marginal rate of return to the high NPK treatment is 870%. If the low NPK + FYM treatment is considered as the benchmark, the marginal rate of return of moving from this to the high NPK treatment is 147%. Thus, farmers may be encouraged to apply optimal levels of fertiliser as fresh root prices have been at high levels for the most recent harvest season (January–March 2019). Given this scenario, it is likely that smallholder farmers—who generally practice a traditional, nonintensive, low-input system of cultivation—will adopt improved agronomic practices in the coming growing season.

Discussion and conclusion

When cassava is grown on ridges, the number of plants per unit area (and sometimes the yield per plant) are higher than for a crop raised on mounds. The production costs for the traditional mound method (Ks807,500/ha) were higher than for the introduced ridge method (Ks692,250/ha). The estimated net income for the mound method was Ks2,154,000/ha compared with Ks2,617,000/ha for the ridge method. One of the advantages of the ridge method is that farmers could save time, as tractors can make ridges. The introduced ridge method also requires less labour for maintenance of the crop, as it is easier to apply fertilisers and control weeds than the traditional mound method.

Table 14.1 Results of the fertiliser demonstration trials in 2018–19

Treatment	Mean root yield (t/ha)	Mean starch %	Mean starch yield (t/ha)
NPK high	29[a]	32[a]	8.9[a]
NPK low	27[ab]	31[a]	8.4[a]
NPK low + FYM	28[ab]	31[a]	8.6[a]
NP low, no K	25[ab]	31[a]	7.2[ab]
Farmer practice	22[b]	29[b]	5.8[b]
No fertiliser	10[c]	28[b]	2.6[c]

FYM = farmyard manure; NPK = nitrogen-phosphorus-potassium
Note: Means with same letter in same column are not significantly different at the 5% level.

Table 14.2 Costs and returns for fertiliser treatments in demonstration trials in 2018–19

Fertiliser treatment	Fertiliser cost (kyat/ha)	Yield (t/ha)	Gross revenue (kyat/ha)	Increase in revenue cf. no fertiliser (kyat/ha)	Return on fertiliser investment (col. 5/col. 2)
NPK high	288,990	29	3,694,179	2,433,655	8.4
NPK low	144,495	27	3,482,121	2,221,597	15.4
NPK low + FYM	274,911	28	3,571,571	2,311,047	8.4
NP low, no K	83,980	25	3,213,257	1,952,733	23.2
Farmer practice	88,920	22	2,794,025	1,533,501	17.2
No fertiliser	0	10	1,260,524	0	na

cf. = compared with; FYM = farmyard manure; na = not applicable; NPK = nitrogen-phosphorus-potassium
Note: Price of fresh roots = 128,520 kyat/t.

Table 14.3 Costs and marginal rates of return from demonstration trials in 2018–19

Fertiliser treatment	Fertiliser cost (kyat/ha)	Extra cost (kyat)	Gross revenue (kyat/ha)	Extra gross revenue (kyat)	Marginal rate of return (%)	Marginal rate of return (%)
No fertiliser	0	na	1,260,524	na	na	na
Farmer practice	88,920	88,920	2,794,025	1,533,501	1,725	1,725
NPK low	144,495	55,575	3,482,121	688,096	1,238	1,238
NPK low + FYM	274,911	130,416	3,571,571	89,450	69[a]	na
NPK high	288,990	14,079	3,694,179	122,608	871	147[b]

FYM = farmyard manure; na = not applicable; NPK = nitrogen-phosphorus-potassium
a Dominated.
b The return resulting from moving from low NPK to high NPK.

The response of cassava to fertilisers varies from place to place, and increasing the rate of NPK fertiliser does not always increase the root yields (Howeler 2002). However, the five demonstration trials showed that applying fertiliser greatly increases root yield and starch content. The highest root yields and starch content were obtained with a high balanced NPK rate (110 kg of N, 55 kg of P_2O_5, 150 kg of K_2O per ha). This treatment also gave a profitable marginal rate of return. Using only urea, as practised by farmers, gave significantly less starch yield than other fertiliser applications, although a higher yield than with no fertiliser.

The trial results indicate that deficiency of particular essential minerals (N, P, K) reduces both the quantity and quality of cassava roots, and balanced fertiliser application is one of the most effective ways to increase fresh root and starch yields, and net income (Howeler 2014; Sopheap et al. 2012; Sophearith 2014).

The optimal fertilisation rates for specific locations are still unknown, as the crop response to fertilisation depends on the variety, soil chemical and physical characteristics, microclimatic conditions, and other crop management practices such as weeding.

Stimulating sustainable intensification of cassava production can help improve the socioeconomic conditions of Myanmar's farmers. However, slow adoption of suitable varieties and good agronomic practices are challenges for scaling-up the trial results. To speed up the adoption of sustainable production technologies, field demonstrations should be conducted in collaboration with local processors, cassava traders and agroinput dealers. Therefore, we propose to conduct cassava trials on local processors' and farmers' fields in the 2019–20 growing season. Additionally, strengthening effective research and development activities and training for project beneficiaries are needed urgently.

Questions from the floor

Q. Yudi Widodo: Is the 'Malaysia' variety in Myanmar the same variety we call Malaysia here in Indonesia?

A. Nilar Aung: I think that it is the same variety introduced to Myanmar.

A. Tin Maung Aye: You mention Malaysia variety—I think that in Myanmar and Cambodia it is the same variety. We should do a study using morphological characteristics to tell.

Q. What method is used to determine the starch content at 28–30%?

A. Nilar Aung: The water-measuring method is used. It is a simple and efficient method requiring no specialised equipment.

Q. Jonathan Newby: Are there enough tractors available in Myanmar to do ridging, or would this be a limiting factor to farmer adoption of the ridging practice?

A. Nilar Aung: Now farmers are investing in tractors and it is very easy to access the tractors.

Q. Imran Malik: What is the density with mounding?

A. Nilar Aung: Good question. The density varies from 1,200 to 2,000 plants per acre, whereas with ridging it is 4,000.

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15 Effect of fertiliser application on cassava and maize yield in an intercropping system in Sikka Regency, East Nusa Tenggara province, Indonesia

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Introduction

Cassava is the second most important crop for the people of East Nusa Tenggara (ENT) province. It is one of the main food items for the rural population. Cassava is planted extensively in the province, mostly as an intercrop with maize, but the yield is very low (less than 10 t/ha). During the reconnaissance and household surveys, we found that the reasons for low yield are:

- low cassava density (1,250–2,500 plants/ha)
- the variety planted is a low-yielding local variety
- little or no fertiliser is applied.

Previous agronomic trials have resulted in several key findings for increasing cassava yield in ENT.

After varietal trials, farmers were very enthusiastic to plant introduced varieties, especially Gajah, Malang 4 and—to some extent—Faroka. Farmers are hesitant to plant cassava at higher densities since they do not want to risk lowering their maize yields, but, after observing the intercropping trials in 2016, most farmers participating in the field day were willing to increase the cassava populations in their maize plus cassava farming. However, increasing crop yield would increase plant nutrient uptake. Therefore, fertiliser application is essential, whether to satisfy the plant nutrient requirement or to prevent soil degradation.

Hence, the aims of the agronomic trial reported here were to:

- investigate the effect of fertiliser application on the growth and yield of maize and cassava in cassava plus maize intercropping in ENT's dry climate
- show farmers the importance of fertilisation.

Methods and design

The fertilisation trial was set up in the village of Wolohuler, Sikka Regency. The treatments comprised:

- cropping systems (monoculture maize; intercropping maize with cassava at cassava spacing of 1 m × 1 m; intercropping maize with cassava at cassava spacing of 2 m × 1 m)
- fertiliser application (nil; nitrogen [N] only; complete fertilisers: nitrogen-phosphorus-potassium [NPK]).

The full set of treatment combinations is in Table 15.1. The treatments were arranged in a randomised block design with three replicates.

Planting was done on 23 November 2017. Maize (Bisi variety) was planted at a spacing of 1 m × 0.30 m on a plot size of 6 m × 5 m. Cassava stems of about 25 cm were planted in between the maize rows. All phosphate and potassium fertilisers were applied on the planting date; urea was applied twice for monoculture maize (half-dose each time) and thrice for maize + cassava intercropping (one-third dose each time). Weeding was done manually at 45 days after planting and after the maize was harvested. Maize was harvested on 9 March 2018, after which a local variety of mungbean was planted at a spacing of about 30 cm × 30 cm. The cassava was harvested in November 2018. A field day was held during the maize intercrop harvest.

Results

The fertiliser treatments, both N and NPK, showed a significant influence ($P < 0.05$) on the maize yield but there was no significant effect of NPK compared with N alone (Figure 15.1). There was no significant difference ($P > 0.05$) in maize yield between the monoculture and intercropping systems (Figure 15.1). For cassava, the closer spacing

Table 15.1 Treatment combinations

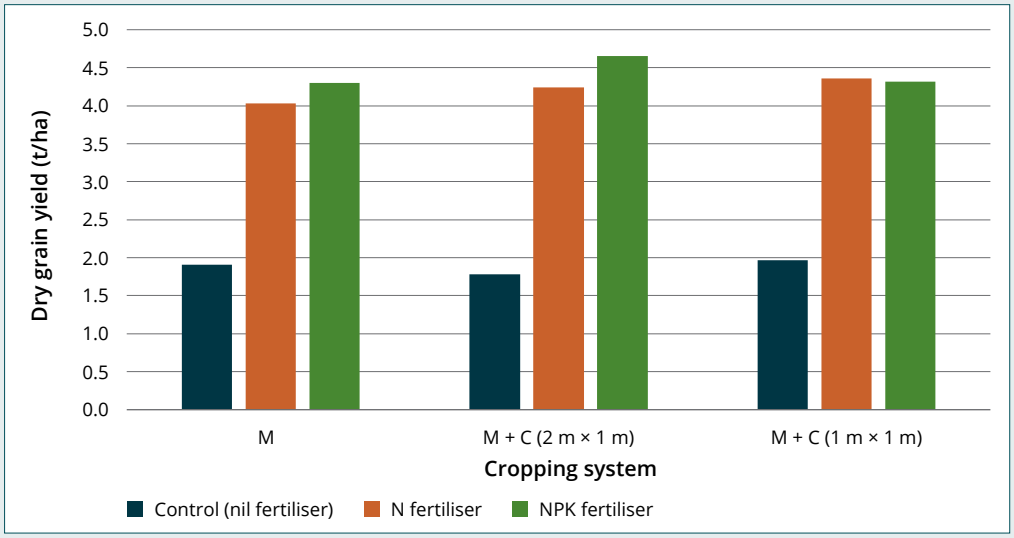
Code	Cropping system	Fertiliser (dose per ha)
MF0	Maize monoculture	Nil fertiliser (control)
MN	Maize monoculture	200 kg urea (half at planting; half at 45 DAP)
MNPK	Maize monoculture	200 kg urea (half at planting; half at 45 DAP); 100 kg SP36 and 100 kg KCl at planting
MC1F0	Intercropping cassava–maize (2 m × 1 m)	Nil fertiliser
MC1N	Intercropping cassava–maize (2 m × 1 m)	300 kg urea (one-third at planting, one-third at 45 DAP, one-third after maize harvested)
MC1NPK	Intercropping cassava–maize (2 m × 1 m)	300 kg urea (3 applications as for MC1N), 100 kg SP36 and 100 kg KCl at planting
MC2F0	Intercropping cassava–maize (1 m × 1 m)	Nil fertiliser
MC2N	Intercropping cassava–maize (1 m × 1 m)	300 kg urea (3 applications as for MC1N)
MC2NPK	Intercropping cassava–maize (1 m × 1 m)	300 kg urea (3 applications as for MC1N), 100 kg SP36 and 100 kg KCl at planting

DAP = days after planting; KCl = potassium chloride; NPK = nitrogen-phosphorus-potassium; SP36 = superphosphate 36

doubled the yield. There was significant influence of fertiliser (both N and NPK) on yield (Figure 15.2). The highest mean yield was obtained from using NPK fertiliser and 1 m × 1 m plant spacing (47 t/ha).

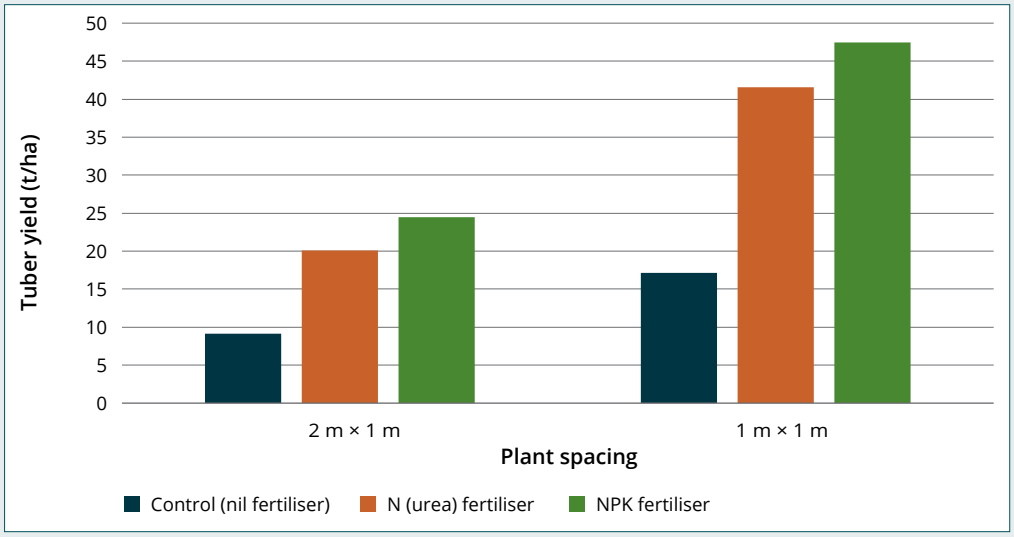
Discussion and conclusion

The main objective of this trial was to show to farmers the importance of fertilisation in the cassava plus maize intercropping system in ENT. The current practice is



C = cassava; M = maize; NPK = nitrogen-phosphorus-potassium

Figure 15.1 Maize yields for different cropping systems and fertilisers



NPK = nitrogen-phosphorus-potassium

Figure 15.2 Cassava yields for different plant spacings and fertilisers

to fertilise (usually NPK) maize only, not cassava. After harvesting maize, farmers do not apply any more fertiliser to the cassava. The results from this trial show that additional fertilisation after harvesting the maize doubles the cassava yield. During the field day, farmers were more than willing to adopt the fertilisation recommendation from the University of Brawijaya – Indonesian Legumes and Tuber Crops Research Institute team. However, fertiliser in ENT can only be obtained through the recommendation of the government agricultural extension officer. This implies the need for close collaboration between farmer groups, agricultural extension officers and governmental agencies to ensure the availability of fertiliser. Further trials will be designed to obtain the appropriate dosage of N and K fertiliser for cassava farmers in ENT. It was also noted that mealybug attacks were common during the dry season and are becoming a serious issue; treatment should be considered.

16 Testing cassava varieties in East Flores Regency, East Nusa Tenggara, Indonesia

Erwin Ismu Wisnubroto
University of Brawijaya, Indonesia
Susilo
Tribhuwana University, Indonesia
Titiek Islam
University of Brawijaya, Indonesia

Introduction

Previous agronomic trials in Sikka Regency showed that farmers preferred the varieties Malang 4, Gajah and (to some extent) Faroka over local varieties. Seeing the success of cassava farming in Sikka Regency, farmers from Hokeng village in East Flores Regency, located east of Sikka Regency, were interested to participate in a variety trial.

The climate in Hokeng is considerably wetter and more humid than in Sikka Regency, and the village is at a higher altitude. In 2018, the team from the University of Brawijaya and the University of Brawijaya collaborated with the farmer group and the Agricultural Vocational School in Hokeng to set up a variety trial. The aims of the trial were to:

- identify cassava varieties that are suitable to the agroecological conditions of the village
- understand farmers' preferences among the cassava varieties tested in the village.

Methods and design

The trial was set up on farmers' land in the village of Hokeng. The varieties tested were Faroka, Gajah, Malang 4, Tambak Udang and two local varieties. These varieties were arranged in a randomised block design with three replicates. Planting was done on 26 November 2017. Cassava cuttings of about 25 cm were planted at a spacing of 1.0 m × 1.0 m on a plot size of 5 m × 5 m. The cassava was fertilised with 300 kg/ha urea, 100 kg/ha of superphosphate 36 and 100 kg/ha of potassium chloride. The latter two fertilisers were applied at planting, and urea was applied in three equal doses at 15, 60 and 90 days after planting. Weeding was done manually at 15, 60 and 90 days after planting. The condition of the plants during the trials is shown in Figure 16.1.

Results

The cassava was harvested in November 2018. The yield of the introduced varieties was significantly higher ($P < 0.05$) than the local varieties (Table 16.1). The highest yield was obtained by the Malang 4 variety, with an average of 53 t/ha, followed by Gajah with 49 t/ha. The local varieties produced 28 t/ha for the white-fleshed variety and 35 t/ha for the yellow-fleshed variety. During

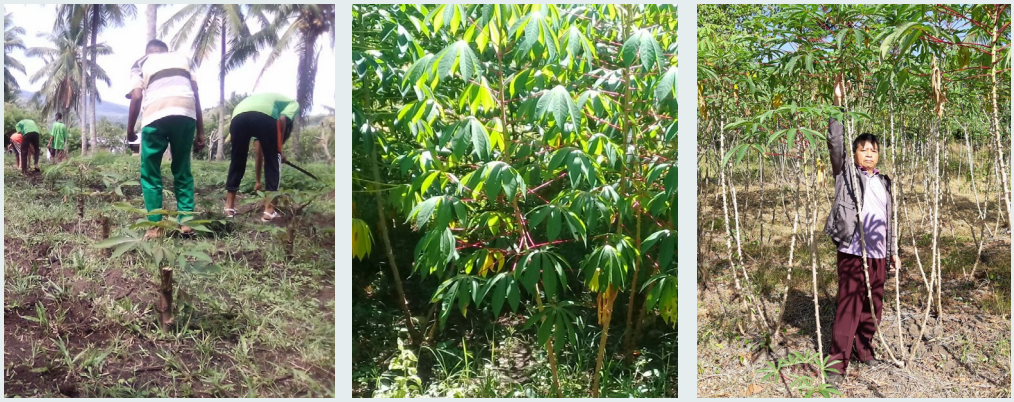


Figure 16.1 Variety trial at Hokeng (left to right): local variety at 15 days, Faroka at 7 months and Faroka at 11 months

Table 16.1 Yield (t/ha) of fresh roots from six cassava varieties tested at Hokeng village, 2018

Variety	Replicate 1	Replicate 2	Replicate 3	Mean
Malang 4	45.35	59.48	54.55	53.12
Faroka	42.28	55.42	41.61	46.43
Tambak Udang	35.73	47.55	39.44	40.90
Gajah	44.02	46.20	56.00	48.74
Local white	21.69	32.58	31.70	28.65
Local yellow	31.06	35.25	40.93	35.64

the field day, farmers were given a short questionnaire to obtain their preferences for the cassava varieties tested. The results are shown in Figure 16.2. Farmers were most interested in planting Gajah and Malang 4 varieties and ranked them above the local varieties. Even though Malang 4 usually has a bitter taste, it was appreciated by farmers after a taste test at the field day.

Discussion and conclusion

All the introduced varieties tested grew well in the wetter climate and higher altitude of Hokeng. Malang 4 and Gajah produced the highest yield; on average, 18–25 t/ha more than the local varieties. Farmers indicated a preference for these two varieties, which were considered suitable to their palate. Hence, for the 2018–19 planting season, 15–20 farmers in Hokeng were willing to participate in a trial of Malang 4 and Gajah varieties on their farms. Cassava stems were provided to them from the previous trial and from Sikka Regency, courtesy of Pak Tommy (an entrepreneur). Moreover, the University of Brawijaya team also signed an agreement with the East Flores Regency Government to support the development of smallholder cassava farming in Hokeng village by working together with the Agricultural Extension Office.

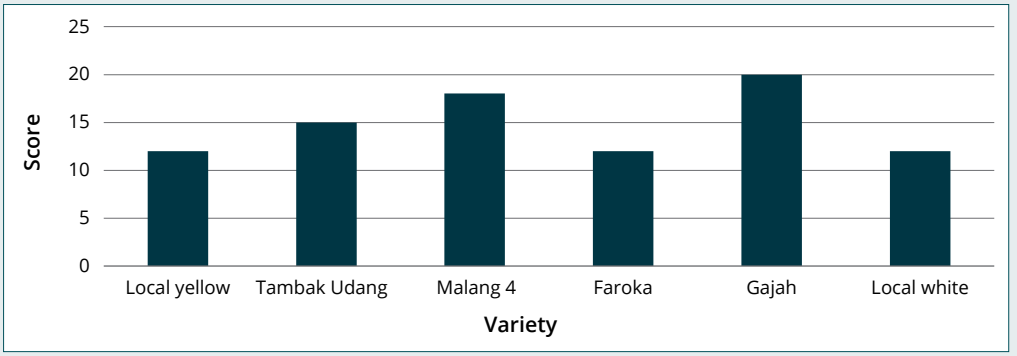


Figure 16.2 Farmers' preference scores for cassava varieties tested

Discussion of East Nusa Tenggara papers

Q. Howard Hall: Why are you recommending 15-15-15 and urea as the most appropriate fertilisers?

A. Erwin Wisnubroto: Simply because that is what is available due to subsidy programs.

Q. Rod Lefroy: In eastern Indonesia quite a few years ago, the limitations to an industrial sector were mostly around price. Farmers did not want to go to bulk industrial markets offering relatively low prices when they could see snack food cassava in the market going for five times more (although the market was very small).

A. Erwin Wisnubroto: Indeed, intensive planting requires different logistics. The East Nusa Tenggara (ENT) local markets will not be able to handle massive amounts, and transport would be an issue.

Q. Soytavanh Mienmany: What is the economic status of cassava farmers in ENT?

A. Erwin Wisnubroto: Poor-to-medium income households make up the typical cassava farmers in our surveys in ENT. Each farmer has around four to six fields, each one of which is one-quarter or one-half hectares. Farmers decide which parcel to use each year, and it is often a rotating cultivation system for the annual upland crops.

Q. Rod Lefroy: For the fertilisers, availability is an issue, but I am still surprised at the level of phosphorus in some of the treatments.

A. Erwin Wisnubroto: This ratio was based on our first trial in 2016–17.

Q. Rod Lefroy: In the case of the application of urea (200 kg after maize harvest in one treatment), this seems very high as well. Are you really benefiting from this?

A. Erwin Wisnubroto: We believed we were working on low-nitrogen soils, and we wanted to replace the nitrogen taken off by the maize intercrop. Farmers have also expressed reticence to apply fertilisers at all. We need an 'easy but not perfect' entry point to get farmers used to the concept.

A. Jonathan Newby: A priority should be a policy paper for both sites in Indonesia focusing on fertiliser.

17 Wilmar fertilisers in Indonesia

Syaiful Bahri Panjaitan
Wilmar Chemical, Indonesia

Wilmar has two fertiliser companies: PT Sentatya Adidaya Pratma was founded in 1999 and PT Wilmar Chemical Indonesia in 2013. Wilmar is headquartered in Jakarta, with a second office in Medan.

Wilmar benefits from an Indonesia-wide distribution network, with a shipping jetty entering the Strait of Malacca. Wilmar has 10 ha of research fields and also runs leaf and soil sample analysis units. Its aim is to eliminate nutrient deficiencies from yield-limiting situations. The organisation is also involved in developing nitrogen-phosphorus-potassium (NPK) granular mixes with different trace element and micronutrient contents (manganese, boron, etc.), and various release rates.

Questions from the floor

Comment. Rod Lefroy: Of the various blends, the one planned for tomato production is actually the best NPK balance for cassava: 13-8-27 + 4 manganese + 0.5 boron.

Q. Khambor Sypaseuth: Does Wilmar trade in only blends and compound fertilisers, or is there also single nutrient production for blending?

A: We focus on fertiliser blends, a more competitive market in Indonesia.

Q. Somsay Didouangdeth: Does your company have a network or connection with Thai dealers? Do you also engage in farmer training about how to apply the fertilisers?

A: In addition to Indonesia, we currently sell products in Africa, Myanmar and the Philippines. Not yet Thailand, since they have a large pre-existing fertiliser sector and competition is more developed. Laos and Cambodia are immediate future targets. In terms of training, we do collaborative trials and field demonstrations with a key group of farmer stakeholders.

Q. Sophearith Sok: What soil types do you have in cassava production, and do you give different recommendations for different soils?

A: Yes, we have several different soil types throughout Indonesia and our recommended fertiliser types are regulated by crop type and soil type under the Indonesian national classification system.

18 Discussion of issues arising from the midterm review

Rod Lefroy
Australia

Rod Lefroy: A question for the International Center for Tropical Agriculture (CIAT). Has there been progress in marker-assisted selection to introgress resistance into local varieties?

Jonathan Newby: The variety TME3 went to Thailand quite a while ago and initial crosses are ongoing. It is also already in the field in Cambodia, for yield trials. There are also four high-starch varieties from the International Institute of Tropical Agriculture, now at the Thai Tapioca Development Institute and Agricultural Genetics Institute in Vietnam. These are going through the quarantine process but we hope to have it in multiple locations to test as part of the new project. An additional 150 or so selections will be heading to southern Vietnam. Cassava mosaic disease will eventually arrive in Indonesia as well, and we need to think about the eating varieties and the impact on food security.

Rod Lefroy: It is great to have so many private-sector partners on board early in the project as opposed to waiting until the end of the project to look for them. A comment on remote sensing: this would be a boon for understanding area in real time, as well as harvest and planting dates regionwide.

Jonathan Newby: We are trying to facilitate other projects to work on this issue. The German-funded International Climate Initiative (IKI) project is taking on the task. We are working with modelling groups and logistic companies to understand stem movement pricing.

Rod Lefroy: There has been good progress with variety trials, but we still need to continue panel testing. Fertiliser trials are complex and difficult, but we are making good progress. There is serious potential in past trial data, although it does not seem to be accessible. Nevertheless, the summary work on these data—available in the regional cassava meetings that have been happening for 20 years—may be enough to give basic crude empirical results.

Imran Malik: I am familiar with the conference books. There is a lot of information in these but mining is a serious job to extract the useable data. Looking at ratios of nitrogen:phosphorus:potassium, we have worked quite a bit on this, including a MSc student of Laothao and a University of Western Australia student, who both looked in depth at nutrient removal, uptake and balance.

Rod Lefroy: Regarding linking farmers and factories, does this link happen effectively and efficiently? What about the role of mobile technologies to facilitate app-based approaches? And concerning the application of sodium chloride, why are people applying this in Indonesia?

Yudi Widodo: It is for nutrient purposes.

Syaiful Bahri Panjaitan: Sodium is available on the black market. Sodium is not recognised as an essential crop nutrient, but some crops respond.

Phommalath Siviengkhek: Sodium has been used in Laos on rice for farm borders. People feel it is organic, clean and cheap. They also tried using wood vinegar, but the concentration was not high enough to control major weeds, only tiny seedlings.

Rod Lefroy: In the Lao uplands it was used as a pre-rice weed treatment, but it quickly disappeared from use as it fell out of favour.

Tin Maung Aye: Seed systems for clean material is another important research area.

Neng Por: Improper timing of herbicide and fertiliser application is a factor in weed control. Many farmers will apply fertiliser right after spraying, encouraging the growth of the next generation of weeds. It is also important to categorise the weeds occurring in cassava fields.

Rod Lefroy: Erosion on sloping lands, and coming up with something that takes up very little space and saves labour is a very serious challenge.

Stephanie Montgomery: I agree with all the above comments. In Vietnam the slopes are incredibly steep, and I am interested to hear from Dr Minh about what type of measurements are being conducted in these systems. Water is a key driver that needs more work, regarding both run-off and its use during dry periods.

Cù Thi Lê Thuy: In terms of the erosion issues, CIAT has worked in the north, central and south with Vietnamese partners for 20 years. There is a book on the topic summarising the results from all of the projects.

Tin Maung Aye: For erosion control, demonstration trials are easy to do but we cannot account for all cropping systems and farming styles. Without an animal component, grass strips are more complicated since you have no economic benefit from the strips.

Jonathan Newby: Land preparation is now mechanised, and ease of ploughing interferes with the erosion-control structures.

Rod Lefroy: The biggest challenge is when tractors are used for the first time. Tractor drivers just need to be sensitised, and it is certainly safer once terrace formation begins.

Syaiful Bahri Panjaitan: We should remember the role of micronutrients. Cassava is a relatively high-uptake crop, and we may face micronutrient issues in the future. We should be thinking about this sooner rather than later.

Rod Lefroy: Cassava exports a lot of nitrogen and a lot of potassium in the roots, but not a lot of phosphorus or micronutrients. Sulfur could be an issue in some soils.

Syaiful Bahri Panjaitan: This already happens significantly in oil palm.

Rod Lefroy: The flower has a serious concentration of micronutrients, but not so much in a root like cassava.

Imran Malik: The leaves and some of the stems are going back into the soil, so the micronutrients are not such a serious issue.

Lê Viet Dũng: Promotion of intercrops in Vietnam is something that has a long history. The most important factors are to choose sites where cassava or maize are highly important for farmers. There are large village areas in Yen Bai where intercropping uptake has occurred over project cycles, but this requires follow up with farmers for the medium term. There are districts (i.e. Van Yen) that have maintained grass strips for more than 10 years.

Nguyen Bach Mai: Fertiliser affects cassava yield significantly, yet there are still many areas where fertiliser use has not been highly adopted. Why can't we produce compound fertilisers that only need to be applied once?

Rod Lefroy: The main reason is that they are expensive. They can be developed. The barrier is not technological; it depends on demand. There are also organic compounds that are essentially slow release.

Industry and government engagement

19 Recap and introduction to the session

Dominic Smith
University of Queensland, Australia

The role of value chains in getting improved technologies to farmers depends on incentives. Private actors are more incentivised if they are more certain of benefiting. For example, if there is a single factory within a supply catchment, it can benefit from demonstrating and disseminating technologies that lead to an increased supply of fresh roots with higher starch content. If there are more factories and trading networks competing for supply, the situation becomes more complex and opaque, and the ability to benefit is uncertain. Value-chain actors will be less willing to invest in technology dissemination. However, collaboration and cooperation is still possible under these more complex circumstances—for example, by forming regional industry associations that agree to co-invest in improving smallholder production within their region.

The key dimensions that will influence the actions of value chains are the characteristics of the technologies and the incentive structure of the value chain. There are varying degrees of learnability and relative advantage among the technologies being investigated in the project, such as improved varieties, soil fertility management, and pest and disease management. The value chains also vary from a single dominant buyer, as in the North Sumatra site, to multiple competing buyers, as in Dak Lak, and buyers from within and beyond national boundaries, as in Laos and Cambodia. A matrix of technology and market characteristics can help us think about the role of value-chain actors in the dissemination of these technologies. With 1 year left in the project, we need to discuss what can be done to make sure that these technologies become more widely available.

20 Increasing the role of value-chain actors for cassava development in North Sumatra, Indonesia

Ruly Krisdiana
Indonesian Legumes and Tuber Crops Research Institute, Indonesia

Introduction

North Sumatra is one of the main cassava-producing provinces in Indonesia. The mean yield of cassava in North Sumatra is about 30 t/ha, higher than the national mean yield, which only 20 t/ha. Most cassava tubers are used for industrial purposes. The study discussed here aimed to investigate the role of value-chain actors in improving cassava production.

Methods

The study used a reconnaissance survey in 2016, a household survey in 2017 and group discussions in November 2018. The study was done in Pematang Siantar, Simalungun district and Tobasa district. The reconnaissance survey involved interviewing key actors involved in the cassava value chain, including farmers, traders, collectors, processors and researchers. The household survey was undertaken with 150 farmers. The key questions covered the production system, marketing, processing and support from input suppliers and extension.

To understand the roles and activities of the value-chain actors, a workshop was held in November 2018. Forty participants, including farmers, traders, collectors, processors, government agencies and researchers (university and research institute) presented their views for developing cassava in North Sumatra. The director of the Legume and Tuber Crops Directorate of the Ministry of Agriculture talked about the National Policy for Cassava. The head of the Provincial Agricultural Service talked about the Policy for Cassava Development in North Sumatra. The head of BPTP North Sumatra talked about the cassava research program in North Sumatra, and the University of Brawijaya – Indonesian Legumes and Tuber Crops Research Institute team presented the study results for 2016–18.

Results

Most of the cassava produced in North Sumatra is used for industrial purposes. In Pematang Siantar and the surrounding area, the main cassava processor is PT Bumi Sari Prima, which processes cassava as tapioca starch. There are five main actors in the cassava value chain (Figure 20.1): farmers as the producers; PT Bumi Sari Prima as the processor; and the agents, collectors and traders who link them. In addition, there are supporting actors who supply production utilities, mainly fertilisers and herbicides.

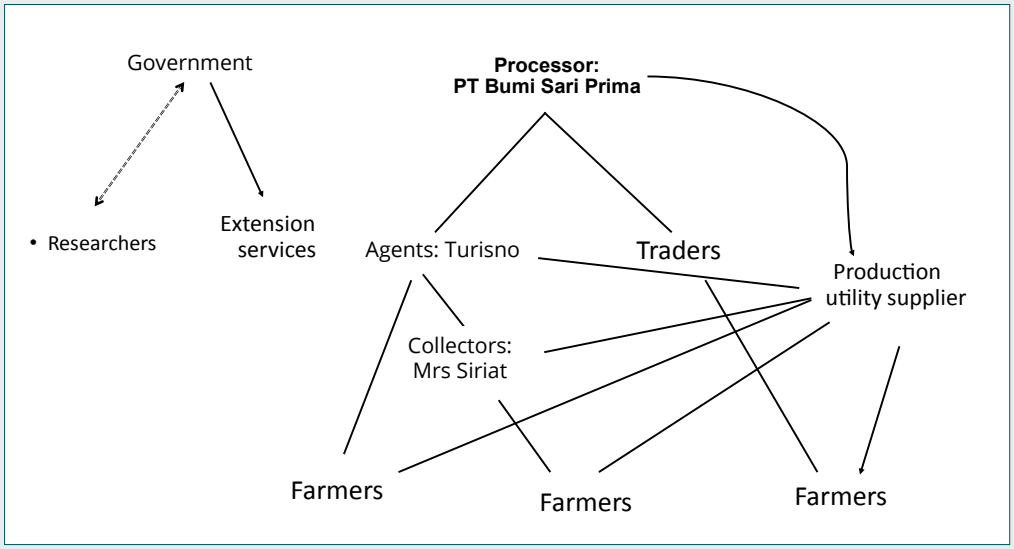


Figure 20.1 Cassava value chain in North Sumatra

Farmers grow cassava in a monoculture system with a simple technology. The cassava varieties commonly planted are local varieties such as Malaysia, Adira-4 and Cikaret. Farmers use cuttings from the previous crops or from their neighbours with no cost. Farmers plant their cassava at a close spacing (100 cm × 60 cm or 80 cm × 60 cm). Some traders supply agricultural production utilities, but they often face the difficulty of obtaining sufficient fertilisers. Hence, farmers often do not fertilise their cassava or, if they do, they use an inappropriate rate. Farmers sell their product mostly in the form of fresh tubers to the factory through collectors, agents or traders.

Agents help the factory obtain fresh cassava for processing. Agents can directly contact farmers or cooperate with collectors. Most agents and collectors also plant cassava in their own fields. Agents and collectors often also act as agricultural extensionists, providing technical advice to farmers. Collectors and agents can also help farmers in the process of production, such as by providing cuttings, land preparation, or lending money for fertilisers and herbicide. They can also arrange for harvesting and transport to the factory.

Agents borrow money from the factory and collectors borrow money from the agents to facilitate their activities. In return, farmers are obliged to sell their product through their collectors or agents. Agents and collectors receive a fee from the factory based on the amount of cassava delivered. Traders function similarly to the collectors. However, they have more choice because they are not strictly tied to the factory. Some traders also plant cassava on their land.

PT Bumi Sari Prima is the main processor in Pematang Siantar and the surrounding area. The price of cassava is determined by the factory and based on the tapioca market price. The factory does not use starch content as a criterion to determine the price. In 2017, the cassava price was very low and only a few farmers planted cassava; hence, in 2018, PT Bumi Sari Prima experienced a shortage of fresh cassava.

To help farmers increase their yield, in 2015, PT Bumi Sari Prima bought Malang 4 from the Indonesian Legumes and Tuber Crops Research Institute in Malang. However, the spread of the variety to farmers has been slow.

There has not been enough attention from the government for developing cassava in North Sumatra. The Office of Agricultural Services in Pematang Siantar indicated that there was a program for developing cassava in Pematang Siantar, but until now there has been no real action.

Discussion and conclusion

During the November 2019 discussion, several issues were raised:

- Although at the national policy level, cassava is not included among the priority commodities; all participants agreed that cassava plays an important role in North Sumatra and expressed support for any program to develop cassava in North Sumatra.
- The limitations of cassava development in North Sumatra are
  - the availability of suitable cassava varieties
  - the availability in quantity and at the appropriate time of production utilities
  - production technology
  - the availability of capital
  - limited uses of cassava by processors
  - price fluctuations.
- All actors in the value chain agreed to take more action to increase cassava production. However, it was unclear as to the share, responsibility and advantage of each actor involved in the program. The discussion concluded that government should take a more active role in the program, especially in providing cassava varieties and technology. Government was also expected to solve the problem of price fluctuation—for example, by mediating between farmers and processors, or providing insurance. Agents, traders and collectors were willing to take part in multiplying and providing cuttings, as long as they obtained a clear advantage in doing so.
- To minimise the risk from price fluctuation, the group supported the development of other end uses for cassava. In addition, intercropping may help farmers to spread risk.

Questions from the floor

Q. Howard Hall: What is the government's role in response to price fluctuation?

A. Ruly Krisdiana: Rice, maize and soybean are three major crops in which the government intervenes to buy farmer produce and ensure a national price. Cassava does not have such a price stabilisation policy in Indonesia.

Q. Soytavanh Mienmany: When did the role of agent enter the value chain? How long has the agent been a key player and how does this function?

A. Ruly Krisdiana: The agent system was developed by Bumi Sari itself. They felt that having the agent in the value chain made a more effective linkage between the factories and the farmers.

Q. Khambor Sypaseuth: You have mentioned that the farmers are facing difficulties in accessing fertiliser. What is the issue? Are there shops nearby?

A. Erwin Wisnubroto: There are fertiliser shops in the area, but the availability of stock is quite low. Farmers know where to buy, but the fertiliser supply to the area is low.

Q. Jonathan Newby: Agents play a key role in trying to stop side selling. With Malang 4, we know that there is strong demand. Do you think that farmers would be willing to buy it, and that there is a potential business for stake sale to other farmers?

A. Ruly Krisdiana: This is possible—and in fact very likely.

Q. U Thant Lwin Oo: How do you arrange supply and demand of roots to the factory?

A. Ruly Krisdiana: There is still a shortage of roots to the factory outside peak times. The factory responds to this using the agent system to search for suppliers outside the original production zone.

21 Industry and government engagement in Vietnam: Dak Lak and Son La

Cù Thi Lê Thuy
International Center for Tropical Agriculture, Vietnam

In Vietnam, the area of land dedicated to cassava has been increasing in both Son La and Dak Lak. However, yields have either been stagnant or on a downwards trend. Increased demand for cassava can be observed with more factories being established, resulting in increased competition for cassava roots. For example, in Dak Lak, there were only four factories in 2012, but these have more than doubled to nine in 2019. Despite the increased demand, the government seems reticent to support cassava and only keen on promoting the crop in remote and disadvantaged areas. There also appears to be less fluid communication between the government and the private sector.

Throughout the project, a consultation and feedback process has been ongoing with relevant stakeholders to identify bottlenecks and opportunities to promote suitable technologies. Agronomic experimental results have been shared with stakeholders, and their feedback has been incorporated to modify subsequent experiments and trials. The relevant stakeholders have been kept abreast of all new developments and new information. Finally, opportunities to cope with emerging pests and diseases related to the cassava crop have also been identified.

Work in Son La has involved collaboration with the extension centre in the Department of Agriculture and Rural Development (DARD). After the agronomic trials are completed, suitable farming practices will be recommended to DARD to promote. Collaborative work with starch factories has also been established, where new varieties have been distributed to farmers through the factory and their designated traders. Through the factories, the project aims to promote sustainable farming practices. However, there appears to be limited willingness of farmers to adopt sustainable practices. The project aims to maintain collaborative work with DARD and the starch factories. However, there is a need for increased involvement of both value-chain actors and the government. For example, the DARD extension centre needs to work with starch factories to aid farmers in extending their harvesting period. The government also has a key role to play in promoting soil conservation practices.

In Dak Lak, as a result of the collaborative work with DARD, the extension service has focused on promoting technology for improving soil fertility. Soil degradation is a problem and the government wants soil conservation measures to be promoted, whereas the factories

want more root supply. The private sector and government do not agree on the delegation of responsibilities. Collaboration with the ethanol factories has led to their involvement in evaluating the various cassava varieties, monitoring and evaluating diseases, testing visible disease-free planting material, and testing legume rotation. Further collaborative work with additional sectors has been considered for the next stage—for example, there is a need to identify opportunities for collaborating with the peanut-processing factories (to encourage peanut as an intercrop with cassava). Additionally there is much scope for the production and distribution of disease-free planting materials. Similar to Son La, the government and value-chain actors need to increase their involvement to achieve these outcomes. Additional challenges in Dak Lak stem from increased competition from the multiple factories. The government has a key role to play in taking adequate measures to curb problems stemming from pests and diseases such as cassava mosaic disease (CMD). It also needs to facilitate better trust between the starch factories and the local farmers, while continuing to support research and technology development.

Questions from the floor

Q. Howard Hall: A lot of the disease discussion has been around CMD. What about cassava witches' broom (CWB) disease in Vietnam?

A. Cù Thi Lê Thuy: In Dak Lak large areas have been affected, mainly through infected planting material. Son La is still fairly clean—red mites and other pests occur but at a low level—as winter helps to reduce pest populations. The Hung Loc Agricultural Research Center in Vietnam is working on CWB disease; early tests say HLS11 is resistant to CWB disease by up to 95%. This new variety has been brought to Dak Lak. There remains much to be done on disease response strategies in Vietnam.

Q. Neng Por: I see that you want to work on extending the harvest period. What is the plan?

A. Cù Thi Lê Thuy: In Dak Lak a major and minor harvest season is possible because of the climate. They also have the advantage of being able to supplement local root supply with roots imported from outside the country. In Son La the factory can currently only operate for 5 months—winter is a big barrier. The factories are therefore very interested in staggered planting regimes to extend this operational period. This would require serious collaboration between factories, extension centres and farmers.

Q. Jonathan Newby: Can you say a little bit about the Vietnam Cassava Association (VICAAS) and the engagement with them?

A. Cù Thi Lê Thuy: This is a young association, established about 7 years ago. They have a good relationship with the government and have some capacity to lobby for legislation. FOCOCEV and the International Center for Tropical Agriculture are members of VICAAS and there is a lot of opportunity to work with them to have a national impact. However, until now, we have not had much success with them. They are interested in CMD and resistant varieties, and they are willing to work with us to cope with disease situations. The leader of VICAAS has just achieved a second mandate, starting last year.

22 Industry and government engagement in Indonesia and Vietnam: panel discussion

Chaired by **Dominic Smith**
University of Queensland, Australia
Nguyen Bach Mai
Dak Lak, Vietnam
Dang Cong Nguyen
Dai Viet Ethanol, Dak Lak, Vietnam
Ngô Quang Tuấn
FOCOCEV, Son La
Trisno
Bumi Sari agent, North Sumatra
Syaiful Bahri Panjaitan
Wilmar Chemical
Sutikno
Farmer and trader with Bumi Sari, North Sumatra

Q. Dominic Smith: Mr Tuan, in Vietnam we know you are very interested in extending the harvest season. How will you work through your network to achieve this in Son La?

A. Ngô Quang Tuấn: Thank you Dominic. Our factory is currently sitting idle for 7 months of the year, so this is a serious issue for us. May and June form the rainy season in Son La, and road transport is very difficult. Government investment in infrastructure would be very helpful. In the meantime, better coordination and a staggered harvest with the different regions of Son La can help to space out our operations. We can only do so much with our trader network; we need government coordination. We need support from researchers to get suitable varieties for the different zones.

Q. Dominic Smith: In Dak Lak there is much potential for a bridge between research and smallholders. What is Mr Nguyen's vision for becoming a link between research (including on factory land) and smallholders?

A. Dang Cong Nguyen: To encourage farmers to plant cassava, the first thing we have to do is work on improving yields and profits. To achieve that, we need broad involvement from farmers, research, government and the private sector. We produce ethanol, and we need the government to promote and encourage the use of E5 fuel. This will increase demand beyond what the current six factories supply. Ethanol processing should be incentivised by the government, allowing us to give farmers higher root prices and compete with starch factories. In Vietnam, the cassava mosaic disease (CMD) issue is very worrying. The government needs to

do something to control the movement of infected materials. We also need resistant varieties. The most important issue is raising awareness and training for farmers to improve their knowledge about CMD. The formation of an institute to improve disease-free planting material production with a reasonable price would be important (perhaps a model similar to the Thai Tapioca Development Institute). Finally, mechanisation could reduce production costs and increase efficiency.

Q. Dominic Smith: Mai, Dak Lak factory investment has increased until about 11 factories are currently in operation. What is the difference between when you started—when there were only two factories in the entire region?

A. Nguyen Bach Mai: Currently there are nine processing factories in Dak Lak, versus only two 20 years ago. In the old days, factories made production contracts with farmers, at very low prices. Since then, new factories have spurred competition. This has resulted in choice for farmers and favourable prices. However, this has made things increasingly difficult for factories. Before, there was no need for traders, collectors or agents, but now selling directly to factories is difficult because the logistics require the factories to work with traders. The factory role has now expanded to include introduction of technologies and varieties for farmers. This has also resulted in economies of scale in the trading business—it is easier for factories to deal with two or three large traders than dozens of small ones. Competition between factories is currently quite strong, resulting in the development of many models for buying roots. Often the high price for roots is only visible to the traders; the farmers cannot see the real price. Traders and factories each have their own policy as far as this obfuscation is concerned.

Q. Dominic Smith: Pak Trisno and Pak Sutikno—what is the role of agents and traders in linking farmers to markets in North Sumatra?

A. Sutikno: The main role of agents is to make sure that the quality of the roots arriving at the factory meets the required standards. This includes monitoring varieties and harvest timing. Traders must buy not only from their area, but also from the surrounding area. They also own a tractor that they can rent out for soil preparation, facilitating cultivation. They manage harvesting (labour) costs as well as transport to the factory (logistics). In addition, they are farmers themselves supplying Bumi Sari, so they feel responsible for educating farmers in their catchment about what they know about sustainable cultivation, including the proper use of fertilisers.

A. Trisno: I am both a farmer and an agent. As an agent I am responsible for linking the farmers to Bumi Sari factory, but I feel responsibility on the farmer side. Good prices from the factory are required to incentivise farmers to continue planting and investing in increasing yields. As an agent, I am also an intermediary in issues farmers have with the factory—a sort of de facto arbitrator.

Q. Dominic Smith: Again regarding traders, what is the role of the agents in access to fertiliser and other inputs?

A. Sutikno: For access to fertiliser, the Bumi Sari Company provides me with a loan. I will manage this loan to allow farmers access to fertilisers when necessary. It is a big responsibility for me to ensure that my farmers will get a good yield, but on the other side of the coin, I need to ensure that they are also rewarded with a good price. This puts me in a situation where I also feel

responsible for searching for and acquiring the needed fertiliser. The success or failure of the farmers in my catchment is my responsibility.

Q. Dominic Smith: Again on this topic—what are the major blockages to access for fertilisers in your area?

A. Syaiful Bahri Panjaitan: Farmers are willing to invest in fertilisers. However, farmers are not confident in the legitimacy of nonsubsidy fertilisers. They fear counterfeits or low-quality products. This is restricting the use of products beyond the subsidised 15-15-15. This is an opportunity for us to help guide and educate them about the proper balance of nitrogen-phosphorus-potassium for cassava fertilisers. Soil and leaf sample analysis, paired with knowledge of nutrient uptake and export, can help us customise fertiliser recommendations for cassava production areas.

A. Trisno: During the past 3 years working with the Indonesian Legumes and Tuber Crops Research Institute, variety and fertiliser recommendations have begun to improve cassava production. In my area, I want to increase the adoption of these practices to meet the demands of both the factory and the farmers.

Q. Somsay Didouangdeth: In Laos traders and agents also have a complicated relationship. How can we manage these relationships more effectively to reduce competition and increase benefits all around?

A. Sutikno: Trading competition can never be avoided. In Sumatra, Bumi Sari has 10 agents. These 10 agents have divided up the area to avoid mixed messages and competition. This can work well with good, consistent communication. Price transparency is also very important. PT Bumi Sari is always very clear on price tables and ensures that all agents receive the same information. Communication between agents also allows farmers contacting traders to be connected to the agent from the appropriate area, which increases efficiency.

A. Turisno: Apart from what my colleague has already said, I just want to stress the importance of the relationship between the farmers and the agents. In cases in which farmers have loans that are difficult to repay, a good agent should also work on helping to settle these matters.

Q. Rod Lefroy: How do you manage the issue of root quality? When traders are doing the payment and collection, and measurement of starch quality is only occurring at the factory level, how is quality determined and rewarded by the trader or agent beforehand?

A. Nguyen Bach Mai: In Vietnam, all the factories buying fresh roots check the starch content. About 10 years ago, farmers would bring roots to the factory, check the quality and then sell. Now, farmers in Dak Lak very rarely go to the factory; this is now done by traders. The trader plays the role of extensionist, banker and trader—it is a complex mix. Traders in Dak Lak know the local varieties well and the general starch content at maturity. They can make reliable estimates with the knowledge that factories pay less for low starch content, but do not pay more for higher content above the ceiling (30%). The traders calculate starch content on the fly, making adjustments based on information they learn about weather, varieties, quality of past truckloads and so on. Traders are very smart!

A. Ngô Quang Tuấn: In Son La, we have tried for a few years to buy roots based on starch content. Farmer awareness about the need for high starch content has increased through this interaction. To control the starch content, we have our

own department measuring and checking, but at the same time we promote varieties with high and stable starch profiles. Varietal distribution to our farmer network is a key tool for us to control our starch content.

Q. Jonathan Newby: Mr Tuan, you have been very involved and supportive of the project. At the FOCOCEV level, what is the willingness to work with researchers to improve technologies? Second question is regarding extending the harvest season—would you consider price adjustments and incentives or premiums to allow farmers to make these changes more acceptable to them?

A. Ngô Quang Tuấn: First question—we have 14 factories in FOCOCEV and we have a consistent strategy to work with government and researchers to support our entire portfolio. We are willing and invested in working with agencies like the International Center for Tropical Agriculture and the Northern Mountainous Agriculture and Forestry Science Institute to achieve our goals. Second question—we have been already experimenting with edge-season subsidies for transportation costs and so on to try to stimulate this. If we can collaborate somehow to extend this to the true off-season, we are willing to pay premium prices to make this possible.

Q. Neng Por: My question is for the Indonesians—concerning the role of the traders in loan management—what are the major challenges with this system? On a related note, how do you see the role of financial institutions in this type of scheme?

A. Sutikhno: Through the agent, all roots sold to Bumi Sari will be paid for within 21 days—not immediately. This is an additional challenge. There are also now some small tapioca companies in adjacent districts buying directly from farmers and creating some competition. I took a loan from the bank to increase available capital. There is much room for increased involvement from the financial sector in this aspect.

23 Industry and government engagement in Cambodia

Chea Sareth
Cambodian Agricultural Research and Development Institute
Jonathan Newby
International Center for Tropical Agriculture, Laos
Dominic Smith
University of Queensland, Australia

There are significant challenges in the cassava sector as a result of weak connections between the different actors. The constraints exist at all stages of the value chain, including farmers and collectors, traders and factories, loan providers, and root buyers. Cassava farmers demand the government intervenes in the market and set a price floor, because farmers believe they are being taken advantage of by the traders who they regard as the price setters. As a result, there is significant mistrust and conflict between farmers and the traders.

Farmers are generally reluctant to change methods of production. For example, they reject weather recommendations from the government and plant in the same season as usual regardless of forecasts. However, they are willing to change crops if higher profit margins can be assured. After seeing demonstration plots, some farmers have adopted recommended practices, although such cases are quite rare.

The eastern provinces of Cambodia are dominated by cross-border trade with Vietnam. While both fresh roots and dried chips were produced in this region, the high prices for feed stock have resulted in fresh roots being shipped to Vietnamese factories, particularly in Tay Ninh. The local SINGSONG factory in Kratie has faced stiff competition from Vietnamese buyers from Tay Ninh. The factory uses independent traders to reach farmers but the higher capacity of their Vietnamese counterparts has convinced the local factory that they are unable to capture adequate benefits, which has further discouraged any cooperation with the project personnel or farmers.

Factories in Kampong Cham have reported similar experiences. The factory personnel seemed to be unaware of the issues prevalent on the fields, such as the ongoing cassava mosaic disease infestations. Unfortunately, they also did not seem to be interested in engaging further with the farmers to understand such issues. However, the dynamics may be changing as a result of a new cassava-processing factory being constructed by Green Leader (Cambodia) Co Ltd, part of a Hong Kong–based conglomerate, which is investing US$20 million in Kratie. The factory is expected to greatly increase processing capacity in the region.

Based on the assessment of the different actors along the value chain, traders play a key role that provides a unique opportunity for them to be involved in increasing overall cassava yields. The existing

structure is quite efficient at moving new varieties adopted in Vietnam into Cambodia. There is also enough evidence showing increased yield resulting from clean elite varieties of cassava and applying appropriate fertilisers. At present, the traders have limited knowledge about cassava production, although many of them are also involved in trading stems. Traders are also found to take the role of extension agents in remote areas, which indicates that there is potential for engaging them for running demonstrations. Although traders may be an important node for information dissemination, they would require proper education and training to carry out this role effectively.

New models for farming, including contract farming, are being explored. Although contracts between factories and individual farmers may be prohibitively costly, there may be scope for such contracts to be drawn up between farmers and agents. Additionally, there is scope for strengthening linkages with other input providers, such as fertiliser and credit providers, although cooperation remains challenging.

Engagement with the Provincial Department of Agriculture, Fisheries and Forestry (PDAFF) varies, largely based on resources, projects and personalities. There is potential for working with other projects linked to the PDAFF, such as the Accelerating Inclusive Markets for Smallholders project and Agriculture Services Programme for Innovation, Resilience and Extension.

Questions from the floor

Q. Kyaw Thura: When you talk about bundles of stems, how many stems are in one bundle (costing US$1–3 in the presentation)?

A. Sophearith Sok: There are 15–20 long stems per bundle.

24 The Cambodia Agricultural Value Chain Program's approaches to cassava work in Cambodia

Neng Por
Cambodia Agricultural Value Chain

The Cambodia Agricultural Value Chain Program (CAVAC) is a development program funded by the Australian Government Department of Foreign Affairs and Trade. The first phase of CAVAC took place between 2010 and 2015, and the second (current) phase is between 2016 and 2021. The program's key objective is to achieve sustainable economic development and reduce poverty. With that in mind, phase II of CAVAC is aiming to increase the productivity and incomes of small farmers and traders in milled rice and other crops by strengthening market systems and investing in irrigation infrastructure.

Of the three key components under the program, work related to the first component—Diversification and Productivity—has focused on scaling-up rice value-chain activities from the previous phase while supporting diversification and productivity of other nonrice crops, including cassava. The second component, Irrigation Development and Operation and Management, has involved expanding the irrigation infrastructure and irrigation management activities initiated in phase I. This has also included community-based water management schemes. The third component, Rice Milling and Export, has been working to introduce new rice varieties geared for export and develop a rice seed market.

CAVAC's priorities specific to cassava include increasing the productivity of cassava by informing about proper input use and quality planting materials. CAVAC has promoted mechanisation (which is of high priority given the scarcity of labour resulting from labour migration) and improved market conditions by involving post-harvest actors (by linking service providers, including private-sector outreach to farmers). CAVAC has also made recommendations to the government regarding favourable policies for cassava production.

The work with input companies, particularly fertiliser companies, has been successful where the focus has shifted from sales towards increasing effectiveness. Bringing together the actors is extremely valuable in understanding the issues and needs of the different sides. Such collaborations are essential in realising yield increases of up to 50%, to 45–60 t/ha, achieved in field demonstrations. Although the direct focus is on improving cassava productivity, there are cross-cutting goals related to improving the environment and achieving gender equality.

The early results of the work with cassava actors have shown some promise where fertiliser company

field staff have improved knowledge of the cassava cropping system and are able to adequately inform farmers. Fertiliser sales have increased, but there is a need for sustained growth where the companies will be required to invest further in activities without co-investment from CAVAC. On the other hand, farmers also have better knowledge of appropriate cassava management practices and have been observed to alter their farming practices by adopting recommended fertiliser applications. Farmers are interested in continuing to invest in the required inputs to realise the higher yields.

Questions from the floor

Q. U Thant Lwin Oo: You have shown large changes in yield with fertiliser use. Does this mean that the farmers were previously using zero fertiliser? Second question—how does the government support fertiliser access for farmers?

A. Neng Por: Our baseline assessment indicated drastic gaps in knowledge about fertiliser application. Use of fertiliser was also very low; after deforestation in particular, yields were very high. Rice farmers' experience is usually limited to use of urea or 15-15-15. There is currently not much government support, unless a new project is emerging. The Ministry of Commerce is supporting the cassava sector and farmers through a project called Accelerating Inclusive Markets for Smallholders. Different from the Indonesian context, the government's extension programs mostly take the form of information services rather than subsidies, and are underfunded. They are provided by the Ministry of Agriculture, Forestry and Fisheries.

Q. Yudi Widodo: This is also a problem with Bumi Sari. Please work on it.

A. Neng Por: Our project is restricted to Cambodia, so at the moment we cannot work in North Sumatra. Let's get a new project!

25 Developing partnerships with public and private sectors for scaling cassava production technologies in Lao PDR

Chanphasouk Tanthaphone
National Agricultural and Forestry Research Institute, Laos
Laothao Youabee
International Center for Tropical Agriculture, Laos
Jonathan Newby
International Center for Tropical Agriculture, Laos

The structure of cassava value chains is dynamic and varies between sites. For example, there is a monopsony in Paklai with a single Chinese factory. In Kenethao, there are multiple product destinations including the starch factory in Paklai and other Thai companies.

The project's work so far has involved building on partnerships with relevant stakeholders through field days organised with farmers, government officials and relevant value-chain partners. Farmer focus groups have been organised to discuss agronomic and economic results. Additionally, district-level stakeholder meetings have been held with village leaders, district and provincial agricultural staff, the private sector and the finance sector. The project has also established partnerships with the fertiliser importing company and participated in dialogues at the national level.

Training programs about cassava management have been held, and participants included government officials, farmers, and personnel from a starch factory and a dry chip company. Extension posters and leaflets were developed and distributed to the relevant groups, and a training manual was developed. Field demonstrations and trials involving fertilisers, cassava varieties and intercropping have also been expanded over the years. In terms of the preferred variety, Rayong 11 in particular has stood out from the rest and has been distributed to 11 target villages. Planted area expansion is creating stem demand in Laos.

However, with increasing demand for stems (the going price is 3 million kip [US$340] per hectare planted) and increased distribution, there is a risk of spreading cassava witches' broom disease around the country and also the potential for importing cassava mosaic disease. As such, there is a lot of scope for developing a source of clean planting material, and a new ACIAR project is being planned to address this issue.

There is need for public–private funding models to further support research and extension programs. It is critical to develop models for breeding and selection, clean seed production, and pest and disease monitoring. A monopsony such as the one in Paklai may be incentivised to invest, but multiple competing firms are not because the incentive structure becomes very much

distorted. Current work involves developing business models and funding models in target districts and value chains. Several activities are necessary to operate at a national scale to maintain Lao's cassava-sector productivity without depending solely on temporary development projects.

26 Moving up or moving out: livelihood trajectories and farmers' decision-making about growing cassava in northern Lao PDR

Soytavanh Mienmany
Australian National University, Australia

In South-East Asia the adoption of cassava by farmers has been motivated by various factors. It was dominated by colonial trade starting in the middle of the previous century and, increasingly, supported by the demand for livestock feed from Europe. However, the more recent booms have been propelled by demand within East Asia, with Chinese demand dominating. As part of China's 'Going Out Strategy', Laos has seen significant levels of Chinese investment to meet China's growing demand for cassava. As a result, cassava is the third most widely grown crop in Laos after rice and corn. It was initially grown for human consumption and animal feed, but now it is mainly grown for the export market. Global influences that result in boom crops have significant impacts on rural farming systems and hence the livelihoods of farmers. It is thus important to assess how changes are manifested in rural areas as a result of boom crops and, more importantly, how policy can be tailored to ensure welfare of rural livelihoods.

My key research questions are:

- How do processes of rural change manifest in the case of boom crops in Laos?
- Why and how do certain crops become boom crops in Laos?
- What do the answers to these two questions suggest as better policies for improving the sustainable livelihoods of farmers?

As part of the study, five villages were selected in which to conduct focus group discussions and in-depth interviews. Based on the initial findings, both external and internal factors were observed to influence farmer's decisions in response to boom crops. External factors included market forces such as the establishment of a Chinese starch factory in Paklai district and market networks at the Lao–Thai border providing financial incentives in favour of adopting cassava. Government policies favouring cassava production were also responsible for influencing some of these decisions. On the other hand, internal factors related to household socioeconomic and demographic characteristics, as well as farmer desires and perspectives, had significant influences on household responses.

Although evolution of cropping systems across the study villages were unique, the popularity of cassava seemed to follow the rise and fall of maize. Furthermore, shifts in Lao national policy, penetration of infrastructure and international markets were also key contributors

towards these changes. Within the villages, the decision to move up or move out of cassava was based on the level of dependence farmers had on cassava as well as the socioeconomic condition of the farmer. In northern Laos, the better-off and medium-wealth households seem to be benefiting from the cassava boom. The medium and the poorer households are 'hanging on' to the cycle of boom and bust, while others are 'dropping out'.

More recently, policies at the national level are having major impacts on the decisions related to cassava adoption and retention. The Lao Government Ministry of Agriculture and Forestry (MAF) is not promoting use of chemical fertilisers; rather, investments related to new cash crops mandate compliance with a new MAF policy of 'clean agriculture', defined as low-cost production, chemical free, stable and sustainable. The clean agriculture policy has led to the arrival of banana plantations, which has the potential to be the next boom crop. Furthermore, decreases in cassava yield have increased demand for fertilisers. However, there is a knowledge gap regarding application of appropriate fertilisers in cassava production, as well as access issues. As such, there is scope for developing meaningful partnerships between the government and the relevant private-sector actors along the value chain to ensure further growth of the cassava sector in Laos.

Questions from the floor

Q. Stephanie Montgomery: Congratulations on the hard work. How long did it take you to do those farmer interviews immersed in the household? Would it have been possible to get the same information from another approach?

A. Soytavanh Mienmany: The interviews were approximately one hour, but I would then return to the home several times. I was also staying in the household I was assigned to by the village chief. This was important to build trust and relationships. It was also a very good experience and a nice memory.

Q. U Thant Lwin Oo: What are the major constraints of cassava production in Laos and the role of cassava in the country? Question 2—what type of policies are there and is the private sector involved? Third question—how long does it take farmers to adopt technology?

A. Soytavanh Mienmany: Adoption is based on price and introduction by the private sector, but technology is influenced by many things. Sometimes it is driven only by projects and falls apart afterwards.

27 Industry and government engagement in Lao PDR and Cambodia: panel discussion

Chaired by **Jonathan Newby**
International Center for Tropical Agriculture, Laos

Somsay Didouangdeth, owner, DDD Chip Factory, Bolikhamxai, Laos

Q: Mr Somsay, what problems have you faced in securing enough feedstock for your factory, and have you heard anything in the meeting this week about how farmers are linking to markets that you would like to try in your situation?

A. Somsay Didouangdeth: The first thing we have to do is make sure we are aligned with the government policies and strategies. Then we need to develop even closer relationships with farmers—support them in cultivation techniques and with access to fertiliser. One important idea is to work on ways to increase 'contracts' and avoiding side dealing. Adherence is important to build trust. Second is to work with farmers on cultivation methods—irrigation and fertiliser use are important. The Indonesian field site had sufficient soil moisture and this is important.

Q: We have heard about issues with delays in payment from factories to farmers. How long is your typical delay, and are you interested in financial instruments or products to ameliorate this situation?

A. Somsay Didouangdeth: For the payment, there are two types: (a) contract farmers (so-called '2 + 3', which means farmers provide land and labour and we provide technology, finance, and markets, including support to the cassava farmers for certain operations—for example, ploughing, fertilisers, root transport); in this case the arrangement is slightly different; (b) for those who arrive as 'spot customers' during normal work hours, payment is immediate.

Khambor Sypaseuth, KP Fertiliser, Laos

Q: What is the KP Fertiliser model and can you introduce a little about yourself and your business?

A. Khambor Sypaseuth: KP has been in business since 1995. Our main businesses are in inputs, fertilisers and agricultural machinery. We are distributors for Kubota tractors in Laos. We import fertilisers from Thailand and market them in Laos. I have learned at this meeting that fertiliser rates across the symposium countries are still quite low. Despite being essentially importers and distributors, we do still have a budget for demonstrations to increase use and adoption. We plan to go on cooperating with government and starch businesses to set up dealership areas for fertilisers.

Leang Seng, Provincial Department of Agriculture, Forestry and Fisheries, Stung Treng, Cambodia

Q: Mr Seng, you have been involved in many projects over the years. What are some examples of projects that have had lasting impact beyond the project implementation period and what are some lessons from these experiences?

A. Leang Seng: Good afternoon, I have been working with the Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) in Cambodia in Kratie since 2004, before moving to Stung Treng. I have worked together with several of you in this room on International Center for Tropical Agriculture and ACIAR projects. In Stung Treng, we have recently been collaborating with the Accelerating Inclusive Markets for Smallholders (AIMS) project and the Agriculture Services Programme for Innovation, Resilience and Extension, both of which intervene in cassava value chains. My experience is not limited to cassava, as we have projects working in rice, livestock, cashew and so on. Among all crops I am working on, cassava probably has the biggest potential. The area continues to grow fast, the processing sector is developing quickly and it is quite dynamic. However, phytosanitary issues are now rapidly emerging, including cassava mosaic disease and cassava witches' broom disease. Past experiences I consider successful include raising awareness and sharing knowledge about cashew and livestock, which have significantly improved household incomes for farmers. Another crop includes the maize value chain in Kratie, where linking demand and supply for appropriate seeds, products and markets was successful.

Q: Do you think in Stung Treng at the moment there are other value-chain actors which the project should be engaging with, but isn't?

A. Leang Seng: There should be more collaboration between ACIAR and PDAFF, especially in Stung Treng. AIMS is a possible target project that is currently ongoing.

Neng Por, coordinator, Cambodia Agricultural Value Chain Program, Cambodia

Q: Are there other sources of information from previous work available and in a usable form for the Cambodia Agricultural Value Chain Program (CAVAC), or are you left starting from zero with most of your data gathering and analysis?

A. Neng Por: As in other South-East Asian developing country contexts, access to quality data can be challenging. We used scientific journals and government data sources (including the National Bureau of Statistics) at the onset of our work. However, often these data are outdated or unreliable. For example, with the data from the Ministry of Agriculture, Forestry and Fisheries on cassava production, it is obvious that the production calculations are estimates that do not match export records. For CAVAC, when less than reliable data are available, we explore other angles such as exploiting social media or internationally reported figures. We use analytical approaches to fill gaps.

Q. Rod Lefroy: Neng, you talked a lot about the impact of fertilisers. I was wondering about the uptake of improved approaches to fertiliser by farmers. In addition, what about uptake of other practices such as agronomic practices or soil erosion control?

A. Neng Por: We focus first on knowledge change, then understanding the attitude change that leads to behavioural change. There are very different characteristics in upland and lowland farmers. For example, cassava farms in the uplands are usually far from home, whereas lowland rice farms are typically close to the house. Field trials and demonstrations with partners have led to different adoption rates for different practices. We learned that, for village-based training, we often did not get active farmers, since they are always out in the field working instead of attending demonstrations. So we have to adjust. For adoption of practices, we are able to learn a lot and adjust our models so farmers are exposed to interventions. For example, a Thai company suggested that farmers do the same thing as Thai farmers, but the application rate was simply too high for farmers to adopt. So in this case it is up to our partner companies to adjust their recommendations based on reality. We also have environmental and gender checklists. There are additional considerations in places such as north Cambodia, a postwar zone with much unexploded ordnance. There is a lot of work to be done in understanding who has the decision power—for example, the tractor driver has the power to decide whether to go across or with the slope.

Questions from the floor

Q. Imran Malik: Mr Khambor, you have mentioned that you have a budget for demonstrations. I would like to know how you decide what treatments to try?

A. Khambor Sypaseuth: We are an importing and distribution company, so we are limited to existing formulas. We engage in soil testing and work with factories to come up with recommended recipes for trial, but are constrained by availability.

A. Chanphasouk Tanthaphone: To add to this, we work with KP for demonstrations in farmers' fields, so that we can help to make the best choices for products to test in a particular environment.

Q. Howard Hall: Mr Seng, you mentioned previous successful projects you have engaged with in Cambodia. Could you please explain more about the project and what led to its success?

A. Leang Seng: The cashew project had relationships with climate change adaptation programming, since it is adaptable and minimally dependent on rainfall. After the end of the project (2012–17), I have seen farmers who gained agronomic knowledge (pest control, disease control, cashew management) achieve very high yields and good income. The value chain between farmers and downstream actors was well defined and is feeding a growing market. Building trust was important at the beginning, and conflicts between traders, farmers and factories were minimised.

28 Industry and government engagement in Myanmar

Tin Maung Aye
Myanmar
Kyaw Thura
Cassava Growers, Millers and Traders Association, Myanmar

Myanmar remains a country heavily dependent on agriculture, which accounts for 23% of gross domestic product and employs 60% of the labour force. Cassava is primarily grown by smallholders, and the majority of farmers own less than 10 acres of land in the Ayeyarwady region. The major use of cassava is for starch processing, with factories concentrated in the Ayeyarwady region. There are, however, a few very large farms of more than 10,000 acres that are run by a starch company in Kachin state. Rice is a priority crop in Myanmar for both national food security and export markets. Cassava, although ranking third in overall agricultural production after rice and pulses, is still considered of low priority by the central government. The total area of cassava also appears to be underreported since most of the cassava growers are small farmers.

Cassava processing in Myanmar began with Daike Company's monosodium glutamate production in the 1980s. There are now several types of starch-processing factories that vary by size and technology, and most of them are in the Ayeyarwady region. For example, Yuzana Starch Factory has a large capacity and caters to the Chinese market. It has a 100,000 ha land concession and uses modern technologies, including a wastewater treatment plant. Tint Agriculture near Yangon plans to process starch and cassava flour. However, most of the more than 200 cassava processors are much smaller in size with a capacity of between 1 and 7 t of starch per day (averaging 2 t/day), employing between 10 and 30 workers. A total of 134 are registered processors that are part of the Cassava Growers, Millers and Traders Association (CGMTA) that was formed in 2015. The factories generally lack basic facilities such as access to electricity, and use diesel, rice husks or gas as a power source, and depend on deep wells or tube wells for water. While all factories own their own cassava fields, they also buy roots from growers in their neighbourhood directly or through agents. There are many activities that involve manual work and the factories are equipped with outdated technologies. Additionally, factories release wastewater into neighbouring lands or directly into streams, which has a significant negative impact on the environment.

Generally, the cassava industry is underdeveloped and lacks adequate investment, as the government does not consider it to be a high-priority sector by the government compared with other sectors such as rice or mining. Development of the cassava sector, however, provides much promise by contributing to farm incomes and rural livelihoods.

In addition, it could greatly increase national income through export earnings. The dominance of smallholders and microlevel processors means it is capable of providing many job opportunities, especially for rural women. Furthermore, improved oversight of the sector can avoid the significant damage to the environment that is currently happening.

Greater opportunities in the sector also stem from increasing domestic demand resulting from food industries and other related businesses in Myanmar that are consuming more cassava and its products. Export demand for cassava products to neighbouring countries such as China and Thailand are expected to increase considerably. Additionally, improvements in cassava management across many of the neighbouring countries ensure significant increases in cassava yield through the adoption of improved varieties, appropriate fertiliser use and careful management practices that minimise the spread of pests and diseases. Improved agronomic practices result in greater levels of root production and a more continuous supply, with potentially stable prices. This is important because very high root prices can reduce competitiveness and can hinder investors in the processing industry. Adopting these agronomic practices could make Myanmar's cassava industry more competitive and improve its ability to access international markets.

Although cassava growers have formed partnerships, these initiatives have been exclusively from the private sector. There are also discussions to form a national-level association for exporting the product. To formulate strategies at the national level, the government must increase its invovlement. There is dire need for increased investments in multiple areas that are both directly and indirectly linked to the cassava sector. Some of these include:

- improvements in infrastructure and services
- improvements in property rights and credit services
- improvements in marketing research and expertise
- investments in better processing technology
- better research and extension services
- better facilitation of private and public partnerships
- empowerment of farmers and processors in production and business management skills
- additional support for sustainable and profitable cassava production towards environmentally friendly products from the cassava industry.

Questions from the floor

Q. Khambor Sypaseuth: I see the CGMTA has been around since 2015. My question is who are the board members and are they elected? If so by whom? Who is involved?

A. Kyaw Thura: We are a private association; however, we are organised under the Ministry of Commerce. The members are invited by the ministry and elected by vote. We are therefore private-sector members, but recognised under the Ministry of Commerce.

Q. Nguyen Bach Mai: The factory equipment and processes are quite old and pollute a lot. However, in your presentation you have not addressed this. How is this dealt with?

A. Tin Maung Aye: This is a big risk for the environment because small factories pollute a lot. We need good regulations, good government and a responsible business sector. It is like Vietnam or Cambodia was 15 years ago.

A. Kyaw Thura: It is a concern for us as well. Last year, the Ayeyerwady Minister of Environment also enquired about the pollution. Officially, the government does not allow wastewater into the rivers. However, 90% of the processors release wastewater into rice paddies, and others make a waste pond. Our processing season is only for 4 months during the rainy season. Banana farmers also collect and use the waste as a biofertiliser. Only 10% of processors release wastewater into the river.

29 Increasing the role of value-chain actors for cassava development in East Nusa Tenggara, Indonesia

Suhartini
University of Brawijaya, Indonesia
Wani Hadi Utomo
University of Brawijaya, Indonesia

Introduction

Cassava is a root crop commonly used as a food and as a source of starch for other industries. Cassava is commonly also used as animal feed in fresh and dry form as cassava chips. Indonesia is the third-largest cassava producer in the world but also a large importer of starch. A major problem is the high cost of transportation, considering Indonesia is a large archipelago of 16,056 islands.

Indonesia is a tropical country with regional differences in land condition and climate. In the west (e.g. North Sumatra), the climate is equatorial with higher rainfall. In the east (e.g. East Nusa Tenggara, ENT), the climate is monsoonal with wet and dry seasons. ENT has a drier climate compared with western Indonesia, with only about 4 months of rain. Drylands dominate ENT, and the main food crops are corn, cassava and beans. Most farmers grow cassava for food and livestock feed, with a small portion being sold to the market.

The research project in ENT has been conducting agronomic trials and disseminating technology to farmers to increase farmers' productivity and income. The objective of this study was to analyse the role of cassava as a subsistence and commercial crop, and how to increase the role of value-chain actors in cassava development on the island of Flores in eastern Indonesia.

Methods and design

The study was conducted in Sikka Regency, Flores, ENT, because it represents areas where cassava is a major staple food. Data sources included:

- a value-chain survey in 2016, interviewing groups of farmers in three villages, as well as traders and small-scale processors
- a household survey in 2017, interviewing 114 cassava farmers selected by simple random sampling
- a workshop in March 2019 on policy and business model development in ENT with stakeholders, including researchers from the University of Brawijaya and the Indonesian Legumes and Tuber Crops Research Institute; the Bupati of Sikka Regency; the regional agricultural agency from Sikka and other districts in Flores; and farmers, traders and scientists from several universities in ENT.

Results

Cassava is one of the main crops in Sikka. The average farm size in Sikka Regency is 0.9 ha. At higher elevations, cassava is cultivated within an agroforestry cropping pattern. At lower elevations, cassava is intercropped with maize and beans. The average yield is 10 t/ha. Farmers cultivate cassava for subsistence consumption, to sell as a food crop and for livestock feed (Figure 29.1). Cassava is mainly used as food, whether consumed by the farming household or traded in local markets. Cassava use is:

- 30% for home consumption, including food (25%), livestock feed (4%) and dried cassava (1%)
- 20% sold directly to local markets
- 50% sold to traders.

Farmers sell cassava gradually in small quantities (about 10–20 bundles, 1 bundle = 5–10 kg). There is no starch factory in Sikka Regency.

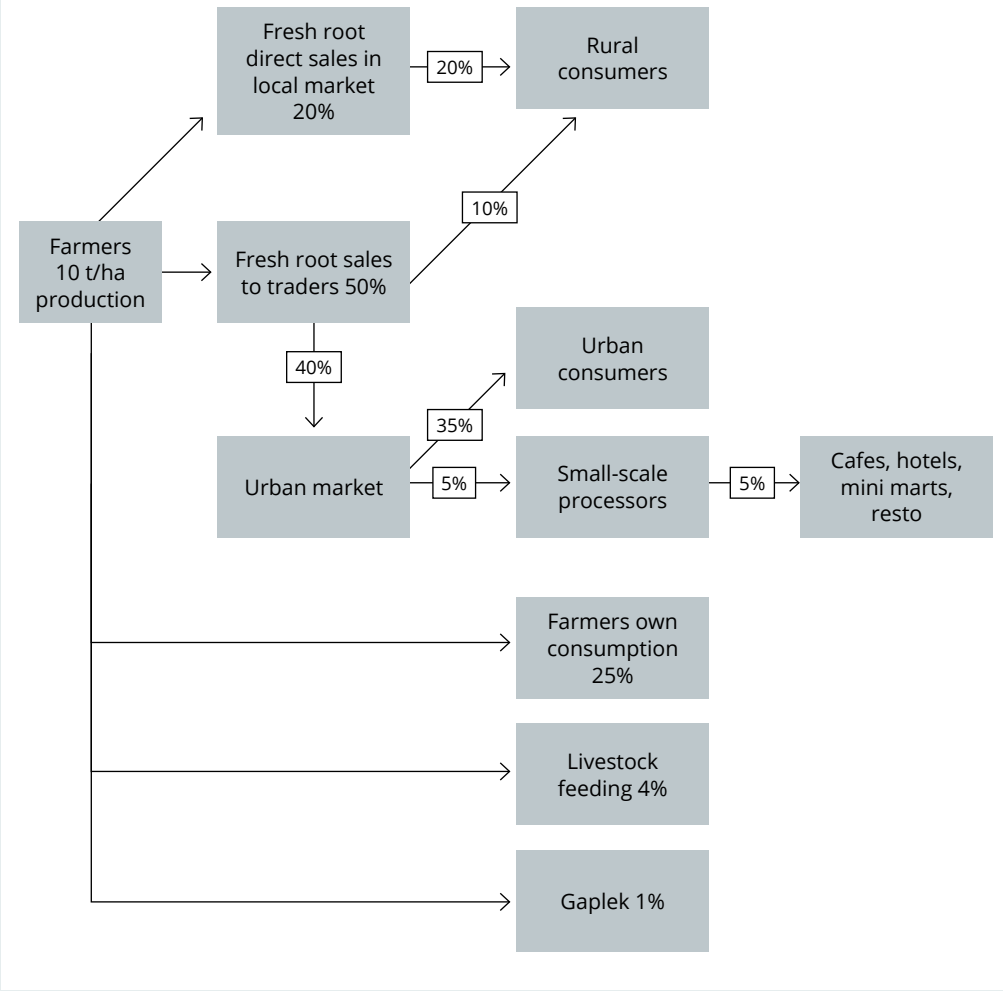


Figure 29.1 Cassava value-chain mapping in Sikka Regency, East Nusa Tenggara

In 2019, 21 farmers from Sikka and East Flores districts participated in the project by adopting the improved technology the project demonstrated (new varieties and improved cropping system). Because maize is the main food for people in ENT, all farmers planted cassava in between their maize crops. The project helped with maize seed and cassava stakes, fertilisers and supervision (in cooperation with the field extension officers).

The workshop 'Cassava Development in Nusa Tenggara Timur' was conducted on 14–15 March 2019 at Maumere, Sikka. The workshop was attended by 40 participants, including government officials (from the District Agricultural Service), researchers form universities and research institutes, extension services, a cassava trader and farmers. The workshop aimed to collect information from various cassava stakeholders for developing cassava in ENT. The workshop was opened by the Bupati of Sikka Regency, with speakers from the ENT Balai Pengkajian Teknologi Pertanian, the University of Brawijaya and a trader. On the following day, the participants visited fertiliser experiments and some adopters' fields.

The key opportunities identified through the stakeholder consultation process and the roles of each actor were:

- the regional government will support cassava development in ENT
- the private sector has the role of buying cassava roots from farmers and processing them into chips as raw material for animal feed
- officials such as field extension workers will assist farmers
- the local government will provide land for planting cassava
- the universities and research institutes will provide research and technological development that will help farmers.

Indentifed barriers were the limitation of water and farmers' capital, and the lack of a feed factory in ENT.

Discussion and conclusion

It is exceptionally challenging to move from a consumption-based production system to one oriented to industrial processing. Fresh cassava roots sell for about US75 cents per kilogram in the local food market, but only US10 cents per kilogram as *gaplek* for animal feed. Moreover, harvesting is intermittent. To develop a processing industry, government support may be needed to ensure sufficient supply to make the industry profitable. The regional government has indicated its support for cassava development in ENT. Work needs to continue on developing business cases and expanding to other districts in Flores to increase sustainability of the value chain.

30 Industry and government engagement in Myanmar and Flores: panel discussion

Chaired by **Rob Cramb**
University of Queensland, Australia

Tommy Jare, Kyaw Thura and Fiator Nong

Q: We know you have been exploring investment in the cassava industry in Sikka and more widely in Flores. This includes the possibility of starch and animal feed factories. Can you please explain some of your experiences and the major constraints to this investment?

A. Tommy Jare: I am a businessperson who actually got into agriculture as a hobby. The opportunities for cassava in ENT showed promise for export. I started running a cassava starch and chips operation (2015–17) but faced a lack of support from the local government. The district head was not focused on agriculture, which exacerbated the lack of raw materials the factory was experiencing. However, with the International Center for Tropical Agriculture (CIAT) – Indonesian Legumes and Tuber Crops Research Institute (ILETRI) project I have become inspired to reopen the factory and address new markets like animal feed. The new Bupati of Sikka (since 2018) is more supportive and interested in investing in developing the processing end of the value chain. I have also explored connections with new areas in East Flores, and they are interested to encourage farmers to plant cassava. There is about 70 ha so far. Dry chips for animal feed is the most likely activity to resume, but the wet weather during the harvest season challenges sun-drying for the chips, threatening quality. A serious constraint in ENT is the high interest on bank loans—12–13%.

Q: In your position as a farmer, processor, contractor and board member of the cassava association, you have a good overview and have been consulting with prospective outside investors. Can you explain your experiences, the challenges businesspeople face and the outlook for investors?

A. Kyaw Thura: There are two major types of investors: those who want to invest in cassava business in Myanmar and those who want to buy Myanmar's cassava products for various applications. Electricity has been a major constraint to running a sizeable factory outside Yangon. Myanmar's government has been subsidising electricity, and losing money on this has not encouraged them to pursue large electricity-consuming industrial businesses. Investment in the electricity sector remains seriously lacking, despite imminent changes to the subsidy system. An even more important factor in agricultural investment is Myanmar's political

situation. Stability is needed for the type of long-term investment agribusiness requires. There are likely many potential investors waiting out the democratisation process. If the country can navigate this complex issue around the next election cycle, foreign investment will become more energetic.

Q: Moving from a subsistence market to industrial applications is quite risky in a place like Sikka. What do you see as the role of government to assist farmers in making this transition?

A. Fiator Nong: A little context on ENT—in the 1980s, Suharto's son had a large project for planting cassava in ENT. They conducted a planting campaign using mostly bitter varieties, but there was no market. This led to disillusionment and scepticism among farmers that remains until today. Nevertheless, cassava slowly integrated itself as a critical component of local human and livestock food markets. However, most varieties took more than a year to be ready for harvest under local conditions. The introduction of new varieties by CIAT and ILETRI, along with new cropping systems, has changed perceptions. The typical local system is piecemeal planting, piecemeal harvesting. Average income is about Rp100,000 or Rp200,000, but very uncertain. When farmers go to the market they are unsure whether they will be able to sell their cassava. The establishment of commercial market buyers in ENT will change this situation and alter the possible production plans farmers can exploit. The government involvement in agricultural activities in Sikka began with an agricultural field extension officer in every community. The government also provided a hand tractor and subsidised fertiliser in every village. The government also provides free maize seed.

Q. Jonathan Newby: Is the constraint to extending the season in Myanmar that it is too wet to dry the starch?

A. Kyaw Thura: Other industries can help to increase the cassava sector—for example, the instant noodle sector. There are commercial buyers who purchase wet starch, eliminating the issue with drying. Varietal considerations are also important. With the Malaysia variety, we have been harvesting early to take advantage of the highest starch profile. Other varieties with stable starch accumulation profiles allow us to escape from the peak price trap we have been in.

Q. Nguyen Bach Mai: What is the biggest constraint to the development of Myanmar's cassava sector? Policy? Government?

A. Kyaw Thura: Our government warmly welcomes all investments into the cassava industry. No problem!

Q. Rod Lefroy: A question for Tommy. Past efforts to increase the cassava industry in eastern Indonesia were precluded by high transport costs. It was cheaper to ship to China than to Surabaya. What is the current situation, for animal feed for instance?

A. Tommy Jare: The cost of a 20 foot container (18 tonnes) is Rp5.8 million. The price in Surabaya at the moment, more than Rp3,000/kg, is reasonable for shipping. However, in the future the best possibility is to develop processing within ENT.

A. Fiator Nong: Government policy in ENT mandates that food should be kept for consumption within the region. Despite this, the majority of flour used is imported from Java. The prospect of a factory serving this market in ENT is welcome.

A. Yudi Widodo: In 2007, I met Rod Lefroy and Reinhardt Howeler when a plant producing bioethanol in Korea also wanted to buy product from eastern Indonesia. However, again in that instance, the transport was too expensive.

Planning for 2020

Overview

Dominic Smith
University of Queensland, Australia

There are four key questions for the country groups to answer:

- What are the best mechanisms for transfer of technologies through the value chains in the sites in your country?
- What is the role of government to support this process?
- What can the program and partners do to facilitate this process in the remaining year of the project?
- What are key bottlenecks and constraints to achieving impact that need revised policies?

Plans for Indonesia

Erwin Wisnubroto
University of Brawijaya, Indonesia

We considered both Indonesian sites—North Sumatra and East Nusa Tenggara (ENT).

Mechanisms for transfer of technologies

In both sites, there is a role for the agricultural extension officers to support farmer groups (Poktan). Agents and traders play an important role in transferring technology and ensuring adherence to practices (e.g. discouraging subsidised access to fertilisers for resale at a profit to others).

Role of the government

There is a need for regional and district-level policies and strategies (Perbup) to strengthen cassava programming through programs and budgets. Agricultural extension officers have a role to play. The district government is currently using these officers for many non-agricultural tasks. The government needs to regulate the tasks of these employees and ensure that they are focused on the extension mandate. District government can facilitate access to credit through banking programs to make interest rates more attractive and encourage investment in agriculture.

Program and partners

The Indonesian Legumes and Tuber Crops Research Institute (ILETRI) and the University of Brawijaya will continue to provide support.

Bottlenecks and constraints

In ENT, it would help to establish a memorandum of understanding to accommodate farmers, agents and traders, local government, and factory interests. There is a need for preventative resistance evaluations for cassava mosaic disease. The ILETRI plant propagation lab can use tissue culture to expand varietal improvement.

Discussion

Q. Howard Hall: What is the importance of getting cassava recognised as a priority food crop?

A. Erwin Wisnubroto: Right now cassava is fourth, so it just needs a little push to get recognised.

A. Wani Hadi Utomo: International exposure and media campaigns can help to emphasise this importance to the national government.

Plans for Lao PDR

Khambor Sypaseuth
KP Fertiliser Company, Laos

Mechanisms for transfer of technologies

We divided priorities into three categories: cultivation, processing and markets. Regarding cultivation, we need improved planting materials and varieties, better information and education for farmers, expanded demonstration plots, and closer involvement from District Agriculture and Forestry Office staff. Regarding processing, we need improved transportation networks. We also need to work on models that build trust with agents. The 2+3 model used by Mr Somsay Didouangdeth is instructive—the two farmer contributions are land and labour, and the three factory contributions are market, knowledge and transport.

Role of government

The government needs to:

- support capacity building in the farming and business sector
- facilitate transportation networks and infrastructure
- encourage microcredit and macrocredit
- support investment in factories
- regulate contract farming to avoid misunderstandings from the beginning
- support farmer groups
- improve the capacity of technical staff.

Program and partners

The project can continue with training and workshops, with increasing private-sector participation in these events. It would be useful to hold a regional workshop with all the stakeholders— farmers, government and all value-chain actors. There could be an exchange of experiences and study tours.

Bottlenecks and constraints

Logistics in the government sector are a constraint, particularly border regulations. The investment registration system needs to be revised. Household-level access to sectoral information is a constraint. More domestic capacity is also needed, such as cassava specialists with knowledge and technical ability in cultivation, processing and markets.

Discussion

Q. Neng Por: What are the current credit access schemes and interest rates?

A. Phommalath Siviengkhek: Microcredit and macrocredit exist for farmers and factories, respectively. For macrocredit we want an interest rate of around 5–8% with long-term loans, but the government lacks capital.

A. Soytavanh Mienmany: In Laos it is 7–8%, which compares favourably to Indonesia's 12–13% that we witnessed in this trip. This should be a strength for Laos that we need to exploit.

Plans for Myanmar

U Thant Lwin Oo
Department of Agricultural Research, Myanmar
Kyaw Thura
Cassava Growers, Millers and Traders Association, Myanmar

Mechanisms for transfer of technologies

Myanmar has approved the best three varieties and there is ongoing expansion to farmers. Transfer of technology can be achieved by working with the Department of Agriculture on fertiliser demonstrations in farmers' fields. For mealybug and cassava mosaic disease, we require additional farmer training. Cooperation with government bodies is a must.

Role of government

Registering the best varieties with the government is necessary to raise their profile and encourage private-sector multiplication initiatives. We need to demonstrate the importance of the sector and raise its profile to get it on government agendas.

Program and partners

We need training, workshops and field demonstrations on pest and disease identification. We also need awareness raising for planting and cultivation techniques. Government cooperation is needed for field days and communication programs.

Bottlenecks and constraints

Planting material is lacking for expansion. Research and development into the country's logistic coordination plans is needed. The government's profile in the industry is low. Building a regional-level policy is a great first step towards pushing for a national program.

Discussion

Q. Jonathan Newby: Who does varietal registration in Myanmar?

A. U Thant Lwin Oo: Seed law says we need registration of new varieties by the National Seed Company. All varieties must have reference data and appropriate documentation.

A. Tin Maung Aye: There is a committee with members from the Department of Agricultral Research and the Department of Agriculture.

Plans for Vietnam (Son La)

Dang Cong Nguyen
Dai Viet ethanol factory, Vietnam

Mechanisms for transfer of technologies

Collaboration with the International Center for Tropical Agriculture (CIAT), the Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) and the Root Crop Research and Development Center is needed to transfer varieties to different regions. We need also to work with traders and starch factories to maximise outreach to the farmer base. There is also a need to collaborate with fertiliser shops and traders to train and provide information on fertiliser application and nutrient balances in cassava production.

Collaboration with local government (farmers groups) and extension services forms a network for exchange of experiences and lessons learned between clusters, increasing the reach of the program. Local governments have been providing training on soil conservation, and this needs to continue to improve soil fertility and reduce erosion. Local authorities are very important for technology transfer. Small networks of farmers (10–15) in close proximity should be supported to form examples of best practices for their communities. Only one or two years of support should prepare farmers for maintaining practices in subsequent seasons. The planting density issues should be approached in the same way. With regard to harvest timing, we need to continue research on the short-season varieties that are popular in southern Vietnam. Factories can pay 10–15% more for off-season production. We need to disseminate recommendations for intercropping with maize and peanut.

Role of government

The local government of Son La has a program to support farmers about soil conservation practices. They also maintain an extension network, which should collaborate with factories to increase the linkages with farmers in poor districts of Son La province.

Program and partners

NOMAFSI will continue to provide training to farmers and organise a final meeting with local government to inform them about the research outcomes from 2017–19 and the policy recommendations that emerge from this work. We are in the process of developing a cassava farming practices manual and training materials. We plan to deliver this to the departments of rural development and extension so they can use it in their activities. We will continue collaborating with the farmer network established in 2017–18. We will also discuss avenues for expanding the network from 2018 onwards. The factory and their associated trader networks are key actors for disseminating technologies. Annual activities involve checking cassava growth within their production zone—an opportune time to derive additional value from these existing relationships. Planting and harvesting calendars will be developed together with government and private-sector players, to encourage off-peak root production.

Bottlenecks and constraints

Cassava farmers are unsure about future prices, which is hampering adoption of costly technologies. Agricultural insurance schemes would buffer this risk and encourage experimentation and investment. Awareness and willingness to try new technologies is still low among farmers. A collaborative mechanism between factories and famers is necessary in technology transfer. The Son La Government is encouraging shifting to fruit trees on sloping land. We need cassava representation in local strategies and planning. Recent collaboration between CIAT and Dai Viet Company to test disease-free multiplication is ongoing. We have planted improved varieties obtained through CIAT. Stakes were planted at 80 cm × 60 cm on ridges by a mechanised planter. We are in the very early stages of monitoring.

Plans for Vietnam (Dak Lak)

Nguyen Bach Mai
Vietnam

Mechanisms for transfer of technologies

This requires coordination among actors, support for factories and farmers (particularly on the results and lessons from project trials), and support for traders about best practices.

Role of government

The government needs orientation on the development of the cassava cash crop sector. Accurate information is needed on the area planted, the development of markets and exports, which are critical for proper planning. There needs to be enforcement of the policies in place for extension, technology transfer and information dissemination (including project-based findings and recommendations). Additional access to capital is needed to facilitate solutions to current blockages in planting and processing. In the past, the government in Vietnam subsidised many farmer activities, but at the moment these have ceased. The government is backing other policies, such as tree planting, through low interest rates. A comparable strategy is required for cassava.

Program and partners

The program needs to compile and increase the visibility of project results to government actors, factories and farmers. Various approaches are needed to disseminate this information, including using different media. Remaining needs or gaps need to be identified to do targeted coaching. We need to begin identifying additional funds to continue and enlarge the most successful demonstrations. We can think beyond the two districts in the current activities.

Bottlenecks and constraints

There are several constraints:

- Perception. Many high-ranking agricultural officers and government officials continue to have negative views towards cassava regarding soil erosion and degradation.
- Expenses. Funding is necessary to increase adoption.
- Market instability. This hampers development of the entire sector.

A national cassava program is needed (following the example of sugarcane). The Vietnam Cassava Association's role should be improved; it needs to strengthen and improve its activities. Member funds should be allocated to appropriate activities. Leaders should be coached on cassava recommendations (cultivation and production techniques).

Plans for Cambodia

Chea Sareth
Cambodian Agricultural Research and Development Institute

The presentation is framed around the cassava mosaic disease (CMD) emergency.

Mechanisms for transfer of technologies

Cambodia has transborder value chains. We need to identify the best actors, with frequent communication to farmers. Traders and input suppliers are key; they should be trained with key messages to transfer technologies. Extension officers are severely lacking in resources and they need support to become more active. Active farmers are extremely important in getting messages out. Local government can also play a role.

Role of government

The Ministry of Agriculture, Forestry and Fisheries has already declared a CMD emergency and produced a policy. What we need now is enforcement on the ground: quarantining infected areas, adopting fallowing and crop rotation, and restricting imports of planting material.

Program and partners

The program needs to raise awareness about our results and activities. The example of Mr Seng is a good one, with project linkages to the Accelerating Inclusive Markets for Smallholders project. There are logical ways for our activities to be complementary.

Bottlenecks and constraints

In Cambodia, the lack of planting material and phytosanitary cleanliness are very serious. Can the government provide a subsidy program for clean stems to make them more affordable? A fertiliser subsidy would help, and the Indonesian example is very interesting. A policy to encourage investment in the processing sector in Cambodia would increase the independence and self-sufficiency of the sector. There is a need for a farmer-incentive system for starch content. Farmers will pay more attention to varietal choice and cultivation practices if they are incentivised to care about starch content. There must be restriction of stem movement at border points.

Closing remarks and conference details

Closing remarks

Jonathan Newby: Thanks to the translators who have made this multicountry meeting possible. Thanks to the private-sector actors and government workers who have taken the time to participate with researchers in this event. Thanks to Dr Lefroy for his contribution. All the research teams have done a lot of work. Everyone is going well beyond the 5-day work week to make all the trials successful. Thanks to ACIAR for this event; it was not budgeted for and the interaction between teams and actors has shown that the investment paid off. Pak Wani Hadi Utomo—we deeply appreciate all the work you and your family have done to organise this event. Thanks to Dr Cramb—congratulations on your retirement today and we look forward to continuing interaction with you in your postcareer life.

Howard Hall: I see some emerging themes:

- the private sector and their increasing involvement in research
- government policies and our interactions with them are of increasing concern
- the cassava mosaic disease issue is showing the need for nutrition, fertiliser, and related practices; improving practices, supply and access are important for quick wins.

ACIAR is particularly interested in business approaches and the involvement of farmers in these discussions is exceptionally important. I would like to encourage us all to think about ways to increase their participation in the next event to benefit from these interactions. Thanks to the local committee for doing an exceptional job in organisation.

Erwin Wisnubroto: Appreciation to everyone for giving us the opportunity to hold this symposium and to all our delegates joining us here. Special appreciation for the representatives of KP, Bumi Sari and the other private-sector actors for their openness and efforts in joining our program.

Attendees

Name	Country	Institution	Position
Howard Hall	Australia	ACIAR	Agribusiness program manager
Sarina Macfadyen	Australia	ACIAR	Associate research program manager
Jonathan Newby	Australia	CIAT, Laos	Asia Cassava Program Coordinator
Rod Lefroy	Australia	Not applicable	Consultant
Stephanie Montgomery	Australia	Northern Ag Focus	Director
Dominic Smith	Australia	University of Queensland	Senior research fellow
Rob Cramb	Australia	University of Queensland	Professor
Imran Malik	Bangladesh	CIAT, Laos	Researcher
Chea Sareth	Cambodia	CARDI	Head of socioeconomics
Ly Darith	Cambodia	CARDI	Research assistant
Pel Dora	Cambodia	CARDI	Research assistant
Neng Por	Cambodia	CAVAC	Coordinator
Sim Pech Chetra	Cambodia	CAVAC	Staff
Sophearith Sok	Cambodia	CIAT, Cambodia	Researcher
Leang Seng	Cambodia	PDAFF, Stung Treng	Director
Phan Sophara	Cambodia	PDAFF, Pailin	Chief of Agronomy
Erik Delaquis	Canada	CIAT, Laos	Researcher
Siti Maryam	Indonesia	BPTP North Sumatra	Researcher
Sirait Herawati	Indonesia	Bumi Sari Prima	Trader
Sutikno	Indonesia	Bumi Sari Prima	Agent/trader
Turisno	Indonesia	Bumi Sari Prima	Agent/trader
Hardiyanto	Indonesia	ICFORD	Researcher
Kartika Noerwijati	Indonesia	ILETRI	Researcher
Yuliantoro Baliadi	Indonesia	ILETRI	Director
Ruly Krisdiana	Indonesia	ILETRI	Researcher
Yudi Widodo	Indonesia	ILETRI	Researcher
Wulan Rahmaini	Indonesia	Makhota Fertiliser Company	Staff

Name	Country	Institution	Position
Suhartini	Indonesia	University of Brawijaya	Researcher
Damanhuri	Indonesia	University of Brawijaya	Dean of agriculture
Titiek Islami	Indonesia	Univeristy of Brawijaya	Lecturer
Wani Hadi Utomo	Indonesia	University of Brawijaya	Professor of soil science
Erwin Wisnubroto	Indonesia	University of Brawijaya	Researcher
Fiator Nong	Indonesia	UNIPA	Dean, Faculty of Agriculture
Abdi Armaidi	Indonesia	Wilmar Bisnis Indonesia	Staff
Dani Ouhardi	Indonesia	Wilmar Bisnis Indonesia	Staff
Amelia Haris Naruhon	Indonesia	Wilmar Bisnis Indonesia Polytechnic	Lecturer
Syaiful Bahri Panjaitan	Indonesia	Wilmar Chemical	Researcher
Aldon Sinaga	Indonesia	Wilmar Chemical	Staff
Tommy Jare	Indonesia	Private businessperson	Factory owner
Soytavanh Mienmany	Laos	Australian National University	PhD candidate
Laothao Youabee	Laos	CIAT, Laos	Researcher
Somsay Didouangdeth	Laos	DDD Chip Factory	Owner
Khambor Sypaseuth	Laos	KP Fertiliser Company	Vice-President of Sales and Fertiliser
Chanphasouk Tanthaphone	Laos	NAFRI	Director, Economics and Rural Research Center
Phommalath Siviengkhek	Laos	NAFRI	Deputy Director, Maize and Cash Crop Research Center
Kyaw Thura	Myanmar	Cassava Growers, Millers and Traders Association	President
Tin Maung Aye	Myanmar	Not applicable	Consultant soil scientist
Nilar Aung	Myanmar	Department of Agriculture, Ayeyarwady Division	Hinthada district
U Thant Lwin Oo	Myanmar	Department of Agricultural Research	Director-general
Cù Thi Lê Thuy	Vietnam	CIAT, Vietnam	Researcher
Nguyen Bach Mai	Vietnam	Not applicable	Consultant
Dang Cong Nguyen	Vietnam	Dai Viet ethanol factory	Vice-president
Lê Viet Dũng	Vietnam	NOMAFSI	Researcher

Name	Country	Institution	Position
Phan Huy Chương	Vietnam	NOMAFSI	Researcher
Ngô Quang Tuấn	Vietnam	Son La Factory, FOCOCEV	Vice-president
Nguyen Van Minh	Vietnam	Tay Nguyen University	Vice-Dean, Faculty of Agriculture and Forestry

CARDI = Cambodian Agricultural Research and Development Institute; CAVAC = Cambodia Agricultural Value Chain; CIAT = International Center for Tropical Agriculture; ICFORD = Indonesian Center for Food Crops Research and Development; ILETRI = Indonesian Legumes and Tuber Crops Research Institute; NAFRI = National Agricultural and Forestry Research Institute; NOMAFSI = Northern Mountainous Agriculture and Forestry Science Institute; PDAFF = Provincial Department of Agriculture, Forestry and Fisheries; UNIPA = State University of Papua

Program

Introduction and regional/international context

Tuesday 2 July 2019

Time	Session	Facilitator/presenter
15:00	Introduction and welcome	Dean, Faculty of Agriculture, University of Brawijaya ACIAR
15:30	Cassava policies and priorities in Indonesia	Kartika Noerwijati on behalf of ICFORD
16:20	Outline and project management update	Dominic Smith
16:40	Global and regional market developments	Jonathan Newby
17:00	Panel discussion. Implications of global and regional trends on local processing businesses: starch factory (Indonesia and Vietnam), dry chip factory (Laos), ethanol processor (Vietnam)	Jonathan Newby

Agronomy and economic analysis

Wednesday 3 July 2019

Time	Session	Facilitator/presenter
8:15	Introduction to Mahkota Fertiliser Company Introduction to the day	Imran Malik

Time	Session	Facilitator/presenter
8:30	Agronomic activity in North Sumatra Abstract a Abstract b	Yudi Widodo and Kartika Noerwijati
9:10	Agronomic results and economic analysis in Daklak	Nguyen Van Minh
9:50	Agronomic results and economic analysis in Sonla Abstract	Lê Viet Dũng
10:30	Coffee break	
11:00	Agronomic results and economic analysis in Cambodia	Chea Sareth
11:30	Agronomic Activities in ACIAR project in NW Cambodia Presentation 1 Abstract a Agronomic Activities in ACIAR project in NW Cambodia Presentation 2 Abstract b	Steph Montgomery and Phan Sophanara
12:00	Assessment of susceptibility and yield impact of CMD on cassava varieties in Cambodia	Sok Sopearith
12:20	Lunch	
13:30	Agronomic results and economic analysis in Lao PDR	Laothao Youbee
14:10	Agronomic results and economic analysis in Myanmar	Nilar Aung
14:50	Agronomic activity in East Nusa Tenggara Abstract a Abstract b Abstract c	Erwin Wisnubroto and Professor Wani Hadi Utomo
15:30	Coffee break	
16:00	Discussion of agronomic results on the opportunities, risks and constraints	Rod Lefroy

Industry and government engagement

Thursday 4 July 2019

Time	Session	Facilitator/presenter
8:20	Introduction to the day	Dominic Smith
8:30	Increasing the role of chain actor for cassava development in North Sumatra Abstract	Rully Krisdiana
8:50	Industry and government engagement in Daklak	Cù Thi Lê Thuy

Time	Session	Facilitator/presenter
9:10	Industry and government engagement in Sonla	Cù Thi Lê Thuy
9:30	Panel discussion: industry and government engagement in Indonesia and Vietnam: • private sector • North Sumatra—factory • North Sumatra—agent/trader • Sonla—Ngô Quang Tuan • Daklak—Dang Cong Nguyen and Nguyen Bach Mai	Dominic Smith
10:30	Coffee break	
11:00	Industry and government engagement in cAMBODIA	Chea Sareth
11:20	CAVAC approach to industry and government engagement	Neng Por
12:20	Lunch	
13:20	Industry and government engagement in Lao PDR	Chantpasouk Tanthaphone
13:40	'Moving up' or 'moving out'? Livelihood trajectories and farmers decision-making about growing cassava in Northern Laos	Soytavanh Mienmay
14:00	Panel discussion: industry and government engagement in Lao PDR and Cambodia: • chip factory (Lao Starch) • KP (fertiliser) • Seng (PDAFF Stung Treng)	Jonathan Newby
15:00	Coffee break	
15:40	Industry and government engagement in Myanmar	Tin Maung Aye and Kyaw Thuya
16:00	Increasing the role of chain actor for cassava development in East Nusa Tenggara Abstract	Suhartini
16:20	Panel discussion: industry and government engagement in Myanmar and Flores: • Kyaw Thuya • Tommy • Fiator	Rob Cramb

Wrap up and consolidation

Friday 5 July 2019

Time	Session
8:30–10:00	Introduction
	Consolidation and next steps
	Indonesia
	Dak Lak
	Son La
	Lao PDR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