Cassava and Sweetpotato Cropping Practices and Farmer Communication Networks in Quảng Bình Province, Vietnam

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Cassava and Sweetpotato Cropping Practices and Farmer Communication Networks in Quảng Bình Province, Vietnam

Identifying Gaps between Existing Root and Tuber Crops Farming Practices and Climate Smart Agriculture Practices and Characterizing Communication Systems to Support Livelihoods

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July 2017

Food Resilience through Root and Tuber Crops in Upland and Coastal Communities of the Asia-Pacific (FoodSTART+)

Wilkins, Kate. 2017. Cassava and Sweetpotato Cropping Practices and Farmer Communication Networks in Quảng Bình Province, Vietnam. Food Resilience through Root and Tuber Crops in Upland and Coastal Communities of the Asia-Pacific (FoodSTART+). International Potato Center. Laguna, Philippines.

This publication aims to disseminate interim results on root and tuber crops research and practices and stimulate feedback from the scientific community.

Published by the Food Resilience through Root and Tuber Crops in Upland and Coastal Communities of the Asia-Pacific (FoodSTART+) Project

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This document was produced with the support of the International Fund for Agricultural Development (IFAD) and the European Union (EU). The views expressed herein can in no way be taken to reflect the official opinion of IFAD and EU.

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ACKNOWLEDGEMENT

The author would like to thank Nam Nguyen, Brice Even and the rest of the CIAT staff for their assistance in planning and executing this research. Also, thank you to the Sustainable Rural Development for the Poor (SRDP) project staff, the Department of Agriculture and Rural Development officials in Đồng Hới city, commune officials in Quảng Thạch and Cao Quảng, as well as the many farmers who graciously hosted the researchers during data gathering.

ABSTRACT

Root and tuber crops (RTCs), especially cassava and sweetpotato, have historically played important roles in the livelihood of smallholder farmers in Quảng Bình province, Vietnam, even during disasters and extreme events. Recognizing the potential of RTCs in increasing the resilience of smallholder farmers against climate change impacts in Vietnam, this research was done with the goal of determining potential gaps in farmer knowledge about climate smart practices for cassava and sweetpotato production. It also aimed to characterize farmer communication networks and knowledge-sharing within the village as well as at the commune-level.

Using qualitative methods, data was gathered from 30 RTC farmers in three villages per commune and other stakeholders such cassava traders, cassava starch factory representatives, and agricultural extension officers. Research results showed that farmers growing RTCs in Quảng Thạch are well integrated into the local and regional processing markets while farmers in Cao Quảng have little access to such profitable markets, particularly for cassava. They also experience quality issues that preclude their entrance into local sweetpotato markets. In both communes, there were gaps in actual practice and climate smart cassava farming including inefficient fertilizer use and plant spacing, limited erosion control, and inadequate pest management. Pests are a major problem for sweetpotato farmers in Cao Quảng, who are in urgent need for significant pest and disease management strategies.

Most farmers' knowledge about RTC cropping is learned through interpersonal communication with family and neighbors. Knowledge about market-related information such as new products, varieties, and prices are often communicated through networks outside the village including fertilizer sales agents, cassava traders and commune agricultural officers. This research also found out that although there is some variety in farmer cropping activities, most farmers act similarly to their neighbors. Therefore, interventions on RTC planting technologies or markets are likely to be taken up by all farmers, by none or very few.

Keywords: climate smart agriculture, root and tuber crops, cassava cropping practices, rural livelihoods

INTRODUCTION

Climate smart agriculture (CSA) is an increasingly popular framework that allows for the sustainable intensification of smallholder farming landscapes while at the same time addressing pertinent environmental issues. This paper subscribes to the FAO definition of CSA, which is farming that aims to 1) sustainably increase agricultural productivity to support equitable income growth, food security and development, 2) adapt and build resilience to climate change at farm to national levels, and 3) develop opportunities to reduce greenhouse gas (GHG) emissions (Howeler et al., 2013). There will be necessary compromise between these objectives in different systems but this framework attempts to integrate these three important concepts.

While the CSA framework is fairly comprehensive, it also recognizes the difficulties that arise in prescribing solutions because interventions must be highly location-specific and knowledge-intensive (Howeler et al., 2013). This is true for the study sites where this research was conducted, where there was great variation in the needs and constraints between farmers even in villages that were separated by less than a few kilometers.

Vietnam, like its neighboring Southeast Asian countries, is highly vulnerable to the threat of climate change especially to agriculture and food security. These sectors are expected to be the most affected by climate change, due to increases in temperature and rainfall that will lead to more frequent flooding, intensify droughts, and aid the spread of plant diseases and pests (MONRE, 2007; ISPONRE, 2009). Warmer temperatures will likely move planting boundaries higher, which will negatively affect smallholders with land constraints (ISPONRE, 2009). Knowing these threats, Vietnam's government has goals to reduce greenhouse gas emissions in the agriculture and forestry sector while continuing to raise yield productivity. Some of the strategies proposed to increase agricultural development while reducing GHG emissions include applying sustainable farming techniques that reduce instances of crop residue burning, improvement of manure management, and irrigation-drainage management in rice fields as well as strengthening the capacity of agricultural research institutions (ISPONRE, 2009). Many of the government's proposed options for climate change adaptation in agriculture align with the CSA framework, including the planned use of irrigation water, development of varieties that can survive harsher environmental conditions, and adoption of appropriate farming techniques (ISPONRE, 2009).

In regions vulnerable to the negative effects of climate change, root and tuber crops (RTCs) such as cassava and sweetpotato are seen as climate-resilient crops that could ensure greater food security for smallholder farmers. Cassava *(Manihot esculenta)* is the world's sixth most important food crop and is tolerant of environmental stress and drought (El-Sharkawy, 2003). It has also turned into a commodity traded globally as the industry for starch and dried cassava for livestock feed and industrial uses

grows (Howeler et al., 2013). At the same time, sweetpotato *(Ipomoea batatas)* is also becoming more popular in processed foods, and for its role in combating Vitamin A deficiency and diversifying diets in developing countries (Scott et al., 2000).

Since it is a relatively new framework for agricultural development, there is a paucity of studies about CSA for RTCs in Vietnam. There is, however, extensive research that has been done on sustainable intensification or sustainable cropping systems involving RTCs, mostly for cassava. For instance, Agricultural Research for Development (CIRAD) researchers conducted farmer trials for minimum tillage rice-potato cropping in Vietnam, as well as direct-seeding mulch-based cassava systems (DMC) in Cambodia. No tillage planting of potatoes combined with rice straw mulch led to high yields and lower pest incidence in Thai Binh Province (Dung et al. 2012). In Kampong Cham province, Cambodia; yields increased over three years (2009-2011) with DMC practices compared to conventional practices. However, the study found that variable biophysical conditions lead to high standard deviation in the results. Moreover, over 40% of farmers abandoned DMC after each season because of the increased risk of investment (Chabierski et al., 2012).

Likewise, a joint effort between the Food and Agriculture Organization (FAO) and the Northern Mountainous Agriculture and Forestry Institute (NOMAFSI) reviewed sustainable land management practices on sloping lands in Northern Vietnam; particularly mini-terracing, legume crop rotation, and reduced tillage (Arslan, 2010). The report offers recommendations on successfully intercropping cassava with peanuts and beans, as well as the use of grass hedgerows to control erosion in Yen Bia province. Phien and Tam (2000) also studied the effects of hedgerows on cassava-peanut systems and concluded that hedgerows reduce soil erosion while maintaining cassava and peanut yields.

Similarly, the International Center for Tropical Agriculture (CIAT) reviewed the conservation agriculture practices in Vietnam's climate smart villages, including grass strips in cassava systems, as part of CGIAR's climate smart village project. From these reviews, Howeler (2002 & 2004) published two papers recommending sustainable cassava production practices that included applying additional potassium to fields and alley cropping with grass hedgerows to reduce runoff and erosion.

Along the same lines, the FAO released *Save and Grow: Cassava; A Guide to Sustainable Production Intensification* that called for a greening of green revolution practices for cassava (Howeler et al., 2013). Their recommendation pulls heavily from CIAT's cassava research and recommendations on reducing soil erosion and improving farmer income with strategies like intercropping, use of hedgerows or efficient fertilizer management. In 2014, CIAT also published a sustainable management guide to cassava production in Asia based on more than twenty years of field trials (Howeler & Maung Aye, 2014).

In terms of improved sweetpotato farming, the International Potato Center (CIP) published a manual in 2013 outlining recommended sweetpotato production and management strategies (Stathers et al., 2013). It should be noted that majority of the current international research on sweetpotato focused on the crop's use for improved livestock feed (Dom et al. 2017; Sheikha & Ray, 2017). However, its role in diet diversification and nutrition as well as its potential resilience to the effects of climate change are still recognized as an important component in many studies (Scott et al., 2000). Most sweetpotato research is focused on Sub-Saharan Africa, where interest in promoting the tuber to improve farming livelihood has been growing in the last decade (Stathers et al., 2013).

The FoodSTART+ project, under which this research was undertaken, is an initiative to enhance the contribution of RTCs to food security, nutrition and income in the Asia-Pacific region. These crops are

widely grown and traditionally consumed by households and are becoming an increasingly important crop for processed food uses (Barlis, 2013). Within Vietnam, cassava and sweetpotato may be better adapted than other crops to withstand climate shocks and provide a source of food and income during these extreme events (Scott et al., 2000).

Recognizing the potential of RTCs in increasing the resilience of smallholder farmers to climate change impacts in Vietnam, this research was done with the goal of determining potential gaps in farmer knowledge about climate smart practices for cassava and sweetpotato production. It also aimed to characterize farmer communication networks and knowledge-sharing within the village as well as at the commune-level.

The results of this research provides supplemental information to the initial FoodSTART+ scoping study that was done in Quảng Bình and Hà Tĩnh provinces between October 2015 and January 2016 (Even et al., 2016) and provides a more detailed evaluation of the RTC systems in two communes in Quảng Bình province.

Research Objectives

Specifically, this study aimed to achieve the following research objectives:

Objective 1: Identify gaps in farmer knowledge and practice and climate smart agriculture practices for cassava and sweetpotato.

Objective 2: Identify how farmer communities get information relevant to cassava and sweetpotato production such as agricultural practices, markets, and climate information, among others.

Description of the Study Area

This research focused on RTC farmers in Quảng Bình (Figure 1), a province on the North Central Coast of Vietnam with a predominately agricultural economy. It is bordered by the South China Sea to the east, Laos to the west, Quảng Trị province to the south and Hà Tĩnh province to the north. Đồng Hới is the coastal capital with about 160,000 residents. This research gathered data from two communes in Quảng Bình, which were chosen by the Sustainable Rural Development for the Poor (SRDP) project, an IFAD-supported investment project with which FoodSTART+ collaborates. These selected communes are Quảng Thạch and Cao Quảng, which are about 60-75 km north east of Đồng Hới. The closest major town to the communes is Ba Đồn, 43 km north of Đồng Hới.

Quảng Thạch commune is composed of eight villages and located in Quảng Trạch District, 17 km North West of Ba Đồn Town. The villages are fairly homogenous in their crop production and economic activity. Village 3, 5, and 8 were selected for data gathering based on the recommendations of the commune leaders. These villages are accessible along a paved road that ends in Village 8, which will be connected to a multi-lane paved highway currently under construction leading to Laos, according to villagers. The villages surveyed in this study have level, low-lying croplands used primarily for growing rice and sloping lands where houses and other crop fields are located.

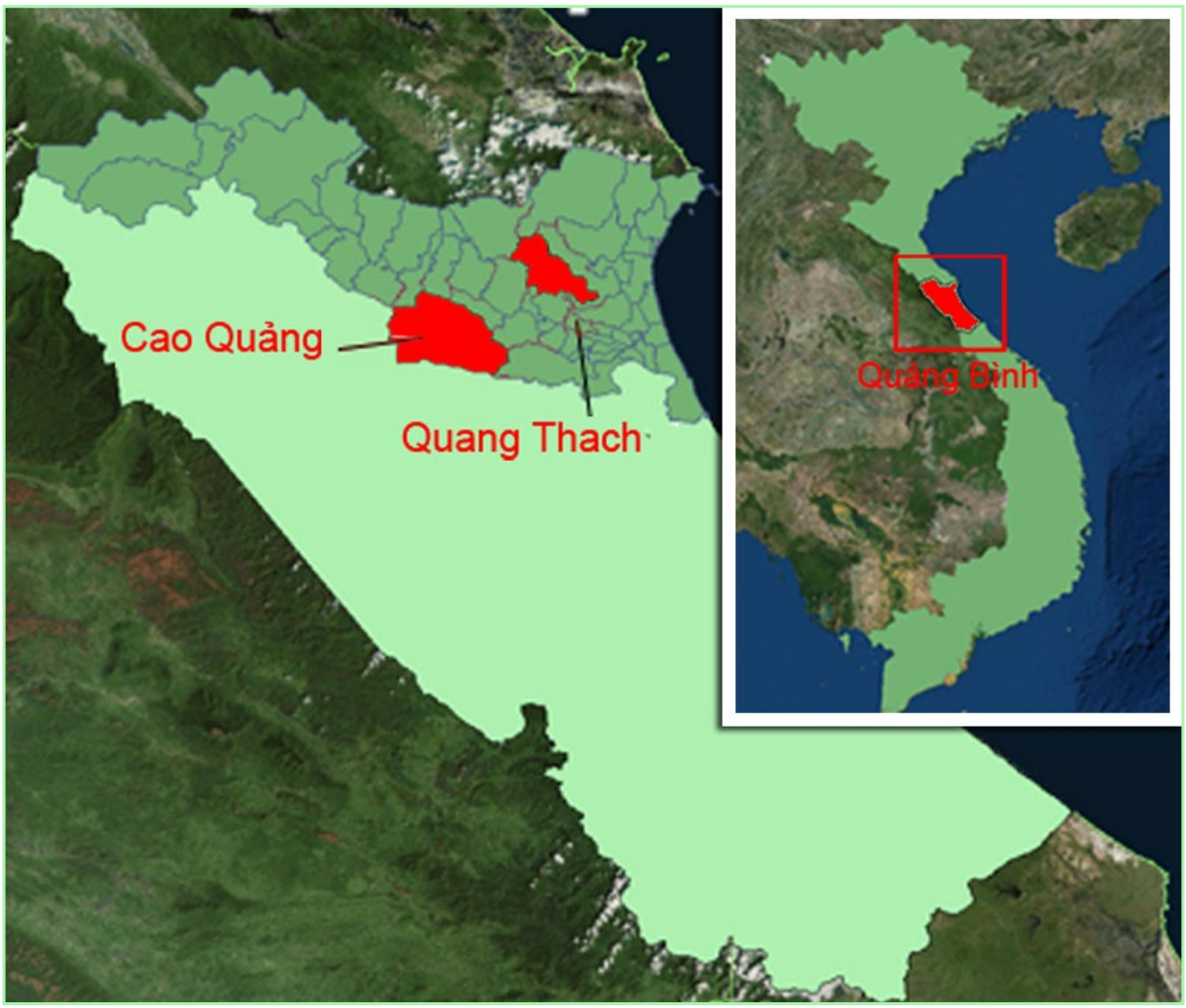

Figure 1. Location of Quảng Thạch and Cao Quảng Communes in Quảng Bình Province, Vietnam

Cao Quảng commune is in a narrow valley located in the Tuyên Hóa District. It is accessible by one paved road that parallels the Song Nan River, 33 km from Ba Đồn. Of the commune's five villages, three villages were selected by the commune leadership for data collection: Vĩnh Xuân, Phú Xuân, and Cao Cảnh. The Song Nan River separates Vĩnh Xuân and Phú Xuân from the other villages and the administrative headquarters of the commune. Access to both villages is through a small bridge suitable only for pedestrians and motorbikes (Figure 2). Four-wheeled vehicles may use a dirt access road that crosses the river at a low point, but is inaccessible during the rainy season when the river is too high to cross.

A satellite image of the two communes as well as the approximate location of the surveyed villages can be seen in Annex 1.

Figure 2. View of Song Nan River from the Foot/Motorbike Bridge to Vĩnh Xuân Village

METHODOLOGY

This study on cassava and sweetpotato cropping practices and farmer communication networks used qualitative methods for data collection, including farmer focus group discussions (FGDs) and structured key-informant interviews (KIIs). Primary data collection was done from June to July 2016. The FGDs and interviews were done in the local language, recorded, transcribed and then evaluated by a native Vietnamese translator.

The FGDs were conducted in six villages from the two communes (Table 1). The villages were chosen by the commune leaders after an initial meetings to discuss the objectives of the project. Convenience sampling was done, wherein farmers who plant cassava or sweetpotato and were available at the time of the FGD were referred by the commune agricultural office in Cao Quảng and the village heads in Quảng Thạch as the participants. When possible, the focus groups were divided into male and female groups of five participants each. The FGDs lasted for about an hour and followed a facilitators' guide which contains the guide questions used in all the activities (Annex 2).

Table 1. FGD Groups and Number of FGD Participants

LOCATION	GROUP	NUMBER OF PARTICIPANTS
Quảng Thạch Commune		
Village 3	Male	6
Village 3	Female	5
Village 5	Mixed	10 (5 male, 5 female)
Village 8	Male	5
Village 8	Female	6
	Total Participants:	32
Cao Quảng Commune		
Cao Cảnh	Mixed 1	5*
Cao Cảnh	Mixed 2	5*
Phú Xuân	Mixed	9 (5 male, 4 female)
Vĩnh Xuân	Male	5
Cao Cảnh	Female	5
	Total Participants:	29

**gender breakdown not available*

After the focus groups were completed, the KIIs with farmers and other stakeholders were done. Five farmers per village were interviewed for a total of 15 farmers per commune. The respondents were selected to represent a range of social classes from poor to middle class to wealthier farmers, upon the recommendation of the village heads. The farmers' availability during the time of the interviews were also taken into consideration. Moreover, the commune agricultural extension officer, at least one cassava trader, and two fertilizer sales agents or input sellers from each commune were also interviewed (Table 2). In both communes, some input suppliers or cassava traders lived outside the target villages, but were within the commune and were geographically close to at least one target village.

Table 2. Breakdown of Key Informant Interviews

LOCATION/OCCUPATION	NUMBER OF INDIVIDUALS
Quảng Thạch Commune	
Village 3 Farmers	5
Village 5 Farmers	5
Village 8 Farmers	5
Agricultural Extension Officer	1
Cassava Traders	4
Input Sellers	2
Total:	22
Cao Quảng Commune	
Cao Cảnh Farmers	5
Phú Xuân Farmers	5
Vĩnh Xuân Farmers	5
Agricultural Extension Officer	1
Cassava Traders	1
Input Sellers	3
Total:	20
Others	
Quảng Lưu Farmer	1
Sông Dinh Cassava Starch Factory Staff	1
Long Giang Cassava Starch Factory Staff	1
Total:	3
Total number of key informants	45

Additionally, there were three interviews done outside of the target communes. Two of which were representatives of the Long Giang and Sông Dinh cassava starch-processing factories in Bố Trạch district and one was a large scale cassava farmer in Quảng Lưu commune, about 6 km from Quảng Thạch. The farmer in Quảng Lưu was well-known among traders and farmers in Quảng Thạch as the first person to bring the newest Sắn Cao Sản cassava variety to the area. He graduated college and thus had the highest level of education among all farmers interviewed and a cassava farm size dramatically above the average at 25 hectares. The size of his farm and his strong ties to nearby starch factories provide an interesting contrast to the smallholder farmers interviewed in this study.

During the KII the farmers were asked if, how, and why they perform specific activities for each component of their cropping practice. They were also asked where they got information that influenced their farming activities, including weather forecasts, crop prices, and emerging pest and disease problems. Moreover, they were asked to describe how their farming practices and cropland has changed over time and what improvements they would like to implement in their cropping systems. The guide questions for the Farmer KII can be found in Annex 3.

On the other hand, interviews with other relevant stakeholders focused on questions that help characterize their interactions with farmers, particularly in the dissemination of information and their influences in setting prices or offering certain supplemental products. Agricultural officer interviews included questions about crop trainings, recommended practices, and methods of farmer outreach. The starch factory representatives were asked about the relationships between factories and farmers, perceived farmer challenges, and desired farmer improvements.

The KII results were then coded and analyzed for themes that included cropping practices, sources of cropping information, extension, yields, and crop and market problems, among others. The data collected were also disaggregated based on gender to identify any differences between female and male farmers' experience and information sources.

Respondents' Profile

Farmer respondents of the KII were also asked about their basic socio-demographic characteristics to provide context as well as a deeper understanding of their responses. Table 3 summarizes and compares the demographic profile between the two communes.

The table shows that the farmers interviewed were gender-balanced, with an almost equal ratio of male and female farmers in both communes. Most of them are between 40-60 years old (76.67%), with an average age of 47 years old for Quảng Thạch and 49 for Cao Quảng. In terms of education, majority of farmers in both communes either reached or completed middle school education (70.00%), while a few reached secondary school (10.00%).

The farmers' economic status was harder to determine because their definition of wealth was not always in monetary value and many could not estimate their income in a year. The farmers were instead asked to describe their perceived economic status. The results show that there are more farmers who perceived themselves to either be well-off (36.67%) or middle class (23.33%) in both communes, than poor (16.67%) or close to poor (16.67%). There were also many (36.67%) who did not provide an answer.

While all farmers interviewed is presently farming either cassava or sweetpotato, one farmer in each commune did not plant cassava while only 73.33% of farmers in Quảng Thạch and 40% of farmers in Cao Quảng planted sweetpotato within the cropping season. In terms farm area allotted to RTCs, the area for cassava is smaller for farmers in Quảng Thạch with an average of 0.15 ha compared to 0.22 ha in Cao Quảng.

On the contrary, the average farm size allotted to sweetpotato cannot be determined since some farmers answered in different units or in ranges, while many did not give an answer or simply said the sweetpotato is planted in their home gardens. Some farmers explained that while planting sweetpotato is common, it is treated more like a casual crop for their own use rather than for

livelihood.

Table 3. Socio-demographic Profile of Farmer KII Respondents

	QUẢNG THẠCH (%) (n=15)	CAO QUẢNG (%) (n=15)	ALL (%) (n=30)
Gender			
Female	7 (46.67%)	8 (53.33%)	15 (50.00%)
Male	8 (53.33%)	7 (46.67%)	15 (50.00%)
Age			
31-40 years old	3 (20.00%)	3 (20.00%)	6 (20.00%)
41-50 years old	7 (46.67%)	4 (26.67%)	11 (36.67%)
51-60 years old	4 (26.67%)	8 (53.33%)	12 (40.00%)
61 onwards	1 (6.67%)	-	1 (3.33%)
mean	47.07	49.2	48.13
min/max	35/62	34/60	34/62
Education Level			
Primary School	2 (13.33%)	-	2 (6.67%)
Middle School	8 (53.33%)	13 (86.67%)	21 (70.00%)
Secondary School	2 (13.33%)	1 (6.67%)	3 (10.00%)
unknown	3 (20.00%)	1 (6.67%)	4 (13.33%)
Economic Status			
Poor	3 (20.00%)	2 (13.33%)	5 (16.67%)
Close to poor	1 (36.67%)	4 (26.67%)	5 (16.67%)
Middle class	5 (33.33%)	2 (13.33%)	7 (23.33%)
Well-off	7 (46.67%)	7 (46.67%)	11 (36.67%)
unknown	4 (26.67%)	7 (46.67%)	11 (36.67%)
Major/Most profitable crops			
(multiple responses)	Pepper (33.33%), Cassava (20.00%), Eucalyptus (20.00%), Sweetpotato (13.33%)	Acacia (60.00%), Peanuts (60.00%), Maize (26.67%)	-
RTC Farming (within the year's cropping season/s)			
Planted cassava	14 (93.33%)	14 (93.33%)	28 (93.33%)
Planted sweetpotato	11 (73.33%)	6 (40.00%)	17 (56.67%)
Cassava Farm Size*			
mean	0.16 ha	0.22 ha	0.19 ha
min/max	0.15/1.15	0.15/0.5	0.15/1.15

**No data for sweetpotato*

RESULTS AND DISCUSSION

The following sections discuss the farmers' cropping practices for cassava and for sweetpotato separately, including market factors such as labor and prices. Each cropping practice; including choice of planting materials, field preparation, planting, fertilization, pest and disease management, and harvesting; are examined in detail to identify the gaps between current and climate smart agricultural practices for each RTC.

The communication networks utilized by RTC farmers are discussed in the final sections to identify where and how farmers get information about agricultural practices, markets, and climate information relevant to cassava and sweetpotato production.

Cassava: Cropping Practices

The FGD and KII results show that cassava cropping practices are similar in both communes, with only slight differences between communes and villages. For almost all farmers, farm size allotted to cassava is small, with an average of less than one fifth of a hectare or 0.19 ha. This is often attributed to pressure from or preference for more profitable crops. Majority of the farmers surveyed grow cassava for their own use as animal feed, particularly in Cao Quảng where only 2 of the 15 (13.33%) farmers interviewed sell the cassava they harvested. These farmers explained that they used to sell cassava in the past but lack of traders and low farm gate prices caused many of them to just feed crops to their livestock.

On the other hand, 12 of the 15 farmers (80%) were growing cassava to sell in Quảng Thạch. The three farmers not selling had various reasons for not entering the market – mainly a lack of extra cassava after feeding livestock. Cassava sold to traders is then sold to nearby cassava starch processing plants. The KIIs are supported by the FGD results on farmers' cassava utilization, as shown in Table 4.

Planting Material/Varieties. The table below shows the FGD result on the various cassava varieties grown by farmers along with its prevalence of use expressed in percentages. In both Quảng Thạch and Cao Quảng, the most commonly used variety is *Sắn* Cao Sản. This is the cassava variety sold for starch processing. This variety is almost certainly KM94, and was likely introduced to Quảng Thạch from the starch factories in Bố Trạch. Quảng Thạch traders and one focus group identified the Quảng Lưu farmer as the person who introduced the variety to farmers. In the interviews, farmers claim they began growing Sắn Cao Sản about 20 years ago, which corresponds with the release of the KM94 in 1995 (Kim et al., 2000)

Table 4. Focus Group Discussion Results: Cassava Utilization

LOCATION	GROUP	CASSAVA END USE
Quảng Thạch Commune		
Village 5	Mixed	50% food, 50% trader
Village 8	Female	50% trader, 50% animal feed
Village 8	Male	70% trader, 30% animal feed
Village 3	Female	80% trader, 20% animal feed or consumption
Village 3	Male	95% trader, 5% animal feed
Cao Quảng Commune		
Cao Cảnh	Mixed	95% animal feed, 5% consumption
Cao Cảnh	Mixed	80% animal feed, 20% trader
Phú Xuân	Mixed	100% animal feed
Vĩnh Xuân	Female	100% animal feed
Vĩnh Xuân	Male	100% animal feed

Table 5. Focus Group Discussion Results: Cassava Varieties Grown

LOCATION	GENDER	CASSAVA VARIETY GROWN
Quảng Thạch Commune		
Village 5	Mixed	90% Sắn Cao Sản, 10% Sắn Tinh
Village 8	Female	70% Sắn Cao Sản, 30% Sắn Tinh
Village 8	Male	70% Sắn Cao Sản, 30% Sắn Tộc
Village 3	Female	80% Sắn Cao Sản, 20% Sắn Tinh
Village 3	Male	90% Sắn Cao Sản, 10% Sắn Tinh
Cao Quảng Commune		
Cao Cảnh	Mixed	90% Sắn Cao Sản, 10% Sắn Đỏ
Cao Cảnh	Mixed	80% Sắn Cao Sản, 9% Sắn Lâm Trường, 1% Sắn Đỏ
Phú Xuân	Mixed	90% Sắn Cao Sản, 10% Sắn Đỏ
Vĩnh Xuân	Female	50% Sắn Cao Sản, 50% Sắn Lâm Trường, >1% Sắn Đỏ
Vĩnh Xuân	Male	60% Sắn cao sản, 40% Sắn lâm trường

While majority of the farmers in Cao Quảng grow Sắn Cao Sản, some farmers also grow Sắn Lâm Trường either exclusively or together with Sắn Cao Sản. Six farmers mentioned this variety by name, including the two farmers who sell to the starch processing factories and the only Cao Quảng trader. Separate accounts by a focus group, extension officer, and farmers described how a local nursery named Lâm Trường introduced the variety between 2002 to 2007 and ceased operation a few years later. The varietal name of Sắn Lâm Trường is unknown and the reported date of release does not coincide with any known variety releases in the area. This variety in Cao Quảng is likely not an alternative name for Sắn Cao Sản because two farmers grow both types and many farmers mentioned growing only Sắn Cao Sản.

In addition to these two varieties, farmers also grow what they refer to as traditional varieties called Sắn Đỏ and Sắn Nguồn in Cao Quảng and Sắn Tộc or Sắn Tinh in Quảng Thạch. A few rows of traditional cassava are always planted alongside the KM94 or Lâm Trường varieties. Many of these traditional varieties may be H34 or Xuan Vinh Phu, which was popular before 1985 (Kim et al., 2000). The Quảng Lưu farmer said that Sắn Tộc is H34.

Field Preparation. Research results show that farmers commonly use buffaloes to till their fields while some rent machinery when they can afford it. Many farmers do tillage in two stages, first is the initial pass with a buffalo or cow to break up the soil referred to as 'Bừa' and then a second tillage to kill weeds called 'Cày'. This method is being done by all farmers except one female farmer who passed to kill weeds first.

During the KIIs, six farmers, the agricultural officer and two traders in Quảng Thạch reported that they rent and use a scooping machine or an excavator first, followed with animal tillage. These farmers explained that it is best to use the excavator every couple years to improve soil quality, because they mix the top 50-60 cm of soil. However, many farmers cannot afford its rental price. It should also be noted that none of the respondents in Cao Quảng have reported using an excavator.

As part of filed preparations to reduce soil erosion, most farmers construct raised beds that slow the flow of water or dig ditches around the crops to divert water around or between cassava rows. This is an important step since many farmers claim that soil erosion is a problem in their cassava fields, especially in sloping plots.

Planting. Planting usually occurs from December to January but may be done from November through February. The farmers described the following method which they commonly use in planting cassava. First, farmers cut sections of cassava into stakes from the green and pliable midsection of the cassava plant. The stakes are then placed in the ground at an angle of 30°-90° depending on the slope. The stakes are placed in the soil so that most of the nodes are underground to stop it from drying out. The farmers explained that the proportion of the stake above and below the ground depends on the temperature and weather forecast at the time of planting. For example, most of the stake is planted underground during hot weather.

This method of planting cassava is very similar in both communes. There is no common technique in the two communes when it comes to stake spacing although most farmers plant their stakes further apart in better soils. The results from the KII and the FGDs on stake spacing were also variable. Some of the Cao Quảng focus groups reported spacing from 33 to 60 cm apart while others estimated the spacing between cassava rows at 100 cm. During the interviews, Cao Quảng farmers reported that they plant between 40 and 80 cm apart with an average of 55 cm. Farmers in Quảng Thạch reported an average spacing between stakes of about 40 cm, with a range of 25-70 cm while rows of cassava are planted 70-80 cm apart. On the other hand, male and female focus groups in Vĩnh Xuân had contradictory techniques: women plant stakes closer together in poor soil while males plant farther apart.

All farmers grow cassava in monoculture (Figure 3), except for one who intercrops with beans. These farmers explained that they or their parents before them have tried intercropping beans or corn but found it unsuccessful because the cassava was stunted or was shaded out and did not grow. Some farmers also attributed this failure to the lack of water while a few farmers suggested that the land is not fallowed enough in past generations.

Fertilization. Almost all farmers in both communes apply soil amendments twice: before planting and during cropping. After land preparation, fertilizer and manure are placed in holes next to the cassava stake, not spread over the planting area. It is difficult to estimate the amount of fertilizer applied using standard measurements because many farmers use informal measurements such as pinches, handfuls, and cart loads. Farmers reporting in standard measures would estimate using kilograms per 'sào' (kg/sào) where 1 sào = 500 m^2. Fertilizer purchased at local stores comes in 25 or 50 kg bags.

Figure 3. Example of a Cassava Monocrop Farm in Village 8, Quảng Thạch

In Cao Quảng, average manure application is estimated at 300-500 kg/sào or 6-10 t/ha while the highest application rate was 700-800 kg/sào or10-14 t/ha. Farmers are usually limited by the manure produced from their own livestock but two farmers reported purchasing extra manure from a nearby cattle farm.

In terms of chemical fertilizers, the most common type used are multipurpose mixes or complete nitrogen (N), phosphorus (P), and potassium (K) amendments such as 'Đầu Trâu' (20-20-15 NPK) (53.33%) (Figure 4) and 'Kali' (40%), a potassium-based fertilizer. Farmer use estimates ranged from a few tablespoons per plant to 30-50 kg/sào (0.6-1 t/ha). Some farmers add other nitrogen-based ('Đạm') or phosphorus-based ('Lân') fertilizers. Three farmers claim that they do not buy any fertilizer and will only use fertilizer left over from other crops. Many farmers cited the high price of fertilizer for their low rate of application but expressed that they would like to use more fertilizer.

On the other hand, most farmers in Quảng Thạch estimated manure application from 1 kg/plant to 300-1000 kg/sào. The most common chemical fertilizers used are also multipurpose mixes such as Đầu Trâu or Ninh Bình (16-16-8 NPK), as well as potassium amendments. Estimated application rates varied from pinches of fertilizer to 1000 kg/ha.

Figure 4. Đầu Trâu Fertilizer at a Local Store

More farmers practice supplemental fertilizer application in Cao Quảng (46.67%) compared to very few farmers in Quảng Thạch (20%). Common supplement are nitrogen or potassium based amendments. However, this practice is highly dependent on weather. For instance, farmers do not add amendments if the day is hot and dry because it will be ineffective or may hurt the plant.

Weeding. All farmers in both communes reported manual weeding after planting cassava. During interviews, farmers explained that the timing of weeding often depends on labor availability and can be put off if the family is engaged in other farming activities.

Pest Management. Farmers in Cao Quảng and Quảng Thạch claim that they do not experience major pest problems and that they do not use pesticides on cassava. In fact, only two farmers reported to have ever used pesticides on cassava. Farmers did mention that most common cassava pests are termites and crickets for Cao Quảng and Quảng Thạch farmers, respectively. Termites can cause damage to newly planted cassava and when soil is dry. Farmers have few strategies to prevent termite damage or to remove them such as removing dry plant matter from the soil surface, spreading lime on the soil surface, or packing the soil tightly around the plants. Crickets, on the other hand, can be a problem when cassava is 10-20 cm tall, but severity of damage varies each season.

Many farmers also have minimal losses from leaf-eating bugs. Two farmers said they use the pesticide 'Terex' to address bug problems. Terex is an organophosphate insecticide manufactured in Vietnam and is considered slightly hazardous (National Profile, 2004). It is used to control cockroaches, crickets, silverfish, bedbugs, fleas, cattle grubs, flies, ticks, leaf miners, and leaf hoppers (Extoxnet, 1993). Four

of the five input suppliers said that farmers do not use pesticides on cassava and that they did not carry any cassava-specific pesticides. One supplier in Quảng Thạch thought he had a cassava specific pesticide, but it was only a fertilizer amendment he prescribed for leaf yellowing.

Disease Management. Farmers in Quảng Thạch did not report any diseases affecting cassava, while root rot was mentioned by six farmers in Cao Quảng. The root rot is characterized by soft, rotted tubers and commonly occurs after flooding events that temporarily submerge the crops. The Quảng Thạch agricultural officer said that there is also root rot in his commune after flooding, but no one in the three villages surveyed mentioned this nor the flood events.

Harvesting. Research results found that farmers growing cassava for animal feed harvest at different time intervals than farmers growing for starch processing. It can also be done by either the farmer or by traders through hired laborers (Table 6). Plants used for livestock feed are pulled up by farmers a few at a time, as needed, while the remaining are left in the ground for up to two years. Some farmers may harvest a large amount at once and then chip and dry the roots to store for later use.

Table 6. Focus Group Discussion Results: Cassava Harvesting Practices

FOCUS GROUP	GENDER	CASSAVA HARVESTING
Quảng Thạch Commune		
Village 5	Mixed	90% trader; 10% farmer
Village 8	Female	dependent on field size (large-trader, small-farmer)
Village 8	Male	unknown
Village 3	Female	50% farmer; 50% trader
Village 3	Male	unknown
Cao Quảng Commune		
Cao Cảnh	Mixed	100% Farmers
Cao Cảnh	Mixed	100% Farmers
Phú Xuân	Mixed	100% Farmers
Vĩnh Xuân	Female	100% Farmers
Vĩnh Xuân	Male	100% Farmers

On the other hand, farmers planting cassava for starch will harvest their field in a day or more and then sell the lot by weight. Farmers aim to have the trader collect the cassava immediately after harvesting and most will not harvest without a buyer because the roots dry out leading to reduced weight and therefore, lower profits. In Quảng Thạch, traders will often pay the farmer for the cassava in his field and then hire laborers to harvest. This arrangement often cause yield uncertainty on both sides, but unfortunately, farmers do not have much control over this process. Traders need to transport the roots to the factory quickly so they do not lose too much revenue from the cassava drying out.

Yield. Farmers growing cassava for animal feed reported yields that were higher and more variable than farmers growing cassava to sell, which could be because farmers who sell to traders have a more accurate accounting of their yield. There was a wide range of yield estimates for cassava for feeds: 350 kg/sào (7 t/ha) to 4000 kg/sào (80 t/ha). The average yield of 13 Quảng Thạch farmers growing to sell was 1.3 tons/sào (25 tons/ha). Only one of the three Cao Quảng farmers engaged in selling cassava estimated yield at 3000 kg/sào (60 t/ha).

It should be noted, however, that most farmer estimates are significantly higher than the official data on average cassava yields in Quảng Bình at 18.5 t/ha (QBSO, 2015 as mentioned by Even et al., 2016). This could mean that farmers, especially those who do not sell cassava, tend to overestimate yields. This research was unable to estimate the amount of cassava that families consume. This was difficult to evaluate because the season's cassava had not been harvested during the study period.

Cassava: Market Factors

Labor. Almost all farmers interviewed do not use hired labor for agriculture because according to a farmer from Quảng Thạch: "work is cheap, but if you have to hire its very expensive", although some farmers in Quảng Thạch may hire an excavator operator to dig up a field if they can afford it. Village women frequently work in groups and rotate through each other's farms to complete cropping tasks. Also, neighbors will often come to help to finish farm work if needed.

The traders who also farmed cassava, as well as the Quảng Lưu farmer, reported that they hire laborers for land preparation, planting, and harvesting. Unlike the smallholder farmers interviewed, these cassava farmers were financially well-off.

Men and women have nearly identical cropping knowledge but perform different cropping activities. Males do most of the tillage, especially involving machinery, and collect and carry livestock manure. Females are often in charge of planting, fertilizing, and weeding. Though this is the common division of activities, it is not uncommon for men and women to perform the other tasks. Three widowed women farmers interviewed say they sometimes rely on children and other family members, but they are the main labor source for most activities. Whole families will participate in certain activities if they need to be done quickly, like harvesting. Children's early experiences helping with cropping activities means both genders are exposed early on to all aspects of crop production and have similar knowledge and skills.

Traders. Traders are local buyers in the villages who purchase and transport cassava from individual farms to the starch-processing factories in neighboring Bố Trạch district. Four of the five traders interviewed also grow cassava themselves. Some traders have factory contracts that are set on expected collection amounts, usually at 500-1000 t per season. It is unclear if it is difficult to get a factory contract, as one interviewed trader signed a contract with a factory after seeing a commercial advertising a trader job. Four of the five traders complained about slow payments from factories and multiple-day waiting times, even if they have a factory contract.

Traders generally offer the same prices for cassava to farmers because of the competition, though there is only one trader purchasing cassava in Cao Quảng commune. A few farmers sell to the factories directly, but others do not have access to transportation to take the cassava to Bố Trạch or choose to sell to traders for other reasons.

Traders will also change the price they offer farmers based on the starch content of the cassava, although it is not known how rigorously this categorization is applied. Starch content is measured at the factory, so traders are incentivized to bring high-starch cassava in order to maximize their profit. The traders use visual clues to assess starch content including color, texture, and plot location. For instance, traders claim that whiter and harder cassava, as well as those planted in sandy soil, has higher starch content and therefore, can command a higher price. Since measuring these qualities is not rigorous and is mentioned quite casually by traders, it is unknown how much it affects the farm

gate price or the factory price. Sometimes traders do lose money on a sale if they have paid a farmer for an entire field with a higher price because of wrong starch content appraisal.

Farm Gate Prices. Farm gate prices for cassava, which are sold in 10 kg bundles, have been decreasing in the last few years according to traders. They claim that their purchase price is dependent on the prices set by the factories, which often changes throughout the season. Prices at the beginning or end of the season are generally higher while prices mid-season are depressed when the majority of the cassava is harvested and transported to the factory.

In Quảng Thạch, current price for fresh cassava for starch processing during the study period average 13,000 VND per 10 kg (Table 7), compared to 15,000-17,000 VND in the last 10 years. Some farmers report receiving offers for as low as 7,000 -10,000 VND. Meanwhile, factory prices for cassava ranged from 16,000-18,500 VND.

Similarly, the lone trader in Cao Quảng reported purchasing cassava in the previous season for 12,000 VND and selling to the factory for 15,000-17,000 VND, netting a profit of about 3000-5000 VND per 10 kg sold.

Table 7. Farm Gate and Factory Prices of Cassava According to Traders

TRADER	FARM GATE PRICE	FACTORY PRICE	FACTORY LOCATION
Quảng Thạch 1	unknown	17,500-18,500 VND	Sông Dinh
Quảng Thạch 2	unknown	unknown	Sông Dinh & Long Giang
Quảng Thạch 3	11,000 VND	17,000 VND	Sông Dinh & Long Giang
Quảng Thạch 4	12,000 VND	16,000-17,000 VND	Sông Dinh & Long Giang
Cao Quảng	12,000–15,000 VND	15,000-17,000 VND	Sông Dinh

Factories. As seen in Table 7, all traders sell cassava to two starch-processing factories, Long Giang and Sông Dinh, located in Bố Trạch district. According to the factory representatives, each factory has one or more agricultural staff that visit farms and villages where the factory purchases large amounts of cassava. They travel most of the year to assist farmers and give recommendations for cassava. However, agricultural staff from the factories have not visited either commune in the last three to five years, but would previously visit and make recommendations about cassava farming practices. The Quảng Lưu farmer said he was regularly visited by factory staff in the past, but their last visit to his farm was two years ago.

The Director of the Sông Dinh factory said that it is important to have model farms to encourage good cassava farming, but he did not cite specific cropping problems or recommendations.

Pressure from Other Crops. In Cao Quảng, land for farming cassava is limited to hilly or sloping lands because low-lying areas near the river are almost exclusively used for rice, peanut, and maize. Upland expansion of cassava farms are also often not possible because farmers are generally not allowed to clear forest to plant crops since the upper hillsides are protected. At the same time, the popularity and abundance of acacia on hilly crop lands have further reduced the land available for cassava. Acacia is harvested after three to six years and cassava can only be intercropped in the first year because of the shade created from the acacia trees.

Even though planting acacia trees is very common among farmers in Cao Quảng (60%), 40% of interviewed farmers, two out of the five focus groups and one trader still claim that cassava is more profitable. They believe so because cassava is harvested annually compared with once every three to six years for acacia. However, most farmers will not transition to cassava while others continue to grow acacia. There is a tendency among farmers to follow what the majority is doing, and they will not change practices unless there is a major transition of all farmers or a more profitable market for cassava.

Meanwhile, farmers in Quảng Thạch are already planting (26.67%) or would like to plant (26.67%) pepper trees instead. Pepper trees are intensely managed and planted generally close to a farmer's house and do not take up much crop land.

Cassava: Gaps between Current Practice and CSA

Farmers in Quảng Thạch and Cao Quảng have grown cassava in the same way for generations and some of their practices may not be considered climate smart. In both communes, the major gaps in practice are cassava stake and row spacing, fertilizer usage, land preparation and erosion control, and the lack of information about pest and disease management.

Crop Spacing. Cassava stakes are planted too closely, at about 40-55 cm apart, while recommended spacing between plants is about 80 cm to 1 meter (Howeler & Maung Aye, 2014). While plants should be grown closer together in poor soil to maximize yield per area, farmers tend to space stakes widely in poor soils and more closely in fertile soils. The Long Giang factory executive recognized that stake spacing is too narrow and he recommended a spacing of 80 cm between plants and 100 cm between rows, which is also suggested in the literature (Howeler & Maung Aye, 2014). This crop spacing may have contributed to the farmers' lack of success in intercropping with cassava, even though intercropping cassava with beans and peanuts have been proven successful in many trials throughout Vietnam (Howeler et al., 2013).

Figure 5. Closely Spaced Cassava in Cao Cảnh Village, Cao Quảng

Fertilizer Use. Some farmers do not apply the optimal mix of fertilizers and generally apply too much phosphorus and too little potassium, while many of the average or wealthier farmers report using more fertilizer than recommended per land area. Additionally, cassava farmers with farm size of 0.5 ha or more use less fertilizer than farmers with less than 0.5 ha. This is likely due to inflated use estimates or greater amendment use on smaller plots of land. It can also be inferred that the application rate of manure and fertilizer on one sào or 0.05 ha could not be sustainably scaled up to a one hectare farm and that farmers could not afford the same rate of application for more land.

In the study sites, nitrogen and phosphorus are often over applied while potassium is under applied. Many farmers also either use compound fertilizers or nitrogen and phosphorus-based fertilizers alone. General recommendations for fertilizing cassava with no soil information is at 80-100 kg/ha of N, 40-50 kg P, and 100-120 kg/ha of K, or 600 kg/ha of compound fertilizer (15-15-15 or 15-7-18) (Howeler & Maung Aye, 2014). Moreover, CIAT recommendations for the sustainable management of cassava suggest increasing nitrogen and potassium inputs and decreasing phosphorus applications over time, something that farmers do not report doing. Supplemental fertilization of nitrogen or potassium should be provided for healthy plant development.

Land Preparation. Many farmers in the six villages already have issues with poor drainage during the rainy season as well as erosion in sloping crop fields. To address this, some farmers use tillage practices that may increase soil compaction and reduce the long-term health of the soil. While it is recommended to use a sub-soiler to improve drainage and reduce potential for cassava root rot (Howeler & Maung Aye, 2014), an excavator dramatically alters soil structure and may create a hard pan layer around 50-60 cm below the surface. Farmers who use these machines claim they improve soil quality and report increases of yield after deep tillage events. But in flood areas, they could reduce water infiltration during the rainy season and cause soil waterlogging, erosion and increase the potential for root rot disease.

While farmers use ditches to channel water around cassava fields, a more climate smart strategy would be to use hedgerows or other living barriers to slow water and reduce erosion. Research in Vietnam has shown the effectiveness of grasses and other plants to slow erosion (Howeler & Maung Aye, 2014). The use of pineapples as a hedgerow was observed on one farm in the study site, but not a surveyed farm.

Knowledge on Pest and Disease Management. Generally, pests are not considered a major issue in both communes, even as some farmers reported occasional major losses of about 20-30% from pests. They seem willing to accept crop losses because they do not have the time, manpower, money or interest in reducing damage from pests; as well as sufficient knowledge about pests and diseases and how to manage them. They are also unable to differentiate between nutritional deficiencies, diseases, and pest issues. Farmers are aware that fertilizer improves plant yields but only one farmer discussed general plant health and using specific fertilizers to improve root or leaf growth.

Sweetpotato: Cropping Practices

While cropping practices are similar for both cassava and sweetpotato, there is a stark difference in that sweetpotato is primarily planted for household utilization as food or animal feed rather than for the market. Farmers responses on cropping practices were less detailed and are often either the same as cassava or unknown. In fact, many farmers were not able to specify the exact size of their farm allotted to sweetpotato, unlike with cassava. Of the 22 farmers who said that they do plant it, many

answered in ranges from 0.5 to 8 sào (Table 8), although majority of the farmers had less than one sào especially in Quảng Thạch. In Cao Quảng, there were more farmers who said that they do not know or are planting only in their home gardens.

Table 8. Farm Size Allotted to Cassava According to Farmers

FARM SIZE (1 sào = 500m²)	QUẢNG THẠCH (n=11)	CAO QUẢNG (n=11)	ALL (n=22)
>1 sào	9	3	12
1-8 sào	1	2	3
Home garden or unknown	1	6	7
Total	11	11	22

These results show that sweetpotatoes are considered a more important crop in Quảng Thạch than in Cao Quảng, but in both communes, its utilization is less than that of cassava. Of the 73.33% of farmers in Quảng Thạch and 40% in Cao Quảng planting sweetpotato within the year (Table 3), only four farmers in Quảng Thạch regularly sell their sweetpotatoes at the local markets, while other Quảng Thạch farmers and all Cao Quảng farmers grow for household and livestock consumption only.

The results of the FGD as shown in Table 9 also reflect this difference in sweetpotato utilization between the two communes, as well as the differences of its use among the villages. The focus group in two of the villages in Quảng Thạch reported selling majority of their sweetpotato produce in the local market, one village said that all of their harvest serves as animal feed, while the rest reported a more balanced use between food, feed, and selling. Those interviewed did not say they consumed sweetpotato leaves, though there is evidence that families in the area do consume them. The harvest and inclusion of leaves in meals is likely routine and done throughout the year, whereas when the entire plant is harvested a majority of the leaves are fed to livestock.

Table 9. Focus Group Discussion Results: Sweetpotato Utilization

LOCATION	GENDER	SWEET POTATO END USE
Quảng Thạch Commune		
Village 5	Mixed	90% local market, 10% animal feed
Village 8	Female	60% animal feed, 40% consumption and selling
Village 8	Male	80% local market, 20% human consumption
Village 3	Female	100% animal feed
Village 3	Male	Consumption, animals, local markets
Cao Quảng Commune		
Cao Cảnh	Mixed	100% human consumption or animal feed
Cao Cảnh	Mixed	100% human consumption
Phú Xuân	Mixed	100% human consumption or animal feed
Vĩnh Xuân	Female	100% human consumption or animal feed
Vĩnh Xuân	Male	unknown

On the contrary, none of the farmers in Cao Quảng sell their sweetpotato harvest. They explained that because of low yields and poor quality due to pests, whatever was left were eaten while the damaged parts are fed to livestock. Despite these differences, cropping practices for sweetpotato are similar in both communes, as discussed in the sections below.

Planting Materials/Varieties. Based on the KIIs with farmers growing sweetpotato, common varieties grown in both communes are Khoai Chiêm dâu and Khoai Đỏ (Table 10). Some farmers also plant a variety that they refer to as "cổ truyền", or traditional, but the exact variety is unknown. For planting material, almost all farmers grow a small patch of sweetpotatoes near their home and take the shoots as needed. If these are not enough, they ask other farmers for planting material.

Table 10. Sweetpotato Varieties Grown According to Farmers

VARIETY	QUẢNG THẠCH (n=11)	CAO QUẢNG (n=11)	ALL (n=22)
Khoai Chiêm dâu	2	2	4
Khoai Đỏ	3	3	6
Traditional	2	2	4
Unknown/no answer	5	4	9
Total	12	11	23

**multiple responses*

Field Preparation. In both communes, farmers always till their fields before planting sweetpotatoes similar to cassava. They then make raised beds and plant shoots at the top of each bed. According to them, planting on the bed crest makes weeding easier because farmers generally weed based on the length of vines down the sides of the bed. Sweetpotatoes are often grown between rice crops and rotated with corns or beans. Because of its short production cycle, sweetpotatoes are often planted in the few months between rice cropping seasons and are rotated with corn or beans.

Planting and Harvesting. In Quảng Thạch, common planting times are July to August and harvest is September to December while in Cao Quảng, limited data show main planting in May or September and harvesting in October or December. Outside of these growing periods, sweetpotatoes are often grown in home gardens for household use and planting material. Crop leaves and small roots are commonly fed to animals while young leaves and larger roots are eaten by the family.

Fertilization. Similar with cassava, farmers also make use of leftover amendments for fertilizing sweetpotato but generally apply less amendment than cassava. The highest manure application estimate in Cao Quảng was 800 kg/sào with focus groups estimating 300-500 kg of applied manure/sào. The most common commercial fertilizer used in the Cao Quảng villages was Kali (P-based) and Đạm (N-based), about 3-10 kg total/sào. In Quảng Thạch, farmers apply between 200-1000 kg/sào manure and 3-30 kg fertilizer/sào, often urea and/or phosphorus amendments.

Most farmers add supplemental fertilizer of urea or Kali, 20 to 30 days after planting or after the first weeding. Use estimates range from 3 to 15 kg fertilizer/sào in Cao Quảng and 3 to 7 kg/sào in Quảng Thạch. Sometimes, additional fertilizer use is dependent on the type and amount of amendment left from other crops.

Weeding. Most farmers in both communes weed their sweetpotatoes once at the same time with adding supplemental fertilizer. While some farmers claim they weed an additional time, many are constrained by labor or do not consider it necessary.

Pest Management. Cao Quảng farmers reported major sweetpotato pest issues, specifically leaf and root eating bugs, which caused a drastic decline in yield in their area. Crop damage from stem borers were also reported by some farmers, as well as a variety of other insects which cause more damage the longer the crop remains unharvested. Inversely, Quảng Thạch farmers did not report any damages from pests in their sweetpotato crops.
None of the farmers in Cao Quảng and only four in Quảng Thạch use pesticides to control pests. Interviews with farmers reveal that majority of them are either unaware of applicable pesticides or were hesitant to spray because of the perceived negative health implications. Those who do use pesticides use Terex, the same insecticide used for cassava.

Disease Management. Six farmers, five from Quảng Thạch and one from Cao Quảng, reported that their sweetpotatoes have crinkled or yellowed leaves, but do not know its cause. Other farmers also experienced diseases but could not describe specific symptoms. A few farmers also mentioned that a combination of poor weather such as drought or heavy rain can increase the effects of disease on their potatoes; however, they do not do anything to prevent or treat the symptoms.

Sweetpotato: Market Factors

As mentioned earlier, data gathered on market factors affecting sweetpotato is significantly limited compared with that of cassava since much of the produce are consumed by the household rather than sold. Two focus groups in Quảng Thạch reported that sweetpotatoes sell locally for 4,000-6,000 VND/kg and 10,000 VND/kg in the off season and are being sold in the local markets for 10,000-15,000 VND/kg.

Sweetpotato: Gaps between Current Practice and CSA

In both communes, poor root quality and yield, as well as limited opportunities to sell in local markets, deter farmers from expanding production. There is, however, a difference in the attitude and the needs of farmers in improving production.

In Cao Quảng, poor quality and inconsistent supply lead to poor public perception towards produce coming from local farmers. Because of this, none of the farmers sell their sweetpotatoes at the local market even though there is local demand and competitive prices. Although the exact cause of the problems are unknown, this study found gaps in terms of poor-yielding varieties and the lack of pest management. The farmers are also either not aware of any alternative or better management techniques or believe that there is nothing that can be done to improve their current practice. Even if they were aware of an improved technology, like an appropriate insecticide, farmers may be trapped in a vicious circle and refrain from using it as long as the quality stigma persists. More intensive research on the root cause of the low yield and quality decline are needed to provide sustainable and long term solutions.

In Quảng Thạch, some farmers can and do sell in local markets, albeit in small quantities and only when there is extra supply or high seasonal prices. Farmers expressed a desire to improve production

through high quality varieties, increased fertilizer use, and more effective pesticides, but capital and inputs currently go to more profitable crops. Despite these, only a few farmers expressed interest in selling or increasing the area for production, and many would rather consume their sweetpotato or use as livestock feed because of competition from other crops and the limited market.

The results reveal that the lack of knowledge on pest management contributes to the reduced quality and yield in the study sites. In addition to these gaps, it is still not certain whether farmers would be willing to invest more in sweetpotato given its fairly low market value. This is a research question that merits further study.

RTC Farmers' Communication Networks

Farmers get information related to cassava and sweetpotato production from different sources, though these sources are consistent across all villages and in both communes. Variation in sources occasionally differed with gender and cassava end use. All identified sources of information relevant in cassava and sweetpotato cropping systems are shown in Table 11 and discussed in the sections below.

Table 11. Sources of Information on Cassava and Sweetpotato Farming

SOURCE	TYPE OF INFORMATION
Family – parents and grandparents	- All cropping techniques including land preparation, planting, fertilizer application, weeding, and pest management
Commune agricultural/ extension officers	- Input use, pesticides - General crop trainings (animals, pepper, acacia) - Finding buyers for cassava
Village farmers (peers/ neighbors)	- Varieties - Fertilizer, other inputs
Village heads	- Ordering manure - Intermediary to local government
Fertilizer sales agents	- Specific fertilizer information - Application techniques
Cassava processing factories	- Varieties - Fertilizer application
Television, radio	- Weather forecasts
Government issued cropping calendar	- Planting dates for other crops, but none for cassava or sweetpotato
Crop traders and buyers (cassava)	- Varieties - Harvesting techniques - Crop prices

Family Members. The primary source of all information about cassava and sweetpotato farming are family members, specifically grandparents and parents. For most cropping practices, farmers and other key informants could not identify a source of the practice; rather it was their knowledge from experience in farming alongside their parents.

***Agricultural/Extension officers*.** There is one agricultural and zoning officer in each commune who is responsible for holding agricultural trainings, identifying crop diseases and pest problems, and recommending pesticides/herbicides. Their role as an agricultural officer is the closest equivalent to an extension officer in the area. They reported that there were no training about cassava or sweetpotato cropping in the past years and recent popular trainings in the communes have focused on pepper in Quảng Thạch and acacia in Cao Quảng, which many farmers and the officers described as high value crops. Agricultural officers get training topics and materials from the government and can ask permission to hold trainings on topics that farmers' request although it is unknown how often this occurs.

Since they experience minimal pest problems and few diseases, farmers have almost no interaction with agricultural officers concerning cassava or sweetpotato production. Interviewed farmers who experienced sweetpotato pests did not talk to the agricultural officer, except a few who got pesticide recommendations. The Cao Quảng agricultural officer said that farmers often contact him to help locate cassava buyers or market outputs, rather than ask questions about cropping issues. Meanwhile, the agricultural officer in Quảng Thạch said that there was a training about cassava recently but the material covered was part of a broader training on fertilizer use, not about cassava-specific cropping practices, but this is not known or attended by any of the farmers interviewed in that area. Both officers said that farmers know how to grow cassava and there are no needed improvements to their cropping.

Village Heads. Farmers said they occasionally get information from the elected village heads, whose role is to engage residents and assemble them for training and events as well as help them with their administrative needs. Individuals in these leadership positions are seen more as a conduit of information from the commune leadership and agricultural officer rather than a source. A few farmers said they might ask the village head questions about cassava or sweetpotatoes if they had a pest or disease problem. In at least one village in Cao Quảng, village heads can order manure for farmers. Five of the six village heads are also farmers and grew cassava, except the village head of Vĩnh Xuân in Cao Quảng.

Village Farmers (peers/neighbors). Within villages, farmer cropping practices are very similar because of the regular and close influence of neighbors growing the same crops. Some farmers said they adopted fertilizing techniques or purchased new stakes from other farmers in their village or commune. If one farmer has higher yields, his neighbors are likely to copy his practices and over time the sweetpotato and cassava systems are nearly identical. In both communes, female family members participate in work groups that allow them to work in each others farms and perform the same tasks.

Furthermore, friends and neighbors trade stories and advice during these planned events as well as during social gatherings in the evenings, usually in separate female and male groups. Farmers often do not try to actively influence others and do not talk about farming practices unless directly asked, even about material from trainings they attend. Many farmers said that if a crop does badly, it is their own fault and they do not expect or seek help from neighbors or agricultural officers as they are highly self-reliant and feel solely responsible for problems.

Fertilizer Sales Agents. These sales agents occasionally visit the communes and organize trainings that focus on the correct application and use of a specific commercial fertilizer. In 2015 to 2016, a Đầu Trâu fertilizer representative held trainings Cao Quảng, and taught farmers about the company's recommendations for fertilizer application. Đầu Trâu is now the most popular fertilizer in the commune and almost everyone interviewed claimed it was the most effective. Fertilizer companies

will also host trainings for input sellers, though it is unclear how often these occur or who is invited.

Factories and Field Staff Officers. The Long Giang and Sông Dinh cassava starch factories are also sources of information about cropping practices and varieties, but only for farmers that have direct contact with the factory, either from trading directly or visiting specifically for information. Farmers who visited the factories to specifically seek out information all perceive themselves to be financially well-off. Traders selling to either of the factories said that the factories and the farmers living around them were information sources.

According to an executive at Long Giang factory, farmers ask questions related to cassava selling and prices, and rarely ask about cropping practices. Long Giang has a university-trained agricultural staff that travel in Quảng Bình province and make cropping recommendations.

On the other hand, a Sông Dinh factory executive said that farmers commonly ask about fertilizers, land preparation and varieties. The factory has two staff members that work as quasi-extension officers within the areas they buy from. They also have six to seven small model farms in Bố Trạch and Lệ Thủy. The executive said that it is imperative for farmers to see demonstration plots or they will not adopt recommended practices.

Traders. Local cassava traders are only source of price information for farmers since only a few farmers reach out to the factories directly to ask the current price. All traders contact one of the two factories to learn the current price and then decide what price to offer farmers based on their transportation costs, labor costs and desired profit margins. Traders also have an important role in bringing new cassava stakes to village farmers from the factories or other areas. Moreover, traders often farm cassava themselves and are well aware of the issues encountered by farmers.

Mass Media. All farmers get daily weather forecasts from television broadcasts as well as weekly forecasts from the radio. There is also a daily weather broadcast over the speaker system in the early morning in each village. Only the Cao Quảng trader checks the 10-day forecast using a smartphone.

***Cropping Calendar*.** The commune government prints a yearly calendar with recommended dates for planting different crops. Farmers do use the calendars for reference, but the guide does not include recommendations for sweetpotatoes or cassava cropping.

Farmers' Groups. There are many village and commune-wide organizations that farmers can join including the farmers' union, farmers' group, women's group, and veterans' group, although it is unclear which groups are at the village or commune level. The primary function of these groups is to help farmers acquire loans from the Vietnam Bank for Agriculture and Rural Development (AgriBank). The majority of the loans are used for purchasing animals, though some use the loans for machinery and other farming expenses. The farmer's union has two to three yearly meetings and the leaders discuss cropping information given to them by the local government. These farmers' meetings focus on particular crops or a farming subject, but never cassava or sweetpotatoes.

Gaps in RTC Farmers' Communication Networks

Based on the KIIs and FGDs done on the farmers' communication sources in Quảng Thạch and Cao Quảng, this research was able to identify gaps in RTC farmers' communication networks and practices. It found that in both study sites, the farmers' knowledge of cassava and sweetpotato are almost

exclusively based on interpersonal communication with family and other village farmers. Farm work often keep adults within or near the village and majority of their social activities occur in the village, such as men and women socializing in separate groups in the evening. There are also commune-level communication channels because of the commune agricultural officer, farmers' participation in civic groups and proximity of neighboring villages.

It can also be observed based on the interviews that farmers rarely interact with people outside their commune, except for more well-off farmers who visit Ba Đồn or other towns, sell directly to factories, or have family and other affiliations outside of the area.

The KIIs revealed that individual farmers have little expectation that someone should help them improve their cassava or sweetpotato cropping systems. When presented with a hypothetical situation of high crop losses, most farmers said they would take no action and try again the next year. Farmers said that they do not seek help for crop issues with cassava and sweetpotatoes because they are generally unimportant, compared to crops bringing in more revenue like peanuts or pepper.

In terms of gaps that stem from the farmers' information sources, results reveal that while traders, agricultural officers, local farmers' groups, and cassava starch factories may serve as primary information sources on more effective RTC farming practices; this is not the case in both the study sites. In fact, they appear to have little influence on the farmers' present farming practices.

For instance, traders may hold some influence over farmers because of their purchasing power and connections to diverse networks. It would also seem that they are potentially a major source of information about RTC cropping because of their larger interpersonal network. In fact, many of the traders interviewed buy cassava from other districts where they are exposed to different varieties or new information; as well as any information that may pass from the factories when they sell their cassava. However, this is not the case, probably because many of the traders also farm cassava and come from agricultural families, thus they have some homophily with farmers. They also oftentimes remain an outsider in their community due to their wealth and the farmers' perception that they are untrustworthy and offer low prices.

Meanwhile, the agricultural officers' small role in RTC communication is likely due to the limiting nature of their work and their most useful role to farmers is likely connecting them to cassava traders. For one, only part of their time is spent doing actual extension work, since much of it is prescriptive in nature, like recommending pesticides. They also spend a lot of time setting up farmer trainings, which have not focused on cassava or sweetpotatoes in many years. Also, similar to farmers, the agricultural officers also believe that no further improvements can be made to these cropping systems on the farm level.

Local groups like the farmers' union, farmers' group and women's group are a major part of the social and economic fabric of villages because of their role as loan brokers, but also seem to have little influence in RTC cropping practices. The positions in the group are held by neighbors and friends, but the usefulness or diffusion of information presented to farmers or passed from local government officials like agricultural officers is unknown.

Although they are a major part of the market chain for starch cassava production, factories seem to have less influence on farmers the further they are from the factory. Most farmers have never visited either of the factories and have not interacted with their extension staff. In addition, with the high cost costs of transporting cassava from either of the communes, farmers that are father away earn less per

kilogram of harvested cassava than farmers closer to the factories. It is also unclear whether farmers in the two communes are aware of Long Giang's recommendation to increase crop spacing and use more fertilizer, or if the factory is relaying this message.

Gender and Information Access. Almost all individuals and focus groups participants maintain that men and women have equal access to information and resources. They attend the same meetings and trainings and are usually involved in farming since childhood. One female farmer in Cao Quảng said that men find out new information more easily because they travel more often than women. Traders and some male farmers have visited factories and farmers in other regions while on business or for interest, while no female, except the Cao Quảng trader, had been to a factory or to farms outside their commune. However, it is not clear how, or if any pertinent outside information is disseminated from one farmer once it reaches the commune or village, therefore any information from factories or travels to other areas may only be known to a few farmers.

CONCLUSION AND RECOMMENDATIONS

Cropping Practices

It can be concluded from the results of this research that it would be beneficial for farmers to change some of their practices into more climate smart cropping strategies. In cassava systems, changes could include adjusting fertilizer use, modifying crop spacing, and reducing deep tillage. For sweetpotato production, farmers could benefit from learning preventative pest management strategies. Intercropped systems are another option, though farmers' past attempts will likely make them hostile to trying again, and the strategy could be ineffective if crop spacing is not modified.

In addition to these, the researcher recommends the following specific climate smart cropping practices for cassava and sweetpotato:

1. While farmers use ditches to channel water around cassava fields, a more climate smart strategy would be to use hedgerows or other living barriers to slow water and reduce erosion. Research in Vietnam has shown the effectiveness of grasses and other plants to slow erosion (Howeler & Maung Aye, 2014).

2. Cassava stakes are planted too closely, at about 40-55 cm apart, while recommended spacing between plants is about 80 cm to 1 meter (Howeler & Maung Aye, 2014). Field research has shown that plants should be grown closer together in poor soil to maximize yield per area, yet farmers tend to space stakes widely in poor soils and more closely in fertile soils. This crop spacing may have contributed to the farmers' lack of success intercropping with cassava.

3. Many farmers use either compound fertilizer or nitrogen and phosphorus-based fertilizers alone. Nitrogen and potassium inputs should increase over time and phosphorus applications should be reduced (Howeler & Maung Aye, 2014), which farmers do not report doing.

However, research results show that the most significant gap in RTC cropping in Quảng Thạch and Cao Quảng is not information, but rather access to markets and varieties. Improving market access and farm gate prices could encourage farmers to expand production of RTCs and participate in markets. This intervention should be coupled with the introduction of new varieties that grow well in poor soils or are resilient to pest damage.

It is also recommended that any intervention for improving RTC production should be made site specific and based on more rigorous examination of the actual needs of farmers. This is to overcome the social and structural barriers to change in cropping practices and entry into markets that are unique to each of the study sites, including:

Cassava

1. Inaccessibility of Phú Xuân and Vĩnh Xuân villages in Cao Quảng due to seasonal floods, which limits the ability of farmers and traders to transport their crops.
2. Low buying prices in the cassava processing trade center in Cao Quảng, likely driven by the limited number of local traders and high transportation cost to factories. Currently, it is more economical to grow cassava for livestock feed and harvest the crop over a long period of time rather than to sell to traders.
3. The mindset of farmers in Cao Quảng, wherein cassava is not treated as an income generating crop, which deter farmers from making changes to their cropping system that would require more labor or inputs.
4. The limited willingness and interest of farmers in both communes to embrace new technologies and innovations due to lack of perceived benefits, except for a call for more fertilizers. Very few farmers also expressed interest in expanding their cassava operation and most are eager to plant other crops that currently bring higher profits.

Sweetpotato

1. Low yields and pest problems in sweetpotato from Cao Quảng that leave farmers with limited marketable product and a stigma for low quality.
2. The low interest of Quảng Thạch farmers to sell their sweetpotato, since they would rather consume it or use as livestock feed.
3. The competition from more profitable crops and the limited market in both communes that deter farmers from expanding sweetpotato production.

Farmers' Communication Networks

On the gaps in farmers' communication networks, this research recommends that efforts should focus on interventions that improve access to accurate, appropriate and up to date information on cassava and sweetpotato production. Interventions should also take into consideration that most information about the farmers' present farming practices comes from family members. Outside the family, farmers communicate with few groups of people – mostly neighboring farmers, local government officials, and input suppliers, and traders. Village and commune life is fairly insular and information passes through farmer working groups and direct observation of other's cropping activities, along with discussions during social gatherings. These farming communities are very homogenous and have few links with outside actors or networks.

While more formal communication channels are present such as local farmers' groups, government extension officers, traders, and factories; their utilization as information sources for RTC are often limited. Local groups are most helpful for providing loan assistance and extension officers are valuable for their connections to possible market actors and prescriptive recommendations for crop issues. Cassava buyers are the primary source of cassava price information for farmers and do not share any other information. One starch factory has cassava cropping recommendations that could be

considered climate smart, but there is no evidence that their recommendation reaches farmers in the communes surveyed. These channels could be further explored and taken advantage of as conduits of information on RTCs in the project sites.

This research also highlights the common occurrence of farmers in one area imitating each others' practices or going with the majority. Therefore any proposed changes to their current RTC farming practices are likely to be taken up by either by all or majority of farmers, or by none or very few.

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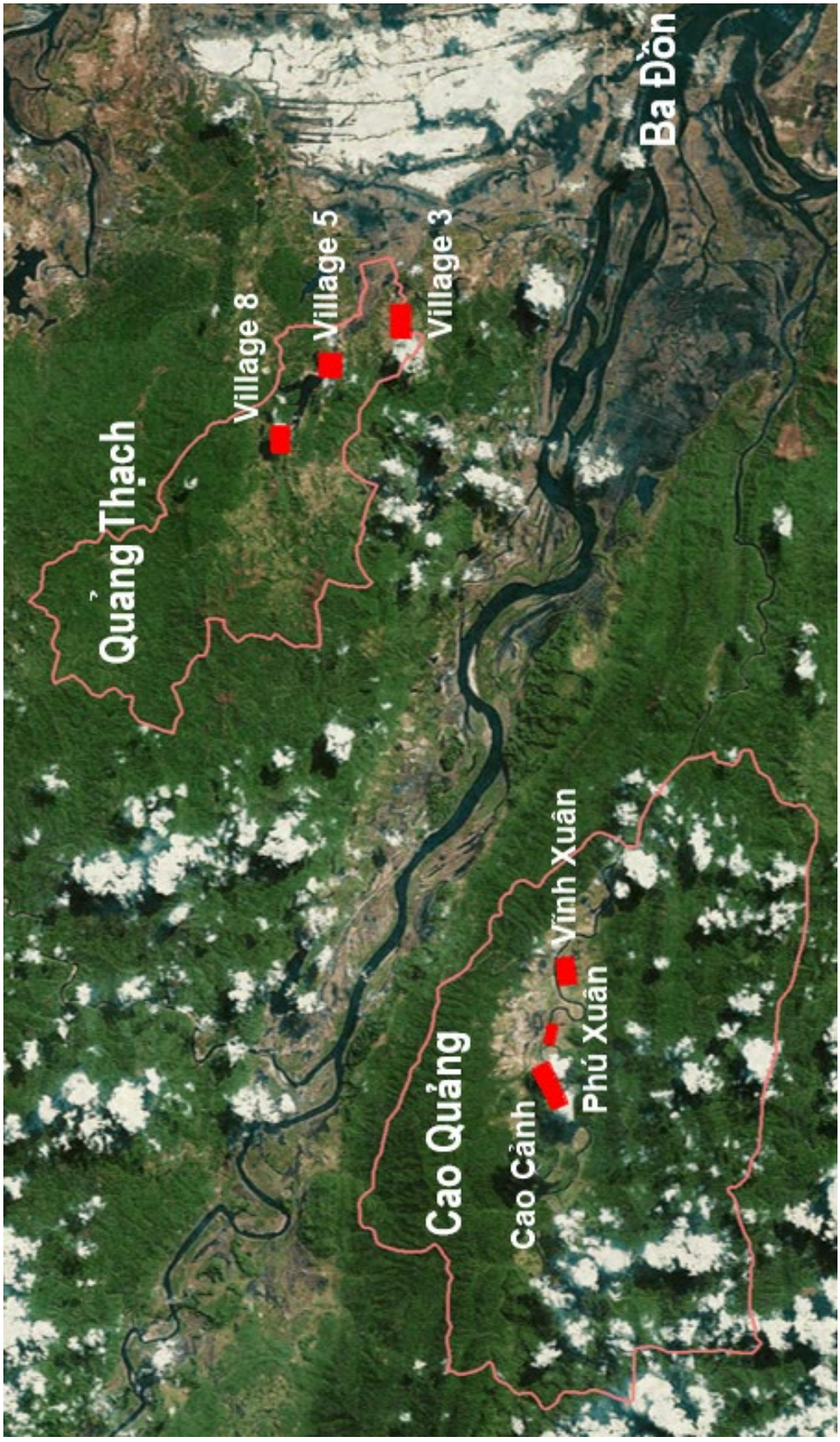
ANNEXES

Annex 1. Map of the Region and Location of Surveyed Villages



Annex 2. Focus Group Discussion Facilitators' Guide

Time:
Location:
Facilitators:
Translator:
Participants:

No	Name	Village	Phone
1			
2			
3			
4			
5			
6			
7			

1. Livelihoods

- What are the different crops and activities that provide income in this village?
- Are there any sources of income from outside of the village e.g. money from government, money from relatives working outside Vietnam, etc.?
- List on paper the different crops/livestock and choose and rank the three most important to each farmer.

2. Cropping calendar

Objectives:

- Identify major events and time periods in the farmer's RTC cropping season
- Characterize when inputs are applied and purchased
- Identify major constraints to farmers cropping

- What does a RTC cropping season look like? When are the major weather events for farmers during the season?
- Materials needed: Large squares of paper, colored markers, post it notes.
- Things to record on calendar: time of rains and amounts, planting, harvesting, weeding, pesticide, droughts, different cropping activities, when inputs purchased, when sell, times of major problems – marks of what farmers agree with.

3. Value chains

Objective:

- Identify cassava and sweetpotato value chains currently in place in the villages.

- What happens to cassava and sweetpotatoes after harvest?
- Who are the actors involved from harvest to processing such as farmer, trader/collector, processor, end product?
- What is the percentage of product going to processors, animal feed, home consumption, etc.?

4. Institution venn diagram (can skip if short on time)

Objectives:

- Identify institutions, organizations, groups and important persons active in the community
- Identify who participates in local organizations by gender and wealth

  - How organizations relate to each other and to farmers in terms of contact, cooperation, flow of information and services
- What groups work in or with the community?
- What groups are most important and why?
- What groups address farming practices/extension?
- Are there groups meant for women or men only?
- Are some groups of people excluded from being members or receiving info from some institutions?
- What groups found in the village or nearby that work with villagers? Also include non formal groups.
- How do these groups assist villagers, what services do they provide? Are they organized around environmental, economic, social, agriculture, etc.?
- How important are these groups to the villagers? How much contact between villagers and the institutions?
- How do farmers benefit from each organization?
- Can everyone participate in these orgs? Men/women? Poor farmers?

5. RTC Challenges

- What are the problems farmers face growing cassava and sweetpotato? Any limitations? Vote on the top three.

Annex 3. Farmer KII Guide Questions

Time:
Address:
Interviewer/s:
Translator:
Interviewee:
Sex:
Age:

1. Who are the members of this household? Describe in terms of age and occupation.
2. How many years did you spend in formal education?
3. How many years of general farming experience do you have?
4. What is the size of your whole farm?
5. Do you rent or own the land?
6. What are your main activities for income?
7. What is your yearly income?
8. What crops do you grow for income and consumption through out the year?
9. What RTCs do you grow or have grown before?
10. How many years have you been farming cassava/sweetpotato?
11. What is the size of your cassava/sweetpotato farm?
12. How import is farming cassava/sweetpotato in your household income?
13. Fill out chart:

Crop	Area	Percent of income	Trend	End uses (%)

14. Describe your cassava/sweetpotato yield and trend in land use.
15. What is done with the harvested cassava/sweetpotato?
16. Do you use these? How would you describe your access (rate: good, okay, poor)?

    - Loans from bank or other organizations: Are they easy to get?
    - Inputs fertilizer/pesticides
    - Machinery and tools tractors, motorbikes, processing equipment, etc.
    - Labor outside of family
    - Planting material stakes and vines

17. How do you pay for fertilizer and other inputs? Do you pay for all of it at once?

18. Do you buy all the fertilizer you need or do you want to purchase more? Explain.

19. What farming practices do you use for cassava/sweetpotato and where did you get the information/why do you do it that way?

    - Field preparation tillage, fertilizer, manure
    - Planting material variety, source of stakes/vines
    - Planting time, stake direction
    - Soil care,intercrop, erosion
    - Weeding frequency, herbicide use, time of application
    - Fertilizer and manure application type of fertilizer, mode of application, amount applied, how often
    - Pest management treating stakes, resistant varieties, crop rotation, stake selection, pesticide use
    - Harvesting time of harvest, method, storage, residue management

20. Where do you get information about the weather?

21. Where do you get information about cassava/sweetpotato prices?

22. If you had a problem with cassava/sweetpotato or wanted to know something about the plant/pests/etc., who would you ask and why?

23. Do you think men and women use the same information sources? If no, what are the differences?

24. Have you attended any government extension trainings? On what topic? How long ago?

25. Have you ever tried any new practices to help your cassava/sweetpotato?

26. Is there anything you do differently in your cassava/sweetpotato farming that you didn't do five years ago?

27. What is the biggest problem with your cassava/sweetpotato? If you could improve something about your practice what would it be??

28. Do you think you will continue to grow cassava/sweetpotatoes in the future? Why or why not?

29. What price does cassava/sweetpotato need to be for you to continue growing it? What price would make you grow more cassava/sweetpotato?

30. What would you like to grow in the future?

The International Potato Center (known by its Spanish acronym CIP) is a research and development organization with a focus on potato, sweetpotato, Andean roots and tubers. CIP is dedicated to delivering sustainable science-based solutions to the pressing world issues of hunger, poverty, gender equity, climate change, and the preservation of our Earth's fragile biodiversity and natural resources.

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The International Center for Tropical Agriculture (CIAT) develops technologies, methods, and knowledge that better enable farmers, mainly smallholders, to enhance eco-efficiency in agriculture by making production more competitive and profitable as well as sustainable and resilient through economically and ecologically sound use of natural resources and purchased inputs.

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The CGIAR Research Program on Roots, Tubers and Bananas (RTB) is a broad alliance led by the International Potato Center (CIP) jointly with Bioversity International, the International Center for Tropical Agriculture (CIAT), the International Institute for Tropical Agriculture (IITA), and CIRAD in collaboration with research and development partners. The shared purpose is to tap the underutilized potential of root, tuber and banana crops for improving nutrition and food security, increasing incomes and fostering greater gender equity, especially among the world's poorest and most vulnerable populations

www.rtb.cgiar.org

Food Resilience through Root and Tuber Crops in Upland and Coastal Communities of the Asia-Pacific (FoodSTART+) is a three-year project (2015-2018) that builds on and expands the scope of the recently-concluded IFAD–supported Food Security Through Asian Root and Tuber Crops (FoodSTART) project. It is coordinated by the International Potato Center (CIP), in collaboration with the International Center for Tropical Agriculture (CIAT) in Asia. The project is also working closely with the CGIAR Research Program on Roots, Tubers and Bananas (RTB); and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). It is funded by the International Fund for Agricultural Development (IFAD) and the European Union (EU).

The project aims to enhance food resilience among poor households in upland and coastal communities of the Asia-Pacific region through introducing root and tuber crops (RTCs) innovations. To achieve this goal at scale, the project will develop, validate and implement effective partnership strategies with IFAD investment projects to promote RTCs for food security.

FoodSTART+ is being implemented in four primary beneficiary countries; specifically Meghalaya State in India, Maluku Islands in Indonesia, Eastern and Central Visayas Regions in the Philippines, and Quảng Bình Province in Central Vietnam. Supplementary beneficiary countries are China and Myanmar.