AGB/2012/078
Developing value-chain linkages to improve smallholder cassava production systems in Vietnam and Indonesia

Mid Term Review Summary Report
Son La

January 2018

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Country Information

Production Statistics

Cassava production in Vietnam increased from around 350,000 tons in 2001 to almost 1.1 million tons in 2016. During the same period, cultivated area roughly doubled, from 292,000 hectares in 2001 to 570,000 hectares in 2016. The significant increase in yield over the same time period is due to the introduction of high-yielding varieties in the early 2000s.

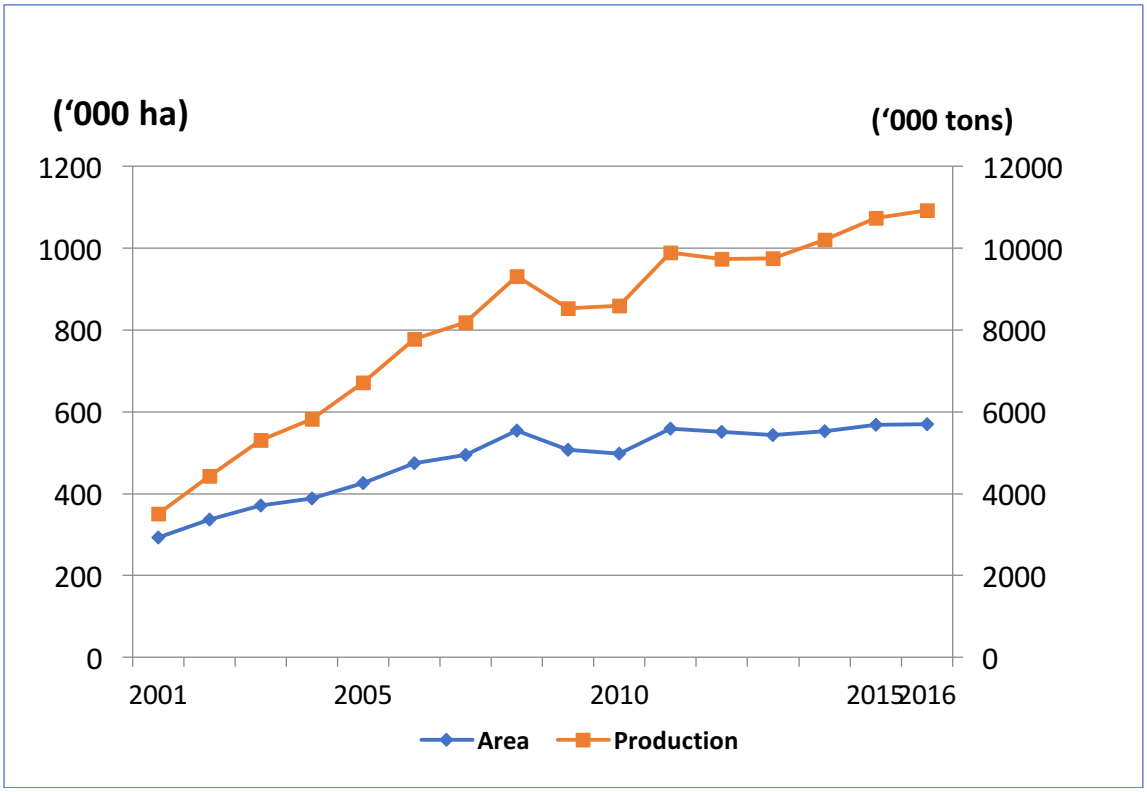

Figure 1: Cassava Cultivated Area and Production in Vietnam 2001-2016

The main cassava producing regions in Vietnam are shown in Table 1. North Central Coast has the highest total production level, but the highest yield among the regions is in South East, at almost 26 tons per hectare.

Table 1: Cassava planted area and production, by region, Vietnam (2016)

Region	Planted Area (ha)	Production (t)
Northern Mountains	117,000	1,485,500
North Central Coast	174,000	3,027,500
Central highlands	149,500	2,542,000
South East	96,000	2,485,000

Processing Statistics

In 2014, there were 94 cassava starch processing factories, producing a total of 2.2 - 2.3 million tons of starch per year. Tay Ninh province alone has 41 starch factories. There 6

ethanol processing plants in the country, but only 3 (Tung Lam, Dai Viet, Nhiên liệu sinh học miền trung) are currently operating. These 3 factories are operating at 50-60 percent of capacity, using 130,000 tons of cassava chips per year.

Trade Statistics

Vietnam exports both fresh roots and starch with a total export value of more than USD1 billion per year. The main market for both starch and chips is China, accounting for more than 85 percent of exports. The remainder is mostly destined for other markets in Asia, including Taiwan, Philippines, Malaysia and Indonesia.

Project Activity Locations

Project activities in Vietnam are being undertaken in two provinces. As shown in Table 2, Son La and Dak Lak both have significant areas of cassava production, and the combined production of the two provinces account for around 10 percent of Vietnam's total cassava production. Differences in agroclimatic conditions, ethnic groupings, value chain linkage levels and the level of commercialization mean that the two provinces have sufficient contrasts to allow very interesting comparisons to be made between value chains in differing locations.

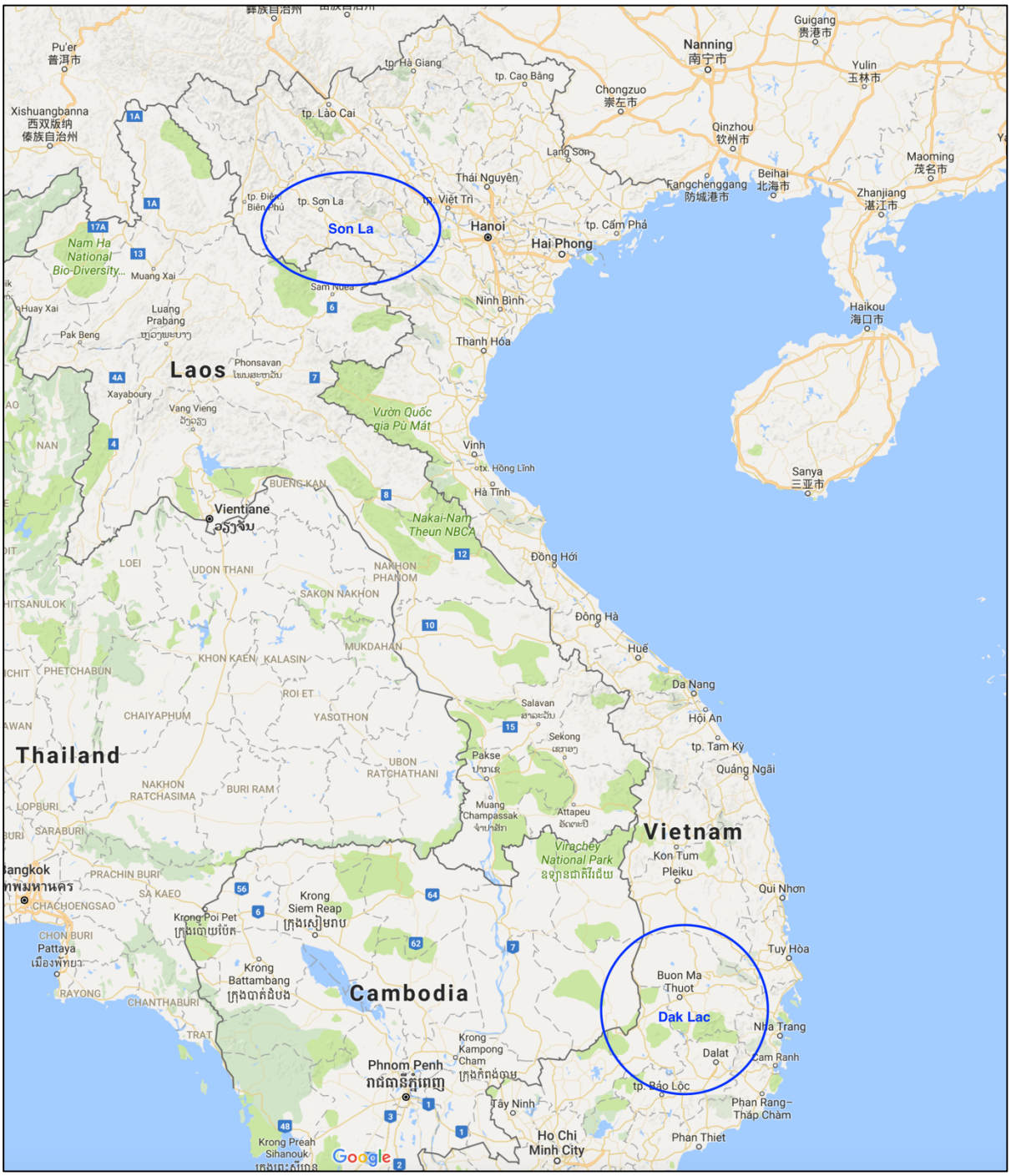

Figure 2: Research Locations, Vietnam

Table 2: Characteristics of cassava production by site, Vietnam (2013)

Province	Area of cassava (ha)	Average fresh yield (t/ha)	Annual Production (t)	Main industries	Number of factories
Dak Lak	25,720	18.4	473,248	Starch, Ethanol Dry chips (industrial)	5 starch 1 ethanol (Dak Nong)
Son La	31,216	11.5	359,485	Starch Dry chips (industrial)	2 starch

Province Information

Production Statistics

Son La is one of the major cassava producing provinces in Vietnam, with increased demand leading to production increases between 2001 and 2011. The increase in production can mostly be accounted for by significant increases in planted area and some small increases in yield (Figure 3). Production has remained relatively stable since 2011, reflecting the influence of government policy as well as the increasing attractiveness of alternative crops – especially Arabica coffee.

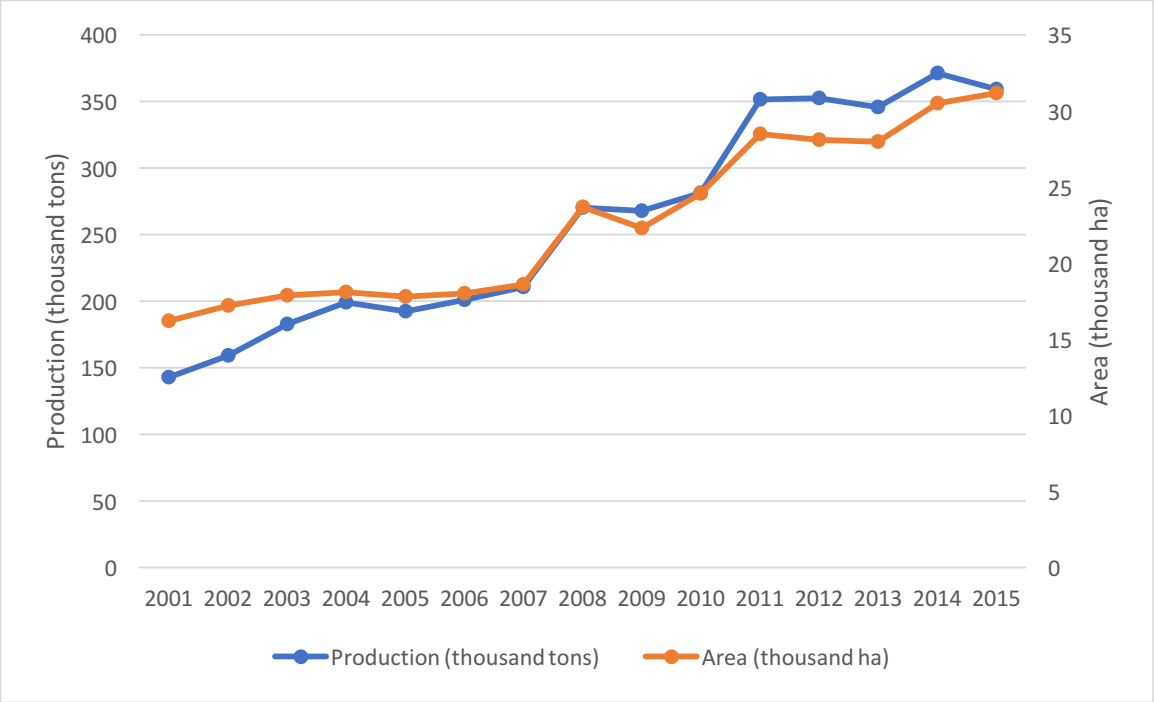

Figure 3: Production and Planted Area of Cassava 2001-2015, Son La

Processing Statistics

The Son La Starch Processing Factory is owned by the Fococev conglomerate[1]. Fococev are a recently privatized (since May 2016) former state-owned food product investment company with a total of 12 cassava starch processing factories under their ownership. Fococev purchased the factory in 2012 for VND10billion from the Son La provincial government and since that time have invested a total of more than VND60 billion in upgrading equipment and installing a biogas digester. Prior to the involvement of Fococev, the factory had not been operational since 2003 due to the limited investment capacity of the province, especially to meet environmental standards.

In 2015-2016 the factory purchased around 40,000 tons of fresh root and produced around 11,900 tons of starch. Production season lasts from mid-October to early April and the factory employs 90 workers on a full-time basis and 25 seasonal workers on contract. Figure 4 shows a summary of the product flows and values for the 2015-2016 season for the factory.

The factory purchases fresh root from two main sources. A total of 30 percent of the fresh root supply is purchased from around 80 local traders from Mai Son. These traders are small

[1] http://fococev.com/vn/trang-chu/

scale and generally deliver product in 10 ton trucks. The majority (70 percent) of procurement is from 20 traders from different districts within the province. These traders use 40 ton trucks to deliver fresh roots to the factory.

The average price paid for fresh root over the course of the season was VND1540/kg with an average starch content 26.8 percent. This was the same for both smaller collectors from Mai Son and for larger traders from other districts of Son La. The factory buys the fresh root from traders without using written contracts and pays either with cash on the spot or through bank transfer if required. Even without formal written contract arrangements, the links with the collectors and traders are relatively stable and long lasting.

When they first took over the factory, Fococev undertook a contract farming system with groups of farmers in Mai Son and other districts. Under the contract farming arrangement they provided planting material and advanced funds for fertilizer. However, they no longer have any contract farming system as they lost money due to farmers side selling.

All of the sales of starch produced by the factory are handled through the marketing department of Fococev. Around 90 percent of production is exported to China through Mong Cai border gate, with the remaining 10 percent destined for other Asian export destinations including Korea and the Philippines as well as domestic noodle and paper producing enterprises.

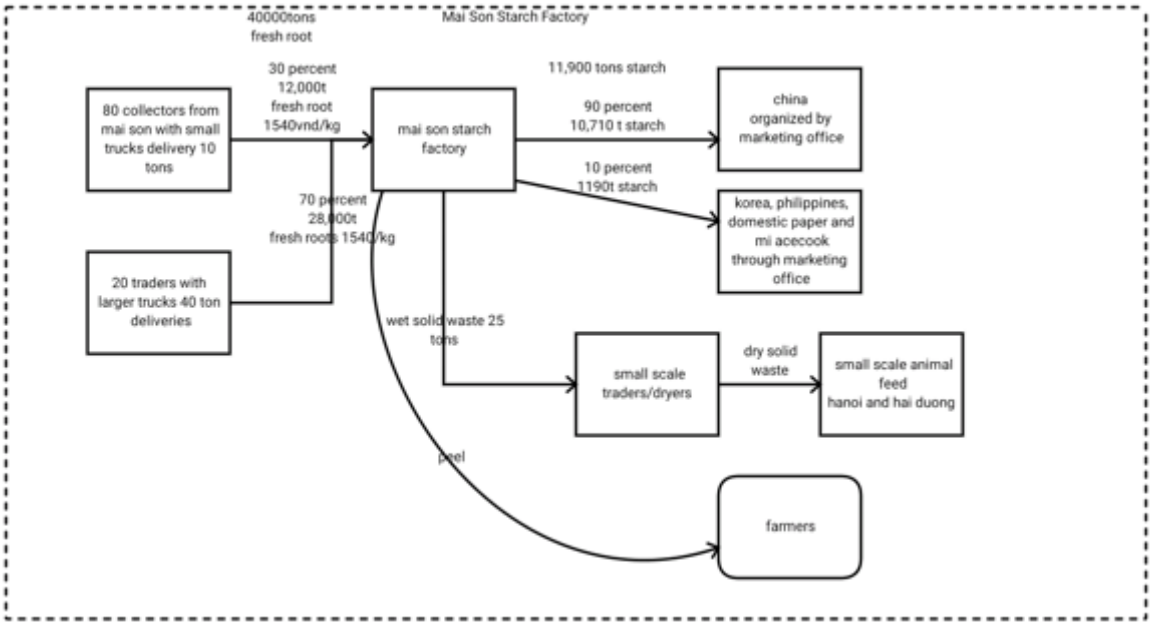

Figure 4: Product flows and values, starch factory, Mai Son, Son La

Value Chain Information

The cassava value chain in Son La has two main end products – cassava starch and cassava chips. Regardless of the end product, almost all of the processing occurs within the province and almost no fresh root is transported out of Son La for processing in other provinces.

The cassava chip value chain is significantly larger than that for starch, accounting for almost 90 percent of the total annual production of fresh root. The one large scale starch factory in the province (Mai Son starch factory) consumed around 40,000t of fresh roots in 2015, with the balance of production (around 320,000t of fresh roots) being utilized to produce dried cassava chips.

There is significant cassava processing in Mai Son, including starch processing at the Son La Starch Processing Company, and dry chip processing by numerous small and medium scale enterprises at or near the airport. In addition to the concentrated processing in Mai Son, farmers in other districts also produce relatively small amounts of dried chips, usually either for livestock feed, because they were unable to sell fresh root, or because the price of cassava chips was relatively favourable at the time. This small-scale farmer processing accounts for an estimated 5000t of the 125,000 tons of chips produced annually in the province.

Small scale collectors generally purchase fresh roots directly from farmers at, or close to their fields and transport roots in 1t -3t trucks to commune centres. Small traders with 10t trucks are based at commune level and purchase fresh roots from the small-scale collectors. In Mai Son district and in the south-east of Thuan Chau district, the communes are located relatively close to the starch factory and chip processors. Small traders from Mai Son and Thuan Chau transport fresh roots purchased from collectors directly to processing into chips or starch. In addition, small traders from Mai Son also travel to nearby districts and purchase fresh roots from collectors.

In the north-west of Thuan Chau district and in other more remote districts of Son La, the long distances from communes to the starch factory or chip processors makes it impractical for many small traders to transport fresh roots from commune to processor. In these areas a significant proportion of the fresh roots is brought by small traders to larger traders based along the major roads of the province. These traders transport the fresh roots in 40t trucks to chip processors based in Mai Son district and to the Mai Son starch factory. The large traders also transport dry chips directly to chip traders located in Mai Son.

Starch produced by the Mai Son starch factory is predominately for export, with around 90 percent destined for China and 10 percent for Korea, Philippines, Taiwan and the domestic market. Dry chips are sold to animal feed production companies in Son La and Hoa Binh as well as for export.

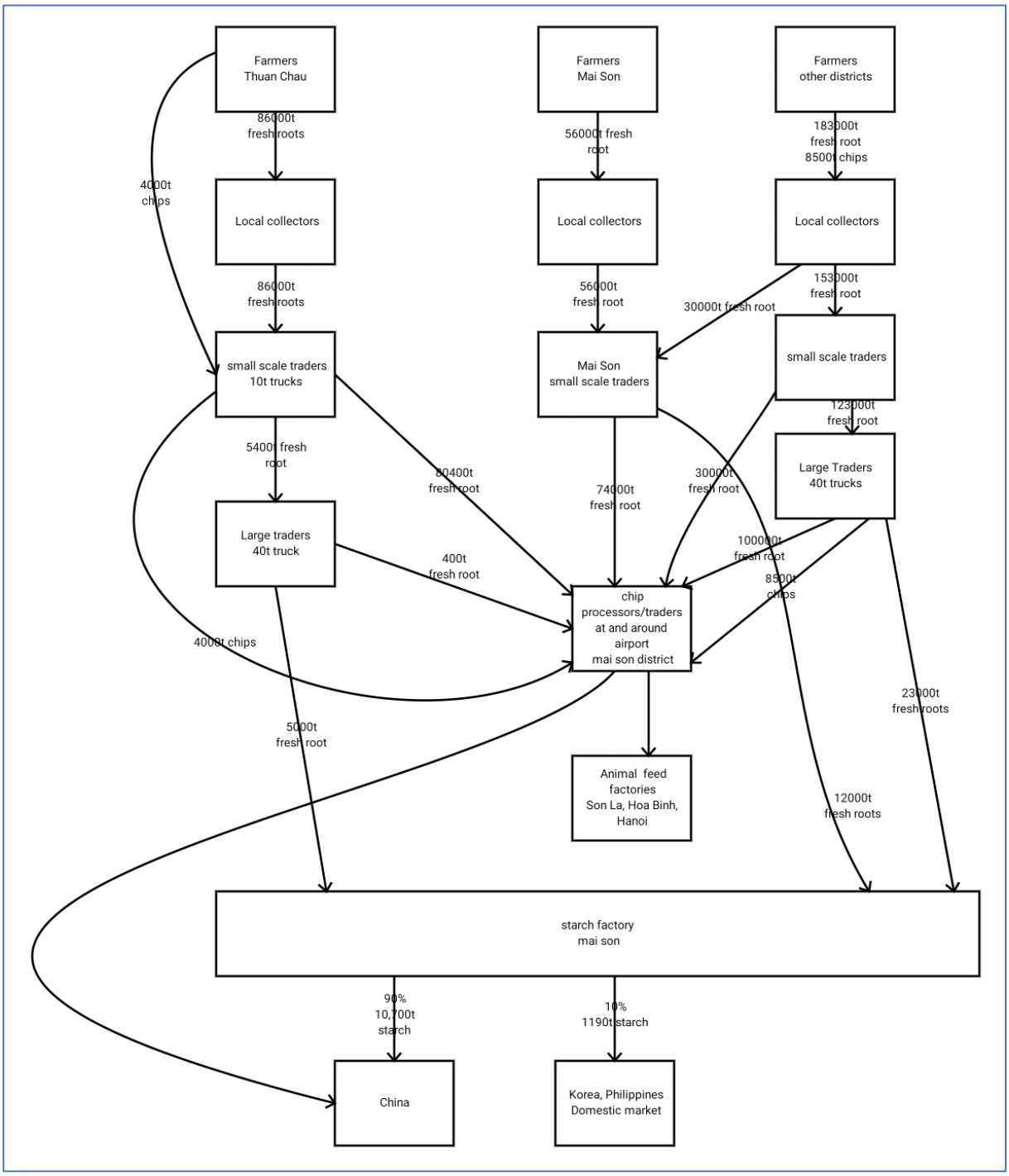

Figure 5: Son La Value Chain Map

The farmgate price for fresh roots paid by collectors was around VND1000/kg, collectors then sold to small traders at commune level for around VND1100/kg. Small traders in Mai Son and in the South East of Thuan Chau who were able to sell directly to the starch factory or chip processors in Mai Son were able to gain a selling price of VND1400-1550/kg. Small traders in more remote areas of Son La sold to larger traders at a price of around VND1200/kg. The large traders then sold to the starch factory or to chip processors at VND1400-1550/kg.

Table 3: Prices of fresh cassava root for different value chain actors in Son La (2015)

Value Chain Actor	Buying Price	Selling Price
Farmer		VND1000/kg
Collector	VND1000/kg	VND1100/kg
Small Trader	VND1100/kg	VND1200/kg (sale to large trader) VND1400-1550/kg (sale to processor)
Large Trader	VND1200/kg	VND1400-1550/kg
Starch Factory	VND1400-1550/kg	
Chip Processor	VND1400-1550/kg	

Despite the presence of numerous layers of actors (and in many cases the long distance) between farmers and processors, the farmgate price even in remote areas of Son La is between 65 and 70 percent of the price paid by processors.

The price for dry chips paid by collectors to household processors was around VND3200-3300/kg, collectors then sold to small traders at commune level or large traders at district level for around VND3400/kg. Traders sold to the chip processor/traders in Mai Son district at around VND3600-3700/kg. Selling price for the chip processors/traders in Mai Son district is around VND4000/kg. Farmgate price is around 80 percent of the factorygate price.

Table 4: Prices of dry cassava chips for different value chain actors in Son La (2015)

Value Chain Actor	Buying Price	Selling Price
Farmer/household chip processor		VND3200-3300/kg
Collector	VND3200-3300/kg	VND3400/kg
Small/Large Trader	VND3400/kg	VND3600-3700/kg
Chip Processor/Trader	VND3600-3700/kg	VND4000/kg

Information Flows

Despite the many value chain actor layers and (in many cases) significant geographic distance between farmers and processors, the transmission of price information through the network of traders and collectors works relatively efficiently. Collectors reported basing their purchase price decisions on the prices offered by small traders at commune level. Small traders based their purchasing price decisions on the prices offered by larger traders and processors. Large traders based their purchase price decisions on the price offered by processors.

Value chain actors at all levels used mobile phones frequently to contact buyers for updated price information. In the absence of formal contracts with price guarantees, basing purchase price decisions on frequently updated information on selling price can be seen as an effective risk minimization strategy.

Information on the relative price of fresh roots and chips and on the levels of demand for each product also is transmitted relatively well through the value chain, with farmers and collectors reporting that they were able to base their decisions on whether to make chips or sell fresh roots on information received from small traders at commune level.

Relationships

Before being bought by FOCOCEV, the Mai Son starch factory purchased a proportion of their fresh root inputs from farmers and traders through a contract supply system which included specified price, quantity and delivery times. Faced with declining market prices and

increasing instability in the market, FOCOCEV does not use a contract system for procurement and now buys on a spot market basis.
Mai Son factory purchases the majority of inputs from medium and large scale traders from many districts within Son La. The factory has long-term relations with these traders (and in the past was involved in contract supply arrangements with many of them) but now operates on a spot market basis with no formal contracts. Trading relations between large traders and small traders, small traders and collectors, and collectors and farmers have in many cases been in place for a significant amount of time. Although the relations have persisted over the long-term, they do not involve formal contracts and purchases are made on a spot price basis.

Location of Project Activities within province

Project activities in Son La are focusing on two of the eleven districts within the province. Thuan Chau and Mai Son districts have been selected as they represent the main cassava producing districts in Son La with a combined production of more than 150,000 tons accounting for almost half of the provincial total.

Table 5: Cassava area, yield and production by district in Son La (2015)

District	Cassava Area (ha)	Yield (t/ha)	Annual Production (t)
Son La City	217	18.0	3,900
QuynhNhai	3,109	8.8	27,328
Thuan Chau	7,028	13.7	96,284
Muong La	2,712	10.2	27,662
Bac Yen	2,836	8.7	24,554
Phu Yen	3,629	9.7	35,201
Moc Chau	527	16.0	8,457
Yen Chau	310	12.1	3,761
Mai Sơn	3,445	16.3	56,278
Song Ma	3,647	10.0	36,437
Sop Cop	2,903	9.8	28,449
Van Ho	853	13.1	11,174
Son La Province	**31,216**	**11.5**	**359,485**

Source: Son La Department of Agriculture and Rural Development

The two districts have also been selected as they present interesting contrasts for research in terms of agro-climatic conditions, topography and value chain links.

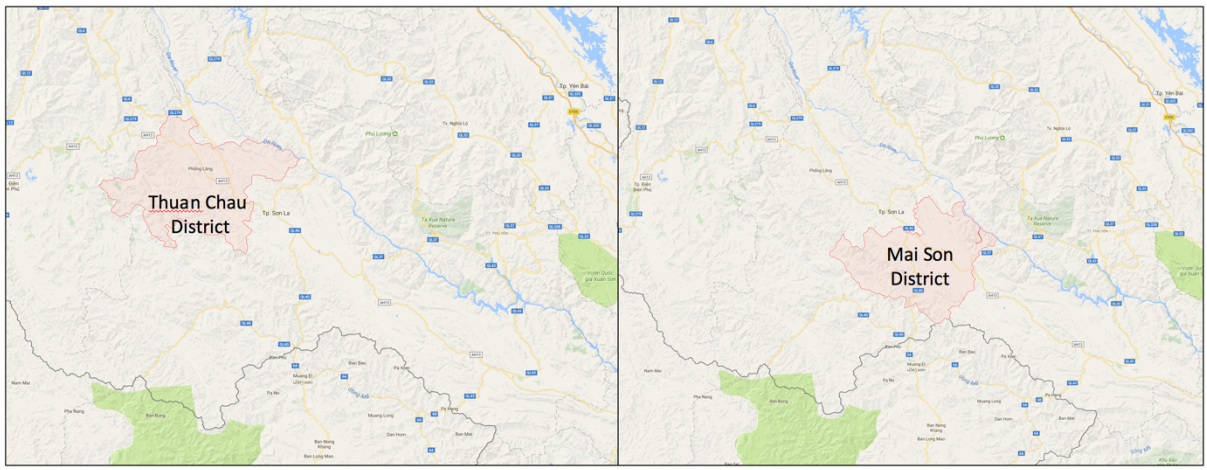

Figure 6: Districts with project activities, Son La

Mai Son is a midland district with uplands in the South-West and North-East and a broad central valley. The district borders Son La City to the North and has relatively good transportation links, with the AH13 highway running through the central valley and an airport located at Hat Lot. Cassava is grown in both the uplands and the midlands of the province and Mai Son is the third largest cassava growing district in Son La, behind Thuan Chau and Song Ma districts. The more commercialized nature of production is reflected in the district having one of the highest per hectare yields in the province and the second largest overall production of fresh cassava root (see Table 5).

There is significant cassava processing in Mai Son, including starch processing at the Son La Starch Processing Company, and dry chip processing by numerous small and medium scale enterprises at or near the airport.

Thuan Chau is a predominately upland district in the north-western portion of the province, with cassava being grown in remote locations on relatively steep slopes. Thuan Chau has the largest cassava growing area and largest fresh root production of any district in Son La. Cassava is grown on more than 7000 hectares in the district, accounting for almost a quarter of the total cassava growing area in Son La.

The centre of Thuan Chau district is around 60 kilometres from the Son La Starch Factory and the major chip producing area around the Na San airport. The rugged terrain means that the distances from cassava fields through communes to the district centre and then to the starch factory and chipping areas can be as much as 200 kilometres.

Value Chain and Household Survey Locations

In Mai Son, farmer focus group discussions were held in two upland communes, Chieng Chan in the North-East of the district and Na Ot in the South-West. Although both communes are a similar distance to AH13, the transportation links in Na Ot are better than in Chieng Chan as National Road (QL) 40 which links the Lao PDR border with AH13 passes through Na Ot.Value Chain actor interviews were undertaken with small scale collectors in Na Ot, collectors/chippers in Muong Bon (close to the airport) and with the Son La Starch Factory.

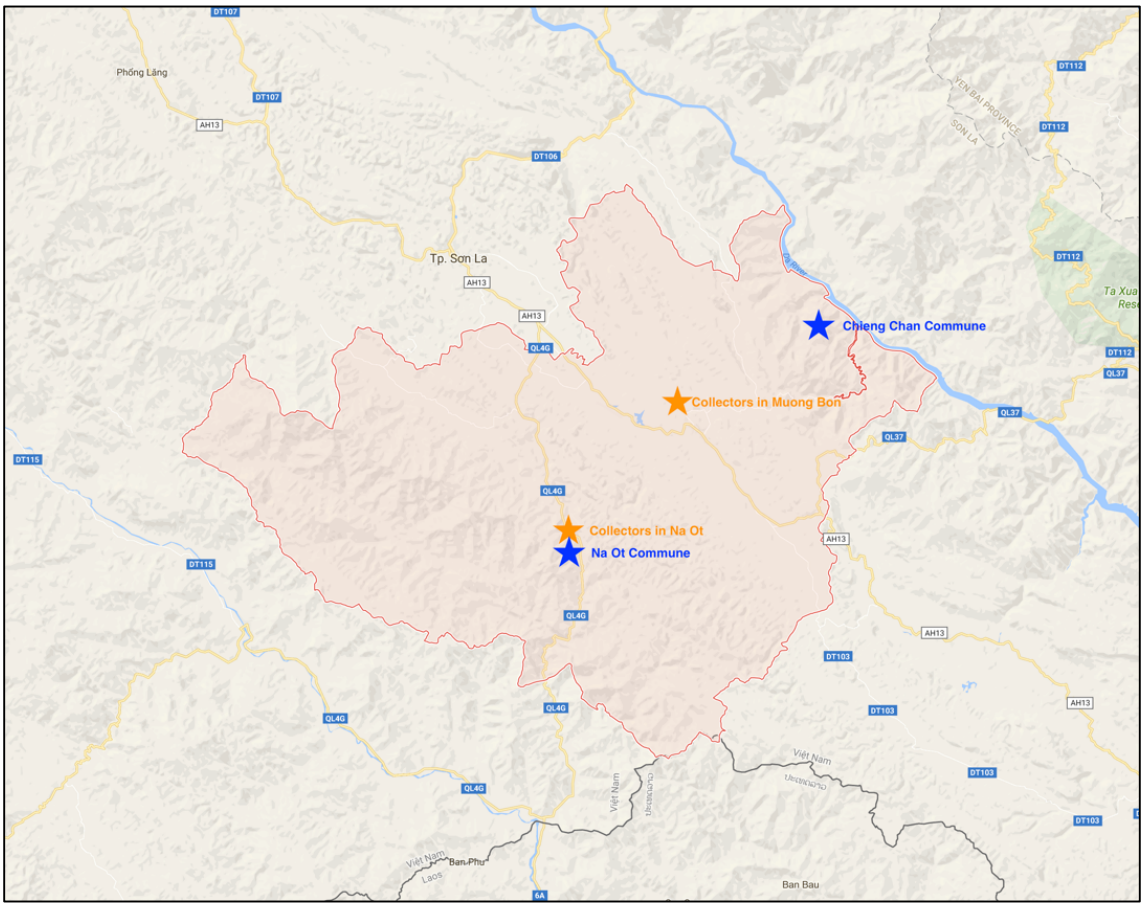

Figure 7: Research Locations, Mai Son District

In Thuan Chau, farmer focus group discussions were held in two upland communes. Bo Muoi commune is around 35 kilometres from Son La City and PungTra is located around 36 kilometres from Son La City. PungTra has significantly better transportation links, being located only 7 kilometres from the main highway (AH13).

Value Chain actor interviews were undertaken with small scale traders in Bo Muoi Commune, small scale chip processors and traders in PungTra commune and a large scale trader in ChiengPha Commune.

Household surveys were undertaken in Chieng Chan, Na Ot, PungTra and Bo Muoi communes. In each commune, 32 households were surveyed in each of 2 villages. In each commune the choice of villages was made in order to have one mid-land village close to the commune centre and one more highland village far from the commune centre. Within each village respondents were selected randomly amongst households producing cassava.

Figure 8: Research Locations, Thuan Chau District

Livelihood Information

Time of first cultivating cassava

In addition to the significant proportion of the farmers that started cultivating cassava prior to 1990, three distinct "peak" years for commencing cassava production can be seen. The first peak, in 1997, saw farmers in all communes starting to plant cassava. Another peak occurred in 2007, with farmers in all communes commencing cultivation. The last peak, around 2012 saw farmers in Bo Muoi, Chieng Chan and Na Ot starting to grow cassava. Numbers of farmers starting to plant cassava has declined each year from 2012 onwards.

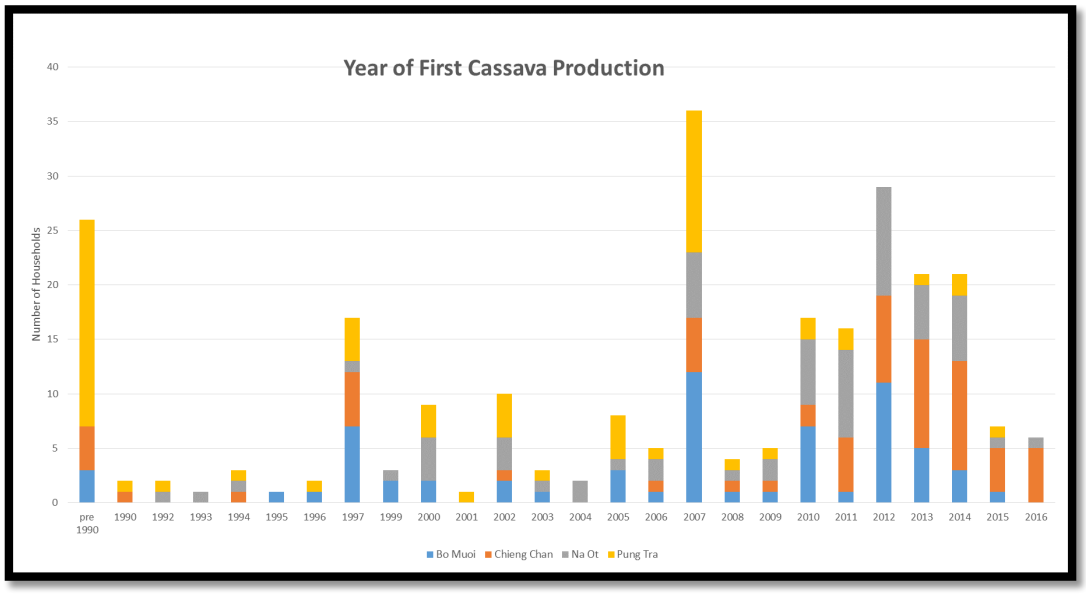

Figure 9: Year of First Cassava Production, by commune

Importance of Cassava in overall livelihood and in cash income

Almost all surveyed households have either lowland or upland rice fields. The production value of paddy and upland rice is an important contributor to livelihoods in PungTra, Chieng Chan and Bo Muoi (Figure 10). Maize is a significant upland crop in Bo Muoi and Chieng Chan, while coffee is cultivated by a majority of households in Na Ot and PungTra. Livestock – especially large livestock is an important contributor to livelihoods in all communes.
Off-farm incomes are important contributor to livelihoods,particularly in PungTra and Chieng Chan. More detailed information about annual incomes from various sources is given in Table 47.

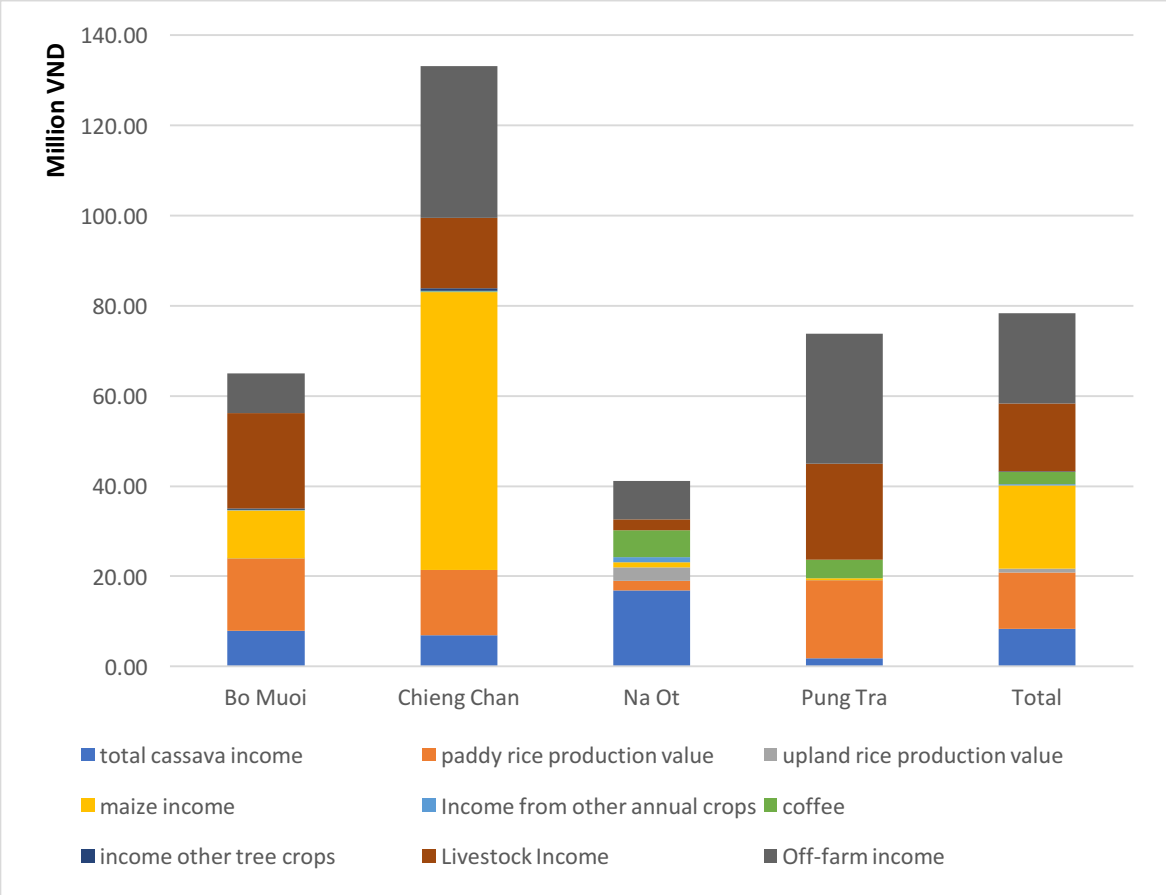

Figure 10: Source of income, by commune

Cassava contributes an average of 30 percent of overall household livelihood to households in the lowest income quartile and a progressively smaller proportion of livelihood of households in higher income quartiles, to a low of less than 5 percent of livelihood of households in the highest income quartile(Table 6 and Figure 11).

Table 6: Annual Income from different sources, by income quartile

Income Quartile	Q1	Q2	Q3	Q4	Total
Total Cassava Income	5,954,687.50	10,212,135.54	7,404,687.50	7,735,000.00	7,835,909.77
Non-Cassava Cropping Income	7,444,531.25	19,074,769.23	38,762,375.00	74,344,062.50	34,844,832.68
Total Livestock Income	404,687.50	5,936,923.08	17,683,344.41	36,604,687.50	15,121,533.24
Off-farm Income	4,129,062.50	7,921,538.46	20,919,218.75	50,161,718.75	20,732,840.47

Given the smaller average land holdings of households in the lowest income quartile, it is not surprising that off-farm income also contributes an average of more than 15 percent of overall livelihood to this quartile. From quartile 2 up to quartile 4, crops contribute a diminishing proportion of livelihood and livestock and off-farm income provide a progressively higher share.

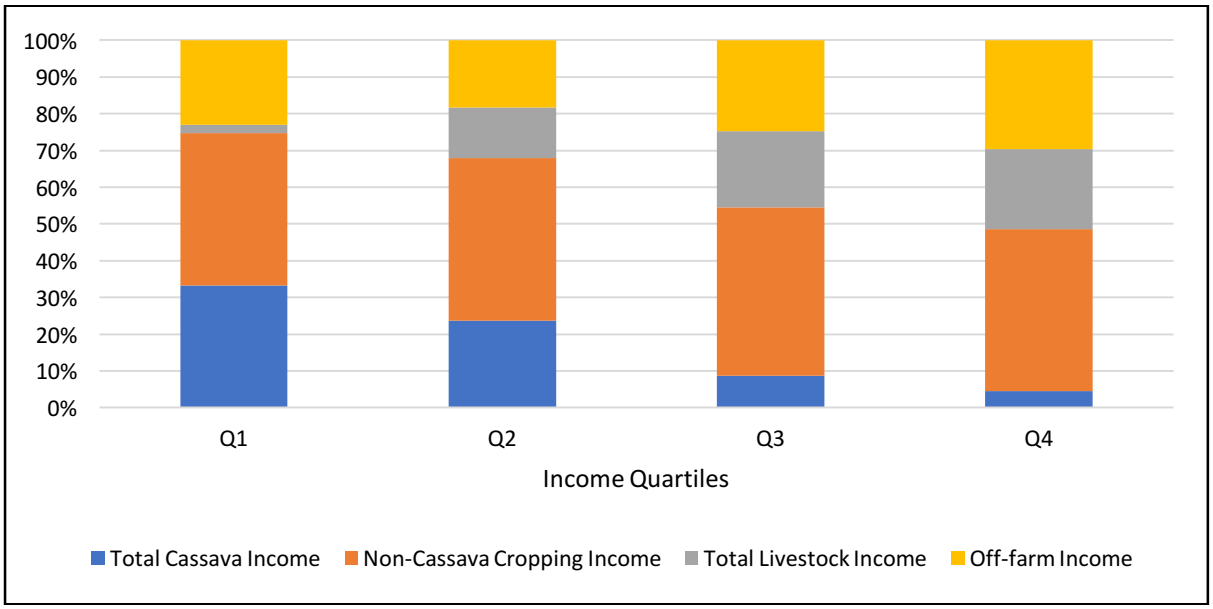

Figure 11: Source of Livelihood, by income quartile

Figure 12 shows the sources of cash income by income quartile. This is derived by not including the value of the staple crop (paddy or upland rice) in the calculation of gross income. Cassava's relative importance to lower income households is shown clearly, with cassava providing on average nearly half of the cash income of households in the lowest income quartile, and an average of 30 percent of income of households in the 2nd income quartile. Cassava provides less than 5 percent of cash income of households in the highest quartile, compared with the almost 60 percent gained from livestock and off-farm income. More detailed information is presented in Table.

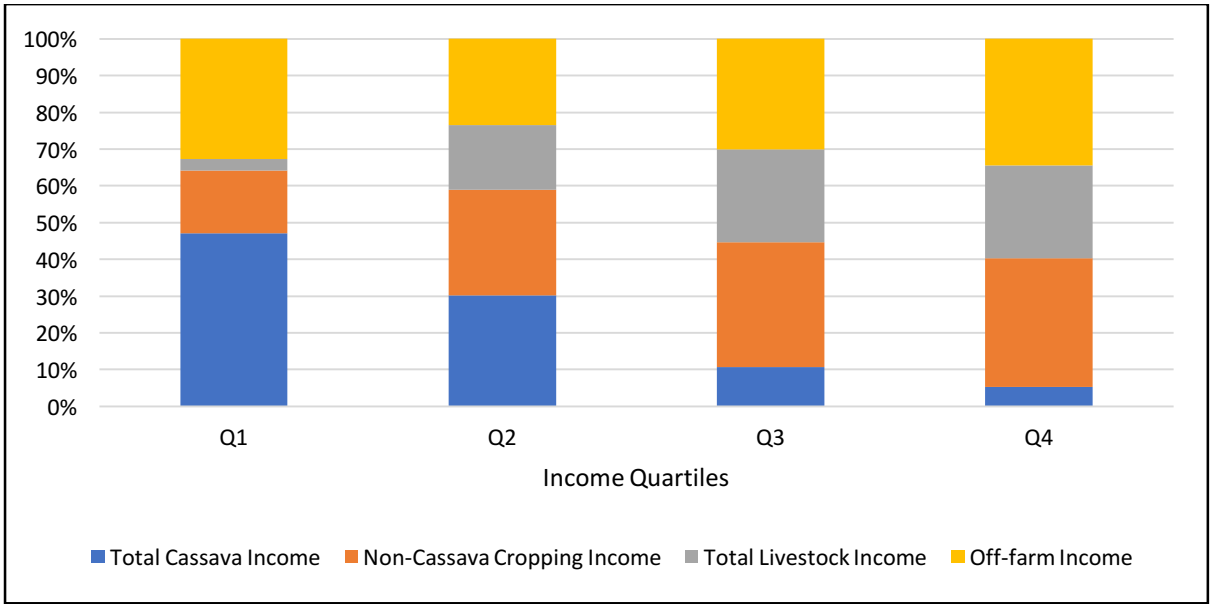

Figure 12: Cash Income Source, by income quartile

Labour Force

Average household size was 5.5, with an average of 3.1 members having at least some involvement in agriculture, of which 2.4 on average were employed full-time.

Table 7: number of family members by employment status

	Average Number of Family Members		
Employment status in Agriculture	**Males**	**Females**	**Total**
Full time	1.2	1.2	2.4
Never	1.2	1.2	2.3
Part time	0.2	0.2	0.3
Rarely	0.2	0.2	0.4
Total	2.7	2.7	5.5

Use of labour by gender and household/non-household

There seems to be no specific gender roles in cassava production, with male and female person-days per year for each cassava production related task being relatively even (Figure 13). This is different to the case of paddy rice, where there is significant gender disparity between different production tasks[2].

[2] See for example, Truong Thi Ngoc Chi, Nguyen ThiKhoa, Bui Thi Thanh Tam, and T.R. Paris (2004), Gender roles in rice farming systems in the Mekong River Delta: an exploratory study, in *G.L. Denning and Vo Tong Xuan (eds). Vietnam and IRRI: A Partnership in Rice Research*. Proceedings of a conference held in Hanoi, Vietnam, 4-7 May 1994.

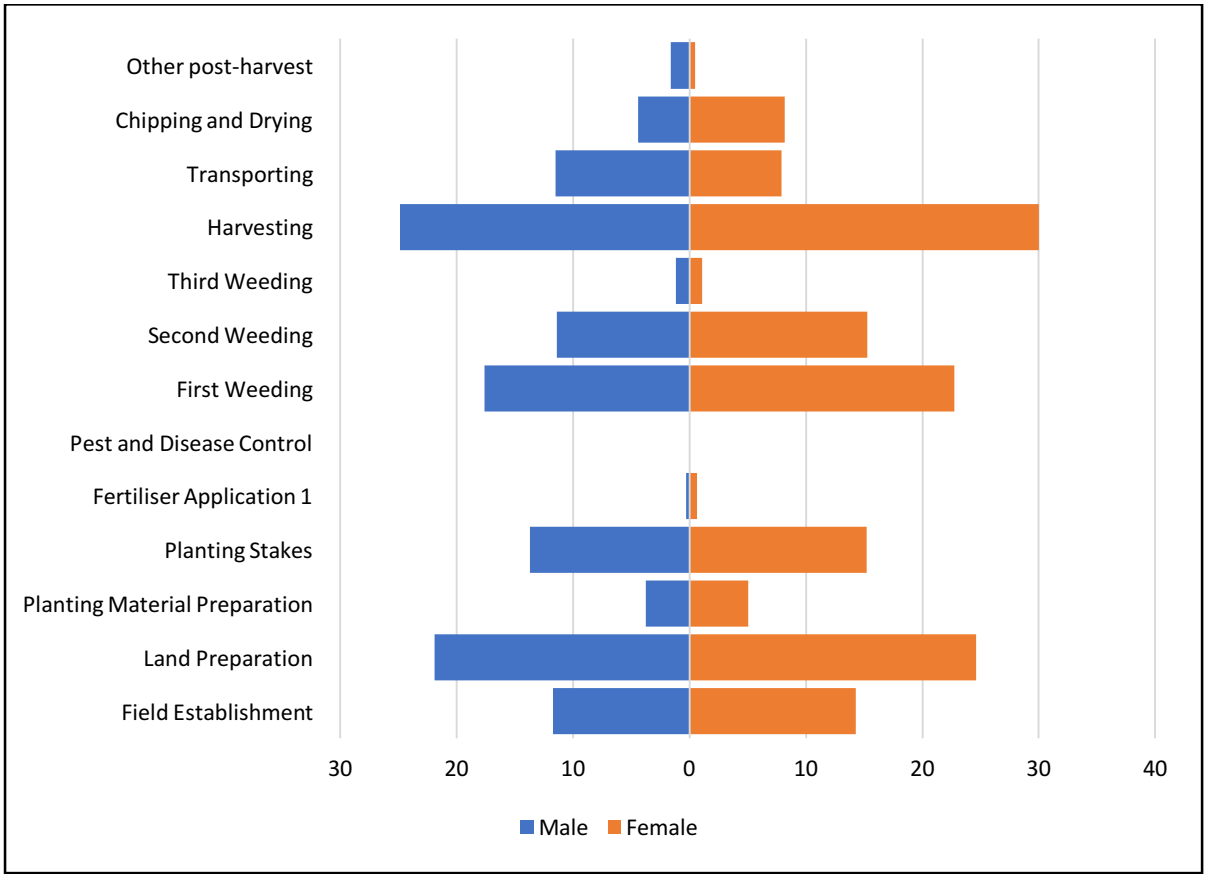

Figure 13:Household Labour Person-Days per hectare, by Gender

The extremely steep slopes that much of the cassava in Son La is grown on mean that land preparation is predominately carried out manually and this is reflected in the large number of person days dedicated to field establishment and land preparation. The relatively small quantities of chemical fertilizer used (partly a function of the steepness of the slopes) is reflected in very low numbers of person days of labour for fertilizer application.

The challenges of transporting heavy loads of herbicide up steep slopes mean that a large number of person days of labour is utilised for two separate rounds of weeding. The largest single activity absorbing household labour is harvesting, accounting for more than 50 person days of household labour per hectare per year. Detailed labour utilisation and cost figures are shown in Table 48.

Given the relatively low income levels of cassava farmers in Son La, it is not surprising that households are the main source of labour, with hired labour and exchange labour only accounting for a very small proportion of total labour used for production. Only harvesting and transportation activities included any outside labour of note, and even this only totalled an average of less than 20 person days per hectare per year (Figure 14).

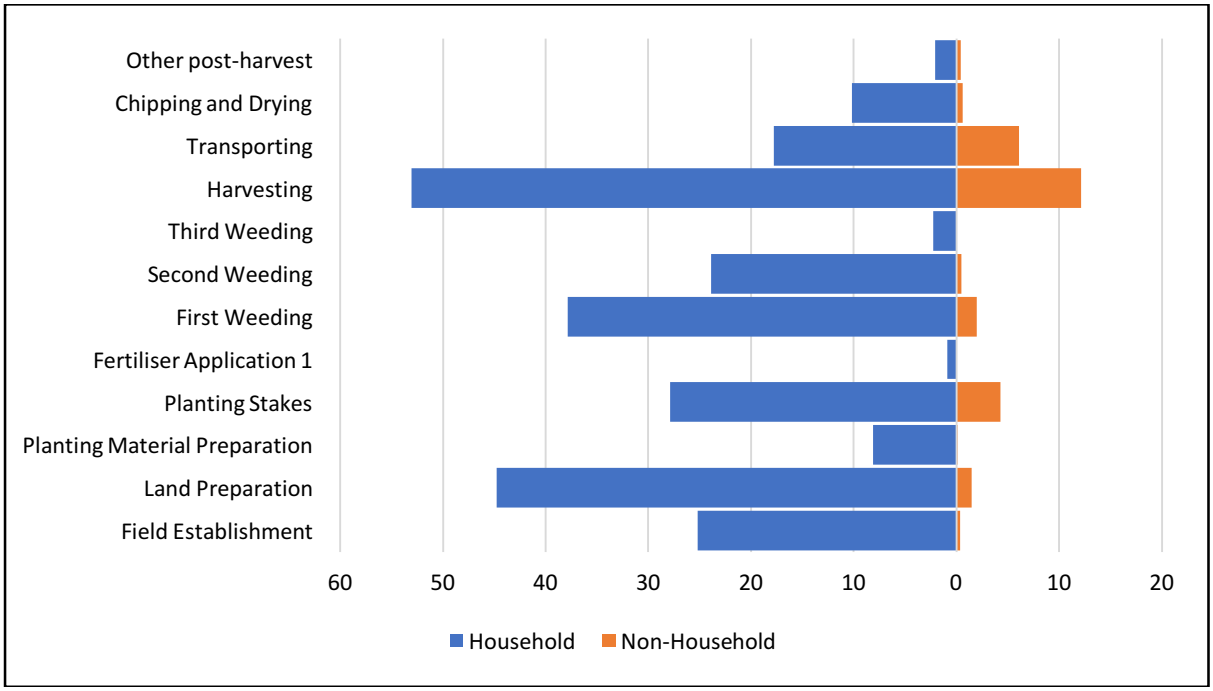

Figure 14:Labour Person-Days per hectare, by Source

Access to credit

Almost 58 percent of households had taken at least one loan in the past 12 months, with the majority of those only having one loan and no household reporting having more than 3 loans. Quartile 2 reported the highest proportion of households with loans (almost 71 percent), while only 45.31 percent of households in the highest income quartile took a loan in the last 12 months (Table 8).

The average amount of debt taken on in the past 12 months was around VND19.6 million.

Table 8: Proportion of households having taken loans

Access to Credit	Q1	Q2	Q3	Q4	Total
Percent of households that received a loan in the past 12 months	57.81%	70.77%	57.81%	45.31%	57.98%
% households with 1 loan	48.44%	64.62%	54.69%	40.63%	52.14%
% households with 2 loans	7.81%	3.08%	3.13%	4.69%	4.67%
% households with 3 loans	1.56%	1.54%	0.00%	0.00%	0.78%
Average value of total loans received (VND)	13,828,125	19,030,769	24,343,750	21,359,375	19,638,132

There were problems around manageability of debt, with more than 70 percent of households reporting at least some concern with their debt level and of those, more than 37 percent reporting that their debt was “unmanageable” or “very unmanageable” (Table 9).

Table 9: Manageability of debt

How manageable is the current level of debt	Frequency	Percent
Very unmanageable	67	31.31%
Unmanageable	13	6.07%
Some concern	72	33.64%

Manageable	56	26.17%
Very manageable	6	2.80%
Total	**214**	**100%**

The most common source of loans was the Bank for Social Policies, with the second most frequent loan source being from family/friends/relatives. Only 7 of the more than 140 reported loans were from shopkeepers or traders and none were reported to have come from the starch factory or from chip processors.

Table 10: Loan Sources

Source of Loan	**Frequency**
Bank for Social Policies	68
Family/Friend/Relative	43
Agribank	27
Credit fund	6
fertiliser, seed seller	6
Other Bank	1
farmers union	1
trader	1
veterans credit fund	1

Access to information

Farmers accessed information on agricultural production most frequently from friends and neighbours, from their family or from TV. Traders and cassava processors were only noted as a source of information a total of 10 times (Table 11).

Table 11: Sources of Information on agricultural production

Source of Information	**Frequency**
Friends and neighbours in the village	224
Family	198
TV	119
Friends and neighbours outside the village	76
District government extension	64
Farmer Group	45
Other	20
Cassava Traders	19
Radio	8
Internet	7
Province government extension staff	6
Cassava Processors	3
Researchers	2

Farmers accessed information on agricultural markets most frequently from traders, friends and neighbours and from their family. Cassava processors were only noted as a source of information a total of 22 times (Table 11).

Table 12: Sources of Information on agricultural markets

Source of Information	Frequency
Cassava Traders	208
Friends and Neighbours in village	190
Family	136
Friends and Neighbours outside the village	61
TV	23
Cassava Processors	22
Farmer Group	14
Other	8
District government extension	3
Internet	3
Radio	2

Group membership

A total of 186 households (72% of all households) indicated that they had a household member participating in a group or a mass organization. The most common organizations were the Women's Union and the Farmer's Union.

Table 13: Household Membership of Groups and Mass Organizations

Name of Organization	Frequency
Womens Union	119
Farmers union	83
Ho Chi Minh Communist Youth Union	56
veterans union	26
Senior Citizens Association	18
Fatherland Front	3
communist party	3
cooperative	1
public security	1

Ownership of assets

Overall, around 90 percent of farmers owned motorbikes. However, only about 67 percent of farmers in the lowest income quartile owned motorbikes. Around 20 percent of farmers owned 2 or 4 wheel tractors, but as shown in Table 29, these were not generally utilised for cassava cultivation. More than 80 of farmers had a mobile phone and almost 35 percent had a smartphone.

Table 14: Asset Ownership by Income Quartile

Assets	Q1	Q2	Q3	Q4	Total
Truck	0.00%	0.00%	0.00%	3.13%	0.78%
car	0.00%	0.00%	0.00%	0.00%	0.00%
motorbike	**67.19%**	**96.92%**	**98.44%**	**98.44%**	**90.27%**
two wheel tractor	1.56%	6.15%	14.06%	28.13%	12.45%
four wheel tractor	3.13%	3.08%	9.38%	14.06%	7.39%
Water pump	1.56%	16.92%	15.63%	32.81%	16.73%
generator	4.69%	3.08%	0.00%	1.56%	2.33%

mobile phone	71.88%	84.62%	89.06%	85.94%	82.88%
smart phone	23.44%	27.69%	37.50%	50.00%	34.63%
tv	85.94%	90.77%	98.44%	96.88%	93.00%
dvd player	54.69%	63.08%	79.69%	67.19%	66.15%
radio	12.50%	4.62%	7.81%	14.06%	9.73%
refrigerator	3.13%	20.00%	46.88%	71.88%	35.41%

Agronomic Information

Area, production, Current yields and trends

Average cassava production area per household was 0.57 hectares, varying between 0.31 hectares in PungTra and 0.96 hectares in Na Ot. Averge production was 7.9 tons, giving a yield of 15.5 tons per hectare (Table 15). The yield per hectare was relatively constant across all four commune with a low of 14.8 tons per hectare in PungTra and a high of 16.6 tons per hectare in Bo Muoi.

Table 15:Household Cassava Production Characteristics, by Commune

	Bo Muoi	**Chieng Chan**	**Na Ot**	**PungTra**	**Total**
Cassava production 2016 (tons)	7.7	6.7	13.0	4.0	7.9
Cassava Harvest Area 2016 (ha)	0.48	0.52	0.96	0.31	0.57
Cassava Yield 2016 (tons /ha)	16.6	15.3	15.3	14.8	15.5

The average highest cassava yield in the past 5 years was 19.3 tons per hectare, while the average lowest yield was 13.9 tons per hectare.

Table 16:Highest and Lowest Production in last 5 years, by Commune

	Bo Muoi	**Chieng Chan**	**Na Ot**	**PungTra**	**Total**
Highest Cassava Production in the last five years(tons)	13.6	8.6	16.8	8.5	11.9
Area Utilized for Highest Cassava Yield in the last five years(ha)	0.67	0.52	1.03	0.53	0.69
Highest Cassava Yield in the last five years(tons /ha)	21.3	19.4	18.9	17.7	19.3
Lowest Cassava Production in the last five years(tons)	7.0	5.7	10.0	3.7	6.6
Area Utilized for Lowest Cassava Yield in the last five years(ha)	0.46	0.51	0.95	0.31	0.56
Lowest Cassava Yield in the last five years(tons /ha)	16.0	14.1	12.4	12.9	13.9

Cassava yields were declining either moderately or rapidly for a majority of farmers in all communes. Overall, only 4.3 percent of farmers reported that yield was increasing, while almost 74 percent reported declining yields (Table 17).

Table 17: Cassava Yield Trends, by Commune

Yield Trend	**Bo Muoi**	**Chieng Chan**	**Na Ot**	**PungTra**	**Total**
Increasing	3.1%	7.8%	4.7%	1.6%	4.3%

Relatively_constant	10.8%	18.8%	14.1%	7.8%	12.8%
Declining_moderately	40.0%	37.5%	39.1%	51.6%	42.0%
Declining_rapidly	43.1%	26.6%	28.1%	29.7%	31.9%
fluctuating,_but_no_clear_trend	3.1%	9.4%	14.1%	9.4%	8.9%

Plans for growing cassava in the future

More than 76 percent of farmers indicated that they intended to plant cassava into the future, with only 8.2 percent not intending to grow cassava after the current season. The remainder were unsure about their future plans for cassava production (Table 18). The proportion of farmers not intending to grow cassava in the future was highest in Na Ot and lowest in Chieng Chan.

Table 18: Future Production Intention, by Commune

Will you grow Cassava in the Future?	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Yes	80.0%	71.9%	70.3%	82.8%	76.3%
No	7.7%	3.1%	17.2%	4.7%	8.2%
Unsure	12.3%	25.0%	12.5%	12.5%	15.6%

Table 19: Future Production Intention, by Income Quartile

Will you grow Cassava in the Future?	Q1	Q2	Q3	Q4	Total
Yes	76.6%	81.5%	73.4%	73.4%	76.3%
No	12.5%	7.7%	7.8%	4.7%	8.2%
Unsure	10.9%	10.8%	18.8%	21.9%	15.6%

Varieties

Farmers reported a large number of names of varieties that they planted (Table 20). The majority of these are local names and do not give any information about the actual variety. The most common "variety" reported is Cao San – this means High Yielding Cassava. The only actual variety name reported was KM 94, which was only reported by 1 farmer.

Table 20: Varieties of Cassava used by farmers

Variety Name	Proportion of total varieties
Cao San	55.3%
La Tre	27.5%
San Den	12.1%
San Xanh	1.9%
San Tau	0.6%
GiongNgheAn	0.6%
KM94	0.3%
Giong Cao Bang	0.3%
San launam	0.3%
san Moc Chau	0.3%
San Mot Than	0.3%
San nguoikinh	0.3%

Soil Erosion Problems and Control Techniques

Almost 90 percent of farmers viewed soil erosion as a problem, with almost 60 percent considering it as serious or very serious. Around 45 percent of farmers were aware of erosion control measures but only 7 percent had received any training on soil conservation measures in the past. Encouragingly, almost 90 percent of farmers were interested in participating in erosion control measure trials on their land.

Table 21: Soil Erosion Perception, by Commune

Name of commune	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Soil Erosion perceived as a problem	92.3%	81.3%	93.8%	92.2%	89.9%
Very Serious Problem	24.6%	18.8%	26.6%	17.2%	21.8%
Serious Problem	38.5%	29.7%	46.9%	32.8%	37.0%
Medium Problem	21.5%	25.0%	17.2%	35.9%	24.9%
Small Problem	7.7%	7.8%	3.1%	6.3%	6.2%
Are you aware of any measure to reduce soil erosion?	53.8%	23.4%	51.6%	51.6%	45.1%
Have you had any training on any soil conservation measures?	4.6%	9.4%	10.9%	3.1%	7.0%
Are you interested in trialling conservation practices on your land?	96.9%	84.4%	92.2%	82.8%	89.1%

Adoption of intercropping is very low, with only 7.4 percent of farmers ever having grown intercrops with cassava and only 2.7 percent of farmers currently growing intercrops. More than 36 precent of farmers are interested in trialling intercrops, ranging from on 14 percent of farmers in Chieng Chan to almost 66 percent of farmers in Na Ot.

Table 22: Awareness of Intercropping, by Commune

Name of commune	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Intercropping					
Have you ever grown intercrops with your cassava?	4.6%	4.7%	17.2%	3.1%	7.4%
Do you currently grow any intercrops with your cassava?	3.1%	1.6%	6.3%	0.0%	2.7%
Are you interested in trialling new intercrops?	29.2%	14.1%	65.6%	35.9%	36.2%

Fertiliser adoption, awareness and correct application

Only 1.2 percent of farmers apply organic fertilizer to their cassava. In contrast the adoption rate of inorganic fertilizer is relatively high, at almost 74 percent. While adoption is high, only 11 percent of farmers understand what the NPK values on their fertilizer mean (Table 23).

Table 23: Fertiliser Practice, by Commune

Name of commune	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Do you apply organic fertiliser to your cassava?	1.5%	0.0%	1.6%	1.6%	1.2%

Do you apply inorganic fertiliser to your cassava?	95.4%	64.1%	59.4%	76.6%	73.9%
Do you understand what the NPK values mean on the fertiliser you apply?	15.4%	7.8%	10.9%	10.9%	11.3%
Have you ever seen a fertiliser trial on cassava?	12.3%	14.1%	12.5%	7.8%	11.7%
Are you interested in visiting a fertiliser demonstration trial to see the result on production and returns?	87.7%	93.8%	95.3%	87.5%	91.1%
Are you interested in conducting a trial on your own land?	90.8%	79.7%	95.3%	84.4%	87.5%

The most common fertilizer formulation used by farmers was 5:10:3, a formulation which is not optimal for cassava production. Almost 30 percent of farmers did not know what the fertilizer formulation that they utilised was. Clearly there is an opportunity for fertilizer companies to develop more appropriate formulations suitable for cassava production.

Table 24:NPK Formulas Used by Farmers

Formula	Proportion of fertilizer users
5:10:3	61 %
don't know	29 %

In addition to application of non optimal fertilizer formulations, the average quantity of fertilizer applied per hectare is relatively low, at around 560kg per hectare. The low level of fertilizer application is not surprising, given the extremely steep slopes on which cassava is planted in Son La.

Table 25: Average Fertiliser Application (kg per hectare) during planting, by Commune

	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
NPK	839	246	543	460	560

Weeding and Herbicides

More than 95 percent of farmers indicated that weeds were a problem and that weeds limited the productivity of their cassava crop. This pattern was relatively constant across all communes.

Table 26: Weed Impact Perception, by Commune

	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Do you think that weeds limit the productivity of your cassava crop?					
large problem	55.4%	54.7%	45.3%	25.0%	45.1%
medium problem	33.8%	31.3%	32.8%	45.3%	35.8%
Small problem	9.2%	12.5%	17.2%	18.8%	14.4%
No	1.5%	1.6%	4.7%	10.9%	4.7%

Despite almost all farmers indicating that weeds were a significant problem impacting on cassava production, only around 26 percent of farmers used herbicide on their cassava fields, ranging from 17.2 percent of farmers in PungTra, to 30.8 percent of farmers in Bo Muoi (Table 27). The cost of herbicide and the steep slopes may explain the low proportion of farmers applying herbicides.

Table 27: Herbicide Practice, by Commune

	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Do you apply any herbicides?	30.8%	26.6%	31.3%	17.2%	26.5%
Have you received any training on herbicide use?	4.6%	7.8%	9.4%	3.1%	6.2%
Do you use protective clothing when applying herbicide?	27.7%	21.9%	29.7%	14.1%	23.3%

Given the seriousness of the weed problem and the low level of herbicide use, it is hardly surprising that almost 100 percent of farmers practice manual weeding of cassava fields. The most common number of times of weeding over a season is two (Table 28).

Table 28: Manual Weeding Practice, by Commune

	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Do you conduct manual weeding?	100.0%	98.4%	100.0%	96.9%	98.8%
1 weeding	16.9%	43.8%	54.7%	32.8%	37.0%
2 weedings	55.4%	37.5%	39.1%	53.1%	46.3%
3 weedings	26.2%	15.6%	6.3%	10.9%	14.8%
4 weedings	1.5%	1.6%	0.0%	0.0%	0.8%

Land Preparation

Given the steepness of cassava fields, it is not surprising that only 2 percent of farmers cultivate cassava fields using 2 or 4 wheel tractors. Only around 22 percent of farmers use buffalo or cattle for ploughing. The dominant form of land cultivation is using manual tools. This is the case in all communes except for Chieng Chan, where the relatively flatter topography means that a majority of farmers can use cattle of buffalo for land cultivation (Table 29).

Table 29: Land Cultivation Practice, by Commune

	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Tractor	1.5%	3.1%	0.0%	0.0%	1.2%
4 wheel tractor	1.5%	0.0%	1.6%	0.0%	0.8%
Buffalo or cattle	10.8%	71.9%	4.7%	1.6%	22.2%
Manual Tools	87.7%	31.3%	85.9%	96.9%	75.5%
Make Ridges	1.5%	0.0%	3.1%	1.6%	1.6%

Cassava Utilisation

Most farmers sold fresh cassava, accounting for at least 80 percent of farmers in all communes except PungTra. A total of 37 percent of farmers also used cassava for livestock production. This was particularly common in PungTra, where more than 87 percent of farmers used cassava for feeding their own livestock. Dried chip production and sales also occurred in Bo Muoi and Na Ot (Table 30).

Table 30: Cassava Utilisation, by Commune

	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Eat	0.0%	0.0%	0.0%	3.1%	0.8%
Use for own livestock	15.4%	42.2%	3.1%	87.5%	37.0%
Cassava Leaf	1.5%	1.6%	0.0%	0.0%	0.8%
Sell fresh cassava	92.3%	84.4%	85.9%	57.8%	80.2%
Sell Dried cassava	10.8%	0.0%	21.9%	1.6%	8.6%

Relationship with Traders

Of farmers that sold cassava to fresh root traders, around 48 percent described the relationship as strong or very strong. Only about 20 percent said that the relationship was weak or very weak. Although the number of farmers selling to dried chip traders was much smaller than the number selling to fresh root traders, the pattern of relationships was relatively similar (Table 31 and Table 32). This could be explained by the fact that at village and commune level the same traders are involved in both fresh root and dry chip trading.

Table 31: Relationship with Fresh Root Traders, by Income Quartile

Fresh root traders	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
very strong	13.7%	12.0%	17.4%	28.8%	18.0%
Strong	29.4%	32.0%	40.4%	21.2%	30.7%
moderate	35.3%	38.0%	19.2%	32.7%	31.2%
weak	3.9%	8.1%	13.4%	11.6%	9.3%
very weak	17.7%	10.0%	9.6%	5.8%	10.8%

Table 32: Relationship with Dry Chip Traders, by Income Quartile

Dry chip traders	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
very strong	14.4%	0.0%	0.0%	0.0%	4.7%
Strong	14.4%	29.9%	100.0%	33.3%	31.4%
moderate	56.8%	50.0%	0.0%	33.3%	45.3%
weak	14.4%	0.0%	0.0%	0.0%	4.7%
very weak	0.0%	20.1%	0.0%	33.3%	14.0%

Trials 2016-2017

Trial Locations

The trials were conducted in 4 sites (4 communes):

In Thuận Châu district: Bó Mười and Búng Tra communes

In Mai Sơn district: Nà Ớt and Chiềng Chăn communes

Table 33: Brief information on the 4 communes

	Mai Sơn District		Thuận Châu district	
	Chiềng Chăn commune	***Nà Ớt commune***	***Bó Mười commune***	***Púng Tra commune***
Area (km^2)	60.03	106.50	62.21	25.64
Population	6449	2976	8163	3138
Ethnicity	Thái, H'Mông, Kinh	Thái, Khơ Mú, Sinh Mun, H'Mông	100% Thái	97,2% Thái 2,8% La Ha
No. of village	19	17	18	14
Cassava area (ha)	244	541	100	750

In each of these communes, as mentioned above, over 70% HHs grow cassava, each in 0.3 – 0.9 ha of land on average, mostly on steep slopes (up to 65^0), and soil erosion is perceived as a serious problem. According to the HH survey, most farmers here have not been accessed to any training in soil conservation.

Regarding fertilizers use, although high rate (74%) of HHs apply NPK, only around 10% of them understand the values of N, P and K. The most common fertilizer formulation used is NPK 5:10:3, although a large part of HHs (30%) do not know what the fertilizer formulation that they utilised was. The fertilizers' level used is rather low, only around 50 kg/ha, of which all is applied once, at the planting time.

Regarding varieties, almost all farmers do not know what varieties actually are under the locally called names, except for KM94 which is correctly mentioned by few farmers. Actually, the most common "variety" reported - Cao San (meaning High Yielding Cassava) is also KM 94 which is a new high yielding variety popularly grown in the region. In the 3 communes of Bo Muoi, Chieng Chan and Na Ot, cassava is mainly for processing (HHs sell fresh roots or as dried trips to traders or processing factories), only a small portion is used for livestock feeding. However, in Pung Tra commune, most HHs (87%) use cassava as feeds and 3% HHs use also for foods. For both feeds and foods locally developed varieties (La Tre) with less bitter roots are preferred.

Over 80% of cassava farmers are willing to take part in trials, and almost 95% are interested in visiting the trials.

Key Activities

On the basis of the above mentioned situation trials were planned to aim at (i) introduction of some new high yielding varieties suitable to the local needs and conditions, (ii) optimisation of fertilizers levels and application method and (iii) validation and dissemination of some soil conservation practices.

Selection of fields and designing of trials:

With participation of the districts' DARD and communes' extension officers and leaders, field trips were conducted to the 4 communes to find suitable fields to conduct the trials. Due to complicated topography and small-scale of plots, it was not possible to find suitable fields in all the 4 communes meeting the previously set-up requirements (rather flat and uniform land conditions for fertiliser and variety trials, and uniformly sloping lands of about 20-25^{o} for soil conservation trial, each trial with 5 replicates, each trial plot area is at least 10 m x 5 m). Therefore, finally, the trials were designed and established in the fields as below.

Table 34: Locations and designs of trials

	Trial	Location	Area (ha)	Slope (degree)	Design	Farmer	Ethnicity
1	Variety	Quỳnh Lương village, **Chiềng Chăn**	0.15	5-10	CRB, 5 replicates	Lường Văn Yêu	Thai
2	Variety	Púng Mé Village, **Púng Tra**	0.15	45-50	CRB, 5 replicates	Lường Văn Ánh	Thái
3	Fertilizer	Quỳnh Lương village, **Chiềng Chăn**	0.15	5-10	Big PLots	Lường Văn Yêu	Thai
4	Fertilizer	Há Xét village, **Nà Ớt**	0.15	55-60	Big Plots	Vì Văn Hom	Thái
5	Fertilizer	Long Sàn Village, **Bó Mười**	0.1	5-10	Big Plots	Lò Văn Phỏng	Thái
6	Fertilizer	Púng Mé Village, **Púng Tra**	0.15	5-10	Big Plots	Lường Văn Tưởng	Thái
7	Soil management	Sài Lương village, **Chiềng Chăn**	0.25	35-40	CRB, 4 replicates	Lường Văn Nón	Thái
8	Soil management	Há Xét village, **Nà Ớt**	0.2	55-60	CRB, 3 replicates	Vì Văn Hom	Sinh mun
9	Soil management	Long Sàn Village, **Bó Mười**	0.15	40-45	CRB, 3 replicates	Lò Văn Yêu	Thái
10	Soil management	Púng Mé Village, **Púng Tra**	0.25	45-50	CRB, 5 replicates	Quàng Văn Kiên	Thái

Notes to the history of soil management and fertiliser trials (order as in the 1st column in the above table):

(3): Rotation between maize, cassava and sugarcane, not necessary following any cycle. In 2016 maize was planted, fertilizers included 1,6 t/ha manure + 600 kg/ha NPK for the basal, 200 kg/ha urea + 200 kg/ha urea for 2 times top dressing, yield was 10 t/ha fresh cobs

(4&8): planted to cassava for many years, with the yield of roots reduced from year to year; for KM94 the yield was 20t/ha in 2013, 15 t/ha in 2014, and almost 7 t/ha in 2016. The fertilizer level in 2016 was about 70 kg/ha NPK, only for the basal application.

(5*): During the past 5 years the land was planted to maize or cassava, depending on the change of market price of these 2 crops, the land owner chooses one of them to grow. In 2016 maize was cultivated and after harvest of maize cowpea was cultivated. Fertiliser level applied to maize was 600kg NPK (5-10-3)/ha for the basal, 150kg urea/ha for top dressing; the maize yield was 14 t/ha fresh cobs.*

(6): The land was planted to cassava for many years. In 2016 the level of fertilizers applied was 120 kg/ha NPK for the basal and 20 kg/ha urea for the top dressing. The HH used roots for animals, and thus harvested small number of plants every time and never knew how much the yield was.

(7): Before 2014 planted to sugarcane, 2014-2016 cassava. In 2016 fertilizers were 200kg NPK, 100 kg urea for top dressing, yield was 16 t/ha.

(9) The land was planted to maize or cassavas, depending on the change of market price of these 2 crops, the land owner choose one of them to grow. In 2016 maize was cultivated and after harvest of maize cowpea was cultivated. The fertilizers level applied to maize was 300kg/ha NPK for basal and 50 kg/ha urea for top dressing. The yield of maize was 11 t/ha fresh cobs.

(10): The land was planted to cassava for many years. In 2016 the level of fertilizers applied was 200 kg/ha NPK for the basal and 30 kg/ha urea for the top dressing. The HH used roots for animals, and thus harvested small number of plants every time and never knew how much the yield was.

Variety trial involved a total of 6 varieties, including KM94, Sa21-12, Rayong 9, BK, 13sa05 and La Tre (a popular local variety). Of those, KM94 and La Tre are used as controls. The trial was conducted in one commune in each district only (Chiềng Chăn commune, Mai Sơn District and in Púng Tra commune, Thuận Châu District). The trial design was CRB with 5 replications; area of each plot was 30 m^2. Participatory evaluation was conducted at the harvest with involvement of farmers, local officers, traders, cassava processing factory, extension staff and project researchers.

Fertilizer trial involved 5 treatments, using the popular high yielding variety in the region - KM94 and, was conducted in all the 4 communes. The objective is to study the response of the cassava variety to the application of various combinations of fertilizers (N, P and K) in order to find the best and most economic fertilizer rate to obtain and maintain high enough cassava yield. Participatory evaluation was conducted with involvement of farmers, local officers, traders, cassava processing factory, extension staff and project researchers. The trial was designed following big plots, with no replication:

In Chiềng Chăn Commune: area of each plot was 175m^2
In Nà Ớt commune: area of each plot was 120 m^2
In Púng Tra commune: area of each plot was 150 m^2
In Bó Mười commune: area of each plot was 120 m^2

T0 (control): None fertilizer
T1: basal fertilizing with 300 kg/ha NPK (5:10:3), none top dressing
T2: basal fertilizing with 600 kg/ha NPK (5:10:3), none top dressing
T3: separate N, P, and K fertilizers; the total volume was (40N + 10P + 40K, equaling 87 kg Urea + 142 kg Superphosphate + 80 kg Kali Clorua)

- *Basal fertilizing: All of P, ½ of K, ½ N*
- *Top dressing: ½ N, ½ K (2 months after planting)*

T4: FDP (fertilizer deep placement, total volume was like that of T3 (40N + 10P + 40K)

Soil management trial aimed to study different intercrops and soil management techniques in order to find effective options in term of both economy and soil erosion management for Son La. The trial was conducted in all 4 communes and involved 6 treatments:

T0 (control): Cassava only
T1: cassava + cowpea
T2: cassava + mung bean
T3: cassava + peanut
T4: cassava + grass trip by Guinea (*Panicum.maximum*)
T5: cassava+ contour lines by residues of cassava from the last

The design was CRB, with 4 replicates in Chieng Chan (area of each plot was 11 x 6 = 66 m^2), 3 replicates in Na Ot (area of each plot was 11 x5 = 55 m^2), 5 replicates in Pung Tra (area of

each plot was 11 x 5 = 55 m^2), and 3 replicates in Bo Muoi (area of each plot was 11 x 6 = 66 m^2).

Trials establishment and management:

All the trials were established during 3-7 April, 2017. Right after planting of cassava intercrops and grass were sown. Farmers managed the trials with the project's staff technical support.

Organisation of harvest field days:

In December, one harvest field day was organised in each commune for participatory evaluation of the trials. Participants included local leaders (communes and villages), provincial and district DARD, commune extension officers and representatives of communes 'women unions and farmers associations, as well as farmers, both directly involved in the trials and not directly involved in the trials, local traders and Son La cassava factory (FOCOSEV).

Farmers and local officers expressed their interest in high yielding varieties. Three varieties, including 13SA05, SA21-12 and Rayon 9 seemed to have higher yield compared to the control, KM94. Farmers were also interested in soil conservation practices and balanced fertiliser levels. Likely, cowpea as an intercrop brought significant additional income and therefore many farmers wished to be supported to test this legume next year in their cassava field.

Harvest of trials:

Of the trials in Thuận Châu and the variety trials in both districts the harvest process were completed right after the field days. In Mai Son farmers have not yet harvested their cassava, and so the trials will be harvested latter, perhaps by the end of this month.

Parameters recorded

Germination: germination rates of all crops

Cassava growth and biomass: Randomly sampled 10 plants in each plot to measure and calculate the mean of their height of stem, fresh weight of non-commercial aerial biomass (stem+ leaves), number of tubers (only roots have length equal or above 12 cm and diameter equal or above 2 cm) and fresh weight of all tubers.

Intercrops growth and biomass: Total fresh biomass of mung bean and cowpea were weighted after 2nd time of harvest, and that of peanut at the harvest.

Grass yield: The sum of all the harvests in the year makes the yield

Yield of cassava: Total weight of all tubers harvested of each plot, and calculate the yield per hectare.

Harvest index for cassava:

$$HI = \frac{Fresh\ turber}{Fresh\ tuber + fresh\ (stem + leaves)}$$

Starch content (%): Calculated according to the method of Cassava Factory in Son La, using weight of fresh tubers in the air, and weight of fresh tubers in water.

Cost: all kind of works (preparing land, planting, weeding, harvesting...); number of working days for each kind of jobs; kind, quantity and cost of any inputs (seeds / chemicals, fertilisers...)

Soil characteristics: Before starting the trials, soil samples were taken (before the establishment of all the trials in 2017). For each trial block samples were taken in 5 locations along the 2 diagonals, in each location 3 samples at 3 layers (0-10 cm, 10-20 cm, 20-30 cm). All samples were analysed separately in the following parameters: pH_{H2O}, pH_{KCl}, OC, Olsen P, N%, CEC, EC, K+, Ca++, Na+ and Nitrat. In the last year, after harvesting of the trials samples will be taken and analysed again, but separately for each trial plot.

Who was Involved

Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) was responsible for all the trials. NOMAFSI also analyse the soil samples.

The Root Crop Research and Development Centre (RCRDC) participated in the variety trial; in charge of providing the stakes and recording data, analysing data and writing the technical report regarding this trial.

Farmers (Table 34), the land owners, participated in all the activities (trials establishment, management and harvest).

DARD of Son La, and DARD of both Thuan Chau and Mai Son districts participated as local supervisors, providing inputs for the trial site selection, implementing and monitoring.

People committees of Chieng Chan, Na Ot, Pung Tra and Bo Muoi communes participated as the communes' focal points, playing the liaison role in connecting farmers with the project, and providing logistical supports to the implementation of all the activities.

Son La Cassava Factory (FOCOCEV) and some local traders participated in participatory evaluation of the trials. FOCOCEV especially was also involved in varieties evaluation and in determination of starch content of cassava roots.

Results

Varieties trials:

As seen (Table 35 and Table 36), all the 4 trialled varieties expressed good growth and gave good yields, and thus could be introduced for using in the production in the region. They all had starch content and root yield equal to or higher than the current locally popular varieties – KM94 and La Tre. However, according to the varieties profiles, Rayong 9 is highly susceptible to red spiders. For more correct conclusions, the trial should be repeated for one more year.

Table 35: Yield and yield factors of trailed varieties in Púng Tra

	Number of roots/plant	Weight of fresh roots (kg/plant)	Fresh root yield (t/ha)	Starch content (%)	Starch yield (t/ha)
Rayong 9	12.10	0.16	19.00 b	29,2	5.55
13Sa05	13.42	0.18	23.67 c	30	7.10
BK	10.77	0.18	18.98 b	29	5.51
Sa21-12	8.77	0.15	13.05 a	30	3.92
KM94 (control 1)	8.37	0.16	13.42 a	30	4.03
Lá tre (control 2)	7.98	0.23	15.13 a	30	4.54
CV%	20.9	33.7	17.1		

Table 36: factors of productivity, yield of variety trial in Púng Tra – Thuận Châu, 2017

Varieties	Number of roots/plant	Weight of fresh roots (kg/plant)	Fresh root yield (t/ha)	Starch content (%)	Starch yield (t/ha)
Rayong 9	8.92	0.19	17.17 bc	29.6	5.08
13Sa05	8.43	0.24	19.49 d	28.1	5.48
BK	9.03	0.21	18.83 cd	28.5	5.37
Sa21-12	6.47	0.24	15.14 ab	30	4.54
KM94 (control 1)	7.39	0.22	16.47 b	30	4.94
La Tre (control 2)	7.08	0.19	13.72 a	27.7	3.80
CV %	11.4	14.3	10.2		

Soil management trials:

Only in Thuan Chau district (Pung Tra and Bo Muoi communes) cassava in the trial was harvested; in Mai Son (Na Ot and Chieng Chan communes) not yet. Thus, the results regarding cassava yield and income presented here are only from Thuan Chau sites. Nevertheless, at the field days some main points were commonly reached by the participant, and this together with parameters 'records allow us to make the following points (for correct discussions and conclusions however to repeat trials for some more years is required):

Germination and plant growth: Seeds of all crops germinated well. However, shortly after their germination, during 20 April – 10 May, there was a long and serious drought period which caused high mortality rate of mung bean (up to 70% in Mai Son and 46% in Thuan Chau) and Guinea grass (up to 61% in Mai Son and 37% in Thuan Chau). Cassava was not significantly impacted by this drought spell while cowpea and peanut also were influences. The survival rates are presented in Table 37. This consequently could significantly impact the yield and biomass of intercrops and grass.

Table 37: Survival rate of legume intercrops and grass, 1.5 months after sowing (15 May, 2017)

	Cowpea	Mung bean	Peanut	Guinea
Chieng Chan	84.2	30.0	74.6	38.8
Na Ot	72.2	40.0	77.8	53.3
Pung Tra	94.7	70.0	76.7	69.7
Bo Muoi	80.0	53.8	68.3	42.5

*Biomass and yield of legume intercrops (*Table 40*):* Legumes, as intercrops, cowpea in particular, brought significant additional income for farmers. The yield and income of intercropped legumes in Chieng Chan and Bo Muoi was higher than in Pung Tra and Na Ot, and that of cowpea was higher than mung bean and peanut (Table 38). In case of mung bean the reason for low yield could be the high mortality rate, while regarding peanut there were evidences of insects damaging seeds and of poorly developed seed (very tiny seeds formed). The yield of legumes was not proportional to the survival rate, and this could be due to the soil conditions. In Chieng Chan and Bo Muoi the lands were quite flats, planted to maize and legumes last year, and with good conditions. In Na Ot and Pung Tra, lands were steeply sloping and planted to cassava for many years with low fertilizers rates. A significant volume of biomass was formed in each site, and this could be a good source of organic fertilisers. At the harvest however all biomass of legumes had already been decayed, and thus intercropping with legumes does not help to build mulch materials.

Table 38: Yield and biomass of intercrops and grass in the soil management trials

	Cowpea		Mung bean		Peanut		Guinea
	Dried yield (kg/ha)	Fresh Biomass (t/ha)	Dried seeds (kg/ha)	Fresh Biomass (t/ha)	Dried seeds (kg/ha)	Fresh Biomass (t/ha)	Total harvest (t/ha)
Chiềng chăn	318.0 b	1,37	93 b	0,47	426 c	1,41	0,90 c
Nà ớt	227.3 a	0,83	52 a	0,39	311 b	1,59	0,82 c
Púng Tra	240.0 a	1,39	80 b	0,43	254 a	0,87	0,25 a
Bó Mười	325.0 b	1,69	200 c	1,04	432 c	1,31	0,51 b

Grass strips provided fresh feeds for cattle and also prevented soil from being washed off away; a significant amount of soil was detained above the strips. Nevertheless it required additional labour for planting and managing the grass, and also additional capital input for grass seeds and fertilizers. On the other hand, fields are often steeply sloping and located far from farmers' houses, and thus, it was difficult for farmers to take grass home to feed their cattle. When not using grass for feeding cattle farmers neither sell grass, and therefore they would not really want to spend inputs for grass planting and management. Last year, in

Chieng Chan the land owner used all the grass harvested for cattle feeding and also managed the grass well; in this site the grass yield was highest. In Na Ot, the field was steeply sloping and far from the farmer's house, and hence only small part of grass harvested was taken out of the field for cattle. In Bo Muoi, the land owner had some grass area near to his house for cattle, and thus all grass in the trial was left in the field for mulch. In Pung Tra, the land owner used all grass for cattle, but in this site part of the grass was stolen. Also in Pung Tra, after 15 May 2017 grass continued to died due and needed to be re-sown few more times. Thus, in Pung Tra the yield of grass was lowest.

Contours of cassava residues had no impacts on the cassava growth and yield, but could also prevent a significant amount of soil from being washed off away.

The yield of cassava (Table 39 and Table 40) in Pung Tra was not impacted by treatments. However, in Bo Muoi, a significant reduction in cassava yield was observed in all the treatments with intercropped legumes and grass; the reason could be competition for nutrition? The starch content was 30% for all the treatments in all sites.

Table 39: Yield of cassava in soil management trial in Púng Tra

	Number of roots/plant	Fresh root (kg/plant)	Above ground biomass (kg/plant)	Fresh root yield (t/ha)	Harvest index (HI)
Control	7.36	1.48	0.97	14.37 a	0.60
C + cowpea	7.06	1.55	1.0	14.22 a	0.61
C+mung bean	7.18	1.45	1.01	15.30 a	0.59
C+peanut	7.74	1.51	1.00	15.02 a	0.60
C+grass	7.90	1.36	1.04	14.77 a	0.56
C+contour by residues	6.64	1.58	1.17	14.38 a	0.57
CV%	11.60	17.40	16.50	12.20	

Table 40: Yield of cassava in soil management trial in Bó Mươi

	Number of roots/plant	Fresh root (kg/plant)	Above ground biomass (kg/plant)	Fresh root yield (t/ha)	Harvest index (HI)
Control	7.57	2.14	2.15	15.47 c	0.50
C + cowpea	6.97	1.90	2.07	12.93 a	0.48
C+mung bean	7.10	2.05	2.15	13.01 ab	0.49
C+peanut	6.73	1.83	2.03	13.76 ab	0.47
C+grass	7,20	2.16	1.99	14.06 ab	0.52
C+contour by residues	7.47	2.15	2.28	15.26 bc	0.49
CV%	9.40	4.70	10.10	6.10	

*Cost and income (*Table 41 and Table 42*)*: Treatments with leguminous intercrops had higher gross and net return due to additional income from the legumes; the highest return, both gross and net, had the treatment with cowpea as an intercrop. The other two treatments (with grass strips and contour by plant residues) had the same gross return as the control, but the treatment with grass strip had reduced net income due to increased material costs required for grass trip planting and management (seeds and fertilisers) while grass did not bring any additional income. A significant reduction in the net return per working day and per 1000 vnd spent was observed for all the treatments, expect the one with contour by plant residues had the same and the one with cowpea had increased net return per working day. The highest reduction in net return per working day and per 1000 vnd spent was observed for the treatment with grass strip, and the reason could be high labour and inputs required for grass while no additional income was obtained. At the field days, farmers and local officers, all expressed their interest in cowpea as intercrop for its higher economic return.

Table 41: Income and input cost, soil management trial in Pung Tra

	Control	C+ cowpea	C+ mung bean	C+ peanut	C+ grass	C+ contour
Gross return (000vnd)	20,118	27,108	23,820	24,076	20,678	20,137
Total material cost (000vnd)	3,342	4,678	4,778	5,078	7,510	3,342
Total labour (working days)	200	232	227	234	215	202
Net return (000vnd)	16,776	22,430	19,042	18,998	13,168	16,796
Net return per working day (000vnd)	83.88	96.68	83.89	81.19	61.25	83.15
Net return per 1000vnd spent (000vnd)	5.02	4.80	3.99	3.74	1.75	5.03

Table 42: Income and input cost, soil management trial in Bo Muoi

	Control	C+ cowpea	C+ mung bean	C+ peanut	C+ grass	C+ contour
Gross return (000vnd)	21,658	25302	20614	22312	19,684	21,364
Total material cost (000vnd)	3,342	4,678	4,778	5,078	7,510	3,342
Total labour (working days)	200	231	228	242	215	202
Net return (000vnd)	18,316	20,624	15,836	17,234	12,174	18,022
Net return per working day (000vnd)	91.58	89.28	69.46	74.29	56.62	89.22
Net return per 1000 vnd spent (000vnd)	5.48	4.41	3.31	3.39	1.62	5.39

Note for both tables 41 and 42: price of cow pea was 30.000 vnd/kg, mung bean: 30.000 vnd/kg, peanut: 12.000 vnd/kg, cassava: 1.400 vnđ/kg, grass: 0 (grass was not sold at all)

Fertilizers trials:

Cassava in Mai Son was not harvested. In Bo Muoi commune of Thuan Chau (Table 43) the FDP treatment and the treatment with separate fertilizers (40N, 10P and 40K) gave the lowest yield; one of the explanations for this could be that the top dressing as well as gradually released fertilizers caused 'over' vegetative growth and consequently reduced yield and reduced harvest index (HI). The other 2 treatments, one with 300 kg/ha NPK and one with 600 kg/ha NPK (applied all as the basal), had the same yield and (HI) as the control; fertilizers in this case had no impact, and one of the reasons could be that the land of this trial in this site was rich in nutrient elements (flat land, in 2016 maize followed by cowpea were cultivated, and a high level of fertilizers, including 600kg NPK kg/ha for the basal, 150kg urea/ha for top dressing, was applied). In this case, fertilizer application did not increase but reduce income and net return (Table 44).

Table 43: Cassava fresh root yield, fertiliser trial in Bo Muoi

	Number of roots per plant	Fresh roots per plant (kg/plant)	Above ground biomass (kg/plant)	Yield (t/ha)	Harvest index (HI)	Starch content (%)
No fertilizer	7.73	2.74	2.47	23.43 b	0.53	30.0
300 kg NPK, only basal	7.23	2.27	2.47	23.22 b	0.48	30.0
600 kg NPK, only basal	7.70	2.48	2.42	22.2 b	0.51	30.0
40N, 10P, 40K), basal & top dress	7.60	2.35	3.32	18.28 a	0.41	30.0
FDP (40N, 10P, 40K)	8.13	2.28	3.11	17.1 a	0.40	30.0
CV%	5.6	8.4	8.4	5.7		

Table 44: Cost and return, fertilizer trial in Bó Mười

	No fertilizer	300 kg NPK, only basal	600 kg NPK, only basal	40N, 10P, 40K), basal & top dressing	FDP (40N, 10P, 40K)
Gross return (000vnd)	32,802	32,508	31,080	25,592	23,940
Total material cost (000vnd)	1,455	2,715	3,975	3,406.8	4,545
Total labour (working days)	210	210	208	207	205
Net return (000vnd)	31,347	29,793	27,105	22,185	19,395
Net return per working day (000vnd)	149,3	141.8	130.3	107.2	94.6
Net return per 1000vnd spent (000 vnd)	21.54	10.97	6.82	6.51	4.26

Note: the price of cassava fresh roots was 1, 400 vnd/kg

In Pung Tra (Table 45), all the treatments had increased yield compared to the control. The highest yield had the treatment with separate N, P and K fertilizers application with 1 top dressing time, followed by the treatments with 300 kg/ha or 600 kg/ha NPK applied all as the basal, and then the DFP treatment. The benefits and income increased accordingly in these treatments (Table 46). Here, in Pung Tra, the soil conditions could be rather different to that in Bo Muoi (the land was more steep and planted to cassava for many years, in 2016 the level of fertilizers was much lower, only 120 kg/ha NPK for the basal, and 20 kg/ha urea for the top dressing), and thus the impacts of fertilizers was also different compared to that in Bo Muoi. In this site, all the tested fertilizer rates increased the yield of cassava as well as both gross and net income and net income per working day. However, the net income per 1000 vnd spent was reduced, especially in FDP and high NPK rate. We nevertheless will need to repeat the trial for in some more years, and also to look at the soil analysis results to have better discussions and conclusions.

Table 45: Cassava fresh root yield, fertiliser trial in Pung Tra

	Number of roots per plant	Fresh roots per plant (kg/plant)	Above ground biomass (kg/plant)	Yield (t/ha)	Harvest index (HI)	Starch content (%)
No fertilizer	7.03	1.24	0.8	12.20 a	0.61	29.1
300 kg NPK, only basal	8.47	1.69	0.95	16.28 b	0.64	30.0
600 kg NPK, only basal	8.90	1. 67	1.0	16. 67 bc	0.62	30.0
40N, 10P, 40K), basal & top dress	9.50	2.34	2.42	22.37 d	0.49	30.0
FDP (40N, 10P, 40K)	8.70	1.99	1.35	18.7 c	0.60	30.0
CV%	8.50	8.30	27.30	6.70		

Table 46: Income and input cost, fertilizer trial in Pung Tra

	No fertilizer	300 kg NPK, only basal	600 kg NPK, only basal	40N, 10P, 40K), basal & top dressing	FDP (40N, 10P, 40K)
Gross return (000vnd)	17,080	22,792	23,338	31,318	26,180
Total material cost (000vnd)	1,455	2,715	3,975	3,407	4,545
Total labour (working days)	190	193	198	200	198
Net return (000vnd)	15,625	20,077	19,363	27,911	21,635
Net return per working day (000vnd)	82.2	104.0	97.8	139.5	109.3
Net return per 1000vnd spent (000vnd)	10.73	7.39	4.87	8.19	4.76

Challenges and constraints

Climate: All the crops were sown/grown during 3 April – 7 April, and shortly after geminating/spouting there was a long spell of drought (during 20 April – 10 May) which caused high rate of mortality of plantlets. Vice versa, during the harvesting period of legumes it was rainy a lot, almost every day, and this may cause some reduction in the yield and quality of legumes. Grass was to re-sown few times because of the high mortality rate caused by drought and latter-re-sown one died due to the lack of sun (cassava plants covered well the ground and little grass seedlings were completely shaded).
Lands: Most of the cases of fertilisers and soil management trials, block are too steeply sloping (45 – 60 degrees) and located far from farmers' houses. This caused difficulties for farmers to visit the fields, especially for harvest and take grass home to feed their cattle.
Fertiliser application: Soil conditions are different between sites, but the same rates were tested in all sites.
Cassava density: The density of 10000 plants/ha (1m x 1m distance) seems to be low and might cause low yield of cassava.
Increased labour requirement for planting and managing intercrops and grass strips, and this seems to be one of the factors hindering the adoption of practices.

Future plans and partnerships

Opportunities and new ideas for 2018

The value chain survey and household survey results point to a number of clear conclusions for future plans and partnerships. Mechanized land preparation could save labour costs but land is generally too steep. The weed problem is serious in all communes and almost all farmers spend a large amount of person days per year on manual weeding. Increased herbicide usage for weed control could reduce labour costs but it is difficult to carry liquid herbicide up steep slopes.

Higher yields could potentially be gained through more appropriate fertiliser formulation and moderate increases in application rates. Higher yielding cassava varieties are likely to have the most potential for increasing yields and improving farmer livelihoods and present the least challenges for adoption.

Declining yields and cassava prices, and the fact that cassava only accounts for a small proportion of farmer livelihoods means that benefits of new technologies must be very significant in order to encourage any widespread adoption

Strategy for engagement with value chain stakeholders for adoption

New Varieties

The main priority for intervention expressed by farmers in Son La was new varieties of cassava. Farmer priorities were varieties with; (i) higher yield than the current varieties planted in Son La; (ii) resistance to disease, and in particular resistance to Witches Broom;

(iii) frost tolerance; (iv) early or late harvesting in order to gain better market price; and (v) good root quality.

The main entry point/partner for an intervention introducing improved varieties in the cassava value chain in Son La could be the Mai Son Starch Factory. There is a significant incentive for the starch factory to promote higher yielding varieties leading to higher raw material supply in order to more effectively use the increased capacity resulting from the investments in productive capacity made since the takeover by FOCOCEV. The technology characteristics of new varieties and the community characteristics in Son La mean that the potential peak adoption level of new varieties by farmers in Son La is relatively high.

While FOCOCEV have a strong incentive to support the dissemination and adoption of new varieties, they lack strong long-term links though the value chain. Larger traders supplying the factory (including Nguyen Thi Ha in Thuan Chau) have strong upstream links in the value chain back to farmers, but have little incentive to promote higher yielding varieties.

In order to facilitate engagement of traders and widespread dissemination of varieties, larger scale traders and associated small traders at commune level need to be incentivised to participate. Incentives could include subsidising the sale of stakes to larger traders and supporting large traders and commune level traders to multiply planting material for sale to farmers. Initial technical support could come from the project, but financial support for subsidising planting material should come from the factory.

More effective fertiliser treatments.

The main entry point/partner for an intervention introducing more effective fertiliser treatments in the cassava value chain in Son La could be fertiliser production companies active in Son La and their associated networks of agricultural input supply shops. There is a significant profit incentive for fertiliser companies to promote the widespread dissemination and adoption of fertiliser for cassava production as less than half of cassava producers in Son La use fertiliser and farmers who do use fertiliser are using relatively small quantities and the formulations used are either inappropriate or are not known by farmers. The linkages of fertiliser companies to farmers are strong due to their distribution networks through input supply shops down to the local level.

While the engagement and dissemination incentives are high, the potential level of adoption of fertiliser is currently low due to the non-availability of appropriate formulations of fertiliser for cassava production. One of the key investments in facilitation of the adoption of fertiliser for cassava production will be working together with fertiliser companies to develop appropriate formulations based on trial results.

Detailed Tables

Table 47: Average Household Incomes from various Sources (VND/Year), by Commune

Average Household Incomes from various Sources (VND/Year)					
Name of commune	**Bo Muoi**	**Chieng Chan**	**Na Ot**	**PungTra**	**Total**
Fresh root income	6,472,462	6,885,469	13,715,156	1,896,875	7,239,494
Dry Chip income	1,406,154	-	3,216,856	-	1,156,727
Total Cassava Income	7,878,615	6,885,469	16,932,013	1,896,875	8,396,221
Paddy rice production value	16,030,769	14,503,906	2,092,188	17,245,938	12,482,062
upland rice production value	18,462	-	2,973,438	337,500	829,183
Income from Maize	10,753,692	61,650,781	1,180,813	447,656	18,478,062
Income from all other annual crops	923	93,750	1,056,250	-	286,615
Income from coffee	140,769	171,875	6,024,375	4,075,000	2,593,424
Income from all other tree crops	210,769	490,625	-	-	175,486
Cropping Income	35,034,000	83,796,406	30,259,075	24,002,969	43,241,054
Non-Cassava Cropping Income	27,155,385	76,910,938	13,327,063	22,106,094	34,844,833
Cattle Income	4,823,077	3,339,063	1,265,625	9,589,063	4,754,475
Buffalo Income	14,000,001	8,563,031	-	5,296,875	6,992,350
Goat Income	838,462	1,981,250	421,875	1,540,625	1,194,163
Pig Income	830,769	1,365,625	175,000	2,912,188	1,318,988
Chicken Income	512,615	226,563	462,500	1,490,625	672,451
Duck Income	85,385	117,188	-	49,219	63,035
Other Livestock Income	23,077	40,625	20,313	406,250	122,179
fish Income	-	-	15,873	-	4,000
Total Livestock Income	21,113,385	15,633,344	2,360,938	21,284,844	15,121,533
On-farm Income	56,147,385	99,429,750	32,620,013	45,287,813	58,362,587
Off-farm Wages	-	562,500	1,370,313	1,275,000	798,833
Irregular non-farm income	3,392,308	14,394,531	3,428,125	14,015,625	8,786,576
Salary Income	3,428,615	11,988,125	3,428,438	4,840,625	5,911,751
NTFP income	-	467,188	679,688	234,375	343,969
Fishing Income	-	395,161	-	-	96,078
Other Income	2,005,538	6,357,969	943,750	9,687,500	4,738,016
Off-farm Income	8,826,462	33,590,625	8,480,000	28,778,125	19,875,642
Total Income	64,973,847	133,020,375	41,100,013	74,065,938	78,238,229

Table48: Average Household Incomes from various Sources (VND/Year), by Income Quartile

Average Household Incomes from various Sources (VND/year)					
Income Quartile	**Q1**	**Q2**	**Q3**	**Q4**	**Total**
Fresh root income	5,112,500.00	7,536,461.54	7,123,437.50	6,930,937.50	6,679,182.88
Dry Chip income	842,187.50	2,675,674.00	281,250.00	804,062.50	1,156,726.89
Total Cassava Income	5,954,687.50	10,212,135.54	7,404,687.50	7,735,000.00	7,835,909.77
Paddy rice production value	4,103,125.00	8,052,307.69	14,527,343.75	23,314,687.50	12,482,062.26
upland rice production value	1,194,531.25	1,330,000.00	573,437.50	210,937.50	829,182.88
Income from Maize	895,000.00	7,226,307.69	20,637,375.00	45,329,375.00	18,478,062.26
Income from all other annual crops	937.50	0.00	0.00	1,150,000.00	286,614.79
Income from coffee	1,240,000.00	2,372,307.69	2,975,781.25	3,789,062.50	2,593,424.12
Income from all other tree crops	10,937.50	93,846.15	48,437.50	550,000.00	175,486.38
Cropping Income	13,399,218.75	29,286,904.77	46,167,062.50	82,079,062.50	42,680,742.45
Non-Cassava Cropping Income	7,444,531.25	19,074,769.23	38,762,375.00	74,344,062.50	34,844,832.68
Cattle Income	78,125.00	3,269,230.77	4,979,687.50	10,714,062.50	4,754,474.71
Buffalo Income	0.00	1,207,692.31	8,266,156.91	18,585,937.50	6,992,350.36
Goat Income	62,500.00	536,923.08	1,539,062.50	2,648,437.50	1,194,163.42
Pig Income	168,750.00	332,769.23	2,139,062.50	2,650,781.25	1,318,988.33
Chicken Income	95,312.50	552,615.38	328,125.00	1,715,625.00	672,451.36
Duck Income	0.00	17,692.31	56,250.00	178,906.25	63,035.02
Other Livestock Income	0.00	20,000.00	375,000.00	95,312.50	122,178.99
fish Income	0.00	0.00	0.00	15,625.00	3,891.05
Total Livestock Income	404,687.50	5,936,923.08	17,683,344.41	36,604,687.50	15,121,533.24
On-farm Income	13,803,906.25	35,223,827.85	63,850,406.88	118,683,750.00	57,802,275.68
Off-farm Wages	1,381,250.00	863,076.92	703,125.00	246,875.00	798,832.68
Irregular non-farm income	1,557,812.50	3,449,230.77	10,667,968.75	19,554,687.50	8,786,575.88
Salary Income	305,625.00	1,238,461.54	4,656,562.50	17,519,375.00	5,911,750.97
NTFP income	457,812.50	353,846.15	275,000.00	289,062.50	343,968.87
Fishing Income	0.00	0.00	70,312.50	500,000.00	142,023.35
Other Income	426,562.50	2,016,923.08	4,546,250.00	12,051,718.75	4,749,688.72
Off-farm Income	4,129,062.50	7,921,538.46	20,919,218.75	50,161,718.75	20,732,840.47
Total Income	17,932,968.75	43,145,366.28	84,769,625.63	168,845,468.75	78,535,116.14

Table 48: Labour Costs for Various Production Activities (VND/Year), by Commune

Name of commune	Bo Muoi	Chieng Chan	Na Ot	PungTra	Total
Field Establishment Household Labour	2,908,718	1,761,692	2,364,153	3,421,763	2,619,560
Field Establishment Outside Labour	-	51,829	77,702	18,750	36,708
Land Preparation Household Labour	5,092,234	1,107,647	3,623,502	8,824,368	4,681,636
Land Preparation Outside Labour	176,923	21,164	194,104	203,646	149,393
Planting Material Preparation Household Labour	932,967	531,387	654,577	1,415,885	886,177
Planting Material Preparation Outside Labour	-	33,333	14,286	-	11,765
Planting Stakes Household Labour	2,850,037	1,596,170	1,976,979	5,169,866	2,906,793
Planting Stakes Outside Labour	153,846	506,525	532,729	642,150	457,140
Fertiliser Household Labour	24,359	105,643	213,379	35,156	93,850
Fertiliser Outside Labour	-	4,233	-	-	1,046
First Weeding Household Labour	4,544,982	1,858,711	2,592,297	7,185,826	4,061,687
First Weeding Outside Labour	53,846	93,122	307,937	375,000	206,928
Second Weeding Household Labour	3,249,524	727,786	924,244	5,759,115	2,681,883
Second Weeding Outside Labour	30,769	8,466	13,605	341,146	98,917
Third Weeding Household Labour	520,989	145,522	60,317	183,333	229,669
Third Weeding Outside Labour	-	-	-	-	-
Harvesting Household Labour	4,869,341	2,045,354	4,622,628	10,488,839	5,521,081
Harvesting Outside Labour	1,615,128	1,945,307	895,314	707,515	1,291,072
Transporting Household Labour	1,293,681	583,951	1,480,860	4,437,649	1,953,655
Transporting Outside Labour	876,026	480,755	1,023,413	197,917	644,592
Chipping and Drying Household Labour	759,744	510,582	565,029	3,214,621	1,266,206
Chipping and Drying Outside Labour	73,846	-	14,966	156,250	61,737
Other post-harvest Household Labour	191,685	130,915	71,605	256,696	163,321
Other post-harvest Outside Labour	-	-	-	156,250	39,216
Total Labour	30,218,645	14,250,093	22,223,626	53,191,741	30,064,030
Household Labour	27,238,260	11,105,359	19,149,570	50,393,118	27,065,517
Outside Labour	2,980,385	3,144,734	3,074,055	2,798,624	2,998,512

Table 49: Detailed cost and labour, soil management trial in Pung Tra commune (for 1 ha)

	Unit price (Vnđ)	Cassava	Cassava + cowpea	Cassava + mungbean	Cassava + Peanut	Cassava + grass trip	Cassava + cotour line
Fertilizers and pesticides							
NPK (kg)	4,200	0	80	80	80	40	0
Ure (kg)	72,000	87	87	87	87	87	87
Kali clorua (kg)	10,000	80	80	80	80	80	80
Suppe lân (kg)	3,700	142	142	142	142	142	142
Herbicide (liter)	65,000	6	6	6	6	6	6
Pesticide (spray times)	600.000		1	1	1		
Seeds							
Cassava (stems)	100	10,000	10,000	10,000	10000	10,000	10,000
peanut (kg)	40,000	0	0	0	20	0	0
cowpea (kg)	40,000	0	10	0	0	0	0
mungbean (kg)	50,000	0	0	10	0	0	0
Grass *Panicum.sp* (kg)	4000	0	0	0	0	1,000	0
Labour (working days)							
Prepare land		60	60	60	60	60	60
Planting		20	20	20	20	20	20
Top dressing		2	2	2	2	2	2
weeding 1st		25	30	30	30	25	25
weeding 2nd		20	25	25	25	20	20
Harvest cassava		73	73	73	73	73	73
Intercroping							
Planting		0	10	10	10		0
Pray pesticide			4	4	4		
Harvest intercrop		0	8	3	10		0
Grass trip							
Planting						10	
Harvest						5	
Control Cotour line							2
Yield and price							
Cassava (tons)	1,400,000	14.37	14.22	15.3	15.02	14.77	14.384
peanut (kg)	20,000	0	0	0	254	0	0
Cowpea (kg)	30,000	0	240	0	0	0	0
mungbean (kg)	30,000	0	0	80	0	0	0
Grass trip (kg)	livestock	0	0	0	0	248	0

Table 50: Detailed cost and labour requirement, Fertilizer trial in Púng Tra (for 1 ha)

	Price (Vnđ)	T0	T1	T2	T3	T4
Fertilizers and hericides						
NPK (kg)	4,200	0	300	600		
Ure (kg)	72,000	0			87	
Kali clorua (kg)	10,000	0			80	
Suppe lân (kg)	3,700	0			142	
FDP (kg)	10.000	0				309
Herbicide (liter)	65,000	7	7	7	7	7
Seeds						
Cassava (stems)	100	10,000	10,000	10,000	10000	10,000
Labour (working days)						
Prepare land		60	60	60	60	60
Planting		20	20	20	20	20
Top dressing		0	0	0	2	0
weeding 1st		25	25	25	25	25
weeding 2nd		20	20	20	20	20
Harvest cassava		65	68	73	73	73
Yield and price						
Cassava (tons)	1,400,000	12.2	16.28	16. 67	22.37	18.7

Table 51: Detailed cost and laboutr requirement, sSoil management in Bó Mười (for 1 ha)

	Price (Vnđ)	cassava	Cassava + cowpea	Cassava + mungbean	Cassava + Peanut	Cassava + grass trip	Cassava + cotour line
Fertilizers and pesticides							
NPK (kg)	4,200	0	80	80	80	40	0
Ure (kg)	72,000	87	87	87	87	87	87
Kali clorua (kg)	10,000	80	80	80	80	80	80
Suppe lân (kg)	3,700	142	142	142	142	142	142
Herbicide (liter)	65,000	6	6	6	6	6	6
Pesticide (spray times)	600.000		1	1	1		
Seeds							
Cassava (stems)	100	10,000	10,000	10,000	10000	10,000	10,000
peanut (kg)	40,000	0	0	0	20	0	0
cowpea (kg)	40,000	0	10	0	0	0	0
mungbean (kg)	50,000	0	0	10	0	0	0
Grass *Ghi-ne* (kg)	4000	0	0	0	0	1,000	0
Labour (working days)							
Prepare land		60	60	60	60	60	60
Planting		20	20	20	20	20	20
Top dressing		2	2	2	2	2	2
weeding 1st		25	30	30	30	25	25
weeding 2nd		20	25	25	25	20	20
Harvest cassava		73	70	71	71	73	73
Intercroping							
Planting		0	10	10	10		0
Pray pesticide			4	4	4		
Harvest intercrop		0	10	6	10		0
Grass trip							
Planting						10	
Harvest						5	
Control Cotour line							2
Yield and price							
Cassava (tons)	1,400,000	15.47	12.93	13.01	13.76	14.06	15.26
peanut (kg)	20,000	0	0	0	254	0	0
Cowpea (kg)	30,000	0	240	0	0	0	0
mungbean (kg)	30,000	0	0	80	0	0	0
Grass trip	livestock	0	0	0	0	248	0

Table 52: Detailed cost and labour requirement, Fertilizer trial in Bó Mười (for 1 ha)

	Price (Vnđ)	T0	T1	T2	T3	T4
Fertilizers and herbicides						
NPK (kg)	4,200	0	300	600	0	0
Ure (kg)	72,000	0	0	0	87	0
Kali clorua (kg)	10,000	0	0	0	80	0
Suppe lân (kg)	3,700	0	0	0	142	0
FDP (kg)	10.000	0	0	0	0	309
Herbicide (liter)	65,000	7	7	7	7	7
Seeds						
Cassava (stems)	100	10,000	10,000	10,000	10000	10,000
Lbour (working days)						
Prepare land		60	60	60	60	60
Planting		20	20	20	20	20
Top dressing		0	0	0	2	0
weeding 1st		25	25	25	25	25
weeding 2nd		20	20	20	20	20
Harvest cassava		85	85	83	80	80
Yield and price						
Cassava (tons)	1,400,000	23.43	23.22	22.2	18.28	17.1