
CASSAVA PROGRAM DISCUSSION PAPERS

Value Chain Analysis, Household Survey and Agronomic Trial Results North Sumatra

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Country Information

Research is being undertaken at two sites in Indonesia – the provinces of North Sumatra and Nusa Tenggara Timur. Research in North Sumatra is concentrating in Simalungun Regency while research in Nusa Tenggara Timur is concentrating on Sikka Regency on the island of Flores.

The two research sites have significantly contrasting value chains for cassava. Cassava production and processing in North Sumatra is long established and commercialised with a well-developed system of factories and traders. Cassava production in Sikka is predominately of sweet cassava as a staple crop. Small scale processing into snack food, dried chips and mocaf is developing, but the sector can still be classified as almost entirely non-commercialised.



Figure 1: Research Locations, Indonesia

As shown in Table 1, the total area of cassava production, in Nusa Tenggara Timur is greater than that of North Sumatra. A combination of better agro-climatic conditions, more commercialized production and higher yielding bitter varieties mean that the per hectare yield of fresh root in North Sumatra is over three times higher than the average yield in Nusa Tenggara Timur. This in turn means that the annual cassava production figures in North Sumatra are almost double that of Nusa Tenggara Timur.

Table 1: Characteristics of cassava production by site, Indonesia 2014

Province	Area of cassava (ha)	Average fresh yield (t/ha)	Annual production of fresh root (t)	Main industries	Number of factories
Nusa Tenggara Timur	79,164	10.2	807,473	Fresh market Kripik Dry chip (<i>gapek</i>)	Very small scale gapek, kripik, mocaf and tiwul processing
North Sumatra	47,141	32.2	1,517,940	Starch Snack food	9 starch 8 non-starch

Value Chain Information

The majority of cassava produced in Simalgun is destined to be used to produce starch by PT. Bumisari Prima. Two major channels for fresh roots from smallholders to the starch factory can be identified.

The first channel is most commonly observed for smallholders located close to the starch factory. In this channel, collectors buy from around 80-100 farmers each and then deliver to factory according to a schedule developed by factory agents. Each collector is linked to a factory agent who has a daily delivery quota. Each factory agent is linked to around 100 collectors.

The factory pays the agent who then pays the collector who pays farmers on the same day as collection. There are formal contracts between the collectors and the agents. Although the factory does not test cassava roots for starch content, roots with high starch content are needed by the factory.

The second channel involves cassava sold directly to factory from more remote locations, with different planting and harvesting seasons. In this channel, collectors buy from around 50 farmers each and then transport and sell directly to the factory. This system does not involve formal contracts and also does not involve agents.

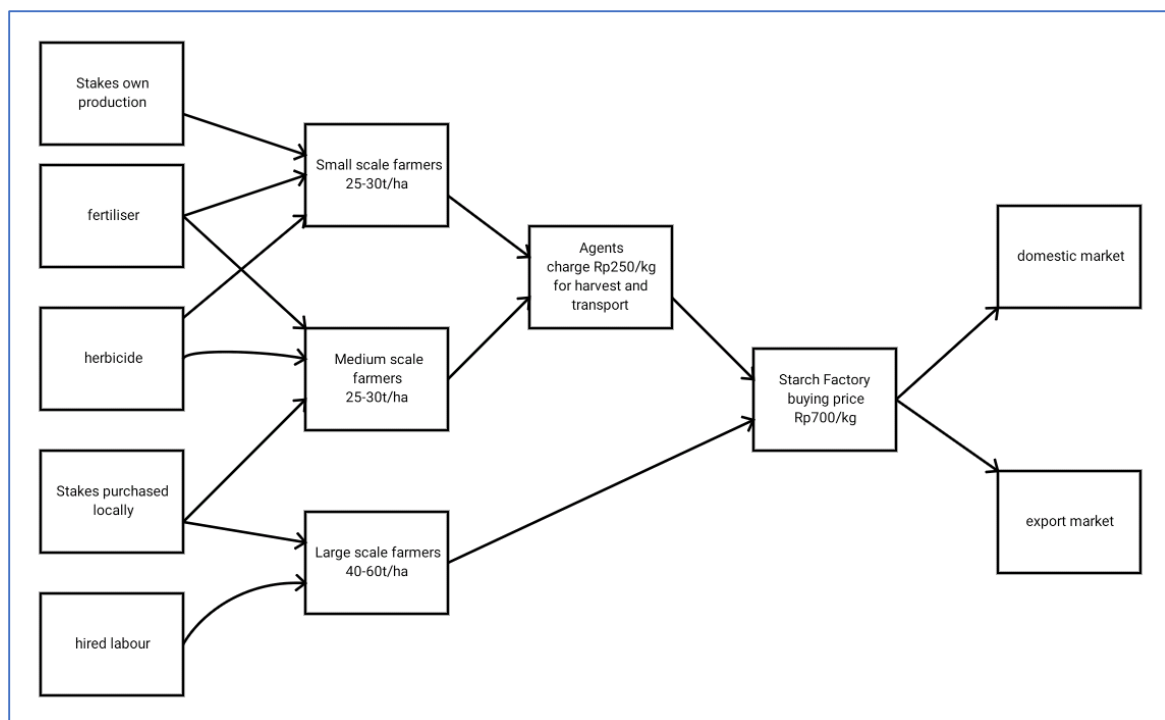


Figure 2: Representation of Cassava Value Chain, North Sumatra

Table 2: Summary of Value Chain information

	Input	Production	Trading	Processing
Actors	Planting material -local variety – other farmers -improved varieties – farmers from Lampung Fertilizer and Herbicides – Agricultural supply shop	Farmers Small – 100% family labour Medium: family and non-family labour Large: hired labour	Small and medium farmers use processors agents based in village Large farmers sell directly	Bitter cassava: starch processing factory Sweet cassava: food products processing factory
Activities	Supply inputs	All production activities from land preparation to harvesting/transporting	Marketing and as mediator between farmers and factory	Producing starch and by-products Producing cassava based food items
Output Form	Planting material, fertilizer, herbicide	Bitter and Sweet cassava roots	Bitter and Sweet cassava roots	Starch Food items
Input Form		Planting material, fertilizer, herbicide	Bitter and Sweet cassava roots	Bitter and Sweet cassava roots
Difficulties	High prices of fertiliser if there is no government subsidy	Unfavourable weather Lack of capital Cassava varieties take long time to mature	Factory is price maker and farmers have very weak bargaining position	High quality requirements of factory (high starch content, low moisture, less broken/rotten roots)
Potential Solutions		Drought resistant varieties Shorter growing period varieties (7-8 months) to enable double cropping with maize	Government facilitates market access, promotion and information.	On-time harvesting Good agricultural practices

Location of Project Activities within province

Farmer focus group discussions were held in three villages in Simalungun Regency, North Sumatra Province (Figure 3).

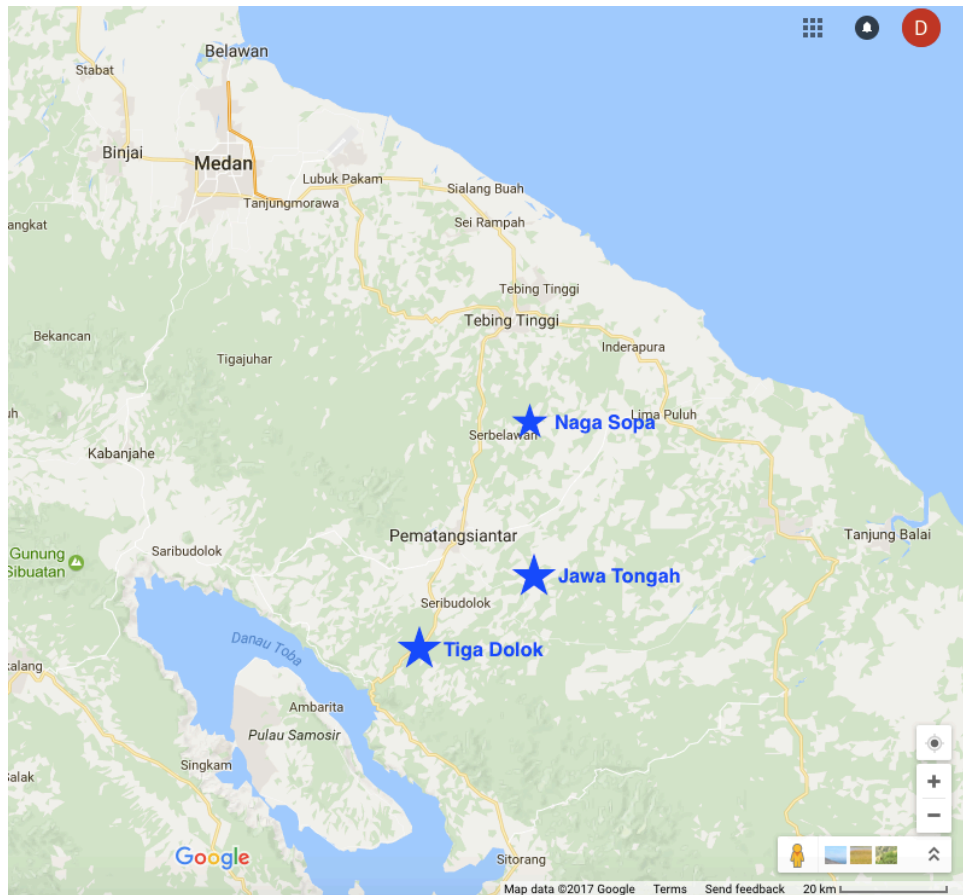


Figure 3: Focus Group Locations, North Sumatra

Tiga Dolok Village, Dolok Panribuan Sub District, Simalungun Regency

Sweet varieties of cassava for home consumption have been planted in Tiga Dolok for many years. Initially the farmers planted a local variety called *ubi merah* (red cassava), which has a red stem and white skinned roots. By the 1970's, a number of small factories were developed and farmers began to sell the red cassava to the factories through traders. By 1987, there were two kind of main varieties of cassava planted in the village: *Ubi adira* (a black stemmed variety with the local name "poisonous cassava"), and *Ubi atong* (a local variety). *Ubi atong* has good production levels, but rots easily during rainy periods. During the 1980s, the development of the PT Bumisari starch factory meant that more farmers began producing cassava for sale to traders - prices were rising and farmers' incomes began to increase.

During the 1990's and the 2000's cassava farmers produced *ubi atong* as well as *ubi merah* and *ubi adira*. By season 2014-2015, most farmers had shifted to production of *ubi roti*. During the initial stages of changing to *ubi roti*, the farmers received relatively high prices (Rp 800/kg) and achieved good incomes. However, by the end of season 2016, the price had decreased significantly to around Rp 650/kg for fresh roots.

Jawa Tengah Village, Hatonduhan Sub District, Simalungun Regency

Before 1974 in Jawa Tengah, people grew sweet cassava varieties only for food consumption. From 1974 there was an cooperation with PT Bumisari to grow cassava with Taiwan variety. In the early 1990s, around 10% of farmers planted cassava but by 1997 this had increased to 60%. The main cassava varieties planted in the 1990's were *ubi adira* and

ubi Malaysia, but by 2015, there were more than 10 varieties of cassava grown in the village. However, the farmers generally do not know the names of the varieties currently planted.

Fresh root prices were high until around 2015, with farmers receiving up to Rp 1115/kg (factory gate price). Prices steadily decreased through 2016, from Rp 900/kg in June, Rp740/kg in August, Rp690/kg in September, and Rp650/kg by October. Most farmers indicated that if the price did not increase in 2017 they would move to oil palm farming or maize farming.

Naga Sopa Village /Dusun Sembat (sub village), Bandar Haluan Sub District, Simalungun Regency

Prior to 2005, Before 2005, farmers in Naga Sopa were only involved in rice and maize production. In 2005, they started to plant *ubi adira*, but unfortunately this variety was not resistant in fungal disease and suffered from root rot. In 2015, the highest price of cassava is Rp 1.050/kg at PT Bumisari factorygate and Rp 940/kg (farmgate). During 2016, the cassava price steadily decreased and by October was reported at Rp650/kg at PT Bumisari factorygate and Rp480/kg at farmgate. Farmers indicated that if the price did not increase in 2017, they would not plant cassava and would move to maize farming.

Household surveys were conducted in four districts, Pakpak Bharat, Pematang Siantar, Simalungun and Toba Samosir, with the majority of surveys (over 80%) conducted in Simalungun. The total usable sample size included 138 households.

Table 2: Households by Survey locations – North Sumatra, Indonesia

Districts	Number of household surveys
Simalungun	111
Toba Samosir	17
Pematang Siantar	9
Pakpak Bharat	1
Total	138



Figure 2: Survey Sites, North Sumatra, Indonesia

Livelihood Information

Time of first cultivating cassava

Cassava has been grown in North Sumatra for a long time with many farmers having adopted them back in the 1960s. Since the 1990s there has been a growing trend in the adoption of cassava although the number of adopters have fluctuated greatly from year to year. The number of new adopters peaked in 2013 and there seems to a gradual decline since.

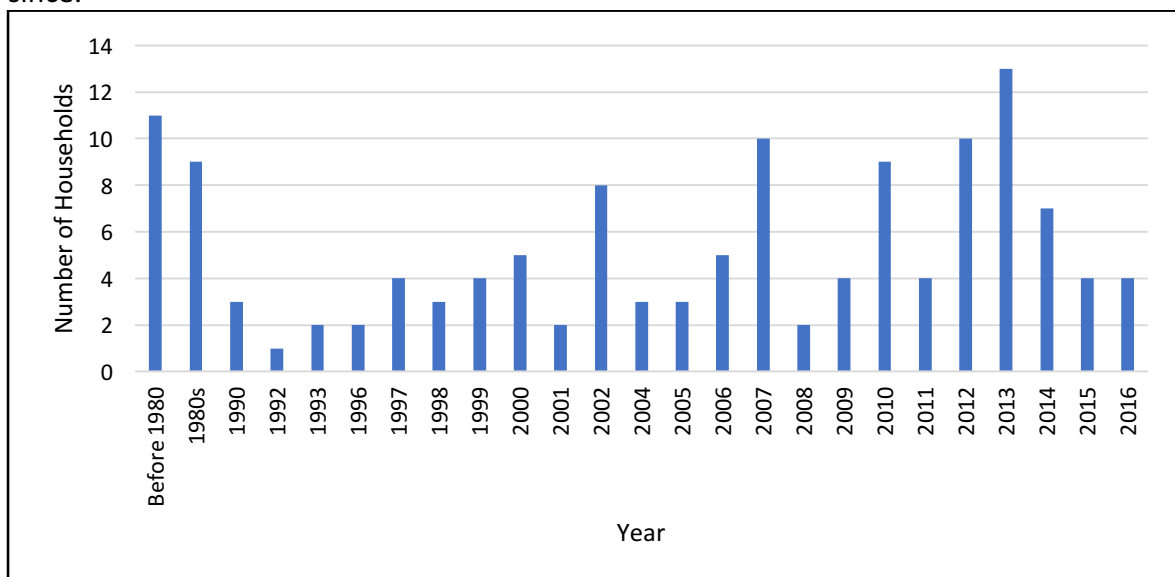


Figure 4: Year of First Cassava Production

Income from various on-farm and off-farm activities

Cassava is an important crop contributing to about a quarter of overall household income. Almost another quarter of household income comes from paddy rice followed by maize which contributes about 3% to household income. Only modest amounts of other annual crops or tree crops are grown in the surveyed region. Livestock, in particular cattle and pigs are important sources of income although they only contribute to less than 6% of household income. The most dominant source of income is through off-farm sources which is responsible for over 40% of households income.

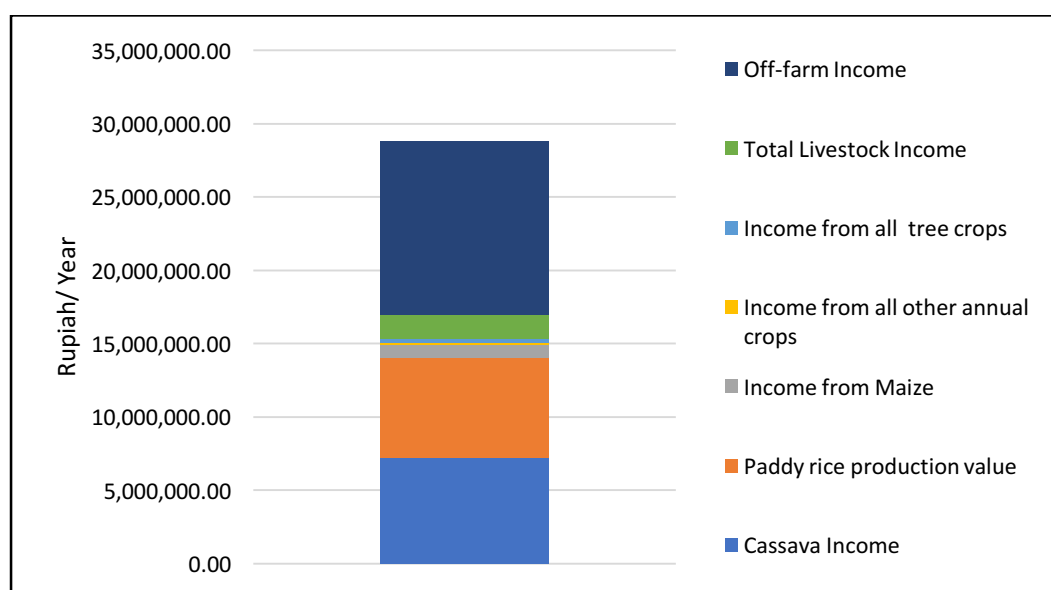


Figure 5: Source of Income

Importance of Cassava in overall livelihood and in cash income

While cassava contributes an average of about a quarter to overall household income, its importance varies across income groups. However, there isn't a strictly linear relationship between income from cassava and overall household income. Cassava is of least importance in terms of an income source for the third quartile where it contributes to only 18% of overall income. The contribution of cassava is higher at 25% for the richest income group while it is highest for the two poorest income quartiles contributing slightly over 30% to overall income. For households in the third income quartile the most important source of income is through crops other than cassava which contributes over 52% of household income. On the other hand, the most important source of income for the richest income quartile involves off farm sources which contributes almost 54% of household income.

Table 3: Annual Income from different sources

Source	Total
Cassava Income	7,230,194.20
Non-Cassava Cropping Income	8,075,611.59
Total Livestock Income	1,673,653.62
Off-farm Income	11,840,869.57

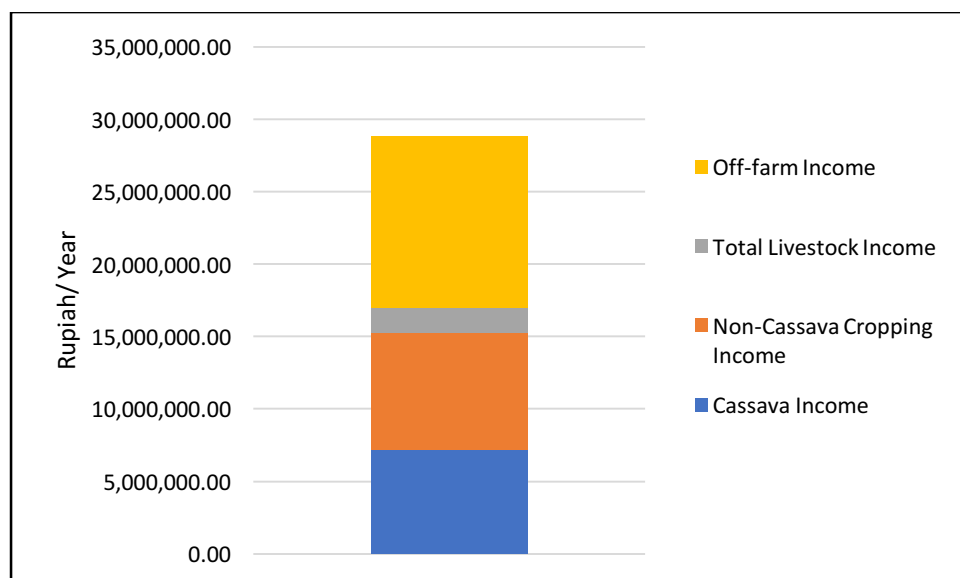


Figure 6: Income Sources

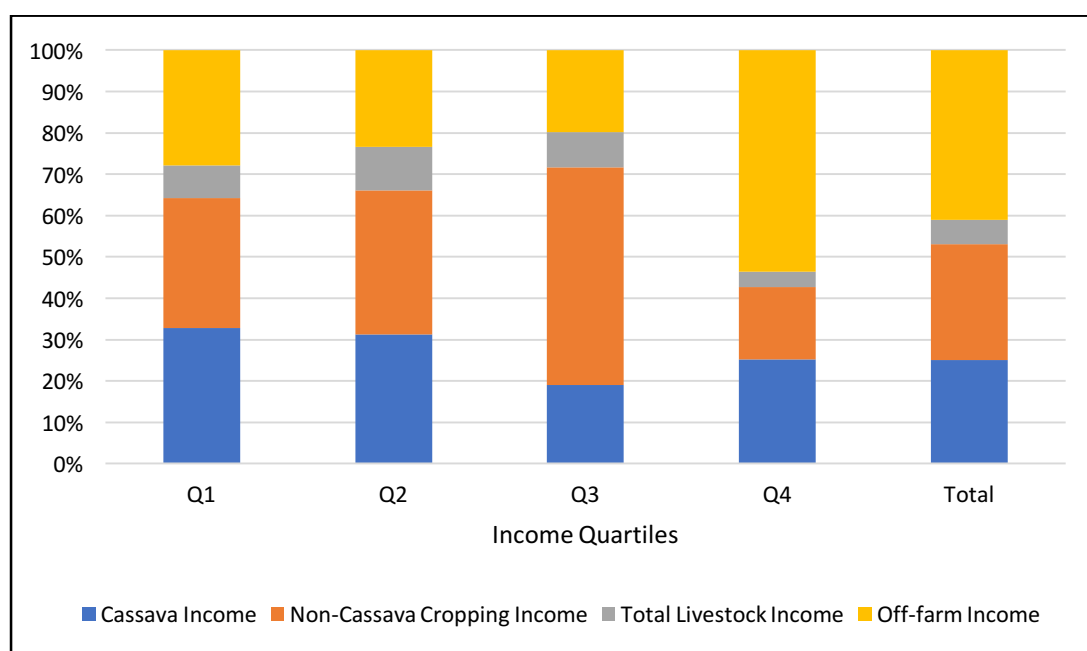


Figure 7: Sources of Livelihood, by Income Quartile

Figure 8 shows the sources of cash income by income quartile. This is derived by not including the value of the staple crop (paddy rice) in the calculation of gross income. The overall contributions change slightly when only accounting for paddy rice that is sold for an

income. However, with more or less similar amounts of paddy rice being consumed at the household level across income groups, this modification does not alter results significantly.

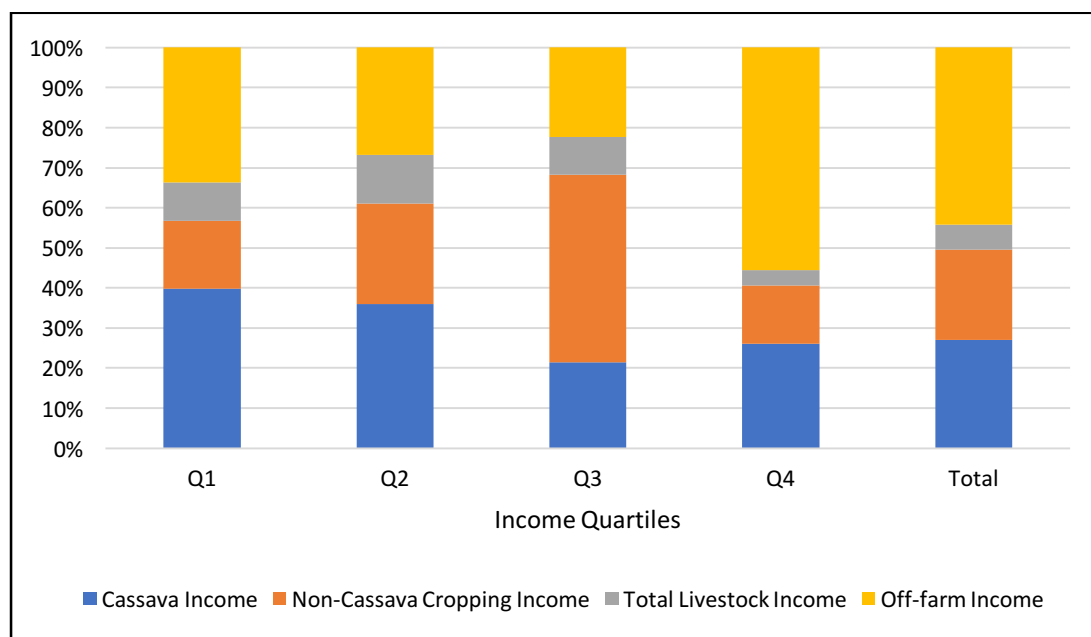


Figure 8: Sources of cash income, by Income Quartile

Labour Force

Across all surveyed areas, the average household size is 4.53. While an average of 1.41 household members are full time agricultural workers, an average of 2.87 members have at least some involvement in agriculture. This implies that about 37% of household members have no involvement in agriculture, most of whom are children. While there isn't a significant difference between men and women with regards to agricultural participation, men are more likely to be full time agricultural workers while women are more likely to be involved only part time.

Table 4: Number of family members by employment status

Employment status in Agriculture	Average Number of Family Members		
	Female	Male	Total
Full time	0.55	0.86	1.41
Part time	0.54	0.38	0.92
Rarely	0.30	0.23	0.54
Never	0.78	0.88	1.66
Total	2.17	2.36	4.53

Use of labour by gender and household/non-household

While specific gender roles do not seem to exist for most activities related to the production of cassava, there is overall greater involvement of men in most of the tasks. Figure X shows that generally men supply more person-days per hectare across all tasks involved in cassava production. For certain tasks such as chipping and drying, harvesting, second weeding, pest and disease control, fertilizer applications, planting material preparation and land preparation, men contribute over twice as many person-days per hectare.

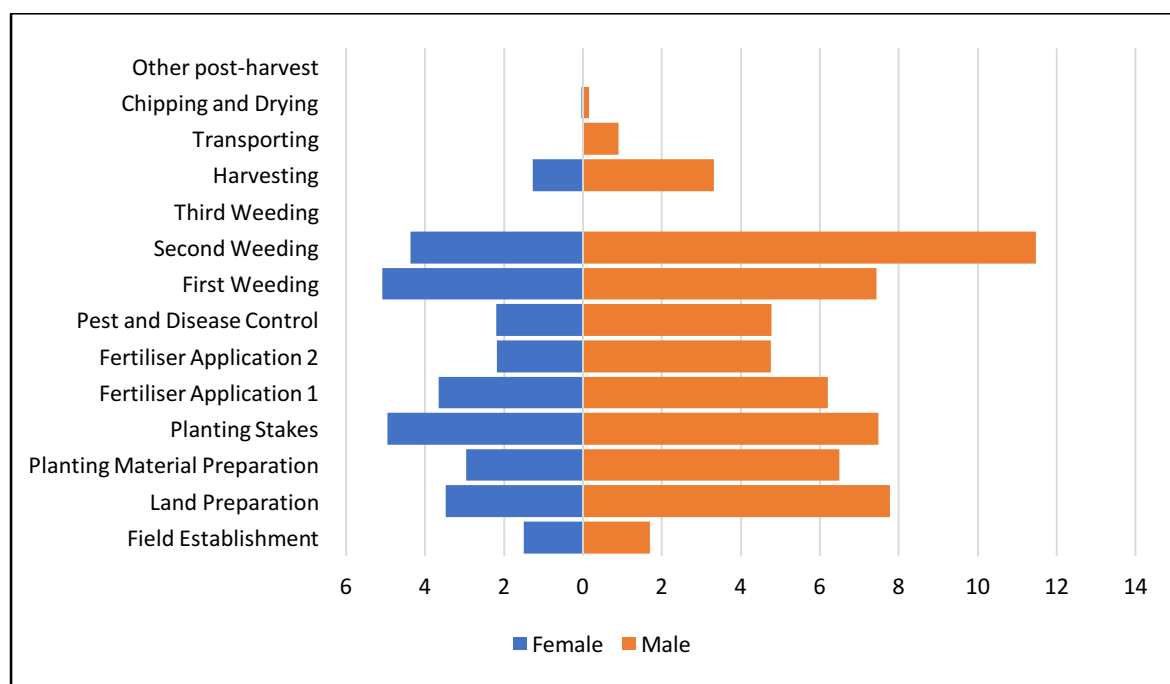


Figure 9: Household Labour Person-Days per hectare, by Gender

Household labour is utilized more often than external sources of labour for all agricultural activities related to cassava production apart from harvesting and transportation. Tasks such as planting material preparation, fertilizer application and weeding are almost exclusively conducted by members within the household. Relatively more non-household labour is utilized only for preparing the land which is likely due to the need for agricultural equipment such as tractors which the households do not own themselves and hence have to depend upon external sources (Figure 9 and Figure 10).

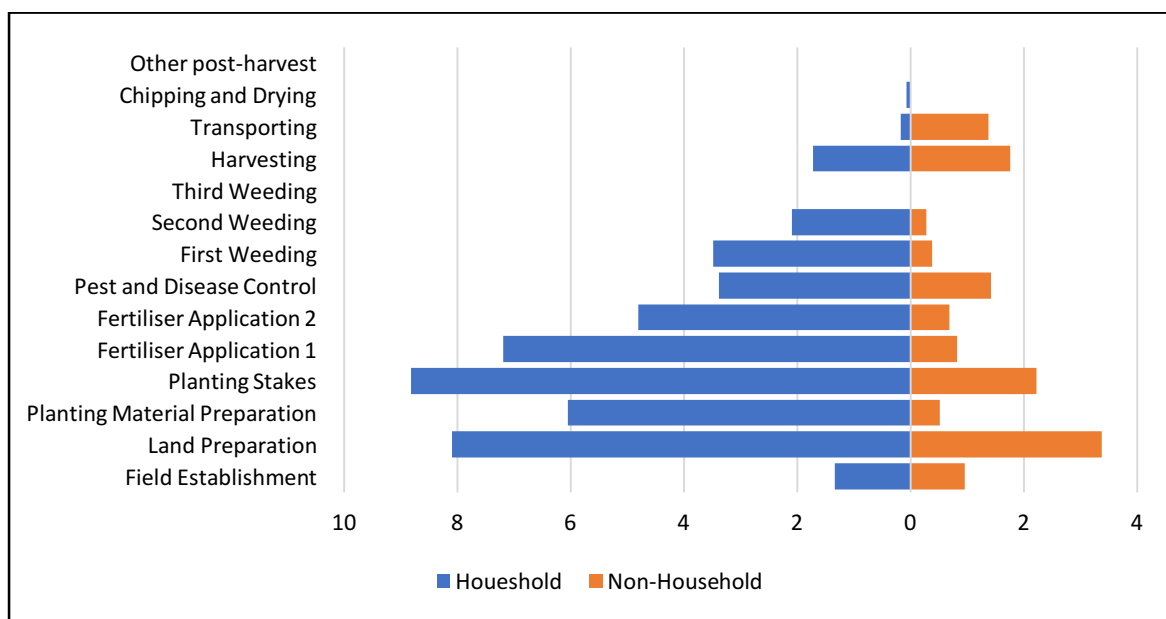


Figure 10: Labour Person-Days per hectare, by Source

Access to credit

Slightly under 30% of households have taken a loan in the past 12 months, with a majority of them having taken out only a single loan. Households in the lowest income group are least likely to have taken a loan compared to those in other income groups. The total value of loans is significantly higher for the highest income group in relation to households in the first three quartiles. (Table 5).

Table 5: 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	14.71%	27.78%	44.12%	29.41%	28.99%
% households with 1 loan	14.71%	27.78%	32.35%	29.41%	26.09%
% households with 2 loans	0.00%	0.00%	8.82%	0.00%	2.17%
Average value of total loans received (Rupiah)	1,420,000.00	1,005,000.00	5,403,928.57	34,800,300.00	11,302,769.23

Of those that have taken a loan, over 95% indicate that their level of debt is either 'manageable' or 'very manageable' while the few remaining respondents seem to have at least some concerns. As shown in Table 6, slightly over 3% report 'some concern' while only one respondent indicates that his/her debt is at 'worrying' levels.

Table 6: Manageability of debt

Manageability of current debt	Frequency	Percent
Very Manageable	43	68.25%
Manageable	17	26.98%
Some Concern	2	3.17%
Worrying	1	1.59%
Total	63	100.00%

Access to information

For farmers, the most common source of information on agricultural production is through 'friends and neighbours within the village' which is followed by 'family' and 'cassava traders'. The role of 'farmer groups' is also important with almost a quarter of households identifying such organizations as a source of information for agricultural production. Unfortunately, there is very limited availability of information from other potentially important sources including the district or province governments.

Table 7: Sources of information on agricultural production

Source of Information	Frequency	Percentage
Friends and neighbours in the village	92	66.67%
Family	59	42.75%
Cassava Traders	55	39.86%
Farmer Group	34	24.64%
District government extension	9	6.52%
TV	8	5.80%
Friends and neighbours outside the village	5	3.62%
Cassava Processors	4	2.90%
Non Government Organization	3	2.17%
Other	3	2.17%
Internet	2	1.45%
Province government extension staff	0	0.00%
Researchers	0	0.00%
Radio	0	0.00%

Similar to the source of information for agricultural production, information on agricultural markets are also obtained primarily from 'cassava traders, and 'friends and neighbours within the village' followed by 'family' and 'farmer groups'. It is encouraging to see an active role taken by cassava traders in providing marketing information to farmers which is able to provide mutual benefits to both parties.

Table 8: Sources of information on agricultural markets

Source of Information	Frequency	Percentage
Cassava Traders	79	57.25%
Friends and neighbours in the village	77	55.80%
Family	52	37.68%
Farmer Group	24	17.39%
Friends and neighbours outside the village	6	4.35%
Cassava Processors	6	4.35%
TV	4	2.90%
District Government Extension	2	1.45%
Non Government Organizations	1	0.72%
Internet	1	0.72%
Province Government Extension Staff	0	0.00%
Researchers	0	0.00%
Radio	0	0.00%
Other	0	0.00%

Group membership

Slightly over 25% of respondents indicate that they have a household member participating in a group or a mass organization. Most of the individuals involved with a group are with a single organization with less than 10% having memberships to two organizations. Apart from a single farmer indicating membership to a political organization the rest are memberships to farmer groups.

Ownership of assets

The mode of transportation used by most farmers is a motorbike. The proportion of households owning a motorbike is slightly under 75% with an uneven distribution of ownership across the different income groups. While households in the second income quartile are most likely to own a motorbike, the poorest income group are the least likely. As expected, the likelihood of owning a car or a truck is highest for the richest income group. Despite the efficiency gains related to the use of tractors in agricultural production, hardly any of the farmers own tractors. As shown in Table 20, about 45% of farmers use two and four wheel tractors to cultivate their lands; however, they must depend upon external sources to utilize them. Slightly under 67% of farmers own mobile phones although only a handful of them have smart phones. Television sets on the other hand are very common with almost 87% of households owning a set.

Table 9: Asset ownership by income quartile

Assets	Q1	Q2	Q3	Q4	Total
truck	0.00%	2.78%	2.94%	17.65%	5.80%
car	2.94%	5.56%	0.00%	14.71%	5.80%
motorbike	55.88%	94.44%	61.76%	82.35%	73.91%
two wheel tractor	0.00%	2.78%	0.00%	2.94%	1.45%
four wheel tractor	0.00%	0.00%	0.00%	0.00%	0.00%
water pump	11.76%	13.89%	5.88%	14.71%	11.59%
generator	0.00%	0.00%	0.00%	0.00%	0.00%
mobile phone	64.71%	69.44%	64.71%	67.65%	66.67%
smart phone	2.94%	2.78%	5.88%	14.71%	6.52%
tv	88.24%	83.33%	91.18%	85.29%	86.96%
dvd player	8.82%	13.89%	11.76%	23.53%	14.49%
radio	20.59%	41.67%	14.71%	20.59%	24.64%
refrigerator	14.71%	30.56%	23.53%	47.06%	28.99%

Agronomic Information

Area, production, Current yields and trends

The average cassava production area per household is 0.54 hectares and the average production is almost 15 tons, resulting in a yield of about 29 tons per hectare (Table 10).

Table 10: Household cassava production characteristics

Cassava Production	Total
Cassava production 2016 (tons)	14.81
Cassava Harvest Area 2016 (ha)	0.54
Cassava Yield 2016 (tons/ha)	28.74

Highest and lowest yields

The average highest cassava yield in the past five years across all surveyed areas was over 32 tons per hectare while the average lowest yield in the past five years reached a low of about 20 tons per hectare. The year with maximum yield for a majority of farmers was 2016 followed by 2015 while the lowest yield years for most were also around the same years between 2014 and 2016.

Table 11: Highest and Lowest Production in last 5 years

Range of Cassava Production	Total
Highest Cassava Production in the last five years (tons)	16.08
Area Utilized for Highest Cassava Yield in the last five years (ha)	0.55
Highest Cassava Yield in the last five years (tons/ha)	32.38
Lowest Cassava Production in the last five years (tons)	9.31
Area Utilized for Lowest Cassava Yield in the last five years (ha)	0.54
Lowest Cassava Yield in the last five years (tons/ha)	20.20

Cassava yields are reported to be declining either rapidly or moderately for over 46% of all farmers which is quite concerning. Only about 6.5% report increasing yields while the rest believe their yields are either ‘relatively constant’ or simply ‘fluctuating’.

Table 12: Cassava yield trends, by Region

Yield Trend	Percent
Declining rapidly	15.94%
Declining moderately	30.43%
fluctuating, but no clear trend	17.39%
Relatively constant	27.54%
Increasing	6.52%
Increasing rapidly	0.00%

Plans for growing cassava in the future

When asked if they believed they would be growing cassava in five year’s time, over 56% of farmers provided a positive response while about 43% said they were not sure. Only one respondent said they plan to discontinue cassava production. The respondents in the second income quartile were the most optimistic about their cassava production with over 71% predicting that their cassava production will be retained in the years to come.

Table 13: Future production intention, by income quartile

Will you grow cassava in the future?	Q1	Q2	Q3	Q4	Total
Yes	50.00%	71.43%	52.94%	50.00%	56.30%
No	3.13%	0.00%	0.00%	0.00%	0.74%
Unsure	46.88%	28.57%	47.06%	50.00%	42.96%

Soil Erosion Problems and Control Techniques

Slightly less than 15% of cassava farmers view soil erosion as a problem with a relatively even distribution across the scale measuring the severity of the issue. About half of the respondents that consider soil erosion as a problem are also aware of measures to mitigate the problem. However only a handful have received any formal training on soil conservation measures. There is considerable interest in learning about soil conservation measures with almost 50% of respondents showing an interest in trialling conservation practices on their own lands.

Table 14: Soil erosion perception

Soil Erosion	Total
Soil Erosion perceived as a problem	14.49%
Small Problem	4.35%
Medium Problem	5.07%
Serious Problem	5.07%
Are you aware of any measure to reduce soil erosion?	8.70%
Have you had any training on any soil conservation measures?	1.45%
Are you interested in trialling conservation practices on your land?	49.28%

Adoption of intercropping is found to be relatively low with only 9% of farmers ever having grown intercrops with cassava and about 7% currently adopting the practice. However there is considerable interest amongst farmers to adopt this practice with over 39% denoting an interest in trialling intercrops on their own lands.

Table 15: Awareness of intercropping

Intercropping	Total
Have you ever grown intercrops with your cassava?	9%
Do you currently grow any intercrops with your cassava?	7%
Are you interested in trialling new intercrops?	39.13%

Fertiliser adoption, awareness and correct application

Almost a third of all cassava farmers claim to be applying organic fertilizers on their land while almost 95% indicate the use of inorganic fertilizers. With a majority of farmers accustomed to inorganic fertilizer use, it is not surprising that over 36% of farmers claim to understand what NPK values represent in a fertilizer. Despite the majority of farmers applying fertilizers on their crops, only 12% report having seen a fertiliser trial on cassava. However there is high level of interest amongst farmers to learn about fertilizers and their correct application with almost 83% willing to visit a fertiliser demonstration trial while 60% are even willing to conduct fertilizer trials on their own lands.

Table 16:: Fertiliser Practice

Fertilizer Use	Percent
Do you apply organic fertiliser to your cassava?	32.61%
Do you apply inorganic fertiliser to your cassava?	94.93%
Do you understand what the NPK values mean on the fertiliser you apply?	36.23%
Have you ever seen a fertiliser trial on cassava?	12.32%
Are you interested in visiting a fertiliser demonstration trial to see the result on production and returns?	82.61%
Are you interested in conducting a trial on your own land?	60.14%

Weeds, weeding and herbicide

Over 95% of farmers consider weeds to be a problem and that they are responsible for limiting the productivity of their cassava crop. However only 11% consider weeds to be a 'large problem' while about 85% consider them a 'medium' or even a 'small problem'.

Table 17: Weed Impact Perception

Weeds	Percent
large problem	11.03%
medium problem	60.29%
Small problem	24.26%
No Problem	4.41%

With almost all farmers denote weeds to be a significant problem impacting their cassava production, a majority of them seem to be taking appropriate action with over 86% applying herbicides on their cassava fields. However only 6.5% claim to have received any formal training for herbicide use and as a result only about 30% report using protective clothing during its application.

Table 18: Herbicide Practice

Herbicides	Percent
Do you apply any herbicides?	86.23%
Have you received any training on herbicide use?	6.52%
Do you use protective clothing when applying herbicide?	30.43%

In addition to herbicide use, almost 35% of farmers also conduct manual weeding, with a majority of farmers conducting two rounds of weeding over a season (Table 19).

Table 19: Manual Weeding Practice

Manual Weeding	Percent
Do you conduct manual weeding?	34.78%
1 weeding	7.69%
2 weedings	84.62%
3 weedings	7.69%
4 weedings	0.00%
5 weedings	0.72%

Land Preparation

About 45% of farmers utilize either 2 or 4 wheel tractors to cultivate their cassava fields although only a handful of households actually own them. Another common method of

cultivation is through the use of manual tools which is employed by almost 50% of farmers. Cultivation practice involves the creation of ridges by over half of the farmers.

Table 20: Land Cultivation Practice

Land Cultivation	Total
Tractor	21.74%
4 wheel tractor	23.19%
Buffalo or cattle	2.17%
Manual Tools	49.28%
Make Ridges	51.45%

Varieties

The most common variety of cassava grown by farmers was “Malaysia”, followed by “Lampung” – both of which most likely refer to the original source of the variety, rather than being a formal variety name.

Table 21: Proportion of Farmers utilising different cassava varieties

Variety	%
Malaysia	55.8
Lampung Ubi Roti	20.9
Adira 4	10.9
Cikaret	5.4
Malang 4	1.6
Taiwan	0.8
Not identified	4.7

Almost 90 percent of farmers reported that they sourced planting material for cassava from their own farms in the last year (2016/2017). Beyond the farm, around 5 percent of farmers exchanged planting material with other farmers and the same proportion purchased planting materials (Table 22).

Table 22: Proportion of planting material (%) from different sources, by site

Source	Proportion
Own Field	89.17%
Exchanged	5.41%
Purchased	5.41%

Cassava Utilization

Cassava is consumed by slightly over 12% of households. These households consume on average 2.76 cassava meals per week which amounts to about 2.7 kgs. Only a handful of farmers feed cassava to their domestic animals. Some of the animals that are fed cassava

include pigs and chicken. Cassava leaf is also harvested by about 12% of farmers. With cassava as a significant source of income, over 92% of households are involved in selling fresh cassava. However, dried cassava is rarely sold with only two farmers claiming to be involved in the business.

Table 23: Cassava Utilization

Cassava Utilization	Percent
Eat	12.32%
Use for own livestock	2.17%
Cassava Leaf	11.59%
Sell fresh cassava	92.03%
Sell Dried cassava	1.45%

Relationship with Traders

The majority of farmers seem to have a relatively good relationship with their traders. Of those involved in selling fresh cassava, over 40% claim to have a 'strong' or 'very strong' relationship with their traders while 55% consider their relationship to be 'moderate'. There were only four farmers that characterized their relationship with their traders as being 'weak'.

Of the two farmers selling dry cassava, one considered their relationship with their traders to be 'moderate' while the other believed it to be 'strong'.

Table 24: Relationship with fresh root traders

Fresh root traders	Percent
Very Strong	14.66%
Strong	26.72%
Moderate	55.17%
Weak	3.45%

Trials 2016-2017

2016 Trials

In North Sumatra 12 cassava genotypes including 3 local varieties widely planted by farmers, 2 genotypes from Brawijaya University, 2 newly national released varieties from ILETRI, and 5 genotypes popular in other provinces of Indonesia. A Randomized Completely Block Design with four replications was utilised. Planting was carried out at December 2015 and harvesting was undertaken at 25-28 October 2016, at the period of around 10 months after planting.

The list of twelve cassava genotypes were:

1. UB ½
2. UB 1472
3. Adira-1
4. Malang-4

5. Cecek Ijo
6. Farsem (Faroka Sembung)
7. Gajab
8. Kejab
9. Caspro
10. Malaysia
11. Adira
12. Cikaret

Soil samples were taken from this site for laboratory analysis of acidity by measuring pH, soil organic matter and its nutrient contents as well (N, P, K, Ca, Mg and Al). Above ground parameters such as plant height, branching and biomass were collected. Root yield and starch content were measured. Farmer and trader preferences were also assessed for each variety.

Based on this varietal evaluation some of the newly genotypes introduced perform better than the existing local genotypes, especially Malang-4, UB1/2, UB1472, Adira-1, Farsem as well as Caspro (see Appendix). Farmer and trader preferences were also assessed based on criteria establish in a focus group discussion.

Enthusiasm of farmers and traders to the newly introduce genotypes was apparent during field day at harvest, some of participants received stem cutting would be planted for propagation. Six genotypes were elected for further evaluation in 2017 in five locations under the management of key farmers who are also typically traders with links to more farmers. According PT. Bumi Sari Prima staff, the higher starch content coincided with higher root yield of Malang-4 is very interesting and will benefiting factory. Currently there is no price difference based on cassava starch. Measurement of starch content more precisely for the harvest in 2017 will occur using a starch balance purchased by the project.

2017 Trials

Variety trials in **North Sumatra** involve the evaluation of 6 cassava varieties (Malang-4, Adira-1, UB1/2, UB1472, Farsem and Caspro) under 4 harvesting periods (8 months, 10 months, 12 months and 14 months). Strip plot design with three replications is applied to run this experiment with experiments being undertaken in 6 sites (Siantar, Raya, Tiga Dolok, Tanah Jawa, Bandar and Prosea). This trial is of particular interest in North Sumatra given that cassava can be established throughout the year.

Fertilizer application trials in North Sumatra are being undertaken in Siantar at an experimental field belonging to PT. Bumi Sari Prima. Strip plot design with three replications is used to carry out this field experiment. The treatment structure of this fertilizer application trial is 7 different fertiliser treatments (including farmer practice) over two cassava varieties (Malang-4 and Malaysia)

Intercropping trials in North Sumatra involve demonstrations of intercropping of grafted and ordinary cassava with peanuts and peanuts followed by mungbeans. These are being undertaken on 6ha of upland fields belonging to farmers and PT. Bumi Sari Prima. The intercropping trial has been of interest to farmers due to the fall in the cassava price. There

appears to be interest from the starch industry if it help ensure farmers continue to grow cassava rather than shifting into other crops.

Results

Variety Trials

The highest yield among the introduced varieties was Malang 4 at almost 50t/ha. Other varieties with relatively high yields included Faroka (41 t/ha), UB ½ (38 t/ha), and UB 1472 (35 t/ha).

Surprisingly the Gajah (elephant) variety produced only 31 t/ha. In its origin location (East Kalimantan) this variety can produce more than 10 kg/plant (if the plant spacing is 1 x 1 m is equal to 100 t/ha).

The lowest recorded yield was for Ketan at 20.57 t/ha. Ketan is an introduced sweet variety from Malang for human consumption. The main reason for the poor yield of Ketan was that it suffered from root rot. In Malang, Ketan is mostly planted by farmers in upland at higher altitude with very good drainage.

The trial site at Siantar has higher rainfall and higher humidity than Malang and hence Ketan was more susceptible to root rot. In addition to this the soil pH in Siantar may be lower than that in Malang.

Future plans and partnerships

Variety Evaluation and seed systems

Variety dissemination will be undertaken using the Malang 4 variety as this variety has a high starch content and is prioritized by farmers and the factory. The activities will be conducted primarily in Simalungun, and Pematang Siantar, with some activities also in Toba-Samosir. There is also potential to undertake network analysis for trading of cassava planting materials.

The variety trials will involve Brawijaya University as the project coordinator and technical advice provider, ILETRI as R&D support and provision of varieties, the local agriculture departments to provide advice and guidance to farmers, and traders to support the dissemination of new varieties.

Fertility Management

Fertilizer experiments in 2018 will be simplified versions of the fertilizer application trials from 2017. The refinement will be based on feedback from traders and from farmers. Experiments will be carried out in Simaungun, Pematang siantar and Toba-samosir.

The fertility management trials will involve Brawijaya University as the project coordinator and technical advice provider, ILETRI as R&D support and provision of varieties and local traders to support fertilizer availability.

Intercropping

Intercropping experiments will be carried out including crops for suitable intercropping in wet-climate condition (peanut, melon, maize, forages-cowpea). Experiments will be carried out in Simaungun, Pematang siantar and Toba-samosir.

The intercropping trials will involve Brawijaya University as the project coordinator and technical advice provider, ILETRI as R&D support and provision of varieties, the local agriculture departments to review results and local traders to support fertilizer availability.

Pests and Disease Management

In 2018, a survey for Root rot occurrence will be undertaken, including gathering information on the timing of root rot, the influence of climatic conditions, the effect on cassava yield and the susceptibility of different varieties to root rot. The survey will be undertaken in Simaungun, Pematang siantar and Toba-samosir.

The pest and disease survey will involve Brawijaya University as the project coordinator and ILETRI as R&D support and other universities to support survey activities.

Detailed Tables

Table 25: Average Household Incomes from various sources (Rupiah/Year)

Average Household Incomes from various Sources	Rupiah/ Year
Cassava Income	7,230,194.20
Paddy rice production value	6,787,260.87
Paddy rice sale value	4,743,139.00
upland rice production value	0.00
upland rice sale value	0.00
Income from Maize	895,750.00
Income from Peanuts	34,782.61
Income from all other annual crops	73,742.75
Income from Coffee	10,637.68
Income from Rubber	34,782.61
Income from Cocoa	51,814.49
Income from Palm Oil	170,434.78
Income from all other tree crops	16,405.80
Cropping Income	15,305,805.80
Non-Cassava Cropping Income	8,075,611.59
Cattle Income	786,231.88
Buffalo Income	0.00
Goat Income	291,666.67
Pig Income	418,095.65
Chicken Income	38,891.30
Duck Income	1,014.49
Other Livestock Income	0.00
fish Income	137,753.62
Total Livestock Income	1,673,653.62
On-farm Income	16,979,459.42
Off-farm Wages	2,607,000.00
Irregular non-farm income	1,775,724.64
Salary Income	1,908,695.65
Remittance Income	600,000.00
NTFP income	0.00
Timber income	2,840,579.71
Fishing Income	0.00
All other Income	2,108,869.57
Off-farm Income	11,840,869.57
Total Income	28,820,328.99

Table 26: Average Household Incomes from various sources (Rupiah/Year), by income quartile

Income Quartiles	Q1	Q2	Q3	Q4	Total
Cassava Income	1,936,367.65	4,612,313.89	4,750,500.00	17,775,588.24	7,230,194.20
Paddy rice production value	1,388,470.59	4,245,500.00	12,028,058.82	9,636,529.41	6,787,260.87
Paddy rice sale value	363,176.50	2,331,000.00	9,290,153.00	7,130,118.00	4,743,139.00
upland rice production value	0.00	0.00	0.00	0.00	0.00
upland rice sale value	0.00	0.00	0.00	0.00	0.00
Income from Maize	336,882.35	627,708.33	375,441.18	2,258,735.29	895,750.00
Income from Peanuts	0.00	0.00	0.00	141,176.47	34,782.61
Income from all other annual crops	45,705.88	125,000.00	24,191.18	97,058.82	73,742.75
Income from Coffee	0.00	500.00	11,764.71	30,882.35	10,637.68
Income from Rubber	0.00	0.00	141,176.47	0.00	34,782.61
Income from Cocoa	19,000.00	16,566.67	74,117.65	99,647.06	51,814.49
Income from Palm Oil	21,176.47	125,000.00	435,294.12	102,941.18	170,434.78
Income from all other tree crops	44,117.65	0.00	7,058.82	15,411.76	16,405.80
Cropping Income	3,791,720.59	9,752,588.89	17,847,602.94	30,157,970.59	15,305,805.80
Non-Cassava Cropping Income	1,855,352.94	5,140,275.00	13,097,102.94	12,382,382.35	8,075,611.59
Cattle Income	0.00	777,777.78	779,411.76	1,588,235.29	786,231.88
Buffalo Income	0.00	0.00	0.00	0.00	0.00
Goat Income	182,352.94	390,277.78	379,411.76	208,823.53	291,666.67
Pig Income	209,117.65	258,333.33	886,176.47	328,152.94	418,095.65
Chicken Income	60,735.29	55,000.00	36,764.71	2,117.65	38,891.30
Duck Income	3,529.41	555.56	0.00	0.00	1,014.49
Other Livestock Income	0.00	0.00	0.00	0.00	0.00
fish Income	6,176.47	77,777.78	0.00	470,588.24	137,753.62
Total Livestock Income	461,911.76	1,559,722.22	2,081,764.71	2,597,917.65	1,673,653.62
On-farm Income	4,253,632.35	11,312,311.11	19,929,367.65	32,755,888.24	16,979,459.42
Off-farm Wages	579,411.76	2,371,111.11	3,235,882.35	4,255,470.59	2,607,000.00
Irregular non-farm income	423,529.41	435,277.78	993,529.41	5,329,411.76	1,775,724.64
Salary Income	105,882.35	638,888.89	423,529.41	6,541,176.47	1,908,695.65
Remittance Income	341,176.47	0.00	294,117.65	1,800,000.00	600,000.00
NTFP income	0.00	0.00	0.00	0.00	0.00
Timber income	0.00	0.00	0.00	392,000,000.00	392,000,000.00
Fishing Income	0.00	0.00	0.00	0.00	0.00
All other Income	194,117.65	0.00	705.88	8,364,705.88	2,108,869.57
Off-farm Income	1,644,117.65	3,445,277.78	4,947,764.71	37,820,176.47	11,840,869.57
Total Income	5,897,750.00	14,757,588.89	24,877,132.35	70,576,064.71	28,820,328.99