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Factors Affecting Adoption and interest in Agricultural Technologies related to Cassava Production[1]

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Introduction

Based on a survey of more than 800 cassava farming households across 4 sites in Vietnam and Laos, this paper presents a series of binomial logistic regression analyses of factors influencing farmer adoption of technologies relating to cassava production, farmer interest in trialling new technologies and farmer interest in continuing to produce cassava into the future.

The results show that for easily observable technologies, such as herbicides and chemical fertilisers, direct farmer observation and evaluation of problems is a major contributor to adoption decision making. For less easily observed/less tangible technologies, such as ridging, clean planting material, conservation agriculture practices, and intercropping, membership of mass organizations and the availability of extension information from private sector or from government played a greater role in adoption decision making or in farmer interest.

In addition, farmers who had received training on fertiliser use, and/or had fertiliser on credit available to them had higher odds of adopting chemical fertilisers, sourcing planting materials from outside their farms, showing interest in clean planting material and being interested in trialling conservation practices on their farms. This could indicate that fertiliser training and provision of credit can form a key component of an integrated extension/information provision package for farmers.

Background

Rogers (1995) suggests that the perceived attributes of an innovation influence its adoption and its spread from early to late adopters. This viewpoint has been widely accepted in studying the adoption of new technologies and management practices. The characteristics of a technology - such as whether it can be trialled prior to

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adoption, its compatibility with the existing values, practices, and the environment, and the relative simplicity with which it can be implemented are all major determinants of adoption (Rogers, 1995). The subsequent decision of a farmer regarding whether to adopt a new technology is argued to be the result of interactions between the attributes of the technology and a range of economic, environmental, institutional, and household factors (Loevinshon et al. 2013; Mwangi and Kariuki 2015).

The multitude of studies over the years highlighting the adoption of a wide range of agricultural technologies have identified numerous factors within the above broad categories as being influential in contributing to adoption decisions. Economic factors such as the size of land generally plays a key role, although the effect can be multidirectional depending on whether the technology in question is land-saving, labour-saving, or capital-intensive. While higher costs of technology adoption and costs related to additional inputs such as hired labour may discourage adoption, the availability of off-farm income may aid adoption decisions. Mwangi and Kariuki (2015) elaborate further on these points.

According to Rogers (1995), it is important to provide access to information on new innovations through dependable sources. However, the potential risks associated with making changes drives the majority of potential adopters to more trusted sources such as peer networks. Hence local organizations such as farmer groups become a reliable source for enhancing the diffusion of agricultural innovations. Other institutional factors such as extension services and access to credit are also found to be important contributors (Mwangi and Kariuki, 2015). Finally, household characteristics, particularly those related to human capital are generally found to influence adoption decisions. Human capital within a household is generally measured through farmer's education level, age, gender and overall size of the household.

Maddala (1983) recommends the use of either logit or probit models for studying adoption behaviour, which is generally characterized by limited dependent variables. Although logit models are generally used in the case of discrete variables, according to Capps & Kramer (1985) there is no clear advantage of adopting one model over the other; and in small sample situations, the outcomes are known to be comparable (Maddala, 1983).

Employing logit models to study adoption behaviour related to agricultural technologies has been a standard practice for many decades and is still widely followed today. Examples of earlier studies include a paper by Polson and Spencer (1991) where the authors utilize both logit and probit models to assess socioeconomic and demographic factors that influence the adoption of high-yielding cassava varieties in south-western Nigeria. A logit model was also employed by Kebede et al. (1990) to study factors that affect the adoption of fertilizer and pesticide technologies as well as a single ox for traction (instead of a pair of oxen, which was the norm).

More recent studies using the logit model include a paper by Banerjee et al. (2008) where the authors identify factors that affect the adoption of global positioning systems by cotton farmers in several US states. Boulay et al. (2012) report on factors affecting adoption of eucalyptus tree farming by smallholder farmers in Thailand using a logit model. Finally, a very recent study by Bezaiet et al. (2018) also uses a logit model to understand decisions related to the adoption of household greywater filtration systems for repurposing wastewater for small-scale agriculture.

Assessing adoption behaviour through microstudies by modelling cross sectional data may be problematic as it is not able to account for dynamic structures (Besley and Case, 1993; Doss 2006). As a consequence, some important policy questions such as those related to welfare resulting from adoption of technologies cannot be determined. Data related issues of this nature can be solved if one is able to collect panel data. However the difficulty of obtaining such data means most studies have to rely on restricted/limited datasets. Regardless, microstudies are still capable of explaining various factors that influence adoption decision; and although localized data collection methods may not be able to address policy questions at a broader scale, they are still able to provide useful results at the local level.

Methods

Model Specification

In this study, a qualitative choice model is used to study the interactions with a discrete dependent variable. The probability that an event occurs in such relationships is a function of a set of non-stochastic explanatory variables and a vector of unknown parameters. In line with Amemiya (1981), the general form of the univariate dichotomous choice model can be written as

$$P_i = P_i(Y_i = 1) = H(X_i, \vartheta) \qquad (i = 1, 2, 3, \dots, n) \qquad (1)$$

In equation (1) the probability that the i[th] farmer adopts a cassava related technology, $P_i(y_i = 1)$, is a function of the vector of explanatory variables, X_i, and the unknown parameter vector, ϑ.

The logit functional specification of the dichotomous choice model is

$$S_i = F(w_i) = e^{w_i}/(1 + e^{w_i}) \quad \text{for } -\infty < w_i < \infty \text{ and } w_i = x_i'\beta \qquad (2)$$

Where S_i is the dependent variable that takes on the value of 1 for the i[th] farmer adopting the cassava related technology, and 0 if no adoption occurs. x_i is the vector of characteristics or attributes associated with farmer i and β is the vector of parameters to be estimated.

The change in the probability that the farmer adopts the cassava related technology given a change in any one of the explanatory variables can be computed as

$$\frac{\partial S_i}{\partial x_i} = \left(\frac{\partial F}{\partial w_i}\right)\left(\frac{\partial w_i}{\partial x_i}\right) = f(w_i)\beta \qquad (3)$$

Where $f(w_i)$ is the logistic density function for the logit model.

The empirical model specified is then,

$$\text{Technology} = \beta_0 + \beta_2 + \beta_3 + \dots + \beta_n + e_i \qquad (4)$$

Where n is the number of explanatory variables in the model. The error term, e_i represents unobserved characteristic and is assumed to be independently distributed.

The set of dependent and independent variables examined in this paper are described in **Error! Reference source not found.**.

Table 1: Definition of Variables

Variables	**Definition**	
Dependent		
Fertiliser	Uses fertiliser	Adopter, 1; Non-adopter, 0
Herbicide	Uses herbicide	Adopter, 1; Non-adopter, 0
Ridging	Produces ridges during cultivation for cassava planting	Adopter, 1; Non-adopter, 0
Intercrops	Plants one or more intercrops with cassava	Adopter, 1; Non-adopter, 0
Plant_material	Obtains planting material from outside own farm	Has obtained 1; Not obtained, 0
Certify_buy	Interested in buying certified disease free stakes	Interested, 1: Not Interested, 0
Intercrops_I	Interested in trialling intercrops	Interested, 1: Not Interested, 0
Conserve_I	Interested in trialling conservation agriculture practices	Interested, 1: Not Interested, 0
Cassava_five	Expect to be growing cassava in 5 years	Expects to be growing cassava in 5 years, 1; Otherwise, 0
Independent		
Female	Gender of household head	Female, 1; Otherwise, 0
Age	Age of household head in years	No. of years
Edu_primary	Education level of household head	Primary Education 1; Otherwise, 0
Edu_high	Education level of household head	At least some high school 1; Otherwise, 0
Income_1	Total household income very low	Household first income quartile, 1; Otherwise, 0
Income_2	Total household income low	Household in second income quartile, 1; Otherwise, 0
Income_3	Total household income high	Household in third income quartile; Otherwise, 0
Good_socio	Household is living in a village defined as having medium or good socio-economic conditions in the selection criteria for the household survey.	Household in medium or good socio-economic condition village, 1; otherwise, 0

Off_farm	Proportion of household income from off-farm and non-farm sources	Proportion as a decimal
Cassava_land	Area of cassava farm	Hectares
Cassava_time	Time growing cassava	Years
Cassava_yield	Cassava yield	Tonnes per hectare
Cassava_five	Expect to be growing cassava in 5 years	Growing cassava in 5 years, 1; Otherwise, 0
Yield_decline	Believes their cassava yields declining	Declining, 1; Otherwise, 0
Member	Any household member belongs to any group or mass organisation	Member, 1; Otherwise, 0
Info_gov	Household receives information on agricultural production from government extension staff	Receives information, 1 Otherwise, 0
Info_pvt	Household receives information on agricultural production from cassava traders or processors	Receives information, 1; Otherwise, 0
Fert_credit	Fertiliser can be purchased on credit from a nearby store	Fertiliser on credit, 1; Otherwise, 0
Fert_trial	Has ever seen a fertiliser trial	Seen a trial 1; Otherwise, 0
Herb_train	Has received training on herbicide use	Received training, 1; Otherwise, 0
Erosion	Considers soil erosion a problem on their cassava fields	Erosion a problem, 1; Otherwise, 0
Weeds	Believes weeds are a medium or large problem	Weeds a problem, 1; Otherwise, 0

Sources of Data

Data were collected through a household survey of more than 800 farmers undertaken in Dak Lak and Son La Provinces (Vietnam) and Xayabouly and Bolikhamsay Provinces (Lao PDR).

The sites have differing agro-climatic conditions, topographies and value chain characteristics. Son La, Bolikhamsay and Xayabouly have sub-tropical/temperate climates with a cool or cold winter and a relatively short harvesting season. Dak Lak has a warmer climate, and the harvesting season is relatively longer (9-10 months per year).

While there are obviously differences in topographies within each site, in general Son La can be classified as having sloping or steeply sloping land, Dak Lak and Bolkhamsay have gently sloping or flat land and Xayabouly has a relatively flat topography.

There are 2 starch factories in Son La in addition to numerous dried chip production facilities. The starch factories are relatively small scale and absorb around 20-30 percent of production. In Dak Lak there are around 10 medium-large scale starch factories operating. In

Vienthong district of Bolikhamsay there is a starch factory and Bolikhan district has a chip factory and a medium scale starch factory. Cassava produced in Kenthao district of Xayabouly is mostly exported to Thailand as fresh roots or as dried chips. Cassava produced in Paklai district is predominately used as inputs for a medium-large scale starch factory targeting the Chinese market.

In **Dak Lak**, field research was undertaken in four communes – Ea Sar and Ea So communes in Ea Kar District and Yang Kang (Dang Kang) and Cu Kty Communes in Krong Bong District (Table 2, Fig. 1). Ea Kar and Krong Bong districts were chosen for field research as they will be key locations of future project activities.

A total of two villages were identified within each of the four communes and about 32 households were selected within each of these villages for conducting household interviews. To ensure adequate diversity in the sample, the villages chosen within each commune differed in terms of their economic conditions, distance to the commune centre, quality of roads and soil fertility.

Table 2: Households by Survey locations – Dak Lak, Vietnam

Communes	Number of household surveys
Cu Kty	63
Dang Kang	62
Ea Sar	65
Ea So	63
Total	**253**

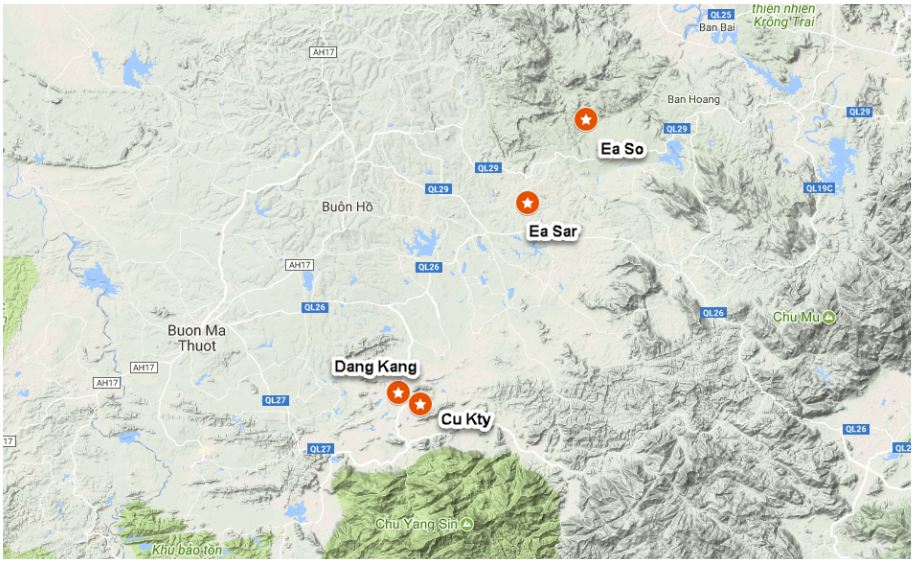

Figure 1: Survey Sites, Dak Lak, Vietnam

In **Son La**, household surveys were undertaken in Chieng Chan, Na Ot, Pung Tra and Bo Muoi communes (Table 3, Fig. 2). In each commune, 32 households were surveyed in each of the two selected villages. In each commune the choice of villages was made in order to have one midland village close to the commune centre and one highland village far from the commune centre. Within each village, respondents were selected randomly from households producing cassava.

Table 3: Households by Survey locations – Son La, Vietnam

Communes	Number of household surveys
Bo Muoi	65
Chieng Chan	64
Na Ot	64
Pung Tra	64
Total	**257**

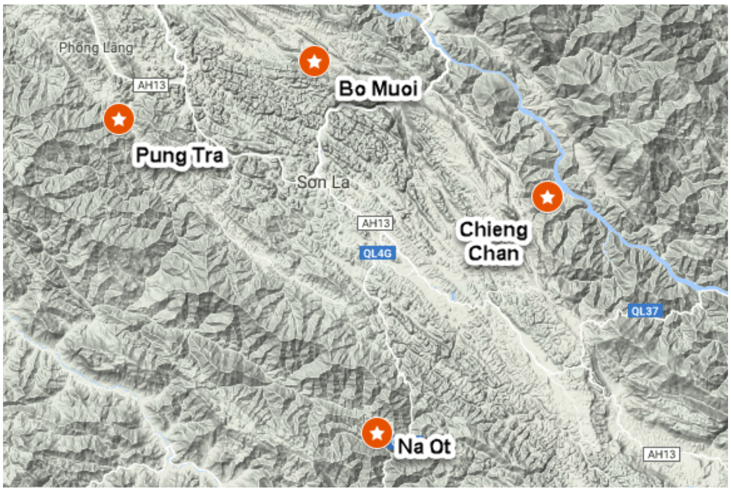

Figure 2: Survey Sites, Son La, Vietnam

In **Sayabouly**, Laos, the household surveys were undertaken in Kenthao and Paklai districts (Table 4, Fig. 3) A total of 180 households were surveyed across the two districts.

Table 4: Households by Survey locations – Sayabouly and Bolikhamsay

	Sayabouly		Bolikamsay	
District	Kenthao	Paklai	Bolikhan	Viengthong
Number of household surveys	90	90	90	90

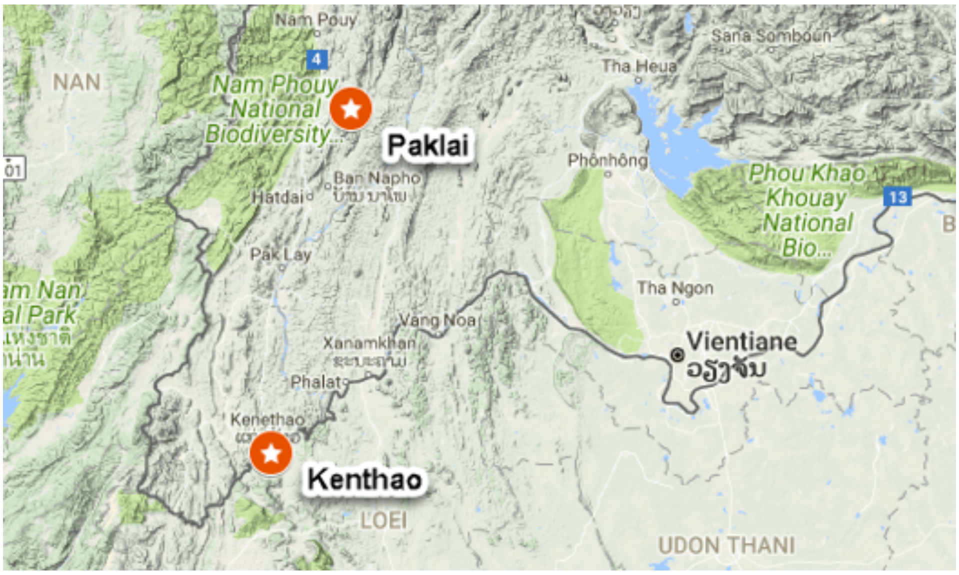

Figure 3: Survey Sites, Sayabouly

In Bolikhamsay, **Laos**, the household surveys were undertaken in Bolikhan and Viengthong districts. A total of 180 households were surveyed across the two districts.

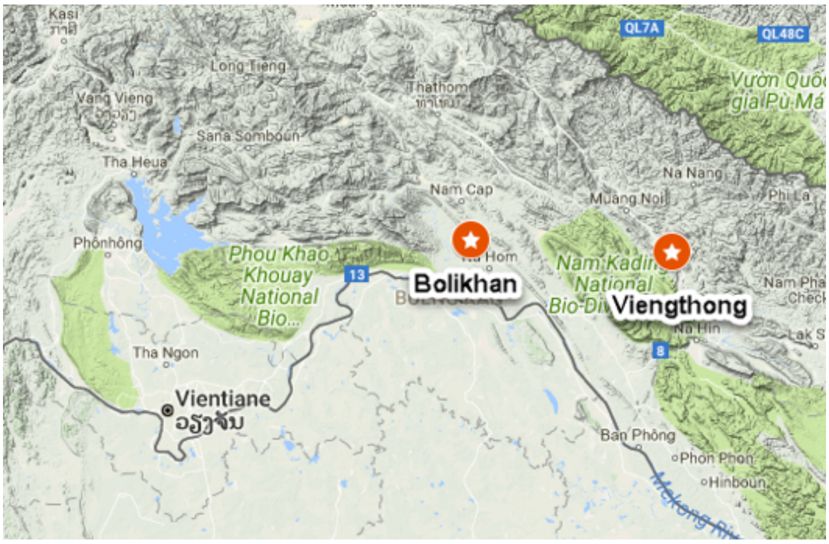

Figure 4: Survey Sites, Bolikhamxay

Analysis of Adoption of technologies

This section presents results of logistic regressions linking adoption of technologies by farmers in different survey locations with demographic, agronomic and socio-economic explanatory variables[4]. The technologies examined are chemical fertilisers, herbicides, ridging and intercropping. Table 5 below lists the mean values and number of observations for each of the dependent and independent variables for the models presented.

Table 5: Means and total number of observations for each of the dependent and independent variables.

Variables	**Mean (proportion as a decimal unless specified) with number of observations in brackets**			
Dependent Variables	**Son La**	**Dak Lak**	**Sayaboulay**	**Bolikamxay**
Fertiliser	0.734 (248)	0.840 (206)		
Herbicide	0.206 (233)	0.858 (239)	0.676 (151)	0.092 (109)
Ridging		0.441 (238)		0.435 (138)
Intercrops		0.950 (242)	0.256 (133)	
Plant_material	0.571 (247)	0.634 (227)	0.221 (136)	0.252 (127)
Certify_buy	0.585 (248)	0.282 (220)		0.298 (131)
Intercrops_I	0.449 (205)	0.518 (218)		0.355 (138)
Conserve_I	0.887 (213)	0.791 (239)	0.461 (89)	0.622 (111)
Cassava_five	0.758 (248)	0.561 (239)	0.347 (150)	0.551 (147)
Independent Variables	**Son La**	**Dak Lak**	**Sayaboulay**	**Bolikamxay**
Female	0.028 (252)	0.215 (251)	0.034 (178)	0.039 (180)
Age	41.23 years (252)	44.48 years (250)	45.72 years (178)	44.78 years (176)
Edu_none	0.194 (252)	0.203 (251)	0.039 (178)	0.139 (180)

[4] For the logit models, instead of β coefficients, we report the odds ratios. Odds ratios are generally reported for logistic regressions as they are easier to interpret in relation to the standard coefficients. Odds ratios that are greater than one imply a higher likelihood of the outcome variable for a unit change in the independent variable while odds ratios that are less than one imply the opposite.

Edu_primary	0.409 (252)	0.323 (251)	0.573 (178)	0.506 (180)
Edu_high	0.397 (252)	0.474 (251)	0.382 (178)	0.356 (180)
Off_farm	0.227 (257)	0.267 (253)	0.121 (180)	0.201 (180)
Good_socio	0.498 (257)	0.376 (253)		
Cassava_land	0.57 ha (257)	1.01 ha (253)	2.65 ha (180)	1.64 ha (180)
Cassava_time	13.17 years (257)	10.60 years (252)	3.58 years (180)	3.77 years (180)
Cassava_yield	15.49 tons/ha (255)	17.48 tons/ha (252)	26.96 tons/ha (180)	18.20 tons/ha (180)
Cassava_five	0.763 (257)	0.546 (253)	0.294 (180)	0.506 (180)
Yield_decline	0.739 (257)	0.472 (248)	0.514 (179)	0.500 (174)
Member	0.724 (257)	0.241 (253)	0.233 (180)	0.306 (180)
Info_gov	0.253 (257)	0.138 (253)	0.050 (180)	0.083 (180)
Info_pvt	0.082 (257)	0.198 (253)	0.328 (180)	0.333 (180)
Fert_credit	0.570 (256)	0.790 (252)	0.044 (161)	0.111 (162)
Fert_trial	0.117 (256)	0.091 (252)	0.039 (179)	0.051 (177)
Herb_train	0.062 (257)	0.012 (253)	0.039 (180)	0.017 (180)
Erosion	0.899 (257)	0.647 (252)	0.050 (180)	0.079 (177)
Weeds	0.809 (257)	0.941 (252)	0.822 (180)	0.872 (179)

Adoption of chemical fertilisers

With respect to the adoption of chemical fertilisers, a stark contrast was seen between the Vietnamese sites of Son La and Dak Lak and the Laotian sites of Sayabouly and Bolikhamxay. While the majority of farmers in the Vietnamese sites (73% in Son La and 85% in Dak Lak) adopted chemical fertilisers, their usage was almost non-existent in the Laotian sites.

The Laotian sites have better soil fertility compared to the Vietnamese sites which may be a factor in explaining the extremely low uptake of chemical fertilizers. Across the two Vietnamese sites the diversity of terrain between Son La and Dak Lak resulting in more fertiliser leaching in the former may also explain some of the differences in adoption behaviour.

Table 6 presents the results of a logistic regression where the dependent variable 'adoption of chemical fertilisers' was regressed against a number of explanatory variables for the Vietnamese study sites.

The likelihood ratio test (LR_chi2) p values are lower than the conventional threshold of 0.05 exhibiting a significant improvement in fit over the null models for both sites. According to McFadden's R2 (Pseudo_R2)) value, the proportion of explained variation stands at 16.7% for Son La and 20.7% for the Dak Lak model. It should be noted that Pseudo R2 values have been derived to mimic the traditional R2 statistic which are valid only for linear models. While the McFadden R2 statistic also provides a measure of model fit, the two statistics are quite different. However as a rough guide, values between 0.2 and 0.4 are considered to represent good model fit. (McFadden, 1973).

With regards to the individual predictors in the model, five variables were found to be statistically significant in one or both sites – ability to purchase fertiliser on credit, perception of declining yields, cassava yield, proportion of income from off farm sources, and socio-economic conditions.

In Son La, farmers who were able to purchase fertilisers on credit had greater odds of adopting chemical fertilisers. It is quite evident that the availability of fertilisers on credit provides greater incentive for increasing its adoption. Higher odds of chemical fertiliser adoption was also found amongst farmers that claimed to have declining yields; which may be due to the realization that they have a higher need of fertilisers to put a stop to their yield decline.

In Son La, farmers that had higher dependence upon non-farm sources for overall household income had a slightly lower likelihood of adopting chemical fertilisers. It is likely that these farmers are not as keen on investing on their farm as their household incomes are relatively less dependent upon farm outputs.

Son La, farmers residing in villages regarded as having medium or good socio-economic conditions were found to have significantly higher odds of adopting chemical fertilizers. The socio-economic conditions of the chosen sites were categorized based upon several factors including road and soil conditions, distance to commune centres and cassava factories, as well as the broader socio-economic outlook of the region.

In Dak Lak, farmers who were able to purchase fertiliser on credit were also more likely to use fertiliser on cassava. Adoption in Dak Lak was also related to higher cassava yields – perhaps indicating reverse causality.

Table 6: Logistic regression results for current adoption of chemical fertilisers by farmers

Chemical Fertiliser	**Son La**	**Dak Lak**
Female	3.432	0.452
	(4.19)	(0.24)
Age	0.985	1.024
	(0.01)	(0.02)
Edu_Primary	0.714	0.745
	(0.34)	(0.47)
Edu_High	0.89	1.233
	(0.46)	(0.79)
Income_1	1.087	2.166
	(0.54)	(1.87)
Income_2	1.571	1.076
	(0.8)	(0.85)
Income_3	1.174	1.788
	(0.57)	(1.43)
Off_farm	0.985*	1.005
	(0.01)	(0.01)
Good Conditions	5.713***	1.001
	(2.37)	(0.59)
Cassava_land	0.81	1.397
	(0.3)	(0.63)
Cassava_yield	1.021	1.095**
	(0.02)	(0.04)
Cassava_time	1.005	1.056
	(0.01)	(0.04)
Cassava_five	0.839	0.766
	(0.34)	(0.4)
Yield_decline	2.095*	1.958
	(0.78)	(0.96)
Member	1.218	1.22
	(0.49)	(0.95)
Info_gov	0.617	1
	(0.24)	(.)
Info_pvt	0.505	3.322
	(0.3)	(3.24)
Fert_credit	3.710***	8.186***
	(1.39)	(4.15)
Fert_trial	2.052	1.624
	(1.15)	(2.04)
Herb_train	6.076*	1
	(4.88)	(.)
Erosion	0.778	0.513
	(0.47)	(0.27)
Weeds	1.275	0.95
	(0.51)	(0.91)
Constant	0.847	0.048

	(1.08)	(0.09)
Obs	248	206
LR_chi2	48.122	48.956
prob>chi2	0.001	0
Pseudo_R2	0.167	0.27
* p<0.05, ** p<0.01, *** p<0.001		

Note: The statistic provided are odds ratios with standard deviations in brackets

Adoption of herbicides

Overall, the proportion of farmers adopting herbicides was higher than the proportion adopting chemical fertilisers with 86% adopters in Dak Lak, 68% in Sayabouly, 26% in Son La and just under 10% in Bolikhamxay.

Table 7 presents the results of a logistic regression of 'adoption of herbicides' on a number of explanatory variables. With regards to fit of the model, the likelihood ratio test p values are higher than the conventional threshold of 0.05 for all four sites suggesting that we would fail to reject the null models. McFadden's R2 values are also generally lower than 0.2 (except for Bolikhamxay where it is 0.35) indicating that the model is capable of explaining very limited proportion of variation in the data.

Despite poor overall model fit a few significant predictors were observed for the models across the four sites, which included age and level of education of farmers, off-farm income, cassava land area, cassava yield, and perception of weeds as a problem.

For Son La, farmers who reported higher cassava yields had slightly lower odds of adopting herbicides. While this result was not expected, a possible explanation could be that low yields as a result of increased weediness may have contributed to a higher likelihood of herbicide use. As expected, farmers in Son La experiencing greater weed problems were found to have lower odds of adopting herbicides. In the absence of herbicide use, weeds are likely to have become a more significant problem.

Farmers with larger cassava fields were found to have higher odds of herbicide use in Dak Lak, presumably because of the need to stretch a given labour resource over the larger area.

A key contributor to the adoption behaviour of herbicides across Son La and Dak Lak could also be due to differences in terms of land gradient used for growing cassava. While farmers in Dak Lak enjoy the benefits of flatter lands, they are also more prone to pests and diseases which require more active adoption and hence application of pesticides and herbicides.

In Sayabouly, lower odds of herbicide use was found amongst older and more educated farmers. Older farmers are generally more influenced by traditional methods and less open to modern technology adoption. While this result was expected, what was not expected was higher levels of education resulting in lower herbicide adoption. Additionally those with a higher percentage of income from off- and non-farm sources had slightly lower odds of herbicide adoption. This may have been because they had greater capacity to hire labour for hand weeding, or because they were less dependent on income from cassava and hence refrained from making additional investments in this activity.

Table 7: Logistic regression results for adoption of herbicides by farmers

Herbicide	**Son La**	**Dak Lak**	**Sayabouly**	**Bolikhamxay**
Female	1.877	0.766	0.883	3.862
	(1.72)	(0.39)	(0.88)	(7.39)
Age	0.988	0.972	0.965*	0.99
	(0.02)	(0.02)	(0.02)	(0.05)
Edu_Primary	1.026	0.485		0.947
	(0.51)	(0.27)		(1.83)
Edu_High	0.694	1.132	0.402*	0.704
	(0.38)	(0.67)	(0.18)	(1.62)
Income_1	0.757	1.499	0.285	0.128
	(0.42)	(1.01)	(0.2)	(0.2)
Income_2	1.567	2.339	0.563	0.282
	(0.81)	(1.58)	(0.35)	(0.44)
Income_3	0.823	1.691	0.49	1.245
	(0.46)	(1.09)	(0.29)	(1.86)
Off_farm	0.987	0.999	0.974*	0.915
	(0.01)	(0.01)	(0.01)	(0.04)
Good Conditions	0.728	0.482		
	(0.29)	(0.23)		
Cassava_land	0.744	2.369*	1.071	0.307
	(0.31)	(0.96)	(0.17)	(0.24)
Cassava_yield	0.927*	1.001	0.992	0.86
	(0.03)	(0.02)	(0.01)	(0.08)
Cassava_time	0.977	1.054	1.086	0.946
	(0.02)	(0.03)	(0.15)	(0.3)
Cassava_five	0.562	0.62	0.728	1.174
	(0.24)	(0.3)	(0.36)	(1.21)
Yield_decline	1.365	2.401	1.443	1.709
	(0.58)	(1.09)	(0.65)	(1.78)
Member	1.343	1.924	1.098	1.7
	(0.59)	(1.14)	(0.58)	(1.63)
Info_gov	1.036	2.2	0.644	1
	(0.46)	(1.78)	(0.69)	(.)
Info_pvt	2.174	0.631	0.957	2.354
	(1.39)	(0.39)	(0.43)	(2.42)
Fert_credit	0.64	1.583	0.235	12.237
	(0.25)	(0.78)	(0.27)	(23.63)
Fert_trial	0.782	0.482	0.812	1
	(0.46)	(0.37)	(0.91)	(.)

Herb_train	1	1	1	1
	(.)	(.)	(.)	(.)
Erosion	0.511	0.593	0.305	1
	(0.3)	(0.27)	(0.27)	(.)
Weeds	0.314**	0.979	0.738	1
	(0.13)	(0.81)	(0.47)	(.)
Constant	17.130*	5.929	46.433**	15.326
	(24.61)	(9.3)	(68.62)	(55.07)
Obs	233	239	151	109
LR_chi2	31.559	26.317	24.267	23.363
prob>chi2	0.065	0.195	0.186	0.104
Pseudo_R2	0.133	0.135	0.128	0.35
* p<0.05, ** p<0.01, *** p<0.001				

Note: The statistic provided are odds ratios with standard deviations in brackets

Adoption of ridging

The incidence of creating ridges during land preparation differed markedly across the four survey sites, with 86% of respondents in Dak Lak following this practice, 36% in Bolikhamxay, 5% in Sayabouly, and only 2% in Son La. The gradient of cassava land is a key determinant for creating ridges during land preparation. While making ridges are more practical on flatter lands such as those found in Dak Lak, this is not the case for steeper lands similar to those used for growing cassava in Son La.

Logistic regressions of ridging on a number of explanatory variables were conducted for Dak Lak and Bolikhamxay (Table 8). The likelihood ratio test p values are lower than the conventional threshold of 0.05 exhibiting a significant improvement in fit over the null models for both sites. In addition, based upon McFadden's R2 value for both Dak Lak and Bolikhamxay of 0.346 and 0.474 respectively, the models represent a very good fit. The statistically significant variables were relatively similar between the two sites.

In both sites, the likelihood of adopting ridging increased with the farmer's age while such likelihood increased with education specifically for the site in Dak Lak. Lower income appeared to decrease the likelihood of adoption of ridges in Dak Lak but to increase it greatly in Bolikhamxay. It is not clear why this would be the case. Likewise, farmers who had been growing cassava for a longer period were more likely to use ridging in Bolikhamxay. In Dak Lak, farmers' expectation that they would be growing cassava in the next five years was associated with a lower adoption of ridging. For Dak Lak, farmers residing in villages regarded as having medium or good socio-economic conditions were found to have significantly higher odds of adopting ridging during land preparation.

In Bolikhamxay, farmers who had access to government sources of information on agricultural production (provincial or district extension staff) had much higher odds of adopting ridging, as did farmers who had access to information from the private sector (cassava traders and processors). Both types of actor may have given positive recommendations for creating ridges.

Table 8: Logistic regression results for creation of ridges by farmers during land preparation

Ridging	**Dak Lak**	**Bolikhamxay**
Female	0.554	4.253
	(0.26)	(7.74)
Age	1.039*	1.064*
	(0.02)	(0.03)
Edu_Primary	3.639*	0.685
	(2.1)	(0.62)
Edu_High	7.960***	4.986
	(4.58)	(4.99)
Income_1	0.125***	8.900*
	(0.08)	(8.86)
Income_2	0.302*	2.005
	(0.16)	(1.91)
Income_3	0.637	4.789
	(0.33)	(4.14)
Off_farm	0.99	1.031*
	(0.01)	(0.01)
Good Conditions	3.439**	
	(1.48)	
Cassava_land	0.9	1.215
	(0.21)	(0.33)
Cassava_yield	1.012	1.002
	(0.02)	(0.01)
Cassava_time	1.032	2.045***
	(0.03)	(0.34)
Cassava_five	0.385*	0.691
	(0.16)	(0.42)
Yield_decline	1.313	1.355
	(0.48)	(0.79)
Member	0.96	1.385
	(0.42)	(0.8)
Info_gov	0.421	26.373*
	(0.25)	(35.73)
Info_pvt	1	4.939*
	(0.48)	(3.31)
Fert_credit	1.539	0.98
	(0.72)	(0.96)
Fert_trial	1.057	0.142
	(0.7)	(0.22)
Herb_train	2.622	3.364

	(4.23)	(5.56)
Erosion	1.175	0.379
	(0.46)	(0.39)
Weeds	0.718	0.784
	(0.54)	(0.77)
Constant	0.066*	0.000***
	(0.09)	(0)
Obs	238	138
LR_chi2	113.046	89.529
prob>chi2	0	0
Pseudo_R2	0.346	0.474
* p<0.05, ** p<0.01, *** p<0.001		

Note: The statistic provided are odds ratios with standard deviations in brackets

Sourcing of planting material

The rate at which farmers sourced planting materials from outside of their own farms in the past five years seemed to be relatively uniform across the Vietnamese and Laotian sites. This practice was as high as 66% in Dak Lak followed by Son La at 56%. Lower rates were observed for the Laotian sites with 26% in Sayabouly and 20% in Bolikhamxay.

Table 9 presents the results of a logistic regression where the dependent variable 'whether or not planting materials were sourced by farmers outside their own fields in the last five years' is regressed against a number of explanatory variables.

The likelihood ratio test p values are lower than the conventional threshold of 0.05 exhibiting a significant improvement in fit over the null models for each of the sites. However according to McFadden's R2 value, models for Son La and Dak Lak may have suboptimal fit in relation to the Vietnamese sites.

In Son La, farmers that reported lower yields revealed lower odds of sourcing planting materials from outside their own fields. On the contrary, farmers that were able to purchase fertilisers on credit had higher odds of sourcing planting materials from outside their own fields.

In Dak Lak, households that obtained information on agricultural production from government sources were found to have higher odds of sourcing planting materials from outside their own fields. On the contrary farmers that expected to be growing cassava in another five years' time, and those that received their information on agricultural production from private sources were found to have lower odds of sourcing planting materials from outside their own fields. Contrary to what was expected, households located in villages that had relatively improved socio-economic conditions were found to have lower odds of sourcing planting materials from outside their own farms.

In Sayabouly farmers that indicated that they would be growing cassava in the next five years and those that experienced declining yields were found to have lower odds of sourcing planting materials from outside their own fields. In Bolikhamxay, older and more educated farmers as well as those that reported higher cassava yields were found to have higher odds of sourcing planting materials from outside their own fields.

Table 9: Logistic regression results assessing factors responsible for farmers to source planting materials from beyond their own fields

Planting Material	**Son La**	**Dak Lak**	**Sayabouly**	**Bolikhamxay**
Female	4.259	2.115	1	4.19
	(5.26)	(0.93)	(.)	(4.96)
Age	1.013	0.997	0.986	1.059*
	(0.01)	(0.01)	(0.02)	(0.03)
Edu_Primary	0.903	1.02		3.307
	(0.38)	(0.48)		(3.28)
Edu_High	0.629	0.799	1.308	11.761*
	(0.29)	(0.37)	(0.73)	(13.24)
Income_1	0.419	1.067	2.19	3.506
	(0.19)	(0.6)	(1.96)	(3.34)
Income_2	0.575	0.963	2.924	3.041
	(0.25)	(0.49)	(2.34)	(2.59)
Income_3	0.761	0.918	2.871	1.745
	(0.32)	(0.45)	(2.14)	(1.42)
Off_farm	0.998	0.998	1.003	0.993
	(0.01)	(0.01)	(0.02)	(0.01)
Good Conditions	1.796	0.449*		
	(0.6)	(0.17)		
Cassava_land	0.647	1.239	0.765	1.326
	(0.22)	(0.29)	(0.16)	(0.28)
Cassava_yield	0.978	1.006	0.971	1.047*
	(0.02)	(0.02)	(0.03)	(0.02)
Cassava_time	0.984	0.96	1.337	0.927
	(0.01)	(0.02)	(0.21)	(0.11)
Cassava_five	0.74	0.401*	0.184*	0.385
	(0.27)	(0.16)	(0.14)	(0.22)
Yield_decline	0.441*	1.597	0.286*	2.121
	(0.15)	(0.53)	(0.17)	(1.14)
Member	1.571	1.284	1.22	0.382
	(0.54)	(0.52)	(0.88)	(0.23)
Info_gov	1.793	5.673**	1	0.643
	(0.65)	(3.26)	(.)	(0.7)
Info_pvt	0.961	0.349*	2.615	1.626
	(0.54)	(0.16)	(1.39)	(0.94)
Fert_credit	2.525**	0.558	0.372	0.453
	(0.8)	(0.24)	(0.58)	(0.47)
Fert_trial	1.273	0.543	12.781	1
	(0.6)	(0.3)	(19.02)	(.)

Herb_train	2.01	0.168	1	1
	(1.33)	(0.24)	(.)	(.)
Erosion	1.628	0.605	3.591	1
	(0.84)	(0.22)	(3.91)	(.)
Weeds	1.088	1	10.883	0.464
	(0.41)	(.)	(15.22)	(0.38)
Constant	1.274	9.88	0.054	0.002**
	(1.43)	(11.76)	(0.13)	(0)
Obs	247	227	136	127
LR_chi2	44.586	50.546	33.805	32.725
prob>chi2	0.003	0	0.009	0.018
Pseudo_R2	0.132	0.17	0.236	0.228
* p<0.05, ** p<0.01, *** p<0.001				

Note: The statistic provided are odds ratios with standard deviations in brackets

Adoption of intercropping

Growing any intercrops with cassava was found to be practiced by very few farmers across all survey regions. While up to 9% of farmers claimed to be currently growing any intercrops in Dak Lak, this was only the case for less than 3% of farmers in Son La. This proportion was even lower for Sayabouly at 1% while none of the farmers in Bolikhamxay were currently involved in growing any intercrops with their cassava.

Table 10 below presents the results of a logistic regression for Dak Lak where the dependent variable 'whether farmers are currently growing any intercrops with cassava' is regressed against a number of explanatory variables.

The likelihood ratio test p values are lower than the conventional threshold of 0.05 exhibiting a significant improvement in fit over the null model. Additionally a McFadden's R2 value of 0.245, exhibits a good model fit.

With regards to specific predictors, those farmers that report having a family member involved with any groups or mass organisations were found to have higher odds of growing intercrops with their cassava. On the contrary farmers with weed problems revealed lower odds of growing intercrops.

Table 10: Logistic regression results to assess current intercropping with cassava

Intercrops	**Dak Lak**
Female	2.542
	(1.57)
Age	0.975
	(0.02)
Edu_Primary	0.421
	(0.31)
Edu_High	0.404
	(0.3)

Income_1	1.395
	(1.23)
Income_2	2.078
	(1.71)
Income_3	0.298
	(0.3)
Off_farm	1.004
	(0.01)
Good Conditions	0.341
	(0.22)
Cassava_land	1.318
	(0.42)
Cassava_yield	0.956
	(0.04)
Cassava_time	1.073
	(0.04)
Cassava_five	1.788
	(1.16)
Yield_decline	0.327
	(0.19)
Member	6.772**
	(4.54)
Info_gov	2.06
	(1.5)
Info_pvt	0.757
	(0.51)
Fert_credit	0.878
	(0.53)
Fert_trial	0.839
	(0.82)
Herb_train	3.503
	(6.18)
Erosion	3.068
	(1.96)
Weeds	0.134*
	(0.13)
Constant	0.566
	(1.19)
Obs	242
LR_chi2	37.237
prob>chi2	0.022
Pseudo_R2	0.245
* p<0.05, ** p<0.01, *** p<0.001	

Note: The statistic provided are odds ratios with standard deviations in brackets

Interest in Cassava Technologies

This section presents results of logistic regressions linking farmers interest in technologies in different survey locations with demographic, agronomic and social explanatory variables. The technologies examined are certified planting materials, new intercrops, and conservation agriculture practices.

Willingness to purchase planting materials certified to be pest and disease free

Up to 56% of farmers in Son La claimed to be willing to purchase planting materials that are certified to be pest and disease free. The proportion of farmers interested in certified planting materials was significantly lower at 25% in Dak Lak, 23% in Bolikhamxay and less than 6% in Sayabouly.

Table 11 presents the results of a logistic regression where the dependent variable 'willingness to purchase planting materials certified as pest and disease free' is regressed against a number of explanatory variables.

With regards to fit of the model, the likelihood ratio test p values are lower than the conventional threshold of 0.05 for Son La and Dak Lak but higher than 0.05 for Bolikhamxay suggesting that we would fail to reject the null model for Bolikhamxay. Also the McFadden's R2 values are also lower than 0.2 for all sites indicating that the model is capable of explaining limited proportion of variation in the data. Despite poor overall model fit a few significant predictors were observed for the models across the three sites.

In Son La, farmers that had been planting cassava for longer time periods were found to have higher odds of being willing to purchase certified planting materials. Higher odds were also found amongst farmers that received their information on agricultural production from government sources and those that claimed to have received training on fertiliser use. On the contrary farmers that obtained a larger share of their income from off-farm sources had lower odds of purchasing certified planting materials. As indicated before this may be because of reduced priority for farm outputs in relation to off-farm sources.

For Dak Lak, farmers that had been planting cassava for longer time periods were found to have higher odds of being willing to purchase certified planting materials. Similarly, farmers that were able to purchase fertilisers on credit and those reporting soil erosion to be a significant problem had higher odds of purchasing certified planting materials.

In Bolikhamxay, farmers that indicated they would be growing cassava in the next five years and those that claim to have received training on fertiliser use were found to have higher odds of purchasing certified planting materials.

Table 11: Logistic regression results for willingness to purchase planting materials that are certified to be pest and disease free.

Purchase Certified	**Son La**	**Dak Lak**	**Bolikhamxay**
Female	3.158	1.294	0.685
	(3.13)	(0.59)	(0.84)
Age	0.978	0.983	0.987
	(0.01)	(0.02)	(0.02)
Edu_Primary	1.582	0.816	1.118
	(0.68)	(0.4)	(0.87)
Edu_High	1.925	0.415	1.529
	(0.9)	(0.21)	(1.35)
Income_1	2.19	0.548	0.448
	(1.01)	(0.32)	(0.36)
Income_2	1.761	0.797	0.453
	(0.8)	(0.44)	(0.35)
Income_3	1.757	1.095	0.986
	(0.76)	(0.57)	(0.71)
Off_farm	0.976***	1.012	0.982
	(0.01)	(0.01)	(0.01)
Good Conditions	0.708	0.457	
	(0.24)	(0.2)	
Cassava_land	2.181	0.958	0.981
	(0.94)	(0.24)	(0.22)
Cassava_yield	0.996	0.996	0.978
	(0.02)	(0.02)	(0.02)
Cassava_time	1.029*	1.062*	0.939
	(0.01)	(0.03)	(0.11)
Cassava_five	0.809	1.501	4.085**
	(0.31)	(0.61)	(2.2)
Yield_decline	1.023	0.992	0.385
	(0.36)	(0.36)	(0.2)
Member	1.871	2.161	2.029
	(0.68)	(0.9)	(1.05)
Info_gov	2.702*	1.426	2.631
	(1.1)	(0.75)	(2.17)
Info_pvt	2.155	1.993	1.027
	(1.38)	(0.88)	(0.56)
Fert_credit	1.524	5.493**	0.914
	(0.48)	(3.18)	(0.65)
Fert_trial	3.491*	1.269	5.557*
	(1.78)	(0.74)	(4.79)
Herb_train	0.797	1.157	1.463
	(0.59)	(1.68)	(2.03)
Erosion	1.144	2.707*	0.933
	(0.61)	(1.13)	(0.86)
Weeds	0.964	4.172	0.407

	(0.38)	(4.95)	(0.34)
Constant	0.481	0.012*	2.222
	(0.56)	(0.02)	(4.18)
Obs	248	220	131
LR_chi2	66.995	47.914	27.873
prob>chi2	0	0.001	0.144
Pseudo_R2	0.199	0.183	0.175
* p<0.05, ** p<0.01, *** p<0.001			

Note: The statistic provided are odds ratios with standard deviations in brackets

Interest in trialling new intercrops with cassava

While existing practice related to intercropping with cassava was found to be quite rare, many farmers across all survey regions seemed to be interested in trialling new intercrops. Up to 46% of farmers in Dak Lak and 36% in Son La claimed to be interested in trialing new intercrops while this fraction was slightly lower at 31% and 20% for Bolikhamxay and Sayabouly.

Table 12 presents the results of a logistic regression where the dependent variable 'whether farmers are interested in trialling new intercrops with cassava' is regressed against a number of explanatory variables.

With regards to fit of the model, the likelihood ratio test p values are lower than the conventional threshold of 0.05 for all sites suggesting that we would fail to reject the null models. Also the McFadden's R2 values are lower, particularly for Son La and Bolikhamxay suggesting that these models are capable of explaining only a limited proportion of variation in the data. Despite poor overall model fit a few significant predictors were observed for the models across the four sites.

In Son La, farmers in the lowest income quartile and those that reported having a family member involved with any groups or mass organisations had higher odds of being interested in trialling new intercrops with their cassava. Higher odds of trialling new intercrops was also found amongst farmers that had larger cassava land areas and greater cassava yields.

For Dak Lak, female headed households and those with higher levels of education were found to have higher odds of being interested in trialling new intercrops with their cassava while the opposite was true for farmers that received their information on agricultural production from private sources.

Similar to Son La, group membership in Sayabouly greatly increased the odds of being interested in trialling new intercrops. Additionally, farmers that reported increasing problems with weeds also revealed more interest in trialling new intercrops.

In Bolikhamxay, farmers that indicated that they would be growing cassava in the next five years were found to have higher odds of being interested in trailing new intercrops. On the contrary farmers that obtained a larger share of their income from off-farm sources and those that fell into the second income quartile were found to have slightly lower odds of being interested in new intercrops. Less dependence upon farm income is likely to be the reason for reduced interest in making further investments on the farm.

Table 12: Logistic regression results assessing farmer interest in trailing new intercrops

Intercrop Interest	**Son La**	**Dak Lak**	**Sayabouly**	**Bolikhamxay**
Female	2.575	3.892**	0.134	1.16
	(2.59)	(1.8)	(0.19)	(1.25)
Age	0.989	1.021	1.009	1.016
	(0.01)	(0.02)	(0.02)	(0.02)
Edu_Primary	0.602	1.812		2.849
	(0.27)	(0.88)		(2.3)
Edu_High	0.744	2.570*	0.578	4.467
	(0.36)	(1.22)	(0.33)	(4.18)
Income_1	6.712***	0.898	1.998	0.261
	(3.58)	(0.52)	(1.95)	(0.2)
Income_2	1.836	0.886	2.458	0.206*
	(0.92)	(0.45)	(2.05)	(0.15)
Income_3	1.333	0.894	0.98	0.357
	(0.65)	(0.44)	(0.77)	(0.24)
Off_farm	0.999	1.006	1.022	0.970**
	(0.01)	(0.01)	(0.02)	(0.01)
Good Conditions	1.744	0.778		
	(0.65)	(0.3)		
Cassava_land	2.206*	1.371	1.037	1.005
	(0.83)	(0.31)	(0.19)	(0.18)
Cassava_yield	1.058*	1.035	0.988	1
	(0.03)	(0.02)	(0.03)	(0.01)
Cassava_time	1.009	0.957	1.205	1.229
	(0.01)	(0.02)	(0.2)	(0.14)
Cassava_five	1.091	1.312	2.638	2.815*
	(0.42)	(0.49)	(1.67)	(1.41)
Yield_decline	1.154	1.611	0.446	0.519
	(0.41)	(0.54)	(0.28)	(0.24)
Member	2.436*	0.527	7.978**	1.851
	(1.04)	(0.23)	(5.07)	(0.89)
Info_gov	1.493	0.298	0.889	1.136
	(0.55)	(0.19)	(1.48)	(0.93)
Info_pvt	0.585	0.270**	1.208	0.637
	(0.35)	(0.13)	(0.71)	(0.32)
Fert_credit	0.75	0.603	1	0.368
	(0.26)	(0.26)	(.)	(0.28)
Fert_trial	1.269	0.694	4.38	0.304
	(0.63)	(0.4)	(7.33)	(0.35)
Herb_train	1.497	1	1.763	1.629

	(1.03)	(.)	(2.45)	(2.45)
Erosion	1.37	0.599	1	0.113
	(0.81)	(0.22)	(.)	(0.14)
Weeds	0.965	4.536	13.094*	0.859
	(0.41)	(5.29)	(17.1)	(0.66)
Constant	0.053*	0.067	0.004*	0.194
	(0.07)	(0.11)	(0.01)	(0.34)
Obs	205	218	133	138
LR_chi2	36.551	67.382	42.658	33.916
prob>chi2	0.026	0	0.001	0.037
Pseudo_R2	0.13	0.223	0.282	0.189
* p<0.05, ** p<0.01, *** p<0.001				

Note: The statistic provided are odds ratios with standard deviations in brackets

Interest in trialling conservation agriculture practices

The level of interest shown by farmers for trialling further conservation practices on their lands was relatively high across the survey regions. In Son La up to 89% revealed such an interest with about 80% in Dak Lak. Farmers in the Laotian survey sites were less keen on trialling such practices with 43% and 29% revealing their interest in Bolikhamxay and Sayabouly respectively.

Table 13 presents the results of a logistic regression where the dependent variable 'whether farmers are interested in trialling new conservation practices on their lands' is regressed against a number of explanatory variables.

With regards to fit of the model, the likelihood ratio test p values are lower than the conventional threshold of 0.05 for all sites (except for Bolikhamxay where it is slightly higher at 0.07) suggesting that we would reject the null models. Also the McFadden's R2 values are between 0.2 and 0.4 suggesting that the models depict good overall fit.

According to the results for Son La, older farmers were found to have slightly lower odds of being interested in trailing conservation practices on their land. On the contrary, farmers that reported having a family member involved with any groups or mass organisations were found to have higher odds of being interested in trialling conservation practices. Finally as expected, farmers who considered soil erosion to be a problem on their fields had higher odds of being interested in conservation measures. This positive relationship between conservation interest and problems related to soil erosion was also found to be the case for Dak Lak farmers. Moreover, farmers in Dak Lak that were able to purchase chemical fertilisers on credit, those that expected to be growing cassava in the next five years, those that considered weeds to be a big problem for their cassava crop and female headed households had higher odds of being interested in trialling conservation practices on their land.

It is quite clear that farmers that expect to be growing cassava in the foreseeable future would be more concerned about the sustainability of their agricultural practices and hence interested in incorporating conservation measures. On the contrary, farmers who have been planting cassava for longer periods of time were found to have lower odds of being interested in trialling conservation practices.

Contrary to Dak Lak, female headed households in Sayabouly and Bolikhamxay were found to have lower odds of being interested in trialling conservation practices on their lands. While farmers in Sayabouly that received their information regarding agricultural production from private sources had higher odds of being interested in trialling conservation practices, the opposite was true for Bolikhamxay farmers that received their information on agricultural production from government sources. In Bolikhamxay farmers that fell into the second income quartile and those that obtained a larger share of their income from off-farm sources had lower odds of being interested in trialling conservation practices. It is likely that farmers who are less dependent upon their farm as a source of household income are also less keen to make further investments on their farm. Finally, it was observed that farmers in Bolikhamxay that had been planting cassava for longer periods of time had higher odds of being interested in trialling new conservation practices on their lands.

Table 13: Logistic regression results assessing interest in trailing conservation practices on farmer's land.

Conservation Interest	**Son La**	**Dak Lak**	**Sayabouly**	**Bolikhamxay**
Female	1.191	7.174*	0.004***	0.068*
	(1.82)	(5.57)	(0.01)	(0.09)
Age	0.948*	1.032	1.011	0.999
	(0.02)	(0.02)	(0.03)	(0.03)
Edu_Primary	1.668	2.136		1.296
	(1.12)	(1.43)		(1.02)
Edu_High	1.326	1.668	0.305	1.471
	(0.98)	(1.09)	(0.25)	(1.28)
Income_1	1.055	0.227	4.311	0.297
	(0.78)	(0.18)	(5.58)	(0.29)
Income_2	1.746	0.762	0.879	0.151*
	(1.22)	(0.55)	(1.02)	(0.13)
Income_3	5.578	0.99	0.322	0.203
	(5.27)	(0.65)	(0.31)	(0.18)
Off_farm	0.983	0.984	1.043	0.972*
	(0.01)	(0.01)	(0.02)	(0.01)
Good Conditions	1.083	0.775		
	(0.6)	(0.43)		
Cassava_land	1.541	1.393	0.956	0.783
	(1.18)	(0.58)	(0.25)	(0.2)
Cassava_yield	1	0.997	1.017	0.98
	(0.04)	(0.03)	(0.04)	(0.03)
Cassava_time	1.041	0.923*	1.6	1.390*

	(0.03)	(0.03)	(0.52)	(0.2)
Cassava_five	0.977	3.367*	0.217	1.896
	(0.61)	(1.86)	(0.26)	(1.06)
Yield_decline	1.533	1.521	0.26	0.54
	(0.96)	(0.77)	(0.22)	(0.29)
Member	5.200**	0.424	234.875***	1.432
	(3.2)	(0.24)	(325.43)	(0.82)
Info_gov	0.807	0.41	1	0.105*
	(0.6)	(0.3)	(.)	(0.12)
Info_pvt	1	2.711	15.826**	1.403
	(.)	(1.92)	(15.26)	(0.79)
Fert_credit	1.098	4.214*	8.124	1.549
	(0.63)	(2.39)	(16.39)	(1.28)
Fert_trial	3.879	0.634	1	0.735
	(3.73)	(0.49)	(.)	(0.74)
Herb_train	1	1	1	1.062
	(.)	(.)	(.)	(1.9)
Erosion	7.972**	16.891***	0.086	0.605
	(5.46)	(8.58)	(0.16)	(0.6)
Weeds	0.863	5.985*	1.159	4.916
	(0.61)	(4.77)	(1.09)	(4.06)
Constant	1.261	0.025*	0.015	1.294
	(2.3)	(0.05)	(0.05)	(2.83)
Obs	213	239	89	111
LR_chi2	38.267	107.566	58.165	31.092
prob>chi2	0.008	0	0	0.072
Pseudo_R2	0.255	0.439	0.474	0.211
* p<0.05, ** p<0.01, *** p<0.001				

Note: The statistic provided are odds ratios with standard deviations in brackets

Likelihood of growing cassava in five years' time

As the household survey was undertaken at a time when cassava prices had declined rapidly and farmers were facing large cuts in income, it is not surprising that only a relatively low proportion of farmers believed they would be growing cassava in the next five years. While this proportion was highest for Son La at 76% followed by Dak Lak at 55%, the Laotian sites of Bolikhamxay and Sayabouly had lower proportions at 51% and 29% respectively.

Table 14 presents the results of a logistic regression where the dependent variable 'whether farmers think they will be growing cassava in five years' time' is regressed against a number of explanatory variables.

With regards to fit of the model, the likelihood ratio test p values are lower than the conventional threshold of 0.05 for all sites suggesting that we would fail to reject the null models. However the McFadden's R2 values are lower than 0.2 Son La and

Bolikhamxay indicating that the model is capable of explaining limited proportion of variation in the data for these sites.

Son La farmers who have been farming cassava for a longer time and those that considered weeds to be a big problem for cassava were found to have higher odds of retaining cassava production in the next five years. On the contrary farmers receiving information on cassava production through government sources and those that had received training on fertiliser use were found to have lower odds of retaining their cassava production in the next five years.

Similar to Son La, farmers in Dak Lak that have been growing cassava for a longer time were also found to have higher odds of growing cassava in the next five years. As a result of growing cassava for long periods of time, it may have been viewed as a way of life by these farmers. Moreover, farmers that fell into the lowest income quartile had higher odds of growing cassava in the next five years while the opposite was true for those that obtained a larger share of their income from off-farm sources. These results together point to the relatively lower opportunities off the farm for farmers in the poorer income categories that may be compelling them to retain their cassava production in the years to come. In addition, lower odds of growing cassava in the next five years was also found to be the case for older farmers and those that had achieved higher levels of education.

Contrary to the case in Dak Lak, older and more educated farmers in Sayabouly had higher odds of retaining their cassava production in the next five years. Farmers who had been growing cassava for longer periods of time were found to have lower odds of retaining their cassava production over the next five years. Farmers receiving their information from government sources had higher odds of retaining their cassava production over the next five years while the opposite was true for those that depended upon this information on the private sector. Finally, those reporting having a family member involved with any groups or mass organisations had higher odds of continuing on with their cassava production in the next five years.

In Bolikhamxay farmers that claimed to be able to access chemical fertilisers on credit had higher odds of retaining their cassava production over the next five years. The ability to purchase chemical fertilisers on credit may have contributed to cassava production being viewed as a more secure alternative in the longer run.

Table 14: Logistic regression results on whether farmers believe they will be growing cassava in five years time

Cassava Five Years	Son La	Dak Lak	Sayabouly	Bolikhamxay
Female	2.224	1.036	0.88	1.745
	(2.6)	(0.41)	(1.02)	(1.9)
Age	1	0.961**	1.044*	0.976
	(0.01)	(0.01)	(0.02)	(0.02)
Edu_Primary	0.784	0.743		1.277
	(0.38)	(0.34)		(0.8)
Edu_High	1.168	0.271**	2.897*	0.323
	(0.62)	(0.13)	(1.56)	(0.23)
Income_1	1.213	4.850**	4.433	0.658

	(0.61)	(2.61)	(3.81)	(0.44)
Income_2	1.58	2.5	3.74	3.232
	(0.78)	(1.2)	(2.77)	(2.06)
Income_3	0.976	1.103	2.219	0.91
	(0.45)	(0.51)	(1.57)	(0.54)
Off_farm	0.995	0.984*	1.023	1.005
	(0.01)	(0.01)	(0.01)	(0.01)
Good Conditions	0.959	0.7		
	(0.36)	(0.27)		
Cassava_land	0.785	1.256	1.143	0.954
	(0.3)	(0.29)	(0.2)	(0.16)
Cassava_yield	0.978	0.973	0.98	1.036
	(0.02)	(0.02)	(0.02)	(0.02)
Cassava_time	1.044*	1.133***	0.686*	0.907
	(0.02)	(0.03)	(0.1)	(0.09)
Yield_decline	1.442	0.69	0.798	0.799
	(0.53)	(0.23)	(0.43)	(0.32)
Member	0.896	0.685	17.596***	1.876
	(0.37)	(0.28)	(10.72)	(0.82)
Info_gov	0.323**	0.483	31.327**	3.609
	(0.12)	(0.26)	(39.83)	(2.77)
Info_pvt	1.862	2.199	0.180**	0.555
	(1.31)	(1.05)	(0.11)	(0.25)
Fert_credit	0.794	0.593	3.251	5.550*
	(0.29)	(0.24)	(3.78)	(4.21)
Fert_trial	0.304**	0.51	0.961	3.869
	(0.14)	(0.31)	(1.23)	(3.48)
Herb_train	2.447	1	0.261	1
	(1.95)	(.)	(0.37)	(.)
Erosion	1.051	1.737	1	2.672
	(0.6)	(0.58)	(.)	(2.08)
Weeds	2.281*	2.09	2.296	2.519
	(0.91)	(1.36)	(2.01)	(2.02)
Constant	2.273	3.658	0.02	1.049
	(2.82)	(4.39)	(0.04)	(1.66)
Obs	248	239	150	147
LR_chi2	(-35.281)	74.067	67.579	34.379
prob>chi2	0.026	0	0	0.017
Pseudo_R2	0.129	0.226	0.349	0.17
* p<0.05, ** p<0.01, *** p<0.001				

Note: The statistic provided are odds ratios with standard deviations in brackets

Conclusion

The main determinants for farmer adoption of fertiliser were declining yields, the availability of fertiliser on credit and the overall socio-economic conditions of the surveyed regions. For herbicides, the main determinants were less clear – in Son La, farmers with higher yields and those who perceived weeds to be a problem were found to be less likely to adopt herbicides. The steeply sloping lands in Son La mean that it is less economical to use herbicides. However the relatively low herbicide adoption rates seem to be contributing to the weed problem. The size of farm was the main determinant in Dak Lak, with large farms more likely to adopt them – likely because of a lack of labour to undertake manual weeding.

Extension/Information related explanatory variables were relatively important explanatory variables for adoption of ridging while farmer and farm household characteristics such as age, education and income also played a significant role. Membership of mass organizations on the other hand played a significant role in the adoption of intercrops.

As was the case with a number of technologies already adopted or at least introduced in the region, the level of interest of farmers in potential new technologies is also positively influenced by information and extension variables. Membership of an organization or group and receiving extension information from the government or private sector is associated with a higher degree of interest in a range of new technologies across different sites.

Farmers who had received training on fertiliser use, and/or had fertiliser on credit available to them had higher odds of adopting chemical fertilisers, sourcing planting materials from outside their farms, showing interest in clean planting material and being interested in trialling conservation practices on their farms. This could indicate that fertiliser training and provision of credit can form a key component of an integrated extension/information provision package for farmers.

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