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Agricultural Business Model and Sustainable Development in Highland: A Case of Nan, Thailand

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Abstract

Over the past decade, forestsin the Northern Thailand have reducedrapidly. Farmers' well-being and highland environment have also suffered vastly, owing to an expansion of maize farming. To induce farmers to adopt a more environmental friendly alternative, it is essential that policy makers must understand potential business models that could lend good support to highland agricultural system and bring forth sustainability. This paper studies constraints and advantages of existing highland business models in Nan. We consider impacts of engaging in various business models on farmers' livelihood and environments. Data were gathered from 146 household-surveys in 7 areas of Nan and in-depth interviews with local stakeholders, government and development agencies. We show that different agricultural systems and business models fare different impacts on economic, social and environment. Contact farming reduces price uncertainty for farmers, but creates significant negative impacts on social and environment. Farmers' aggregation help strengthen farmers' capacity and open up market opportunity, but it does not guarantee a lift in bargaining power. Cultivating high-quality product may add value to final product and benefit environment, yet farmers need to be linked to high-end market and pass quality guarantee system. Product processing helps diversifying market risk, but whether or not the value added will be returned to farmers is questionable. Developing business model for an area depends on several factors including readiness of community and requirements of each model. We assert the "four essential principles" that need to be embedded and nurtured in upland agricultural business. These are: 1) give high returns per unit area 2) reduce risk 3) strengthen farmers and community and 4) set explicit conditions to improve environment. We offer various means that business and farmers may choose to adopt so as to deliver results according to each principle.

Keywords: Agricultural business model; highland agriculture; sustainable agricultural system; sustainable development

JEL classification O13, Q01, Q13, Q15, Q18

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Introduction

The northern part of Thailand has always been known for its richness of nature and high ecological value. Not only that 80% of the country's highland locates in the region, it is home to more than half of the country's total forest areas. It is estimated that there are more than 1 million people living and cultivating on the vulnerable sloping land where their rights to the land have always been a questionand linking their products to the market is never easy. Most importantly, any agricultural practice including the supporting business model adopted has far-reaching effects not only among their communities, but also on those residing in lowland or in downstream areas.Over the past decade, this region's reserved forests have rapidly shrank in size and farmers' well-being and highland environment have suffered vastly, owing to a widespread culture of maize farming which relies on heavily use of herbicide and chemical fertilizer. Nan, a province where 85% of its land is highland, got badly affected, and has been a center of attentions.Efforts have been made by government units, private sector, NGOs to induce farmers to adopt more environmental friendly alternatives. While some start to bear fruits, most cannot manage to secure a tangible change.One important message from many studies on maize farming is thatthe business model linking maize from the region to final market has successfully unlocked considerable physical, institutional and market limitations of highland. Although there are other plants or crops that offer higher returns compared to maize, they raise other market concerns that cannot be easily addressed by farmers.This is why, to induce farmers to adopt a more environmental friendly alternative, focusing on mere potential returns generated by the product will not suffice, the understanding of potential business models that could lend good support to highland agricultural system and bring forth sustainability to the region is thus essential.

Amidst the watershed crisis triggered by cash crop, another concern regarding highland usage comes up. Given no clear policy regarding highland cultivations, a number of large agricultural investments from both domestic and international agribusinessesstart to flood in. Promises of price guarantees, market certainty were commonly used to attract farmers' interest, yet in many cases farmers still face with recurring problems of very low product's price, no bargaining power, bearing all risks and some crops still require heavy use of chemicals and fertilizers. The issue of environmental protection comes last in farmers and business' priority list. This circumstance poses one important question: what kind of agricultural business should be allowed to operate on this "officially" forest land?

This research focuses on areaswhere farmers have started to leave/ or have left maize farming and adopted other more environmental friendly agricultural systems which are perennial tree crop such as mango and coffee; integrated farming, and seeds cultivation. Within each agricultural system, farmers may adopt different business models. One may go for traditional market system where intermediate buyers have most influential role, some may sell their products via farmers' aggregation. Some maychoose to engage with buyer of social enterprise nature, some may form a village enterprise to target high-end market and some may prefer to get into contract farming system.

We depart from most research whose main focus were on impacts agricultural system on highland sustainability by looking deeper at the agricultural business adopted to support the agricultural system. Our aim is to investigate impacts of various business models on farmers' livelihood and environments by considering relationships between business models and indicators of sustainability, including the advantages and weakness of each business model and how one business model can be transformed to the other. This understanding helps us develop aframework of essential principles for highland agricultural business conducts that would facilitate sustainability in all key aspects: economic, social and environment.

We find that different agricultural systems and business models fare differently in their impacts on economic, social and environment of highland community. Although contract farming helps reduce high variation in product price received by farmers, it could make significant negative impact on social and environment. Farmers' aggregation may help strengthen farmers' capacity and open up market opportunity, but it does not, on its own guarantee a lift in bargaining power; farmers may still suffer from high variation in price. Moreover, cultivating to serve market of high quality product may add value to final product and ensure good treatment on environment, yet to have a good share in this value added, farmers need to be linked to appropriate market and be accustomed to local or internal quality guarantee system. Product processing may allow farmers to diversify some market risk as they create extra market channels, but whether or not the value added via processing is significant enough or will be returned to farmers is entirely a different matter. To develop a supporting business model that fits well with farmers, and their agricultural system depends on several factors including readiness of community and whether they have possessed essential elements required for each type of business model. We then assert the "four essential principles" that need to be embedded in upland agricultural business; these are 1) give high returns per unit area 2) reduce risk 3) strengthen farmers and community and 4) set conditions explicitly to improve environment. The four principles form fundamental pillars for both livelihood and environmental sustainability. We offer various means that business and farmers may choose to adopt so as to deliver results aimed by each principle. The chosen means should fit with product of their agricultural practice, particular socioeconomic context and desire of each community.

The paper is organized as follows: section 2 reviews most relevant literature, the survey research methodology is discussed in section 3. Section 4 discusses problem of highland agriculture . Section 5 explains statistical and econometrical techniques employed in the studies and provides results of the analysis. Section 6 discusses the essential principle for highland agricultural business. Section 7 concludes and offers policy recommendation.

Literature Review

This paper is much related to two streams of literature, one regards the meaning and how to measure agricultural sustainability especially on highland, the other one is on types of business models that could support smallholders inhabited on highland or reserved forests. Given the official meaning of agricultural sustainability as stated by FAO council (1988), Mueller (1997)summarized 6 pre-conditions for agricultural sustainability as 1) efficient production 2) restoration of ecosystem, 3) using appropriate technology; 4) preserve environment 5) preserve diversity in culture and 6) ability to respond to basic needs. Among various methods of measuring this sustainability, one is to use sustainability indicator analysis which gains popularity due to its flexibility and applicability. However, it is not possible to get a set of best indicators as meaning of sustainability can be differed in detail depending on researchers' perspective In choosing appropriate indicators, our research made use of the studies byHayati et al. (2010) which reviewed and compared set of indicators that were presented in numerous research work during the year 1991-2007, and gave summary of the indicators that were commonly used to measure economic, social and environment aspects of sustainability, Bosshag et al (2012), Potchanasin (2008) and Pham and Smith (2013).

Past works have mostly applied sustainability concept to address two main questions. One is to compare sustainability across areas or across agricultural systems in order to find which agricultural systemis better in nurturing sustainability in the area, the other one is to assess sustainability of some specific areas and investigate factors affecting sustainability, for examples,Rasul and Thapa (2004); Bosshaq et al (2012); Praneetvatakul et al. (2001), Potchanasin (2008), Lopez and Almeida (2003), and Zhen and Routray (2003). Fewer studies concentrate on drivers of indicators and their relationship with sustainability outcome or indicator (Pham and Smith (2013)). We depart from the previous study by focusing more on characteristics of business model that could enhance sustainability on highland. By using a set of economic, social and environment indicators to observe symptoms of sustainability of areas, we observe impacts of different business models on sustainability.

As far as highland agriculture is concerned, a number of studies focus on problem of highland agriculture, what were obstacles of practicing sustainable agriculture on highland and how to fix it. Examples of these works are APO (2014), FFTC (1997), Partap (2004), Pokhriyal and Bist (1988), Fujisaka (1994). Evidence gathered from studies focusing on highland of ASEAN and neighboring countries suggested 3 points that should be taken into account for highland agricultural development. First, options for land utilization should base on specific ecosystem of the area. Second, development of farm system should take advantage or be relevant to unique characteristics or distinctive feature of the area. Lastly, positive relationship between people and ecosystem must be established and enhanced. Undoubtedly, the agricultural system universally acknowledged as supporting highland sustainability are such as integrated farming with perennial fruit tree and agroforestry (APO (2004)).

Another stream of literature that is highly related to our research is the studies on business model for smallholders. A number of studies conduct survey and reviewed business

model which can give opportunity to smallholders in marginal land (e.g. Vermeulen and Cotula (2010), Thapa and Ghina (2011)). Some focused on effects of the foreign agricultural investment on smallholders of the recipient countries, and what are typical business models used by foreign agribusiness investor, for examples, FAO (2012, 2013), Lui (2014) and Hallam (2009) Some focused on case studies of existing agricultural business model in countries that become targets of agricultural investment such as Laos (Campbell et al. (2012); Manorom et al. (2011)), Indonesia (Thambunan (2012, 2014)), and Mexico (Amador and Vera-Cruz (2013)). Their findings point to similar conclusion. There is no "best" business model for smallholders. The appropriate model must take into account specific context of the area. A sustainable business model must be financial viable and manageable for farmers. Anyadopted model directly affects farmers' income and environmental management (Vermeulen and Cotula (2010)). However, due to limitation of macro data, evidence to illustrate these effects systematically is still lacking. Most researches thus rely on synthesizing results from various case studies around the world especially of the countries that are target of agricultural investment (e.g. Africa, Asia and Latin America).

Survey

In order to address the main question of what kind of business model that would help bring sustainability to the region, the research used both qualitative and quantitative analyses. We selected 7 areas (scattering in 6 districts) of Nan province where farmers have begun to or already left maize farming behind, and adopted more environmental friendly agricultural practice. Our sites represent variety of agricultural practices adopted as better alternatives for upland. Farmers in two areas called Ban Maneepruek and Ban SanCharoen cultivate Arabica coffee as both villages locate on high altitude. Farmers in Ban Mae Charim, Ban PongKhamadopted integrated farming and focus on cultivating green-house vegetable such as Chinese kale, Pak Choi and Japanese Cucumber. A group of farmers in Ban Mae Charim also engage in seed productions (i.e. seed of cucumber, bitter cucumber and watermelon). Farmers in Ban ThamWiang Kaealso grow green-house vegetables (e.g. sweet pepper and Thomas tomato)as major crop. Farmers who adopted green-house vegetable cultivations in Ban Mae Charim, Ban Pong Kham and Ban Tham Wiang Kae are given direct supports of Highland Research and Development Institutes. Farmers in Ban Sop Pet and Ban Pa Klang grow mangoes as major crop.That means we could categorize our samples into four types of agricultural practices: perennial fruit trees, coffee planting, greenhouse vegetables and seed production. We undertook a survey of 146 households from these 7 areasand conducted in-depth interviews with leaders of communities, local stakeholders, governmental and development agencies. What interest us here, are heterogeneity in business models chosen by farmers of the same agricultural practice.We postulate that to attain highland sustainability in all economic, social and environment aspects focusing on just agricultural practice will not suffice; a bigger weight needs to put on what type of business farmers will adopt to support the chosen agricultural system.

For areas where mangoes were chosen as main crop, Sop Pet is one with the most primitive business model. The mango growers have no other option but to engage in traditional selling setting, whereby farmers sell their products to middlemen who come to buy products in the area during mango season. Attempts to form farmer's group are not yet successful, farmers independently and competitively sell their products to middlemen (this business model will be called traditional henceforth). In Ban Pa Klang, there are two types of business models. Majority of the farmers engage in traditional selling model, but there is also a small village enterprise that represents group of farmers who aim to sell their products in high end market i.e. exporting company, their products are of higher standard and GAP (Good Agricultural Practice) certified. Among the two areas representing coffee cultivation, Ban San Charoen has long adopted coffee as main crop, most people in the village involve in coffee cultivation, and many are members of the village enterprise for coffee processing. The enterprise buys fresh coffee (cherry) from members and performs several step of processing. Coffee beans are sold in many forms, as parchment coffee, green bean coffee and roasted coffee beans. Farmers in Ban Maneepruek started adopting coffee cultivation almost 10 years ago. Although coffee is not yet a major crop, but it has certainly gained popularity among farmers and will soon substitute ginger which used to be grown as main crop in the area. Some coffee growers sell their products to local gatherer/middlemen who then sell cherry coffee to external processors. Some sell fresh cherry to local processor whose business shows strong sign of social enterprise and focuses on high quality coffee. One advantage of Ban Maneepruek is that it locates on high altitude; 1,200 meters above sea level, hence special variety of Arabica coffee can be grown such as tippica, Java or Geisha, these breeds are rare and expensive. In Ban Mae Charim and Ban Pong Kham where farmers cultivate green-house vegetables, HRDI helps farmers establish a small group of green-house vegetable growers, together they sell products as a group directly to retailers, end consumers. Similarly, farmers who grow sweet peppers in Ban Tham Wiang Kae form a group and sell their product together to end market. The difference is that, unlike Chinese Kale, Pak Choi or cucumber, sweet pepper can be grown only in area situated at least 600 meters above sea level. Hence, it is not a crop that buyers can easily find replacement elsewhere. Lastly, a group of farmers in Ban Mae Charim who engage in seed production must adopt a model of contract farming with agribusiness firm. The firm will supply factors of production in advance, farmers know about buying price before they start planting, and sell seeds that meet standard at agreed price. The agricultural practice and the corresponding business model observed in these survey sites are summarized in table 1

Table 1: Agricultural system and the corresponding business model

Sites	Sample size (% of population)	Representative crop	Corresponding business model
Ban Sop Pet	26 (24%)	mango	Traditional model
Ban Pa Klang	22 (18%)	mango	Traditional model/ village enterprise for export
Ban Maneepruek	26 (90%)	Arabica coffee	Traditional/ local buyers
Ban San Charoen	24(29%)	Arabica coffee	Village enterprise/ local buyers
Ban Mae Charim	19(34%)	Integrated farming with greenhouse vegetable Seed production	Farmers' aggregation under support of HRDI Contract farming
Ban Pong Kham	16(33%)	Integrated farming with green house vegetable	Farmers' aggregation under support of HRDI
Ban ThamWiangKae	13(50%)	Greenhouse vegetable (sweet pepper)	Farmers' aggregation under support of HRDI

Data gathered comprises two main forms: ones reflecting current status of household well-being, agricultural practice and business characteristics, the other reflects changes incurred after the farmers have adopted the corresponding business model. However, for convenience and to make it best serve our purpose of study, we categorize this data into six categories:

1. households characteristics and utilization of their land (e.g. years of education, household agricultural labor force, amount of cultivated land, % of highland out of total land holding, accessibility to water supply, land ownership)
2. characteristics of the adopted agricultural practice (e.g. amount of land allocated to major crop, characteristics of major crop, land diversification, % of perennial tree, percentage of agricultural income.
3. characteristics of the corresponding business model (e.g. high-end/quality product, setting quantity purchase in advance, setting price in advance, give technology support to farmer, give market and price negotiation supports to farmer, give financial related supports to farmers, farmers' participation in business)
4. household's economic context indicators (e.g. % of net income generated by major crop, total net income, annual income distribution, happiness rate in terms of household finance)
5. household social context indicators (e.g. amount of loan taken for cultivation of major crop, short term debt, formal and informal debt, expenditure on rice, overall happiness level;

6. household's environmental context indicators (e.g. change in pattern of land-use, change in chemical, chemical usage, pesticide usage and herbicide usage)

Problem of Highland Agriculture

Low purchasing price, no bargaining power, high production cost and highly fluctuating price are common problems regularly faced by highland farmers, resulting in number of protests, road blockings by groups of farmers in the Northern part of Thailand from time to time. As we aim to find appropriate business model that would be supportive to highland agriculture and bring sustainability, we need to understand the rationale behind or limitation of highland agriculture that makes the problems above become recurring challenges every year.

As we conduct comparative studies of agricultural systems and agribusiness model across our survey sites, it is evident that majority of farmers got caught in a trap of traditional market model, where farmers sell their products separately to middlemen who come to purchase products on spot. Farmers in some areas managed to establish a business model that over time would lead them out of the trap. However, due to a number of highland limitations, only a handful of farmers succeeded.

Main problem of farmers in this traditional market is that they have virtually no bargaining power, they end up selling product at low price; bear all market risks and other uncertainty. Most of them rely on producing large quantity, on heavy use of chemical fertilizer, pesticide and herbicide. Some may even deforest to get more land, and many cannot leave maize farming. Environment or ecosystem issues can never be among their top priority.

These problems originate from three categories of limitation faced by highland farmers:

Area- specific limitations: no irrigation, farmers can only grows certain type of crops and only in some season. Cultivation site is far from market, hence high transportation cost. There may not have many buyers interested in the products.

Farmer's limitations: farmers do not possess good knowledge regarding appropriate crop option, lack capital to make any investment, have no product management skills, or knowledge on how to preserve quality, or knowledge of the end market.

Institution's limitations: most farmers have no ownership of the land they cultivate on. Most land is in reserved forest area, and is ecological vulnerable. Farmer has no security in terms of land use.

These limitations determine type of crop grown in the area and market characteristics. Most farmers end up choosing common crop with no distinctive point and get damaged or rotten quickly. Buyers can find substitutes elsewhere easily. Also, farmers tend to grow crop that requires little care, so that it can be grown in vast quantity. With disadvantage in terms of transportation cost, there may be little number of buyers who come to buy in the area. There may be chain of middlemen. The product price fluctuates quickly as they are common products with large amount of substitutes.

These characters of crop and market then shape the way farmers and middlemen behave. During season, as prices move often, farmers take risk by waiting to sell when price is high. However, middlemen can wait to buy at the right time too, also they may collude to set low purchasing price. Once middlemen inform farmers that price would start to fall, farmers would have pressure to rush and compete to sell their products before the price actually falls. Farmers are desperate to sell all their products before they start to rot, and willing to sell their product without sorting into grades and accept low price. Cooperation is very hard to form, as everyone fears to be the last to sell. With these farmers and middlemen's behaviors, the farmers virtually have no bargaining power; hence other problems of low price, high risk,etc. follow.

What we observed from the 7 survey sites was that farmers tried to get out of this trap. Some managed to find business model that helped increase their incomes, some find contract farming beneficial as it reduced risk and offered some certainty. What we will do in the following sections is to look in detail how much the adopted business model help improve farmers' well- being and address environmental issue at the same time.

Statistical and Econometric Analysis

Given this set of cross-sectional data, we can divide our analysis into two parts. For part one, samples were grouped according to their agricultural systems. We then usemultiple regressionsto test relationship between agricultural system and performance of economic, social and environmental sustainability indicators. In part two, we concentrate on relationship between agricultural business model and the three groups of indicators. This is to disaggregate the impact of agricultural system and business model on sustainability indicators.

Relationship between Agricultural Practice and Sustainability Indicators

Here, the samples were grouped into 5 categories: perennial fruit tree, shade-grown coffee, greenhouse vegetable (sweet pepper), seed production and combination of greenhouse and open-air vegetables.In a broad sense, statistics of each group which are shown in table 2 suggest that to adopt greenhouse vegetable, access to water is a key. Perennial fruit tree would suit with the area where farmers have relatively secured land ownership, and this system has lowest degree of land diversification. The greenhouse vegetable and seed production needs only small plot of land

As far as economic indicators are concerned, we found that growers of sweet pepper and seeds producers receive highest net income per rai. Conversely, perennial trees such as mango and coffee produce relatively low income per rai, compared to other crops. Greenhouse vegetables and shade grown coffee are quite good at income diversification while mango and seed production give lowest degree of income diversification.

Seed producers rely heavily on informal credit as they acquired factors of productions such as fertilizer and other chemicals from the company, and repay after harvesting. They have larger debts and lowest happiness score. Although variable cost of producing sweet peppers is

much higher compared to other crops, farmers can sell products at high price, hence generating high income per rai. Farmers keep part of this income for investment in next crop, so they do not rely much on taking loan. Mango growers have highest proportion of rice expenditure to income as they allocate most of their land for mango cultivation especially those who grow mango for export market; they stop growing rice for household consumption and concentrate purely on mango farming. When faced with unexpected situation that badly affected their products or price of their products or income, farmers of perennial tree and seed producers tend not to change to new crop, whereas those who grow greenhouse vegetable may adopt new crop more easily as they have more options. Most of them do not return to maize farming.

In environmental dimension, coffee growers and farmers of greenhouse vegetable make most positive change regarding land utilization. Whereas seed production uses highest level of chemicals/ compared to other crops, which could harm environment more than other crops.

When production costs are considered, we found that although greenhouse cultivation incurs relatively low variable cost per year, it has much higher fixed cost compared to other crops as it requires investment in greenhouse construction and installing water system. Labor cost/rai is also much higher compared to other crops, which implies that household labour force is very important for the success of greenhouse vegetable cultivation. Growing mango and coffee incurs relatively low labor cost, which implies that farmers may want to cultivate supplementary crops or engage in other non-agricultural occupation.

Seed production incurs high variable cost compared to other crops, and farmers rely on factors of productions supplied on credit by the contracting company. In bad situation where products got damage, farmers can fall into debt cycle easily. Other crops may have higher fixed cost, but because of their low variable cost per year, farmers are able make their own investment.

Along the same line as previous studies regarding relationship between agriculture practice and sustainability, we added in the element of business model and estimated regression equations of the following type:

$$Sustainability\ indicator_i = f(household\ i's\ characteristic,$$

$$household\ i's\ agricultural\ practice, characteristics\ of\ household\ i's\ business\ model)$$

Endogenous variables of economic, social and environment sustainability indicators are estimated with the same specification.

In estimating each regression equation, we started off with finding correlations among all exogenous variables and deleted variables that pose multicolinearity problem. For each equation, the White Test is used to check for heteroskedasticity problem. Equation with the heteroskedasticity problem would then be corrected with White's heteroskedasticity consistent standard error and covariance method. After that we used Durbin-Wu-Hausman test to test for endogeniety. Equations with endogeniety problem would be corrected by Instrument variable methods and 2 stage least square (2SLS)

Table 2: Statistics of sample categorized by agricultural practice

	Perennial fruit tree- mango (Sop Pet, Pa Klang)	**Shade-grown Coffee** (Maneepruek)	**Greenhouse vegetable** (ThamWiangKae)	**Seed production**)Mae Charim(	**Combination of greenhouse and open-air vegetables** (Mae Charim, Pong Kham)
Characteristics of household and area					
highland	0.73	0.91	0.92	0.59	0.84
land right	0.35	0.04	0.08	0.73	0.67
irrigation	0.08	0.62	0.77	1.00	0.92
Characteristics of agricultural practice					
tree	1.00	1.00	0.85	0.55	0.92
Area major	11.22	9.47	0.98	0.95	1.35
mixed	0.63	0.94	0.92	1.00	1.00
land diversify	0.60	0.42	0.41	0.30	0.21
Economic indicators					
Net inc major 1	14,785.24	7,990.13	58,976.39	54,166.89	25,638.09
total income	251,934.83	199,880.29	184,692.31	116,072.73	90,886.54
income diversification	0.56	0.70	0.78	0.51	0.70
hap_finance	5.21	6.45	5.31	3.36	5.50
Social indicators					
dependency rate_major1	0.30	0.21	0.20	0.82	0.16
debt_major	11,617.73	8,620.00	20,769.23	28,636.36	2,812.50
ST debt_ratio	0.21	0.19	0.22	0.89	0.99
Formal debt	0.21	0.14	0.17	0.24	0.95
Informal debt	0.02	0.04	0.05	0.69	0.02
food secur	0.06	0.04	0.01	0.01	0.04
resilence	1.00	0.88	0.85	0.91	0.75
hap overall	8.24	8.25	8.24	7.45	8.58
Environmental indicators					
landuse change	0.69	0.91	0.69	0.45	0.88
chemical change	2.49	2.45	2.08	2.91	2.13
water problem	3.14	2.99	3.15	3.09	3.13
chem	64.09	62.64	333.75	356.36	66.41
organic	214.97	30.23	128.57	0.00	334.98
pesticide	1.00	0.46	2.79	2.50	1.08
herbicide	1.02	0.70	0.60	3.13	0.28

As we aimed to test relationship between agricultural system and indicators of sustainability, we added two dummy variables. One dummy reflects perennial cultivation, TREE (TREE = 1 if adopting perennial tree as major crop, TREE = 0 if not), the other reflects greenhouse vegetable cultivation, GS (GS = 1 if adopting greenhouse vegetable cultivation, GS = 0 if not). We observed how these two variables affect sustainability indicators. In this estimation, the seed production which indicates TREE = 0 and GS = 0 became our base case for comparison purpose.

We select four endogenous variables as economic indicators which are net income per rai, total income, income diversification index and happiness in terms of household finance.

The chosen social indicators are dependency rate, debt, formal_debt, informal_debt, food secur and hap_overall. The indicators representing environmental sustainability are landuse_change, chem_change, water_problem, chem, organic, pest and herb.

The above endogenous variables are regressed against a number of exogenous variables which are age, generation, education, agri_labour, area, highland, land_right, irrigation, year, area_major, land_diverse, tree, GS, high_end, quantity_agree, price_agree, knowledge, market and involvement[1].

Table 3: Regression results showing relationship between agricultural system and economic indicators

	NET_INC		TOTAL_INC		SID		HAP_FINANCE	
AGE					-0.01	***	0.04	*
GENERATION								
EDUCATION	1,098.97	***					0.11	**
AGRI_LABOR								
AREA			2,268.87	***			-0.04	***
HIGHLAND							3.68	***
LAND_RIGHT								
IRRIGATION								
YEAR			2,533.43	*				
AREA_MAJOR			5,976.91	***				
LAND_DIVERSE			-73,226.32	*				
TREE	-45,997.65	***			0.13	*	1.19	**
GS	-29,515.43	***	-85,609.05	***	0.25	***		
HIGH_END								
QUANTITY_AGREE			-42,107.11	*				
PRICE_AGREE	-15,438.98	***	-73,413.49	***				
KNOWLEDGE	6,701.66	*					1.30	***
MARKET								
INVOLVEMENT	11,640.83	***	69,008.68	***				
C	51,517.11	***	143,797.70	***	0.73	***	-0.61	
Observations	146		146		146		146	
Adjusted R-squared	0.39		0.49		0.11		0.17	
Prob(F-statistic)	0.00		0.00		0.00		0.00	

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[1]Refer to complete meaning of these variables in table 2.

Table 4: Regression results showing relationship between agricultural system and social indicators

	Dependency	DEBT	FORMAL_ DEBT	INFORMAL_ DEBT	FOOD SECUR	HAP_ OVERALL
AGE	0.01 *				0.00 ***	
GENERATION						
EDUCATION	0.02 ***					
AGRI_LABOR					0.01 *	0.12 *
AREA						
HIGHLAND						
LAND_RIGHT			0.24 *		-0.05 *	
IRRIGATION	0.14 *	7,935.07 **				
YEAR				-0.01 **		
AREA_MAJOR						
LAND_DIVERSE					0.07 ***	
TREE	-0.35 ***	-17,304.59 ***		-0.60 **		0.78 **
GS	-0.63 ***	-19,763.51 ***	0.44 ***	-0.55 ***		0.91 **
HIGH_END						
QUANTITY_ AGREE	0.25 ***					
PRICE_AGREE	-0.31 ***	-8,591.98 **				0.39 *
KNOWLEDGE						0.96 ***
MARKET	0.14 *			0.10 *		-0.51 **
INVOLVEMENT				-0.20 ***		
C	0.20	29,293.28 ***	-0.12	0.74 ***	-0.06	6.53 ***
Observations	146	146	146	146	146	146
Adjusted R-squared	0.25	0.08	0.18	0.36	0.12	0.16
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

Table 5: Regression results showing relationship between agricultural system and economic indicators

	LANDUSE_ CHANGE	CHEM_ CHANGE	WATER_ PROBLEM	CHEM	ORGANIC	PEST	HERB
AGE							
GENERATION							
EDUCATION			-0.02 **		12.79 ***		
AGRI_LABOR							
AREA					-4.05 **	0.02 **	
HIGHLAND							
LAND_RIGHT			0.32 ***		137.24 ***		
IRRIGATION	0.16 *			71.49 ***			0.97 ***
YEAR							
AREA_MAJOR		0.02 ***			5.65 **		
LAND_DIVERSE					129.21 **	1.55 ***	
TREE				-267.12 ***		-1.66 ***	
GS				-260.06 ***	243.26 ***		-1.16 **
HIGH_END	0.29 **				76.84 ***		
QUANTITY_ AGREE		0.70 ***			-86.92 ***	-0.62 **	
PRICE_AGREE		-0.32 *		-95.30 ***			-0.77 ***
KNOWLEDGE							
MARKET				54.80 **			
INVOLVEMENT		-0.60 ***					
C	0.65 ***	2.54 ***	3.12 ***	340.32 ***	-17.33	1.38 ***	1.12 ***
Observations	146	146	146	146	146	146	146
Adjusted R-squared	0.04	0.18	0.09	0.40	0.38	0.21	0.09
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.00	0.00	0.01

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

The regression results as shown in table 3, 4 and 5 and previous statistical analysis, we found that:

1. Growers of perennial tree receive lowest net income per rai compared to other crops (46,000 bahts lower than the case of seed production and 16,000 bahts lower than the case of greenhouse vegetable). However, as they have larger area of cultivation, their total incomes do not significantly differ from farmers of other crops. Their income diversifications are better than those producing seed, but not as good as those growing greenhouse vegetables. They have relatively higher level of happiness compared to seed producers but less than greenhouse vegetable growers. The perennial tree growers have lower dependency rate (proportion of loan taken to total production cost) lower than seed producers but higher than vegetable growers. They rely on informal credit least compared to growers of other crops. Cultivation of perennial trees uses less chemical fertilizer and pesticide per rai than seed production (267 kilograms/ rai and 1.66 liter/rai respectively).

2. Farmers of greenhouse vegetable attain moderate level of net income per rai. However, as they cultivate on small plot of land, they have lowest total income. They attain highest level of income diversification (SID index). They have lowest level of dependency rate and debt, partly is because of low variable cost. They have highest overall happiness score. As far as environment is concerned, greenhouse vegetable cultivation uses chemicals and herbicide significantly less than seed production (lower by 260 kg./rai and 1.16 litre/ rai respectively) and uses organic fertilizer 243 kg. more than seed production.
3. Seed producers have highest net income per rai, and moderate level of total income. They have lowest level of income diversification and highest rate of dependency. Their proportion of informal debt is significant higher than growers of other crops. Seed productions have negative impact on environment as it requires heavy use of chemicals and pesticides.

Moreover, we found that farmers with longer years of education tend to have higher level of net income per rai. Higher degree of land diversification positively affects total income. Both knowledge supports and farmers participation have positive impact on net income per rai. Interestingly, price guarantee system, or advanced price setting negatively affects net income per rai; farmers are willing to trade off certainty with lower buying price. And this positively affects their overall happiness. Farmers with more diversification of land use tend to fare better in terms of food security, they have lower rice expenditure.

Relationship between agricultural practice and sustainability indicators

Given the common problem of highland agriculture as discussed previously in section… Business model becomes a crucial structure that would help unlock a number of highland limitations. It would shape how farmers tackle problem of low price, no bargaining power and high risks. Evidence from the fields showed that farmers in some area manage to find business model to solve their limitation, and get them out of a pitfall of traditional market and improve their well-being. Yet farmers in many areas have difficulty in establishing an appropriate business model to support their agricultural system. Farmers still face with problem of no bargaining power, and cannot use agricultural system to improve their well-being.

Various business models found in the survey sites allow us to categorize business model into 5 groups: traditional market, contract farming, farmers' aggregation to sell their products, a village enterprise selling high quality products, a village enterprise processing products and a farmer's aggregation to process and produce high quality products

In this part, we study the impact of different business models on sustainability indicators. It is important that the impact comparison must be done for the same agricultural system so that we can make a correct interpretation of the comparison and regression results.

Among 7 sites there are 4 sites where farmers in the village cultivate similar products but choose to engage in different business models. These are:

1. Mango growers in Ban Pa Klang: some sells their products to middlemen who come to area during season (traditional market), some farmers form enterprise to sell high quality mango to exporting company (quality group);
2. Farmers in Ban Mae Charim adopt agricultural system that allow them to cultivate on small plot of land: some farmers form group to grow and sell greenhouse vegetable under support of HRDI, some engage in contract farming with private company to produce seeds;
3. Coffee growers in Ban Maneepruek: some sell cherry coffee to local middlemen or external middlemen (traditional market), some sells to local buyer/processor who puts high importance on quality, environment and give price guarantee two months prior to harvesting (will call "social enterprise" henceforth);
4. Coffee growers in Ban San Charoen: some sell cherry coffee to village enterprise to process, some sells to local buyers/processors. These buyers have their own small farmers' group.

For each group categorized above, we first conduct T-test to check for significant differences. Later on we perform multiple regression analysis to study determinants of sustainability.

Impact of "quality group" and traditional business model on sustainability indicators (using mango case)

When mango growers in Ban Pa Klang were separated into two groups, and t-test was used to check for significant differences, we found that farmers in "quality group" differs from farmers of "traditional market group" in many aspects, for example, farmers of quality group have longer years of formal education, have higher degree of land-use diversification, they sell higher proportion of the product to high quality market, and most of them are informed of the buying price prior to harvesting. More importantly, those in quality group have much higher net income per rai owing to significant higher product price (the buying price of "quality" mango is three times higher than that of the common one sold in traditional market). This makes the total income of the quality group farmer twice as large as that of the traditional market group. Regarding environments, those in quality group engage in more environmental friendly agricultural practice, they generated more positive change in land use pattern, reduced chemical usage compared to the prevailing rate before the quality group was formed. Also, they use less chemical and pesticide compared to farmers under traditional market group.

In estimating the relationship between business model and sustainability, we employ similar steps as explained in previous part (section 5.1). Also, we combine samples of Namdokmai mango growers in Sop Pet with those of Ban Pa Klang in order to increase sample size (to 48 households). We then use dummy variable to extract the village effect. Contrasting to the estimation done in previous section, for this part we used dummy variable to represent different business model. Using characteristics of business model such as high- end, price –

agreed in advance, quantity agreed in advance, farmers' participation is not applicable, because most farmers in the same group are under identical characteristics of business model, implying high possibility of collinearity problem among variables reflecting characteristics of business model.

Thus, in this mango case, we added dummy variables indicating village enterprise of exported mango, EX (EX =1, if farmer is a member of the enterprise and EX= 0, if not) and farmers from Ban Sop Pet (V=1, if farmer is from Sop Pet, and V = 0, if not)

Table 6: Regression results showing relationship between business model and economic indicators, the case of Namdokmai mangofarmers in Ban Sop Pet and Ban Pa Klang

	NET_INC	TOTAL_INC	SID	HAP_FINANCE
AGE			-0.01 *	
GENERATION	3,493.45 *		-0.18 ***	
EDUCATION		10,266.74 ***		
AGRI_LABOR				
HIGHLAND				
LAND_RIGHT				
IRRIGATION				
YEAR		4,778.94 **		
AREA_MAJOR	-405.15 ***	7,895.02 ***		0.09 *
LAND_DIVERSE			-0.50 *	
V1				
EX	11,600.06 **			
C	9,539.71 **	12,782.85	1.60 ***	4.31 ***
Observations	48	48	48	48
Adjusted R-squared	0.33	0.41	2SLS	0.05
Prob(F-statistic)	0.00	0.00	0.01	0.07

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

Empirical evidence suggests that farmers in quality group has higher income per rai compared to those engage in traditional market (11,600 bahts higher), but they have similar level of total income, as those engage in traditional market cultivate on larger area, and have supplementary occupation. Regarding social indicators, there is no significant difference between the exported group and the traditional market. In terms of environmental sustainability, farmers in the enterprise significantly reduced their chemical usage and herbicide, increase use of organic fertilizer.

In addition, compared to Ban Sop Pet, farmers in Ban Pa Klang have a better change in pattern of land-use, lower chemical usage but experience more problem of water shortage.

Table 7: Regression results showing relationship between business model and environment indicators, the case of Namdokmai mangofarmers in Ban Sop Pet and Ban Pa Klang

	LANDUSE_ CHANGE	CHEM_ CHANGE	WATER_ PROBLEM	CHEM	ORGANIC	PEST [a]	HERB
AGE							
GENERATION				-24.19 *		-0.24	0.45 **
EDUCATION				-5.01 **	9.52 ***	-0.02	
AGRI_LABOR					21.66 *	0.08	-0.56 ***
HIGHLAND						0.29	
LAND_RIGHT			0.37 *			0.30	-0.77 **
IRRIGATION						0.96	
YEAR		-0.02 *				-0.01	-0.04 **
AREA_MAJOR					-4.00 *	-0.01	-0.08 ***
LAND_DIVERSE	-0.71 ***				210.44 ***	-0.24	
V1	-0.57 ***	0.81 ***	-0.16 *	125.69 ***		-0.25	1.46 ***
EX		-0.66 **			74.83 *	-0.08	-0.88 **
C	1.42 ***	2.47 ***	3.10 ***	124.12 ***	-12.83	1.90	2.80 ***
Observations	48	48	48	48	48	48	48
Adjusted R-squared	0.19	0.62	0.15	0.45	0.47	-0.24	0.50
Prob(F-statistic)	0.00	0.00	0.01	0.00	0.00	0.93	0.00

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a]indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable

Impact of "contract farming" and "farmers' group to sell products" on sustainability indicators

As we divide farmers in Ban Mae Charim into group of contract farmers for seed production and greenhouse vegetable growers, we used T-test to check for significant difference between the two groups. We found that, although both groups adopt model of cultivation on a small plot of land, they are significantly different in many aspects.

Farmers in greenhouse vegetable groups perform better in terms of land diversification and proportion of perennial tree to total cultivation land. Their products are of better quality compared to products available in common market and farmers have significantly higher degree of participation in the business and better income diversification level compared to seed producers group.

Seed producers achieve higher income per rai, but not significantly differ in terms of total income, since growers have greenhouse vegetable have other supplementary crops. Seed producers also have higher degree of dependency and proportion of informal debt. In terms of environment, greenhouse vegetable growers have better pattern of land use, and significantly lower chemical usage.

In the estimation stage, we combine samples of greenhouse vegetable growers from Ban Pong Kham and Ban Mae Charim as they are under similar agricultural practice (achieved

sample size of 35). We then introduce two dummy variables indicating greenhouse vegetable group, GS (GS=1, if farmer is a member of the greenhouse vegetable group and GS = 0, if farmer is a seed producer) and village dummy, V3 (V3=1, if farmer is from Ban Mae Charim and V3 = 0, if farmer is from other village).

Table 8: Regression results showing relationship between business model and economic indicators, the case of contract farming and greenhouse vegetable in Ban Mae Charim and Pong Kham

	NET_INC	TOTAL_INC [a]	SID	HAP_FINANCE
GENERATION		5,277.60		
EDUCATION	1,963.62 **	2,622.85	0.02 **	0.25 **
AGRI_LABOR		-9,913.26		
AREA		894.06		
HIGHLAND	36,037.44 **	40,387.51		3.38 *
LAND_RIGHT		15,591.81		
IRRIGATION		6,241.92		
YEAR		-1,481.37		
AREA_MAJOR		-4,938.39		
LAND_DIVERSE		25,283.68		
GS	-32,582.20 ***	-58,911.43	0.24 ***	
V3		-40,259.24		-3.00 ***
C	15,669.48	82,650.09	0.35 ***	2.14
Observations	35	35	35	35
Adjusted R-squared	0.39	-0.14	0.23	0.26
Prob(F-statistic)	0.00	0.77	0.01	0.01

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a]indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable

Farmers of greenhouse vegetable in Ban Mae Charim and Pong Kham formed village group to sell product to end customers with supports from HRDI. Even though their income per rai is significantly less than that of seed producers under contract farming, their total income do not differ. They have high degree of income diversification. As far as social indicators are concerned, the group of greenhouse vegetable farmers fare better than the seed producers in many ways, they have lower dependency rate, lower amount of loan taken for cultivation, lower informal debt and higher score of happiness. Moreover, they perform better in the aspect of environment; they significantly use less chemical and more of organic fertilizers and substances.

Table 9: Regression results showing relationship between business model and social indicators, the case of contract farming and greenhouse vegetable in Ban Mae Charim and Pong Kham

	Dependency	DEBT	FORMAL_ DEBT	INFORMAL_ DEBT	FOODSECUR [a]	HAP_ OVERALL
GENERATION					0.00	
EDUCATION					0.00	
AGRI_LABOR	-0.18 ***				0.00	
AREA		584.66 **			0.00	
HIGHLAND			1.14 *	0.65 **	0.02	
LAND_RIGHT					0.01	
IRRIGATION					-0.04	
YEAR			0.11 ***		0.00	
AREA_MAJOR					0.00	
LAND_DIVERSE			-5.06 **		0.11	
GS	-0.72 ***	-22,420.22 ***		-0.83 ***	0.00	1.13 *
V3					-0.02	
C	1.27 ***	11,495.12	0.47	0.31	0.03	7.45 ***
Observations	35	35	35	35	35	35
Adjusted R-squared	0.47	0.30	0.38	0.31	-0.16	0.07
Prob(F-statistic)	0.00	0.00	0.00	0.00	0.82	0.07

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a]indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable

Table 10: Regression results showing relationship between business model and environment indicators, the case of contract farming and greenhouse vegetable in Ban Mae Charim and Pong Kham

	LANDUSE_ CHANGE [a]	CHEM_ CHANGE	WATER_ PROBLEM	CHEM	ORGANIC	PEST	HERB
GENERATION	0.12	-0.38 *		52.32 *			
EDUCATION	-0.01				21.31 *		
AGRI_LABOR	-0.03		0.38 **				
AREA	-0.01						
HIGHLAND	-0.06						
LAND_RIGHT	-0.39		0.47 **		131.36 *		
IRRIGATION	-0.11						
YEAR	-0.01		-0.04 **				0.10 *
AREA_MAJOR	-0.03	-0.56 **	0.29 **		94.75 **		
LAND_DIVERSE	-0.38	5.84 **					
GS	0.60			-200.56 **	750.84 ***		
V3	0.35			112.70 ***	423.76 ***	2.80 ***	2.53 ***
C	0.69	2.86 ***	1.83 ***	72.45	-792.43 ***	0.26	-0.45
Observations	35	35	35	35	35	35	35
Adjusted R-squared	-0.06	0.21	0.23	0.51	0.69	0.39	0.52
Prob(F-statistic)	0.62	0.01	0.02	0.00	0.00	0.00	0.00

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a] indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable

Impact of "social enterprise" and "traditional market" on sustainability indicators (the coffee case- Ban Maneepruek)

Most coffee growers in Ban Maneepruek sell their cherry coffee to local buyer/processor that put emphasis on product quality and environment (informal social enterprise). Some growers still sell to local middlemen (traditional market). T-test comparison showed that although these two groups do not differ much in their agricultural practice, coffee growers who sell product to this informal social enterprise (call social enterprise group, henceforth) care more about quality of the products. The price and quantity were agreed in advance. The social entrepreneur gives supports in terms of knowledge, technical and factor of production to farmers, and bought cherry coffee at higher price.

In social aspect, farmers in the traditional market system have higher proportion of debt to income, and higher ratio of informal debt. The farmers who belong to social enterprise group used significantly less chemicals and herbicide compared to the other group.

When estimating the relationship between the business model and sustainability indicators, we added two dummy variables: one is to indicate farmer who sell products to the informal social enterprise, SE (SE = 1 for those who sell product to SE, and SE = 0 for those who sell products to other traditional buyers); another one is to indicate sub-village, V2(v2= 1 for farmer who lives in sub-village (Moo) 1 and v2 = 0 for farmer who lives in sub-village 2 and 3.

We found that farmers who sell their product to social entrepreneur have higher income per rai (4,000 bahts higher) than the traditional market group due to higher purchase price. Also farmers from sub-village 1 have higher net income per rai, total income and better income diversification compared to farmers from other sub-village, as they are more focused on coffee cultivation. The two groups do not differ much in terms of impact on social indicators. Nonetheless, no farmers in this area borrow money to invest in coffee cultivation, production cost were financed by their own savings. As far as environment is concerned, farmers in the social enterprise group used less chemicals and herbicide and more organic substances than the traditional market group.

Table 11: Regression results showing relationship between business model and economic indicators, the case of coffee in Ban Maneepruek

	NET_INC	TOTAL_INC	SID	HAP_FINANCE [a]
GENERATION			-0.04	-0.52
EDUCATION	167.99 *		-0.01	0.06
AGRI_LABOR			-0.01	0.68
LAND_RIGHT			-1.39 *	-8.58
IRRIGATION			0.13	-0.17
YEAR			-0.03	-0.37
AREA_MAJOR			-0.02	-0.28
LAND_DIVERSE			1.25	12.39
SE	4,069.09 **		-0.01	-0.53
V2	3,170.05 *	134,244.70 *	0.39 *	1.18
C	380.16	98,702.27 ***	0.54	5.21
Observations	26	26	26	26
Adjusted R-squared	0.35	0.21	-0.14	0.13
Prob(F-statistic)	0.01	0.01	0.72	0.27

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a]indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable

Table 12: Regression results showing relationship between business model and environment indicators, the case of coffee in Ban Maneepruek

	LANDUSE_ CHANGE [a]	CHEM_ CHANGE	WATER_ PROBLEM [a]	CHEM	ORGANIC	PEST[a]	HERB
GENERATION	-0.08	-0.39 ***	0.11		-15.42 *	-0.05	
EDUCATION	0.01		-0.02		4.28 **	0.00	-0.05 ***
AGRI_LABOR	0.04		-0.12			-0.04	
LAND_RIGHT	-0.64		2.10			-0.55	
IRRIGATION	0.10		0.41			0.10	
YEAR	0.00		0.02	1.34 ***	-4.77 *	-0.01	
AREA_MAJOR	-0.03	-0.32 ***	0.08			0.02	
LAND_DIVERSE	0.87	-2.24 **	-3.21			0.38	
SE	-0.08		0.17	-31.33 ***	40.21 *	-0.36	-0.61 ***
V2	0.18	2.01 ***	-0.30		75.15 ***	-0.18	
C	0.67	4.01 ***	3.68 ***	50.19 ***	45.64	0.51	0.94
Observations	26	26	26	26	26	26	26
Adjusted R-squared	-0.08	0.50	-0.07	0.90	0.40	-0.03	0.35
Prob(F-statistic)	0.62	0.00	0.61	0.00	0.01	0.54	0.00

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a]indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable.

Impact of "small processing group" and "village enterprise" on sustainability indicators (the coffee case – Ban San Charoen)

About 50% of total cherry coffee production of the village is sold to village processing enterprise. While majority of farmers are members of the processing enterprise, there are also 7 small groups of farmers. Local buyer/processor is a leading agent of each group.

When comparison was made between members of village enterprise group and members of small processing groups, the T-statistics showed that members of village enterprise were mostly informed in advance about the purchase price; farmers have higher degree of participation in the business, and score higher on overall business. Both group do not significant differ in terms of income and their income diversification index (SID), this is primary because there were competitions among groups, farmers received relatively the same purchasing price, regardless of which group they belong to.

When estimating the relationship between business model and sustainability indicators, we added dummy variables to indicate farmer who sells to village enterprise, CE (CE = 1 if farmer sells product to village processing enterprise, CE = 0 if farmers sell products to other small processing groups)

We found that village enterprise farmers and the smaller group farmers do not differ in terms of net income per rai, total income, and income diversification. In terms of social indicators, it was shown that farmers of the village enterprise group have significantly higher score of happiness. The two groups do not perform significantly different in the aspect of environment, only that the village enterprise group used more organic fertilizer.

Table 13: Regression results showing relationship between business model and economic indicators, the case of village processing enterprise and small processing groups in Ban San Charoen

	NET_INC [a]	TOTAL_INC	SID	HAP_FINANCE
GENERATION	-75.82			
EDUCATION	-107.27			
AGRI_LABOR	-103.42			
HIGHLAND	12,248.21	278,771.80 *	0.25 *	
IRRIGATION	-3,640.51	-193,005.80 **	0.08 *	
YEAR	177.74			0.09 **
AREA_MAJOR	-174.31	9,739.02 ***		
LAND_DIVERSE	-14,920.17	-337,122.40 **		
CE	-2,419.40			
C	13,656.40	187,178.00		3.49 ***
Observations	24	24	24	24
Adjusted R-squared	-0.16	0.56	0.39	0.16
Prob(F-statistic)	0.73	0.00	0.00	0.03

*, **, *** indicate statistical significant atlevel 0.1, 0.05, and 0.01 respectively.

[a]indicates that the estimated equation has no statistical significance, that is the regression cannot explain endogenous variable.

In sum, results from statistical, econometrical analysis, and in –depth interview point to the same direction that : 1) although contract farming makes market more reliable for farmers, but farmers still have low bargaining power. On its own, the model does not have mechanism that can strengthen farmers or community, nor can it take good care of

environment. 2) A model of farmers' aggregation to sell product and open up market helps strengthen farmers and community but farmers may still have low bargaining power and face with high price volatility. It does not have a direct mechanism to care for environment either. 3) Farmers' aggregation to lift product quality helps add value to the product, it reduces price volatility as products have fewer substitutes and become more special. Also increase in product quality that comes from improvement in production process usually leads to better treatment to environment. 4) farmers 'aggregation to process products has important role in adding value to the product, reduce market risks as there are more channel to sell products. If processing can be done locally, it helps reduce farmers' pressure to sell.

Principles for Highland Business Model

The above empirical results showed that different agricultural system and business models generate diverse effects on sustainability indicators. Each agricultural system and business model has its own strong point and weakness. Some may significantly lift farmers' income, reduce market risk, provide higher certainty, but has no regards on environment. Some agricultural system is already good at diversifying risk, and need to find supporting business model that would help secure higher income/rai. Appropriate business model must help establish well-being sustainability and environmental sustainability. To have these two aspects of sustainability, we propose that business model must have elements to uphold the 4 following principles:

1) Generate high income/rai, to ensure that farmers can live on small scale farming, and have no incentive to deforest to expand cultivation land.

2) Reduce risk, to ensure flexibility when there is unexpected and unfortunate situation.

3) Enhance farmer/ community capacity, to increase capacity of farmer's group formation. Farmers' aggregation is a basic requirement to secure higher income/ reduce risk and be supportive to environment.

4) Set explicit condition concerning environmental responsibility, this is vital for highland agricultural business model. As shown by empirical evidence, environmental responsibility is not likely to be automatic for profit-seeking business unless it is already directed by the end market.

We proposed several methods as evident from the survey sites, and established in other areas in the north of Thailand that could help agricultural business found the 4 principles. Provision of access to water supply, technology for cost reduction/low-cost crop, farmers' aggregation, product processing, increase quality of product all help secure higher income for small cultivation area. Adopting integrating farming, targeting more than one market, and contract farming are means to reduce risk. Capacity building through knowledge sharing and training is needed for strengthen farmers' skill, hence enhance the opportunity for farmers' aggregation. Using condition set by end- market, business itself or community such as

certification, village rule/regulation, and land-use allocation as means to make certain that environment is also taken care of.

Each method performs different role in establishing sustainability, some method is good at securing high income per rai but cannot be used to reduce risk, or care for environment. The important message here is that appropriate combination of methods is needed get farmers out of traditional market trap, and alleviate some aspect of highland limitations. The chosen combination should fit with product of their agricultural practice, particular socioeconomics context and desire of community.

Conclusion and Policy Recommendation

Finding solution to the deforestation problem in the north of Thailand which arose from rapid expansion of cash crops such as maize, potatoes and ginger, one cannot overlook the importance of business model to support adoption of alternative crops that are more environmental friendly.The appropriate business model must be able to link agricultural product to end market effectively, address highland limitations, and bring about sustainability in all economic, social and environment aspects.

The research paper studied various agricultural business models in highland of Nan, to understand the strength and weakness of each model, and more importantly, to understand the relationship between certain characteristics of the business model and sustainability indicators. Only with these understandings can we propose the principles for highland agricultural business. This is what we contribute to existing literature

Data from 146 household surveys conducting in 7villages and in-depth interview allow us to understand the unique problem of highland agriculture and to perform statistical and multiple regression analysis in order to compare impacts of different business model on sustainability. We showed that different agricultural systems and business models affect economic, social and environment indicators differently. Although contract farming reduces price risk, it could make significant negative impact on social and environment. Farmers' group may help open up market opportunity and lower production cost, but farmers may still suffer from low bargaining power; and high variation in price. Targeting high end market which demands high quality products may add value to final product and ensure better treatment on environment, but farmers need to be able to establish internal quality guarantee system so as to retain bigger share from high product price. Product processing may allow farmers to diversify some market risk as they create extra market channels, but they have no direct linkage to protect environment.

We propose "four essential principles" that need to be embedded in highland agricultural business. The business should find means to: 1) give high returns per unit area 2) reduce risk 3) strengthen farmers and community and 4) set conditions explicitly to improve environment. We offer various means that business and farmers may choose to adopt so as to

comply with the principles. Right combination of methods is needed to unlock some important highland limitationsand get farmers out of the pitfall of traditional market.

Cultivation on highland concerns activities on area with high environmental value, ecologically fragile and sensitive in institutional sense. Development of appropriate agricultural business is a key device to restore forest in area that is prone to market failures. Government policy regarding highland needs to take into account this fact and should be able to prevent inappropriate business decisions.

A number of policy implications can be drawn from the study. Government should have 1) development roadmap or policy for highland/area under forest lawset apart from those of flatland/land with private ownership; 2) should make use/or amend laws governing agricultural business to prevent inappropriate business model from operating on highland such as law on contract farming;3) should set clear direction and condition for agricultural investment on highland. Certain type of investment which may exert adverse effect on highland sustainability should be stated explicitly.

Reference

Amador, J. F. and Vera-Cruz, A. O. 2013."Agricultural business models: a Mexican case", Paper presented at ALTEC 2013, XV Ibero-American Conference on Management of Technology.

Asian Productivity Organization (APO). 2004. "Sustainable Farming Systems in Upland Areas", *Report of the APO Study Meeting on Sustainable Farming Systems in Upland Areas held in New Delhi, India, 15–19 January 2001*, edited by Partab, T., APO, Tokyo, ISBN: 92-833-7031-7.

Bosshaq, M.R.; Afzalinia, F. and Moradi, H. 2012."Measuring indicators and determining factors affecting sustainable agricultural development in rural areas: a case study of Ravansar, Iran", *International Journal of AgriScience*, 2(6), 550-557.

Campbell, R.; Knowles, T. and Sayasenh, A. 2012, "Business Models for Foreign Investment in Agriculture in Laos", TKN Report, IISD, Manitoba.

FAO. 2012. "Trends and impacts of foreign investment in developing country agriculture: evidence from case studies", Rome.

FAO. 2013. "Trends and impacts of foreign investment in developing country agriculture: evidence from case studies", Rome.

Food and Fertilizer Technology Center (FFTC). 1997. "Sustainable Agriculture in Upland Areas", *Report of the FFTC International Seminar held in Tokyo and Takamatsu, Japan, 27 October-2 November 1997*, Taipei, Taiwan.

Fujisaka, S. 1994. "Learning from six reasons why farmers do not adopt innovations intended to improve sustainability of upland agriculture", *Agricultural Systems*, 46(4), 409-425.

Hallam, D. 2009. "Foreign investment in developing country agriculture-issues, policy implications and international response", OECD Global Forum 8 on International Investment, 7-8 December, 2009, OECD.

Hayati, D., Ranjbar, Z. and Karami E. 2010. "Measuring Agricultural Sustainability", In Lichtfouse, E. (ed.), *Biodiversity,Biofuels, Agroforestry and Conservation Agriculture* (pp. 73-100), Amsterdam: Springer.

Liu, P. 2014. "Impacts of foreign agricultural investment on developing countries: evidence from case studies", FAO commodity and trade policy research working paper No. 4, FAO, Rome.

López, S. B. and Almeida, J. 2003. "Methodology for comparative analysis of sustainability in agroforestry systems", *Revista de Economia e Sociologia Rural*, 41, 183-208.

Manorom, K.; Hall, D.; Lu, X. Katima, S.; Medialdia, M. T.; Siharath, S. and Srisuphan, P. 2011. "Cross-Border Contract Farming Arrangement: Variations and Implications in the Lao People's Democratic Republic", Greater Mekong Subregion-Phnom Penh Plan for Development Management Research Report Series, Vol.1 (2).

Mueller, S. 1997. "Evaluating the sustainability of agriculture: The case of the Reventado River Watershed in Costa Rica", European University Studies, Series 5, Economics and management Peter Lang GmbH, Germany.

Partap, T. 2004. "Farming on Sloping Uplands of Asia: Sustainability Perspectives and Issues" a chapter in *Sustainable Farming Systems in Upland Areas*, edited by Partap, T., APO, 2004, Tokyo.

Pham, L. V. and Smith, C. 2013."Agricultural sustainability in developing countries: an assessment of the relationships between drivers and indicators in HaoBinh province, Vietnam", *Agroecology and Sustainable Food Systems*, 37(10), 1144-1186, DOI 10.1080/21683565.2013.833153.

Pokhriyal H.C. and Bist N.S., 1988."Planning for Agricultural Development in the Himalayan Region: An Environmental Approach", *The Environmentalist*, 8(1), 47-56.

Potchanasin, C. 2008. "Simulation of the Sustainability of Farming Systems in Northern Thailand", Dissertation, University of Hohenheim, Stuttgart.

Poulton, C.; Tyler, G.; Hazell, P.; Dorward, A.; Kydd, J. and Stockbridge, M. 2008."Commercial agriculture in Africa: lessons from success and failure", Background paper for the Competitive Commercial Agriculture on Subsaharan Africa (CCAA) Study, World Bank, FAO.

Praneetvatakul, S.; Janekarnkij, P.; Potchanasin, C. and Prayoonwong, K. 2001."Assessing the sustainability of agriculture: a case of Mae Chaem catchment, northern Thailand", *Environment International*, 27, 103-109.

Rasul, G and Thapa, G. B. 2004. "Sustainability of ecological and conventional agricultural systems in Bangladesh: an assessment based on environmental, economic and social perspectives", *Agricultural Systems*, 79, 327-351.

Tambunan, T, 2014. "Identifying business models adopted by FDI in agriculture in Indonesia", *Journal of Economics and Development Studies*, 2(1), 99-130.

Tambunan, T. 2012, "A survey of business models for agricultural investment in Indonesia", TKN Report, IISD, Manitoba.

Thapa, G. and Gaiha R. 2011. "Smallholder Farming in Asia and the Pacific: Challenges and Opportunities", Paper presented at the IFAD Conference on New Directions for Smallholder Agriculture 24-25 January, 2011, IFAD, Rome.

Vermeulen, S. and Cotula, L. 2010."Making the most of agricultural investment: A survey of business models that provide opportunities for smallholders", IIED/FAO/IFAD/SDC, London/Rome/Bern. ISBN: 978-1-84369-774-9.

Zhen, L. and Routray, J. K. 2003."Operational Indicators for Measuring Agricultural Sustainability in Developing Countries", *Environmental Management*, 32(1), 34-46.

Appendix

Appendix 1A: Variables and their meaning,

variable	explanation	unit	meaning
Characteristic farmers and their land holdings and land-use			
age	age	year	-
generation	number of generation resided in the area	number	-
education	years of formal education	year	-
agri_labor	Household agricultural labour force	person	-
area	Total cultivation area	rai	-
highland	% of highland out of total cultivation area	-	Ranging from 1-0
land_right	Land ownership	-	0- has no official land certificate 1–has legal ownership such as title deeds including sor- por- kor[1]
irrigation	Access to public water supply/storage (e.g. irrigation, reservoir)	-	0no access to public water supply 1has access to public water supply
ลักษณะเกษตรกรรม			
year	year of major crop cultivation	Year	
area_major	Area used for major crop cultivation	Rai	
mixed	Number of crop grown	-	0 only one crop grown 1more than one crop grown
agri_income	Proportion of agricultural income to total income	-	Ranges from 0 to 1
land_diverse	Diversification of land used	-	Using formula $\frac{\sum_i(\text{area used for crop } i/\text{total agricultural area})}{\text{total number of crops grown}}$ Index ranges from 0 to 1 0-high diversity 1- No diversity, only one crop grown over entire area
tree	Perennial crop grown	-	0- major crop is not perennial tree 1major crop is perennial tree
gs	Greenhouse crop grown	-	0major crop is not greenhouse vegetable 1 major crop is greenhouse vegetable
Characteristics of business model			
high_end	Product quality	-	0aim for traditional market, no quality requirement 1 high quality market such as market that requires GAP certification
quantity_agree	Quantity purchase agreed prior to actual purchasing date	-	0no quantity purchase set in advance 1amount of purchase is set in advance, or previously agree to purchase all.

[1]Sor- Por-.Kor.document is not a land title deed. It refers to land allotted by the Land Reform Committee with the strict provision of agricultural or forestry usage for certain persons (such as farmers).

variable	explanation	unit	meaning
price_agree	Price agreed prior to actual purchasing date	-	0no price setting in advance 1 purchase price agreed in advance, used guarantee price or farmers are informed of price range
knowledge	Give technology support to farmers	-	0 business model gives no support 1business model gives supports
market	Give market and price negotiation support	-	0business model gives no support 1business model gives support
financial	Give financial support or benefit such as reduction in cost of factor of production , transportation cost, provide dividend	-	0business model gives no support 1business model gives support
involvement	Farmer's participation in making business decision (e.g. high degree of group communication, group meeting to communicate news and knowledge and make decision, internal quality assurance	-	0business model does not require farmers' participation 1business model requires farmers' participation
Economic indicators			
net_inc_major	Net income per rai of major crop	Baht/ rai	
total_inc	Total income	Baht	Total income (both agricultural and non-agricultural income)
Inc_diverse	Annual income diversification	-	Use formula $1-\sum_i\left(\frac{\text{income in month } i}{\text{total income}}\right)^2$ Ranges from 1-0 0 income received only once a year 1income received regularly (every month) throughout the year
hap_finance	Happiness rate in terms of household finance	scores	Ranges from10-0 0no satisfaction 10highest satisfaction
Social indicator			
dependency	Proportion of loan taken to total production cost of major crop	-	Ranges from 1-0
debt	Amount of loan taken to grown major crop	baht	-
debt_ratio	Proportion of short-term debt to total income	-	-
formal_debt	Proportion of formal debt to total income	-	-
Informal_debt	Proportion of informal debts to total income	-	-
food_secur	Proportion of expenditure on rice to total income	-	0 self –subsistence, farmers do not need to buy rice
resilience	Response to shock that heavily affects income from major crop	-	0change to grow other crops or change occupation 1 stay with this crop
hap_overall	Overall happiness score	score	Ranges from10-0 0no satisfaction 10highest satisfaction
Environmental indicator			
landuse_change	Change in pattern of land-use (e.g. change from forest to field crop, change from field crop to perennial tree)	score	Translate to three score levels -1 a negative change 0no change 1a positive change
chemical_change	Change in chemical usage	score	Translate to five score- level 1drastically decrease in usage 2decrease in usage 3no change 4increase in usage 5drastically increase in usage
water_problem	Shortage of water for agricultural use	score	Translate to five score- level 1problems drastically decrease 2problems decrease 3no change 4problems increase 5problems drastically increase
chem	Amount of chemical fertilizer used on major crop	kilogram	-
organic	Amount of organic fertilizer used on major crop	kilogram	-

variable	explanation	unit	meaning
pesticide	Amount of pesticide used on major crop	litre	-
herbicide	Amount of herbicide used on major crop	litre	-

Appendix 2A: Characteristics of samples of each village, their land used and agricultural practice

		Village (Ban)						
	Total	**Sop Pet**	**Pa Klang**	**Maneepruek**	**San Charoen**	**ThamWiangKae**	**Mae Charim**	**Pong Kham**
Sample size(households)	146	26	22	26	24	13	19	16
Proportion of sample to population*)percentage(	-	24	18	90	29	50	34	33
Major crop in the study		**Mango**		**Coffee**		**Greenhouse vegetable (sweet peppers)**	**Integrated farming)both greenhouse and open-air vegetable) and seed production**	
Farmer and household characteristics								
Age	45.51	45.50	51.05	42.42	39.17	43.15	44.58	55.44
Education	6.56	7.65	6.41	4.42	6.50	7.69	9.05	4.69
agri_labor	2.75	2.81	2.14	3.15	3.50	2.92	2.16	2.25
Characteristics of area								
Area	23.61	28.27	10.41	13.55	31.28	27.40	34.04	23.53
Highland	0.82	0.92	0.50	0.93	0.89	0.92	0.73	0.80
land_right	0.30	0.19	0.55	0.08	-	0.08	0.68	0.69
Irrigation	0.53	0.12	0.05	0.42	0.83	0.77	0.89	1.00
Agricultural practice								
Year	10.26	16.85	15.64	4.69	14.88	3.62	5.49	5.38
Mixed	0.85	0.85	0.36	1.00	0.88	0.92	1.00	1.00
area_major	7.48	15.37	6.32	2.81	16.69	0.98	1.15	1.32
land_diverse	0.44	0.44	0.79	0.35	0.48	0.41	0.27	0.21
agri_income	0.84	0.90	0.78	0.77	0.88	1.00	0.91	0.70

* Proportion of sample to farmers who grow major crop in each village