Analyzing farm household strategies for food security and climate resilience:

The case of Climate-Smart Villages of Southeast Asia

Working Paper No. 248

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Abstract

This paper develops a conceptual framework with an indicator-based approach to assess Climate-Smart Villages (CSVs) and applies it to case study sites in Lao PDR (Ekxang CSV), Cambodia (Rohal Suong CSV), and Vietnam (Tra Hat CSV) in Southeast Asia. The intensification, extensification, diversification, commercialization, alteration of practices, use of common lands, migration strategies that can augment climate resilience, farm income, assets, and food security are assessed based on a composite index of the strategies and key outcome variables. The study demonstrates a method that can be applied widely for assessing climate-smart agriculture strategies and finding possible entry points for climate-smart interventions. The influence of gender in resource control and livelihood strategies is also discussed. It is also evident that the climate-smart interventions can augment different livelihood strategies of farmers and enhance the developmental and climate resilience outcomes. There is a need to prioritize the possible interventions in each case and implement them with the help of donor agencies, local institutions, and government offices.

Keywords

Climate-smart village; resilience; livelihood strategy; food security; indicators

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Conflict of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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Acronyms

CSV	Climate-Smart Village
FSI	Food Security Index
HBS	Household Baseline Survey

1. Introduction

Southeast Asia is a hotspot of climatic changes as the region faces precipitation changes, rising temperature, and extreme climatic events such as flood and drought (Reed et al. 2017). These climatic changes pose significant challenges to the wellbeing and food security of millions of smallholder farmers in the region (Thirumalai et al. 2017, Morton 2007, Adger 1999).

One approach to respond to climatic changes is the development of Climate-Smart Villages (CSVs). Starting 2010, the Consultative Group for International Agricultural Research (CGIAR) research program on Climate Change, Agriculture and Food Security (CCAFS) has implemented the CSV approach in 20 countries around the world: 5 West Africa, 4 in East Africa, 3 in South Asia, 4 in Southeast Asia, and 4 in Latin America (Aggarwal et al. 2018). CSVs aim to enhance farmers' income, food security, and resilience to climate change using a portfolio of climate-smart agricultural interventions. These interventions can augment the livelihood strategies of farmers directly or by influencing the natural, social, financial or physical capital (Mutabazi et al. 2015).

In the case of CSV, farmers prioritize interventions (i.e., weather-smart, water-smart, carbon-smart, nutrient-smart, energy-smart, and knowledge-smart) to enhance productivity, food security, incomes, climate resilience, and contribute to climate mitigation. The current paper provides a conceptual framework to assess the CSV approach and apply it to case study sites in Lao PDR (Ekxang), Cambodia (Rohal Suong), and Vietnam (Tra Hat).

1.1 Conceptual Framework

Farm households resort to complex livelihood strategies when faced with climatic changes or extreme events depending on their natural, financial, physical, human, social, and other capitals (Aggarwal et al. 2018). The mix of strategies that each farm household undertakes result in formation of farm household types with specific food security, nutritional security, asset ownership, resilience capacity, and aggregate wellbeing outcomes. The continuous effort of farmer households and communities to evolve into better adapted ones that can be resilient to climatic changes or shocks can be supported by climate-smart agriculture interventions (Figure 1) such as, among others, weather advisories, water saving technologies, improved seeds, resource conserving measures, market interventions, insurance, and institutions.

These interventions can help to remove barriers in undertaking various livelihood strategies that improve the food security, financial security, and wellbeing. They could also improve the natural, human physical, social and financial capitals that can enable them to take better

livelihood strategies. It is to be noted that the control of resources or the level of these capitals can be shaped by gender-specific factors in many communities and hence the livelihood strategies can also be restricted, especially for women. It could also be possible to design interventions that can support women in overcoming the barriers and transition to higher performing farm household types and contribute to the climate smartness of the village/community. Nevertheless, the measures vary based on the CSV site, agro-ecology, level of development, and the capacity and interest of the farmers and of the local government (Thirumalai et al. 2017).

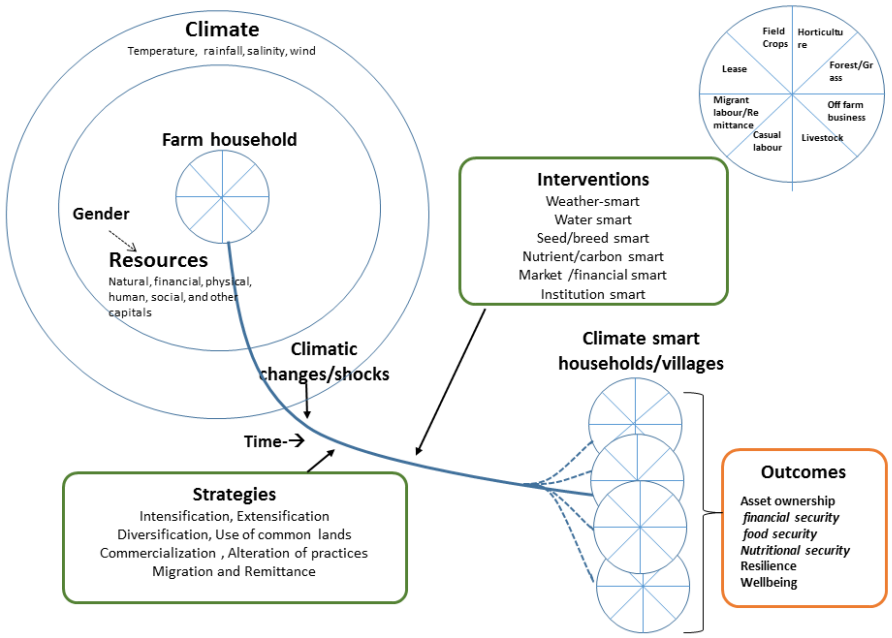


Figure 1. Transition of a farm household within a Climate-Smart Village
Source: Authors and partly adapted from Li et al. 2018

2. Study Area and Methods

This paper describes the climate change challenges, resource constraints, livelihood strategies and current outcomes such as food security and asset ownership in three sites in Southeast Asia: Ekxang in Lao PDR, Rohal Suong in Cambodia and Tra Hat in Vietnam (Figure 2). It also identifies possible climate-smart interventions that could augment various strategies undertaken by farm households to ultimately become CSVs. The main data source for this paper is the Household Baseline Survey (HBS) conducted in the three study sites (Bui et al. 2015, Eam et al. 2015, Truc et al. 2015).

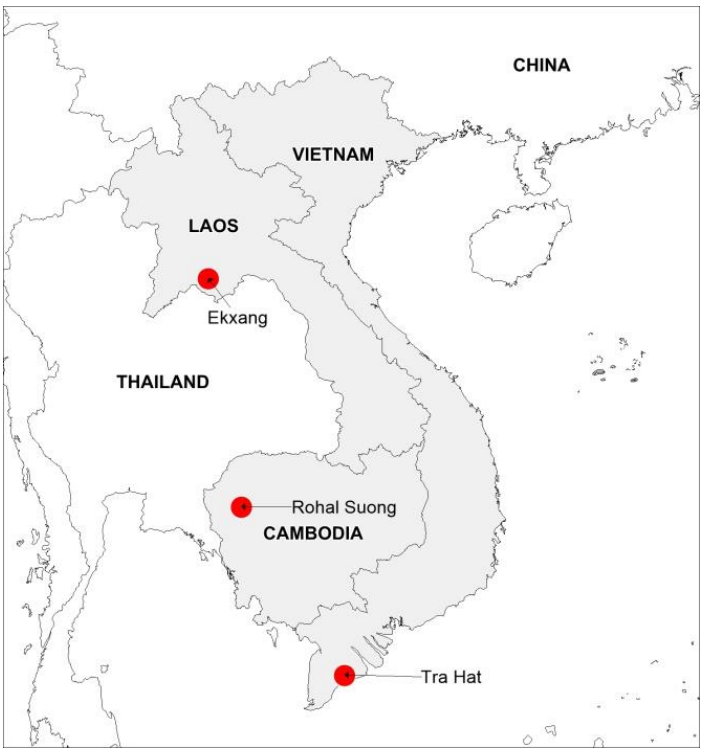


Figure 2. Location of Climate-Smart Villages in Southeast Asia

The HBS followed the prescribed protocol for data collection. The uniform and pilot-tested HBS questionnaire consisted of questions on: climate and weather information, household resources, livelihood strategies, farming systems, soil, land and water management; food security; and assets among others. The questionnaire was translated into the local language. The data enumerators were trained in questionnaire administration conducted from December 2014 to January 2015 in Tra Hat, January 2015 in Rohal Suong, and April to May 2015 in Ekxang. Several meetings with the commune and village authorities were conducted to inform about the purpose, scope, and procedure of the survey.

Each study site had 140 survey participants. The main survey participant was the identified household head or one of the spouses. In Ekxang, 61% of the respondents were males and 39% were females. Similarly, 65% were males and 35% were females in Tra Hat. In contrast, 36% were males and 64% were females in Rohal Suong. The participating households belonged to the three main ethnic groups in Ekxang: Loum (56%), Mong (27%), and Khumu (17%). All households in Rohal Suong belonged to the Khmer group, while in Tra Hat, almost all households (97%) belonged to the Kinh ethnic group and a few belonged to Hoa or Khmer groups (3%). The mean household size was 6 in Ekxang, 5.4 in Rohal Suong and 4.5 in Tra Hat. The percentage having no secondary school education was approximately 8% in Ekxang, 25% in Rohal Suong, and 9% in Tra Hat.

Prolonged dry season and floods that damage crops were common in the three study sites (Table 1). Changes have been observed in Ekxang regarding the onset of the rainy season, the intensity of rainfall, and the onset, level, and duration of floods. Moreover, in Rohal Suong, the prolonged very low temperature was reported to have damaged rice production. Floods occurring in September and October were referred to as "normal flood" because these were no longer considered a problem by the households. However, the floods occurring before September can destroy the rice nearing maturity. Similarly, the floods that occur after October delay the next cropping season in November. In Tra Hat, rising temperature, prolonged dry season, and unpredictable onset of the rainy season were reported. The problem of saline intrusion during the long dry season was minimized with the construction of the dykes.

Table 1. Climate Change Challenges in the selected study sites*

Ekxang	Rohal Suong	Tra Hat
• Prolong dry season, resulting to water shortage and damaged crops • Deepening of water table • Overflow from the river and the natural ponds in rainy season	• Seasonal flood and drought. • Increased Climate variability (onset of rainy season, extreme rainfall events, low temperature) • Changes of regular flooding patterns (levels of water, onset and duration of floods) • Pests and diseases in rice are increasing • Cold temperature damaged rice production and reduced seed production • Stronger winds during the rainy season as a result of less forest to break wind	• Rising temperature • Shortage of water for irrigation in dry season • Prolong hot/dry spell, • Unpredictable rainfall/heavy rain (later rainfall) • Very low underground water during dry season • Salt water could flow further inland, but not common recently. • Saline intrusion during the long dry season when the rivers are low, sea water now moves easily upstream and contaminates the canals the farmers uses for irrigation

*Includes information from the Village Baseline Survey conducted in the CSVs

3. Results

3.1 Livelihood strategies

3.1.1. Intensification

Increasing aggregate production by practicing multiple cropping or increasing resource use can be an offset strategy against declining productivity due to climate change. Globally, one of the key intensification indicators is the presence of irrigation. It is well documented in many developing countries that the use of fertilizers and high yielding varieties, fertilizer use and pesticides that can intensify production are a function of water access and irrigation availability.

Canal irrigation was the most common practice in Ekxang (86%) (Table 2) and two-thirds of the households had access to groundwater from boreholes (73%) and used motor pumps (78%). In contrast, in Rohal Suong, almost half of the households had access to canal irrigation (49%) and almost no farmer had access to groundwater. In Tra Hat, almost all farmers had access to irrigation canals (99%) but only 30% had boreholes for tapping underground aquifers. Sourcing water from water harvesting structures like check dams or water ponds was not a major practice in the study areas.

Table 2. Indicator of intensification strategy (irrigation access)

On-farm water sources	Ekxang (N=140)	Rohal Suong (N=140)	Tra Hat (N=140)
Canal Irrigation	85.7	49.3	99.3
Dams or water ponds	4.3	7.9	5.7
Boreholes	72.9	0.7	30.0
Water pumps	77.9	18.6	0.7
Inlet/water gate	0.7	0.0	0.0
None of the above	7.9	46.4	0.0

One-fourth of the households in Ekxang reported having purchased certified seed in the last 12 months; half of the households purchased fertilizer, veterinary medicine for livestock or pesticides (Table 3). One-fourth of the households received credit for agricultural activities. In the last 12 months, the households in Rohal Suong, purchased seed (70%), fertilizer (67%), pesticides (83%), and veterinary medicine (35%). One-third of the households reported to have received credit to fund their agricultural activities. In the last 10 years, farmers shifted from rainy season rice ("floating rice", which was low yielding) to dry season rice (modern high yielding varieties). The latter was high yielding but required high use of fertilizer, pesticides, and farm machineries. In Tra Hat, the farm inputs purchased by the households included seed (70%), fertilizer (99%), pesticides (99%), and veterinary medicine (54%). Half of the households (54%) reported to have received credit for their agricultural activities.

Table 3. Indicator of intensification strategy (input use, %)

Inputs	Ekxang (N=140)	Rohal Suong (N=140)	Tra Hat (N=140)
Purchased seed	25.0	70.0	70.0
Purchased fertilizer	50.7	67.1	99.3
Purchase pesticides	58.6	82.9	99.3
Purchase veterinary medicine	50.0	35.0	54.3
Received credit for agricultural activities	26.4	36.4	53.6
None of the above	17.9	7.1	0.7

3.1.2. Extensification

As a response to declining productivity due to changing climatic conditions, it is possible also to horizontally expand the cultivation of crops. Specifically, in Ekxang, more than 50% of the households had 1 to 5 hectares of arable land while 15% of the households had more than 5 hectares. However, the majority (65%) of the households dedicated less than 1 hectare for crops. About 57% of the households would be able to expand up to one hectare of agricultural land and 37% responded that they could expand even more than one hectare. It indicates significant scope for the extensification strategy by the farmers.

In Rohal Suong, more than half of the households had access to land of less than one hectare (55%) while 40% of the households had access to land size of between 1 and 5 hectares. Few households (4%) had access to land of more than 5 hectares. In contrast to Ekxang, for 59% of the households, there is no more land for expansion, while 38% reported that only less than a hectare is available for expansion. Few households (3%) indicated that the land available for expansion is more than a hectare. Though horizontal expansion of cropping is possible for 41% of farmers, it has less scope compared to Ekxang.

In Tra Hat, two-thirds of the households had access to lands with an area between 1 and 5 hectares, while near one–third of the households had access to land of less than one hectare Few households (5%) had access to land of more than five hectares. For most households (91%), the land available for expansion was less than a hectare. Few households can expand to more than one hectare (3%), while the rest (6%) reported to have no land available for expansion. Same with Rohal Suong, Tra Hat also had a scope of extensification although on a lesser scale.

3.1.3. Diversification

3.1.3.1. Diversification of production

It is well documented that diversification is a strategy that can offer resilience from climatic variability. A simple diversification indicator is used for assessing the diversification strategy of farmers. The diversification indicator is an ordinal variable that represents the number of on-farm products reported (1 stands for 1 to 4 products, i.e. low production diversification; 2

stands for 5 to 8 products, i.e. intermediate production diversification and; 3 stands for 9 or more products, i.e. high production diversification).

Near two-thirds (63%) of the households in Ekxang were classified under intermediate diversification while most (86%) households in Rohal Suong were classified under low production diversification (Table 4). It is to be noted around 11% of the farmers produce nine or more products in Ekxang indicating very high use of the diversification strategy. The households in Tra Hat were almost equally divided between low (54%) and intermediate (46%) production diversification. The diversification strategy is explained further in next section.

Table 4. Indicator of on farm diversification strategy (% of respondents)

Diversification Index	Ekxang (N=140)	Rohal Suong (N=140)	Tra Hat (N=140)
Low	26.4	85.7	53.6
Intermediate	62.9	14.3	46.4
High	10.7	0.0	0.0

Food crops (92%), small livestock (89%), livestock products (86%), fruits (73%), and large livestock (55%) were the main agricultural products of the households in Ekxang (Table 5). Most of the food crops (e.g., grain rice) and fruits were for consumption. The livestock products and large livestock (e.g., cow, buffalo) were mainly for selling, while the small livestock were for consumption and for sale. One-fourth of the households were into fish farming for consumption.

Table 5. Production, consumption, and sale of own farm produce of the households, %

Products	Ekxang (N=140)			Rohal Suong (N=140)			Tra Hat (N=140)		
	Producing	Consuming	Selling	Producing	Consuming	Selling	Producing	Consuming	Selling
Food crop (raw)	92.1	92.1	29.3	87.9	86.4	58.6	98.6	87.1	97.1
Food crop (processed)	2.1	2.1	1.4	1.4	1.4	1.4	0.7	0.7	0.7
Vegetables	46.4	45.7	15.7	53.6	52.1	40.0	30.0	27.9	10.7
Fruit	72.9	70.7	7.9	24.3	23.6	22.1	72.1	72.1	26.4
Other cash crops	36.4	20.7	32.9	10.0	8.6	9.3	8.6	6.4	7.9
Fish	26.4	26.4	7.9	9.3	7.1	7.9	63.6	63.6	11.4
Large livestock	55.0	12.1	49.3	30.7	8.6	25.0	0.00	0.00	0.00
Small livestock	89.3	88.6	47.9	65.0	56.4	43.6	75.7	65.7	55.7
Livestock products	85.7	85.7	20.7	0.7	0.0	0.0	2.9	2.9	1.4
Manure/ compost	38.6	37.1	0.0	3.6	3.6	0.7	0.7	0.7	0.0
Fodder	0.0	0.0	4.3	0.7	0.7	0.0	0.7	0.7	0.0
Others	0.0	0.0	0.0	1.4	1.4	0.0	5.0	4.3	3.6

In Rohal Suong, the households that produced and sold on-farm products had one or combinations of the following: food crops (raw and processed), fruits, vegetables, other cash crops, fish, livestock (large and small), fodder, livestock products, manure, compost, timber and wood for fuel. Most households (88%) produced raw food crops for consumption (87%), while more than half of the farmers (57%) sold these products. The majority (54%) of households produced vegetable for consumption (52%), and also for sale (40%). Near one-fourth of the households produced fruits for consumption (24%) and for sale (22%). Few were fishers (9%). Two-thirds of the households (65%) raised small livestock for consumption (56%) and for sale (44%). One-third of the households raised large livestock, mainly for sale (25%) and a few raised large livestock for consumption (9%).

In Tra Hat, the common products were food crops, fruits, small livestock, fish, and wood for fuel. Most households sold (97%) and consumed (87%) food crops that they produced. Rice was the dominant food crop and considered as the most important source of both cash income and food supply for the households. Although income from rice production may sometimes be less than the income from livestock or off-farm activities, rice was still considered as the most reliable product by most of the households. Livestock was important in the farming system of the households. More than 75% of the households raised small livestock for consumption (66%) and for the local market (56%). Swine fattening was considered the second important source of income. Chicken and duck raising was considered more important to the households during occasions (e.g., new year, birthday, anniversary). The main problems with chicken and duck raising were disease control and low market price.

No large livestock were reported in Tra Hat. The likely reason for this was the highly mechanized farming system. Near three-fourths (72%) of the households produced fruits and was mainly for home consumption (72%). Only one-fourth of the households (26%) reported selling fruits. The fruit trees were grown around the residential areas or on field border. Common trees were coconut, star apple, durian, and jack fruit. The households in Tra Hat were also into fish farming (64%) in small ponds. The farmed fish were mainly for consumption. Only 11% of the households reported selling fish. Near one-third of the households were producing (30%) vegetables, mainly for consumption (30%), with only 11% of these households selling vegetables.

3.1.3.2 Diversification of income sources

In addition to agricultural diversification, broadening of income sources of off-farm activities can be an effective strategy to improve resilience of income for farm families facing climatic vagaries. In the last 12 months prior to the survey, nearly 43% and 37% of the households in Ekxang received cash income from farming employment or other paid employments,

respectively. About one-third of the households were involved in business (Table 5). Renting land was not a popular strategy in Ekxang.

In case of Rohal Suong, it reported the widespread use of the strategy of diversifying to off-farm cash income sources (93%). The majority of the households had one or two sources of off-farm cash income. One-fifth of the households had at least five sources of cash income. The top sources of off-farm cash income of the households were business-related (63%) (e.g., motor taxi, delivery vehicles, food stalls/vending, buy and sell business), other paid employment (44%) (e.g., work somewhere else during off-farm season, construction work, wage labor, government employment), and being employed in someone else's farm (22%). Other sources of income were cited by less than 15% of the households. Few households reported not having a source of off-farm cash income (7%).

In case of Tra Hat, 92% of the households had off-farm cash income sources. One-third of the households had one or two sources off-farm cash income while one-fifth of the households had at least three sources of off-farm cash income. The top sources of off-farm cash income reported by the households were other paid work (48%), other payments for projects/government (27%), business (23%) and working on someone else's farm (21%). and renting out own land (3%) or farm machinery (1%). Few households (8%) reported not having other sources of cash.

Table 6. Diversification of income sources indicator (Sources of off farm cash income, %)

Sources of cash income	Ekxang (n=140)	Rohal Suong (n=140)	Tra Hat (n=140)
Employment on someone else's farm	42.9	22.1	21.4
Other paid employment	37.1	44.3	47.9
Business	30.0	62.9	22.9
Renting out own land	4.3	7.1	2.9
No off-farm cash source	8.6	7.1	7.9

3.1.3.3 Commercialization

Increasing commercialization can also be a strategy for farmers by which they can access cash income that can improve food, financial security, and asset ownership (Table 6).The commercialization strategy of farmers is measured using a simple ordinal index that denotes the number of products sold by the households. It has four levels viz. 0 denoting no products sold (no commercialization), 1 denoting 1 to 2 products sold (low commercialization), 2 denoting 3 to 5 products sold (intermediate commercialization), and 3 denoting 6 or more

products sold (high commercialization). Table 6 indicates large share (60-65%) of farmers in Ekxang, Rohal Suong, and Tra Hat had very low commercialization.

Table 7. Commmercialization index, %

Commercialization index	Ekxang (N=140)	Rohal Suong (N=140)	Tra Hat (N=140)
No commercialization	17.1	13.6	1.4
Low	44.3	50.7	63.6
Intermediate	34.3	35.0	33.6
High	4.3	0.7	1.4

3.1.3.4 Use of common lands (Forest, rivers, swamps and communal lands

Use of common lands such as the river, ponds, and communal lands is a strategy to augment food security and cash income and can offset declines in production off farm. Collecting forest products (e.g., timber, fuel wood, charcoal, honey, and manure) was also popular with about 62% of the households in Ekxang. However, only a few of them were selling these products. It was likely that households shared off-farm products with neighbors or friends or had wasted these products.

In Rohal Suong, three-fourths (73%) of the households was catching fish from common water bodies for consumption (44%) and for sale (33%). Fuel wood was collected mainly for own use (41%). Fishing was active during the rainy season or flooding season during the months of September to November. On the other hand, wood for fuel were manually collected from flooded forest, during rainy and dry season and transported to the village using a cart.

In Tra Hat, as a result of land tenure policy in Vietnam since 1990s, land use right was awarded to individual households. Few resources were open access, including rivers or swamps. Only 35% of the households reported having produced and consumed produce from common lands (i.e., harvesting from the wild or communal lands), with fish as the common produce (86%).

Table 8. Consuming and selling of products from common lands among the households, %

Products	Ekxang (N=140)		Rohal Suong (N=140)		Tra Hat (N=140)	
	Consuming	Selling	Consuming	Selling	Consuming	Selling
Food crops/fruit	8.6	0.7	7.1	2.9	2.9	0.0
Fish	9.3	0.7	43.6	32.9	85.7	1.4
Others	30.0	1.4	46.3	4.2	28.6	0.0

In Tra Hat, nearly half (43%) of the households were collecting fuelwood for own consumption. Most of the households in the Ekxang (71%), Rohal Suong (99%), and Tra Hat (99%) did not use the communal lands. Those who accessed the communal lands in Ekxang, were collecting food crops, vegetable, fish, herbs and non-timber forest products and grazing livestock. In Rohal Suong and Tra Hat, very few households were growing crops in communal lands. These communal lands were reported to be degraded or "under tree cover".

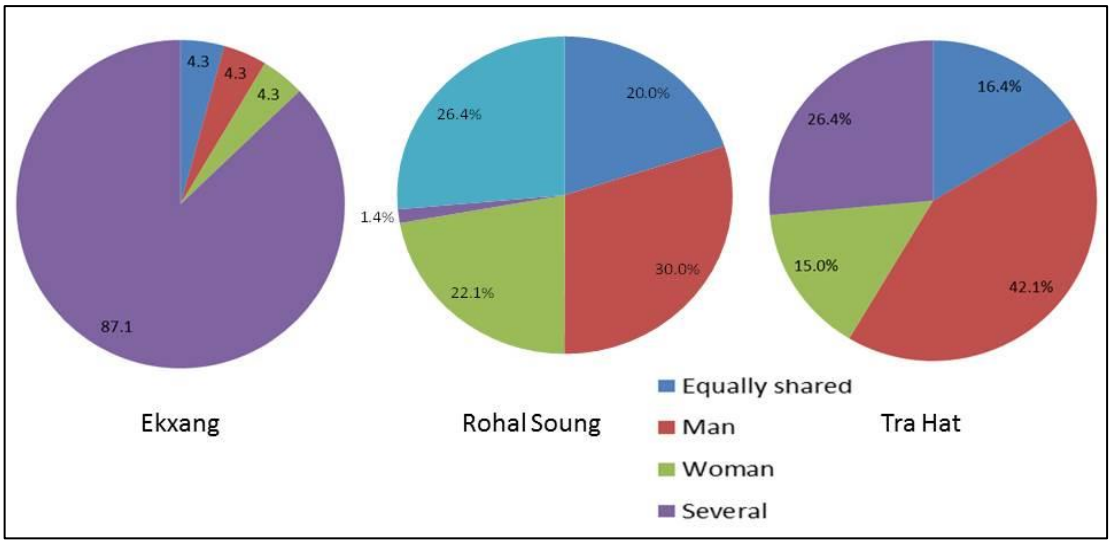
3.1.3.5 Migration and remittance

Another strategy that can be employed by farmers is outmigration to other cities and sending back remittances (Adger, 1999). It is reported that 23% farm households in Ekxang, 23.6% in Rohal Suong and 7.9% in Tra Hat did receive remittances.

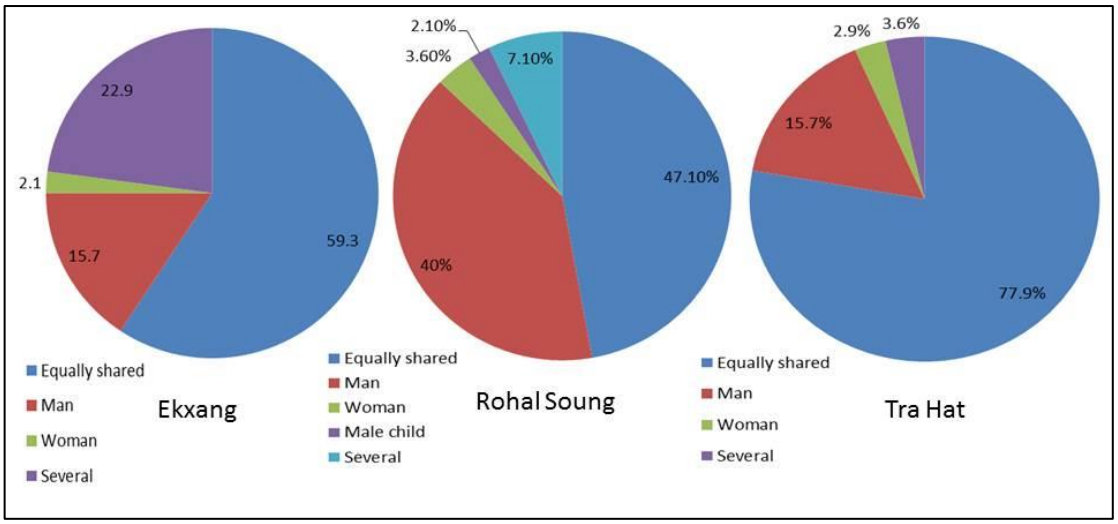
3.1.3.6 Gender dimension of strategies

Among the households in Ekxang, 87% reported that farm work is equally shared among gender (Figure 3a). In case of off-farm work load (Figure 3b), more than half (59%) of the households reported that men and women equally shared the work. Near one-fourth (23%) of the households reported that off-farm works were shared by several members in the family, including the children.

Figure 3. Agricultural workload on-farm and off-farm by gender



3a. Sharing on farm workload



3b. Sharing off farm workload

In Rohal Suong, the households reported that farm work distinct for men (30%), and the women (22.1%) and only smaller share work was done jointly (20%). One-fourth of the households reported that women were responsible for taking care of small livestock (26%) and in growing vegetables (24%). For other products from own farm, women's participation in the production was reported by less than 20% of the households. In contrast, off-farm production activities were shared by the men and women (47%) and by the men only (40%) (Figure 3b.).

In Tra Hat, farm work was predominantly done by men (42%). The women also work with men (16.4%) or work alone (15%) (Figure 3). Farm work was also reported to be shared by several individuals (26%). Women were reported to be responsible for taking care of small livestock and gathering wood for fuel in 37% and 24% of the households, respectively. For the other products from own farm, women's participation in production was reported to be less than 15% of the households. In contrast, off-farm production activities were equally shared by the men and women (78%) (Figure 3). Still, there were production activities where the responsibility rested on the men alone (16%) or the women alone (3%).

3.2 Livelihood outcomes

3.2.1. Food Security

Food Security Index (FSI) denotes the number of months in a year that the households reported they have experienced hunger. The index has five classes: more than six hunger

months, five to six hunger months, three to four hunger months, one to two hunger months, and no hunger month. In this paper, hunger means "not having enough food from own farm" or supply from own farm was low relative to what was needed.

In Ekxang, few households (<3%) reported having experienced hunger during the last 12 months (Table 8). Most of them, identified the months of June to July and October to December as the months they have experienced hunger.

Table 9. Food Security Index, %

Experience with hunger	Ekxang (n=140)	Rohal Suong (n=140)	Tra Hat (n=140)
More than 6 hunger months	0.7	21.4	5.7
5-6 hunger months	0.0	5.0	1.4
3-4 hunger months	0.7	22.9	14.3
1-2 hunger months	1.4	12.1	13.6
No hunger months	97.1	38.6	65.0

In Rohal Suong, for every 10 households, four reported not to have experienced hunger throughout the year, while six reported having experienced hunger at least one month in a year. One in every five households reported experiencing hunger for more than six months. October to December were reported to be lean months with the food supply running low and hunger was commonly experienced. The food supply crisis was reported to have happened during the big floods, which regularly occur every five years. Hunger was expected to be likely, when late flooding (after October) occurs that cause the start of the rice planting season to be late.

In Tra Hat, two-thirds of the households reported that they have not experienced hunger throughout the year. One-third of the households reported having experienced hunger at least one month in a year, or during the months of November to January.

3.2.2 Asset ownership

The common assets in all the study sites are the motorcycle and bicycle for transportation; water pump or motor-powered spraying tank for production assets; LPG for energy; television and cellular phone for information; and electric fan for luxury items (Table 9). However, the percentage distribution of the households in terms of ownership of each asset differed. For instance, the ownership of motorcycle among households was highest in Ekxang (96%), followed by Tra Hat (89%), and Rohal Suong (78%). There was more who owned a bicycle in Rohal Suong (73%) than in Ekxang (54%), and Tra Hat (39%). More Ekxang households

owned production assets compared to households in other villages. More households in Rohal Suong owned fishing boats and nets. In Ekxang, more households had nets, but less with boats, indicating fish farming rather than fish catching. It was the opposite in Tra Hat with more households with boats than nets, indicating rental of nets for fishing as common. In Rohal Suong, 42% of the households had boats and nets.

Table 10. Ownership of assets by the household

Assets	Ekxang (N=140)	Rohal Suong (N=140)	Tra Hat (N=140)
Transport assets (%)			
Motorcycle	96.4	77.9	89.3
Bicycle	53.6	72.9	39.3
Car or truck	18.6	2.9	0.00
Production assets (%)			
Mechanical plough	66.4	9.3	17.1
Mill	0.7	0.0	1.4
Water pump/treadle pump	83.6	21.4	51.4
Petrol trimmer	10.0	0.7	1.4
Motor powered spraying tank	39.3	14.3	54.3
Thresher	1.4	0.7	2.1
Boat	5.0	42.1	26.4
Fishing nets	43.6	42.9	5.0
Energy assets (%)			
Liquid pressurized gas	5.0	2.9	77.9
Battery (large - e.g. car battery)	0.7	10.0	5.0
Biogas digester	1.4	0.0	3.6
Information assets (%)			
Television	97.9	86.4	97.9
Cell phone	95.7	83.6	94.3
Radio	57.1	58.6	24.3
Computer	15.0	2.9	13.6
Internet access	12.9	0.7	12.1
Luxury assets (%)			
Refrigerator	81.4	4.3	41.4
Air conditioning	10.0	0.0	1.4
Electrical fan	97.1	55.7	89.3
Bank account	35.7	1.4	10.0

3.2.3 Overall assessment of livelihood outcomes

Considering the intensification, extensification, diversification, commercialization, use of common lands and migration strategies of farmers, an overall score of livelihood strategies is made. The score is constructed by adding the percentage of farmers engaging in the activities at least at a minimum level. Table 10 presents the results and shows that Ekxang receives the maximum score followed by Tra Hat and Rohal Suong. The livelihood outcomes prove the utility of the assessment method and shows that it follows the same order. Ekxang has

maximum reported food security and asset ownership score followed by Tra Hat and Rohal Suong. It also proposes the scope of using the conceptual frame and the approach for rapid assessment of livelihood strategies aiming at climate resilience, income gains and food security. The assessment can also provide pointers for climate-smart interventions that can be useful in any given village.

Table 11. Assessment of livelihood strategies and outcomes (%)

	Ekxang	Rohal Suong	Tra Hat
Intensification			
Irrigation	92.1	53.6	100
Inputs	82.1	92.9	99.3
Extensification	94	41	94
Diversification			
On Farm*	73.6	14.3	46.4
Off farm	91.4	92.9	92.1
Commercialization	82.9	86.4	98.6
Use of Common lands	62	73	35
Migration	23	23.6	7.9
Overall score	601.1	477.7	573.3
Food Security	97.1	38.6	65
Asset Owner-ship	39.79	30.98	34.75

4. Discussion

The study sites, Ekxang in Lao PDR, Rohal Suong in Cambodia and Tra Hat in Vietnam had similar major climate change challenges, i.e., prolonged dry season and flooding. One major strategy of farmers was intensification using canal irrigation, especially in Ekxang and Tra Hat. Near two-thirds of the households in Ekxang also reported pumping water from boreholes, especially during the dry season. The availability of other water sources aside from irrigation enabled vertical expansion to three rice seasons in a year, contributed to the higher production. But there is still scope of intensified production in Ekxang given the fact that fertilizer and chemical use is lower than other sites.

This inadequate source of farm water in Rohal Suong could be one reason for the low diversification in the area and underscores the importance of water source in farm production, particularly when the area is challenged by drought. Tra Hat is observed with more intensive use of fertilizer and chemicals but the lack of access to groundwater could be limiting the expansion of rice cultivation similar to Ekxang. In case of diversification of farm products,

Ekxang had a higher diversification index compared with the households in the two other study sites. Most of the households produced food crops and livestock products, raise small and big livestock, and grow fruits. Among the produce, only the large livestock was sold by most of the households while the rest were for consumption.

The availability of seeds could also be a reason. Only a quarter of the households in Ekxang reported to have purchased seeds for the next cropping yet they had two to three cropping a year. It was likely that they have set aside own seeds before consumption and for sale. In the other sites, most of the households were purchasing seeds. The use of credit to buy fertilizers and agro-chemicals with a promise to pay at the end of the harvest season was more practiced in Tra Hat than in Rohal Suong and Ekxang. Reliance on credit and the need to pay was one of the reasons why they had to sell their produce even when market price was low, which also translates to their low income.

The small size of the farm lands in the three sites could also be the reason why commercialization index was similar and low among households across sites. The low commercialization index indicates that most households were producing for consumption. The small size of farmlands along with the problems of drought could likely account for the household level of production. Large-scale production in terms of volume was not observed in the selected villages. It was also noted that the size of the households in Ekxang was bigger compared to Tra Hat and Rohal Suong.

This means that more household members n Ekxang could be tapped for farm work. Most of the households in Ekxang reported that farm work is shared by many individuals and not just by women or by the men. More than a shared activity between men and women, farming seemed to be a more of a family activity in Rohal Suong and Tra Hat. Probably this was likely a result of the shortage of labor in the rural area that everyone was engaged in farming activities or by the difficulty of hiring labor outside the family. Recruiting family labor was the usual economic response of households facing labor shortage or wanting to ensure all produce (given small amount) goes to the family and not shared with others. On the other hand, in some households, the men were out and earning a living elsewhere. The women in these households were left to engage in farming activities.

Ekxang had the highest percentage of households not engaged in the market. In contrast, the households in Tra Hat and Rohal Suong scored lower in the diversification index. More than the majority of households in Rohal Suong produced only food crops, vegetables and small livestock. Among the produce, only the food crops were consumed and sold in the market; the rest were mainly for consumption. Households in Tra Hat produced food crops, fruits, fish, and small livestock. Among these products, most of the households were also selling food crops and small livestock. Given that most of the produce in Ekxang was for food, then cash income was derived off farm. More than one-third of the households in Ekxang were employed on someone else's farm, engaged in other paid employment, and have availed of formal loan or credit. Near one third were also in business. Thus, in Ekxang, the farm was the main source food, but not of cash income. One-third of the households in Rohal Suong and Tra Hat sites were engaged in paid employment. Two-thirds of households in Rohal Suong were into business. Although some households in Tra Hat and Rohal Suong worked on someone else's land, Ekxang recorded the highest number of farmers working as paid labourers. Meanwhile, more households in Ekxang use farm machineries in their farms. Although the use of farm machineries was also reported in Rohal Suong and Tra Hat, more of the households in these study sites were renting. More households in Ekxang, owned mechanical plough (66% vs. 9% vs. 17%, respectively) and water/treadle pump (84% vs. 21% vs. 51%) compared to Rohal Suong and Tra Hat.

More of the households in Ekxang owned assets, particularly production and luxury assets. Lastly, one-third of the households in Ekxang reported having a bank account, while few of the households in the two other sites. In terms of food security situation, households in Ekxang seemed to have fared well compared to the two other sites. It had fewer households (3%) that experienced hunger in the last 12 months prior to interview compared to Rohal Suong (61%; 21% more than 6 hunger months), and Tra Hat (35%). The reason for this lower incidence of households who experienced hunger in Ekxang can be gleaned from the characteristic of Ekxang relative to the other sites.

4.1. Climate-smart interventions that can support livelihood strategies

There is a huge scope of augmenting the livelihood strategies to enhance climate resilience, enhance income levels and ensure food security. The intensification efforts can be augmented by climate-smart interventions such as tolerant varieties, pest clinics, water harvesting

structures, leaf colour charts and solar groundwater pumping that can strengthen irrigation, seed, fertilizer use, and pest management efforts.

In case of extensification, additional area can be farmed by mechanization, providing market for the additional products, and empowering women to manage farms efficiently. The additional production from the intensification and extensification strategy can ensure food security and resilience at household and regional levels. The current farming systems in Ekxang show high level of diversification, and Rohal Suong and Tra Hat need to enhance diversification to reach the level of Ekxang. It is also possible to find new ways to diversify such as mushroom farming in rice straws, fresh water aquaculture, etc. The scaling-up potential of diversification possibilities need to be identified and supported.

Production diversification can add resilience to climatic fluctuations and enhance income levels. It is also found that the common lands are underutilized, and it could act as additional income source for the farm households or provide carbon services if opportunities for agro-forestry systems in these lands are tapped. The rivers, ponds and forests are supporting in ensuring food and nutritional security of the study areas but are limited in generating cash income.

The livelihood strategy score of Rohal Suong is augmented by the use of common lands, which highlights the role of common lands in areas with lower scores in livelihood strategies. It is to be noted that Rohal Suong is an area that is impacted by climate variability and extreme events. To meet the investment needs raised by the climatic changes, there is a need for generating higher cash income by commercialization of farm products.

Tra Hat scores high in commercialization that Ekxang and Rohal Suong. It could be possible that marketing interventions that can augment the share of consumer dollar realized by farmers can be relevant in generating cash flows and supporting autonomous adaptation to climate change. It is also to be noted that the there is scope to change farmers practices to augment productivity and resilience. For example, renting out machinery is a not a common practice in the area and promoting the rental services of farm machinery can support extensification and intensification of the lands.

Use of weather services and altered crop calendars are other examples. In case of the migration strategy, it is adding additional farming responsibilities to women and enhancing their efficiency in farm operations, climate-smart practices and marketing can add more resilience to farming systems. In addition, provision of climate related safety nets (insurance programmes, employment guarantee, etc.) could prevent further migration out of rural areas. In addition, contribution to global mitigation efforts by using techniques such as alternate wetting and drying or mid-season drainage can offer adaptation benefits by reducing water use. There is a need for providing payments for these carbon mitigation services, which could act as a new income source for farmers.

Table 12. Portfolio of climate-smart interventions that can support livelihood strategies

Climate-smart livelihood Strategy	Indicators used	Relevant climate-smart interventions
Intensification	Fertilizer, chemicals, irrigation, varieties	Tolerant varieties, pest clinic, water harvesting ponds, groundwater pumps
Extensification	Availability of unutilized land	Empowering women in farm management, market interventions
Diversification	Diversity of production (crop, livestock, fish, poultry etc.), diversity of income sources	Rice straw based mushroom production, promotion of aquaculture
Use of common lands	Utilization of forests, ponds , rivers and common grazing lands	Agro-forestry practices
Commercialization	Share of sale to production of rice, livestock, fish etc.	Market information, marketing interventions
Alteration of practices	Renting out land, Renting of farm machinery, hiring in farm labour, division of labour	Weather forecasts, , resource saving fuel efficient machines
Migration and Remittance	Remittance	Introducing climate related safety nets
Emission mitigation	Not currently practiced	AWD, mid-season drainage, biochar addition, biogas based stoves

5. Conclusions

The current study provides conceptual clarity for efforts to increase climate smartness of farming systems and create CSVs. It is found that farmers use various livelihood strategies and the current study realized a simple but powerful set of indicators to assess the existing strategies and identify entry points for climate-smart strategies. In case of the study sites the comprehensive assessment of the strategies could reveal the actions that each study area can undertake and improve the climate resilience, food security and asset ownership outcomes. It

is also evident that the climate-smart interventions can augment different livelihood strategies of farmers and enhance the final outcomes. There is need to prioritize the possible interventions in each case and implement them with help of donor agencies, local institutions and government.

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