Outcome and impact assessment of the Climate-Smart Village Program in Northern Vietnam

Working Paper No. 398

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

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Working Paper

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About CCAFS
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Abstract

Yen Bai province inherits representative biophysical, socio-economic, smaller-holder farming characteristics to economic marginalization and climatic risks and impacts to agricultural production and local livelihoods of Vietnam's northern mountain region (NMR). The CCAFS project deployed to Ma Climate-Smart Village (CSV) in Yen Bai in 2015 with bilateral funding support from two other research projects aimed at setting up a demonstration-for-scaling example of a rural community equipped with capacities for enhanced climate adaptation and resilience. This study applied a three tier interview data collection methodology (key informant interviews – focus group discussions – indepth farmer interviews) to thoroughly investigate 120 households about six main outcomes accomplished by the project up until 2021: (i) *Overall changes in the village* include improved crop productivity and thus household income; better access to information (eg. weather forecasts, tolerant varieties, etc.), knowledge (eg. technical training, internet-based extension materials, etc.) and resources (eg. loans); better coordination and cooperation among villagers in CSA and CSV actions and knowledge sharing. (ii) *Improved farmer's knowledge in CSA and CSV implementation* is evidenced by the ability to strategize, plan and implement CSA solutions and sustainably maintain CSV activities by themselves. (iii) *Improved perceptions of climate risks and their impacts* help farmers proactively, correctly and quickly respond to risks. (iv) *Women's role in CSA and CSV implementation* has been seen much more profound with at least 50% project participants being female farmers involved in all project activities. (v) *Horizontal scalability of the CSV model* automatically took place within Ma CSV when the CSA T&Ps were successfully tested by farmers and has spread now to neighboring villages to these days. (vi) *A clear pathway for vertical scalability through policy* has been initially achieved with a policy issued by the Yen Bai government based on some main project outcomes. Apparently, the project has achieved great outcomes from the village to the provincial levels. However, the project work still has a potential to be scaled to the National Target Program on New Rural Development (NTM) given its interest in developing resilient communities in climate-vulnerable regions across the country applying the CSV approach in its 2021-2025 strategy. Despite the closing of the CCAFS program by December 2021, this most important scaling pathway will be continued by the VIBE 2018.05 (funded by the Irish Aid) and COALESCE/2020/34 (funded by the Irish Research Council) under the management of Vietnam National University of Agriculture – a long-term strategic partner of the CCAFS program in the NRM.

Keywords: *Climate risks, impacts, Climate-Smart Village, adaptive capacities, outcomes, scalability, resilience, Vietnam*

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Acronyms

AGF	Agroforestry
BD	Bio-diversity
BIC	Biological cushion
BMC	Better market access
CARE	CARE is an international humanitarian organization fighting global poverty and world hunger by working alongside women and girls (https://www.care.org/)
CC	Climate change
CCC	Changing crop calendar
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
CPT	Composting
CSA	climate-smart agriculture
CSV	Climate-Smart Village
DARD	Department of Agriculture and Rural Development
DCI	Decreased cost of input use
DCL	Diminishing cost of household labor
DRP	Dripping irrigation
EP	Environmental pollution
FR	Fertilization
FGD	Focus group discussion
ICM	Integrated Cropping Management
ID	Insects and diseases
IPM	Integrated Pest Management
IPSARD	Institute of Policy and Strategy for Agriculture and Rural Development
IQAP	Improved quality of household agri-products
ITC	Intercropping
IYP	Increased yield and productivity of household agri-products
KII's	Key informant interviews
MARD	Ministry of Agriculture and Rural Development
NAEC	National Agricultural Extension Center
NDC	Nationally Determined Contributions
NMR	Northern Mountain Region
NOMAFSI	Northern Mountainous Agriculture and Forestry Science Institute
NTM	National Target Program on New Rural Development or Nông Thôn Mới
ORF	Organic farming
PDM	Pest and diseases management
PLC	Polyculture
RM	Risk management
SANRM	Sustainable Agriculture and Natural Resources Management

SDG	Sustainable Development Goals
SM	Soil management
SQ	Soil quality
SRD	Sustainable Rural Development
SRI	System of Rice Intensification
SRV	Selection of resilient varieties
VAAS	Vietnam Academy of Agricultural Sciences
VNUA	Vietnam National University of Agriculture
WM	Water management

I. Introduction

Climate change seems far removed from the immediate problems that we have been facing today like poverty, disease, and economic stagnation. However, without the attentive consideration of climate change impacts, progress on addressing these other core development priorities will be severely affected. There is no denying the fact that climate change will increasingly affect the basic elements of life for people around the world: water resources, food production, health, and the environment. If left unchecked and controlled, climate change can cause ecological instability in the natural environment, especially for vulnerable populations. While many development projects can help reduce vulnerability to climate change impacts in some communities, they can sometimes increase vulnerability to others. In addition, consideration of the impacts of climate change can enhance the importance of supporting specific sectors such as agricultural development, rural development, and water resource management.

Over the last 30 years, Vietnam's rapid growth in agricultural production has transformed the country's socioeconomic status: alleviating national food insecurity, reducing poverty, fostering agricultural exports, and providing livelihoods to nearly half of the labor force nationwide. This substantial growth in agricultural production has come at a significant environmental cost. The intensive use of chemical fertilizers, pesticides, and water to boost productivity has made agriculture the second-largest source of greenhouse gas (GHG) emissions, after energy. This, without feasible measures in a long term, is becoming an additional factor to rising threats by climate anomalies that have increasingly created obstacles to the nation's agricultural sector, especially in regions that are vulnerable to climate impacts, such as heavy rains-triggered erosion and flooding in the northern mountain region (NMR) (Bui et al., 2020a). Measures towards climate adaptation and resilience in agriculture need to be closely linked to support and complement each other for sustainability and efficiency across the agri-food sector in a so-called circular economy (Toop et al, 2017). Furthermore, they also need to address objectives of national targets related to Sustainable Development Goals (SDG), Nationally Determined contributions (NDC), and the National Target Program on New Rural Development (NTM) (Bui et al., 2020b).

In 2014, the Research Program on Climate Change, Agriculture, and Food Security in Southeast Asia (CCAFS-SEA) of the Consultative Group on International Agricultural Research (CGIAR), selected Ma village to implement the model "CSV - Climate-Smart Village" (CCAFS Flagship 1.1). The project integrated agricultural technologies for enhanced adaptive capacity and resilient livelihoods in Ma CSV, which aims to provide climate-smart agriculture options (CSA Community Learning) to enhance adaptive capacity and resilience to climate change among Ma smallholder farmers and stakeholders. Ma village, Vinh Kien commune (Yen Binh district, Yen Bai province) has about 200 farmer households, with 750 people, of which 50% of the population is the Cao Lan ethnic group. The main income of the people here is mainly from animal husbandry, crops, and forestry production. Climate change over the past few decades has brought about consequences to the livelihoods of ethnic communities in

Ma. Common climate change impacts have been identified as prolonged droughts that remarkably change cropping patterns (eg. delayed seasons) and increase harvest losses; a smaller number of rain events but more intensive rainfall amount in a single rain event that lead to more severe landslides, soil erosion, and degradation problems; increase in cold stress events and intensity kills more cattle every year; more severe floods triggered by increased intensive rainfall events create more causalities and losses in infrastructure as well as crops.

In the continuation of the initial CCAFS work in Ma CSV in the 2015-2018 period, the study of Bui et al. (2020a) covering all three agro-ecologies of Yen Bai developed a set of step-wise guidelines for CSV implementation that can be applied at the local and national levels and are recommended for adoption within the NTM program in the 2021-2025 strategy (Bui et al., 2021c; 2021d; Bui Le Vinh, 2021). These achievements were strongly supported by the Yen Bai government, its relevant districts and the national NTM program with a great interest in having strong evidence for national application of the CSV approach in their 2021-2025 strategy.. The research has been jointly funded by the CCAFS program, the Irish Aid VIBE program under the Embassy of Ireland in Hanoi, and the NTM program of the Ministry of Agriculture and Rural Development (MARD) through Vietnam National University of Agriculture (VNUA) . These major research findings have been documented and provided to the national NTM program and Yen Bai Department of Agriculture and Rural Development (DARD) for wide adoption and implementation of CSV in enhancing adaptive capacity and resilience in climate-vulnerable rural communities.

The CSV work in Yen Bai has been documented in various forms of publications, including peer-reviewed articles, working papers and policy briefs, blogs, and national/regional workshop PPT presentations. The project team also captured various types of project activities, from evaluating impacts of certain climate-smart-agriculture technologies and practices (CSA T&Ps) (Bui et al., 2021a; 2021b; Trieu et al., 2021), farmers' perceptions of climate change in agricultural production (Vu et al., 2020; Nui et al., 2021), participatory CSA priority setting (Bien et al., 2021), assessment of livelihood improvement CSV farmers via CSA implementation (Bien et al., 2021), impact assessment of CSA conservation measures (Bui et al., 2020a; 2020b), documentation of CSV implementation achievements (Vernooy et al., 2015; 2018; Hoang and Vernooy, 2017), evaluation of climate risk impacts in the implementation of the NTM program (Bui et al., 2020c), to policy recommendations for CSA T&Ps and CSV adoption into the national NTM program in the 2021-2030 strategy (Bui et al., 2020d; 2020e). Furthermore, the project team submitted a policy brief for policy recommendations of adopting the CSV approach into the 2021-2030 NTM implementation nationwide (Bui et al., 2021c). To assist the nationwide adoption, the team developed detailed guidelines for CSV implementation that can be flexible application in the national NTM program in its 2021-2030 strategy (Bui et al., 2021d). Throughout implementation, the project was updating the CCAFS Flagship 1.1 activities in regards to testing and evaluating specific CSA T&Ps (Renz Louie Celeridad, 2018; Bui Le Vinh, 2016; CIAT, 2016; Emilene Sivagnanam, 2016), and supporting elements for CSA upscaling and out scaling (Eisen Bernard Bernardo, 2018; Madelline Romero, 2017).

Aggarwal et al. (2018) reveals 36 CSVs within the global Climate Change, Agriculture and Food Security Program (CCAFS), of which three were successfully developed for Vietnam, including one in Yen Bai province (northern mountain region - NMR), one in Ha Tinh province (central region), and one in Bac Lieu province (Mekong River Delta). This CCAFS funded study aims to harvest outcomes that were generated from the CCAFS FP2.1 project (2015-2018) at since 2015 up until now. The study also looks at possible outcomes for horizontal scaling (out-scaling), i.e., from Ma CSV to the surrounding community, and vertical scaling (upscaling), i.e., to commune, district, and provincial levels.

II. Objectives

This study aims to identify the realized outcomes from the CSA prioritization of the Ma CSV project and evaluate its influence on the radical adoption strategies of CSA T&Ps and scaling of the CSV approach, applying an integrated methodology (combination of qualitative and quantitative methods). Results of the work will be published in scientific journals and should be aligned with actionable intervention to improve policy uptake towards addressing adaptive capacity, resilience to climate change (CC), and food security. Therefore, the specific objectives of the study were the following:

i. Investigate the achieved scalability of the CSA T&Ps within and from Ma CSV to the surrounding villages. This was obtained through focus group discussions (FGDs) and in-depth interviews of pre-identified representative farmers that combined on-line and direct interactions due to the Covid-19 lockdown in Hanoi;

ii. Assess the overall performance of the CSV model in Ma village, focusing on changes in (a) general socio-economic conditions; (b) perceptions of climate impacts and ability to adaptively cope with risks through skills and knowledge gained from the project; and (c) synergies among villagers in joint climate actions;

iii. Assess the institutional role of the communal government in scaling out CSV related works, not only limited to promoting the adoption of CSA T&Ps, to other villages and communities within Vinh Kien commune;

iv. Assess the progress of any possible provincial DARD's efforts and limitations in adopting and advocating the CSV approach in Yen Bai's agricultural development plans and strategies, such as *Nong thon moi*.

III. Methodology

3.1 Site selection

The study was conducted in Vinh Kien commune, Yen Binh district of Yen Bai, a province in the Northern mountainous region of Vietnam (Figure 1). This region is characterized by low-moderate to high mountain ranges (see Picture 1, Appendix). The northeastern and northwestern mountain regions of Vietnam are home to many ethnic groups, which has resulted in the diversity of culture, customs, and farming systems. Climate change over the past few decades has brought about consequences to the livelihoods of ethnic communities that live in high mountains.

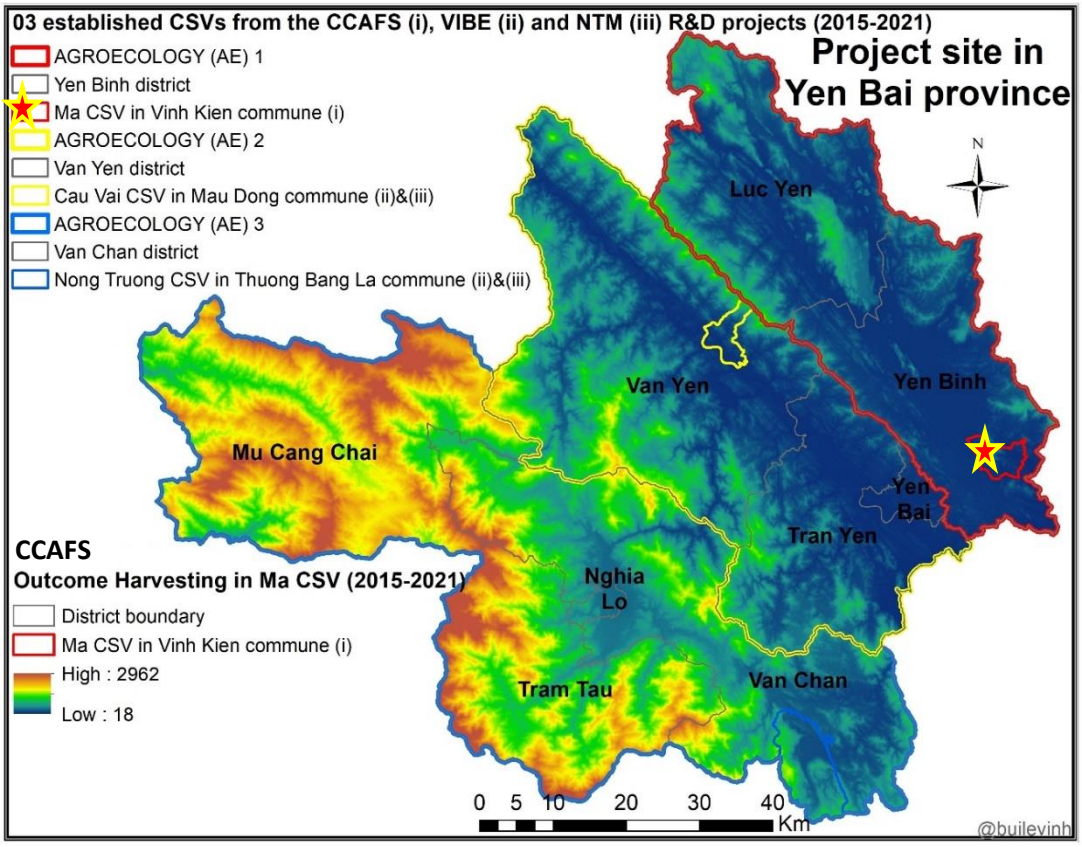

Figure 1. The research site for outcome harvesting study in Vinh Kien commune, Yen Binh district, Yen Bai province

In addition to the main research activities on Ma village, Vinh Kien commune, we also carried out the household investigation in the other three villages adjacent to Ma. These are the villages of Dong Cum, Ba Chang, and Da Coc, which have similar natural conditions and socio-economic structures to Ma village. This selection enabled the research team to investigate how the CSV's intervention impacts the change in farmers' perception and knowledge spillover in agricultural production related to the three dimensions of sustainable development, namely the economic, social, and the environmental. From there, it helped the research team to build identical sets of criteria for change outcomes assessment.

3.2 Research design

Guided by the theory of change, we defined outcomes as the general changes in socio-economic and environmental sustainability at the household and communal level (in outcome-mapping language) that the CSV project influenced but did not control. In recognition of the uncertainty and dynamism generated by climate change impacts, these changes could be expected or unexpected, as well as positive or negative. CSV's project contributes to these changes could be small or large, direct or indirect.

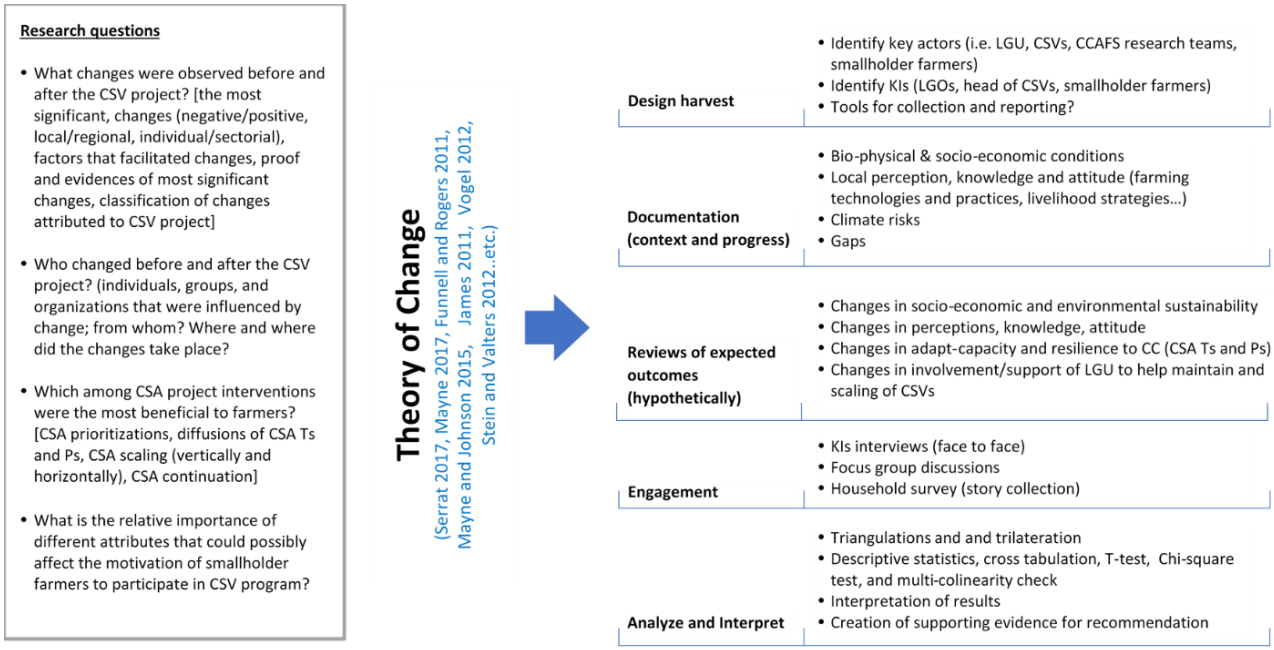

Figure 2. Design of outcome harvesting process

In addition to the change outcome, we briefly formulated its significance and how CSV's intervention contributed to the change in farmer's perception, knowledge, and attitude to climate change impacts, the adaptive capacity and resilience, and the involvement and support of the state and local authorities to help maintain and stimulate the scaling of CSVs. As the name implies, at the core concept of outcome harvesting is the collection of evidential data. Between August and September 2021, the research team engaged pre-selected CSV and non-CSV participants in Ma and surrounding villages through MS Teams calls for in-depth interviews and focus group discussions (FGDs). The essence of the study was to focus on outcomes as the indicators of progress, as it was constituted from the CSA T&Ps transferring process of the CSV project. The details of the outcome harvesting activities are shown in Figure 2.

3.3 Data and sampling

Using a two-stage sampling procedure, we conducted a 'revealed preference'[1]survey in Ma village, Vinh Kien commune, Yen Binh district of Yen Bai, and some surrounding villages. The first stage involved a purposive sampling of 120 household farmers in the CSV areas, consisting of Ma CSV and some villages surrounding it, where the CCAFS FP2.1 project carried out the identification and assessment of climate risks to select and prioritize CSA T&Ps for testing at the CSV level during 2015-2018. The second stage was to stratify two groups of farmers, which are the adopter (A) and the non-adopter (NA) of CSA, with an expectation of 60 farmers per stratum. The (A) farmers are those that have adopted CSA T&Ps and the non-adopter possesses similar farming systems without CSA interventions. During the sample selection process, we consulted local authorities, Yen Bai extension centers, and officers from the Yen Bai Department of Agriculture and Rural Development (Yen Bai DARD). In addition, the Farmer Association (FA), cooperative directors, and village heads were also involved in the finalizing stage of the respondent list.

Both primary and secondary data sources were utilized from document analysis (i.e. project reports, data sets, and publications; documents and statistics from Yen Bai province), key informant interviews (KII's), expert interviews, focus group discussion (FGD), and the household survey. The preliminary survey (including both KIIs and FGD) served to justify the structure and contents of the questionnaire as well as the respondents' understanding of concepts and terminologies in each question. Thus, we analyzed responses and incorporated modifications in the finalized questionnaire (main household survey). Document analysis gathered reports and official statistics from Yen Bai DARD, local DARDs, and the CCAFS FP2.1 project in terms of changes attributed to the adoption of CSA T&Ps. The key informants were selected based on their potential to offer distinct and important perspectives in regards to general benefits, problems, and issues of CSV participation facing smallholder farmers. The most important key informants were the official staff of MARD, Vietnam Academy of Agriculture Sciences (VAAS), Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), Sustainable Agriculture and Natural Resources Management (SANRM) platform, National Extension Center, Yen Bai Extension Center, Yen Bai DARD, and field trips are supplementary to the focus group discussions and household survey.

The household investigation was supposed to cover 120 farmers in Yen Binh districts, Yen Bai Province. However, the empirical analysis was based on 116 farmer households due to exclusion of cases with significant missing data. Tables 1 and 2 present the descriptive statistics of specific socio-economic characteristics of surveyed groups of the farmer, the CSA adopter (45 household farmers), and CSA non-adopter (71 household farmers). On average, the non-adopters are characterized by 51.3 years old, 6.5 years-education level, 28 mils VND annual income, more than 30 years of agricultural production experience, and 2.5 family labors. The statistics of the adopter group are 53.7, 6.9, 39.4,

[1] Revealed preference is a way to infer the preferences of individuals given the observed choices (developed by Paul Anthony Samuelson in 1938)

32.6, and 2.4 respectively. Descriptive statistics also showed a significantly higher education level of the adopters than the non-adopters.

Table 1. Descriptive statistics of sampled household

	Non-adopter				Adopter			
	Mean	Max	Min	SD	Mean	Max	Min	SD
Age	51.3	75.0	20.0	13.6	53.7	80.0	27.0	11.3
Education	6.5	12.0	0.0	2.6	6.9	12.0	0.0	2.6
Income	28.0	120.0	0.0	25.3	39.4[a]	120.0	0.0	22.3
Experience	30.8	60.0	2.0	15.4	32.6	60.0	10.0	12.5
Male	1.3	4.0	0.0	0.8	1.2	3.0	0.0	0.7
Female	1.2	3.0	0.0	0.6	1.2	3.0	0.0	0.6
Total labor	2.5	7.0	0.0	1.2	2.4	5.0	0.0	1.0

Note: a denotes significant higher income of the adopters according to pairwise comparisons using the Bonferroni correction

The frequency analysis showed the majority of female farmers in both groups (25.9% of total sample for the non-adopter and 31.9% for the adopter). Ethnic minority farmers dominate the agricultural production in both groups (17.6% in the non-adopter and 34.5% in the adopter group). Ma's surrounding villages are Dong Cum, Ba Chang, and Da Coc of Vinh Kien commune.

Table 2. Descriptive statistics of sampled household

		Non-adopter[a]		Adopter[b]		Chi-square
		Amount	Frequency	Amount	Frequency	
Gender	Female	30	0.259	37	0.319	2.391
	Male	15	0.129	34	0.293	
Ethnicity	Minority	32	0.276	40	0.345	2.553
	Kinh	13	0.112	31	0.267	
Location	Others	16	0.138	42[a]	0.362	6.136
	Ma village	29[b]	0.250	29	0.250	

Note: a,b. Results are based on two-sided tests with a significance level of 0.05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion.

3.4 Questionnaire

The semi-structured questionnaire was designed based on the existing literature of smallholders' participation in climate-smart agriculture, theory of change, and rational choice theory. The questionnaire was pre-tested in the preliminary survey that includes 2 FGDs and 5 KII's (Ma village). The questionnaire compiles a set of both closed and open-ended questions that are organized into six sections. First, we asked the respondents to provide general information on households' demographic characteristics including age, gender, education level, ethnicity, and farming experience. The second section specifies farm performance in terms of the land area allocated for agricultural production, factors of production, yield, selling price, and gross return.

The later sections focus on change outcomes relative to CSV participation, including general changes in communal level, changes in individual perception, knowledge, and attitude, changes in adaptive

capacity and resilience to CC, and changes in the involvement of local stakeholders to help boost CSV scaling. In detail, the general change addresses economic, social, and environmental conditions at the communal level. The individual changes in their perception, knowledge, and attitude describe the farmers' environmental consciousness regarding different climate change (CC) impacts, the improved managerial and practical knowledge and skills, their compliance, and reconciliation toward requirements of the CSV program. The involvement of local stakeholders to help the scaling of CSVs specifies the local policies, programs, and supports that are in line with the interventions of the CSV program. In general, the dichotomous and non-dichotomous choice approaches are applied across questionnaire sections using revealed preference techniques.

3.5 Data analysis

The data analysis was carried out in two steps by using the Statistic Package for Social Science (SPSS 22.0). Data were analyzed using frequency counts, percentages and Chi-square test statistics based on the fact that most of the variables are categorical. First, the simple descriptive analysis served to identify basic socioeconomic characteristics (age, gender, ethnicity, education, average annual income, experiences, family labor, and land) of farmer household and farm performance (farm size, factor of production, yield, selling price, gross margin, and gross return from their main agricultural production) under two different groups of CSA T&Ps adoption decision. The significant change outcomes attributed to the adoption of the CSV project were cross-tabulated and then also layered with farmers' adoption decisions. These are categorical variables that specify change outcomes including general changes (different economic, social, and environmental aspects) at the communal level, change outcomes in individual awareness, perception, knowledge, and attitude that shape the pathway of farmer's cognitive changes, and outcomes in adapt-capacity and resilience to climate change, and lastly the involvement process of local authorities relative to the implementation and scaling of CSVs. Second, an analysis of cost and gross benefit of the household (CBA – Cost-Benefit Analysis) based on gross return was done to determine whether the CSA-adopter group of the farmer has gained more benefit than the non-adopter group. In this part, we also included pairwise comparisons (2-sided z-test with Bonferroni method) to obtain unbiased statistics. Initial data analysis also included multivariate assessment, as most analysis has to deal with the problem of multicollinearity. With the presence of multicollinearity, the standard error will increase and it makes the value of the t-test smaller. The multicollinearity test was utilized using the variance inflation factor (VIF) and the Eigenvalue (Wurst, Neter, and Godfrey 1989). However, no multicollinearity problems among variables in the sample (main agricultural production data) were detected by the VIF test. The variance inflation factor (VIF) ranges from 1.183 to 5.832 and from 1058 to 7.362 for the main crop and animal husbandry production variables. The study results were simple descriptive statistics, so the heteroscedasticity test was unnecessary.

3.6 Research limitations

Within its scope, the **site selection** of the study might be an issue because there exist unobservable variables (preference, motive, social embeddedness...) that are correlated with both adoption and

non-adoption decision, which would lead to bias results. Further, if the selection of the non-adopter and the adopter farmers is an issue, which is sometimes called **heterogeneity bias**, "failure of common support" or "spillover effects" to the comparison group, this would have slightly been a concern in evaluating the impacts of the CSV program on the farmer's well-being. In addition, the empirical results pertained from the small research sample, so the study was not **extrapolated** to the entire agricultural and rural system of Yen Bai province. Finally, due to the problem that the COVID-19 pandemic has affected all sectors of the Vietnamese economy and society, **online surveys** through MS team may suffer from two serious methodological limitations: the population to which they are distributed cannot be described, and respondents with biases may select themselves into the sample (Andrade 2020). However, the sample of 120 household farmers in the CSV areas was selected via a process of "theoretical sampling" (Glaser and Strauss 1967) based on their participation in the CSV program (the adopter) and their potential to offer distinct and important perspectives on CSA intervention and recent issues regarding farmers' participation in the CSV project.

IV. Results

4.1. CSA interventions in Vinh Kien

Vinh Kien together with Dai Minh, Han Da, Vinh Kien, Bach Ha, Vu Linh, Cam Nhan, Tich Coc is among the communes of Yen Binh district that the local government recently have restructured the agricultural sector toward the development of citrus fruits (approximately 1100 ha), cinnamon plantation (approximately 1200 ha), and specialty rice production (approximately 500 ha). Besides, agricultural production in Yen Binh district also includes a 400-hectare area of water surface as part of Thac Ba lake for fish farming, which is owned by 2,000 fish farmers. Considered as one of many vulnerable areas to climate risks, Vinh Kien commune authorities have taken this opportunity to renew the future planning for the development of agricultural and fishery production in the regards of market-oriented agricultural commodities, improvement of yield and quality, construction of network linkages in the value chain, and especially enhancement of farmer's resilience. The quick response of the local government the initiation and spreading of the CSV's interventions since 2015 has significantly helped diversify agricultural production in Vinh Kien against severe impacts of climate change, food insecurity, adaptive incapability, and climate-related risk aversion of small household farmers[2].

The main CSA T&Ps introduced to Ma CSV by the CCAFS project are as follows:

- Cassava-legume intercropping (CLI): Leguminous crops are intercropped cassava on arable sloping land to prevent soil erosion; to restore declined soil quality through improved land cover and thus soil moisture content, enhanced soil nutrients through their biological nitrogen fixation mechanism, better soil aeration and root penetration; and to increase household mixed income. This CSA T&P has various climate smartness, such as nutrient, water and income smartness; and a potential adaptive capacity to impacts of monsoonal climate, such as carbon sequestration to degraded soils.
- Cassava-contoured grass strips (CCGT): Forage grass is planted along contour lines on cassava slopes to prevent soil erosion; restore degraded soils; and provide forage to cattle through the cut-and-carry system, thus, additional income. CCGT offers nutrient and income smartness, and better adaptation to soil erosion and degradation with the capacity to improve soil organic carbon in the topsoil.
- Vermicomposting (VC): Earthworms are fed with livestock dung in well managed environment that become feed for poultry and fish, thus, saving household budget for animal feed. Compost is then used as fertilizer for crops and/or home garden vegetables. This practice has nutrient smartness and cost effectiveness and an effective measure for reduction of emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) – mitigation pillar of CSA.

[2] https://yenbai.gov.vn/nongthonmoi/noidung/tintuc/Pages/chi-tiet-tin-tuc.aspx?ItemID=135&l=Tinhoatdong

- Alternate wetting-drying (AWD): In the paddy rice production system, flooding is only maintained periodically, compared to continuous flooding in the farmer's practice, in accordance with water-intensive growth stages of rice – water smartness. Rice seedlings are planted more sparsely for full plant development and maximum flowering and grains – resource smartness and productivity pillar. This measure helps mitigate emissions of CH_4 from reduced flooding time – mitigation pillar.
- Rice straw processing (RSP): Rice straw, which is a great source of nutrient provided back to soils if processed right, is commonly burnt in most rural areas and a significant source of CO_2 emission in the country. Mixing effective microorganism products with rice straw in layers for two months can quickly produce a large quantity of fertilizer for crops and/or fertilizer. This practice can usefully achieve the mitigation pillar through reduced CO_2 emission and save cost for fertilizer.
- Integrated home garden (IHG): Home garden can contribute greatly to household economy from subsistence to market orientation. Main components of a home garden in Ma CSV are fruit trees, vegetables, animal keeping (eg. cattle, pig, and/or poultry), and fish ponds. Eco-efficient combination of these components can help maximize an integrated production system and total income from the garden. Some CSA T&Ps above can be practiced in a home garden, such as VC, legume intercropping, cut-and-carry livestock system and all three CSA pillars (adaptation, mitigation, and productivity) can be achieved here.

One household can practice more than one CSA T&P based on their available resources (land, labor, budget, etc.) and farming strategies. The combination of different CSAT T&Ps is called an integrated agricultural model that a household applies and illustrated in Figure 3.

4.2 Change outcomes generated by the CSV approach

As an effective response to the negative impacts of climate change in Yen Bai, the CSV project (CCAFS FP2.1) has consecutively been making efforts to engage smallholder farmers into the process of knowledge enhancement of CSA technologies and practices (CSA T&Ps) via experiential/field learning, sharing of knowledge and experiences on CSA technologies and practices among farmers and CSV support institutions, and exhibition of community-based CSV approach. Most of the CSV participants realized the positive impacts of the CSV's interventions in terms of economic efficiency, environmental protection, and social welfare. However, according to the group of the CSV non-participants, farmers' involvement in this program stems from the typical problems of limited access to capital and technical assistance, and market information. Therefore, a farmer could either continue traditional intensive farming due to his/her availability of household resources or adopt the CSA technologies and practices and look for overall benefits in the future. This section emphasizes the several significant change outcomes that are essential for smallholder farmers in Yen Bai province to mitigate the impacts of climate change.

4.2.1 Production practices

Within the surveyed sample, the outcome harvesting study uncovers significant differences in performed agricultural production (a total of 23 models in Figure 3) between the non-adopter and the adopter groups of farmers in Vinh Kien. The majority of farmers in both groups (8.6% for the non-adopters and 12.1% for the adopters) practice the integrated agricultural model (ACDE) that includes staple crops, industrial crops, poultry, and livestock production. The agricultural production models selected by the groups of households participating in CSV (the adopters) with a lower frequency are the ABDE, ACD, and ADE integrated models with the frequencies of 7.76%, 7.76%, and 10.34%, respectively. Besides the majority of the ACDE model (12.07% of the total number of the adopters and 8.62% for the non-adopters), the non-adopter favored the agricultural models AC (5.17%), ACD (4.31%), and the same frequency of 3.45% for each ACE, AD, and ADE model. None of the adopters selected the C, CD, CDE, and CE agricultural models. Similarly, none of the farmers in the non-adopter group selected the BD, BDE, and BE models. The different frequencies in the farmers' selection of household agricultural models was mainly influenced by their accumulated self-experiences in agriculture, access to different resources (extension, finance, technology, climate change, marketing services) and gained knowledge from their participation in the CSV work (the Pearson chi-square test was 15.668, 19.321, 26.835, 26.038, 33.261, 31.829, and 32.450 respectively). The diversity of their preference to agricultural models partly exhibits the initial change outcome of the CSV's prevention on the production behavior of smallholder farmers in Vinh Kien.

Vinh Kien is like many other mountainous areas in the North of Vietnam where many ethnic minorities reside, the household economy is mainly agricultural and forestry production with small-scale and self-sufficient production (see Picture 2, Appendix). More recently, the local government paid more attention to specific agricultural production development goals, including providing price support and other measures to improve rural livelihoods, which created remarkable change in the rural economy of Vinh Kien through household's farm and non-farm activities, household's income improvement,

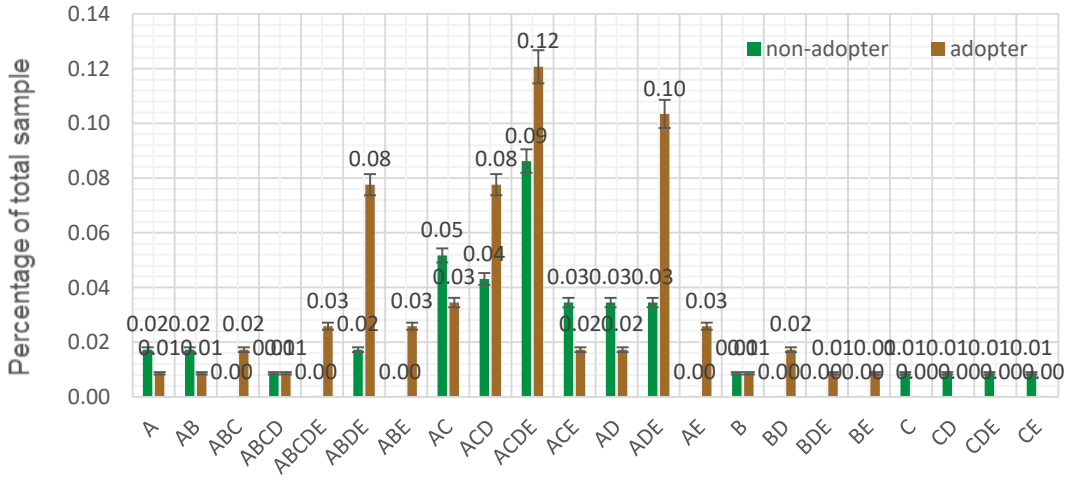

Figure 3. Dynamic agricultural model

Note: A. staple crop; B. fruit and vegetable; C. industrial crop; D. poutry; E. livestocks. Chi-square: 27.203 (df 21). Results are based on nonempty rows and columns in each innermost subtable.

household's nutrition, hunger eradication, and poverty reduction. Specifically, policy amendments focused on the provision of high-quality rice varieties, hybrid maize varieties, fertilizer, and other necessary inputs, (nylon materials to cover rice production in the winter-spring season), household training to make hay dune to store fodder (other agricultural foodstuffs) for livestock, supplying acacia trees and medicinal plants for agroforestry household, land reclamation for paddy rice cultivation, provisions of grass seeds for buffalo and cow raising, and financial support for poor and pro-poor households to raise buffaloes and cows (see picture 3, Appendix). The general picture of different agricultural activities in every farmer household can be seen in Figure 4, which indicated five household production activities including staple crop, fruit and vegetable, industrial crop, poultry, and livestock. There are a significantly higher number of the adopters who is cultivating staple crops (56.9%) (such as rice, maize, cassava...), fruit and vegetable farming (20.7%), growing industrial crops (30.2%), with poultry (45.7%) and livestock production (41.4%).

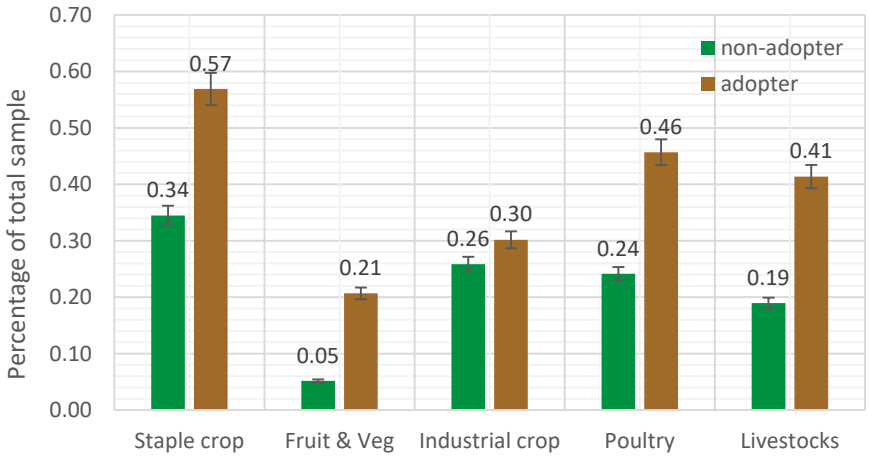

Figure 4. Agricultural activities of farmer household

Note: Chi-square statistics (df 1) are 0.579; 6.019; 3.374; 2.018; and 4.032 respectively.

Through the participation in the CSV, farmers increased their awareness about climate change and its impacts, scientific and technical knowledge, CSA technologies and practices in production. The transforming voice and agency among the CSA-adopters '*attracted a large number of other farmers to join and created a joyful and excited atmosphere in the community, which contributed to improving their adaptive capacities and resilience to climate change impacts'* (said Mr. Hai, Ma village, from focus group discussion). Up to now, there are still large groups of CSA-adopted farmers who have continued to maintain CSA T&Ps in their agricultural production. The most effective and efficient CSA practices are the integrated home garden (44.8%), rice straw processing (20.7%), cassava-legume intercropping, and alternate wetting and drying (8.6%) (see Pictures 4 and 5, Appendix). The description of these CSA T&Ps can be found in Bui et al (2015, 2016, 2017). The main source of household agricultural knowledge is from accumulated self-experience (59.5%) and knowledge sharing in the local communities (53.4%), while only 24.1% of surveyed farmers reported that their agricultural knowledge is mainly from CSA training. In terms of access to different resources as an outcome of the

project, there are a large number of adopters (50.9%) recently having access to extension services (sanitation, vaccination, farm pasteurization, crop protection….), finance services (51.7%), climate change services (50.9%) (mostly the weather forecast on public media), and science and technology transfer services (36.2%) that include new varieties, new machinery, new practices from training, and technical brochure from the local agent (agricultural inputs provider). Market access services (sale incentives by local traders or market information services from the public media) only reached 17.2% of the total adopted farmers. In this case, those farmers who did not have access explain that their production is only for household self-sufficiency.

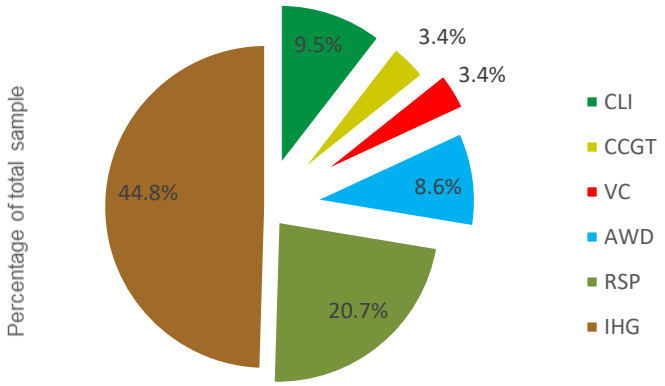

Figure 5. Agricultural practices adopted from CSA

Note: Chi-square statistics (df 1) equal to 7.702; 2.626; 2.626; 6.936; 19.179; and 59.736 respectively. CLI (Cassava-legume intercropping); CCGT (Cassava-contoured grass strips); VC (Vermicomposting); AWD (Alternate wetting-drying); RSP (Rice straw processing); and IHG (Integrated home garden)

4.2.2 Farmer's knowledge

Over the focus group discussions (FGDs) among the adopter groups, farmers all agreed that the great change from traditional/habitual techniques to resilient techniques through CSA's scientific and technical knowledge has contributed to the improvement of productivity, quality, and value of their agricultural products. Many poor rural households who adopted of CSA T&Ps enhanced their resilience to climate change. Chosen as a member of the Program Steering Committee, Mr. Nguyen Van Tam, the head of Ma village, has actively learned much of knowledge and passed it on to other farmers. Since then, local farmers in Ma village have understood that the "Climate Smart Village" model is a solution that combines all eco-friendly techniques and practices, such as raising earthworms, contoured grass strips on cassava planting slopes, intercropping forest trees with grass strips, selection of drought-resistant varieties, and using biological products to prevent pests and diseases, which in turn contributed to building sustainable and environmentally friendly agriculture.

Through the survey, the majority of farmer households also believed that their agricultural production knowledge comes from long-term accumulated experience in agricultural production activities at the farm (ASE - Accumulated self-experiences), then knowledge from the exchange and sharing with other farmers in the village (KD - Common knowledge diffusion), from training activities provided by rural

communal extension units (TR). On average, 24.14% of the total farmers participating in the CSV project and 12.93% of the total farmers not participating shared the story that their knowledge accumulated from the former research and development projects that have been implemented in the area (CP). Other sources of knowledge are different information packages in the public media, from consulting activities of agents who have been supplying inputs for local agricultural production (Other knowledge). In brief, the CSV project as well as other agricultural research and development programs have greatly influenced the change in agricultural production knowledge in the local community, through propaganda, education, consulting, training, guidance, and finally the spread of knowledge in the community.

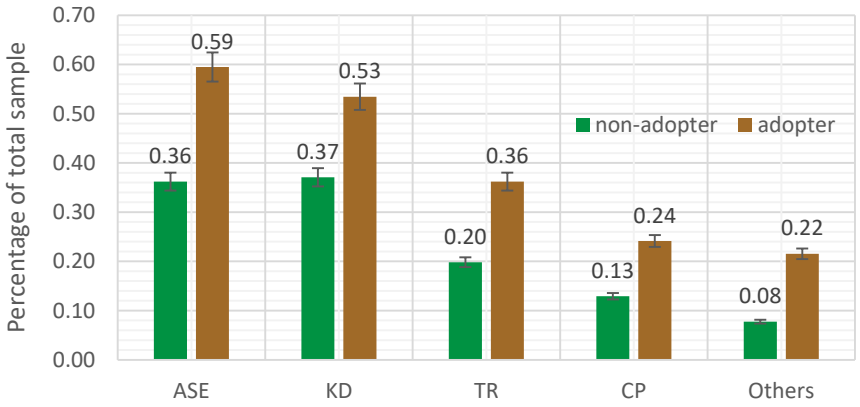

Figure 6. Main source of agricultural knowledge

Note: Chi-square statistics (df 1) equal to 0.990; 2.174; .723; .440; and 3.076 respectively. ASE (Accumulated self experiences), KD (Common knowledge diffusion), TR (Knowledge from extension training activities), CP (Common knowledge from project participation), and other source of knowledge.

"Since the application of captivity-raising techniques instructed by CSV project, goats have limited diseases caused by weather, especially in the rainy season and unusually hot days. The source of goat manure is composted by my family as fertilizer for crops, so it not only limits environmental pollution but also has a very good source of fertilizer for fruit trees".

Nguyen Van Tam, Ma village.

Knowledge improvement at the household level attributed to the CSV project including (APBV) animal & plant breeding and varieties, (SM) soil management, fertilization (FR), (PDM) pest and diseases management, and (RM) risk management. Statistic results on farmers' reflection regarding the improved knowledge come from the majority of the groups of farmer households who participated in the CSV project. Specifically, there is a statistically significant difference in the knowledge of pest and diseases management between the adopter and the non-adopter when the P-value of the PDM variable was smaller than 0.5. In addition to other economic, social, and environmental benefits, the statistic results also symbolized the fact that, improved production knowledge is consistently

appreciated among the dynamic and well-endowed groups of farmers as if they have been involved in such agricultural research and development projects similar to CSV (Figure 7).

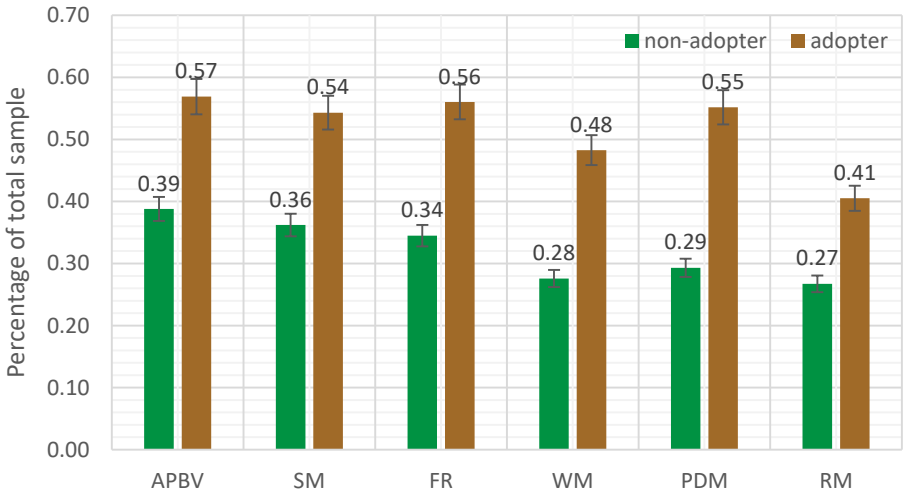

Figure 7. Improved agricultural knowledge at household level

Note: Chi-square statistics (df 1) equal to 3.312; .679; .227; .906; 4.470; and .091 respectively. The two-sided tests (with P-value < .05) statistically showed the significant difference in the PDM between the groups of farmers

An example, Mr. Tran Trung Kien and his wife (Ma village, Vinh Kien commune) are both disabled people, and they were previously in very difficult circumstances, lacking knowledge in farming and animal husbandry. In 2014, Mr. Kien's family participated in the implementation stage of the "Ma Climate-Smart Village" model. Mr. Kien shared: *"Joining in the model, I received a lot of training in husbandry and farming knowledge such as raising earthworms from waste from buffaloes and cows. The earthworms are then used as food for chickens, creating humus for the soil and also as fertilizer for plants. I make use of sawdust from wood processing factories in the area and rice bran to make biological cushions, deodorize waste in chicken raising, etc. I know different practices about husbandry, livestock, and poultry production that help to raise them well and limit the diseases."* Similar household conditions to Mr. Kien's family, the other households in Ma village have also received advanced CSA's knowledge regarding household's economic development plans associated with environmental protection. Many others, for example, have planted cassava interspersed with grass strips on the hill, to both have grass for livestock and prevent soil erosion. This progress helps spread advanced agricultural knowledge and farm-management skills to the local people. Furthermore, the CSV project also invested in a loudspeaker system and a community library with over 200 books and a computer so that farmers can easily learn, look up techniques and practices in agriculture and forestry as well as animal husbandry production (see Pictures 6 and 7, Appendix). In general, farmers' knowledge and skills are significantly increased.

Statistics on the improvement of knowledge regarding the (APBV) Animal & plant breeding and diseases, (SM) Soil management, Fertilization (FR), (PDM) Pest and management, RM (Risk management) according to the Likert-scale in are in Figure 8. The surveyed households in Vinh Kien

confirmed that the most improved knowledge was PDM and FR for the group of the adopter, and the APBV, SM, FR for the non-adopter group. The size of such a variation depends largely on how many CSA T&Ps that the CSV project has brought and delivered to the adopted households in Vinh Kien.

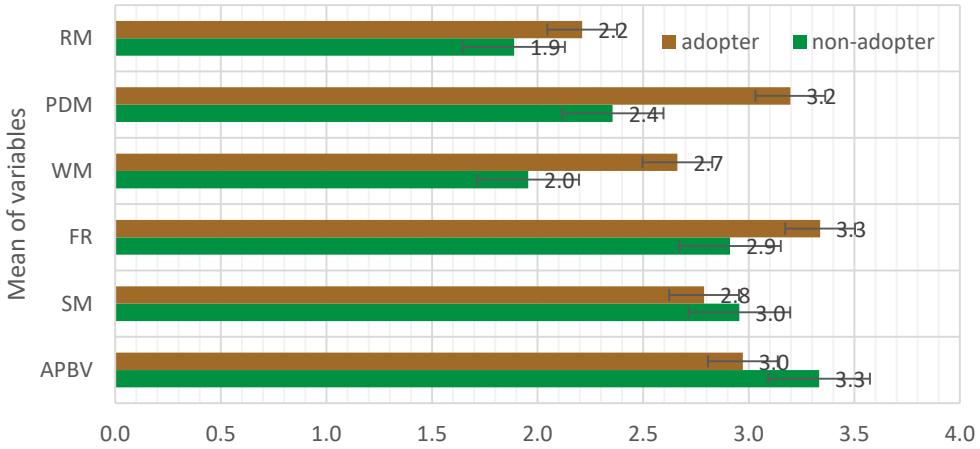

Figure 8. Magnitude of knowledge improvement

Note: Results are based on 5-point Likert scale (1. Poor; 2. Unremarkable; 3. Meets expectation; 4. Better than expected; 5. Outstanding). Pairwise comparisons (T-test) statistically showed the significant higher knowledge attainment (FR and SM) in the adopter group.

In addition to the farmer's knowledge improvement, the communities sharing of knowledge to enhance capacity to adapt to climate change was analyzed at the communal level (Figure 9). In the survey, farmer households responded that the knowledge shared and exchanged in agricultural production and daily life also includes: (APBV) Animal & plant breeding and varieties, (SM) Soil management, (FR) Fertilization, (PDM) Pest and diseases management, and RM (Risk management). The statistics in Figure 9 indicated the percentage of adopters who shared and exchanged knowledge in terms of animal & plant breeding and varieties (56.9%), proper use of fertilizers (56.03%), and pest and diseases management (55.17%). The groups of households who did not participate in the CSV model often lack knowledge on soil management (36.21%), which is the primary source of knowledge targeted by the CSV project at the initial phase in the implementation of the project.

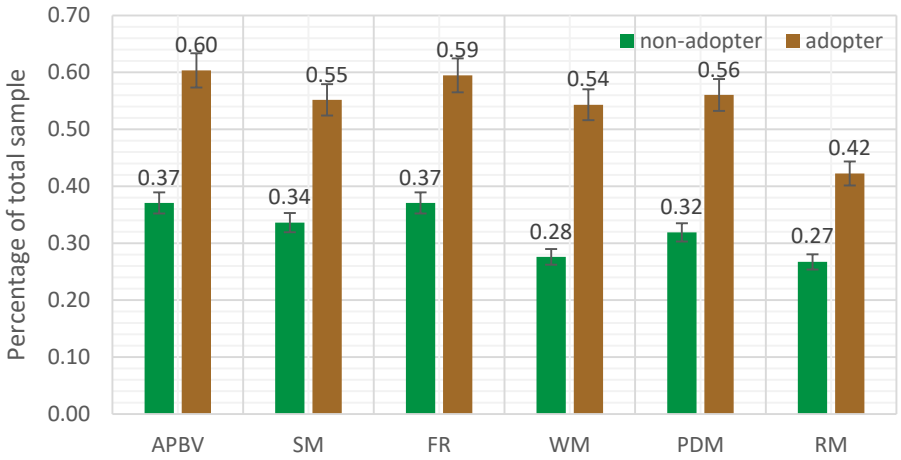

Figure 9. Household's share of knowledge

Note: Chi-square statistics (df 1) equal to 1.008; .334; .219; 5.768; 2.258; and .000 respectively. The two-sided tests (with P-value < .05) statistically showed the only significant difference in the WM between the farmer groups

One of many CSV approaches to stimulate knowledge exchange (knowledge diffusion) was the photovoice exhibit. Fifteen farmers prepared fifteen topical stories about climate impacts on their daily production and life activities through photography. With participation of provincial and local leaders and farmers from Ma and surrounding villages at the exhibit, these farmers presented their observation-based stories and conveyed their specific messages to the participants about needs for joint actions within the community and support from the Yen Bai government in capacity building and investment for better adaptation and resilience. Mrs. Ha Thi Luyen highlighted the majority of farmers preferred this way of communicating farmers' problems and issues in agricultural production management.

"The photovoice activities of the CSV project is very interesting and useful. We have learned a lot about the seriousness of climate change impacts on household agricultural production and their daily lives. By the photovoice, we could send our messages to the local government about the challenges that we have been facing. We hope the government will have the suitable solutions to help us".

Ha Thi Luyen, Muong Village, Thuong Bang La Commune.

To assess the frequency of knowledge exchange on agricultural production practices to improve the ability to respond more effectively to the climate change impacts, we continued utilizing the 5-point Likert scale (1. hardly ever; 2. occasionally; 3. sometimes; 4. frequently; 5. almost always). Therefore, knowledge categories were regularly exchanged at the farm level including pest and disease management (3.2), technical use of fertilizer (3.34.), and breeding and varieties of different animals and plants (2.97). Knowledge regarding water management (1.96) and risk management (1.89) were rarely exchanged and shared by farmer households in the non-adopter group (Figure 10). It is quite a surprising fact that the soil and geographical conditions in Vinh Kien always put the household's

farming activities in a state of drought or lack of water. However, farmers did not have many discussions about the situation. On the other hand, risk aversion behaviors that prevailed in the rural society explained why production risks could not be shared at a higher frequency.

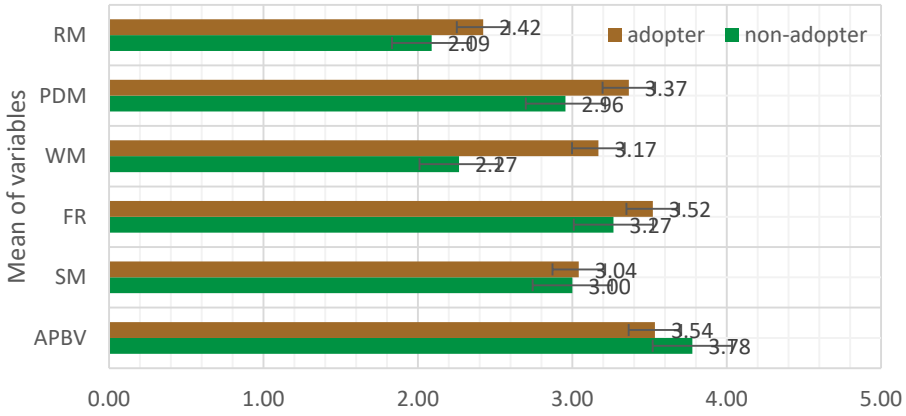

Figure 10. Frequency of knowledge exchange

Note: Results are based on 5-point Likert scale (1. hardly ever; 2. occasionally; 3. sometimes; 4. frequently; 5. almost always). The two-sided tests (with P-value < .05) statistically showed the only significant difference in the WM between the farmer groups

Knowledge sharing and exchange in agriculture involves both the justification of the knowledge source and the acquisition and application of knowledge by the household farmers. It comprises the multi-directional movement of knowledge among farmers and involved stakeholders in agricultural sectors. It also relates to an exchange and sharing of knowledge between two individual farmers. The focus of knowledge sharing and exchange in agriculture is on different endowed household production resources and practices, and the interaction of individual farmers. Knowledge sharing and exchange are more effective in agriculture where the learning process is stimulated, emphasized, and implemented. In Vinh Kien, knowledge sharing and exchanges are *'learning something from other farmers. It enhances sharing of know-how, understanding, and skills, which ignite the adaptive capacities and resilience to climate change impacts'* (said Mrs Me Thi Nham, Ma village, from group discussion).

4.2.3 Access to resources and services

Access to productive resources is a crucial factor in rural development in Vinh Kien. Rural households improve their livelihoods by obtaining access to productive resources, which leads to the household family's well-being. Productive resources can be both tangible, as in capital, land, labor, and raw materials, and intangible, such as knowledge, ideas, and market. Access to such resources is also a major issue in the discourse of gender empowerment, especially in remote rural areas. Several resources and services in Ma village are found in the survey. That includes extension, finance, science and technology, climate change, and market access services (Figure 11).

The agricultural extension service in Vinh Kien is a crucial factor for farmers to access new scientific and technical advances in agriculture, through a team of extension engineers. They provide the most suitable practices for each type of crop to reduce production costs and increase economic and environmental efficiency. They closely cooperate with research institutes, universities, and other professional agencies to conduct training sessions, scientific seminars, test new products and varieties, demonstrate new agricultural models, etc. The household survey found the total number of 50.86% of the CSV-adopters and 25% of the CSV-non adopter had access to extension services.

It is an ironic fact that the majority of vulnerable farmers to climate change impact lives in rural areas and depends on agricultural production, the supply of finance and insurance services to the sector is inadequate, with a small proportion being allocated. Hence, improving access to financial services and insurance is a vital part of addressing the farmer's adaptive capacity in Vinh Kien. Finance and insurance in agriculture relate to the activities such as input supply, production, distribution, wholesale, processing, and marketing (51.72% of the total in the group of adopters having access to financial services, the same statistic is only 26.72% for the non-adopters). However, participating in the model of "Climate Smart Village", farmers can benefit from agricultural insurance to be covered for the risk of crop failures and livestock losses due to abnormal weather changes. The CSV program also financially encourages farmers to use fuel-saving machine tools, manage agricultural by-products, apply measures to save water for crop irrigation (take advantage of groundwater, rainwater), and establish public teams to effectively consult and protect water sources.

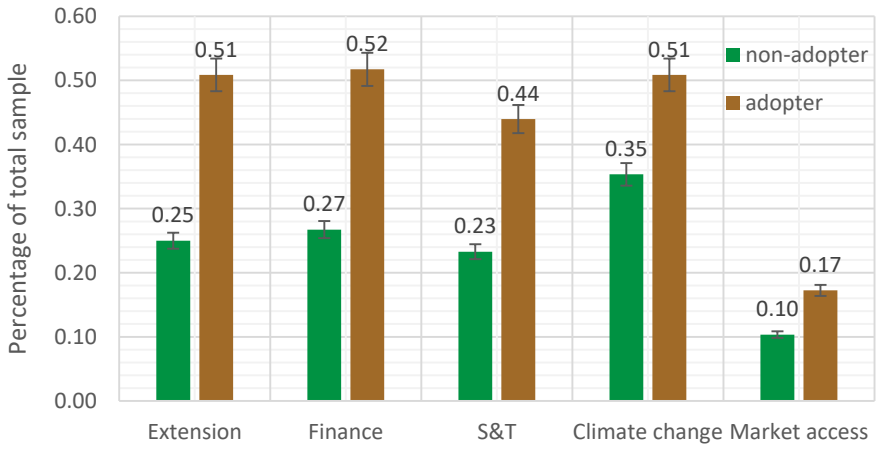

Figure 11. Farmer's access to services in agricultural sector

Note: Chi-square statistics (df 1) equal 5.234; 3.974; 1.750; 2.968; and .031 respectively. The two-sided tests (with P-value < .05) statistically showed the significant smaller number of the non-adopter having access to extension and financial services compared to the adopter

In general, climate change service ranges from conducting scientific and policy assessments to performing the calculation and diagnosis of greenhouse gas emissions and climate risk modeling services, which develops and implements effective adaptation and mitigation solutions at the regional and local levels. This also helps to develop site-specific analyses and strategic recommendations to

improve the resiliency of communities. The agricultural sector of Vinh Kien is developing and dominated by multiple sector players which creates diversity in service provision. The study found that current national institutions charged with the production and dissemination of climate services are the Yen Bai Meteorological Agency, the Department of Agriculture and Rural Development, the Department of Environment, Science, and Technology, and Yen Bai Environmental Protection Agency (EPA). Different climate service providers come up with climate information in different forms depending on their target user groups and interests. Through the direct interviews, farmers acknowledged the importance of climate knowledge-based deliverables from the CSV program. This is also highlighted in the farmer's active response to the weather and climate information service (CIS) in the CSV village. The survey statistics confirmed that the frequency of 50.86% CSV farmers in Ma village having access to climate change services, while the smaller statistics accounted for the non-adopter group of farmers.

4.2.4 Economic gain

Cost-benefit analysis (CBA) in Tables 3 and 4 reveals the significant differences in input use, yield, selling price, gross return, and profit of the main crop and animal production. From this point, adopters were able to achieve significantly higher (t-statistic was -3.1033) gross profit (2339.32 thousand VND/Sao[3]) through lower production cost (2159.37 thousand VND/Sao) and higher price premium (7.58 thousand VND) in their main crop production (Table 3).

Table 3. Cost-benefit analysis of the main crop

	Non-adopter[a]			Adopter[b]		
	Mean	SD	SE	Mean	SD	SE
Tillage	1044.44	826.01	123.13	810.07	650.58	77.21
Seedling	330.78	374.27	55.79	324.23	422.07	50.09
Fertilizer	741.44	543.34	81.00	775.70	780.96	92.68
Pesticide	312.00	239.58	35.71	234.86	232.89	27.64
Water	53.33[b]	302.71	45.13	14.51	71.71	8.51
Family labor	11.94	8.83	1.32	15.61	25.10	2.98
Total cost	2482.00	1627.92	242.68	2159.37	1595.06	189.30
Return	3898.64	1971.85	293.95	4498.68[a]	3352.01	397.81
Gross profit	1416.64	1053.73	157.08	2339.32[a]	2127.09	252.44

Note: a,b. Results are based on two-sided tests with a significance level .05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion. See appendix.

Due to the exclusion of family labor cost in CBA, however, there was no significant difference in gross profit between these farmer groups from their main animal husbandry production. The reason is each farming system required different labor-intensity of different practices. The initial results revealed the "climate-smart" approach of the CSV program has succeeded in maintaining the sustainability of the household's economic well-being and the adaptive capacity to climate change. Accordingly, after 5 years of the implementation phase, the people of Ma village have diversified farming activities and

[3] 1 sao = 360 m^2

livelihoods and increased economic and cultural interactions with other farmers. Adopting CSA technologies and practices, many families in Ma village *'have not only enhanced productivity in agricultural production but also increased hygienic living conditions from a cleaner environment'* (said Mrs Au Thi Thanh, Ma village). In addition, the rate of poor and pro-poor household families has been reduced by 45% compared to 2014.

Table 4. Cost-benefit analysis of the main animal husbandry

	Non-adopter[a]			**Adopter[b]**		
	Mean	SD	SE	Mean	SD	SE
Breeding	1373.11	3550.85	529.33	2765.21	10273.98	1219.30
Feed	2754.44	5911.88	881.29	4379.44	11214.58	1330.93
Yeast	2.89	12.54	1.87	7.89[a]	28.23	3.35
Medicine	200.00	331.49	49.42	400.14	1017.48	120.75
Energy	27.11	91.37	13.62	89.51[a]	188.82	22.41
Family labor	16.27	53.16	7.92	14.40	30.14	3.58
Total cost	4357.56	9503.11	1416.64	7628.10	16664.72	1977.74
Return	9424.44	12400.24	1848.52	12931.27	29636.69	3517.23
Gross profit	5115.78	8711.44	1298.62	7258.03	17816.23	2114.40

Note: SD denotes standard deviation; SE standard error; a,b. Results are based on two-sided tests with a significance level .05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion. See appendix.

In the analysis of the household general change from the economic aspect, the variables related to the agricultural production efficiency of farmer households include the IYP (Increased yield and productivity of household agri-products), IQAP (Improved quality of household agri-products), DCI (Decreased cost of input use), BRM (Better risk management in production planning and sale), DCL (Diminishing cost of household labor), and BMC (Better market access). Descriptive statistics revealed the fact that the higher frequency of the adopted farmer households achieved positive changes in yield and productivity (46.6%) and quality of household agro-products (52.6%), decreasing production cost (49.1%), and better risk management in production (44.0%) (Figure 12). The empirical evidence supports our previous findings and conclusions from the CBA analysis of the main crop and animal husbandry.

"The household economic conditions have developed, improved a lot because it is easier to make money than before. The village roads have been concrete-built, the house is also better equipped, such as air conditioners…"

Dinh Thi Chi, Ba Chang Village

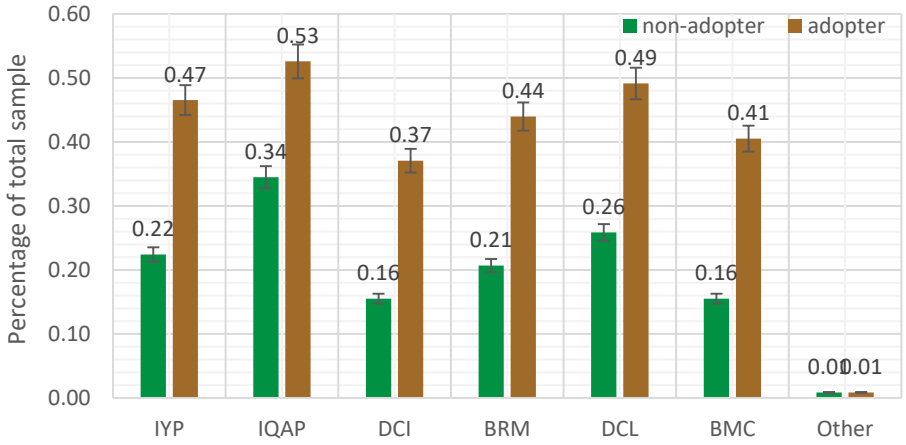

Figure 12. Economic benefits to household farmer

Note: Chi-square statistics (df 1) equal to 4.300; .216; 4.671; 4.124; 2.723; 7.673; .108 respectively. The two-sided tests (with P-value < .05) statistically showed the significant smaller number of the non-adopter who have gained economic benefits in terms of IYP, DCI, BRM, and BMC

4.2.5 Social benefits

In terms of the social aspects related to the change outcomes of CSV's interventions, we focused on the farmer's well-being, health conditions, knowledge sharing and diffusion, family situation, gender equity, and their capability to improve access to different services embedded in rural sociology (Figure 13).

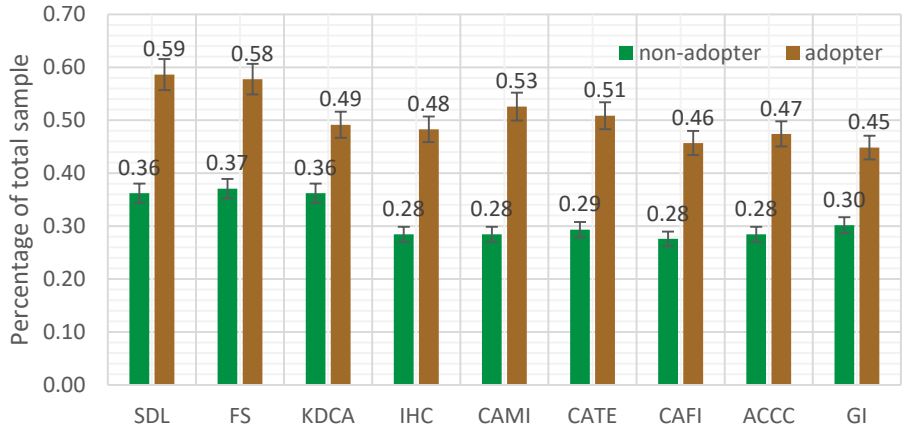

Figure 13. Social benefits to farmer household

Note: Chi-square statistics (df 1) equal to .335; .079; 3.751; .473; 2.837; .986; .176; .257; and .303 respectively. The two-sided tests (with P-value < .05) statistically showed the significant indifference in the social benefits obtained by both groups of farmer.

Empirically, the above criteria are specified in the following variables including SDL (standard of living of the household family), FS (family solidarity), KDCA (increasing knowledge diffusion and collective action among household members), IHC (improved health conditions), CAMI (improved communication and access to market information), CATE (improved capability to access to technology and extension services), CAFI (improved capability to access to finance and insurance markets), ACCC

(improved adaptive capabilities to climate changes), GI (decreased gender inequity in household's agricultural activities and decision-making process). These variables all accounted for larger than 45% of the total response in the adopted groups, meaning that a large number of local farmer households have been increased their social benefits since the CSV project.

From group discussions and in-depth interviews with the CSV-adopters, women identified a range of personal development outcomes including developing new ideas, building a range of production skills, and awareness about key issues on climate change adaption (cropping renovations, livestock care etc.). Women also identified an increased recognition by their local authorities of their increased knowledge, contributing to the resilience of their communities and as vital CC/DRR resources.

Experiences of gender change were more commonly reported at both the household level and community level. Most of women participants self-identified increased empowerment outcomes. Through the project activities, the improved communication between wives and husbands, females and males increased women's influence over the household decision-making process. Women increased trust in their abilities to step beyond theexisting cultural norms where men are the primary decision makers and income generators and advocate for their needs and priorities. The boundary of the tasks commonly assigned strictly for one gender is fading: women can now handle tasks that commonly done by men: drive motorbike, running machines. In the family where women earn more money than men, the power relations become more equal and women perceived themselves to have become more self-confident than men perceived them to be. It is common to hear that husband and wife together developed their household vision and action plan including both economic development and gender equality.

It is clear that women increased self-confidence to participate in the CSV project, extension trainings or community meetings. In addition, they take collective action to not only engage in community activities and planning but also express their power to act freely, exercise their rights, and begin to fulfill their potential as full and equal members of society (especially for women who took part in exchange visits with other provinces and abroad). Women feel more confident and empowered to work as leader (from training group lead to wooden workshop manager). Surprisingly, some Ma women could identify common agendas for advocacy and women's concerns, expressing their need to better understand about the village-commune-district-province-national connections, particularly understanding where their own village fits into the whole picture. One woman attended the study tour in Philippine said that being invited to international events elevated women status and respect in the community. The participationof women in exchange visit abroad positively reinforced women's roles as representative in their own community.

Women have improved knowledge of gender differences in their perception of climate change and household adaptation strategies. The participation of women in communal activities positively reinforced women's roles as representatives to prepare for and respond to gender-related risks of climate change and related crises (fetching water, taking care of sick animals, cleaning the house, caring for children…). The empowerment that women in Ma have experienced is sustainable beyond

the project as expressed by the women and some local government officials. Some women have a new understanding where they envisage themselves as leaders and instructor of CC/DRR adaptation for their communities. There is evidence that project was conducive to longer-term sustainability due to the high-levels of buy-in and engagement of the diverse stakeholder groups. This is particularly evident in terms of its capacity to mobilise village members in the collection of data for this study and information on the implementation of CC/DRR activities.

…." women in Ma village have changed a lot since they participated in the project. The project has helped them improve knowledge and perception about resilience to climate change, changing production habits…not letting animals roam, interactively exchanging ideas, and experience more and more…not differentiating Cao Lan or Kinh (such as via training, photovoice…). The project has also helped them feel more confident in terms of agriculture techniques when talking with their husbands…we Ma village women together contribute to the activities in the village such as environmental sanitation, building New Village"…

Mrs. Thu, Women Union, Ma Village

Due to the 4-year time frame of the project, the impact is yet to be determined. However, the most significant impact beyond women's increased empowerment, access to decision-making, capacity and knowledge is that of the attitude and habits that the project created and disseminated. The researchers did not have sufficient time to collect data on gender transformation mostly because the magnitude of such change is significant and it would not be realistic to expect that outcome in a 4-year project. However, the study confirms that the project has enabledthe process of collaboration towards joint advocacy, networking of women and collective action for change; understanding of the value and power of women's voices in advocacy, capacity building (confidence, skills and knowledge) for influencing at provincial and national scale; and awareness of policy change and potential to influence decision making by the women participants.

4.2.6 Enabling environmental management

Among the selected villages of the CSV project, Ma village most effectively applied the model of "Climate Smart Village". The village has 193 households, 750 people, and half of which are Cao Lan people. With the guidance and support from CSV scientists, many types of livestock production are favored and selected by farmers such as worm farming (vermicomposting), chicken raising with biological cushion, semi-industrial husbandry, etc. This farming model not only reduces greenhouse gas emissions, protects the environment, but also guarantees household livelihoods and improves the quality of life. The positive change outcomes regarding the environmental benefits were also seen in other villages as they are highlighted by the statement of Mr. Dam Van Thuy from the People's Committee of Van Yen District.

"Under the context of climate change, the CSV project in Cau Vai village, initiated and implemented by CGIAR Research Program on Climate Change, has proven its effective impacts on the productivity of crop and

animal husbandry production, restoration of degraded soils, reduction of environmental pollution including air, water, and greenhouse gas (GHG) emission, for example".

Doan Van Thuy, People's Committee of Van Yen District.

In terms of environmental benefits to the local household farmers, we focused on the following variables: EP (decreasing environmental pollution from burning straw, overuse of pesticide and fertilizer, etc., CCI (eliminating the appearance of extreme weather events such as flood, drought, hail…etc..), SQ (improved soil quality), BD (sustain the appearance of bio-diversity in the agriculture), ID (eliminated impacts of insect and diseases), and WM (better water use management). From there, the biggest environmental change in the adopters was realized in the better water-use management (40.5%), improved soil quality in the farm (36.2%), and decreasing environmental pollution through straw burning and overuse of pesticide and chemical fertilizer (confirmed by the similar story from farmer group discussion). Conceivably, the positive change from the environmental aspect under the intervention of the CSV project is considered a core principle of sustainable development to improve household farmers' well-being and to sustain these improvements under the consequences of climate change over time (Figure 14).

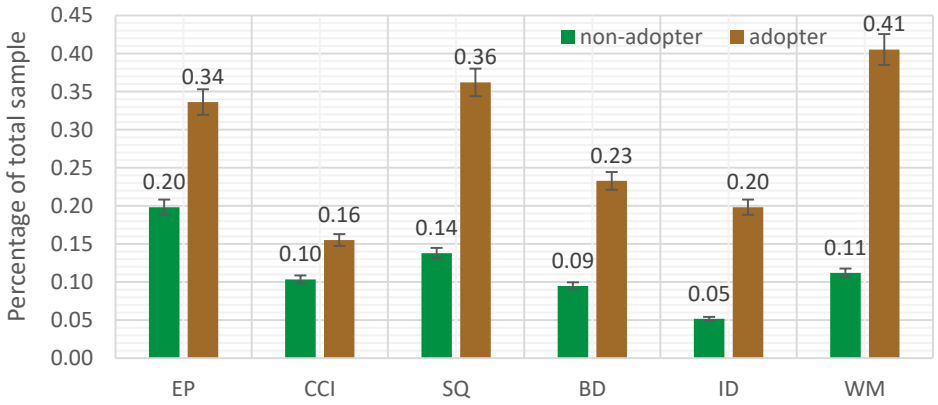

Figure 14. Change outcomes in environmental management

Note: Chi-square statistics (df 1) equal to .161; .025; 6.136; 2.307; 5.337, and 15.353 respectively. The two-sided tests (with P-value < .05) statistically showed the significant difference in the change outcomes of environmental management in terms of SQ, ID, and WM.

In addition, according to the survey results of household farmers who raise earthworms in the vermicomposting practice, the waste of buffaloes and cows that was previously the main cause of offensive odors and smells (contribute to the level of air pollution in our local communities), is now a source of food for worms to create organic fertilizer for crop production. Worms have also become a source of nutritious food for raising chickens. Taking advantage of sawdust from wood processing factories in the village, CSV scientists have consulted household farmers on how to make the biological cushion to eliminate the odor of chicken waste.

"The biological cushion uses yeast and rice bran, the manure is always dry, there are no mites, the smell is not irritating at all, I can comfortably stay in the barn".

Tran Thi Lam, Ma Village

For the area of dry fields in Ma village, CSV experts advised farmers to intercrop fruit trees with grass to create a source of nutritious food for animal husbandry production (used as fodder for buffaloes, cows, and goats). The cassava farmers were also instructed to intercrop with grass. These practices helped to improve the nutrient and structure of the soil, increase water permeability). While other crops cannot be grown on sloping and infertile land, the cassava-grass intercropping has brought considerable income increase to farmers, especially those who also combined with fish farming. With new technologies and practices, the CSV model has aided farmers to disseminate farming techniques at the community level. Further, the mobilization of farmers' participation early on in the program during selection of techniques has promoted use of local indigenous knowledge. Farmers are able to adapt their techniques to local soil types and farming practices. The CSV model has positively changed farmers' perceptions regarding the environmental impact of their actions.

4.2.7 Farmer's perception

According to the survey data on the ability to recognize extreme climate phenomena in Vinh Kien, farmers all believed that 5 common and frequent extreme climate phenomena affect not only the agricultural production but also their daily lives including excessive rainfall, hail, drought, flood, cold and hot spells. Through a communication network built from the CSV project, the majority of the adopted households notified each other to build their perception of these extreme weather phenomena (excessive rainfall, hails, drought, flood, hot/cold spells. Statistics on the ability to recognize the above weather phenomena among the adopters are 60.34%, 56.03%, 56.9%, 47.41%, and 56.9%, compared to 28.4, 24.1%, 34.5%, 28.4%, and 31.0% of the non-adopters, respectively (Figure 15). To further confirm the above, according to Yen Bai Meteorological Agency, 2020 was an abnormal year with weather extremes that have not been observed for more than 10 years. Climate change has significantly affected the weather and climate conditions of Yen Bai as some local areas in the province have been witnessed severe thunderstorms and hail.

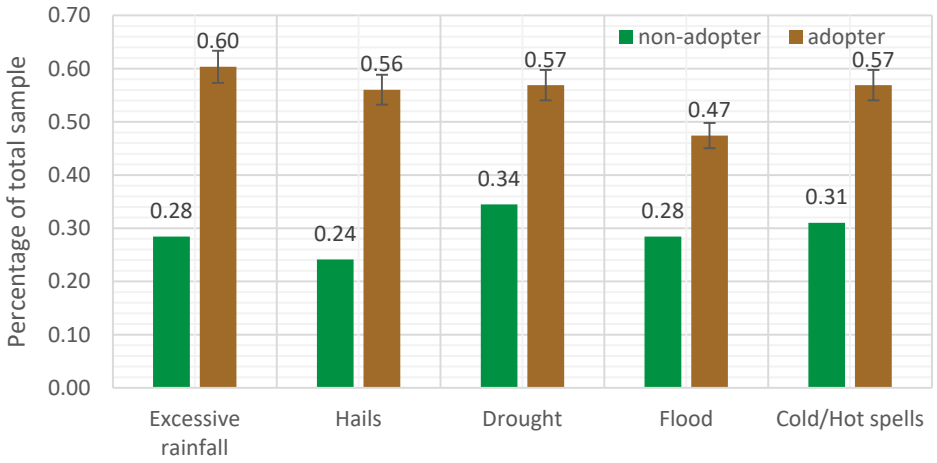

Figure 15. Perception of extreme weather events

Note: Chi-square statistics (df 1) equal to . 17.658; 14.902; .579; .257; and 4.358 respectively. The two-sided tests (with P-value < .05) statistically showed the significant difference in the farmer's awareness of extreme weather in terms of excessive rainfall, hails, and cold and hot spells.

The group discussion among farmer households revolved around the stories that Vinh Kien in the future may still be affected by severe weather phenomena such as storms, whirlwinds, hail, lightning, strong winds, and heavy rain. In addition, due to the extreme effects of climate change, the large-scale and unusually heavy rains may cause flash floods and landslides. At worst, the intense heat waves will also greatly affect agricultural production as well as people's lives.

"Agricultural production in Cau Vai village, Mau Dong commune, has been affected by soil erosion and land slices triggered by climate anomalies"

Nguyen Thanh Huyen, Center of Agro-Services in Van Yen District.

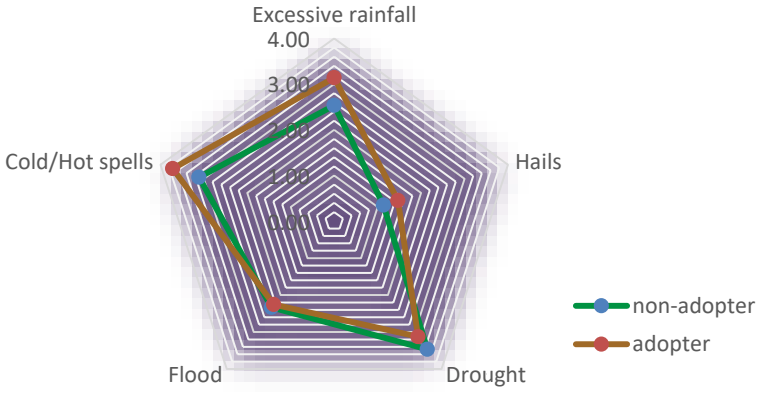

Figure 16. Perception of extreme weather frequency

Note: The two-sided tests (with P-value < .05) statistically showed the significant difference in the frequency of excessive rainfall and cold/hot spell awareness by the groups of farmers

To evaluate the occurrence frequency related to the above extreme weather events in recent years, we used the 5-point Likert scale (1. hardly ever; 2. occasionally; 3. sometimes; 4. frequently; 5. almost

always). Farmers participating in the CSV project agreed that the three extreme weather events with the most frequent occurrence included excessive rainfall (3.14), drought (3.13), and the most common is cold/hot spells (3.72) (Figure 16).

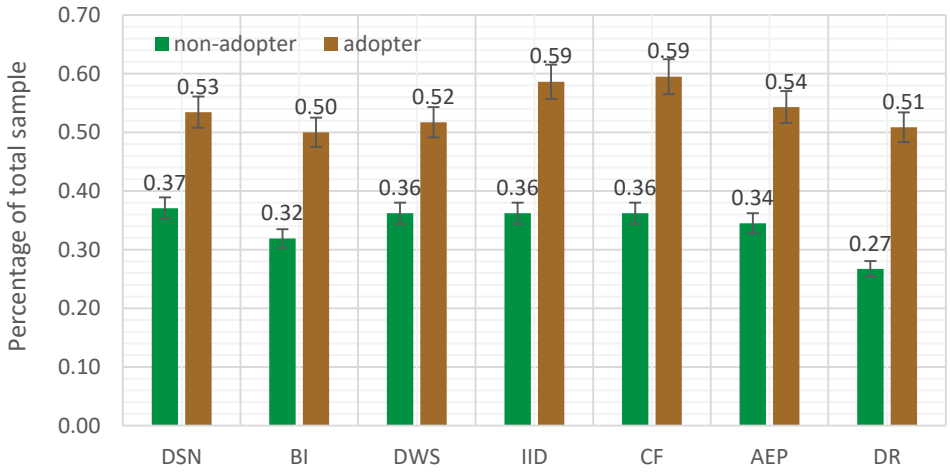

Figure 17. Perception of climate change impacts

Note: Chi-square statistics (df 1) equal to 2.174; .005; 2.022; .335; .990; .001; and 3.198 respectively. The two-sided tests (with P-value < .05) statistically showed the significant indifference in the farmer's perception of climate change impacts.

The common negative impacts from climate change on agricultural production in Vinh Kien included: DSN (Decreasing soil nutrients), BI (Biodiversity imbalance in the agricultural fields), DWS (Depleting). water source), IID (Invasive insects and diseases), CF (Crop failure due to extreme weather events), AEP (Agri-environmental pollution ie acidification, water pollution…), DR (Diminishing returns from agricultural productions). The survey statistics showed that the groups of households participating in the CSV project have been suffering the above impacts at 53.45%, 50%, 51.72%, 58.62%, 59.48%, 54.31%, and 50.86, respectively. % (Figure 17). Interviewing the key informants (KIs) from the local authorities, a government official in Mau Dong commune, Mr. Pham Tien Duy, pointed out the fact that the CSV project implemented in the commune has brought significant changes in terms of farmer's increased perception about the negative impacts of climate change on agricultural production and people's lives in Vinh Kien.

"The CSV activities match well with the local bio-physical and socio-economic

conditions as well as farming practices of smallholder farmers in this area. Since the beginning, the project has improved farmers' perception of climate change impacts and knowledge for enhanced adaptation and resilience".

Pham Tien Duy. People's Committee of Mau Dong Commune

4.2.8 Adaptive solutions to climate change impact

The reason it is called "Climate Smart Village" is because these villagers are guided by the CCAFS program to adopt the smart agricultural model that is suitable to natural conditions, farming practices, and climate-related risks in different regions. This model aims to ensure food security, strengthen farmers' adaptive capacities to climate change, build resilience to negative climate change impacts, and improve household incomes. From 2014 to now, many CSA technologies and practices have been successfully adopted and initially replicated to neighboring areas. These are practices of raising earthworms, farming on sloping soils to prevent erosion (intercropping forestry trees, intercropping with legumes to improve soil fertility), biological padding for livestock and poultry, application of crop varieties resistant to climate change (drought-tolerant, salt-tolerant, flood-tolerant), improved farming practices (ICM, SRI, IPM), eco-based plant protection, measures that contribute to the reduction of greenhouse gas emissions (alternating drying-wetting; processing agricultural by-products), and agricultural consulting services based on climate and weather information (Figure 18).

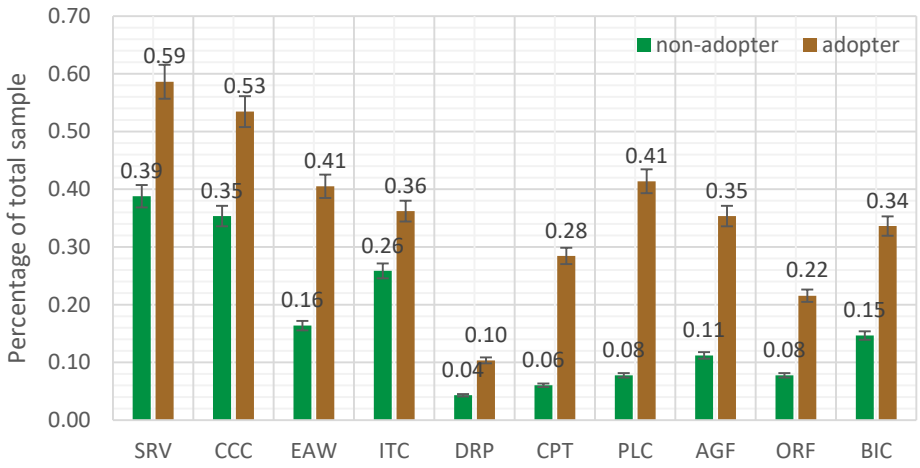

Figure 18. Changes in household's adaptive strategies

Note: Chi-square statistics (df 1) equal to 1.952; .397; 6.456; .660; .738; 11.658; 24.976; 9.219; 3.076; and 3.245 respectively. The two-sided tests (with P-value < .05) statistically showed the significant differences in the EAW, CPT, PLC, and AGF between the farmer groups

Adaptive farming techniques have helped many farmers in Ma village to reduce the negative impacts of climate change and extreme weather events. With the CSV approach, the whole community has made an incredible effort to enhance its adaptability, which is synchronously changed the whole agricultural production system. Analysis of the change outcomes in the adaptive strategies to respond to climate change in Vinh Kien, we focused on some basic variables provided by local farmers through pre-investigation, then conducted the statistics on the opinions of household farmers about these solutions in the main survey. These adaptive strategies included: SRV (Selection of resilient varieties), CCC (Changing crop calendar), EAW (Exploitation of alternate water source), ITC (Intercropping), DRP (Dripping irrigation), CPT (Composting), PLC (Polyculture), AGF (Agroforestry), ORF (Organic farming), BIC (Biological cushion). The farmers stated that most of these solutions were recommended by the CSV project, local authorities, and agricultural extension. The statistics reflect three basic solutions

implemented by farmers in the adopter and non-adopter groups, respectively are: selection of resilient varieties (58.62% and 38.79%), changing crop calendar (53.45% and 35.34% respectively), and intercropping (36.21% and 25.86%) (Figure 18).

Agricultural technologies and practices adapted to climate change always aim to reduce the amount of water misuse and waste from agricultural production into the environment. In Ma-CSV village, farmers are instructed on the appropriate treatment of agricultural by-products and limit the burning of straw. Measures to reduce the application amount of chemical fertilizers and pesticides for crops are prioritized. Similar to the statistics in Figure 18, the adoption frequency of three adaptive solutions is shown in Figure 19. The statistics revealed that the frequency of the adopter and non-adopter groups in applying resilient varieties, changing crop calendar, and intercropping are 3.68 and 4.04, 3.14 and 3.44, 2.04 and 2.33, respectively. Both groups of farmer households in the survey had a very low frequency of practicing drip irrigation (0.45 and 0.27), although water shortage and drought were common among farmer households.

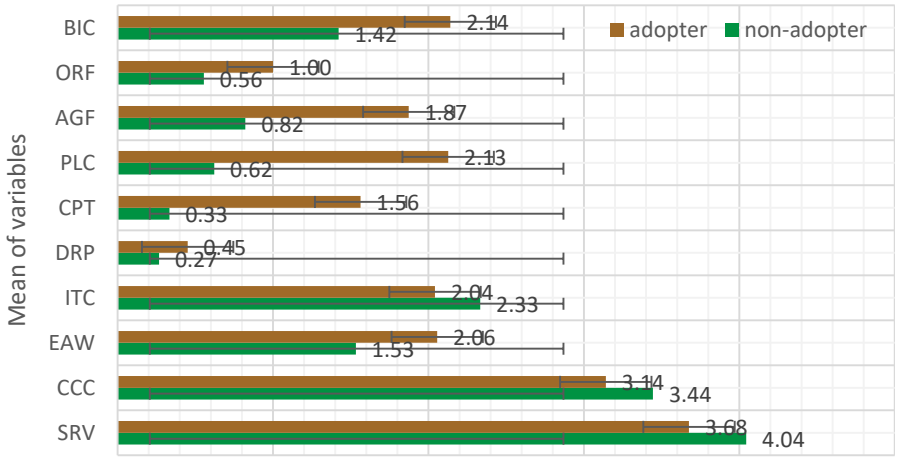

Figure 19. Frequency of adaptive strategies

Note: Results are based on 5-point Likert scale (1. hardly ever; 2. occasionally; 3. sometimes; 4. frequently; 5. almost always). The two-sided tests (with P-value < .05) statistically showed the significant differences in the CPT, PLC, and AGF between the farmer groups

Currently, according to farmers in Vinh Kien, where Ma village is the focal point of the CSV project implementation activities, they believed that the most effective technical solution in the farmer's adaptive strategies to climate change is the selection of resilient varieties (31.02% from the adopter group and 24.14% from the non-adopter group) (Figure 20).

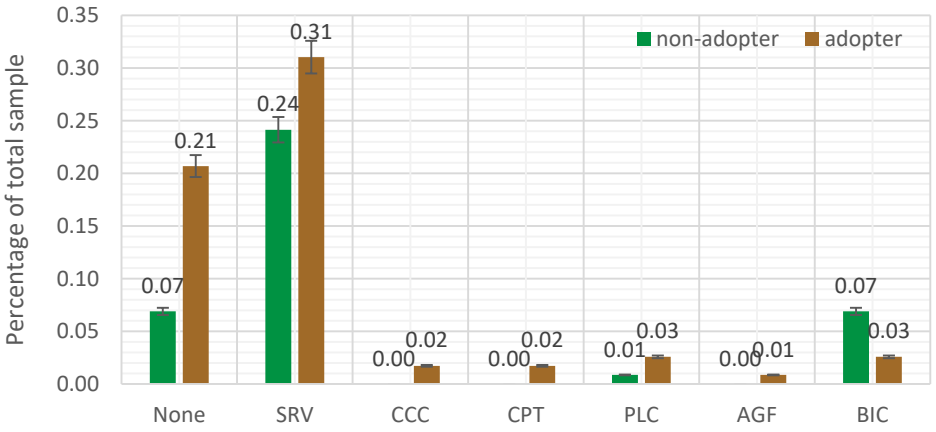

Figure 20. Effective strategy to enhance resilience

Note: Chi-square statistics (df 1) equal to 12.051. The two-sided tests (with P-value < .05) statistically showed the only significant differences in the BIC between the farmer groups

4.3 Empowering local authorities

Local government benefit from proximity to the community that makes them the most accessible authority when addressing and managing the severe impacts of climate change. Additionally, the local-level government possesses the most up-to-date knowledge of the local environment and population. While international and national climate change policies are still required to align on targets, there is increasing attention to the role of local government. In general, the local government of Vinh Kien has already conducted several supporting activities to address these climate change issues including land policies, agricultural investment policies, science and technology, education, and communication (propaganda, news on public media, lectures in school), etc. Among the most effective intervention, knowledge and capacity building through the provision of different training activities (also with support for CSV project) have been implemented and achieved initial positive results. Statistics on farmers' participation in training activities provided by different organizers are shown in Figure 21.

The empirical data in Figure 21 statistically shown a significantly higher number of the adopters involved in training activities organized by the Yen Binh Department of Agriculture and Rural Development, Yen Binh DARD, the communal department of agriculture, the CSV project, and especially the agricultural extension units in Vinh Kien. One of the farmer's reflections related to the above training activities among the group of farmers who participated in the CSV project came from Mrs. Tuyet, Ba Chang villager. This empirical evidence indicated the willingness to pursue knowledge of good agricultural practices and to enhance the perception of the climate change impacts among farmer groups are not equal, which might lead to a decrease in the effectiveness of the local actions in building capacity and collective actions through training activities.

I have been in some extension training activities. The local government has encouraged people to participate, but the rate of practice following the training is low. There are few practical and useful training, for example, the biological cushion is suitable because many farmers raise chickens, and feed fermentation is also practical because it is very necessary to store feeds for cattle. I think if the local government organizes adequate training courses and provides the financial support, and the farmers will simultaneously apply".

Lương Thị Tuyết, Ba Chang Village.

On the contrary, the organization of training activities by the CSV project was different. From the investigated production conditions of the CSV participants, the CSV experts divided the farmers into three groups: the vermicomposting group raises earthworms, the integrated home garden group, and the cassava-grass strips group, which is to support each other in the application. Group activities were coordinated by the group leader and occasional meetings were held to exchange and share experiences among the farmers as well as the collective planning to replicate the model. The role of the group members is to encourage other villagers to carry out the model through different channels of communication. The well-trained farmers then later acted as a trainer.

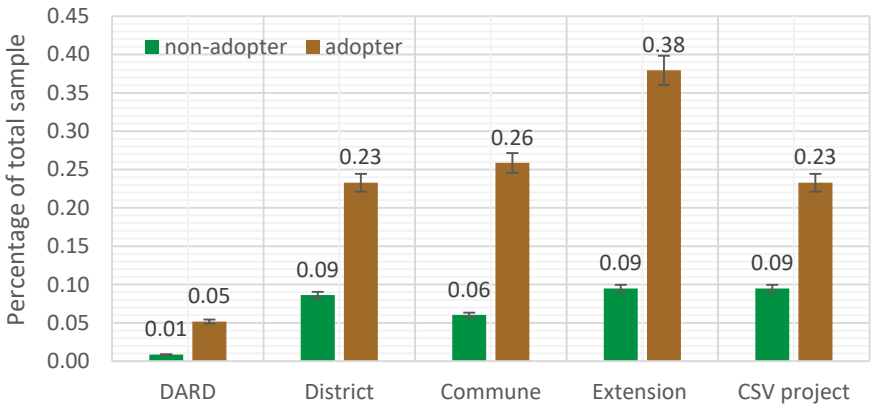

Figure 21. Organization of training activities

Note: Chi-square statistics (df 1) equal to 1.884; 3.168; 9.038; 15.557; and 2.307 respectively. The two-sided tests (with P-value < .05) statistically showed the only significant differences in the number of training activities (provided by the commune authorities and the extension center) between the surveyed farmer groups

To improve the effectiveness of local government interventions parallel with the CSV's objectives, we asked farmers about the necessary actions to take and incorporated them into 9 variables. These actions that the local government needed to target include: LA (land policy), CA (capital investment), TE (technical support), MKI (market information), MKA (market access), EC (education and communication), CCS (climate change services), IS (institutional reform), EFA (enhancement of farmer's autonomy). The statistics in Figure 22 indicate that the government's policy and actions should focus on investment policies in agriculture, technical assistance, market access, education and communication, weather information services, institutional reforms to improve farmer autonomy.

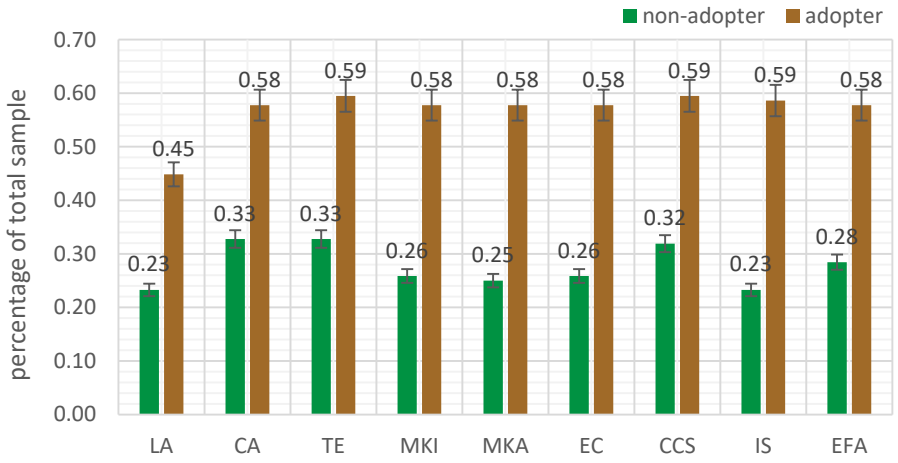

Figure 22. Local actions to enhance adaptive capacity

Note: Chi-square statistics (df 1) equal to 2.222; 3.159; 6.245; 15.429; 17.282; 15.429; 7.826; 23.776, and 10.247 respectively. The two-sided tests (with P-value < .05) statistically showed the significant differences in the TE, MKI, MKA, EC, CCS, IS, and EFA between the surveyed farmer groups

4.4 Scaling the CSV

In Vietnam, the CSV model has been introduced to different levels of government (the state and local) in terms of empirical evidence and lesson learned through the efficacy and effectiveness of technologies, practices, services, and institutional options. Scaling up/out options of the model have been included in the agenda of the agricultural sector that is reflected in many action plans. The CSV promotes the collective actions and cooperates social responsibility of the community in applying solutions toward sustainable agriculture in long-term harmony with nature. The CSV model was introduced to ensure food security, enhance adaptability and resilience to negative impacts of climate change, and at the same time improve the living standards of rural people. Recently, the National Target Program on New Rural Development has considered the scaling of the CSV model as one practical option for the rural villagers to adapt to the new context in the rural areas. Therefore, the CSV approach has great potential for replication and integration in the national development programs as well as other development projects from international organizations.

"The initial successes have proven that the CSV model can help prioritize technologies and practices that not only leverage household's income while also improving climate adaptive capacity. This is also cross-cutting factor within the National Target Program on New Rural Development (NTM) with the climate change and natural disasters being made as criteria to be addressed in the guidance documents and implementation plan of the NTM program. The achievements have created a strong basis for policy uptake regarding the scaling of CSV approach to greater geographical boundaries within the NTM program".

Nguyen Minh Tien, Central Administration of the NTM Program.

Within the scope of this study, we focused on the crucial issues in the introduction and implementation of the CSV model in Ma village, Yen Bai. From the subjective opinions of the farmers who did and did not participate in the CSV model, farmer's preference, and farmer's assessment of the aspects that the project did not yet get targeted and resolved. We formulated a group of 5 main factors that hypothetically affect the scaling of the CSV model. These factors include the extent of propagation and promotion of the CSV's positive outcomes by the local government (Communication), the efficacy to improve the livelihoods of farmers from participating in the model (Livelihood), the increase of production knowledge and climate change adaptive response (Knowledge), the ability to allocate local resources in production and marketing of agricultural products (Resource), and the environmental problems still exist that have not been addressed or mitigated (Environment). The statistics in Figure 23 shown three basic issues that impede the replication of the CSV model in Ma village, which include: Communication (9.48% of the total responses from the CSV adopters, 4.31% of the total responses). from the CSV non-adopters), Livelihood (6.03% and 4.31%, respectively), and Environment (5.17% and 0.86%, respectively).

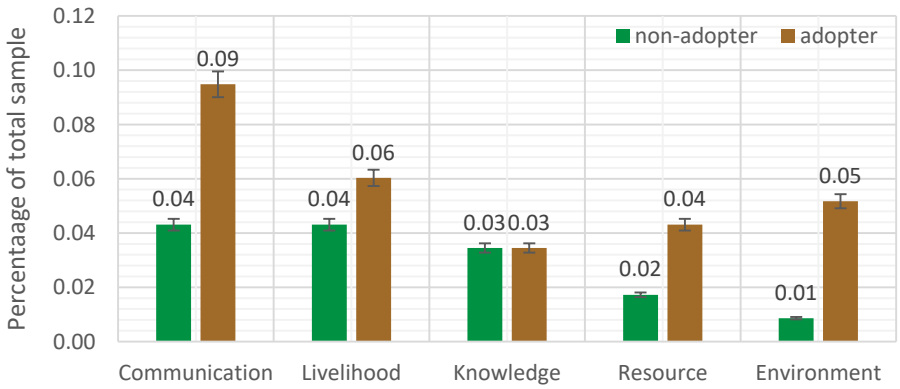

Figure 23. Problems and concerns in CSV scaling

Note: Chi-square statistics (df 1) equal to 3.293 . The two-sided tests (with P-value < .05) statistically showed the significant indifference regarding the problems and concerns in CSV scaling between the farmer groups

Along with the model of Smart Climate Village, there are currently many climate change adaptation models being deployed in Vietnam. According to Mr. Vu The Thuong (Center for Sustainable Rural Development), rural smallholder farmers need more effective and practical projects to actively adapt to climate change and sustain their livelihoods. For this reason, international organizations can improve the prospects for domestic implementation by engaging in capacity-building strategies from local levels such as communes, districts, and higher-level of state administrative agencies to jointly advocate the development of a national adaptation plan on climate change. In regards to policy adoption, some problems and issues need to be addressed to ensure ultimate success. Extension services can play a very important role in scaling out the CSV. Upscaling CSV will certainly entail the problem of changing the farmer's farming decision, adaptive strategies, and agricultural practices, which have been for some time embedded in farmers' behavior under the complex rural sociology.

Extension services have traditionally served as a bridge between research and farming and supported farmers through the delivery of knowledge. For that reason, the successful upscaling of CSV requires strategies that go well beyond changing farm-level agronomic practices.

4.5 Policy advocacy

Climate change is not only a challenge but also an opportunity to transform agricultural production into a way that is in harmony with nature, organize and re-allocate resources for agricultural development towards efficiency and sustainability. The Climate-Smart-Village (CSV) approach aims to generate evidence at local scales of what climate-smart agricultural options work best, where, why, and how, and use this evidence to draw out lessons for policymakers, agricultural development practitioners, and investors from local to global levels. The testing was done through a multistakeholder collaborative platform at CSV sites. The CCAFS FP2.1 project advocates for this integrated approach at the community level by supporting the local governments in the development of CSV approaches, providing policy-relevant evidence and tools, assisting in the design of communal climate change adaptation plans. At the national level, the change outcomes from the planned phase of the CCAFS FP2.1 provide policy advice to raise awareness of the importance of climate-smart agriculture in achieving food security under the new realities of climate change. Hence, the key policy messages are the following:

- CSV approach is not a new set of sustainability practices or production systems, but an approach to provide the means for integrating the specificities of adaptation and mitigation into sustainable agricultural development policies, programs, and investments.
- The pilot scaling (up/out) of the CSV approach draws more attention and increases knowledge, favorable attitude, and strong support from policymakers, researchers, and experts at the province and national level.
- The joint platform for action among the CIAT, NOMAFSI, MARD, VNUA, IPSARD, VAAS, CARE, SRD, SANRM, NAEC, and other supporting institutes should be built for the potential scaling up CSV in different locations in Vietnam (given demographic characteristics of each region e.g. flooding in Central, saline in Cuu Long delta…).
- Improved policy coordination among agricultural sectors (e.g. crops, livestock, forestry, and fisheries) and across other sectors (e.g. energy, water, industry) with CSV approach as important inputs for the new version of NTM 2021–2025, National Target Program on sustainable poverty reduction for 2021-2025, National Target Program on socio-economic development in ethnic and mountainous areas for 2021-2030, National Target Program related to SDGs (1- No poverty, 2- Zero hunger, 5- Gender equality, 10- Reduced inequality, 13- Climate action), National Program on Collective Economy/Cooperative and Climate Change 2021-2030, and provincial and national SEDP (Socio-economic Development Program).

…" I think the project is effective thanks to its approach and has potential in terms of sustainability and integration with many other MARD's programs such as NDC, cooperative strengthening, climate change resilient program…Therefore it is important to analyze cost-effectiveness, policy barriers "….

Tran Cong Thang, IPSARD

…" CSV approach is relevant to Vietnamese context…because this model is a community based that focuses on the strengthening of the whole system to be resilient …it is based on the community's priorities, needs, knowledge, and capacity to empower them in terms of planning for the response to climate change impacts… Hence helping people improve their livelihoods and minimize the impact of climate change and other extreme weather conditions"…

Dao The Anh, VAAS

V. Conclusion

Ma village is a typical example of the CSV approach that proposed several technological, institutional, and policy interventions to help farmers adapt to current and future weather variability and to mitigate the climate change impacts. The purpose of the Outcome Harvesting approach is to reflect on how much of the change outcomes are being generated by the CSV's intervention in Ma village. Guided by the theory of change, the study emphasized more than **60 change outcomes** which were categorized into **8 main outcome groups** including *production practices*, *farmer's knowledge, access to resources and services, household's economic gain, social benefit, environmental management skills, farmer's perception of climate change impacts, and adaptive strategies to climate change impacts*. In addition to a great deal of farmers' knowledge improvement regarding the perception of climate change, climate change impacts, and farmer's adaptive strategies, the most significant change outcomes from participating in the CSV program was the diversified farming activities and livelihoods of people in Ma village associated with their improvement of economic and cultural interactions with other farmers in the region. In addition, the empowerment that women in Ma have experienced is sustainable beyond the project expectation as their ability to determine their own choices, and their right to influence social change for themselves and others. The positive change from the environmental aspect under the intervention of the CSV program is considered a core principle of sustainable development to improve household farmers' well-being and quality of life under the consequences of climate change over time. From this point forward, selection of resilient varieties and crop calendar shift should be the main climate change adaptation solutions in Ma village. Throughout the study, numerous barriers restrain adoption of CSA technologies and practices (i.e. knowledge, access to resources, market information), however, the CSA non-adopters also benefit from the CSV project through significant amount of agricultural knowledge and innovation diffusion.

There is a belief that communities' empowerment and institutionalization of the CSV approach are supposed to accelerate the scaling progress from a policy perspective. However, agricultural production efficiency, effective resources allocations, market access, and appropriate selection of demand-driven factors might be the obstacles that constraint the horizontal replication of the CSV. Hence, local government's policy and actions should focus on investment policies in agriculture, technical assistance, market access, education and communication, weather information services, institutional reforms to improve farmer autonomy. Finally, the involvement of the MARD, CIAT, NOMAFSI, VNUA, IPSARD, VAAS, CARE, SRD, SANRM, NAEC, and other supporting institutes are expected to raise more awareness of the importance of climate-smart agriculture in achieving food security under the new realities of climate change.

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Appendix

I. Tables

Table 1. Independent Samples Test (the main crop)

		Levene's Test for Equality of Variances							
		F	Sig.	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Tillage	a	0.9455	0.3329	114.0000	0.0918	234.3740	137.8291	-38.6644	507.4125
	b			77.8371	0.1109	234.3740	145.3390	-54.9833	523.7313
Seedling	a	0.0650	0.7992	114.0000	0.9324	6.5524	77.0347	-146.0527	159.1576
	b			101.9011	0.9305	6.5524	74.9795	-142.1708	155.2757
Fertilizer	a	0.0177	0.8945	114.0000	0.7974	-34.2598	133.1684	-298.0653	229.5457
	b			112.9449	0.7813	-34.2598	123.0877	-278.1201	209.6005
Pesticide	a	1.3213	0.2528	114.0000	0.0883	77.1408	44.8724	-11.7510	166.0327
	b			91.7921	0.0910	77.1408	45.1604	-12.5542	166.8359
Water	a	4.5074	0.0359	114.0000	0.3014	38.8263	37.3999	-35.2626	112.9152
	b			47.1480	0.4021	38.8263	45.9216	-53.5483	131.2009
Family labor	a	2.4319	0.1217	114.0000	0.3478	-3.6682	3.8907	-11.3756	4.0391
	b			94.3092	0.2629	-3.6682	3.2568	-10.1344	2.7979
Total cost	a	0.9432	0.3335	114.0000	0.2945	322.6338	306.3598	-284.2627	929.5303
	b			92.3458	0.2972	322.6338	307.7751	-288.6036	933.8712
Return	a	4.5411	0.0352	114.0000	0.2795	-600.0457	552.2464	-1694.041	493.9501
	b			113.4848	0.2276	-600.0457	494.6284	-1579.948	379.8571
Gross profit	a	9.4961	0.0026	114.0000	0.0079	-922.6795	341.2138	-1598.621	-246.7377
	b			108.7614	0.0024	-922.6795	297.3209	-1511.974	-333.3846

a. Equal variances assumed; b. Equal variances not assumed

Table 2. Independent Samples Test (the main animal husbandry)

		Levene's Test for Equality of Variances							
		F	Sig.	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Breeding	a	1.8201	0.1800	114.0000	0.3833	-1392.100	1590.560	-4542.987	1758.787
	b			93.5834	0.2977	-1392.100	1329.239	-4031.488	1247.288
Feed	a	1.9065	0.1701	114.0000	0.3725	-1624.992	1814.816	-5220.128	1970.144
	b			110.9178	0.3109	-1624.992	1596.256	-4788.107	1538.122
Yeast	a	5.2003	0.0244	114.0000	0.2657	-4.998	4.469	-13.851	3.854
	b			104.3071	0.1955	-4.998	3.837	-12.607	2.610
Medicine	a	2.7277	0.1014	114.0000	0.2047	-200.141	156.907	-510.973	110.691
	b			91.3337	0.1285	-200.141	130.473	-459.297	59.015
Energy	a	6.4608	0.0124	114.0000	0.0411	-62.396	30.196	-122.215	-2.577
	b			107.8563	0.0191	-62.396	26.223	-114.376	-10.416
Family labor	a	0.3555	0.5522	114.0000	0.8099	1.865	7.736	-13.460	17.190
	b			62.1381	0.8308	1.865	8.694	-15.513	19.243

Total cost	a	2.9531	0.0884	114.0000	0.2335	-3270.543	2730.702	-8680.042	2138.956
	b			112.9530	0.1815	-3270.543	2432.759	-8090.300	1549.214
Return	a	1.1417	0.2875	114.0000	0.4535	-3506.823	4662.185	-12742.57	5728.929
	b			101.6702	0.3795	-3506.823	3973.401	-11388.35	4374.706
Gross profit	a	0.7650	0.3836	114.0000	0.4543	-2142.250	2853.041	-7794.102	3509.601
	b			108.2630	0.3899	-2142.250	2481.352	-7060.584	2776.084
a. Equal variances assumed; b. Equal variances not assumed									

II. Photographs

Picture 1. The mountainous commune Vinh Kien, Yen Binh district, Yen Bai province

Picture 2. Agriculture and forestry production in the mountainous Vinh Kien

Picture 3. Mixed production units – agro-forestry-pastoral - with rainfed rice in Vinh Kien

Picture 4. CSA's cassava-legume intercropping in Vinh Kien

Picture 5. CSA's integrated home garden in Vinh Kien

Picture 6. Public library for farmers in Vinh Kien

Picture 7. CSV's loudspeaker system in Vinh Kien

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