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Drivers, Barriers and Success Factors in Climate Change Adaptation for Smallholder Farmers: A Case Study in Thai Nguyen Province, Vietnam

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Abstract

This paper aims to identify appropriate approaches and interventions of local governments and extension services through identifying the most potential adaptive measures in agricultural production of local farmers in Thai Nguyen province (Vietnam) and analyses of key drivers, barriers and success factors for climate change adaptation (CCA).The study was conducted during October 2019 – April 2020 in Thai Nguyen and two selected communes with 92 smallholder farmers and relevant stakeholders from the provincial to commune levels using both quantitative and qualitative methods. Results showed a highly vulnerable situation of the local farmers under the context of climate change with 60.9% and 44.6% of the interviewed farmers stating reduced crop/livestock productivity and crop losses, and reduced arable production land and number of crop seasons/year respectively. Ten most potential livelihood models and production practices were identified. For example, animal husbandry (pigs, cattle) combined with biogas digester installation; intercropping between fruit crops and annual crops; use of drought and disease resistant maize varieties; changes of crop patterns and calendars; water saving production techniques, etc. Driver, barriers and success factors for CCA suggestguiding actions for the local government and extension services to plan adequate approaches and interventions for embracing and upscalingthe CCA initiatives towards climate resilient farming communities.The guiding actions include: strengthening capacity of extension staff; providing update market information to farmers for their decisions of crops and livestock; disseminating new and locally appropriate CCA models and practices together with on-field demo-plots and farmer field schools; and building capacity for community organisations, production groups/cooperatives to promote community learning for wider adoption and thus sustainability of their farming systems in response to the changing environment.

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Introduction

Climate change is emerging as one of the most serious challenges humanity has ever facedin this century[1-5]. Changes of climate factors such as increase in temperature, in rainfall pattern or rise of atmospheric carbon dioxide are closely linked to agricultural sector which is highly prone to weather and climatic conditions[6-9]. Hence, agriculture is deemed to be one of the economic activities that would be most influenced by climate change[10].

Therefore,adaptation initiatives are necessary to cope with the increasing impacts of climate change[8,9,11]. Different studies all over the world have proven that through sustainable farming systems such as shifting cropping patterns, crop diversification, integrated livestock production and restoration of degraded land, agriculture have an inherent potential to both reduce emissions of greenhouse gases, enhance carbon sequestration in the soil and increase the ability to adapt to climate change[12,13].

Although there have been significant success in identifying CCA initiativesfor farming households, there has been limited research on barriers, success factors for CCA and how local governments andextension servicesshould provide relevant support and advice to embrace and scale the CCA initiatives.Therefore, this paper addresses the current knowledge gap and provides insights and practical recommendations for promoting and supporting locally appropriate CCA initiatives.

Vietnam is among the countries that will be worst affected by the impacts of climate change[14].Studies for the Southeast Asian region show that climate change could lower agricultural productivity of the nation by 2–15% [15]. Notably, in Vietnam agricultural production provides the major livelihoodfor the rural poor16 and is typically characterized by small-scale rice-based production. Therefore, smallholers farmers arehighly vulnerable to climate change[17].

Vo Nhai is a mountainous district of Thai Nguyen province, located in the northern midland and mountainous region of Vietnam. The district has complex topography, mainly hills and limestone mountains and is the land of 8 ethnic minorities. With agricultural land accounts for more than 78% of total land, and up to 50% labour is working in the agricultural sector, the district have been seeking for ressolutions to boost the development of the agriculture and poverty reduction[18]. In the last few years, the district has been influenced by increase of disasters and considerable impacts of climate change. Particularly, increased number of hot days, heavy rain, hail, storms, flood and landslide during rainy seasons, and water shortage, drought and cold spells during dry seasons. According to a recent report, only one storm on 8 May 2020 caused total damageestimated at 647,826.09 USD[19]. However,to date there hasbeen no study in Vo Nhai on the vulnerability of smallholder farmers in the context of climate change, adaptive measures of smallholder farmers and how the local government and extensions services should provide relevant support for local farming households to adapt to climate change.

This study aims to (1) understand the impacts of climate change on agriculture production of smallholder farmers in the district; (2) identify the most locally appropriate adaptive measures toward climate resilient livelihoods; (3) analyze drivers, barriers and success factors for embracing and scaling the identified climate resilient models and production practices; and (4) provide insights and recommendations on approaches and areas of support for the local government and extension services.

Methodology

This study was conducted in two communes (Binh Long and TrangXa) of Vo Nhai, a northeastern mountainous district of Thai Nguyen province during October 2019 – April 2020. The district has 15 communes. Based on the key informant interviews (described below), the most two climate vulnerable communes were selected for this study. Both qualitative and quantitative methods were employed using a participatory approach. The methodology includes desk studies of literature review, followed by key informant interviews, farmer survey, workshops and focus group discussions among farmers and relevant stakeholders.

The key informant interviews aimed to gather relevant information with regard to the current situation of agricultural production in the research

areas, key challenges of smallholder farmers, impacts of climate change on the local livelihoods; strategies and policies of the local government in response to climate change. Respondents were representatives of the local authorities, and relevant departments and organisations. These include Department of Agriculture and Rural Development (DARD), the extension networks from commune to provincial levels, and community civil organisations (including women unions, farmers' associations and youth unions).

Household survey was conducted in two most vulnerable communes. This step aimed at collecting information on their livelihoods, key challenges and needs, and impacts of climate change. A stratified sampling method was employed to guarantee the representativeness of farmers in terms of geographical locations (villages that are vulnerable to the impacts of climate change), gender, age, wealth groups, ethnicity, and types of production systems. A sample size of 92 farmers was determined for the survey.

Table 1: Profile of the Surveyed Households in VoNhai District (n = 92)

Category	Statistics
Age (years old)	
Mean	42.80
S.E	1.226
Gender (%)	
Male	38.0
Female	62.0
Location (number of respondents)	
Binh Long commune	46
TrangXa commune	46
Total	92
Wealth groups (%)	
Above average	6.5
Average	66.3
Marginally poor	18.5
Poor	8.7
Household size	
Mean	4.57
S.E	.157
Number of main labourers/household	
Mean	2.66
S.E	.118
Number of members working in the agriculture & forestry sector	
Mean	2.14
S.E	.127
Number of members working in other sectors	
Mean	.50
S.E	.083

(Source: Fieldwork, 2019).

Workshops and focus group discussionswere carried out for identifying the most potential agriculture-based livelihood models and production practices, drivers and barriers to climate change adaptation (CCA) and success factors for embracing and scaling CCA models and practices.Fifty participants included representatives of the division of agriculture & rural development, centre for extension services, commune authorities, extension staff, civil organisations (including women's unions, farmers' associations and youth unions) and farmers in the studied areas.

Data Analysis

quantitative data from the household surveys were subject to statistical analysis using SPSS software (version 20)[20].P-values in Tables 2, 3 and 6 were included to indicate the level of statistical significance for comparing different indicators between the two communes using Pearson-Chi Square Tests.

Results and Discussions

Household Characteristics and Impacts of Climate Change on the Farming Communities

Table 2 reveals that the smallholder farmers are mainly dependent on agriculture-based livelihoods. Crop production and animal husbandry account for more than 80% of their income sources, whereas other off-farm jobs have recently become emerging important sources of income streams for the farming households in the studied areas. These findings are consistent with results of other studies in the northern midland and mountainous region of Vietnam e.g.[17,21,22].

There are some differences in income structure between the two communes. Income source from crop agriculture of farmers in Binh Long is higher than that of Trang Xa, whileV income streams from livestock, aquaculture and forestry of Binh Long are significantly lower. This is possibly because of its lower forest and aquaculture areas (Table 2). Results in Table 2 also indicate the nature of small-scale production of the farmers in rural districts of Thai Nguyen. It is worth noting that the number of pigs per household at the interviewed time did not reflect its scale of production due to the recent impact of swine fever since March 2019. As of 15 October 2019, 10,436 infected pigs in Vo Nhai district had been destroyed.

Table 2: Characteristics of Farming Households in the Studied Areas (n = 92)

	Vo Nhai district		Binh Long commune		TrangXa commune		P-value
	Mean	**S.E**	**Mean**	**S.E**	**Mean**	**S.E**	
Income sources (%)							
Crop production	64.78	2.621	70.87	4.268	58.70	2.812	*
Animal husbandry	15.49	2.085	12.17	3.012	18.80	2.833	*
Aquaculture	1.20	.460	0.22	0.217	2.17	0.874	*
Forestry	7.12	1.198	3.04	1.199	11.20	1.905	**
Services	2.55	1.072	2.93	1.762	2.17	1.240	n.s
Other sources	8.86	2.229	10.76	3.551	6.96	2.707	n.s
Production area (m^2)							
Agricultural prod. area	3,129.09	362.428	2,447.57	301.872	3,841.59	658.259	n.s
Forest land area	2,434.44	498.074	685.65	244.507	4,262.73	912.562	**
Water surface area	140.00	44.681	15.65	15.652	270.00	86.110	*
Livestock							
Buffalo number	0.29	0.130	0.26	0.133	0.31	0.227	n.s
Cow number	0.38	0.175	0.15	0.116	0.62	0.331	n.s
Pig number	1.52	0.589	0.70	0.381	2.36	1.118	n.s
Poultry number	88.07	19.817	69.57	24.512	106.98	31.308	n.s
Other livestock	0.44	0.341	0.11	0.114	0.76	0.659	n.s

Note: S.E: Standard Error of Mean;Pearson Chi-Square Test:n.s: Not significant; * P < 0.05; **P < 0.001.

When being asked about the impacts of climate change compared to 15 years ago, most of the respondents (80.7%) stated “increased”, while 9.1% and 10.2% of farmers opined “no change” and “unsure”, respectively.

Direct impacts of climate change on the farming households are presented in Table 3. Reduced crop and livestock productivity, crop losses, and reduced arable production land and number of crop seasons/year were stated as the three most prominent impacts. In which, farmers in Binh Long commune were more severely impacted by crop losses and a significant proportion of the farming households had to find alternative livelihood options. Power outage was also said to be more frequent than those in TrangXa commune due to heavy rain and thunderstorms.

Table 3: Direct Impacts of Climate Change on the Local Farming Households (n = 92)

#	Direct impacts on households	Average for Vo Nhai	By communes		P-value
			Binh Long	TrangXa	
1	Reduced crop and/or livestock productivity	60.9%	58.7%	63.0%	n.s
2	Crop losses	60.9%	80.4%	41.3%	***
3	Reduced arable production land and number of crop seasons/year	44.6%	50.0%	39.1%	n.s
4	More frequent power cut	38.0%	52.2%	23.9%	*
5	Changes of land use purposes or crop types	22.8%	17.4%	28.3%	n.s
6	Had to change livelihoods	21.7%	32.6%	10.9%	*
7	Water shortage in aquaculture	7.6%	6.5%	8.7%	n.s
8	Other	4.3%	6.5%	2.2%	n.s

Note: Pearson Chi-Square Test: n.s – not significant; *P < 0.05; ** P < 0.01; *** P < 0.001.

Identification of Climate Resilient Production Models and Practices

The FGD results showed 10 most potential adaptive measuresin the studied location. These include complete and/or integrated production model, new cropping patterns, and production practices together with their perceived benefits of the models and practices in order to effectively adapt to the changing environment.

Table 4: Identified Climate Resilient Livelihood Models/Production Practices in VoNhai District

#	Potential production models/practice	Reasons for adoption/key benefits
1	Animal husbandry (pigs, cattle) combined with Biogas digester installation.	Treating farmyard manure to become clean organic fertilizers (bio-slurry); Reduced air pollution; Utilising renewable energy (biogas) for cooking.
2	Intercropping between fruit crops and annual crops.	Utilising land for improving yields and income; Improved soil cover and moisture; utilising green manure.
3	Use of drought and disease resistant maize varieties (GM maize).	Drought tolerance and diseases resistance; Improved yield.
4	Change of crop patterns: planting other crops (fruit crops, legume and/or chilli pepper, etc.)on one-crop rice land areas.	Improved income, while adapting to the current context of increasing water shortage and drought.

5	Water saving production techniques (e.g. using sprinklers for tea and fruit crops; mulching materials for tea, fruit crops and maize, etc.). plants. Thus, reduced fertiliser input.	Saving irrigation water and energy; Reduced labour input for weeding; Utilising agricultural by-products as mulching materials that help keeping soil moisture, and supplement nutrients for the
6	Afforestation (mainly short cycle plants, including acacia and eucalyptus).	Storing water for irrigation; goodmarket outlets for acacia and eucalyptus.
7	Rescheduling of crop calendar	Avoiding cold spells and frost in early spring season, and storms and flooding during summer seasons.
8	Storing water for irrigation (digging ponds, building dams).	Harvesting and storing water to irrigate crops during dry seasons.
9	Use of indigenous crops (e.g. local soybean, custard apple).	Drought and cold tolerant and disease resistant; stable yields and high income.
10	Producing vermicompostfor organic crop production.	Reducing air pollution and production risks due to the traditional way of applying untreated farmyard manure.

The identified models and practices were used as inputs for further discussions with regards to drivers, barriers and success factors for CCA in the district.

Drivers and Barriers, and Success Factors for Climate Change Adaptation

The desktop studies, in-depth interviews and FGD with relevant stakeholders indicated a number of important drivers for CCA. These include the national policies and strategies on climate change, and disaster prevention, response and prevention; Action Plan Framework for Adaptation and Mitigation of Climate Change of the Agriculture and Rural Development Sector; National target program to respond to climate change; and agricultural restructuring plan, etc. Besides, there have been a number of assistance projects funded by donors, NGOs and the private sector. For example, the system of rice intensification (SRI), reducing emissions from deforestation and forest degradation and enhancing forest carbon stocks (REDD+), biogas development program for the Animal Husbandry Sector, and planting new drought and disease resistant maize varieties. In addition, the production risks caused by climate change could be seen a driving factor for the smallholder farmers to seek alternative adaptive measures in securing their production and income.

There were some similarities and differences in viewpoints of extension staff and local farmers regarding key barriers to adoption and scaling of the identified adaptive measures (Table 5). However, these all reflect the current shortcomings in the government support policies, local awareness, and challenges for embracing the CCA initiatives. Opinions of the farmers, particularly the first two stated challenges, suggest areas of interventions and approaches of the extension networks to address the existing challenges of local farmers.

Results of a FGD among the farmers and stakeholders shed light on a number of success factors for adoption and scaling of the defined models and practices. These include:

Evident benefits and higher income compared to the traditional models and practices;
Active support from the government, commune authorities, community organizations and extension networks;
Initial support of field demo-plots and technology transfer activities;
Creating more learning and experience sharing opportunities among peer farmers;
“Local champions” (influential people) and effective production groups and cooperatives.

Table 5: Key Challenges and/or Barriers to Adoption and Scaling of the Climate Resilient Livelihood Models and Production Practices

Opinions of extension workers	Opinions of farmers
Limited awareness and shared long-term vision among individual farmers.	Limited information on market demand and insecure market outlets.
Lack of good demo-plots for local learning.	Lack of information on new and effective production practices and crops, and limited learning opportunities.
Insufficient government budget for extension work.	
Limited capacity of extension staff for effective support of CCA.	Production risks due to natural disasters, pests and diseases.
Lack of motivation in agricultural production due to high risks, while off-farm jobs are more lucrative.	Low profits from agricultural production.
	Lack of production capital.

In addition, the farmer survey on the most effective forms of learning among farmers (Table 6) reveals important insights for the extension services. Their support should focus on training of new production guidelines, particularly for new crops and/or production models, in accordance with on-field technology transfer activities, and engaging and building capacity of community organizations for their continuing support and scaling, and eventually long-lasting impact.

Table 6: Most effective forms of farmer learning in agricultural production (n = 92)

#	Forms of learning among farmers	Average for Vo Nhai	By communes		P-value
			Binh Long	TrangXa	
1	Training classes	53.3%	41.3%	65.2%	*
2	Farmer field schools	38.0%	30.4%	45.7%	n.s
3	Civil organisations	37.0%	43.5%	30.4%	n.s
4	Village meetings	37.0%	28.3%	45.7%	n.s
5	Demo-plots of extension staff	32.6%	10.9%	54.3%	***
6	Neighbours	30.4%	37.0%	23.9%	n.s
7	TV and radio	22.8%	13.0%	32.6%	*
8	Production groups and cooperatives	12.0%	13.0%	10.9%	n.s
9	Other	2.2%	2.2%	2.2%	n.s

Note: Pearson Chi-Square Test: n.s – not significant; *P < 0.05; ** P < 0.01; *** P < 0.001.

The above results not only provide strong implications for the extension services, but also for the local government and other stakeholders to utilize supporting factors and address the current challenges for informed decisions and interventions.

Conclusions

This study has highlighted the vulnerable situation of the smallholder farmers in a rural mountainous district of Thai Nguyen province under the context of climate change. The most locally appropriate CCA initiatives together with supporting factors, barriers and success factors for CCA have been defined. These provide a strong foundation for the future interventions of the extension services.

The local government and extension networks should pay attention to (1) build capacity of extension staff; (2) provide update market information to farmers for their decisions of crops and livestock; (3) disseminate new and locally appropriate CCA models and practices together with on-field demo-plots and farmer field schools; (4) build capacity for community organisations, production groups/ cooperatives to promote community learning for wider adoption and thus sustainability of their farming systems in response to the changing environment.

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Conflict of Interest

The authors do not have any conflict of interest.

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