A systematic review of Climate-Smart Agriculture (CSA) practices and its potential for adoption in the implementation of Nong thon moi in the 2021-2030 Strategy

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Abstract

Being one of the world's most climate vulnerable countries, Vietnam is facing many challenges in the process of restructuring the agricultural sector towards climate resilience and adaptation. Begun in 2011, the Climate-Smart Agriculture (CSA) movement has spread globally to reach and support people in developing countries that are strongly affected by climate change. CSA has been introduced to Vietnam since 2015; however, has not been widely applied in the country guided by state development policies. This study synthesizes successful CSA lessons learnt from the world and Vietnam to propose policy development in mainstreaming CSA into the implementation of the National Target Program on New Rural Development (NTM) in the 2021-2030 Strategy. The study used the PRISMA method in searching, selecting documents and data analysis. 44 references, 29 qualitative, 12 quantitative and 03 records combining qualitative and quantitative, were classified into 05 key CSA themes (adaptation, mitigation, finance, social aspects, and others) and 32 CSA technologies and practices (CSA T&Ps) suitable for Vietnam. These CSA T&Ps were then studied for integration into the implementation of 6/19 NTM criteria relevant to enhancing climate adaptation, including: planning, irrigation, electricity, information and communications, production organization, and culture. Based on this, an organizational structure for multi-level cooperation for CSA implementation within the NTM 2021-2030 was proposed.

Key words: Climate change, CSA, NTM, PRISMA, CSA integration, multi-level cooperation

Dear readers,

This translation, sponsored by the International Center for Tropical Agriculture (CIAT) under the CCAFS P1596 project, is from an original Vietnamese peer-reviewed scientific study which has been accepted for publication in December 2020 in the Special Issue Climate Change and Sustainable Development of the Journal of Agriculture and Rural Development. The translation can ONLY be used for communication purposes and is NOT considered as an English publication. In addition, the translation is made from the original submission which is longer than the manuscript accepted for publication by the Journal. This translation aims at conveying the full work of the authors to wider audiences besides the academic community.

Correct Vietnamese citation: Bùi Lê Vinh, Vũ Thanh Biển. 2020. Tổng quan về các giải pháp nông nghiệp thích ứng với biến đổi khí hậu (CSA) phục vụ lồng ghép với xây dựng nông thôn mới giai đoạn 2021-2030. Tạp chí Nông nghiệp và Phát triển Nông thôn. Chuyên đề 11/2020 "Biến đổi khí hậu và phát triển bền vững". 154-166.

Correct English translation: Bui Le Vinh, Vu Thanh Bien. 2020. A systematic review of Climate-Smart Agriculture (CSA) practices and recommendations for adoption in the implementation of Nong thon moi in the 2021-2030 Strategy. Science and Technology Journal of Agriculture and Rural Development. Special Issue of November 2020 "Climate Change and Sustainable Agricultural Development". 154-166.

Sincerely yours,

Bui Le Vinh (translator)

1. Introduction

The world's agriculture currently has been switching to changes for adaptation to increasing climate anomalies. The global warming due to greenhouse gas emissions from the industrial and agricultural sectors has increased the frequency and unpredictability of extreme climatic patterns (Pandey et al., 2010). This has resulted in many negative impacts, significantly with reduced crop yields, especially in tropical and subtropical countries (Aggarwal et al., 2018), and increased pests and diseases (Bui et al., 2020a; Nguyen et al., 2020). These mainly affect smallholder farmers in developing countries that are more vulnerable to risks and have limited access to markets (Pandey et al., 2010). The growing world population increases the pressure on production and prices of agricultural products, which in the long run could lead to a global food security crisis (Aggarwal et al., 2018). It is the responsibility of national governments in supplying sufficient food demand of the world's population from resources available, while having to maintain and enhance sustainably adaptive capacities and resilience to rising climate impacts.

Climate Smart Agriculture (CSA) is a term used to describe integrated technologies and practices (T&Ps) to resolve challenges in agricultural development in the context of climate change while maintaining the food security goal. CSA should achieve the following three main goals: (i) Adaptation enhancement; and (ii) Mitigation or elimination of greenhouse gas (GHG) emissions (Migitation); and (iii) Sustainable growth in productivity and income (FAO, 2013). FAO (2013) provides solutions to achieve CSA goals, including: agroforestry, sustainable landscape planning, rational water use management, land protection and improvement, and energy use, smart intake for agricultural production, conservation of indigenous genetic resources and biodiversity, and sustainable farming and livestock systems. At the United Nations summit in September 2014, The United Nations Secretary-General Ban Ki-moon (UN Climate Summit, 2014) formally called for global cooperation on climate change actions at five fronts: (i) cutting GHG emissions, (ii) mobilizing financial resources and creating markets for development, (iii) carbon payment, (iv) resilience enhancement, and (v) promoting cooperation for implementation. He emphasized that the establishment of a global action coalition of 16 countries and 37 organizations has helped build a roadmap to help 500 million farmers worldwide access and practice CSA by 2030.

For nearly a decade, the CSA movement has taken place globally and achieved remarkable results through ambitious research and development (R&D) such as the Climate Change, Agriculture and Food Security program (CCAFS) of the Consultancy Group of International Agricultural Research (CGIAR). The CCAFS program has been implemented in South Asia since 2011 (Aggarwal et al., 2018; Khatri-Chhetri et al., 2017), and has since then been spread to other geographic regions such as Africa (Simelton and Ostwald, 2020; Partey et al., 2018), Central America, Latin America (CGIAR, 2014), and Southeast Asia (Romasanta et al., 2017; Simelton et al., 2015; Bui et al., 2020a). In Vietnam, CCAFS has been implemented since 2015 in three major ecological regions of the country, including the Northern mountainous region (Yen Bai province), the Central region (Ha Tinh province) and the Mekong River Delta (Bac Lieu province).

In recent decades, the Vietnamese government has made significant achievements in improving the efficiency of agriculture and improving the lives of rural dwellers through agricultural development and poverty reduction programs; while paying efforts to limit the impacts of climate change through climate action programs (Bui et al., 2020c). In particular, the National Target Program on New Rural Development (Nong thon moi - NTM), the most strategic and largest programs with an average annum investment of 13 billion USD since 2010, has the ability to leverage performances in agriculture across the country. However, besides remarkable achievements achieved in the 2010-2020 Strategy, mainly on infrastructural investments for socio-economic, educational and health care developments in rural areas, the NTM program has not succeeded in capacity development for climate adaptation and resilience in agro-ecological regions with climate vulnerability (Bui et al., 2020c). This paper, as result from a long-term research initiative jointly funded by the CCAFS program, the Irish Aid since 2015 and the NTM program, was conducted with the three following objectives: (i) to provide an overview on CSA, implementation methods and success stories in various geographic regions during 2011–2020; (ii) to discuss possibilities for mainstreaming CSA into some NTM criteria for the 2021-2030 Strategy, that have been identified to be suitable for CSA adoption, to help enhance adaptive capacity and resilience in agricultural development in climate-vulnerable regions; and (iii) to propose a multi-level coordination mechanism for CSA implementation within the NTM's 2021-2030 Strategy.

2. Methodology

2.1.PRISMA

PRISMA (**P**referred **R**eporting **I**tems for **S**ystematic reviews and **M**eta-**A**nalyses) is a minimal set of scientific works for systematic assessment and analysis of research problems, a tool commonly used in the fields of medical science, environmental management and climate change (Shaffril et al., 2018). Sierra-Correa and Cantera Kintz (2015) pointed out three advantages of PRISMA, including (i) it helps clearly define research questions for a review study; (ii) it helps identify inclusion and exclusion of criteria in selecting references relevant to the study; (iii) it helps thoroughly investigate a large database of references in a preferred time. The PRISMA method was applied to collect and examine studies conducted within the 2009-2020 duration.

2.2.Identification of literature sources

This research used three main sources of literature: (i) English papers from the Scopus database; (ii) Vietnamese and/or English papers from the Vietnamese academic database; (iii) publications from citation tracking and reference searching using search engines (eg. google, google scholar, etc.); and (iv) good quality project and/or program publications (eg. working papers, reports, policy briefs, etc.) that are relevant to the research (Figure 1).

2.3.Criteria for inclusion and exclusion of literature

The criteria for selecting and classifying literature are shown in Table 1. References need to meet certain scientific, practical and legal requirements that can be referred to possible adoption into the NTM program. These can be peer-review journal articles; good quality and relevant reports and other publications from CCAFS projects; and valid Vietnamese legal documents that support adoption of the work. References must be presented in English or Vietnamese, conducted in countries/territories vulnerable to climate risks and published between 2009 and 2020.

Table 1. Eligibility criteria for literature selection

Criteria	Eligible	Ineligible
Literature type	Research articles, good quality project/program publications and reports conducted under the CCAFS program in Vietnam that are relevant to the research	Systematic articles, conference proceedings, poor quality work on internet
Language	English, Vietnamese	Other languages
Timeline	2009 – 2020	Before 2009
Countries and territories	Countries and territories that are vulnerable to climate impacts *(referable to Vietnam)*	Not referable countries

2.4.Systematic review process

The reference search process consists of four steps as shown in Figure 1. In step one, research-related keywords were used to search for records according to the criteria presented in Table 1. In step two, document screening was implemented to remove ineligible documents and keep more eligible records. In step three, the authors searched for the full-text documents of the relevant records screened from step two, and proceeded to review and remove the ineligible records after the examination of full-text documents. In step four, the selected documents were classified according to the qualitative and quantitative criteria for the systematic review and general analysis of the study.

2.5.Data synthesis and analysis

From references selected for the study, qualitative and quantitative data on CSA T&Ps were selected and classified into five major themes (Table 2). These themes swere analyzed according to three CSA objectives, as cross-cutting, to highlight references for Vietnam, such as (i) **Productivity** and income; (ii) **Adaptation**; and (iii) **Mitigation**. The full-text documents of the references were well examined and numbered with years of publication (Table 2).

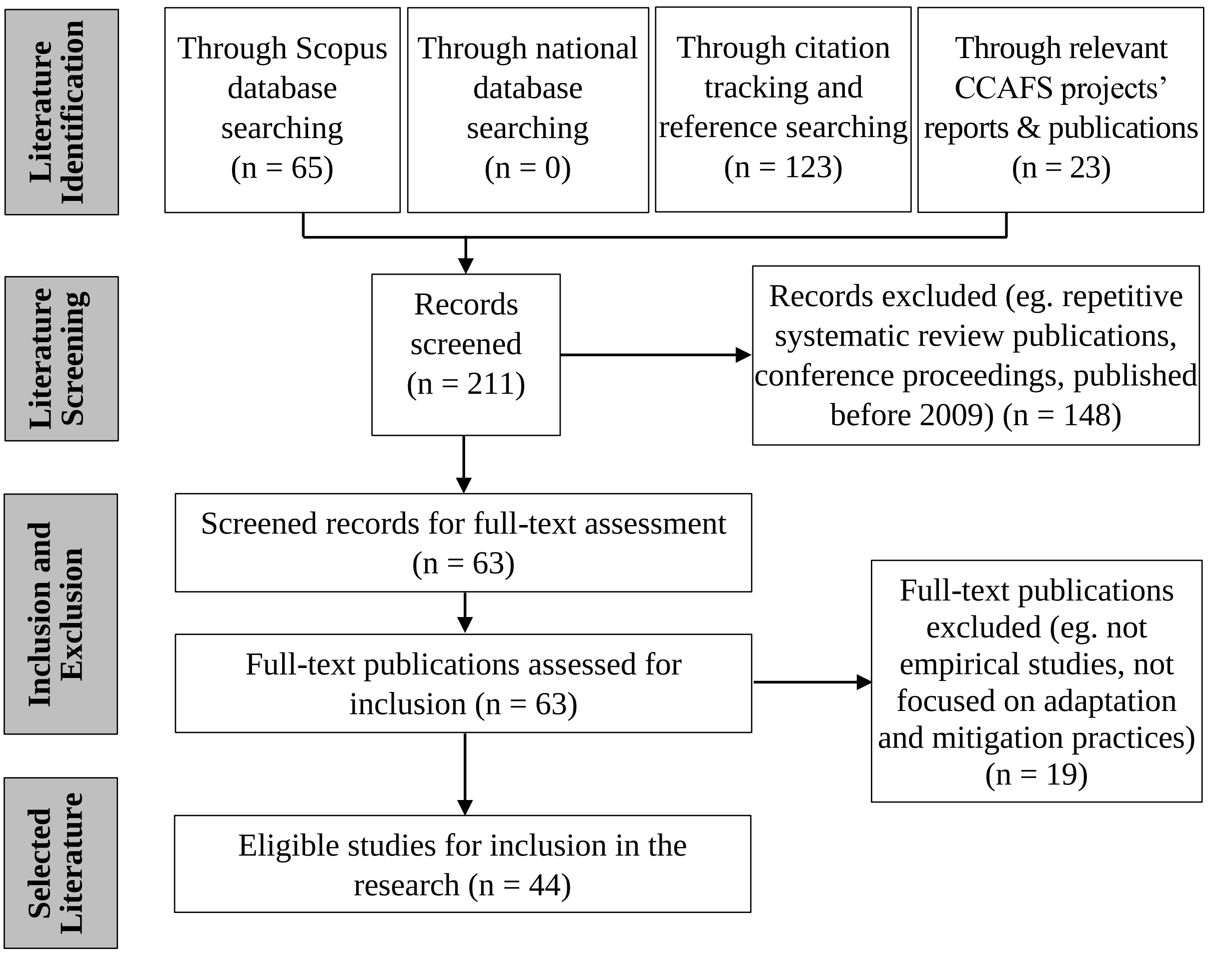

Figure 1. Systematic review process using a PRISMA diagram (n – records) (Adapted from Moher et al., 2009)

3. Results and discussions

The research arranged 44 eligible references according to 32 CSA T&Ps belonging to 05 major themes (Table 2). The **adaptation** theme, the largest theme, consists of 12 CSA T&Ps divided into 03 subthemes, of which 03 CSA T&Ps under *'crop management'*, 05 CSA T&Ps under *'irrigation & water management'*, 04 CSA T&Ps under *'farm management'*. From the other 04 themes, 05 T&Ps are under **mitigation**, 06 under **finance**, 05 under **social**, and 04 under **others**. The classification of included references was carefully examined based on empirical studies from farmers' practices and scientific experiments in different countries and territories that have reference values for Vietnam. Out of 44, there are 29 qualitative, 12 quantitative, and 3 records that combined both qualitative and quantitative methods. 36 references are country-specific and 08 general research papers from regions or territories. The majority of the 17 studies conducted in Vietnam (Bui et al., 2020a, 2020b, 2020c; Vu et al., 2020; Nguyen et al., 2020; Nguyen HQ et al., 2019; Huyer et al., 2019; Simelton et al., 2015, 2019; Le Dang et al., 2013; Tuan et al., 2014; Bastakoti et al., 2014; Le et al., 2018; Tran et al., 2017; Trung et al., 2019; Simelton and Le, 2017; Bui et al., 2017) are all directly involved in global funding programs for research and development (R&D) on climate change. The purpose of selecting such a large number of releases carried out in Vietnam out of 44 references was to relate R&D success stories and lessons learnt from similar works in the Vietnamese contexts to recommending CSA adoption in the NTM's 2021-2030 Strategy.

In a descending order for countries with more than 1 reference, 04 records were conducted in India (Nidumolu et al., 2018; Khatri-Chhetri et al., 2017; Singh et al., 2017; Gadde et al., 2010), 04 in China (Jianjun et al., 2015; Yin et al., 2016; Liu et al., 2017; Chen et al., 2019); 03 in Bangladesh (Abdur Rashid Sarker et al., 2014; Rahman and Alam, 2016 ; Mallick et al., 2017); 02 in the Philippines (Romasanta et al., 2017; Gadde et al., 2010), 02 in Thailand (Bastakoti et al., 2014; Gadde et al., 2010), and 02 in Sri Lanka (Esham and Garforth, 2013; Galhena et al., 2013). Countries with 01 record include Nepal (Gautam and Andersen, 2017), Pakistan (Ashraf et al., 2014), Iran (Keshavarz et al., 2014), Malawi (Kaczan et al., 2013), Zambia (Kaczan et al., 2013), and the United States (Nouri et al., 2019). 03 records are from Africa (Simelton and Ostwald, 2020; Partey et al., 2018; Leal Filho et al., 2013) and 05 records from other territories in the world (Singh and Singh, 2017; Wassmann et al., 2010; Aggarwal et al., 2018; Gummert et al., 2020; Bogdanski, 2012).

3.1.The 'adaptation measures' theme

29 out of 44 records are focused on adaptation measures and claissified into 03 sub-themes, including: crop management, irrigation and water management, and farm management.

3.1.1. Crop management measures

17 out of 44 references are repeatedly on *crop management* adaptation measures, of which 14 are for crop scheduling (**CR**), 12 for organic farming (**OR**), and 4 for seed improvement for enhanced climate adaptation (**SE**). Different cropping patterns, such as crop rotation, intercropping and crop diversification (**CR**), are preferred by many farmers in the world for having better adaptation and resilience to climate (Simelton and Ostwald, 2020; Bastakoti et al., 2014; Singh et al., 2017). In Thailand, farmers' continued cultivation of short-term crops, such as cassava, beans, tobacco, and maize on the same area of post-harvest rice has increased total income and reduced the risk of crop (rice) failure due to possible climate impacts on rice (Bastakoti et al., 2014). Research by Yin et al. (2016) in northeastern China shows that farmers are willing to diversify maize varieties to improve resilience if they receive sufficient varietal information and support, price subsidies for corn products from local governments and if the planting areas are expanded. Indigenous communities in the

Lawachara National Park area of Bangladesh adopt a wide range of crops (eg. cash crops, fruit trees, maize and paddy rice) to diversify their incomes and reduce the risk of crop failures climate extreme events (Rahman and Alam, 2016). This is also a response to droughts of farmers in the northwestern Balochistan region of Pakistan (Ashraf et al., 2014). According to Onojo (2020) in Simelton and Ostwald (2020), Nigerian farmers often adopt cassava-based intercrop systems (e.g. cassava-banana, cassava-maize-vegetable, cassava-fruit tree-maize, cassava-maize) because they provide high mixed incomes, good resistance to pests and diseases, and high adaptability to unpredictable climatic events.

In Vietnam, these intercop systems have been applied in many regions, especially in the uplands that are seriously affected by the changing climate and cultivation on sloping land (Bui et al., 2020a). Research by Nguyen et al. (2020) in Van Yen district, Yen Bai province, shows that the cassava-intercropped cowpea system on hill slopes helps reduce the population density of red spider mites through a population increase in natural enemies, increase nitrogen and carbon contents in the topsoil and mixed income on a same planting area by 10% and 80%, respectively, after a two-year experiment. Research by Tuan et al. (2014) in Yen Chau district, Son La province of northern Vietnam shows that erosion reduced by 93–100% by the maize-Pinto peanuts (*Arachis pintoi*) intercrop system and the maize-minimum tillage with relay cropping of Adzuki beans (*Phaseolus calcaratus*).

In some countries, organic farming (**OR**) measures are used as an adaptive response to climate impacts. According to Singh and Singh (2017), compost application is an effective traditional way of Indian farmers in increasing soil nutrients, reducing GHG emissions caused by chemical fertilizers, and improving the efficiency of organic and domestic waste management. Thai farmers adopt OR practices and reduce the amount of chemical pesticides and fertilizers to improve soil fertility, soil moisture, flexibility and sustainability of local livelihoods (Bastakoti et al., 2014). Results of the EPIC model in Chen et al. (2019) show that carbon stocks could reach 24.4 Tg/year (1Tg = *1 million tons*) if farmers keep crop residues in the field instead of burning them after harvest. The study of Adewopo (2020) in Simelton and Ostwald (2020) highlights positive impacts of the agricultural development policy of Nigeria (issued in 2016) on fertilizer management on the use of organic fertilizers, fertilizer supply strategies for regions and technical assistance in organic fertilizer application to improve production qualityand environment.

Some other studies worked to upgrade and improve crop varieties (**SE**) to enhance adaptive capacities to climate impacts. Research by Jianjun et al., 2015 in Yongqiao province of China on adaptation measures shows that, among different solutions, farmers rated drought-tolerant varieties the best measure in drought conditions. The use of drought-tolerant varieties is also a preferred solution by the Adi community in the eastern Himalayas of India (Singh et al., 2017). In Bangladesh (Abdur Rashid Sarker et al., 2014) and Sri Lanka (Esham and Garforth, 2013), farmers wanted to use short-term rice varieties in combination with changing the seasonal calendar to avoid climate extreme events with higher frequencies and intensities.

Table 2. Review results of CSA T&Rs in the world and Vietnam ([1] *Qualitative*, [2] *Quantitative*, [3] *Qualitative & Quantitative*)

CSA T&Ps	ADAPTATION												MITIGATION					FINANCE						SOCIAL					OTHERS			
	Crop management			*Irrigation & water management*					*Farm management*																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Authors/countries, territories	SE	CR	OR	AWD	RH	WC	II	WP	LP	CA	HG	AF	AWD	RI	CO	RE	CS	IN	CL	SA	CF	LA	OF	VC	IG	CE	TR	KS	Cl	AP	GE	PA
Bui et al. (2020a) – Vietnam[1]		✓								✓															✓	✓	✓	✓				✓
Bui et al. (2020b) – Vietnam [2]										✓							✓															
Vu et al. (2020) – Vietnam[1]										✓															✓	✓	✓					✓
Nguyen et al. (2020) – Vietnam[2]		✓								✓							✓															
Nguyen HQ et al. (2019) – Vietnam[2]																		✓											✓			
Bui et al. (2020c) – Vietnam[1]																										✓		✓	✓	✓		
Huyer et al. (2019) – Vietnam[1]																												✓			✓	
Simelton et al. (2019) – Vietnam[1]																											✓		✓	✓	✓	✓
Simelton and Ostwald (2020) – Africa[3]		✓	✓							✓		✓					✓														✓	
Kaczan et al. (2013) – Malawi, Zambia[1]										✓		✓																				
Nouri et al. (2019) – USA[2]									✓	✓							✓															
Wassmann et al. (2010) – Global[2]				✓									✓																			
Nidumolu et al. (2018) – India[1]																													✓	✓		
Simelton et al. (2015) – Vietnam[1]											✓	✓																				
Le Dang et al. (2013) – Vietnam[1]																		✓						✓								
Tuan et al. (2014) – Vietnam[2]		✓							✓	✓																						
Abdur Rashid Sarker et al. (2014) – Bangladesh[1]	✓	✓										✓							✓	✓		✓										
Bastakoti et al. (2014) – Thailand, Vietnam[1]		✓	✓			✓		✓				✓							✓			✓			✓							
Jianjun et al. (2015) – China[1]	✓	✓					✓											✓														
Partey et al. (2018) – West Africa[1]					✓	✓	✓			✓		✓															✓		✓	✓		
Khatri-Chhetri et al. (2017) – India[1]		✓			✓													✓											✓			
Aggarwal et al. (2018) – Global CCAFS research sites[1]																					✓											
Le et al. (2018) – Vietnam[1]																					✓					✓	✓					
Yin et al. (2016) – China[2]		✓						✓	✓	✓																						
Singh et al. (2017) – India[1]	✓	✓										✓								✓			✓					✓				
Rahman and Alam (2016) – Bangladesh[1]		✓	✓		✓	✓	✓	✓				✓			✓							✓	✓									
Leal Filho et al. (2013) – Africa, The Carribean, Asia Pacific[3]																✓																

CSA T&Ps	ADAPTATION												MITIGATION					FINANCE						SOCIAL					OTHERS			
	Crop management			*Irrigation & water management*					*Farm management*																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Authors/countries, territories	SE	CR	OR	AWD	RH	WC	II	WP	LP	CA	HG	AF	AWD	RI	CO	RE	CS	IN	CL	SA	CF	LA	OF	VC	IG	CE	TR	KS	Cl	AP	GE	PA
Gummert et al. (2020) – South Asia, Southeast Asia[3]														✓																		
Tran et al. (2017) – Vietnam[2]				✓									✓																			
Esham and Garforth (2013) – Sri Lanka[1]	✓	✓				✓																		✓								
Singh and Singh (2017) – Global[1]		✓	✓									✓			✓							✓										
Trung et al. (2019) – Vietnam[1]											✓	✓		✓	✓																	
Simelton and Le (2017) – Vietnam[1]											✓	✓			✓																	
Liu et al. (2017) – China[2]			✓											✓																		
Chen et al. (2019) – China[2]			✓											✓																		
Bui et al. (2017) – Vietnam[1]																								✓	✓	✓	✓	✓				✓
Romasanta et al. (2017) – The Philippines[2]														✓																		
Bogdanski (2012) – Global[1]																✓																
Keshavarz et al. (2013) – Iran[1]			✓		✓																		✓						✓			
Gautam and Andersen (2017) – Nepal[1]																			✓				✓					✓				
Mallick et al. (2017) – Bangladesh[1]							✓												✓	✓		✓										
Ashraf et al. (2014) – Pakistan[1]		✓	✓			✓						✓								✓		✓	✓									
Galhena et al. (2013) – Sri Lanka[1]											✓																					
Gadde et al. (2009) – India, Thailand, the Philippines[2]														✓		✓																

Adaptation measures

- SE = **SE**ed improvement for enhanced climate adaptation
- CR = **CR**op Scheduling (intercrop, rotation, diversification)
- OR = **OR**ganic Farming
- AWD = **A**lternate **W**etting-**D**rying (water saving)
- WC = **W**ater **C**onservation
- II = **I**rrigation **I**nfrastructure
- RH = **R**ainwater **H**arvesting
- WP = **W**ater **P**ump
- LP = **L**and **P**reparation
- HG = Integrated **H**ome **G**arden
- CA = **C**onservation **A**griculture
- AF = **A**gro-**F**orestry

Mitigation measures

- AWD = **A**lternate **W**etting-**D**rying (reduced GHG emissions)
- RI = **RI**ce straw for biofertilizers, renewable energy
- CO = **CO**mposting for biofertilizers and reduced GHG emissions
- RE = **R**enewable **E**nergy (solar, wind, wave…)
- CS = **C**arbon **S**equestration

Finance measures

- IN = **IN**surance (agriculture, climate)
- CL = **C**redit **L**oans
- SA = **SA**vings
- CF = **C**ommunity credit **F**unds
- LA = **L**ivestock & **A**quaculture (extra income)
- OF = **O**ff-**F**arm activities

Social measures

- VC = **V**illage **C**onvention on climate actions
- IG = **I**nterest Groups
- CE = **C**limate **E**ducation
- TR = **TR**aining on adaptation/mitigation
- KS = **S**haring of local **K**nowledge, seeds and animals

Others

- Cl = **Cl**imate services
- AP = Multi-stakeholder **A**ction **P**lanning
- GE = **G**ender **E**quity
- PA = **PA**rticipation of stakeholders

3.1.2. Irrigation and water management measures

12 out of 44 references are repeatedly on *irrigation and water management*, of which 05 are on water conservation (**WC**); 04 on rainwater harvesting (**RH**); 04 on irrigation infrastructure (**II**); 03 on water pump (**WP**); and 02 on alternate wetting-drying in paddy rice production (**AWD**). People in the Lawachara National Park area of Bangladesh (Rahman and Alam, 2016) often use plastic containers or build water jars to increase their water storage capacity (**WC**). 27% of Sri Lankan farmers interviewed in the study of Esham and Garforth (2013) said that they need to increase WC for domestic use and cultivation in low rainfall conditions; however, they lack capital to invest in storage equipment. Alternatively, some farmers apply mulching and tree shade to reduce evapo-transpiration and maintain soil moisture for crops in the absence of rainfall.

Another effective water management solution is harvesting and storage of rainwater (**RH**). This is one of the adaptation measures that 84% of Iranian farmers interviewed in areas with rainfall <600 mm/year appreciate (Keshavarz et al., 2013). The people of Lawachara region of Bangladesh (Rahman and Alam, 2016) dig ponds and wells to store rainwater. In West Africa, farmers dig small holes (called *'zai'*) and larger semicircle holes (called *half-moon* rainwater harvesting technique) to collect rainwater and plant crops (Partey et al., 2018). Rainwater harvesting techniques have also been adopted quite commonly by Vietnamese and Thai farmers (Bastakoti et al., 2014). Jianjun et al., 2015 and Partey et al. (2018) emphasized the need to upgrade infrastructures (**II**) for improving irrigation capacities, which is an important criterion in the 19 criteria of the national NTM program.

In Yin et al. (2016), in summer and autumn, Chinese farmers use pumps (**WP**) to bring water from rivers, streams, canals or drilled wells to irrigate their maize fields. However, the efficiency of this option is not high, often resulting in water waste. In addition, a majority of people cannot afford drilled wells and electric pumps. WP is also a solution used by farmers in Bangladesh (Rahman and Alam, 2016), Thailand and Vietnam (Bastakoti et al., 2014). In paddy rice, the alternate wetting-drying (**AWD**) technique has been proven to be an efficient water use solution. The review work of Wassmann et al. (2010) shows that AWD saves 15-20% of irrigation water compared to conventional continuous flooding practice without affecting rice yield. This figure is 14-15% in Tran et al. (2017) in the Mekong Delta, Vietnam.

3.1.3. Farm management measures

20 out of 44 references are repeatedly on *farm management*, of which 12 are on agroforestry (**AF**); 10 on conservation agriculture (**CA**); 04 on integrated garden management (**HG**); and 03 on land preparation (**LP**). Conservative agriculture (**CA**) is one of the most common sets of farming practices in rural areas of the developing world (Bui et al., 2020a; Simelton and Ostwald, 2020; Partey et al., 2018). Zambia has 40,000 hectares applied with CA measures, more than any other African countries in the Sahara (Kaczan et al., 2013), that have helped improve soil quality, crop yields, and better adapt

to climate impacts. In some West African countries (Partey et al., 2018) CA is often about soil and water conservation measures, including: minimal or no tillage, land cover and relay cropping, and crop rotation. In the USA, Nouri et al. (2019) shows a significant improvement in soil quality of cotton farms applying no tillage and cover crops over 34 years, including increases soil moisture (by 28.6% - 36.4%), soil wet soil aggregates in the 0-15cm topsoil layer (by 13%), soil moisture, water infiltration and cotton yield. Studies by Bui et al. (2020b) and Nguyen et al. (2020) in Yen Bai province of northern Vietnam show that contoured grass barriers and intercropped cowpea on cassava hill slopes helped increase soil cohesiveness, soil nitrogen and carbon contents, reduce erosion and the impact of red spider mites on cassava, increase cassava yield and mixed income by 20% and 80%, respectively. Land preparation (**LP**) is one of the most effective solutions adopted by Chinese farmers (Yin et al., 2016), which increased maize yield by 438-459 kg/ha in drought years. Research by Tuan et al. (2014) in Son La, Vietnam shows that minimum tillage combined with cover crops on upland maize can reduce soil erosion by up to 94%.

In Malawi, agroforestry (**AF**) is applied to a variety of short-term crops, of which maize plays the most important role for the country's 70% coverage of arable land (Kaczan et al., 2013). The combination of maize with leguminous crops helps farmers reduce the cost of chemical fertilizers and increase maize yield by 1.3-1.6 tons/ha. Research by Simelton et al. (2015) in northern and central Vietnam shows that AF can help improve climate change adaptation. Planting trees with major crops helped shorten the recovery time of soil quality and create larger economic and environmental buffers than areas without tree planting. This is also one of the most preferred solutions by West African farmers in terms of climate change adaptation, land reclamation and livelihood improvement (Partey et al., 2018).

Integrated home garden (**HG**) is a form of crop diversification (**AF**) but is concentrated in the garden area within farmers' homestead. Vietnamese farmers in the central and northern mountainous regions (Simelton et al., 2015; Simelton and Le, 2017; Trung et al., 2019) appreciate advantages for climate adaptation (carbon sequestration), mitigation (wind breaking function of multi-storey tree levels), and improved mixed incomes (diverse income sources from various garden-based systems). Galhena et al. (2013) analyzed the effectiveness of the *"Kandyan Forest Gardens"* (KFG) model after the civil war in Sri Lanka. The KFG model is a traditional agroforestry system, consisting of an integrated cropping system with cash and perennial crops combined with a diverse livestock system around the the homestead. In addition to maintaining and enhancing people's livelihoods, the KFGs also preserve biodiversity and preserve precious timber and medicinal plants of Sri Lanka.

3.2.The 'mitigation measures' theme

17 out of 44 references are repeatedly on mitigation measures, of which 06 are on rice straw management for biofertilizers and renewable energy (**RI**); 04 on compost for biofertilizers and reduced GHG emissions (**CO**); 04 carbon sequestration (**CS**); 03 renewable energy (**RE**); and 02 on alternate wetting-drying for reduced GHG emissions (**AWD**). Using agricultural residues (crop residues and

manure) as organic fertilizer for crops is one of the most effective and popular solutions in many rural communities around the world. These solutions also contribute to reducing emissions of CO_2 from post-harvest burning (Gummert et al., 2020). In China, Liu et al. (2017) in the wheat-rice rotation system indicates that rice straw (**RI**) mixed with NPK fertilizer combined with effective microorganisms results in a 13–26% reduction in N_2O emissions and increases the efficient use of post-harvest residues. Chen et al. (2019) shows that CO_2 emissions across China could be reduced by 149.9 Tg/year if farmers return crop residues to the soil instead of burning immediately after harvesting. Gadde et al. (2010) reported that 95% of crop residues in the Philippines were burned immediately in the field after harvesting, leading to a 13% increase in total GHG emissions (Romasanta et al., 2017). Crop-based compost (**CO**) is one of the most effective indigenous solutions for people living around Bangladesh's Lawachara National Park (Rahman and Alam, 2016) and the Himalayas in India (Singh and Singh, 2017). RI and CO are also two adaptation practices applied by Vietnamese farmers; however, they are not commonly and widely practiced because many farmers still burn rice straw after harvest (Bastakoti et al., 2014). The CCAFS program in Vietnam (2015–2018) attempted to disseminate these practices among the rural communities in the three regions in the north (Yen Bai province), central (Ha Tinh province) and south (Bac Lieu province) as mitigation measures (Simelton and Le, 2017; Bui et al., 2017; Trung et al., 2019).

Many of the CSA T&Ps presented above, for instance CR, OR, CA, HG, AF, contribute to increasing carbon stocks (**CS**) in the soil – an adaptation measure to restore soil degradation due to erosion and crop intensification – such as AF practices presented in Simelton and Ostwald (2020) in African countries, or CA practice of no-till and cover cropping on cotton fields in the United States in the 34-year study by Nouri et al. (2019). Research by Nguyen et al. (2020) in Yen Bai, Vietnam, shows that carbon and nitrogen reserves in the soil from cowpea intercropped with cassava increased by 10% compared with the traditional cassava monoculture after 02 years of experiment. Similar results, i.e. improved soil fertility, are shown in studies by Bui et al. (2020a) and Bui et al. (2020b) after more than 5 years of applying the contoured grass barriers on cassava hill slopes.

The renewable energy (**RE**) sources in general and in agricultural production in particular are necessary to help reduce greenhouse gas emissions. Studies in Leal Filho et al. (2013) in Africa, the Caribbean and Asia Pacific indicate the inevitable trend in the use of natural energy sources (solar, wind, waves, etc.) for better adaptation in the world's increasingly climate-vulnerable agriculture. Wind and solar energies can help farmers with limited access to traditional energy supplies, such as electricity and gas, still be able to secure energy demand for their operations (Bogdanski, 2012). The study by Gadde et al. (2009) in India, Thailand and the Philippines found out that straw, instead of burning after harvesting, can be used to create an alternative energy source. Estimated annual post-harvest straw amounts in India, Thailand and the Philippines are 97.17, 21.86 and 10.68 Mt, respectively. If 50% of these amounts are reused to generate electricity, the annual surplus electricity outputs for these three countries would be 10.8, 8.2 and 4.9 TWh, respectively. In the case where 100% of straw is used, the surplus annual electricity outputs would be 21.6, 16.5 and 9.8 TWh, respectively.

In paddy rice, the alternate wetting-drying (**AWD**) practice reduces emissions of CH_4 and N_2O. Research by Tran et al. (2017) in Thua Thien Hue, Vietnam, found that AWD reduced CH_4 and N_2O emissions by 26–29% compared with the traditional regular continuous flooding practice. Wassmann et al. (2010) found that CH_4 emissions from paddy rice cultivation account for 9–19% of global GHG emissions. As a result, the widespread application of the AWD practice can significantly reduce GHG emissions, and slow down the global warming process.

3.3.The 'financial measures' theme

15 out of 44 references are repeatedly on financial measures, of which 06 are on livestock and aquaculture (**LA**); 05 on off-farm activities (**OF**); 04 on agriculture and climate insurance (**IN**); 04 on credit loan (**CL**); 04 on savings (**SA**); and 02 on community credit funds (**CF**). These solutions aim to improve farmers' financial capacity to help them sustain the implementation of CSA T&Ps in the long term. The study of Singh and Singh (2017) shows that **LA** consists of important traditional farming practices that help to secure food security and enhance rural livelihoods in support to implementation of other adaption and mitigation T&Ps in many countries around the world. The study by Ashraf et al. (2014) in the northwestern region of Balochistan, Pakistan, shows that livestock is an effective solution to help farmers adapt better to drought conditions and prevent them from migrating to other localities and stay with their communities. Cattles are an important source of finance for farmers through times of crop failure due to droughts. This result coincides with the study of Abdur Rashid Sarker et al. (2014) in Rajshahi province of Bangladesh, where droughts happen regularly. Research by Mallick et al. (2017) in the southwest coast of Bangladesh shows that fishing is an important economic means for sustaining livelihoods in localities that are vulnerable to cyclones.

Off-farm activities (**OF**) are sources for farmers' additional incomes. These activities are particularly important for poor female-headed households (Singh et al., 2017) in the Adi community in the eastern Himalayas of India who receive much less knowledge and technical training than better-off male-headed households. The OF activities of this group of people are mainly to collect and sell traditional medicinal plants, ornamental plants and other plants. Taking advantage of forest resources from the Bahanugach National Park and tourism potentials in Moulavibazar province, Bangladeshi farmers (Rahman and Alam, 2016) make and sell cooking stoves, indigenous clothes, bamboo handicrafts; collect and sell firewoods, medicinal plants; provide ecotourism services to tourists to increase household incomes while agriculture is seriously affected by weather extreme events. Off-farm trade is an income source of farmers (Gautam and Andersen, 2017) in Humla district, western Nepal, including daily wage labor and seasonal labor in the winter. Farmers in Ma village, Vinh Kien commune, Yen Binh district, Yen Bai province, one of the three CCAFS research sites in Vietnam, also consider off-farm activities as an important source of income in their household economy. Ma villagers can make an additional income of 120-170 USD/person/month from working as hired labor in 17 timber factories that are located within the village, which is a significant amount added to the total household income (Bui et al., 2017).

Agricultural and climatic insurance (**IN**) is an option for farmers in many parts of the world in minimzing financial risks from crop failures caused by extreme climatic events. Research results of Jianjun et al. (2015) in Yongqiao district, northern Anhui province of China, show that over 50% of the surveyed farmers said they purchased IN in parallel with investing in adaptation measures to minimize financial risks due to crop failures. In the research by Partey et al. (2018), the West African country of Senegal promotes the application of IN to leverage farmers' confidence in adopting CSA T&Ps. Indian farmers in Khatri-Chhetri et al. (2017) rated IN the most effective solution in maintaining the sustainability of CSA T&Ps. IN is not really popularly implemented in Vietnam (Nguyen HQ et al., 2019), especially by smallholder farmers in the northern and central regions of Vietnam – regions with climate vulnerabilities. However, in regions with better conditions for agricultural development, such as the Mekong River Delta, IN has become more popular. The study of Le Dang et al. (2013) shows that 76.8% of the surveyed farmers said they purchased IN to minimize investment risks in the context of climate change, where risks of crop failure are covered by IN.

Research by Abdur Rashid Sarker et al. (2014) shows that improved accessibility to credit loans (**CL**) can help farmers increase the chance (by eight times) of practicing adaptation measures, e. short-term rice, compared to those who have limited access. This is also a finding in Bastakoti et al. (2014) in Thailand and Vietnam. Meanwhile, CL help poor farmers in Nepal solve the problem of temporary food shortages and restore production in Bangladesh (Mallick et al., 2017) after being affected by climate impacts (Gautam and Andersen, 2017). Some farmers with better financial conditions can use their savings (**SA**) to deal with their problems. In Singh et al. (2017), poor women in India try to generate SA to cope with climate risks from selling seeds and fermented foods. 18.4% of Bangladeshi farmers surveyed in Mallick et al. (2017) said they were aware of the importance of SA and tried to maintain this source as a financial adaptive solution. Pakistani farmers in Ashraf et al. (2014) use their savings to invest in CSA T&Ps to increase resilience rather than to generate non-farm revenues.

In addition to personal financial solutions, community credit funds (**CF**) have been introduced in several parts of the world. These funds can be set up by communities, local governments, or any organizations or individuals for charitable purposes to help poor farmers quickly borrow money with low interest rates to invest in production or overcoming impacts of natural disasters and/or weather anomalies. In the synthesis study of Aggarwal et al. (2018), a *'community innovation fund'* has been applied in East Africa to help replicate CSA T&Ps in rural communities that the work had been scaled into. A similar fund was implemented in My Loi CSV in Ha Tinh province, one of three CCAFS sites in Vietnam during the period 2015–2018 (Le et al., 2018). In Ma CSV, the CCAFS program also set up a similar fund called *'climate micro finance fund'* to support poor, disadvantaged and women farmers to practice CSA T&Ps during 2015–2018 (Bui et al., 2017).

3.4.The 'social measures' theme

14 out of 44 references are repeatedly on social measures, of which 06 are on sharing of local knowledge, seeds and animals (**KS**); 06 on adaptation and mitigation training (**TR**); 05 on climate

education (**CE**); 04 on interest groups (**IG**); and 03 on village convention on climate actions (**VC**). Knowledge sharing (**KS**) on climate risk adaptation takes place naturally and informally within the community or through multi-governmental channels (Nidumolu et al., 2018). Local information can be about prices of agricultural inputs and outputs, types of non-agricultural commodities with market potentials that the community can provide, and varieties of native crops and livestock that are highly adaptive to climate risks (Singh et al., 2017). Local knowledge can be on traditional conservation-like agriculture and existing local adaptation measures (Bui et al., 2020a). Channels for knowledge and information sharing can come from weather forecasts, local development programs, agricultural product subsidies, cross site visits and training programs (Nidumolu et al., 2018).

Climate education (**CE**) activities and technical trainings on adaptation and mitigation (**TR**) for adaptive capacity development play a very important role. The CCAFS program in general and in Vietnam in particular dedicated the first year of all of its projects to education and social mobilization activities in order to leverage understanding and knowledge of farmers on climate change and its. These activities were to prepare the farmers for making action plans with appropriate adaptation and mitigation practices (Bui et al., 2017; Le et al., 2018). Once an action plan was made, including suitable CSA T&Ps with a good cooperation and coordination mechanism set up for a multi-stakeholder platform, key technical partners, such as scientists and local extension professionals, started training activities to guide farmers through different stepwise procedures for implementing the prioritized T&Ps (Bui et al., 2020a; Vu et al., 2020; Simelton et al., 2019). Interest groups (**IG**) of farmers in the community were established to practice CSA T&Ps and help each group member achieve expected outputs, outcomes and impacts (Bui et al., 2020a). It is important to understand biophysical and socio-economic characteristics, customs, educational backgrounds and needs for change of a community in order to make a good action plan (Esham and Garforth, 2013). In addition, communities also need to develop village action conventions (**VC**) to guide farmers' implementation in accordance with plans and strategies of local governments (eg. commune, district and province) for the sustainability of climate adaptive and resilient agriculture while still achieving the productivity and income goal (Bui et al., 2017).

3.5.The 'others' theme

12 out of 44 references are repeatedly on other measures, of which 07 are on climate services (**Cl**); 04 on multi-stakeholder action planning (**AP**); 04 on participation of stakeholders (**PA**); and 03 gender equity (**GE**). Extreme weather events are hard to predict and increasingly posing major risks to agricultural production and farmers' livelihoods in many geographical regions of the world (Aggarwal et al., 2018; Singh and Singh, 2017; Simelton and Ostwald, 2020; Partey et al., 2018), especially to poor farmers in developing countries. They need accurate short, medium, and long-term weather forecasts (**Cl**) to have appropriate livelihood and adaptation strategies to be able to cope well with the impacts of possible climate risks. In addition to the lack of accurate forecasts, the transfer and sharing of weather information to farmers and producers is still limited, leading to ineffective utilization of information for adaptation measures. Nidumolu et al. (2018) proposed three ways to overcome the

limitations above for southern India, including (i) identification of champion individuals and organizations in the community that possess accurate information and can promote effective information sharing; (ii) application of value chain analysis tools on learning how farmers and producers utilize weather forecasts to make decisions for recommending effective use of information to improve their production; and (iii) provision of decision support tools that analyze impacts of climate risks as the basis for timely adaptation plans. Also, in India, the study by Khatri-Chhetri et al. (2017) shows that over 80% of the surveyed farmers chose a *weather-based agricultural consulting service* as one of the most important adaptation solutions in agricultural production.

In Vietnam, Nguyen HQ et al. (2019) used mathematical modeling integrated with hydro-meteorological data, crops and remote sensing data to develop climate maps and assess the suitability of spatial planning for crops in Ky Anh district, Ha Tinh province. The study by Simelton et al. (2019) for the period 2015–2018 in Vietnam, Laos and Cambodia concludes that having accurate and timely weather forecast information can help identify suitable adaptation measures and minimize the risk of crop failures. The work of of Bui et al. (2020c) also pointed out the necessity of weather-based agroadvisory services in improving the efficiency of implementing 06 relevant NTM criteria in NTM's 2021-2030 Strategy. All of these studies emphasize the need for good cooperation and coordination (**AP**) among multi-level governments (from the central to local) in transfering and sharing information on hydrometeorological forecasts, development and action plans climate vulnerable regions. Besides the main *'farmers'* actor, Nidumolu et al. (2018) emphasized the role for information sharing and participation in jointly developing action plans of local government leaders, extension professionals, non-governmental organizations, etc.

That strongly reinforces the importance of participation all levels, sectors and partners (**PA**) in successfully and sustainably implementing common adaptation and mitigation goals. This approach is commonly used in research and development programs and projects around the world as well as in Vietnam. Bui et al. (2020a) highlighted the effective joint forces of local leaders, businesses, agricultural extension and farmers in Van Yen district, Yen Bai province, in the successful implementation of a conservation program on cassava hill slopes since 2003. Vu et al. (2020) in Van Yen district also pointed out that effective cooperation and coordination of the above partners will be key to help Van Yen farmers restore degraded soils. Simelton et al. (2019) concluded that coordination in information sharing and participatation in programs on climate service actions can help leverage the efficiency of adaptation measures in Vietnam, Laos and Cambodia. The successful CSV model in Ma village (Bui et al., 2017) indicated the importance of farmers' participation in adopting, practicing and scaling CSA T&Ps through farmer-to-farmer knowleddge diffusion as farmer extension workders.

The gender (**GE**) issue is often a forgotten aspect of development programs and projects. Women and men, as well as the elderly and young people, have equally important voices, responsibilities and contributions in their communities. Promoting gender equity through creating opportunities for all to participate in their community adaptation and resilience work will help optimize their synergies, knowledge and experience (Huyer et al., 2019; Simelton et al., 2019; Simelton and Ostwald, 2020).

4. Recommendations for CSA adoption in the implementation of NTM's 2021-2030 Strategy

4.1.Mainstreawming CSA into some NTM criteria

The authors proposed a specific framework (Figure 2) for integrating 32 CSA T&Ps (1-32) from Table 2 into implementation of for 6/19 NTM criteria and some of their sub-criteria (Table 3), identified in accordance with CSA (Bui et al., 2020c), towards climate resilience for the 2021-2030 Strategy. The **planning** criterion clearly indicates the necessity of mainstreaming climate change response factors in restructuring the agricultural sector. A commune-level master plan should be developed based on assessment of the vulnerability to climate change, and the natural, financial, social and human resources available in the area to meet certain needs for adaptation and resilience. From there, the remaining requirements for investment can be accurately identified to achieve the highest budget use efficiency. Furthermore, commune-level planning should take into consideration of, at least, all of the 32 CSA T&Ps to ensure a best and most effective and efficient action plan for climate adaptation and resilience in agricultural production and rural livelihoods.

The **irrigation** criterion should incorporate all *irrigation and water management* measures (4–8) in order to achieve active irrigation for over 80% of agricultural land. In addition, the NTM program needs to have a financial mechanism for activating investment for improving the local irrigation infrastructures, such as from the local government, credit loans (19). In order to synchronously achieve the irrigation targets, the implementation levels (commune, district, province) need to develop an overall cooperation and coordination plan for effectively and efficiently joint actions (30). Water pumping (8) has been confirmed to be an important practice in improving irrigation (Yin et al., 2016; Rahman and Alam, 2016; Bastakoti et al., 2014). However, unstable **electricity** systems are the main obstacle to irrigation in many remote and climate-vulnerable areas. The short-term solution can be investment in renewable and alternative energy sources (16), for example solar, wind energies or water generated electricity from streams and rivers commonly in mountainous regions. Funding sources can come from the state budget, loans, non-refundable aid, cost-sharing from people and enterprises, etc.

The **information and communications** criterion needs to ensure best support for implementation of social measures (24–28). Stable internet and high-quality information technology can help stakeholders exchange and share weather information, develop joint action plans, and all farmers can access to information, participate, monitor and evaluate the implementation of CSA T&Ps (29–32).

Production organization is the most important technical criterion for mainstreaming CSA T&Ps into the NTM's 2021-2030 Strategy. All 32 CSA T&Ps need to be implemented within the sub-criterion 13.2 to sustainably link production with value chain developments of agricultural commodities. Among these measures, some need to be emphasized for their greater importance and strategic investment priorities, such as agriculture and climate insurance (8) in helping to reduce the risk of crop failures; climate services (29) in helping local leaders and farmers come up with production strategies relevant with climate forecasts and market needs; and multi-stakeholder action planning (30) in helping guide the monitoring and evaluation of the overall implementation process.

The **culture** criterion needs to be linked with community-based educational activities on climate impacts and resilience strategies for enhancing production and local livelihoods (26). There is a need for village conventions (24), which set culture-bound regulations for climate actions, that guide farmers through the culture-based climate resilience implementation process. Community behavior and rules for gender equity (31) in the community need to be fully addressed in implementing the culture criterion to leverage the position, the voice and contribution of women in climate resilience activities in NTM implemetation

4.2.Logical framework combining multi-level cooperation and coordination in CSA implementation with climate advisory services

Overall, the NTM program should have an action framework combining (a) improvement of the quality of weather forecasts on the daily, monthly and seasonal bases; utilization of modern technologies in collaboratively transferring and sharing forecast information to local leaders and authorities and farmers (*climate component*); and (b) an effective coordination mechanism between commune, district and province levels in capacity development for climate change mitigation and adaptation in NTM implementation (*coordination component*) (Figure 2).

In the ***climate component***, besides the coordination with with regional/provincial hydro-meteorological stations, the Central Hydrometeorological Forecasting Center needs to cooperate with relevant R&D programs and projects with forecasting capacities using good mathematical models in improving the quality of weather-based advisory services for adaptation and resilience adaptation strategies and planning. In addition, there is a need for improving the efficiency of communications, information transfer and sharing among partners for well coordinated actions in order to develop best weather-driven adaptation and resilience measures.

In the ***coordination component***, information on climate vulnerabilities, resources available for local responses, and needs for additional support are investigated and gathered from the communal level for aggregation at the district and provincial levels. With these accurately done, the provincial government can identify correctly climate vulnerable areas and right amounts of investment going into implementation, avoiding budget wastes like in the 2010-2020 Strategy for not having this coordination mechanism run effectively (Bui et al., 2020c). This coordination also makes it easier for a province to monitor and evaluate the progress of the work in areas more accurately. The bottom-up reporting and top-down guidance, if well implemented, can help strengthen cooperation amd collaboration between different levels of implementations and stakeholders in achieving general and specific adaptation and resilience goals.

Table 3. Recommendations of mainstreaming CSA T&Ps into 6/19 relevant NTM criteria for the 2021-2030 Strategy

	CSA T&Ps	**ADAPTATION**												**MITIGATION**					**FINANCE**						**SOCIAL**					**OTHERS**			
		Crop management			*Irrigation and water management*					*Farm management*																							
Criteria	**Sub-criteria**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1. Communal planning	1.1. Communal planning[1] approved and publicized in-time	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Irrigation	3.1. Over 80% of arable land is irrigated				✓	✓	✓	✓	✓								✓			✓											✓		
4. Electricity	4.1. Standardized electricity system								✓								✓																
8. Information and communications	8.2. Good telecommunications and internet at commune																									✓	✓	✓	✓	✓	✓	✓	✓
	8.3. Communal radio station and village loud speaker system																								✓	✓	✓	✓	✓				
	8.4. Communal information technology application in management and governance																								✓	✓	✓	✓	✓		✓	✓	
13. Production organization	13.1. Communal cooperatives implemented in accordance with the 2012 Cooperative Law																								✓						✓		✓
	13.2. Communal production sustainably linked with value chains of major local commodities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
16. Culture																									✓		✓					✓	

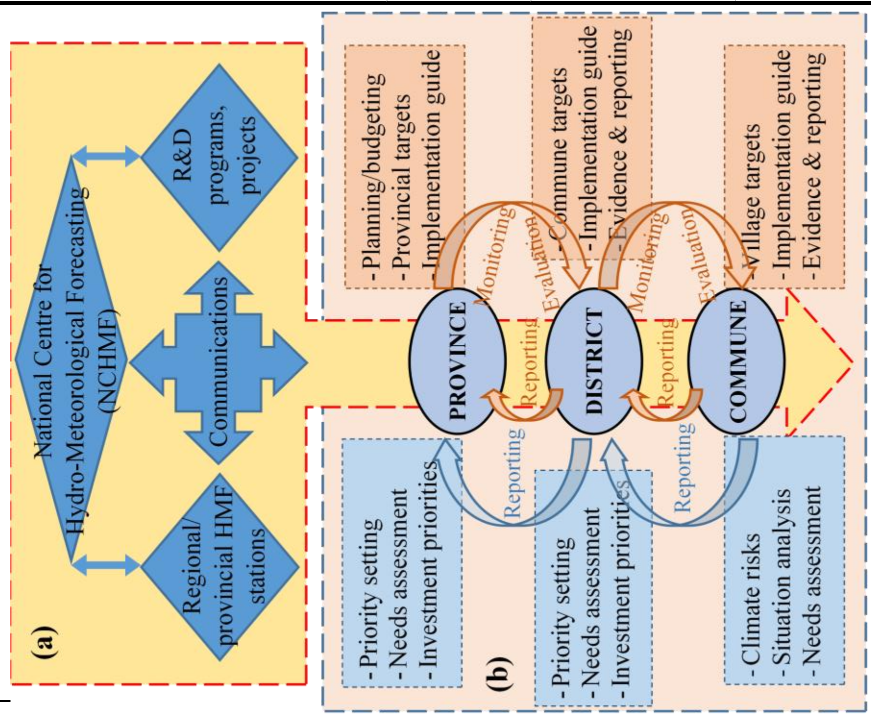

Figure 2. Recommendations for sharing accurate weather forecast information AND multi-level CSA cooperation for implementation of NTM's 2021-2030 Strategy

(a) Sharing accurate weather forecast information

(b) Multi-level CSA cooperation for implementation based on **(a)**

[1] Communal planning needs to ensure the mainstreaming of agricultural restructuring with climate adaptation, urbanization of peri-urban areas and meeting rural environmental requirements

5. Conclusions

The study has resolved 03 main research objectives as follows:

- The study selected 44 eligible references relevant to the research topic, including 29 qualitative records, 12 quantitative records and 03 records combining qualitative and quantitative. The references were examined and classified into to 5 main groups of: adaptation, mitigation, financial, social and other measures. 29 main CSA T&Ps relevant to Vietnam's agricultural context (except 26, 27 and 29) identified from 44 selected references.

- The study analyzed the possibilities for integration of the CSA T&Ps into the implementation of the 06/19 NTM criteria (1, 3, 4, 8, 13 and 16) identified by Bui et al. (2020c) in the 2021-2030 Strategy.

- To make this integration possible, the study proposed an inter-level coordination mechanism with a harmonious combination of top-down and bottom-up approaches in CSA implementation within the NTM's 2021-2030 Strategy.

ACKNOWLEDGEMENT

This publication was jointly funded by:

- Vietnam's Ministry of Agriculture and Rural Development through the research project ***"Scaling climate-smart villages in Yen Bai province to promote implementation of climate-smart agriculture and One Commune One Product (OCOP) initiative of the National Target Program on New Rural Development"***,

- The Embassy of Ireland through the VIBE 2018.05 project ***"NUI Galway – Vietnam National University of Agriculture (VNUA) Vietnam Ireland Bilateral Education Exchange (VIBE) Programme on Climate Resilient Agriculture & Environmentally Sustainable Landscapes"***, and

- The Climate Change, Agriculture and Food Security program of the CGIAR through the CCAFS P1596 project ***"Gender-sensitive CSA options trialed and tested in CSVs and business case development for scaling"***

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