

Climate change policy instruments in agriculture sector: From policy to adaptation practice at local level in Nepal

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Abstract

The current study explores synergies between climate change policy instruments and agriculture sector; reviews identified gaps and understands the translation of policy instruments at local level in five sample municipalities of three ecological regions. Understanding the adaptation actions and knowledge on implementation practices at household level is as the objective of this study. It adopted qualitative research approach using both primary (KII, FGD and household survey) and secondary data (review of existing policy documents) based on qualitative document analysis, (QDA). The study found that, policy and programs formulation at national and sub-national level in different period, are designed within the same setting from national to local level but there is divergence in programs formulation and implementation methods. Capacity and understanding of policy instruments has resulted different policy output which implicate farmers' response to implementation practices. It is found that municipal authorities are implementing climate friendly agriculture programs without explicitly declaring climate action. The farmers are practicing autonomous adaption in agriculture with

limited understanding and technical knowledge of long term climate change effect on farming. This has resulted maladaptive practices, which has contested planned climate change adaptation plan and programs. It devaluates the effort and resources spent by national and international institutions on CC policy instrument formulation and implementation. The need of field based demonstrative understanding and awareness campaigns for smallholder farmers is anticipated. It concludes that, flexibility of policy instruments through regular improvements and modification aids context-specific localization provide custom solutions. The custom solution match the traditional and existing adaptation practices assuring ownership at ground level.

Keywords: *autonomous adaptation, climate policy instruments, climate smart agriculture, smallholder farmers, implementation practices*

Introduction

Climate of Nepal varies significantly seasonally and with diverse physiography and intense altitudinal variation, typifying different climate zones and climate variability at micro-spatial level (DHM, 2017; GoN 2021b). Agriculture, on the other hand is heavily dependent on climatic factors like rainfall, temperature and soil moisture. Such climatic diversity provides enormous potential for assorted agriculture and agriculture based livelihood, but also renders complex climate risk exposure i.e. the potential adverse consequences of climate change, (MoALD, 2019a; World Bank, 2021). Agriculture contributes 23% to Nepal's GDP and nearly 66% of the total employment, of which 57.3% population is directly engaged in agriculture related economic activities (GoN, 2021a; MoALD, 2023; NSO 2023). It is estimated that 70% crop production in Nepal is determined by climate variability and 10-30% production failure is attributed to climate induced effects like no rain, drought and flood event (GoN, 2021b). However, agriculture sector also contributes negatively to climate change by emitting Green House Gas (GHG) in the atmosphere and it is estimated that by 2030, GHG emission from agriculture will increase up-to 36% (Baniya, 2023). Increased extreme weather events, increased frequency of climate induced hazards and disasters, temperatures and precipitation are characteristics observed climate change effect in Nepal making agriculture one of the most vulnerable sectors. Climate risk index, a measure of countries' exposure and vulnerability to climate-related risks listed Nepal as one of the highly affected countries and was ranked 10th (among 189 countries) in the two-decade period of 1999–2019 (Eckstein *et al.*, 2021). Policies, legal and regulatory frameworks and institutional arrangement are three essential features for climate change impact and risk management, and Government of Nepal has formulated and implemented a number of instruments to reduce and mitigate the adverse consequences of climate risk and CC impact. The most recent documents include National Climate Change Policy in 2019

(NCCP, 2019), National Determination Contribution Plan, NDC (2021-2030), Third National Communication to UNFCCC, TNC, 2021 and National Adaptation Plan 2021-2050 (NAP, 2021-2050) and all of these documents outlines CC impact and adaptation in agriculture sector.

Small landholding and subsistence farming practice is characteristic of Nepalese agriculture (MoALD, 2023). Farmers are facing various challenges due to differential effect of climate change and variability at local level in different ecological regions. Similarly, cumulative effect of topographic and climate change /variability has increased vulnerability of farmers with low adaptive capacity (Ghimire & Chhetri, 2022). CC impact on agriculture in Nepal is well documented (Bhandari, 2023; MoFE, 2019b; Panthi, *et al.*, 2015) and major impact are, reduced productivity, increased agriculture input cost, decreased soil fertility, reduced water supply and storage, increasing drought, and damage in crop yield (GoN, 2021a; World Bank, CCAFS & LI-BIRD, 2017). In this context, the current study is an attempt to explore synergies between National climate change policy instruments and agriculture sector, identify gaps and understand the translation of policy instruments at local level with reference to adaptation actions. Understanding the adaptation actions and knowledge on implementation practices at household level is also explored and analysed.

Concept

Policy instruments (policy, strategies, plans, legislatives and institutions) are regarded as governing tool to tackle the climate change impacts and building climate resilient agriculture system. The effective implementation to meet the target of such policy instruments are largely governed by and depend upon various institutional, socio-cultural and geographical factors. Policy and related instrument formulation in principle is guided by policy coherence (integration, interaction and consistency) and synergies and trade-off in relation to relevant sectoral policies, but, policy coherence is political in nature as interest and objectives vary across sectors (Mackie, 2020).

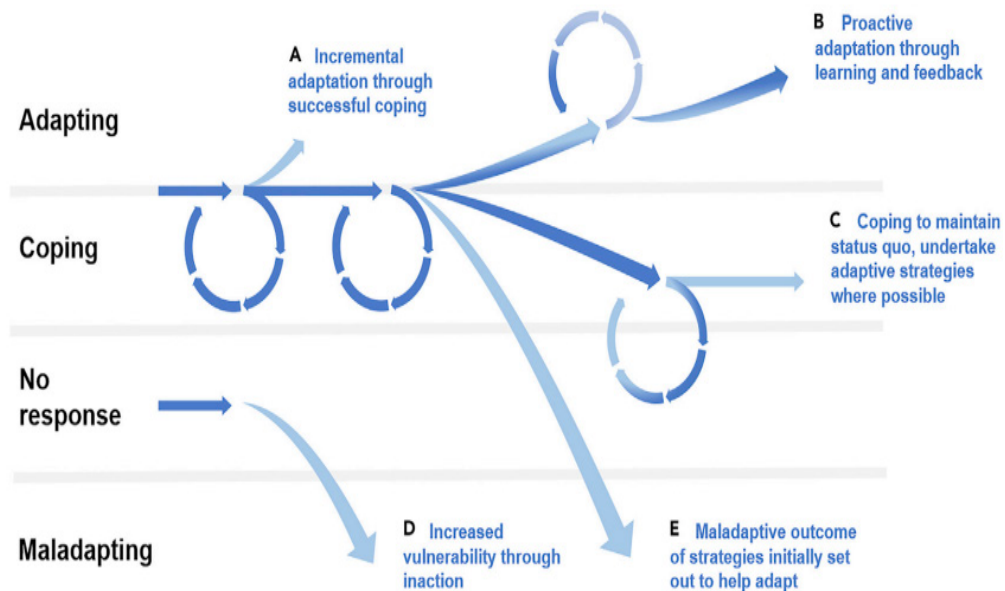
Climate change policy from local to global level is framed around two major categories: i: climate change mitigation which focuses on greenhouse gas emission reduction and minimizing the extent and effect of climate change and, ii) climate change adaptation which focused on minimizing risk of climate change by including innovative adaptation (Ensor *et al.*, 2019). Climate Change Adaptation (CCA) revolves around five indicators: risk and vulnerability reduction, resilient society, improved environment, increased economic resources, and enhanced governance and institutions (Owen, 2020). It is broadly categorized into autonomous or reactive adaptation and planned or anticipatory adaptation as well as maladaptation (Schipper, 2020). Autonomous adaptation refers

to self-identified reactive action which may not involve conscious climate motivations (IPCC, 2001).

Planned adaptation is an intentional policy decision, based on a knowledge to achieve a desired target. In contrast, maladaptation is the result of an action taken casually to avoid or reduce vulnerability but adversely increases the vulnerability of other systems (Barnett & O'Neill, 2010). The current study is confined to climate change adaptation as referred by Singh *et al.*, (2016) and depicted in Figure-1 with particular focus on agriculture sector.

Figure 1

Conceptual frame on adaptation outcomes (adopted from Singh et. al., 2016)



Data and method

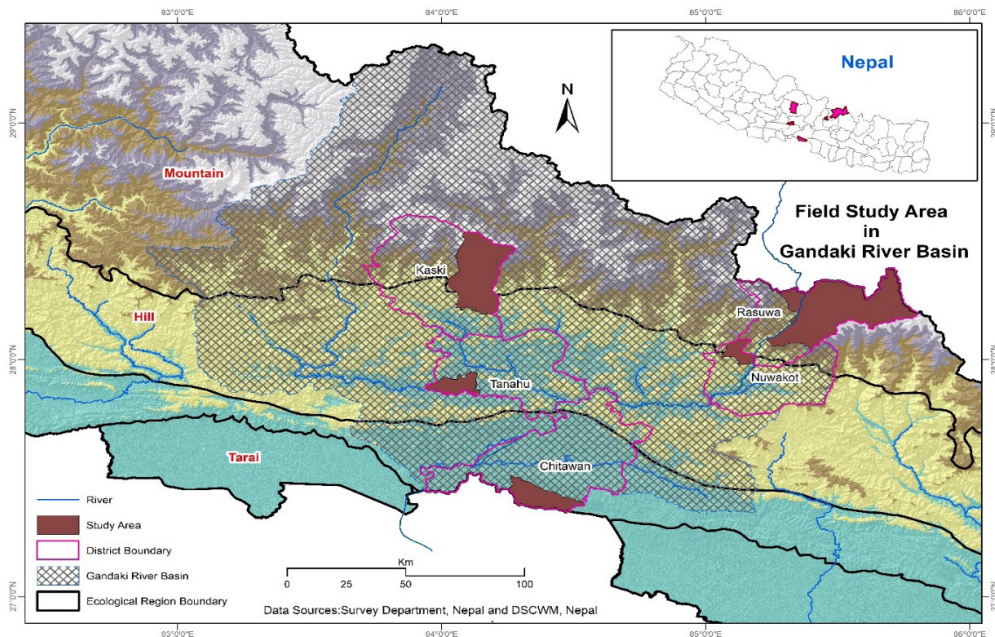
The current study adopted qualitative research approach using both primary and secondary data and information. Desk research consisted the reviews on policy and institutions and identified gaps and weaknesses was carried out by adopting qualitative document analysis (QDA), a systematic procedure for reviewing or evaluating documents which consists of analyzing various documents including, academic journal articles, institutional reports, newspaper articles, in both printed and electronic versions (Morgan, 2022). QDA was carried out in combination with focus group discussion

(FGD), Key Informant Interview (KII), farm household survey (FHH), informal discussion, and non-participant observation. Collected data and information obtained were triangulated for analysis purpose.

Review and assessment of these climate change, agriculture and related policies, legislative document covered period since endorsement of NCCP, 2019 to the most recent one being Nationally Determined Contribution Implementation Plan, (NDCIP) 2023. Synergies and trade-off between policy instruments and implementation practices were examined at sample municipal units in Gandaki Basin which include one rural municipality from Mountain region, three rural municipalities from Hill region and one municipality from Tarai region (Figure 2). The study was carried out in three stage. At the first stage, an overview on climate change situation of Nepal is carried out based on secondary literatures and government reports on climate change status and future scenarios. The second stage was document review through desk study where content review(Zembe, NemaKonde, & Chipangura, 2023) of key agriculture and climate change policy documents was carried out.

Figure 2

Sample study municipalities in Gandaki Basin, Nepal



The third stage is a field survey, carried out in five districts of Nepal to explore ground reality of local knowledge on climate change policy and instruments of knowledge and

implementation practices. The study area covered: Gosainkunda rural municipality of Rasuwa district in Mountain Region, Kispang rural municipality of Nuwakot, Ghiring rural municipality of Tanahu, and Madi rural municipality of Kaski in Hill region and, Madi municipality of Chitwan district in Tarai region. A total of 15 FGDs (3 in each municipality), 30 KII (6 in each municipality) and 211 FHH survey (71 in Mountain and Tarai and 69 in Hill) was conducted. FGD was carried out with mixed group which included 10-12 persons. KII included elderly farmers, local agro- veterinary agents and local extension officers, politicians, farmer user group leaders and local authority staffs. The checklist for FGD, KII and questionnaire for FHH focused on knowledge on climate change and agriculture policies, implementation and interventions, experience on climate variability, effect of climate and weather on farming and adaptation practices.

Results

Climate change trend and future scenario

The overall annual climate trend of Nepal (1971-2014) shows decreasing precipitation trend with value $-1.333/\text{yr}$. in all season, and increasing trend of temperature with value 0.056°C for maximum and value is 0.002°C for minimum temperature (DHM, 2017). Seasonal and annual time series (1971-2014) of maximum temperature shows increasing trend with inter-annual variability in all seasons. Monsoon season has the significantly highest positive trend of $0.058^{\circ}\text{C}/\text{yr}$. and pre-monsoon has the lowest trend of $0.051^{\circ}\text{C}/\text{yr}$. Minimum temperature for seasons is in decreasing trend except for monsoon season. The highest decreasing trend of precipitation is in the post-monsoon season with observed value is $-0.3\text{ mm}/\text{yr}$. though there is no significant trend (DHM, 2017). In the future (with base line 1991-2010), variation in temperature rise will be between $1.0-1.30\text{ C}$ with vertical variation across altitude zones and horizontal variation along east-west and north-south region (MoFE, 2021). Increase in extreme events, and warm days and nights in middle hill and high mountain area is also projected putting pressure on farming practices. Predicted uncertainty in precipitation, together with increasing heavy and intense rainfall further, escalates the stress in agriculture sector. In Gandaki basin, hill area receives highest rainfall and mountain region will be dryer (Panthi *et al.*, 2015). Delay in monsoon and increase in pre-and post-monsoon and winter rainfall is another projected characteristic.

Review of guiding policies and instruments

Different sectoral policy and policy instruments reflect climate change and agriculture consideration either explicitly or implicitly. The policy and related documents published up-to December 2023 are mapped against nine thematic priority area identified in NCCP, 2019 and NAP, 2021-2050 and presented in Table 1. It is apparent that thematic

priorities of agriculture sector are highly interrelated with thematic priority-2 i.e. forest biodiversity and watershed conservation, and cross cutting priority-8 i.e. Disaster risk reduction and management followed by priority 4-Rural and urban settlement. Climate finance is the crucial cross-cutting priority area to address CC mitigation and adaptation activities of all sectors.

Table 1

Sectoral coverage to NCCP thematic priorities

SN	Policy instruments	Year	Potential impact area										
			1	2	3	4	5	6	7	8	9		
1	National Adaptation Plan of Action (NAPA) to Climate Change	2010	*	*	*	*	*	*	*	*	*	*	*
2	Strategic Vision for Agricultural Research (2011-2030) NARC	2010	*										
3	National Framework on Local Adaptation Plans for Action	2011	*						*	*	*		
4	Rangeland Policy, 2012	2012	*							*			
5	Irrigation Policy, 2013	2013	*	*									
6	National Seed Vision 2013- 2025	2013	*										
7	Agro Biodiversity Policy, 2014	2014	*	*									
8	Agriculture Development Strategy 2015 - 35	2014	*										*
9	National Land Use Policy, 2015	2015	*	*	*	*	*	*	*	*	*	*	*
10	National Land Policy, 2018	2018	*	*		*						*	
11	National Climate Change Policy, 2019	2019	*	*	*	*	*	*	*	*	*	*	*
12	National Agroforestry Policy, 2019	2019	*	*									
13	Environment Conservation Regulation, 2020	2020	*	*		*	*					*	
14	Nationally Determined Contribution (NDC) Implementation Plan	2020	*	*	*	*	*	*	*	*	*	*	*
15	Fifteenth Periodic Plan 2019/2023/24	2020	*	*	*	*	*	*	*	*	*	*	*
16	Gender and Social Inclusion Strategy and Action Plan	2019	*	*	*	*	*	*	*	*	*	*	*
17	Roadmap for Adaptation Planning in Nepal's Agriculture Sectors	2019	*	*							*	*	
18	Climate Change Management Planning Guideline, 2020	2020	*	*	*	*	*	*	*	*	*	*	*
19	National Adaptation Plan (2021- 2050)	2021	*	*	*	*	*	*	*	*	*	*	*
20	Nepal's Long-term Strategy for Net-zero Emissions 2021	2021	*	*	*	*	*	*	*	*	*	*	*
21	Vulnerability and Risk Assessment and Identifying Adaptation Options in the Agriculture and Food Security sector	2021	*										*
22	Sixteenth Periodic Plan: Approach Paper 2023	2023	*	*	*	*	*	*	*	*	*	*	*
23	Nepal's Third National Communication to the UNFCCC	2023	*	*	*	*	*	*	*	*	*	*	*

Note: The sectors are identified according to the National Climate Change Policy, 2019 and National Adaptation Plan (NAP) 2021- 2050: 1. Agriculture and food security, 2. Forest Biodiversity and watershed conservation, 3. Water resources and energy, 4. Rural and urban settlement, 5. Industry, transport and physical infrastructure, 6. Tourism, natural and cultural heritage, 7. Health, drinking water and sanitation, 8. Disaster risk reduction and management, 9. Gender equality and social inclusion, livelihood and governance.

National Climate Change Policy 2019 (NCCP, 2019) and related instruments (including previous 2011 CC policy) are abiding to Paris Agreement (2015), Sendai Framework (2015-2030) and Sustainable Development Goal, SDGs (2030) to address climate impact adaptation and building climate resilient society (GoN, 2021a). NCCP includes eight sectoral and four cross-cutting area among which, agriculture and food security focuses on climate-friendly agriculture system and inclusive agriculture based adaptation program.

National Adaptation Plan (NAP) 2021-2050, was formulated in 2021 by repelling NAPA 2010, with short-term (2025), medium-term (2030), and long-term (2050) climate change adaptation actions. It comprises a total of nine agriculture sector priority adaptation programs as presented in Table 2 (GoN, 2021a). It underscores sensitization and engagement of local stakeholders to mainstream adaptation action plan at local level, which was originally articulated in National Framework on Local Adaptation Plan for Actions (LAPA) in 2011 (MoFE, 2019a). Besides, Second Nationally Determined Contributions, NDC-2020 also prioritizes agriculture sector and includes targets like include: operationalization of institutional structure for CC management at local level, establishment of 200 climate-smart villages and 500 climate-smart farms, promotion of inter-cropping, crop and livestock waste management to reduce carbon emission and climate-resilient and gender-responsive adaptation plan preparation in all 753 local units. Similarly, Third National Communication (TNC) focuses on agriculture commercialization, enhancing farmer's resilience, promoting organic farming and bio-fertilizer (GoN, 2021b).

Agriculture Development Strategy (ADS) 2015-2035 is a landmark policy instrument formulated in 2014 (after agriculture policy of Nepal 2004) with the objective of increasing productivity to alleviate poverty by utilizing local potentialities and comparative advantages. Another important focus of ADS is identification of pocket area. ADS identified 10-year action plan and a roadmap which include, four outcomes, thirty-five outputs, with a total of 232 activities. It focuses on climate smart agriculture (CSA) and aims to reduce vulnerability of farmers by improving agriculture-based livelihoods. Besides fifteenth five-year plan (2019/20-2023/24) has also focused CC and agriculture sector such use of improved seeds, increasing yields, provision of extension services, and identifying comparative advantages of ecological regions. The coherence and synergies amongst NCCP, NAP, and ADS priorities and programs is presented in Table 2.

Table 2

Coherence and synergies amongst NCCP, NAP and ADS

Policy Components	NCCP	NAP	ADS
CC Risk Sharing	Agriculture based adaptation for target group (1), Crop diversified kitchen garden (6), Climate-induced disaster risk insurance (12).	Development of Insurance, community/peasant based Risk Sharing Model (3)	Agricultural finance and insurance, Provident fund for small and landless farmers, Subsidy policies including fertilizer and irrigation, Customer access to finance
Sustainable agriculture, CSA and irrigation	Identification of dry and wet area suitable crops (2), Climate tolerant protective crop (3), Crop diversification, agriculture biodiversity organic farming (5), Promotion of agroforestry in abandoned agriculture land (7).	Sustainable agriculture, food and nutrition security (1), CSA promotion in Hill & Mountain region (6)	CSA practice with agro-ecological area approach, Intercropping systems, conservation tillage, organic farming and agroforestry
Agriculture input	Water efficient irrigation technology (4), Low carbon emission & energy efficient technologies in livestock sector (11).	Climate-Resilient Water Management Systems (5), Integrated soil and nutrient management (7)	Non-conventional irrigation development, Increase irrigation intensity, Promote organic and bio-fertilizer, Agri-based livelihoods improvement through natural resource management
Capacity, Knowledge and Research	Traditional knowledge/skill/practice promotion, expansion of innovative climate-friendly agricultural technologies (8).	Institutional capacity building on CC adaptation research (9), Genetic resource conservation and development program (4)	Research on stress tolerant varieties and breeds, Research and technology transfer programs, Capacity building for improved breed production
Information Communication Dissemination	Dissemination of prior weather information to farmers (9).	Strengthening climate services and agriculture information system (8.), Commercial livestock farming model (753 demonstrative Project) (2)	Climate information and weather indexation systems

Source: GoN 2019a, GoN, 2021

Table 3

Gaps across climate change policy and agriculture sector

Policy Components	Gaps/ Limitations	NCCP	NAP	ADS	LAPA
Thematic integration	Silent/Reluctant on GHG emissions from agriculture sector	*		*	
	Insufficient agriculture-specific climate mitigation actions	*	*	*	
	Priority on infrastructure development over CC adaptation		*	*	*
	Ownership gaps at local level	*	*	*	*
	Misalignment of agriculture sector targets to national priorities	*		*	
Institution and mechanism	No clear coordination mechanism on Provincial and Local government		*	*	
	Lack of coordination/ cooperation between GOs and NGOs	*	*	*	*
	Gap in institutional alignment among CC related policy instruments				
	Lack of CC Act aligning to Federal structure	*	*	*	
	Limited local government representation	*	*		
	Limited participation of women and indigenous group	*	*	*	
	Institutional focus on immediate and short-term targets	*	*	*	*
Knowledge and communication	Low awareness among politician and inadequate commitment	*	*	*	*
	Lack of understanding among authorities	*	*		*
	Low recognition of local knowledge			*	*
	lack of technical knowhow at the community level		*	*	*
Capacity and Financial Resource	Limited capacity and skill at all level	*	*	*	*
	Lack of financial mechanism on private sector	*		*	*
	Under-utilization of available resources	*	*	*	*
	Duplication, Project based and scattered budget		*	*	*
	Lack of robust designing			*	*
	Insufficient resources	*	*	*	*
	Power differences among institutions and between local-level stakeholders	*	*	*	*
Monitoring and Evaluation	Lack of timely revision of policies			*	*
	Based on outdated data	*	*	*	*
	Lack of implementation support		*	*	*

Source: Baniya, 2023; Karki, 2023; Acharya, 2022; Ghimire & Chhetri, 2022; Bishwokarma, *et al.*, 2021; Joshi & Joshi, 2021; Khanal *et al.*, 2020; Maharjan, 2019; Nepal, 2019; Singh *et al.*, 2019

Policy gap review

Policy review literatures emphasized on four major factors: implementation of climate resilient/smart agriculture (CRA/CSA) practices, water management strategies, CC-induced extreme event and disaster risk, and institutional structure. A policy and institutional gap identified in literatures demonstrate that major gap is in institutional mechanism and structure followed by capacity and financial resources (Table 3). Lack of coordination among sectoral organizations and across government and non-government sector is outlined in all policy review literature. Another challenge is duplication of programs with scattered budget, and under utilization of available resources (Acharya, 2022; Maharjan, 2019).

From policy to practice at local level

Local authority programs and financing

MoALD has implemented different programs in all study municipalities. Major regular programs include: improved seed distribution, hybrid crop species distribution, indigenous varieties promotion and agriculture subsidies district level programs include, subsidies/grant on indigenous varieties farming, hybrid crop species use, improved seed use, and breed improvement. At local level, one-village-one production and pocket area promotion, one-ward-one extension staff, farmer registration, and agriculture inventory are major programs.

The responsibility of local authorities to CC adaptation as stipulated in NAP, 2021 is local context specific policies preparation, public awareness, capacity enhancement of communities through, indigenous knowledge and skills promotion and promoting technology by establishing dedicated CC management unit. Periodic plans and annual programs of study area local authorities exhibit agriculture programs endorsed and outlined in NCCP, NAP, and ADS. However, they do not explicitly refer any of these policies. Major agriculture focused yearly program and budget allocation and periodic plan focus relevant to CC adaptation is presented in Table 4.

The table shows that study area municipalities has federal, district and local level programs but there is variation in budget allocation. The highest budget allocation is on agriculture mechanization, subsidy and irrigation programs at local level.

Table 4

Program and budget allocation in sample local authorities

Municipalities	ADS monitoring	PAMP	AD/LD Subsidy	Local level programs in Addition to central programs	Periodic plan programs
Gosainkunda Rasuwa	**	*	**	Small irrigation: ***** Agricultural road: *****	2019/20-2023/24: Agriculture incentives, Community farming, Pocket area development, High-altitude commercial agriculture and livestock
Kispang, Nuwakot	**	*	****	Agriculture mechanization: ***** Livestock development: ***** Fertilizer transport facility: *	2019/20-2023/24: Quality hybrid seed promotion, Commercial livestock farming, Breed improvement program
Madi, Kaski	*****	**	***	Agriculture mechanization: ***** Livestock breed improvement: ***** Irrigation: ***** Cold storage: *****	2020/21-2024.25: Agriculture modernization, Livestock improvement, Pocket area development
Ghiring, Tanahu	**	*	*****	Agriculture: commercialization / mechanization/subsidy/training: *****	2018/19-2023/24: Agro-tourism, Farmer registration, Pocket area development, Indigenous species identification, commercial horticulture, multipurpose nursery
Madi, Chitwan	*****	**	*****	Subsidy on Dairy: ***** Pocket are/ improved seed/ cold storage ***** Small irrigation: *****	2021/22-2025/26: Agriculture -financing/ insurance Eco/organic -agriculture, 100% irrigation coverage, hybrid/improved seeds center

Note: (NRs in 000): *<500, **500-1000, *** 1000-1500, **** 1500-2000, *****>2000-5000, *****>5000

Source: MoALD, 2023, Rural municipality and Municipality offices of study district, 2023

Climate change and adaptive action in agriculture at household level

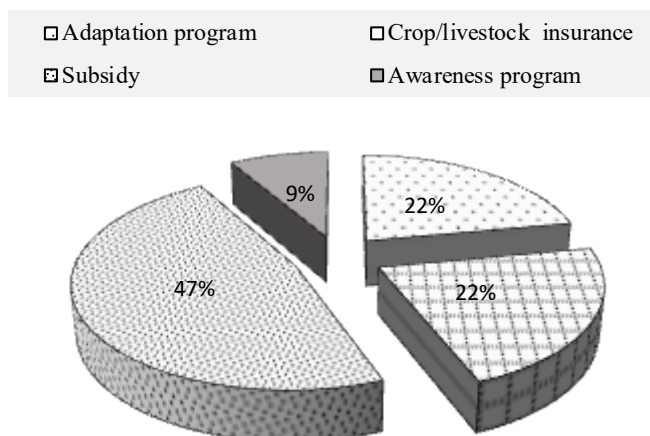
The farm households in the study area mostly are small holders and subsistence farmers. They have experienced CC and climate variability effect in different forms and are using different autonomous adaptation actions to sustain farming-based livelihoods. Variation in adaptive actions across ecological region is prominent. Table 5 exhibits farmers’ range of adaptive actions to tackle CC effects. Change in crop plantation is the most common adaptive action across ecological region while switching to new vegetable and crop varieties is less practiced.

Table 5
Farmer’s adaptive actions across ecological region (in %)

Adaptation Actions	Mountain (Rasuwa)	Hill (Nuwakot, Kaski and Tanahu)	Tarai (Chitwan)	Total
New crop varieties	21.1	44.9	32.4	32.7
New Vegetable varieties	14.1	31.9	2.8	16.1
Change crop planting time	15.5	56.5	81.7	51.2
Change vegetable planting time	8.5	23.2	9.9	13.7
Plan to switch to new crop type	12.7	32.0	4.2	16.1
Plan to change occupation	39.4	24.6	12.7	25.6

Source: Field survey, 2022

Figure 3
Agricultural interventions in community



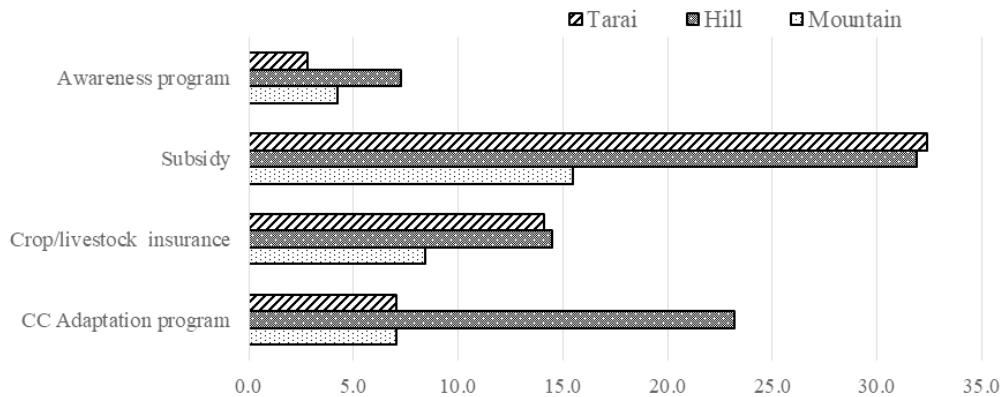
Knowledge on climate change and agricultural interventions at community level

Knowledge of farmer on CC and agriculture adaptive intervention is found to be modest in sample municipalities. Of the total sample household, 56% farm household reported presence of climate change and agriculture related interventions at community level. The Hill region dominated with 77% farmers reporting presence of intervention program, followed by Tarai (56%) and knowledge in Mountain region is lowest with only 35% farmers reporting presence of such. Regarding type of intervention 47% reported subsidy and only nine percent reported awareness programs (Figure 3).

Similarly, when knowledge on intervention type across ecological region was explored, knowhow on agriculture subsidy in Tarai and Hill is found to be highest and low in Mountain region (Figure 4). Knowhow on adaptation is reported highest in the Hill while awareness program is least reported across all three regions.

Figure 4

CC and agriculture interventions by ecological region



Discussion

Policy gaps

Increasing productivity and enhancing agriculture livelihoods remained agriculture sector priority whereas CC policies remained aimed climate resilient and CSAis CC policy priority (GoN, 2021b). Review research on policies show that there is no standard guideline, criteria and methodology neither clear time frame for consolidating policy instruments review process though, some sectoral guidelines based on international guidelines do exist (Bishwokarma *et al.*, 2021; Dhungana *et al.*, 2017). Policy

formulation based on obsolete data due to lack of relevant and detailed database i.e. data gap is identified as one of the major issue (Nepal, 2019). This is evident in ADS formulation, where most of strategies and programs are based on reference and base data of 2009/2010 which may misrepresent at various level. The identified gaps show that despite the policy revision and updating process, recurrence of same or similar policy gaps on institutional, financial and mechanism aspects and implementation gaps urges critical thinking on policy formulation process through careful and representative wider participation and incorporation of stakeholders and local actors at ground level (Baniya, 2023; Khanal *et al.*, 2020; Singh *et al.*, 2019). Major consideration should be on context specific localization of policy instruments tailored region specific implementation programs (Bhandari, 2023).

Implementation practices

Autonomous adaptation options in agriculture sector which range from crop varieties to water and heat stress, diversification to non-farm activities and better use of weather forecast. This study shows that planting time adjustment is the most common adaptation followed by switching to new varieties. The use of weather information is very low, only 21% farmers trusting the information and 17% transfer it into adaptive action. A study found that, farmers in Western Tarai adapted actions like early planting time to avoid longer cold wave, early harvest to avoid increasing hot wave, improved variety, cooperative seed banking and agro-forestry (Havukainen *et al.*, 2022). This study also found that more than 81% farmers in Tarai and 56% in the Hill are adjusting the planting and harvesting time to avoid adverse weather effect. Regardless of the geographic location; climate variability is affecting the farmers and limited technical know-how and resources are the major constraints, impeding the productivity. Number of case studies carried out in eight municipalities of three ecological regions recommended CSAs for different ecological regions (GoN, 2019) also accords with the adaptation actions being practices in the study area without realization of such as CSA.

CC understanding: Planned or autonomous adaptation?

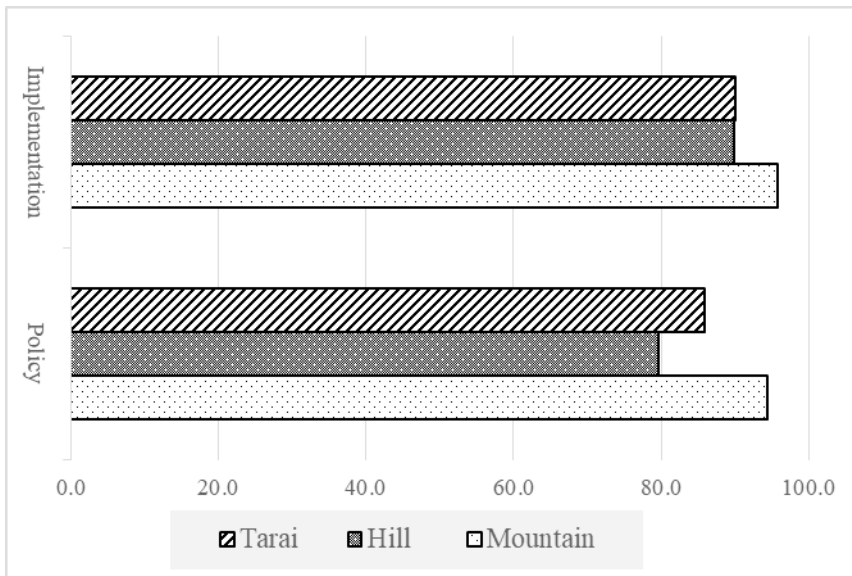
Exploration of awareness on NCCP, NAP implementation strategies and plans demonstrated that 76.3% of sampled household were unaware of NCCP, NAP and 78% were unaware of strategies and implementation plan. Geographic variation on awareness is trivial, though it is slightly higher in Tarai(Figure 4).

The NCCP and NAP has outlined local municipal authority's responsibility of mainstreaming climate change plans and programs as well as public awareness and dissemination of climate change effects to the public. Unfortunately, the study municipalities do not explicitly mention the CC policy instruments in the periodic plan

and annual programs. However, they have implicitly incorporated CC related aspects in agricultural programs. Madi Municipality of Chitwan district is the only local level authority, which has explicitly stated climate smart agriculture and imbedded in local planning and programs.

Figure 5

Awareness on policy and implementation in agriculture sector



A major policy gap identified is supply driven top-down approach (with limited local level consultation) instead of demand driven bottom-up approach and low focus on geographic diversity, a determinant of diverse economic and socio-cultural setting (Khanal *et al.*, 2020). The farmers, who are the ultimate implementor of all the policy instruments at ground level, are largely unaware of policy instruments. In this context, NAP priority one program with the objective of ‘strengthening the adaptive capacity of local agriculture-based institutions’ becomes important. Nonetheless, farmers are adapting autonomously to tackle CC effect with limited technical intricacies of CC impact. The earlier studies carried out in Chitwan and Kaski also suggest that people, in general doesn’t refer to climate as significant issue affecting their agriculture-based livelihoods (Ensor, *et al.*, 2019) Autonomous adaptation tends to be short-term reactive solution and ineffective to tackle intensity of CC impact (Regmi & Pandit, 2016). Limited understanding of long-term CC effect has resulted maladaptation contesting planned adaptation. This devaluate the effort and resources spent by national and international

authorities on policy instrument formulation and implementation. The NAP adaptation priority of climate-resilient adaptive technologies and practices, and strengthening farmer's field-schools' could be the most effective adaptation action.

Climate financing

The provision of 80% budget allocation (foreign investment source) to local level for climate change management is clearly defined, though the mechanism not clearly defined. It is estimated that only 11.4 percent of the total national climate change budget has been allocated to local programs (Kaur, 2014). Though climate financing is increasing in Nepal, it is well behind the target i.e. 27% allocated in 2018/19), only 43% of which is spent and only 20% is spent on highly relevant CC program area (Freedom Forum, 2019). Thematically, highest share of spending is on agriculture sector (39% of total share). The policy to adaptation practice gap is largely attributable to inadequate investment planning besides under financed and under prepared from global to local level (Acharya, 2022; Ghimire & Chhetri, 2022; JVS/GWP, 2016; Tiwari *et al.*, 2014; UNEP, 2023). Some studies have highlighted inabilities of authorities from to utilize the available resources wisely and sustainably (Maharjan, 2019; Regmi *et al.*, 2016). However, this study has found that agriculture remains the first priority despite limited financial resources being critical factor. Noteworthy is the budgetary allocation for CSA, without explicit mention of CC adaptation.

Conclusion

Successful implementation of CC adaptation policy instruments pivots on multiple factors; though financial resources is noted as primary factor. The flexibility of policy instruments through regular improvements and modification aids context-specific localization and provides custom solutions that matches the traditional and existing adaptation practices assuring ownership at ground level.

Implementation programs, are designed within similar setting at national and sub-national level, but deviation in implementation method at local level implicate farmers' response to implementation practices creating different policy outputs. Active engagement of local community in policy priority programs with better understanding of long-term CC impacts escorts towards enhanced autonomous and planned adaptation strategies. Adoption and replication of good autonomous adaptation practices and replacement of maladaptation through planned adaptation should be major consideration while formulating strategies and action plans. Equally important is context-specific localization at ground level. Coherence among agriculture development sector and climate action across governance level should be an obligation for sustainable development.

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References

- Acharya, D. (2022). *Nepal's local adaptation plans for action (LAPA): A reflection*. South Asia Nadi Sambad, SONAS, Kathmandu, Nepal. <https://soanas.org/nepals-local-adaptation-plan-for-action-lapa-a-reflection/>.
- Baniya (2023). Mainstreaming climate change mitigation actions in Nepal: Influencing factors and processes. *Environmental Science & Policy*, 124, 206–216. <https://doi.org/10.1016/j.envsci.2021.06.018>.
- Bartlett, R., Bharati, L., Pant, D., Hosterman, H., & McCornick, P. (2010). *Climate change impacts and adaptation in Nepal*. Colombo, Sri Lanka: International Water Management Institute. p35, (IWMI Working Paper 139). <https://doi.org/10.5337/2010.227>.
- Barnett, J., & O'Neill, S. (2010). Maladaptation. *Global Environmental Change*, 20(2), 211–213. <https://doi.org/10.1016/j.gloenvcha.2009.11.004>.
- Bhandari, M. P. (2023). Using Nepal to understand the nexus of climate change and landuse. *Strategic Planning for Energy and the Environment*, 42(4), 725–748. <https://doi.org/10.13052/spee1048-5236.4247>.
- Bishwokarma, D., Sherchan, P., & Singh, P.M. (2021). *Localizing climate actions in Nepal: The role of local Governments in implementing National Climate Change Policy and Nationally Determined Contribution*. Working Paper. Prakriti Resources Centre (PRC), Kathmandu, Nepal.
- DHM, (2017). *Observed climate trend analysis in the districts and physiographic regions of Nepal (1971-2014)*. Department of Hydrology and Meteorology, Kathmandu, Nepal.
- Dhungana, N., Khadka, C., Bhatta, B., & Regmi, S. (2017). Barriers in local climate change adaptation planning in Nepal. *Journal of Law, Policy and Globalization*, 62, 20–24.
- Eckstein D, Künzel V, & Schäfer L (2021) *Global climate risk index 2021*. Germanwatch e.V., Bonn, Germany. <https://www.germanwatch.org/en/crri>. Assessed: 15.08.2023

- Ensor JE, Windstorm P, Bhattarai A *et. al.*, (2019). Asking the right questions in adaptation research and practice: seeing beyond climate impacts in rural Nepal. *Environ Sci Policy*, 94, 227–236. <https://doi.org/10.1016/j.envsci.2019.01.013>.
- Freedom forum. (2019). *Nepal climate citizen budget: Where is Nepal's money being spent? 2018–2019*. Freedom Forum, IBP and UNDP, Kathmandu, Nepal.
- Gaihre, S., & Dhakal, S. C. (2022). Overview of agriculture in different periodic plans of Nepal. *Food and Agri Economics Review (FAER)*, 2(2), 79-84. DOI: <http://doi.org/10.26480/faer.02.2022.79.84>.
- Ghimire, R., & Chhetri, N. (2022). Challenges and prospects of local adaptation plans of action (LAPA) initiative in Nepal as everyday adaptation. *Ecology and Society*, 27(4). <https://doi.org/10.5751/ES-13630-270428>.
- GoN, (2010). *National adaptation plan of action (NAPA) to climate change*. Ministry of Environment, Kathmandu, Nepal. pp. 1-96.
- GoN, (2011). *National framework on local adaptation plans for action*. Government of Nepal, Ministry of Environment, Kathmandu, Nepal. pp. 1-56.
- GoN. (2019). *National Climate Change Policy, 2076* (2019). Government of Nepal, Ministry of Forests and Environment, Kathmandu, Nepal. https://www.mofe.gov.np/downloadfile/climatechange_policy_english_1580984322.pdf. Assessed: 10.07.2023
- GoN. (2020). *The Fifteenth Plan (Fiscal Year 2019/20 – 2023/24)*. Government of Nepal, Kathmandu: National Planning Commission. https://www.npc.gov.np/images/category/15th_plan_English_Version.pdf. Assessed: 10.07.2023
- GoN. (2021a). *National adaptation plan (NAP) 2021-2050*. Government of Nepal, Ministry of Forests and Environment, Kathmandu, Nepal. <https://doenv.gov.np/rules/NAP-2021-2050-1700841577.pdf>. Assessed: 10.07.2023
- GoN, (2021b). *Nepal's third national communication to the united nations framework convention on climate change (UNFCCC)*. Government of Nepal, Ministry of Environment, Kathmandu, Nepal. pp. 1-262.
- Havukainen, M., Mikkilä, M., & Kahiluoto, H. (2022). Climate policy reform in Nepal through the lenses of the Institutional Analysis and Development Framework. *Sustainability*, 14(12), 7391. <https://doi.org/10.3390/su14127391>
- IPCC. (2001). *Climate change 2001: Impacts, adaptation, and vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press,

Cambridge, United Kingdom and New York, NY, USA, p1042 https://www.ipcc.ch/site/assets/uploads/2018/03/WGII_TAR_full_report-2.pdf. Assessed: 12.07.2023

- Joshi, G. R., & Joshi, B. (2021). Agricultural and natural resources policies in Nepal: A review of formulation and implementation processes and issues. *Nepal Public Policy Review*, 1, 212-227. <https://doi.org/10.3126/nppr.v1i1.43459>.
- Karki, G. (2023). A glimpse of Nepal's national adaptation plan (NAP) process and outcomes. *New Spotlight*, 17(8), 26-27.
- Kaur, N. (2014). *Climate Change Planning in Nepal*. GGBP Case Study Series. Global Green Growth Institute, Kathmandu, Nepal. <https://www.undp.org/sites/g/files/zskgke326/files/migration/np/Nepal-Climate-Citizen-Budget-English.pdf>. Assessed: 15.07.2023
- Khanal, N. R., Nepal, P., Zhang, Y., Nepal, G., Paudel, B., Liu, L., & Rai, R. (2020). Policy provisions for agricultural development in Nepal: A review. *Journal of Cleaner Production*, 261, 121241. <https://doi.org/10.1016/j.jclepro.2020.121241>.
- Khatri, D.B., Pain, A., Ojha, H., Adhikari, B., Pandey, C.L., Dhungana, H., & Joshi, T. (2016). *Climate change, local politics and institutional responses in Nepal: A synthesis of research findings*. Forest Action Nepal and South Asia Institute of Advance Studies, Kathmandu, Nepal. pp. 1-47.
- Mackie, J. (2020). Promoting policy coherence: Lessons learned in EU development cooperation. *Policy Brief*, September. European Centre for Development Policy Management, Maastricht. pp. 1-30.
- Maharjan (2019). Local adaptation plan of action framework and process in the agriculture sector in Nepal. *International Journal of Conservation Science*, 10(2), 351-364.
- MoALD. (2019a). *Integrating climate change adaptation into agriculture sector planning of Nepal*. Government of Nepal, Ministry of Agriculture and Livestock Development, Kathmandu, Nepal. pp. 10-106.
- MoALD. (2023). *Statistical information on Nepalese agriculture 2077/78 (2020/21)*. Government of Nepal, Ministry of Agriculture and Livestock Development, Kathmandu, Nepal. pp. 1-269.
- MoFE, (2019a). *Local adaptation plan of action framework*. Ministry of Forest and Environment, Kathmandu, Nepal. pp. 1-56.

- MoFE. (2019b). *Climate change scenarios for Nepal for national adaptation plan NAP*. Ministry of Forests and Environment, Kathmandu, Nepal. pp. 1-85.
- MoFE (2021). *Nepal's third national communication to the United Nations framework convention on climate change (UNFCCC)*. Ministry of Forest and Environment, Kathmandu, Nepal. pp. 1-262.
- Morgan, H. (2022). Conducting a qualitative document analysis. *The Qualitative Report*, 27(1), 64-77. <https://doi.org/10.46743/2160-3715/2022.5044>
- MoSTE. (2015). *Indigenous and local knowledge and practices for climate resilience in Nepal*. Mainstreaming Climate Risk Management in Development. Ministry of Science, Technology and Environment, Kathmandu, Nepal. pp. 1-122.
- Nepal, P. (2019). Mainstreaming climate change adaptation into sectorial policies in Nepal: A review. *Geographical Journal of Nepal*, 12,1-24. <http://dx.doi.org/10.3126/gjn.v12i1.23412>
- NSO. (2023). *National population and housing census 2021: National Report*. National Statistical Office, Government of Nepal, Kathmandu, Nepal. pp. 1-614.
- Owen, G. (2020). What makes climate change adaptation effective? A systematic review of the literature. *Global Environmental Change*, 62, 102071. <https://doi.org/10.1016/j.gloenvcha.2020.102071>
- Panthi, J, Dahal, P, Shrestha, M. L., Aryal, S., Krakauer, N. Y., Pradhanang, S. M., & Karki, R. (2015). Spatial and temporal variability of rainfall in the Gandaki River-basin of Nepal Himalaya. *Climate*, 3(1), 210-226. <https://doi.org/10.3390/cli3010210>
- Regmi, B. R., & Pandit, A. (2016). *Classification of adaptation measures in criteria for evaluation: Case studies in the Gandaki River Basin*. HI-AWARE Working Paper, 1-51.
- Regmi, B.R., Star, C., & Leal Filho,W. (2016). Effectiveness of the local adaptation plan of action to support climate change adaptation in Nepal. *Mitigation and Adaptation Strategies for Global Change*, 21, 461-478(2016). <https://doi.org/10.1007/s11027-014-9610-3>
- Schipper, E. L. F. (2020). Maladaptation: when adaptation to climate change goes very wrong. *One Earth*, 3(4), 409-414. <https://doi.org/10.1016/j.oneear.2020.09.014>
- Singh, P. M., Khadka, M., Wijenayake, V., & Mombauer, D., (2020). *Policy Gaps and Needs Analysis for the Implementation of NDCs on Adaptation and Loss and*

Damage in Bangladesh, Nepal, and Sri Lanka. APN, 10(1), 90-98. <https://doi.org/10.30852/sb.2020.1283>

Smit, B., Burton, I., Klein, R. J. T., and Street, R. (1999). The Science of adaptation: A framework for assessment. *Mitigation and Adaptation Strategies for Global Change*, 4(3), 199-213

Singh, C., Dorward, P., & Osbahr, H. (2016). Developing a holistic approach to the analysis of farmer decision-making: implications for adaptation policy and practice in developing countries. *Land Use Policy* 59, 329–342. <https://doi.org/10.1016/j.oneear.2020.09.014>.

World Bank; CCAFS & LI-BIRD (2017). *Climate-smart agriculture in Nepal*. CSA Country Profiles for Asia Series. International Center for Tropical Agriculture (CIAT); The World Bank; CGIAR Research Program on Climate Change, Agriculture and Food Security (CAAFS); Local Initiatives for Biodiversity Research and Development (LI-BIRD). Washington, D.C. p26.

World Bank.(2021). *Climate risk country profile: Nepal*. World Bank Group, Washington, DC 20433. <https://climateknowledgeportal.worldbank.org/country/nepal>. Assessed: 11.07.2023

Zembe, A., NemaKonde, L. D., & Chipangura, P. (2023). A policy coherence framework for food security, climate change adaptation and disaster risk reduction in South Africa. *International Journal of Disaster Risk Reduction*, 95, 103877. <https://doi.org/10.1016/j.ijdr.2023.103877>