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論説 Article

Climate-Smart Agriculture (CSA): A Systematic Assessment and Analysis of Policies/plans and Practices in South Asia, Particularly Focusing on Nepal and India

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Abstract: Climate-smart agriculture (CSA) is a promising concept in agriculture to deal with the climate change impacts through innovative policies/plans, approaches, and practices. This study presents the assessment and analysis of the concept, policies, and practices in relation to CSA in South Asia, particularly focusing on Nepal and India. Both countries have different climatic contexts, but most of the farmers rely on rainfall for agriculture, which is the main source of livelihood and food security. This study applied the systematic review of published papers relating to climate policies/plans and CSA practices in Science Direct (SD) and Springer Link (SL) for the period of 2009 to 2019 with specific inclusion and exclusion criteria. It was found that these studies had specifically focused on climate policies/plans and CSA practices chiefly focusing on agriculture and food security in these countries. However, the CSA practices were different based on the local climatic contexts either initiated by farmers themselves or supported by the government, non-government, and other agencies. Farmer-initiated CSA practices were mostly spontaneous, whereas institution-supported practices were planned, guided by the climate policies/plans. However, these policies/plans and practices lacked specific indicators to assess the successes. Many of these practices were common prior to the emergence of the CSA concept and approach. Thus, it is important to define and understand the CSA concept, approaches, and mechanisms through research, development, and promotion at the national as well as local levels.

Key words: climate-smart, agriculture, adaptation, policies and practices, indicators

Ⅰ Introduction

1 Background

Agriculture is the main source of livelihood and food security in South Asia including Nepal and India since more than 70% of the people, even in the present time, live in the rural areas relying mainly on it. It also contributes significantly in the local and national economy and gross domestic products (GDP) in both countries. However, the contribution has been decreased over the years due to shrunken of agricultural lands for cultivation, reduced agricultural production, change in the livelihood and social security including youth out-migrating from it and many other socio-economic and political reasons and factors. For instance, the agricultural imports have been increased over the years and agricultural lands have been converted to housings and other forms of industries such as brick industries. According to the United Nations Population Fund (2007), the average land per person would be 1.5 ha in 2050, which was 13.5 ha/person in 1950 that reduced to 3.2 ha/person in 2005. Porter et al. (2014) estimated the loss of crop yields (rice-35%, wheat-20%, sorghum-50%, barley-12%, maize-60%) due to ongoing and future climate change, however, it may vary depending on the location, future climate scenarios and projected years. Average total economic losses are estimated to be 8.7% in India and 9.9% in Nepal (Aryal et al., 2019). The loss in agriculture is considered as a huge socio-economic concern in Nepal (Chalise and Naranpanawa, 2016). These losses are mainly due to instability in area, production and yield, lack of effective policies and less adaptive capacities (Sendhil et al., 2018). On the other hand, the demand for food is expected to be increased by 60% by 2050, thus, it needs a radical transformation in production and efficient utilization the available resources with the minimum impacts of climate change (FAO, 2013).

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Practical and location specific adaptations are required to address the climate variability and impacts (Hochman et al., 2017a). The concept of climate-smart agriculture (CSA), thus, emerged in 2009 with triple-win goals of increase in production, adaptation and mitigation, which was first mentioned in the FAO report entitled "*Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies*" (Lipper and Zilberman, 2018, p.18). It was later redefined and utilized, as appropriate, by different national and international organizations including the individual researchers based on their own contexts. However, the goals or pillars or outcomes of CSA – sustainable growth in agricultural productivity and incomes, improvement in adaptive capacity and resilience and reduction of greenhouse gases – remain consistent (Hochman et al., 2017b). As stated by Gurung et al. (2016), the main purpose of CSA practices is to sustainably increase the productivity and income in agriculture through research, technological advancement and mechanization, product quality assurance, increased investment and policy frameworks. The roles and contributions of United Nations Food and Agriculture Organization (FAO) and Consultative Group of International Agricultural Research (CGIAR) are significant in promoting it as an approach to address the climate impacts and supporting livelihood and food security (Tripathi and Mishra, 2017). Number of international conferences on agriculture, food security and climate change have also emphasized on promotion of CSA approach starting from Hague conference in 2010 (FAO, 2013). CSA is reflected in the Intended Nationally Determined Contributions (INDCs) of 31 countries to minimize the climate change impacts and reducing poverty as well as harnessing environmental benefits (FAO, 2016).

Since its emergence, the concept of CSA has received substantial attention in the policy debates and practices in agriculture and climate science. Agriculture, food security and climate-smart technologies and approaches have been integrated in the climate policies and plans in some ways (Maharjan, 2019). The consequent conferences have been organized in Wageningen International, Netherlands in 2011, University of California, Davis, USA in 2013, Montpelier, France in 2015, Johannesburg, South Africa in 2017 and Bali, Indonesia in 2019 (GACSA, 2019). The conference in 2014 came up with Global Alliance on Climate Smart Agriculture (GACSA), mainly to bridge the policy and science debates into practices of knowledge, enabling environment and investments in CSA (Lipper and Zilberman, 2018). The CSA initiatives and interventions have also begun in the regional and national levels through the organizations of regional and national conferences, seminars/workshops and formulation of policies/plans and CSA practices. The CSA practices in this study include the CSA technologies, approaches, innovations, services and activities carried out by farmers themselves or with the support of institutions to address the adverse impacts of climate change. Some of these practices are specifically guided by the climate change, agriculture and CSA policies and plans. This paper aims to systematically review and analyze the relevant and specific policies/plans and practices in South Asia specifically in Indian and Nepalese contexts particularly referring to the papers published in Science Direct (SD) and Springer Link (SL). Both of these neighboring countries have similar agricultural practices including the cropping patterns, agricultural technologies and public/private investments in addition to the similar geographical and climatic contexts. In fact, many of agricultural commodities are easily imported and exported between the countries formally and informally. Furthermore, Climate Change, Agriculture and Food Security (CCAFS), the research program of CGIAR revealed that both of these countries are in the process of developing climate-smart investment strategies (CCAFS, 2020). Both of these countries have similar contexts in agriculture such as majority of farmers are smallholders, illiterate, marginal and more importantly have the least adaptive capacities (Tripathi and Mishra, 2017).

2 Conceptual framework

We believe climate-smart (either climate related or agriculture related) policies/plans have direct and reciprocal relationships and influences with climate-smart practices/perceptions and relevant people and institutions (Figure 1). We assume that the policies/plans basically guide the strategies/frameworks and programmes/projects. These policies/plans are usually formulated and executed by the people and institutions including policymakers, decision-makers and the concerned

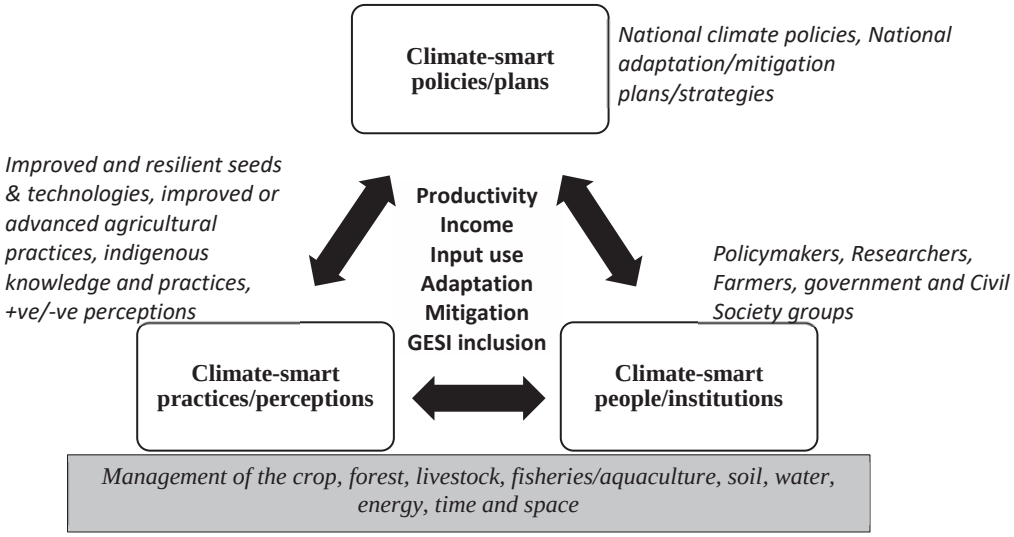

Figure 1 Conceptual framework on inter-relations between CSA policies/plans, practices/ perceptions, people/institutions

Source: authors.

stakeholders who have own perceptions, knowledge and understanding towards specific issues that either encourage or impede the programmes/projects to become the practices. Through the joint efforts of policies/plans, practices/perceptions and people/institution, the overarching goals of CSA such as increase productivity, income, and input use efficiency, building resiliency and adaptive capacity, reduce greenhouse gases and presence of successful gender and social inclusion would likely be achieved (Khatri-Chhetri, 2017). The joint efforts need to be focused on efficient management of crops, livestock, forests, fisheries/aquaculture, soil, water, energy, time and space to meet the CSA goals (CCAFS, 2019). New CSA practices and technologies are required to increase the total agricultural production through effective use of resources such as land, labor, water and other financial inputs and investments in the sustainable agriculture (Dunnett et al., 2018). But, many of ongoing agricultural practices are also considered as CSA practices.

All CSA practices are not applicable to all ecosystems and institutional mechanisms and political situations (Thornton et al., 2018). Considering the concepts, this paper has focused on following research questions: 1) What are the relative synergies and trade-offs between policies/plans, practices/perceptions and people/institutions relating to CSA? 2) How effective the policies/plans, practices and institutions in targeting the CSA goals in the selected countries? 3) What are the applicable local/national policies/plans, practices, in the selected countries? 4) What are the possibilities to achieve the investments and institutional supports required to CSA to enhance its adoption? 5) How do we scale out the policy, finance and institutional innovations effectively considering the gender and social dimensions?

Much attentions have been given to CSA since 2009/10 through research, development and innovations at different levels. Number of research papers have been also published in academic and professional journals. This paper concentrates on systematic review of those journal papers published in SD and SL, especially focusing on CSA in South Asia in general, India and Nepal in particular. There are many similarities between these two countries in terms of geography, climate, agricultural operations and socio-economic contexts. However, in terms of government policies/plans, institutions and interventions relating to CSA in particular and climate change impacts in agriculture may not be similar. Thus, it is worthwhile to analyze and understand the differentiate approaches on policies/plans, practices and interventions relating to CSA in these countries. This paper further strengthens the ongoing researches and studies relating to CSA, climate change and agriculture through the integrated approach of policies/plans, practices/perceptions and people/institutions.

3 Methodology

There are numbers of researchers who have published the papers related to CSA based on their

research interests and own contexts. These papers could be sources of information to assess and analyze the policies/plans, practices/perceptions and the roles of people/institutions in the implementation. Systematic review approach was adopted for this study particularly focusing on the papers published under the Science Direct (SD) and Springer link (SL) databases. This is a stepwise method to review, assess and analyze the specific papers with defined criteria. The specific inclusion and exclusion criteria were defined prior to search the papers. The details of the inclusion/exclusion criteria were presented in the Table 1. After finalization of the criteria, the first search was carried out with the keywords *"Climate-smart agriculture in South Asia, climate-smart agriculture in India and climate-smart agriculture in Nepal"* separately. Likewise, the second search was done with the keywords "*Climate-smart agricultural policies and practices in South Asia, in India and in Nepal"* separately again. We used the whole sentence in the search assuming it as the potential title of the paper. These sub-regional and country specific searches were carried out separately to analyze the country specific papers in line with the sub-regional level papers respectively. Surprisingly, the numbers of papers in India alone appeared even more than South Asian context in the first and second searches, which indicated the CSA-related country specific researches are advanced in India being a large country even more than the regional or sub-regional researches. But Nepalese cases is just opposite as very few related researches in Nepalese context. The summary of the papers selected for the assessment and analysis with the criteria is presented in Table 2. Later, the titles and abstracts of the papers were studied to exclude the review and conference papers, book chapters, short communications and editorials etc. and finalize the total number of papers for detail review and analysis. There are some papers frequently appeared (given in the parenthesis) in the search either in South Asia or India or Nepal. Furthermore, there are number of climate and agriculture related specific policies/plans, strategies and papers (either published or unpublished) in these countries, that are not included in the databases, were also reviewed separately.

Table 1 The inclusion and exclusion criteria to lessen the number of papers in the systematic search

Inclusion criteria	Exclusion criteria
• Open access journals in SD and SL. • Papers published in English. • Research papers only. • Papers published in between 2009 to 2019. • The first search with keywords "*Climate-smart agriculture in South Asia, in India and in Nepal*" separately. • The second search with keywords "*CSA policies and practices in South Asia, in India and in Nepal*" separately.	• Review papers, conference papers, book chapters, short communications, editorials were excluded. • Papers on CSA from other geographical regions except India and Nepal such as Africa, South East Asia. • Papers on energy, smart cities, sustainable urban planning and transportation, air quality, pollution and health, cotton, biofuel and plantation, oil palms etc.

Source: authors.

Table 2 The summary of the papers for detail assessment and analysis under systematic review

Name of Database	First Search	Second Search	Third Search with titles of the paper	Fourth with abstract	Total papers for review
Science Direct (SD)					
South Asia	734	482	27	20	**20**
India	948	569	26 (20)	2 (2)	(2)
Nepal	134	94	12 (8)	2 (2)	(2)
Springer Link (SL)					
South Asia	118	89	11	8	**8**
India	175	114	11 (8)	5 (4)	**1** (4)
Nepal	43	33	8 (6)	2 (2)	(2)

Note: The number in the parenthesis represent the papers overlapped in the searches (South Asia, India and Nepal) in the database.
Source: authors.

Ⅱ Results and discussion

1 CSA policies/plans

Numbers of agricultural and climate policies and plans at the national and local levels have been formulated and being implemented particularly in India and Nepal. For instance, the Government of India (GoI) implemented National Mission of Sustainable Agriculture (NMSA) in 2013, commenced National Initiative on Climate Change Resilient Agriculture (NICRA), National Adaptation Plan on Climate Change (NAPCC), National Food Security Mission (Tripathi and Mishra, 2017). The current phase of climate policy in India is pragmatic (shifted from idealism in the initial phase) with the concrete actions at the international and national level (Saryal, 2018). The NAPCC has separate national mission on sustainable agriculture and also precisely incorporated the appropriate adaptation and mitigation practices and technologies for reducing greenhouse gases and uplifting the poor and vulnerable sections of the society but it hasn't specifically mentioned anything related to CSA (GoI, 2008). Likewise, Government of Nepal (GoN) has initiated to develop number of policies/plans and frameworks and institutional mechanisms in recent decades (Mahat et al., 2019). It ratified the Kyoto Protocol in 2005, formulated National Adaptation Programme of Action (NAPA), National Climate Policy, Framework on Local Adaptation Plan of Action (LAPA) and now in the process of finalizing National Adaptation Plan (NAP), and Low Carbon Economic Development Strategy (Shrestha and Dhakal, 2019). MoE (2010) emphasized on climate-smart and robust agricultural development policies and strategies to address the current and future climate risks in NAPA document. There are limited local adaptation policies/plans and practices at the local level, though we witness some progress at the national level (Bhatta et al., 2015).

Multiple factors have been reported in the papers that are influencing these policies and plans such as identification and prioritization of the appropriate policies/plans and practices (Hochman et al., 2017b), interests and roles of the policymakers and institutions involved, resources and investments (Hochman et al., 2017b), socio-economic and cultural characteristics of farmers, bio-physical features such as locations, etc. (Khatri-Chhetri et al., 2017). These policies/plans and political engagement have also influenced in the adoption and scaling up of successful CSA practices (Westermann et al., 2018). Aryal et al. (2019) further underlined on the requirement of institutional set up and its strengthening for adoption, dissemination and scaling up of these practices and technical solutions. There are always the positive influences and sometimes counteracting policies and interests of the policymakers and political bodies especially at the local level. Westermann et al. (2018) further emphasized on appropriate institutional and governance mechanisms with enforcement of regulatory framework supported by effective participation of relevant institutions and their coordination. In Nepalese context, the institutions representing public, private and civic effectively participated and harmonized in national and local climate policies and plans.

Moreover, sectoral policies particularly agricultural and forestry policies in both countries have also support to adaptation and mitigation. These policies/plans and practices have shown the presence of both synergies (eg. creating enabling environments) and trade-off (eg. food and carbon nexus) at national level between adaptation and mitigation (Shrestha and Dhakal, 2019; Shirsath et al., 2017). The effective policies/plans guiding appropriate CSA practices lead to maximizing the synergies and minimizing the tradeoffs (Shirsath et al., 2017). The policy driven or planned, and incentivized adaptation strategies are prominent in India (Tripathi and Mishra, 2017), perhaps in Nepal as well because farmers have minimum skills and adaptive capacities to address the risks through autonomous adaptation. However, if the farmers have reliable information and better to access to the resources, they are able to deal with the impacts autonomously based on local knowledge, skills and experiences as they have been dealing with it for generations. The farmers and local communities have perceived and understood the climate and weather patterns more than any institutions. The policies/plans need to provide the information on potential CSA practices and possible sources of resources that can be accessible for efficient adoption in the specific locations (Khatri-Chhetri et al., 2017).

2 CSA practices/perceptions

Several adaptation and climate-smart practices and perceptions were portrayed in the papers that have enhance the agricultural productivity and food security, improve the climate resilience and reduce the greenhouse

Table 3 List of the papers selected for systematic review

S.N.	Source	Author(s) name	Titles of the papers and its thematic focuses	Name of the Journals
1.	SL	Aryal et al. (2015)	Impacts of laser land leveling in rice-wheat systems of the north-western Indo-Gangetic plains of India ○	Food security
2.	SL	Aryal et al. (2019)	Climate change and agriculture in South Asia: Adaptation options in smallholder production systems ◎○	Environment, Development and Sustainability
3.	SD	Bastakoti et al. (2016)	Community pond rehabilitation to deal with climate variability: A case study in Nepal Terai ○	Water Resources and Rural Development
4.	SL	Beddington et al. (2012)	The role for scientists in tackling food insecurity and climate change ◎ Δ	Agriculture and Food security
5.	SL	Bhatta et al. (2015)	Agricultural innovation and adaptation to climate change: Empirical evidence from diverse agro-ecologies in South Asia ◎○	Environment, Development and Sustainability
6.	SD	Chalise and Naranpanawa, (2016)	Climate change adaptation in agriculture: A computable general equilibrium analysis of land-use change in Nepal ◎○	Land Use Policy
7.	SD	Dunnett et al. (2018)	Multi-objective land use allocation modelling for prioritizing climate-smart agricultural interventions ○	Ecological Modelling
8.	SD	Findlater et al. (2019)	Misunderstanding conservation agriculture: Challenges in promoting, monitoring and evaluating sustainable farming ○	Environmental Science and Policy
9.	SD	Fischer et al. (2016)	Can more drought resistant crops promote more climate secure agriculture? Prospects and challenges of millet cultivation in Ananthapur, Andhra Pradesh ◎○	World Development Perspectives
10.	SL	Gangopadhyay et al. (2019)	Spatial targeting of ICT-based weather and agro-advisory services for climate risk management in agriculture ○	Climatic Change
11.	SD	Groot et al. (2019)	Business models of SMEs as a mechanism for scaling climate-smart technologies: The case of Punjab, India ○	Journal of Cleaner Production
12.	SD	Hochman et al. (2017a)	Smallholder farmers managing climate risks in India: 1. Adapting to a variable climate ○ Δ	Agricultural Systems
13.	SD	Hochman et al. (2017b)	Smallholder farmers managing climate risks in India: 2. Is it climate-smart? Δ	Agricultural Systems
14.	SD	Khatri-Chhetri et al. (2017)	Farmers' prioritization of climate-smart agriculture technologies ○	Agricultural Systems
15.	SD	Khatri-Chhetri et al. (2019)	Stakeholders prioritization of climate-smart agriculture interventions: Evaluation of a framework Δ	Agricultural Systems
16.	SD	Kumar et al. (2019)	Farm typology analysis and technology assessment: An application in an arid region of South Asia ◎○	Land Use Policy
17.	SD	Lopez-Ridaura et al. (2018)	Climate-smart agriculture, farm household typologies and food security: An ex-ante assessment from Eastern India ○	Agricultural Systems
18.	SL	Mahat et al. (2019)	Climate finance and green growth: Reconsidering climate-related institutions, investments and priorities in Nepal ◎	Environmental Sciences Europe

19.	SD	Mittal and Hariharan (2018)	Mobile-based climate services impact on farmers risk management ability in India ○	Climate Risk Management
20.	SL	Pradhan et al. (2019)	Finger millet in tribal farming systems contributes to increased availability of nutritious food at household level: Insights from India ○	Agricultural Research
21.	SD	Seidler et al. (2018)	Progress on integrating climate change adaptation and disaster risk reduction for sustainable development pathways in South Asia: Evidence from six research projects ◎	International Journal of Disaster Risk Reducation
22.	SD	Sendhil et al. (2018)	Extent of vulnerability in wheat producing agro-ecologies in India: Tracking from indicators of cross-section and multi-dimension data ◎	Ecological Indicators
23.	SD	Shirsath et al. (2017)	Prioritizing climate-smart agricultural land use options at a regional scale ◎	Agricultural Systems
24.	SD	Shrestha and Dhakal (2019)	An assessment of potential synergies and trade-offs between climate mitigation and adaptation policies in Nepal ◎	Journal of Environmental Management
25.	SL	Singh and Singh (2017)	Traditional agriculture: A climate-smart agriculture for sustainable food production ○	Engery, Ecology and Environment
26.	SD	Thornton et al. (2018)	A framework for priority-setting in climate smart agriculture research ◎	Agricultural Systems
27.	SL	Thornton et al. (2019)	Human adaptation to biodiversity change: An adaptation process approach applied to a case study from Southern India ◎○	Biodiversity Change and Human Adaptation
28.	SD	Tripathi and Mishra (2017)	Knowledge and passive adaptation to climate change: An example from Indian farmers ○	Climate Risk Management
29.	SD	Westermann et al. (2018)	Scaling up agricultural interventions: Case studies of climate-smart agriculture ◎	Agricultural Systems

Note: SD represents Science Direct, SL represents Springer Link, ◎ represents policies/plans, ○ represents practices/perceptions, and Δ represents people/institutions.
Source: authors.

gases (Table 3). CSA has these 3 specific goals of increase productivity, resilience/adaptive capacity and reduce greenhouse gases, thus, it is crucial to systematically and quantitatively assess whether adaptation practices are climate-smart or not (Hochman et al., 2017b). Whenever at least one goal of CSA is achieved, it can be considered as the CSA practice (Khatri-Chhetri et al., 2017). They further combined the agricultural and adaptation technologies, practices and services together as CSA technologies in their paper, but it is categorized as the CSA practices in this paper. The specific indicators relevant to the specific CSA goals or pillars or outcomes need to be defined in the current and future scenarios. Furthermore, the favorable policies and building adaptive capacities are pivotal for effective CSA practices (Maharjan and Maharjan, 2017). Kumar et al. (2019) emphasized on the participatory tools in consolidating the local climate complexities and prioritizing the locally appropriate CSA practices depending on local perceptions and household types.

Khatri-Chhetri et al. (2017) categorized the CSA practices into water-smart, energy-smart, nutrient-smart, carbon-smart, weather-smart and knowledge-smart to improve the use efficiency of water, energy and nutrient, reduce greenhouse gases emissions and carbon sequestration in agriculture and effective use of scientific and local knowledge. These practices were also differentiated as crop production, livestock management, soil management, water management, forestry and agroforestry, aquaculture and fisheries and energy management as entry points for CSA practices (CCAFS, 2019; Maharjan, 2019). Both categorizations have commonalities but emphasized on different aspects. These practices have potentials to fulfill the CSA goals,

however not effectively managed to the full extent due to low adoption rate by the farmers in the developing world (Westermann et al., 2018). They further highlighted the prevailing issues of food insecurity and poverty in many rural areas despite the continuous efforts and innovative approaches. Singh and Singh (2017) emphasized on the agricultural or CSA practices that enhances sustainable food production to address the issues of climate change, soil degradation and biodiversity loss and also to feed the increasing population. They further highlighted the increased attention on traditional agriculture as the sustainable source of food production in the context.

Most of these agricultural or CSA practices are materialized while responding to several policy, socio-economic, institutional and natural factors over the years (Bhatta et al., 2015). The preferences and adoption choices of CSA practices are influenced by the policies/plans, socio-economic and climatic conditions including the observed risks in the areas. The adoption of these CSA practices largely relies on farmers' preferences, perceptions and willingness to invest in those practices (Khatri-Chhetri et al., 2017; Shirsath et al., 2017) and supports provided by the institutions particularly in value chains, information and communication technologies (ICT) and advisory services (Westermann et al., 2018). *'Perception is a cognitive process that involves the receiving sensory information and interpreting it'* (Tripathi and Mishra, 2017, p.2). The study conducted by Mittal and Hariharan (2018), demonstrated that ICT, particularly use of mobile phones, enhanced the adoption and implementation of CSA practices. However, there is still a huge gap between the awareness level of farmers improved and the farmers who have adopted and implemented CSA practices. Lopez-Ridaura et al. (2018) revealed the potentiality of CSA practices such as conservation agriculture in food security with the least costs and energy consumption though it is comparatively less attractive to the smallholders in India. Khatri-Chhetri (2017) emphasized the gender and social inclusion aspect and input use efficiency through the CSA practices. Some of the CSA practices such as water pond or plastic pond specifically reduce the workload of women and save time for additional income generating activities (Bastakoti et al., 2016; Gurung et al., 2016). Furthermore, these ponds provide water for agricultural productivity and fishing ultimately supporting the income and livelihood (Bastakoti et al., 2016).

The information and awareness on climate change, associated risks and CSA policies/plans and practices and their actual and potential benefits can play role in changing the perceptions. The perceptions and understanding the climate change and related risks lead to the actions to minimize the risks. The correct perceptions help to tackle the risks in positive way otherwise, the actions based on incorrect perceptions may lead to adverse impact (Tripathi and Mishra, 2017). Such information and awareness are initial steps to motivate the farmers to act on it by adopting and implementing CSA practices (Mittal and Hariharan, 2018). They further emphasized on requirement of additional resources and supports such as training and extension services, inputs and financial supports for effective adoption, implementation and scale up of CSA practices. The investments to the CSA practices also depend on the potential benefits and costs incurred for the practices (Khatri-Chhetri et al., 2017). Participatory planning and execution considering the farmers' needs might improve the adoption, but it is time consuming and needs additional resources (Westermann et al., 2018).

3 People and institutions in CSA policies/plans and practices/perceptions

The supports and additional resources have been provided by the people and institutions including public, private and civic agencies and groups. The governments and civil society groups are influential in climate related research and development in India and Nepal. These agencies have been actively involved, contributed and collaborated in the formulation and implementation of CSA policies/plans and practices. The services and supports provided by them are significant in strengthening the CSA adoption by increasing the awareness and accessibility to the relevant knowledge, skills, technologies and practices. The individual researchers and institutions have own perceptions, capacities and interests of engagement and collaborations at the local and national levels. Hochman et al. (2017b) highlighted the participatory interventions of researchers, farmers and NGOs in the climatic issues relating to rice-based farming. These people and institutions also support in identifying and prioritizing the appropriate CSA practices for better adaptability, resilience and addressing the climate variability. Likewise, Beddington et al. (2012) emphasized

on the role of academic and scientific groups in conducting research, building awareness and policy recommendations on the contemporary and sustainable resource generation, wise use of resources in CSA for climate resilience, increase productivity and minimization of greenhouse gases emissions.

The climate impacts have been observed locally, thus, the responses logically need to come from the local communities and institutions, but it is often planned and guided at the higher levels with the policy and regulatory frameworks and specific responsibilities (Seidler et al., 2018). In Nepalese context, the local and community adaptation plans in the form of bottom-up planning and execution have been initiated, but the skills, capacities and confidence of the local people and institutions are not fully satisfactory. The capacities of the local people and institutions and the requirement of resources at the local level have been often the issue for bottom-up approaches, thus most often business-as-usual approaches dominate. Thus, combination of top-down (NAPA, NAP and national climate policy) and bottom-up (LAPA and CAPA) approaches would be most appropriate climate policies/plans in Nepalese and some other countries contexts including India. Some local level institutions have also applied the bottom-up planning and execution of climate and disaster risk reduction practices in India (Seidler et al., 2018). Furthermore, the study conducted by Khatri-Chhetri et al. (2019) emphasized on the gender and social inclusion specifically the role of women in CSA adoption as an important indicator.

4 Interrelationships among the CSA policies/plans, practices/perceptions and people/institutions

Climate change is an important domain in the policy arena (Tripathi and Mishra, 2017) at the local, national and international levels. Agriculture, on other hand, is the primary sector for food security and livelihood of the people in Nepal and India, which experience most of the prevailing impacts of climate change (Groot et al., 2019). Number of climate and agricultural related policies and plans have been developed and executed at the national and international levels to address the impacts and also to increase sustainable food production to ultimately fulfill the food demands of the growing population. However, it is also reported that commercial agriculture is problematic in sustainable food and energy production and also contributing to the climate change (Findlater et al., 2019; Tripathi and Mishra, 2017). Fischer et al. (2016) suggest restructuring the policy to encourage climate-smart agriculture. The triple-win goals of CSA also complement increase in food production with minimum greenhouse gases emission and enhanced adaptive capacities.

Multiple institutions and stakeholders have joint efforts to address the impacts and sustainable food production at the national and international levels. The initiatives of some of the organizations such as FAO, CCAFS in initiating and promoting CSA policies/plans and practices are promising and motivating for the governments, civil society groups and farmers to promote, adopt and implement these practices in the field levels. Farmers have multiple options and practices to sustainably increase the productivity, resilience and reduce greenhouse gases supported by several institutions and individuals including the researchers and policymakers. However, there is a huge gap in adoption and scaling up of many of these practices noticeably due to lack of extension services, access to the information, resources and technical skills and knowledge (Groot et al., 2019). CDKN (2017) further highlighted the unavailability of inputs and resources at the local market to adopt CSA practices, thus, poor farmers and smallholders are not capable to adopt, implement and scale out CSA practices at the local level. Groot et al. (2019) further emphasized that the small and medium-sized enterprises (SMEs) and their business models can be supportive in adoption and scaling up of these practices with the specific case in Punjab, India.

Also, the private institutions and business owners have also indicated the interest to invest in CSA practices in recent years. They used to be less attentive towards it as they were interested more on short-term gains (Groot et al., 2019). They further emphasized that the CSA business model needs the involvement of multiple people and institutions including the policymakers, researchers and research institutes, investors at the national and international levels. It may be necessary to develop multi-stakeholder's learning and sharing forum to develop and execute the large-scale CSA policies/plans and practices. In many instances, the existing multi-stakeholder forum at the district and national level could integrate and promote the CSA policies and plans. In this relation, Shrestha and Dhakal (2019) suggested an institution or

platform to promote sufficient and operative coordination among the relevant institutions and also to explore the potential synergies and trade-offs in the CSA policies/plans, which will be supportive to effectively implement and execute CSA practices.

The CSA pathway (Figure 2) depicts the interrelationship between the CSA institutions and the people, CSA policies/plans and CSA practices, technologies and perceptions. This is a general pathway which maybe applicable in most of the cases under the business as usual (BAU) situation. Even in the BAU, the institutions/people need appropriate investments and resources, skills and capacities for research, development, promotion and scaling up of the policies/plans and practices. Gurung et al. (2016) also followed similar pathway for scaling up of specific CSA practices in Nepal (e.g. Plastic house technology) in their report emphasizing the institutions, policy, technology and finance. In this case, the institutions (i.e., District Agriculture Development Offices) are responsible for promotion of specific practice/technology with the specific policy of waiving of tax and subsidy on import of plastic sheets for agricultural use. The government and/or civil society organizations provide the skills and capacities through the training to the farmers on the use of plastic technology in agriculture. This specific case of plastic house technology portrays the CSA pathway in Nepal. Likewise, th GoI invested 21.8 billion USD to build 10,000 MW solar power plant to irrigate the farms at the national scale by distributing 1.75 million off-grid solar agricultural pumps (Shah, 2018). The concept of climate-smart village (CSV) has been implemented by the support of multiple institutions in both countries. Almost 500 CSVs have been launched in rice-wheat systems in Haryana, India (Cecilia, 2012). Number of policies/plans developed by the GoN including

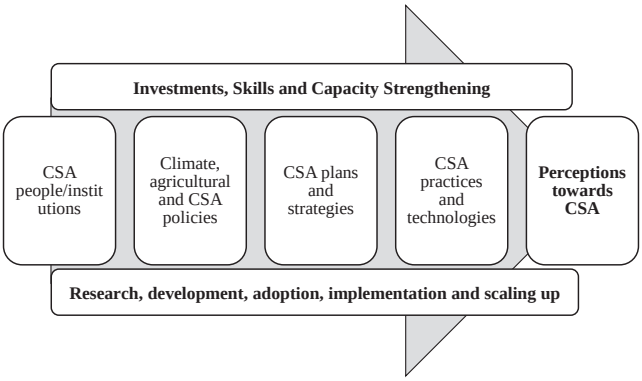

Figure 2 CSA Pathway
Source : authors.

National Adaptation Plan of Action (NAPA-2010), National Climate Policy-2011, Nepal Biodiversity Strategy and Action Plan 2014−2020 and sectoral plans have directly or indirectly supported CSV in Nepal (Adhikari et al., 2016). The institutions and people play active roles in formulating the relevant policies and plans through inclusive and interactive process, which support the effective implementation, adoption and scale up of CSA practices in cross-sectoral and interdisciplinary approach for synergies and climate resilience pathways.

Both countries are geographically, climatically, and culturally diverse, thus single CSA policy/plan and practice may not be applicable. Multiple challenges prevail in CSA concept itself, its implementation and sustainability. The foremost challenge is the conceptual clarity despite multiple institutions and researchers have redefined and utilized in different research and development interventions for almost a decade. The concept itself is defined broadly which include different agricultural practices including the simple change in cropping pattern to advanced biotechnologies (Khatri-Chhetri, 2017). Furthermore, some of the agricultural practices and technologies that have been practiced and popular among farmers prior to the CSA concept and approach such as mulching, organic farming, agroforestry, rainwater harvest etc., are also categorized as the CSA practices and approaches. Many of agriculturalists have argued on such integration of already popular practices and approaches as CSA practices/approaches.

5 Challenges

However, the report published by CDKN (2017) and Gurung et al. (2016) highlighted the lack of adequate recognition of CSA in the policies, plans and strategies, lack of documentation and extension services, and lack of scientific evidences and coordination among the institutions including the government departments and relevant organizations. They further underlined the lack of sustainability of CSA practices since most of it focused on project-based approaches, but not long-term plans. Moreover, the issue of lack of capacities among the public, civic and private sectors was also underscored in the report particularly in the Nepalese context. These contexts are also somehow relevant in Indian context.

The complexity of climate change itself is a challenge in prioritizing the CSA policies/plans and

practices in any specific geography. Besides, the limited capital and resources to invest in CSA concept, policies/plans and practices are additional challenges especially in developing countries like Nepal and India (Shirsath et al., 2017). They, further, highlighted the limited studies on CSA in these countries mainly due to lack of scientific data on biophysical, climatic and production economics for detailed analysis. For instance, it is difficult to gather the reliable data on rainfall and temperature for climatic trend analysis and farmers' yields and incomes of all commodities, costs and benefits of adaptation and mitigation practices in these countries.

Moreover, the prioritization of multiple aspects of productivity, adaptation and mitigation in CSA make it more complex and challenging in its research and development (Thornton et al., 2018). It's hard that single CSA practice and approach fulfill multiple goals of the CSA. In this regard, Khatri-Chhetri et al. (2017) have clearly stated the fulfillment of at least a goal is important for CSA. It would be certainly helpful to define specific indicators with respect to the CSA goals to effectively monitor and evaluate the progresses. Khatri-Chhetri (2017) has included increase in income, increase in efficient use of inputs and gender and social inclusion as important aspects of CSA in the context of India and Nepal, which make it more complex and complicated in these countries. Thornton et al. (2018) further emphasized on uncertainty of sustainable source of funding and investment in CSA including the scale and temporal dependencies. Khatri-Chhetri et al. (2019) further revealed lack of technical knowledge, cost for investment in those technologies and the least incentives provided as additional challenges for adoption of CSA practices.

However, we believe that these complications and challenges would be minimized over the years. Khatri-Chhetri et al. (2019) revealed the increased government's investment to promote the CSA practices in India. Likewise, Government of Nepal has also emphasized on allocation of 80% of financial resources for the implementation of the local adaptation plans. The local government bodies have more power and authority in mobilization of the local financial and technical resources at present. The issues of investment and institutional supports would be increased as multiple institutions including the private sectors, cooperatives have expressed their interests in it (Groot et al., 2019). Hochman et al. (2017a) emphasized on participatory action research with farmers and relevant institutions with reliable field data and analysis to promote the CSA more practically and in a productive manner. Maharjan et al. (2017) also emphasized on assessment and analysis of local vulnerabilities, risks and adaptation practices and perceptions for location specific policies/plans and practices. It is also advisable to build the capacities and skills of local people and institutions to fully understand the CSA policies/plans and also implement, monitor and scale up the CSA practices with positive perceptions towards it.

Ⅲ Conclusions

CSA is comparatively a new concept for the improvement in agricultural system to address the emerging issues, however it has integrated some of the agricultural practices which have been taking places for decades. Since its inception in 2009, it is gaining popularity and attentions in policies/plans, practices among the policymakers, researchers and multiple institutions at all levels. Through the multiple years of its adoption, implementation and scale up, the perceptions of the farmers, researchers, policymakers and institutions towards CSA has been changed and/or in the process of changing. The developing countries such as Nepal and India have also integrated it in different possible forms either in policies/plans or in practices. However, the rate of adoption and scaling up in these countries are comparatively less because of multiple reasons including the lack of awareness, information dissemination, lack of specific CSA policies/plans, lack of investment among others. India has adopted several CSA practices throughout the country, but success rate is still not fully satisfactory. In Nepalese context, few CSA practices have gaining popularity due to the efforts of the government and civil society organizations. Some of the agricultural and climate policies/plans including the sectoral policies/plans have also integrated it.

Since it is still a new concept, further research and development including specific CSA policies/plans, enhancing skills and capacities are required for clarifying the controversies in addition to the mainstreaming it in the policies and plans at the local to national levels. The joint efforts of people and institutions at top and bottom level are important to develop and execute the CSA

policies/plans and practices by changing the perceptions of the people and institutions as appropriate. The trade-off should be minimized whereas the synergies need to be enhanced in the CSA approaches and processes at all level. Both countries have many CSA practices being implemented despite minimum direct integration and reflection of CSA in the policies/plans because some of the existing agricultural practices are also included as CSA practices in both countries. The adoption and scaling up of successful CSA practices are exceptionally needed, which would be enhanced through the consolidated efforts of institutions and increased investments. The specific indicators including the aspects of gender and social inclusion is crucial in both countries. This assessment and analysis have conveyed the current contexts of the climate and agricultural policies in India and Nepal from the perspectives of the papers published in the Science Direct (SD) and Springer Link (SL) from 2009 to 2019. Further detail assessment of specific climate policies/plans and practices in these countries would be carried out in coming days.

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