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Review Article

Climate Smart Agriculture Concept and Adaptation in Nepal: An Overview

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ABSTRACT

Nepal is the fourth most vulnerable country with Global Hunger Index (GHI) of 21.2 % scored indicating various risks and vulnerability. Impact of climate change seen on agriculture, forestry and fisheries. Nepal in a frontline of climate change as 42 districts classified as food insecure, 21 glacial lakes are potentially dangerous and Nearly 1.9 million people are highly climate vulnerable is dangerous statistical data for future Nepal. Change in rainfall pattern, temperature variation, unseasonal rain and long drought are some impacts on climate which ultimately impact on agriculture systems. Climate Smart Agriculture (CSA) is an approach for transforming and reorients agricultural system to support food security under changing environmental condition. CSA promotes only by collaborate actions of small holder farmers, marginalized group, policy makers and others related sectors. In this paper bird's eye views on issues of climate change, Climate smart agriculture (CSA), local institution, policy makers, adaptation and practices, Program, policy, project ongoing in Nepal to tackle all of such concerns of impacts of climate change in agriculture, climate, food security particularly in the context of Nepal.

Key words: Climate change, Climate Smart Agriculture, Adaptation, Policy

INTRODUCTION

Climate Change is defined as change in climate which is due to human activity that alters the general composition of global atmosphere and natural climate over a period of time (UN, 1992). According to the Intergovernmental Panel on Climate Change (IPCC), Climate change affects negatively on crop production in several regions of world and negative impacts are seen in developing countries (IPCC, 2014).Changes in rainfall pattern, variation in temperature, sea level rises, salinization, changes in water availability, and various extreme events impacts on agriculture, forestry, and fisheries (Thornton & Cramer, 2012). Most evident impact of climate change is global warming (UNCTD, 2009). Climate change has been taking place from the origin of earth as a natural process but in the recent years it hampers agricultural growth (Lobell, Schlenker, & Costa-Roberts, 2011).Climate change increases crop and livestock productivity in mid to high latitudes but decreases in tropical and subtropical (IPCC, 2007). Climate change expected to cause crop reduction in South Asia up to 10 % by 2030 for staples such as Rice, more than 10% for maize and millet (Lobell, Burke, Tebaldi, Mastrandrea, Falcon, & Naylor, 2008). Lack of efforts towards mitigation of climate change results in rising of temperature by 4 degree Celsius above pre-industrial levels brings calamitous consequences for whole planet (Birdlife, 2018). In 2010, Total non-carbon

dioxide (CO_2) green house gas (GHGs) emissions from agriculture are estimated at 5.2-5.8 gigatonnes of CO2 equivalent per year which contributes 10-12 % of global anthropogenic emissions (Bajzelj, et al., 2014). As an integral part of economy agriculture sector has to contribute to mitigate climate change (UNFCCC, 2008).

Nepal is the fourth most vulnerable country in term of climate change (Dangal, 2012)and its impact are seen more severely in Nepal (Synnott, 2012). It is in the frontlines of Climate change impacts as out of 75 district 42 districts classified as food insecure, 21 glacial lakes are potentially dangerous, Nearly 1.9 million people are highly climate vulnerable which is most dangerous statistical data for future Nepal (Lamsal, 2017)The Global Hunger Index (GHI) of Nepal ranks 72nd out of 119 countries with a score of 21.2 % indicating as a serious problem of food security (IFPRI, 2018). Climate Change Policy of Ministry of Environment Nepal (MOE) states that temperature rises rate of Nepal is 0.06 % (Climate Change Policy, 2011). Others claim that there is variation in an average temperature across the country (Gautam & Pokhrel, 2010; ADS, 2015). The rising temperature of Himalayan and Hilly region is 0.08ºc per annum which is higher than 0.04ºc per annum of Terai region of Nepal(Malla, 2008).In Nepal Reduction of GHGs emission is not a high priority but Agriculture Development Strategy (ADS) aims to forwarded green technologies, improved resilience to climate change, capacity strengthen of farmers (ADS, 2015).Climate change is challenge to our food system but it's also an opportunity to innovate and adapt new practices (Farmingfirst, 2016)In recent years, Nepal faced long drought during monsoon and unseasonal rains during winter and increased temperature which caused distress to farmers' communities in many parts (Khatri-Chhetri, Poudel, & Shirsath, 2017). Farmers' perception on climate change affect climate induced risks and its management, adaptation measures in order to mitigate the adverse impact of climate on agriculture (Joshi, Aslamansari, & Raghuvanshi, 2018). On study it was confirmed that Dalits, janajati and women household are most vulnerable as compared to others in Nepal (Bhatta, et al., 2015). A mainly smallholder farmer with average landholding is less than 0.5 hectare (CBS, 2011). Small landholder categories farmers are highly vulnerable due to climate change and low adaptive capacity. Due to these various risks and vulnerability we must need to identify, promote and practices technologies that can increases productivity, development of coping capacity.

MATERIALS AND METHODS

This paper is based on review of various national and international documents of agriculture, climate change and food security sectors. The national documents, policies, plan, strategies, brochure, booklets, reports, programmes, projects, international article, sourcebook, conference, research results and published materials related to agriculture, climate change and food security were collected from concern departments, directorate, offices, multimedia, official website, fields offices of programme and projects.

Scanning, Skimming and sorting were adopted during reviewing. Climate change, Climate Smart Agriculture(CSA), Food security related important matter were marked and drawn for the study from the International Journal, Policy, CSA Sourcebook while Plans, projects, policies, practices and adaptation scenario were marked and drawn from Nepal's plan policies, strategies and programme. The current policies, plan and programme were also studied and deliberated briefly.

DISCUSSIONS

Based on review of Sourcebook, international journal, National policies, various non-governmental publication, brochure, plans and institutional documents following finding out were drawn which are very much related to Climate smart

agriculture its concept, practices and adaptation in Nepal.

CONCEPTON CLIMATE SMART AGRICULTURE

Climate smart agriculture is an approach to transform and reorient agricultural system under new verity of climate change (Lipper, Thornton, Campbell, & Torquebiau, 2014).Food and agricultural Organization of the United Nations (FAO) defines CSA as is an approach to sustainably increases productivity and income, enhances adaptation, mitigation of Green house gas (GHGs) emissions where possible, and Support development and food security condition under changing climate condition (FAO, 2013). FAO identified productivity, adaptation and mitigation as interlinked pillars to secure sustainable food security and development goals.

Mitigation, adaptation and productivity are 'triple wins'. Climate Smart Agriculture (CSA) brings all types of practices, institutions and policies which may be unfamiliar to farmers but used in climates changes context (Papuso & Faraby, 2013). The Climate Smart Agriculture highlights agriculture's contribution to global greenhouse gas (GHGs) emission and its vulnerability to climate change.

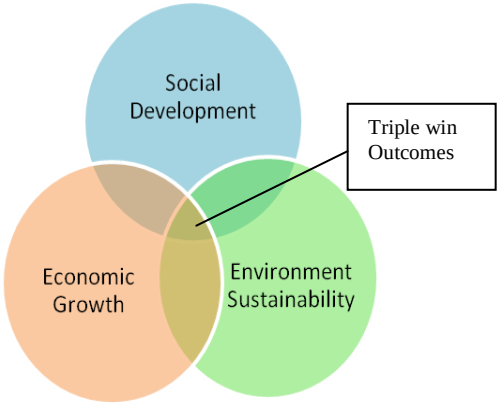

Figure 1: Sustainable development and Triple wins presented Venn-diagram (adopted from UNDP, 2012)

The World Bank promoted Climate smart agriculture as Triple win which enhances mitigation, productivity and carbon sequestration (Cecilia, 2011).To make climate smarter in reality we must expand the base, empower local institutions, support the necessary technical policy, investment solution and combine new financial areas and policies (FAO, 2015). During designing of CSA strategies, adaptation options need to be evaluated and prioritized by local farmers of particular location where prominent climatic risks are seen (FAO, 2012).

Practices under Climate Smart Agriculture are new agricultural technologies and practices at the farm level (Scherr, Shames, & Friedman, 2012). Some potential possible Climate Smart Agriculture Interventions are listed in table:

Table 1 Some potential possible Climate Smart Agriculture (CSA) Interventions

Soil and	Crop	Integrated	Agro forestry	Livestock	Access to
Water	Management	Food/energy		Management	Climate information
Management		Systems			
C. A	crop rotation	Biogas	Hedge rows	manure	Use of climate
Terraces, bunds	Inter cropping	Efficiency	N- fixing trees	Treatment	analogues to predict
Contour farming	crop diversity	that improve	Using	Grassland	future changes
Water harvest	Value chain	Efficiency	multipurpose tree	Restoration	Develop local expertise
improve irrigation	marketing manage	and plants	fertilizer shrubs	animal husbandry	in climate science agriculture
Alternate wetting	improve storage	improved	Woodlots	Improvement	Introduce forecasting
and drying		stoves	fruit orchards	fodder crops	and scenario planning

Source: adapted from (Neufeldt, et al., 2011)

There is still confusion on practices and technologies adaptation in Climate smart Agriculture. One considered agricultural practices that used resources efficiently with improves productivity as climate smart (Neufeldt, et al., 2013) whereas other consider CSA as complementary for sustainable agricultural system(Campbell, Thornton, Zougmore, P., & Lipper, 2014).

Selection of Suitable champion CSA options based on technical appropriateness, climate sensitiveness, scalability and farmers acceptance and also in Nepalese

agriculture using above mentioned different methodologies developed by FAO and CCAFS (Dunnett & Shirsath, 2013).

There is not any demarcation between Conservation Agriculture (CA) and Climate smart Agriculture (CSA) but Practices under CA is considered as CSA. Many Conservation agriculture practices such as zero tillage/minimum tillage, soil surface cover, crop rotations, and nutrient and irrigation management and reduce Green House gas emission (Sapkota, Jat, Aryal, Jat, & Khatri-chhetri, 2015). CA principles are adapted in different parts of world in particular farming practices. Local experiences with Conservation Agriculture includes More long term rain fed experiments along with crop rotation in Mexico (Dendooven, Gutierrez, Patino-Zuniga, & Ramirez-Villanueva, 2012), Rice and wheat under zero tillage (India) and manually dug planting basins in rain fed maize (Malawi) (Richards, et al., 2014). Similarly, practices and technologies of rainwater harvesting, agricultural insurance and uses of improved seed help to cope with extreme climate events (Altieri & Nicholls, 2013).Farmers around the world practices Climate smart agriculture to combat the impact of climate change in crop. Similarly, Gender amelioration, better outputs can be obtained by gender inclusive works. 'Enhancing awareness and capacity of women leaders and policy makers on gender, agriculture and climate change ' Project entitled of CCAFS along with LI-Bird of Nepal raised awareness of women members of parliament, women officials and women members of presidents office on Agriculture, climate change, right to food and gender equality, provide wide range of knowledge products such as leaflets, summary of relevant policies, Right to food bill, Climate change status (Sherpa & Khatri-Chhetri, 2017). That will build up capacity and output must gear towards gender inclusive outcomes. CGIAR Research Program on Climate Change, Agriculture and Food security works in Nepal as a research initiative to overcome the threats to food security, agriculture in a climate change. CGIAR is conceived to strengthen capacities of policy makers towards more gender informed policies in Nepal (CCAFS, 2017). It engages women and marginalized groups. Women have less access and legal right to resources of their farm as we seen in our society. CSA engages them and help in build of their adaptive capacity to manage with various events like floods, droughts (Huyer, Twyman, Koningstein, Ashby, & Vermeulen, 2015).Climate smart agriculture consolidated climate change in planning as well as in sustainable agriculture development (Lipper, Thornton, Campbell, & Torquebiau, 2014).Moreover, CSA espoused Landscape approach which integrated planning and management (FAO, 2012). In order to respond to climate change and achieve food security we must need significant transformation of agriculture (Thapa, 2016).Also, for the realization of Sustainable Development Goals (SDGs), secure food security and sustainable agricultural practices climates change adaptation need to be implemented (Paudel, Khanal, KC, Bhatta, & Chaudhary, 2017).In working on sustainable agriculture practices CSA is distinct in several ways. However, there is a great dilemma in selection and practices of appropriate technologies to meet these SDGs objectives. So Climate smart agriculture (CSA) is one of the adaptable parts.

ADAPATATION AND PRACTICES IN NEPAL

In Dolakha district, UNDP's Integrated Climate Risk Management Program (ICRMP) with financing from the Swedish Government and Government of Nepal organized and provided training on offseason vegetable farming and plastic tunnel construction which aims to strengthen risk management practice and makes positive impact on poverty reduction and development (UNDP, 2018).International Center for Integrated Mountain Development (ICIMOD) in

collaboration with Ministry of Forests and Environment, Nepal organized one day national consultation has been drafted which provided platform for stakeholders, researcher, policymakers and all other related parties in order to cushion socio-ecological resilience in Nepal(ICIMOD, Resilient Mountain Solutions for Sustainable Development in Nepal, 2018).International Center for Integrated Mountain Development (ICIMOD) with its partner Environment and Agricultural Policy Research, Extension and Development (CEAPRED) developed Climate Smart Village (CSV)approaches which provide communities tools to ameliorate their resilience to climate change and promote sustainable development (ICIMOD & CEAPRED, 2015). Climate smart Village (CSVs) is multi-stakeholder approach practices in local level to promote Climate smart agriculture. Potential practices, technologies and services on smart features of CSV include: Nutrient Smart, Water Smart, Crop Smart, Future Smart, ICT Smart and Energy Smart (Aggarwal, Zougmore, & Kinyangi, 2013). Climate-Smart Village approaches lead to identification of more appropriate CSA responses based on women and men's differing farming needs and constraints (CGIAR & CCAFS).

Table 2: Various Climate Smart Village (CSVs) Model practices in Farmers Level in Kavre, Nepal

CSV Model	Introduced Practices	Results
Nutrient Smart	Use of bio-fertilizer and bio-pesticide Jholmol	Enabling Sustainable growth, effective nutrient management
		mitigate negative impact of chemical management
Water Smart	Plastic ponds for wastewater and rainwater collection	Increase in vegetable production
Crop Smart	Using different crop varieties in multiple locations	Improve Soil fertility, Moisture through crop rotation,
		mixed cropping and Nitrogen fixation by intercropping
Future Smart	Provided information on insurance and supports	Mitigation loss and damage
ICT Smart	SMS notification on weather and market	Improvement on pest management, land preparation,
		weeding irrigation and harvesting
Energy Smart	Installation of biogas plants	Environmentally sustainable energy used

Source: adapted from (ICIMOD & CEAPRED, 2015).

Moreover, Scaling-Up Climate Smart Agriculture in Nepal project in Kaski, Lamjung and Nawalparasi districts aimed to

- Identification, testing and Screened CSA technologies and Practiced in context of Nepal involving poor farmers, extension agencies and researchers
- Development and implementation of Champion CSA practices with active participation of local and governmental stakeholder (Gautam, Thapa, & Khattri-Chhetri, 2015). Study on Nawalparasi, Hill and high hills area Kaski and Lamjung districts indicate about CSA technology and practice tested and evaluated in these pilot sites can be scaled out in the similar condition for adaptation to climate change (Khatri-Chhetri, Poudel, & Shirsath, 2017).Similarly, 'Climate Smart Agriculture in the Himalayan – an Innovative Green Business Model for Food Security and Poverty Reduction of Mountainous Communities of Nepal' project worked in Bajura district which aimed to transform the traditional agriculture and forestry into attractive and socially prestigious business (ANSAB, 2015). CIMMYT launched a new flagship project on CSM which focuses on up and scaling of local CSM practices in India Bangladesh and Nepal (CIMMYT, 2015). These projects made farmers benefited but not yet in mainstream and it is in ongoing.

Priority Framework of the Ministry of Agriculture Development and Government of Nepal's National Adaptation Plan of Action with SNV project designed programmes which aim to develop Climate Smart practices in selected value chains (Ministry of Environment, 2010). In Jumla and Surkhet districts of Nepal Climate Smart Agriculture activities targeted in value chains of apples and offseason vegetables respectively (SNV, 2015). SNV project worked in integration of CSA practices into the value chains, facilitate in knowledge sharing, analyzed cost-benefit of CSA practices in value chain (Beautiful

Nepal, 2018).ICCO's Climate –Smart Agriculture Project (ICCO, 2017)has been awarded the Adaptation at Scale Prize for their following innovative efforts in the field of climate change adaptation in Nepal:

- Innovative Agro-solution in the Karnali zone in Nepal
- Subsistence farming in Karnali
- 250 vulnerable households are engaged in solar pumping irrigation systems
- Initiation of selling surplus food to international markets

Major Program and Policy

Climate Smart Agriculture for successfully benefitted and delivering needs institutional arrangements. For successful Institutions and program design there is important of the six "ins" of CSA: inclusive institution for information, investment, innovation and insurance (Meinzen-Dick, Bernier, & Haglund, 2013).

There are many Institutional arrangements, policies, plans and strategy developed by Government of Nepal (GoN) as well as other NGOs and INGOs.

Adaptation Initiatives here includes Institutional arrangements and policy Frameworks.

1. National Adaptation Program of Action (NAPA) under Government of Nepal was supported by the Embassy of Denmark, UK Department for International Development (DFID), Global Environment Facility (GEF) and United Nations Development Program (UNDP), Nepal (Ministry of Environment, 2010)
2. Climate Change Policy 2011 under Nepal Climate Change & Development Portal (Ministry of Environment, 2011)
3. Climate Resilient Planning: A tool for Long-term Climate Adaptation under National Planning Commission (NPC, 2011)
4. Local Adaptation Plan of Action (LAPA) under Ministry of Science Technology and Environment (GoN, 2011)
5. Nepal second national communication to UNFCC (GON, 2014)
6. Climate Change Budget Code under Government of Nepal, National Planning Commission with support from UNDP/UNEP (NPC, 2013)
7. Agriculture Development Strategy (2015-2035) under Government of Nepal (ADS, 2015)
8. National Bio-Diversity Strategy and Action Plan 2014-2020 under Government of Nepal (GON, 2014)
9. Agro-biodiversity Policy 2014
10. Irrigation Policy 2014 under Government of Nepal with support from The World Bank (GON, 2014)
11. Land use policy, 2015 under Government of Nepal (MoLRM, 2015)
12. Nepal National REDD Strategy 2018 (MoFE, 2018)
13. Nepal Constitution 2072 (GoN, 2015)
14. Environment friendly Local Governance Framework, 2013 under Ministry of Federal Affairs and Local Development (GON, 2013)

Table 3: Projects undergoing in Nepal

National Adaptation Plan formulation process
Community based flood risk and Glacial Lake Outburst Flow (GLOF) risk reduction program
Nepal pilot country- Ecosystem based adaptation programme (EbA)
Nepal Climate Change Support Programme (NCCSP)
Hariyo Ban Project
ASHA adaptation action
Vulnerability reduction and increasing adaptative capacity in agriculture sector
Building adaptation to Climate Change in health through climate resilient WASH
Enhancing capacity, knowledge and technology support to build
climate resilience of vulnerable developing countries
Pilot Programme for Climate Resilience (PPCR)

Source: Adopted from (Lamsal, 2017).

CHALLENGES

In spite of various benefit of CSA practices and adaptation of it is quite low in Nepal.

Uncoordinated funding for adaptation and mitigation is key constraint for climate smart agriculture (Buchner, Falconer, Herve-Mignucci, Trabacchi, & Brinkman,

2011) which is similar in Nepalese condition as well. Socio-economic characteristics of farmers, agro-ecological zones and ascribe of a new technologies are major factors that influences in adoption of CSA (Cabell & Oelofse, 2012).So, diversity in climatic zones, socioeconomic characteristics and food production systems may makes CSA a complex. To achieve a targeted parameter it must include gender, youth and marginalized farmers. Local institutions play a great role to transform coping capacity into adaptive capacity, motivate smallholder's farmers and marginalized groups (Berman, Quinn, & Paavola, 2012). The collaboration of different sector of agriculture, climate change, food security, Program, policy is needed in order to achieve desirable results in Nepal.

CONCLUSION

There are both opportunities and threat to adapt and practices Climate Smart Agriculture (CSA) in Nepal and to integrate it with Triple wins goal as well as sustainable development. Single practices and planning is unable to develop adaptation and mitigation against climate change. So, collaborate efforts of Planning, Research, Government policies, Several NGO/INGOs programs would significantly help to achieve CSA in reality. A Revived and strengthened commitment on Soil and water management, crop management, Integrated food/energy system, Agro-forestry, livestock management and Access to climate information as well as increased focus on climate smart village (CSV) models/practices, would help to promote CSA and integrates that have enhanced adaptation and mitigation potential. CSA plays great role in decreasing food security and poverty in short term while in long term on climate change threat reduction.

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