Report on Farming System Study in ASHA Project area in Nepal

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Executive Summary

Most people in ASHA project depends on farming for living. Almost all people of project area (99%) who live in the village are farmers. But farming is the most important part of the lives though farmlands owned by most farmers are small and they grow just the food for living. Most farmers do not have extra production of food for selling in the market. This field study is carriedout to identify potential farming systems and the existing farming practices in the project districts. Mostly the farming land is sloppy and soil erosion in every monsoon is the common issue in the project districts. Review of project documents,use of checklist, focus group discussion and field survey were the methods used in the study. Expert views in analysing on the explored information were used and potential farming systems were recommended. Often the farm income is not enough for survival and men go overseas as laborers to earn some money to supplement their farm income. Rice-wheat -fallow and Rice-rice-wheat are the dominent cropping pattern of the Khet land whereas off-season vegetable and Maize/finger millet-fallow are the major cropping pattern in the Bari land respectively. Based on community consultation and expert judgment, existing cropping pattern in the study area are due to physical factors such as soil, climate, technological factors like irrigation, improved varieties of seeds, plant protection chemicals; Institutional factors like land reform, consolidation of holding, credit and marketing facilities. Among them, climate plays a crucial role in determining existing and adaptation of new cropping pattern. Similarly, study area cropping pattern depends and vary due to variation in the terrain, slope, temperature, amount and reliability of rainfall, soil, availability of water for irrigation, use of fertilizer, pesticides and other technologies. Furthermore, threats to biodiversity, deforestation and increased frequency of extreme weather events have affected existing farming system, agricultural production and undermined the livelihoods of the rural poor. High levels of poverty and the dependency on subsistence farming by a large portion of farmers, have limited the coping ability of the rural poor and increased the percentage of those who are food insecure. High levels of poverty and the dependency on subsistence farming by a large portion of farmers, have limited the coping ability of the rural poor and increased the percentage of those who are food insured. In addition, crop calendar is very important tool that provides timely information about seed to promote local crop production. It contains all the information on planting, sowing and harvesting period of locally adopted crops. This tool support farmers and agriculture extortionists in taking appropriate decision on crops and their sowing period, respecting local condition. However farmers from study districts don't have adaptation of cropping calendar. So that, production is not satisfactory as per their speculation and farmers are reluctant to agriculture practices.

In order to cope with current stresses to livelihood, ASHA project need to adopt several strategies for coping with climate change and food insecurity. Many methods assisting in the rual area need to promote that offer great potential for improved community based adaptation. These include organic farming, permaculture, integrated farming system, sustainable land management, conservation agriculture , climate smart farming practice, promotion of NTFP, sustainable cultivation and management of herbs, incorporation of agro ecology and agroforesty into current farming system, improvement of water management including rain water harvesting, livelihood diversification and climate risk management through detail study in cropping pattern and crop calender to the differnet location of ASHA project.

Acronyms

ASHA	Adaptation for Smallholders in Hilly Areas
CA	Conservation Agriculture
CSA	Climate Smart Agriculture
DADO	District Agriculture Development office
DFO	District Forest Office
DHQ	District Headquarter
FGDs	Focus Group Discussions
GHG	Green House Gas
HHs	Households
HVC	High Value Crop
IFAD	International Fund for Agricultural Development
IPM	Integrated Pest Managemet
KIIs	Key Information Informants
LRP	Local Resosurce Person
MOA	Ministry of Agriculture
NAPA	National Adaptation Programmes of Action
NARC	Nepal Agriculture Council
NGO	Non-Governmental Oragnization
NTFPs	Non Timber Frest Based Products
SLM	Sustainable Land Management

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Chapter One: INTRODUCTION

Background

Adaptation for Smallholders in Hilly Areas (ASHA) project is an undertaking of Ministry of Forest and Environment, Nepal with a financial support of International Fund for Agricultural Development (IFAD) designed to work in a six hilly districts (Salyan, East Rukum, West Rukum, Dailekh, Jajarkot, Kalikot and Rolpa). The ASHA project intends to support vulnerable smallholders to improve their climate resilience. ASHA seeks to reduce the increasing vulnerability of climate change related effects and raise the resilience of highly vulnerable households defined under the National Adaptation Program of Action (NAPA) by strengthening local communities through building knowledge and methodologies for improving participatory planning and facilitating strategic development in agriculture and food security, physical infrastructure, water, energy, human heath for investing in climate resilient livelihoods at household and community levels. The major climate change effects in the project area are erratic rainfalls, shifts in precipitation patterns, longer droughts, more severe floods and deficit in the recharge of groundwater.

The objective of the project is to reduce the vulnerability of local communities to climate related risks and strengthen enabling institutional environment for climate change adaptation. This is a six-year project (effective from 26 February 2015), works in six[1] districts; Kalikot, Dailekh, Salyan, Jajarkot, Rukum and Rolpa. MoFE is the executing agency with overall project implementation responsibilities. Department of Agriculture and Department of Livestock of the Ministry of Agriculture and Livestock Development (MoALD) are the implementing partners. The project implements its activities in close collaboration with District Coordination Committee in each district. The project has two main outcomes; a) Framework for local-level climate adaptation strengthened and b) Climate resilience of vulnerable smallholder farmers improved. ASHA Project‘s target groups include climate vulnerable households including poor, Dalit, Janajati and other ethnic minority and socio-economically marginalized groups. ASHA project has been providing grants to groups based on Local Adaptation Plans for Actions (LAPAs) for implementing climate resilient activities: i) community infrastructures and ii) profitable production.

With an aim to identify possible and relevant highly return farming systems in ASHA project districts the project has conducted a field research through a social based natinoal Non-Governmental Oragnization (NGO). In each ASHA project districts. The major purpose of the field research is to find out the current farming systems of an area and recommend with the most suitable and highly return farming system enhancing the livelihoods of local vulnerable households and communities. This assignment also aims to define the major effects of climate change and their adaptation techniques at the local level to mitigate its impacts in crop production and come up with some better resilience ideas that could help communities and people to cope with the adverse impact of climate change.

The outcome of this study will be useful for the project to further test in multiplying the relevant farming systems in the project areas and increase use of climate resilient farming practices as

[1] Currently seven districts since Rukum has split in to Rukum East and Rukum West districts

identified through this study.

Objectives of the Study

The study will focus to explore following objectives:

i. To assess the socio-economic circumstances and farmers knowledge on agricultural practices in the face of climate change.

ii. To analyze the existing farming system of ASHA project area and recommend with the best suitable farming system which could uplift the socio-economic condition of the vulnerable/ marginalized households through the better agricultural practices.

iii. To assess the major impacts of climate change in the agricultural sector and suggest with the adoption strategies to mitigate the risk being caused for achieving the higher agricultural production.

Limitation of the Study

The time duration allocated for conducting research activities is found to be the major limitation of the study. The area to cover and the information to gather from the study area is big but the time allocation for the purpose is too short which has limited us to cover each and every sector as proposed in the proposal and limited the information gathered. This report is completely based on the information gathered during the short period of field study. The meteorological data obtained were extracted from secondary data and online source and only of ten years and the information collected from the study site were entirely based on the farmers view. Hence, the problem of memory lapse and personnel biasness, though tried to be kept at minimal level, was inevitable. Likewise, limited research on farming ststems were carriedout which has limited information availability.

Chapter Two: STUDY APPROACH AND METHODOLOGY

This study used a range of methods and approachs to collate data and information for farming system study in ASHA Project area in Nepal which combines both qualitative and quantitative methods. Prior to determining detail data collection methodology, key indicators for the farming system were identified.

Study Approach

The study was accompanied by applying various theoretical and practical approaches to achieve realistic and most representative information. The approach of consultations and discussions were participatory, consultative and facilitative. Both the indigenous knowledge of local communities and scientifically tested knowledge from academia/scientists were justifiably used in this assignment. More specifically, the following approaches were employed:

Participatory and Inclusive

To obtain the realistic and most representative information of the study area, the study team used participatory and inclusive approach. Multi-stakeholder, multi ethnic and multi-classes representation was maintained in the process. It was ensured that the poor, women, dalits and marginalized communities alongside farmers/collectors, traders, service providers had a good proportion as a respondent during study in respective districts of ASHA project.

Effective Communication

Open communication with a variety of stakeholders through prior consents, planned meetings and briefings was maintained to collect and exchange opinions, information and ideas.

Disclosure and Verification approach

The study team followed the disclosure and verification approach to ensure the transparency of the findings as well as to develop the ownership and confirm accountability. This approach also facilitated to develop dialogues with concerned stakeholders on issues raised apart from providing the explanations for given situation. For this, briefing, debriefing and field level consultations was organized to discuss and share the study findings especially on status of farming system and best practice that can be adopted onwards.

Comparative Analysis

Comparative approach envisioned being fruitful in complementing analysis and interpretation of the data were maintained in the course of the study. The comparison was done with national, district and community level situations.

Analytical Approach

Analytical approach inferring the investigation and inspection of the data generated from the statistical tools was employed in the study. In addition, the information generated through FGDs, KIIs and informal discussions with stakeholders were accordingly suited the data requirement of the study. All data sets and information collected during the study at all levels was

transformed to some sort of quantitative form so that the computer based statistical software was applied for scientific analysis of available information.

Study Methodology

Cataloguing of existing information

Cataloguing of existing information was initiated immediately after the finalization of the contract. Reviews of the following documents was made and necessary information on policy, law & regulations and past interventions were extracted for successful completion of study.

a) **Review of pertinent documents** of Ministry of Agriculture (MOA), Nepal Agriculture Council (NARC) and publications from District Agriculture Development office (DADO), District Forest Office (DFO) etc.was carried out. Review the existing national (government) and international policies and guidelines related to the assignment will thoroughly be consulted.

b) **Review of project documents:** All the project documents that are useful in finalizing the study toolkit and help in understanding of project objectives and outcome are collected and analyzed.

c) **Study of relevant publications**, documents, reports, journals articles and other information was done. Following specific documents will be appraised thoroughly.

- Annual report and record of DADO and DFO, NARC for the respective distrcts
- Report and publication from other I/NGOs in ASHA proejct area

Questionnaire/Checklist preparation, pretesting and finalization

Several sets of questionnaires/checklists were developed to gather primary data. The questionnaire for local purpose was in Nepali language and have multiple options for the respondents to choose. This helped to smoothen the work in the field. For FGDs, KIIs and expert consultations, a set of guiding checklists were developed. The questionnaires were pretested during the induction to the local surveyers.

Focused Group Discussions

After the completion of orientation (induction) training to supervisors and local enumerators, they were mobilized to study districts. Focused group discussions (FGDs) were conducted in selected farmer group of the project area. In the FGD, the applied checklists were mostly open ended and also semi- structured. The purposes of the checklists were to direct the discussions and queries within the periphery of the information requirements and also to minimize time spent on those exercises. The checklists were based on the research objective and subject matter to the extent possible. In the discussion, number of locl farmers, local resosurce person (LRP), and technical staff in the respective districts from different organization were recorded. Apart from this, the study team also explored new potential farming system in local level. The following checklists were used:

- Description on socio-economic status and circumstances, farmer knowledge and their interest in agricultural practices linking to the climate change
- Identification of existing farming system in ASHA project area, type of household (HHs) involved
- Identification of major impacts of climate change in agriculture level faced by local inhabitants, their own suggestions for the adoptation stategies to mitigate the risk to acheieve higer agriculture production, and local need from government, I/NGOs level etc.
- Identification of at major agricultural commodities, best agriculture practies and lapses in systematic agricultural practices.

Description of ASHA project districts

Adaptation for Smallholders in Hilly Areas (ASHA) Project is an undertaking of Ministry of Forests and Environment (MoFE) with the financial support of International Fund for Agricultural Development (IFAD). This is a six-year climate change adaptation project works in two districts of provience five (Rolpa, Eastern Rukum) and in five districts of Karnali provience (Daileh, Jajarkot, Kalikot, Western Rukum and Salyan) of mid-western development region of Nepal.

The ASHA Project intends to support vulnerable smallholders to improve their climate resilience.There is high diversity in temperature and climatic conditions of ASHA project sistrict as the region ranges from 129-7767 masl. The minimum average temperature of an area in winter is 5.4oC (Humla) which rises up to 35oC in the summer time (Salyan). More than 70% of the population in an area is dependent on agriculture for their day to day living.

Table 1: Brief description of the study area

District	Provience	Geographical location	Altitude range (m)	Average temperature range (^{0}C)	Average annual rainfall	Climatic variation
Kalikot	5	29º 5'N 29º 83'N latitude, 81º 28' E 82º 2'E longitude	738 -4790	Max: 36ºC Min:1ºC	730 mm	Sub tropical and temperate
Eastern Rukum	5	28°29'N to 29°00'N Latitude, 82°29'E to82°53'E Longitude	714-6603	Max:34°C Min: 0.4° C	1600-2400 mm	Sub tropical and temperate
Western Rukum	Karnali					
Jajarkot	Karnali	28º 37' N to 29º 7' N latitude 81º 49' E to 82º 34 E longitude.	610-5412	Max:34°C Min: 8° C	1868.5 mm	Sub tropical and temperate
Rolpa		28°80'N to 28°380'N Latitude, 83°10'E to 83°90'E Longitude	701-3639	Max:34°C Min: 4° C	1800 mm	Sub tropical and temperate
Dailekh	Karnali	28°35′N to 29°00′ N Latitude, 81°25'E to 81°53'E Longitude	544-4168	Max:34°C Min: r5° C	1,700 mm	Tropical to temperate

(Sources: DDC office-Information and Social Development Section, 2018)

Kalikot

Kalikot is one of the district of Bheri zone in Karnali Provience of Nepal having a total area of 1641.30 km^2. It has diverse agro-climatic and socioeconomic condition. Kalikot lies between 29º 5' to 29º 83'north latitude and 81º 28' to 82º 2'east longitude. It starts from the lowest 738 m to highest 4790 m above sea level. Of a total area, 17984 ha of land is cultivable and of which 16350 ha of land is being cultivated. 1060558 ha of land is covered by forest and 45000 ha by grazing land. Of a total 16350 ha of cultivated land 5353 ha of land has an irrigation facility and remaining has to depend on rainfall. The annual rainfall of a district is 730 mm with maximum temperature of 36ºC and minimum temperature 1ºC.

Picture 1: Map of Kalikot District

Table 2: Description of Kalikot District

S.N.	District	Local level organization name	Population	Area (km^2)
1	Kalikot	Khadachakra Municipality	20288	133.29
2		Raskot Municipality	16272	59.73
3		Tilagufa Municipality	15766	162.56
4		Pachaljharna Rural Municpality	12343	166.92
5		Saanni Tribeni Rural Municipality	12846	136.71
6		Narharinath Rural Municipality	21366	143.86
7		Kalika Rural Municipality	14080	97.32
8		Mahawai Rural Municipality	8323	322.07
9		Palaata Rural Municipality	15303	318.84
Total			136587	1641.3

(Source: MoFALD, 2018)

- **Topography and soil**

Most of the area of the district is hilly area. The agricultural land in the district is sloppy and terrace land is predominant. There is very much diversity in the soil type but in most of the hilly areas clay and loamy soil are predominant.

- **Temperature**

According to latest information provided by meteoblue (www.meteoblue.com) the average maximum temperature of Kalikot district was 36 ºC and average minimum temperature is 1 ºC. Due to the climate change effect and global warming the temperature of the district is increasing in the recent years.

- **Rainfall**

There has been change in rainfall patterns (high, low, and intensive rainfall) and seasons due to climate change with direct and indirect impacts on water resources, agriculture, forest and biodiversity, health, infrastructure development, tourism, and livelihood. Obviously, due to its higher dependence in weather, Kalikot agriculture has been vulnerable to climate change. Rainfall is the main source of water in Kalikot district as most of the cultivated land depends on rainfall for the irrigation purpose. According to latest information provided by meteoblue (www.meteoblue.com) the average rainfall of the district is 730mm annually.

- **Major cultivated crops in the study area**

Even though the area is very poor in soil condition and with the irrigation facilities various crops can be grown in this district. There is no penetration of improved crop varities as well the technology. Traditional varities as well the technology is very dominent in the site. The crop production therefore is affecting largely where the productiviry is very low. This has ramparting the food security situation. There are lots of fclimatic oppurtunity for this district. In addition to minor vegetable like some guards, potatoes, bean and local lentils, major cereal crops are maize legums, millet and paddy.

- **Horticultural crops status of an area**

Mainly temperate fruits like Apple and Nuts are dominated in Kalikot district. Till now dominantly the traditional practices of growing agricultural crops as well as seed production is common, however, which needs replacing by the morden practices. Seed processing, grading and branding facilities would largely add in value addition and rural livelihood upliftment.

All the crops grown in this area are now being affected by the climate change impact. There are severe impacts of frought by which vegetable seed production has been affecting. Coping technologies through vegetable gardening is important.

- **Livestock status of an area**

Buffalo, cow, Goat and chicken are being raised in the district in a small scale. Though, there is an immense opportunities for commercial livestock rearing nobody has yet started.

- **Human resource**

Kalikot has a total population of 136948 and most of the population is dependent on agriculture for their day to day living. The human life expectancy is very low due to the under-nutrition. Main sources of income came from the agrucultural activites foloowed by off-farm works. Some off-farm sources of income are: construction, employment, remittance Trend of youth going to abroad for work is increasing day by day leaving women, children and old aged people in the district. This has limited them to perform agricultureal activities on a subsistance way just to join hand on mouth. Introuction of small farm power and tools which are suitable in the area is inevitable.

- **Effect of climate change in Agriculture**

Climate change is due to emissions of greenhouse gases from fuel combustion, deforestation, haphazard used of land resulting variations in solar energy, temperature and precipitation. It has real threat to the lives in the study area that largely affects water resources, agriculture, freshwater habitats, vegetation and forests, snow cover and melting and geological processes such as landslide, desertification and floods, and has long-term affects on food security as well as in human health.

The rising temperature and emission of CO_2 to some extent is helpful in production of major crops. For example, increase in agricultural production by enhancing photosynthetic processes, water use efficiency, shortening physiological period and soil microbial activities. Decrease in grain filling period due to increase in respiration process, fertilizer use efficiencies, shift in agricultural zone, increase in insect pest population, desertification, increase in soil erosion, evapo-transpiration and cause malnutrition.The impacts on agriculture are the decrease of productive land in some region and increase in other region. The low crop productivity is an major indicator of climate change effect that impact in agriculture along with drought as a limiting factor for many crops.

Adoptation practices as a measure of coping to climate change imapcts and natural shocks are almost limited in this area. There is no alternative measures to irrigate the crops. Similarly, damage due to insect pests and biotic factors are large on which the farmers has less control.

Recommendations/ Future outlooks

This study just took the picture of the hilly areas of Kalikot district. As we took the condition of climate, soil, elevation and also the other socioeconomic condition, the district seems suitable for horticultural crops like apple cultivation, cereals crops like maize, whet, millet and vegetables like potato, onion. At the beginning, the trial should be done in different elevation and locality. Different agricultural groups could be formed at the local level and start the cultivation

commercially. Focus should be given to those commodities having high value in the market and is non-perishable for longer period of time as road condition in the district is very poor.

Special recommendation for the Kalikot district are as following:

- Develop irrigation infrastructure for reducing drought hazards such as drip and sprinkler irrigation system
- Develop minimum tillage and zero tillage in the rice, wheat and maize to reduce carbon and water loss from soil.
- Develop heat, drought resistant verities/breeds, insect pest resistant varieties and increase mechanism of IPM (integrated pest management)
- Develop safe agrochemicals to minimize pest and disease damage in the crops.
- Develop cooperation and coordination with neighboring country to cope with vulnerabilities.
- Develop climate-forecasting system for reducing hazards.
- Research on land use planning, watershed management, vulnerability assessment and resource management.
- Research on yield gap analysis to analyze the factors responsible to climate change

Rukum

After federal system in Nepal, Rukum district is divided into two district Eastern Rukum and Western Rukum. Among two, Western Rukum belong to Karnali Provience where as Eastern Rukum belong to provience number five. The total area of Eastern and Western Rukum is of 287700 ha. It has diverse agro-climatic and socioeconomic condition. Rukum lies between 28º 29’ to 29º 00’north latitude and 82º 12’ to 82º 53’east longitude. It starts from the lowest 754 m to highest 6000 m above sea level. Of a total area, 35359 ha of land is cultivable and of which 27480 ha of land is being cultivated. 167856 ha of land are covered by forest and 59205 ha by grazing land. Of a total 27480 ha of cultivated land 6934 ha of land has an irrigation facility and remaining has to depend on rainfall. The annual rainfall of a district is 2000 mm with maximum temperature of 34ºC and minimum temperature 4ºC. Total of 89 % of population is engaged in agriculture sector in this district.

Picture 3: Map of Eastern Rukum Disstrict

Picture 2: Map of Western Rukum District

Table 3: Description of Western and Eastern Rukum Districts

S.N.	Distric	Local level organization name	Population	Area (km^2)
1	Western Rukum	Musikot Municipality	32939	136.06
2		Chaurjhari Municipality	27438	107.38
3		Aaathbiskot Municipality	33601	560.34
4		Tribeni Rural Municipality	18696	190.42
5		Sani Veri Rural Municipality	19404	85.49
6		Bafikot Rural Municipality	22194	133.8
Total			**154272**	**1213.49**
1	Eastern Rukum	Putha Utarganga Rural Municipality	1932	560.34
2		Bhume Rural Municipality	18589	273.67
3		Sisne Rural Municipality	16497	327.12
Total			**53018**	**1161.13**

(Source: MoFALD, 20180)

- **Topography and soil**

This is a hill and mountain district having variation in topography and climatic condition. It consists of a mountainous area where apple can be grown and also has a low land where temperate fruits like mango, litchi, and banana can be grown. As, most of the land in this district is virgin (no pesticides and chemical fertilizers being used) there is huge potentiality of organic farming.

- **Temperature**

According to latest information provided by meteoblue (www.meteoblue.com) the average maximum temperature of Rukum district was 34 ºC and average minimum temperature is 0 ºC. Due to the climate change effect and global warming the temperature of the district is increasing in the recent years.

- **Rainfall**

According to latest information provided by meteoblue (www.meteoblue.com) the average rainfall of the district is 2000 mm annually.

- **Major cultivated crops in the study area**

In Nepal, Rukum is one of the famous district for agricultural production, it is special hub for the production of vegetables and vegetables seeds. In this district, the government has establishd Rukum Vegetable Farm, which has left its major impact in rural economy and recognization of Rukum. The production of raddish seeds, onion seeds along with the seed of major cereal is one of the dominent impacts. In additon to minor cereals and major vegetable crops, maize, beans, cowpea, paddy, cauliflower, cabbage, radish carrot and vegetable seeds of various crops are the major crops growing in this district.

- **Horticultural crops status of an area**

Horticultural crops are the major crop in this district where freshs vegetables as well as vegetable seed is common. Growing vegetable and seed production has becoming important enterprises in the district. Among major fruits, apple wallnuts, mango, banana, mandarin orange, lemon are dominent, whereas radish, legumes and cucurbits, potatos and solanaceous crops are the important one. Till now dominantly the traditional practices of growing agricultural crops as well as seed production is common, however, which needs replacing by the morden practices. Seed processing, grading and branding facilities would largely add in value addition and rural livelihood upliftment.

All the crops grown in this area are now being affected by the climate change impact. There are severe impacts of drought by which vegetable seed production has been affecting. Coping technologies through vegetable gardening is important.

- **Herbs and Medicinal Plants**

The district is equally famous in growing different herbs and medicinal plants such as Yarshagumba, Panchaunle, Kurilo, Timur, Gurjo, Bojho, Amla, Chiraito, Jatamashi etc.There is ample oppurtunity of growing and trading with these crops. Some households are substantially invoded in herbal business. Establishment of processing plants and assurance of marketing is very inevitable. There are lots of prospects of making prosperous state by utilizing and sustainable cultivation ofthe herbal plants

- **Livestock status of an area**

This is suitable to small ruminant along with the buffalo and cow. Goat and chicken are bening raised in the district in a small scale. Though, there is an immense oppurtunity for commercial livestock rearing nobody has yet started. There is large demand of meat, which can only be supplied by the inititation of commerical scale of poultry farming. Similarly, there are needs of commercial cow herds in the district, where large amount of milk is in demand.

- **Human resource**

Rukum has a total population of 207270 and most of the population (more than 89%) is dependent on agriculture for their day to day living. Main source of income came from the agricultural activities followed by off farm works. Some off farm sources of income are: construction, employment, remittance. Trend of youth going to abroad for work is increasing day by day leaving women, children and old aged people in the district. This has limited them to perform agricultural activities on a subsistence way just to join hand on mouth. Attracton of youngs can only be done by increasingly introduction of the farm power and tools which is the agriculture mechanization. Similarly, the agriculture needs drudgery less. The cost of production can be significantly reduced by introducing farm machinary.

- **Effect of climate change in Agriculture**

It is almost difficult to see the direct impacts of climate change, however, the major climatic parameters like rainfall is going to be less and less. Similarly, the long dry spell days with longer drought period are other visible impacts. Scanty rainfall, hurricanes, hailstorm and landslides are some of the amjor climate change effects hampering agriculture sector of an area. These all factors are impacting agriculture and livestock production directly as well as indirectly which needs dealing urgently through any of the climate resilient program such as Local Adaptation Plan of Action (LAPA)

Recommendations/ Future outlooks

This study just took the picture of some areas of Rukum district. As we took the condition of climate, soil, elevation and also the other socioeconomic condition, the district seems suitable for horticultural crops like apple and walnut cultivation in the high hills, mandarin orange and citrus crops in the mid hills and mango and banana in the low belts of the districts. Cereals crops like maize, wheat, millet, rice and vegetables like potato, onion, fresh vegetables found to be suitable in the region. Also, Both Rukum districts are potential for vegetable seed production which could be further developed and well managed in the coming days. At the beginning, the trial should be done in different elevation and locality regarding the horticultural to cereals crops. If found suitable different agricultural groups could be formed at the local level and start the cultivation commercially. Focus should be given to those commodities having high value in the market and is non-perishable for longer period of time as road condition in the district is very poor (only accessible in the dry season). Livestock raising (cow, buffalo, goat, chicken) could be done in the district but priority has to be given in the fodder and forage management and strong market linkages.

Agriculture and livestock rearing in fact are very integral components of the farming system in both Rukum districts, which however, are disintegrating these days. Largely there is unablanced coordination between these sectors. Farmers have very few level of coping capacities, hence the training in climate change mitigation and adoptation would highly useful to enrich the agriculture production.

Jajarkot Jajarkot district is the most remote and least developed upper hill district of the Karnali Provience. The total 2223.35 km^2 area of the district is 2, 23000 ha and Khalanga is the District Headquarters (DHQ), located at elevation 2,945m. Accessibility to the DHQ and the rural municipality's of Jajarkot district is heavily dependent on road conditions, monsoon and landslides. Khalanga is connected to Surkhet district by the Chhinchhu-Jajarkot road, a 63km section of which (Sallibazaar to Jajarkot) is mostly rocky, with steep turns and difficult to travel on. Jajarkot's population totalled 170113 in 2011, 50% of which female. Of the economically active population, a majority (84%) are involved in agriculture, though the share is higher among women than men; conversely, a larger share of economically active men (14%) than women (7%) engages in wage labour. Most migrants go to India during the agricultural off-season (June to September and November to April), though some youth find employment in countries like Malaysia or Qatar. Though the vast majority of the population in Jajarkot depends on agriculture for their subsistence, there are only 28,596 ha of cultivable land (13% of the total area). Jajarkot is highly ecologically vulnerable; exposed to landslides and epidemics during monsoon period (July and August), snowfall in December and January; and occasional fire incidents (UNDAF: District profile, 2013). Jajarkot lies between 28º 37' to 29º 7'north latitude and 81º 49' to 82º 34'east longitude. It starts from the lowest 610 to highest 5412 meter above sea level. Of a total 16698 ha of cultivated land 7908 ha of land has an irrigation facility and remaining has to depend on rainfall. The annual rainfall of a district is 800 mm with maximum temperature of 36ºC and minimum temperature 2ºC. Agriculture, livestock and cottage industries are the main economic activities of the district. Agriculture is the major source of income for about 96.85% of the households, however the district frequently suffers from food deficit.

Picture 4: Map of Jajarkot District

Table 4: Description of Jajarkot District

S.N.	District	Local level organization name	Population	Area (km^2)
1	Jajarkot	Bheri Municipality	33515	211.77
2		Chedagad Municipality	35295	284.2
3		Tribeni Nalgad Municipality	25597	387.44
4		Barekot Rural Municpality	18083	577.5
5		Kuse Rural Municipality	20621	273.97
6		Junichade Rural Municipality	21733	346.21
7		Shivalaya Rural Municipality	15269	134.26
Total			**170113**	**2223.35**

(Source: MoFALD, 20180)

- **Topography and soil**

This is a hill and mountain district having variation in topography and climatic condition. It consists of a mountainous area where apple can be grown and also has a low land where temperate fruits like mango, litchi, and banana can be grown. As, most of the land in this district is virgin (no pesticides and chemical fertilizers being used) there is huge potentiality of organic farming. The

- **Temperature**

According to latest information provided by meteoblue (www.meteoblue.com) the average maximum temperature of Rukum district was 36 ºC and average minimum temperature is 2 ºC. Due to the climate change effect and global warming the temperature of the district is increasing in the recent years.

- **Rainfall**

According to latest information provided by meteoblue (www.meteoblue.com) the average rainfall of the district is 800 mm annually.

- **Major cultivated crops in the study area**

In additon to many of the locally adapted crop cultivars and cereals and vegetables, major crops in the district are maize, wheat, mustard, beans, cowpea, paddy. It is itereesting to note that penetration of some of the improved lines and hybrid crop varities are appearing in the district. In such cases, observation of the locally adapted varities and improved varities in terms of the tolereance mechanisms needs studying.

- **Livestock status of an area**

Buffalo, cow, Goat and chicken are being raised in the district in a small scale. Though, there is an immense opportunity for commercial livestock rearing nobody has yet started. There is ample

scope of herd improvement using improved breeds either throug natural insemination or artificial inseminaton. More than 25 % milk and meat yield can be achieved over the local breeds.

- **Human resource**

Jajarkot has a total population of 254470 and most of the population (more than 84%) is dependent on agriculture for their day to day living. Main source of income came from the agricultural activities followed by off farm works. Some off farm sources of income are: construction, employment, remittance. Trend of youth going to abroad for work is increasing day by day leaving women, children and old aged people in the district. This has limited them to perform agricultural activities on a subsistence way just to join hand on mouth.

- **Effect of climate change in Agriculture**

Less rainfall, longer drought period, heavy rainfall, hurricanes, hailstorm and landslides are some of the major climate change vulnerabilities hampering agriculture sector of an area. Some of the climatic related negative impacts are appearing such as ultimately on set of flowering and fruiting of plants like Rhododendron and tempertaure fruits such as Pear, Peach, Plum etc.

- **Recommendations/ Future outlooks**

This district is highly potential for the production of mandarin orange, potato, fresh vegetable, vegetable seeds production, honey bees, soyabean etc. As the most of the areas in the district has road access only in the dry season, commercial production of the crops in the larger scale without considering the market demand and market possibilities could create a big problem. Provision of cold storage in some of the rural potential areas where the road condition is not that good could help to hold the commodities produced for a certain period of time minimizing the production loss. Also, establishment of some processing industries in an area helps to add the value of the product and could be stored for a longer period of the time. Livestock raising (cow, buffalo, goat, chicken) could be done in the district but priority has to be given in the fodder and forage management and strong market linkages.

Salyan

Salyan district, a part of Karnali province, is one of the seventy-seven districtsof Nepal. Salyan covers an area of 195178 ha. Salyan district comprises 3 municipalities and 7 rural municipality with its district headquarters in Salyan Khalanga.

Picture 5: Map of Salyan District

Table 5: Description of Salyan District

S.N.	District	Local level organization name	Population	Area (km^2)
1	Salyan	Sharada Municipality	33730	198.34
2		Bagchour Municipality	34118	163.14
3		Bangad Kupinde Municipality	36052	338.21
4		Kalimati Rural Municpality	13005	500.72
5		Tribeni Rural Municipality	16624	119.11
6		Kapurkot Rural Municipality	18204	119.21
7		Chatreshori Rural Municipality	21452	150.69
8		Dhorchour Rural Municipality	13593	89.36
9		Kumakhamalika Rural Municipality	24972	177.28
10		Darmaa Rural Municipality	19966	81.46
Total			**241716**	**1937.52**

(Source: MoFALD, 20180)

- **Topography and soil**

Although Salyan is considered a hilly district, its southwest salient is actually outside the Pahari-inhabited hill region, in the lower Siwalik Hills that are more an extension of the Terai.

- **Temperature**

According to latest information provided by meteoblue (www.meteoblue.com) the average maximum temperature of Salyan district was 34 ºC and average minimum temperature is 3 ºC. Due to the climate change effect and global warming the temperature of the district is increasing in the recent years.

- **Rainfall**

According to latest information provided by meteoblue (www.meteoblue.com) the average rainfall of the district is 1100 mm annually.

- **Major cultivated crops in the study area**

In Nepal, Salyan is one of the low productivity district for agricultural production, however, maize, wheat, cowpea, beans, paddy, vegetables as well as NTFP (Timur, Tejpat etc) are mmajor crops of the Salyan district.

- **Livestock status of an area**

Buffalo, cow, Goat and chicken are being raised in the district in a small scale. Though, there is an immense opportunity for commercial livestock rearing nobody has yet started.

- **Human resource**

Salyan has a total population of 242400 and most of the population is dependent on agriculture for their day to day living. Main source of income came from the agricultural activities followed by off farm works. Some off farm sources of income are: construction, employment, remittance. Trend of youth going to abroad for work is increasing day by day leaving women, children and old aged people in the district. This has limited them to perform agricultural activities on a subsistence way just to join hand on mouth.

- **Effect of climate change in Agriculture**

Less rainfall, longer drought period, heavy rainfall, hurricanes, hailstorm and landslides are some of the major climate change effects hampering agriculture sector of an area.

- **Recommendations/ Future outlooks**

This district is highly potential for the production of mandarin orange, peach, pear, apple, citrus, ginger, chilly, off season vegetables, vegetable seeds production. As the most of the areas in the district has road access only in the dry season, commercial production of the crops in the larger scale without considering the market demand and market possibilities could create a big problem. Provision of cold storage in some of the rural potential areas where the road condition is not that good could help to hold the commodities produced for a certain period of time minimizing the

production loss. Also, establishment of some processing industries in an area helps to add the value of the product and could be stored for a longer period of the time. Livestock raising (cow, buffalo, goat, chicken) could be done in the district but priority has to be given in the fodder and forage management and strong market linkages.

Rolpa

Rolpa district covers 1885.41 km^2 of the Rapti zone in the Mid - Western region of Nepal and belong to Provience five. The Mid western region is remote and developmentally challenged. Rolpa district consist of one municipality (Rolpa Municipality), two electoral constituencies with its district headquarters (DHQs) in Liwang municipality. Liwang is connected by blacktop road Bhalubang, Dang district and from there to the East-West Highway (107km). Most of the part of Rolpa municipality in Rolpa (39 of 51) are connected with road networks. Still many rual municipality are without acess to the blacktop road are not accessible by road during the monsoon season (June-August).

Picture 6: Map of Rolpa Distrct

Table 6: Description of Rolpa District

S.N.	District	Local level organization name	Population	Area (km^2)
1	Rolpa	Rolpa Municipality	32759	270.42
2		Tribeni Rural Municipality	22957	205,39
3		Duekholi Rural Municipality	20778	163.01
4		Madi rural Municpality	17986	219.05
5		Runtigadi Rural Municipality	27929	232.69
6		Lungri Rural Municipality	23631	135.23
7		Sukidaha Rural Municipality	20009	124.38
8		Sunchahari Rural Municipality	16034	277.62
9		Subarnawoti Rural Municipality	28213	156.55
10		Thawang Rural Municipality	10881	191.07
Total			**221177**	**1885.41**

(Source: MoFALD, 20180)

Topography and soil

Rolpa's topography is primarily rugged highland and cultivable land is in short supply. Only 18 % of total area is under cultivation. As the district is a hilly district, most of the agricultural lands are sloppy and terrace. Rolpa is highly vulnerable to landslides and washing away of fertile soil hampering the agricultural productivity.

Temperature

According to latest information provided by meteoblue (www.meteoblue.com) the average maximum temperature of Rolpa district is 31ºC and average minimum temperature is 4 ºC. Due to the climate change effect and global warming the temperature of the district is increasing in the recent years.

Rainfall

According to latest information provided by meteoblue (www.meteoblue.com) the average rainfall of the district is 1612 mm annually.

Major cultivated crops in the study area

Based on the field study, Maize, wheat, Beans, Cowpea, Paddy, mustard, Lentil, vegetables are the major cultivated crops in the Rolpa district. In addition, there is collection and marketing of NTFP poducts and have good possibilitiy in livelihood enhancement of rural smallholders of Rolpa district.

All the crops grown in this area are now being affected by the climate change impact. There are severe impacts of drought by which vegetable seed production has been affecting. Coping technologies through vegetable production is important.

Livestock status of an area

Buffalo, cow, Goat and chicken are being raised in the district in a small scale. Though, there is an immense opportunity for commercial livestock rearing nobody has yet started.

Human resource

Rolpa has a total population of 224506 and most of the population is dependent on agriculture for their day to day living. Main source of income came from the agricultural activities followed by off farm works. Some off farm sources of income are: construction, employment, remittance. Trend of youth going to abroad for work is increasing day by day leaving women, children and old aged people in the district. This has limited them to perform agricultural activities on a subsistence way just to join hand on mouth.

Effect of climate change in Agriculture

Less rainfall, longer drought period, heavy rainfall, hurricanes, hailstorm and landslides are some of the major climate change effects hampering agriculture sector of an area.

Recommendations/ Future outlooks

This district is highly potential for the production of citrus plants, peach, pear, apple, large cardamom, Potato, off season vegetables, vegetable seeds production, honey bee etc. Commercial

production of the crops in the larger scale without considering the market demand and market possibilities could create a big problem. Provision of cold storage in some of the rural potential areas where the road condition is not that good could help to hold the commodities produced for a certain period of time minimizing the production loss. Also, establishment of some processing industries in an area helps to add the value of the product and could be stored for a longer period of the time. Livestock raising (cow, buffalo, goat, chicken) could be done in the district but priority has to be given in the fodder and forage management and strong market linkages. The production of the commodity has to be done on a pocket basis by the formation of farmers group after the successful production on a trial phase.

Dailekh Dailekh district covers 150051 ha of Nepal and belong to Karnali Provience. Its elevation ranges from 544 to 4168 metre above sea level. Administratively. Its District headquarters is Dailekh Bazaar (Narayan municipality). Most rural municipality's in Dailekh (53) are connected with road networks but few are accessible during monsoon season (June-August), as Surkhet-Dailekh blacktop road passess through those rural municipality's. Of suitable land, nearly 80% is being cultivated, but only 26% is irrigated.Agriculture, livestock and cottage industries are the major economic activities of the district. Agriculture is the major source of income for 93.22% of the households. Among the registered small and cottage industries, majority work in the service sector followed by the production sector.

Picture 7: Map of Dailekh District

Table 7: Description of Dailekh District

S.N.	District	Local level organization name	Population	Area (km^2)
1	Dailekh	Narayan Municipality	27037	110.63
2		Dullu Municipality	41540	156.77
3		Chamunda Bindrasaini Municipality	26149	90.6
4		Aathabis Municpality	29227	168
5		Bhagawoti Rural Municipality	18778	151.52
6		Gurans Rural Municipality	22033	164.79
7		Dungeshwor Rural Municipality	15883	105.11
8		Naumule Rural Municipality	20802	110.8
9		Mahabu Rural Municipality	19277	110.8
10		Bhairabi Rural Municipality	21233	11046
11		Thantikadh Rural Municipality	18896	88.22
Total			**260855**	**1485.57**

(Source: MoFALD, 20180)

- **Topography and soil**

This is a hilly district having variation in topography and climatic condition.

- **Temperature**

The average maximum temperature of Dailekh district is 34 ºC and average minimum temperature is 5 ºC. Due to the climate change effect and global warming the temperature of the district is increasing in the recent years.

- **Rainfall**

The average rainfall of the district is 1700 mm annually.

- **Major cultivated crops in the study area**

Based on the field study, Maize, wheat, Beans, Cowpea, Paddy, Potatos and seasonal vegetables are the major cultivated crops in the Rolpa district. In addition, there is collection and marketing of NTFP poducts and have good possibilitiy in livelihood upliftment of rural dwellers of Dailekh district.

Hoever, all the crops grown in this area are now being affected by the climate change impact. There are severe impacts of frought by which vegetable seed production has been affecting. Coping technologies through vegetable gardening is important.

Maize, wheat, Beans, Cowpea, Paddy, potato, vegetables

Horticultural crops status of an area

Mainly Dailekh district is potential for the coultivation of orange and banana. All the horticultural crops grown in this area are now being affected by the climate change impact.

- **Livestock status of an area**

Buffalo, cow, Goat and chicken are being raised in the district in a small scale. Though, there is an immense opportunity for commercial livestock rearing nobody has yet started.

- **Human resource**

Dailekh has a total population of 261770 and most of the population (more than 92%) is dependent on agriculture for their day to day living. Main source of income came from the agricultural activities followed by off farm works. Some off farm sources of income are: construction, employment, remittance. Trend of youth going to abroad for work is increasing day by day leaving women, children and old aged people in the district. This has limited them to perform agricultural activities on a subsistence way just to join hand on mouth.

- **Effect of climate change in Agriculture**

Less rainfall, longer drought period, heavy rainfall, hurricanes, hailstorm and landslides are some of the major climate change effects hampering agriculture sector of an area.

Recommendations/ Future outlooks

This district is highly potential for the production of mandarin orange, large cardamom, Potato, off season vegetables, vegetable seeds production, honey bee etc. The production of the selected commodities has to be first done on a trial basis. If succeed on a trial, then the production could be multiplied in the other areas commercially. Commercial production of the crops in the larger scale without considering the market demand and market possibilities could create a big problem. Provision of cold storage in some of the rural potential areas where the road condition is not that good could help to hold the commodities produced for a certain period of time minimizing the production loss. Also, establishment of some processing industries in an area helps to add the value of the product and could be stored for a longer period of the time. Livestock raising (cow, buffalo, goat, chicken) could be done in the district but priority has to be given in the fodder and forage management and strong market linkages. The production of the commodity has to be done on a pocket basis by the formation of farmers group after the successful production on a trial phase.

Existing cropping pattern and crop calendar

Rice-wheat -fallow and Rice-rice-wheat are the dominant cropping pattern of the Khet land whereas off-season vegetable and Maize/finger millet-fallow are the major cropping pattern in the Bari land respectively. Field assessment reveals that existing cropping pattern in the study area are due to poor technical knowledge to change beneficial products and physical factors such as soil, climate, technological factors like irrigation, unavailability of good quality of seeds, plant protection measures. Climate plays a crucial role in determining existing and adaptation of new cropping pattern. Detail of the cropping pattern existing in the study area is presented in Table 8.

Table8: Existing cropping pattern

Khet Land	**Percentage distribution**	**Bari Land**	**Percentage distribution**
Rice-Rice -Wheat	11	Maize/Upland rice-Fallow	09
Rice-Wheat-Fallow	22	Maize/Millet- Fallow	26
Rice-Wheat-Maize	15	Maize/Millet- Wheat	23
Rice-Wheat-Vegetable	01	Upland rice-Fallow-Fallow	02
Rice-Pulses-Fallow	05	Maize-Mustard-Fallow	11
Rice-Wheat- Moong	01	Maize-Upland rice-wheat	06
Rice-Potato-Fallow	03	Maize-Barley	15
Rice-Maize-Fallow	24	Vegetable-Maize	04
Rice-Fallow-Fallow	17	Off season vegetable	01
Other	01	Other	03
Total	100		100

Source: Field Survey 2018; DADO's report from ASHA project 2018

The crop calendar is very important tool that provides timely information about seed to promote local crop production. It contains all the information on planting, sowing and harvesting periodof locally adopted crops. This tool support farmers and agriculture extortionists in taking appropriate decision on crops and their sowing period, respecting local condition. However farmers from study districts don't have adaptation of cropping calendar. So that, production is not satisfactory as per their speculation and farmers are reluctant to agriculture practices. Based on information provided by the farmers and expert field visit, general cropping calendar of the study area is as below Table 9.

Table 9: General Cropping Calendar of the Study Area

Crop	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainy Season Rice					XXX	XXX	XXX	XXX	XXX	XXX	XXX	
Wheat	XXX	XXX	XXX								XXX	XXX
Potato	XXX	XXX	XXX	XXX								XXX
Vegetable												
Winter	XXX	XXX						XXX	XXX	XXX	XXX	XXX
Spring	XXX	XXX	XXX	XXX	XXX							
Rainy				XXX	XXX	XXX	XXX	XXX	XXX			
Red Lentil	XXX	XXX	XXX						XXX	XXX	XXX	XXX
Chickpea	XXX	XXX	XXX	XXX						XXX	XXX	XXX
Mustard	XXX	XXX							XXX	XXX	XXX	XXX
Groundnut					XXX	XXX	XXX	XXX	XXX	XXX		
Soybean					XXX	XXX	XXX	XXX	XXX	XXX		
Black gram							XXX	XXX	XXX	XXX		
Horse gram							XXX	XXX	XXX	XXX		
Potato	XXX								XXX	XXX	XXX	XXX
	XXX	XXX	XXX	XXX	XXX	XXX						
Fruits (Orange)					XXX	XXX	XXX	XXX	XXX	XXX	XXX	

Source: Field Survey 2018; DADO's report from ASHA project 2018

ASHA project districts analysis

Farming system in the hills go hand in hand with elevation as proxy for differences of resource availability and its use. The project area (then Mid Western development region) is divided into three parts as Terai, mid hills and hills according to its geographical condition. Every geographical areas has its own and different social and climatic diversity which has wide opened the possibility of producing different types of agricultural commodities. Villages on the bottom of the hill and near the bank of the river have relatively more irrigated flat as well as leveled terrace land usually cut into the valley side slopes. Tar is the land which is large in size and more flat having year round irrigation facilities. Relatively alluvial flat terraces having irrigation facilities during the dry season are known as khet, rice in grown in both the types. Normally they are located below 1500 masl. In such surroundings fewer livestock are seen which tend to be tethered and grazed within the vicinity of the households and farmers make compost with animal bedding and forest litter. One can see the fodder trees on the edges of the terraces, in a few cultivated holdings and also on the edges of the terraces in their courtyard. Overgrazed pastures and shrublands can be seen. Rotations in the cropping pattern which have two to three crops per year are found and there is little access to forest (intact).

Farmer perceived change in climate within a decade

The information collected on climate is based on the perception of individual farmers or key informants. Most of the respondents in the study areas perceived the change in temperature (29.5%) and change in rainfall pattern (24.6%) as the most prominent and important indicators of climate change. Similarly, the decrease in snowfall is especially felt in the high hilly areas. During FGD, farmers reported that snowfall used to occur 8-9 times to 4- 5 feet few years before but had decreased to 4-5 times to 4-5 inches these years. Similarly, thunderstroms, early flowering of forest plants like Rhododendron and tempertaure fruits such as Apple, Pear, Peach, Plum etc. were felt in mid and high hilly areas. Similarly, the drying of natural water resources, drying of ponds/lakes were felt in ASHA project districts. The increasing disease pest infestation however was felt by most of the respondents of the study area. Changing climate has also been realized by the farmers through unpredictable period of rains and increasing

Box 1: Experience of farmers of Rukum

Farmers of Rukum district felt that snowfall used to occur in the lower areas also which was now restricted to the upper areas only. Interestingly, hailstone which was uncommon during nights have been felt during nights also. Similarly, the incidence of aphids used to decrease after rainfall but not felt these years. The grey leaf spot of Maize and late/early blight of Potato have shown devastating effects. Also, the stem of Onion used to be straight but now started curving the reason after which was unanswered.

temperature. The weather has become unpredictable and crop failures have become common. During FGD, farmers discussion concluded that the change in climate led the settlement of Nanikot of Kalikot district; in the verge of shifting due to continuous drying of water resources in that area.

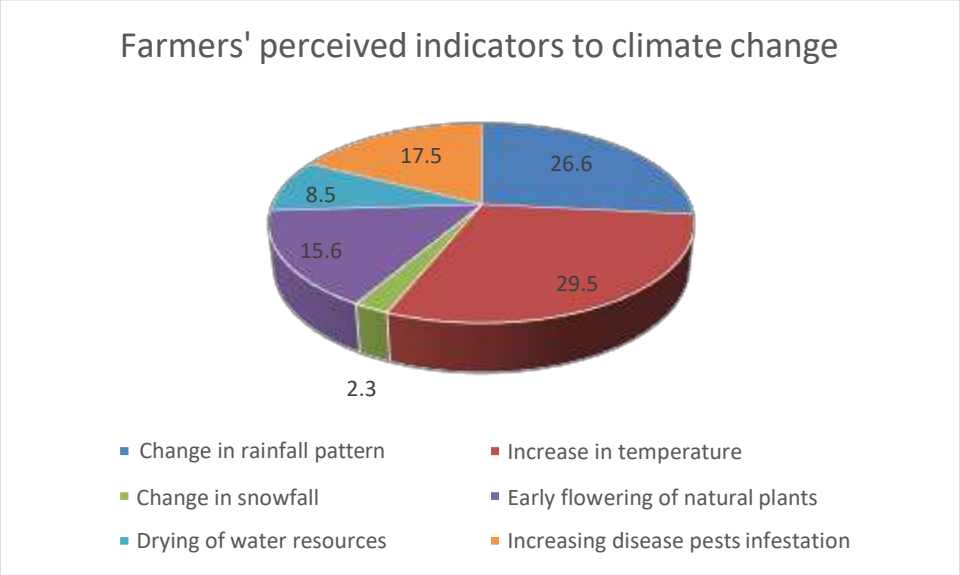

Figure 1: Farmers' perceived indicators to climate change

Change in temperature & Rainfall within last decade

Change in temperature and rainfall pattern is the most prominent indicators of climate change as perceived by farmers. Almost all the respondents (86% in high hills, 72% in mid hills) responded that they felt increase in temperature as compared to previous years. None of the respondents have reported the decrease in temperature concluding that days are getting hotter and felt more in high hills. Similarly, the increase in winter temperature was felt more than that of summer experiencing warmer winters than previous years. The high hills received higher amount of precipitation in the recent years in terms of intensity and duration of monsoon. Almost all vegetable seed producers in high hill felt increased precipitation whereas trend of rainfall was in decreasing pattern in mid hills as experienced by 81% of the respondents respectively. Also, 34%, and 94% of respondents in high hills and mid hills respectively felt the initiation of monsoon has delayed thus enforcing delayed plantation of major crops. Similarly, the intensity, duration and season of snowfall in high hills was found to be changed within the past decade. People reported that heavy snowfall used to occur in the month of December but now it is occurs in the month of February and March. Similarly, the problem of increased storm (59% in Mid Hills and 46% highhill) and drought (77% in mid hills and 73% in highhill) were felt. Similarly, most of the farmers of Jajarkot had experienced prolonged drought between the month of November to May thus hindering the production of summer crops especially Maize and other vegetables. Farmers of Dailekh has shifted from their practice of making wet seed beds of Rice to dry seed beds. Similarly, the transplantation of Rice shifted to July-August and lack of moisture in soil affected the sowing of Wheat as well.

Many farmers of Rukum reported some positive effects from climate change as well. Farmers of the Rukum district have noticed improved Apple sizes in recent years which might be due to favorable environment as well as due to improved cultivation practices. However, most of the respondents reported a number of negative effects of major concern. Over the past three years, the delay in monsoon season experienced in Nepal has changed the cropping pattern and crop maturity period. It has delayed the planting and harvesting season by a month, which has in turn affected rotation practices. The delay in monsoon season has also made thousands of hectares of farm land fallow and reduced production due to lack of water. In Gam , Rolpa, farmers were found replacing their traditional Rice cultivation with commercial Chilli cultivation basically due to irregular monsoon felt in the recent years. The increasing market of Chilli in nearby Liwang Bazzar has increased their income level as well. Flooding in the mid-western and far-western regions in last decades in in mind of farmers and reported destroyed crops in many places.

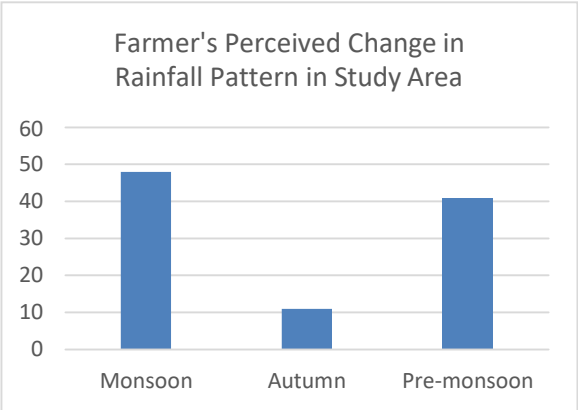

Figure 2: Farmer's perceived change in rainfall pattern in study area

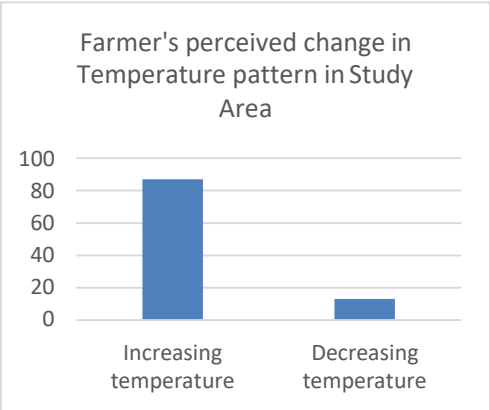

Figure 3: Farmer's perceived change in Temperature pattern in Study Area

Effects of climate change in vegetable and vegetable seed production

There was mixed response of the farmers when they were asked about the effect of climatic change on the vegetable and vegetable seed production. Very few farmers from study area reported that they felt some positive impacts due to climate changes. Farmers of Rukum (Taksera and Hukum) able to grow Chili, Tomato and Cucumber, which used to require plastic houses in order to survive. Similarly, some farmers of Dailekh reported that the shif in planting time of Lady's finger from June to August has prevented seed damage due to excessive rain.

41% of the respondents in Rukum expressed their view that cultivation of Brinjal, Chilli and cucurbits has been done successfully in Rukum these days due to favorable environment created due to changed climatic condition. The flowering and ripening of Broad leaf mustard, Cabbage, Carrot has shifted 10-15 days before. However, higher proportion of respondent experienced negative impact of changed climate. Most negative effects were felt in Kalikot and Jajarkot. Increased temperature had affected the flowering, seed setting and ripening of specially the

cucurbits and Tomato. Hybrid seeds are more sensitive to humidity and temperature. Therefore, their germination and development is directly affected by such weather conditions. Dry spell directly affects the quality of vegetable seed produced. There is higher pest incidence due to drought conditions. The increasing disease pest infestation, as indicated by 63% of respondents in Jajarkot, 21% in Rolpa and 32% in Salyan was the major negative impact. Decreased quantity and quality of seeds produced (22%) was another negative impact felt.

Ram Chand, an experienced farmer of Rolpa stated that due to increased rainfall in late monsoon the harvesting and drying of Bean seed has adversely affected. In rain fed areas, where the seed production activities depends highly in rainfall, the lack of moisture in soil and increased temperature leads to forced maturity of seeds leading to distorted shape, size and luster hence difficulty in selling for seed purpose. Decreased number of bees however was reported mainly due to excessive use of pesticides rather than climate change.

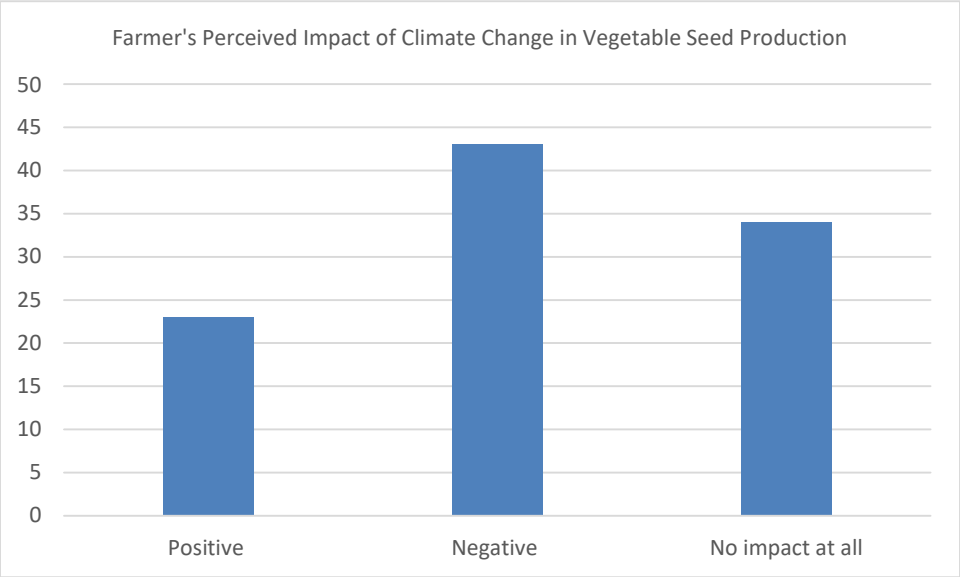

Figure 4: Farmer's Perceived Impact of Climate Change in Vegetable Seed Production

Shift in planting time

The impact of climate change as perceived by the ASHA project area farmers was the shift in planting time. Most of the respondents (61% in Dailekh, 76% in Rukum and Rolpa and 76% in Salyan and Jajarkot) felt that the planting time has pre-pond by about 15-20 days. The shift was found greater in Jajarkot (25 days) and lower in case of Dailekh (13 days). However, planting time in case of rainy season crop had shifted some days after generally due to delayed monsoon.

Change in flowering time

Change in climate as perceived by the farmers of the study area had direct affect on flowering and ripening of vegetable crops. Majority of the respondents in ASHA project area (80%) felt early flowering of vegetable crops especially the Cole crops and Radish. Similarly, flowering in Tomato, Brinjal was felt earlier in Terai region. Moreover, early flowering of Broad leaf mustard in Rukum is more prominent by 20-30days.

Change in ripening time

Change in ripening time was found in line with that of flowering time of vegetable crops. The early flowering crops had early ripening as well. Eighty nine percent of farmers study area experienced crops reaching early maturity. Farmers had their opinion that the increase in temperature leads to forced maturity of the seeds. During cold waves in Rolpa the ripening time of vegetable seeds were found delayed. Both the early and late ripening had adverse affect in seed quality. Problem in seed shape, size and luster was experienced due to early maturity.

According to DADO Kalikot and Salyan, rapid rise of temperature at the time of the pollination lead to pollen abortion in Cabbage hence no viable seed was produced. Though no cases of complete failure to seed set in any of the vegetable seed produced in the study area, the increased temperature decreased the setting of seeds especially in beans in mid Rukum and Rolpa (71%) and Tomato and Cabbage in Dailekh (54%). The production per unit area of seeds was found decreasing as responded by 74.1% of the respondents.

Intensity of disease pest

Climate change parameters: temperature, rainfall pattern and humidity have an impact on the development and distribution of pests and diseases. Increase in temperature and CO2 increases the rate of reproductive cycle of insect and pest and hence increased incidence. Results indicate that climate change could alter stages and rates of development of the pathogen, modify host resistance, and result in changes in the physiology of host-pathogen interactions. The most likely consequences are shifts in the geographical distribution of host and pathogen and altered crop losses, caused in part by changes in the efficacy of control strategies. Incidence of pest and diseases was found more severe in intensive farming area of ASHA project area. The incidence and damage caused range from medium in some crops to devastating loss in other.

The increased infestation of aphids, fruit fly and borer had directly affected the production and increased cost of production whereas the yellow mosaic virus in lady's finger and mosaic virus in Tomato has decreased the quality of the produced seed. Cabbage butterfly and Diamond back moth infestation in Cabbage, Cauliflower and Radish, neck rot in Tukinashi variety of Radish was felt increased in Mustang. Gradual shift of pest and diseases of Sarlahi have felt in hills and mountains. The infestation of aphids and powdery mildew were found increased in Salyan, Rukum and Rolpa.

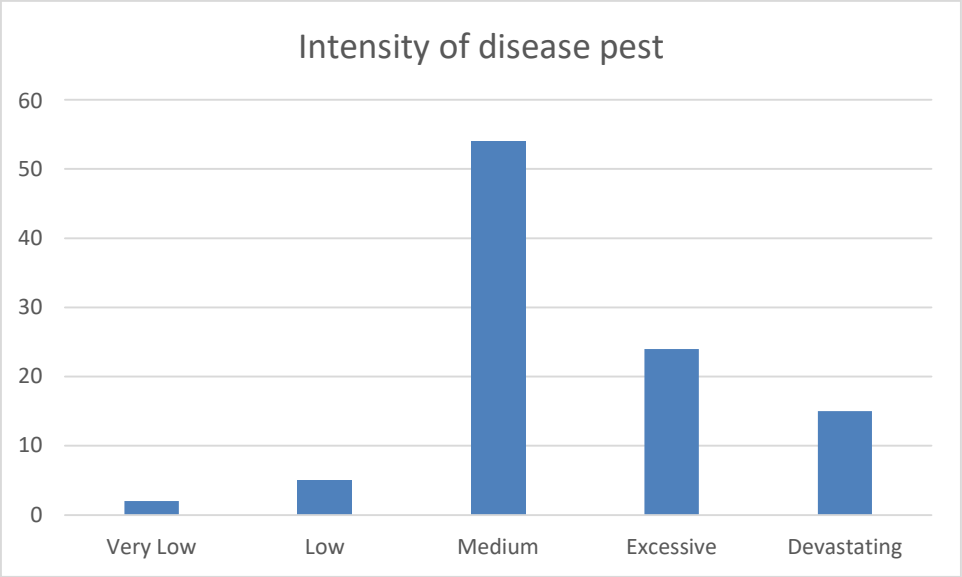

Figure 5: Farmer's Perceived Intensity of Disease and Pest

The farmers of the study area are using many pesticides (insecticides and fungicides) in the process of seed production. Among insecticides, Malathion, Endosulfan, Methyl Demeton, Dimethoate are commonly applied whereas Carbendazim and Mancozeb are commonly used fungicides. They had the view that pesticide spray was necessary, especially against diseases. According to their experience, if the crop is not sprayed before the disease incidence, it is not possible to control it later on. Interestingly, the number of sprays has increased in recent years. The least number of sprays (1-2) are required in onion seed production. Most of the farmers are applying 1-2 sprays of Malathion and Endosulfan insecticides during flowering. Few of them are also using Rogor which is systemic and highly toxic to bees and other pollinators. But the effectiveness of IPM program in ASHA has convinced farmers towards the use of safe pesticides like Nuvan. Increase use of organic pesticides, animal urine has decreased the use of chemical pesticides to some extent though the increasing infestation, relatively more effectiveness, less quantity requirement, less effort needed for preparation and easier in availability forced farmers to use these harmful pesticides.

Potential HVC and cropping calendar

Agriculture in the study areas has long been based on subsistence farming where farmers derive their living from fragmented plots of land cultivated in difficult conditions. Government programs to introduce irrigation facilities and quality seeds and other inputs have been proved inadequate and their delivery has been hampered by the mountainous terrain. Population increases and environmental degradation have ensured that the minimal gains in agricultural production. Owing more to the extension of arable land than to improvements in farming practices, have been cancelled out.

In this regards introduction of high value crops can provide much higher income than cereal crops. High value crops are particularly appropriate for smallholder farmers (0.5 ha or less), because they are labour intensive activities and it offers offer higher returns per Ha. Several studies show that households growing at least some high value crops have significantly higher net incomes than those only producing food grains.

Based on administrative records of DADOs and subjective assessments of extension workers and expert field assessment off-season vegetables production, potato and spice crops have significant contribution to livelihood improvement, income generation and poverty reduction of the local communities in study areas. A large number of potential fresh vegetables are identified for the study districts, including cauliflower, cabbage, broccoli radish, broad leaf mustard, spongeguard, cucumber, bitterguard, bottle gourd, pumpkin, tomato, garlic, pea pods and beans. Similarly, potato, onion, ginger, turmeric, groundnut, orange, lemon, soybean and horse gram is identified as a potential high value crops,

In addition, these study area are belong to high altitude areas are also ideally suited for the production of conventional and organically grown vegetables,.non timber forest based products (NTFPs) including medicinal and aromatic plants with the demand of the latter increasing as awareness of consumers in the city areas.

Potential High value crop and cropping calendar:

Based on the DADO's practice of experience, following high value crops are grown good as per the following calendar. The below table and its information is based on the practices of DADOs in the project districts and their recommendations to the farmers in practicing to their field based on the good performances. Detail list of potential high value crops with their varieties and feasibility to the ASHA project districts are presented in Table 10 respectively.

Table 10: Potential HVC and cropping calendar

Growing Period	Name	Variety	Feasibility in the Study District (High/ Medium/ Low)						
			Dailekh	Jajarkot	Kalikot	Rolpa	Western Rukum	Eastern Rukum	Salyan
August- December	Cauliflower	Snow Crown.	Low	Medium	Medium	High	High	Medium	Medium
		Snow Mistik							
		Kathmandu Local							
		Snow Queen							
		Madhuri							
		Kibo Giant							
	Cabbage	Green Coronet	Low	Medium	Medium	High	High	Medium	High
		Super Green							
		Marpha							
	Brocoli	Green Dom	Medium	Low	Low	Medium	Medium	Medium	Medium
		Green Sprouting							
		T 621							
	Radish	Mino early / Long white	Medium	Low	Medium	High	High	High	High
		Chalis Dine							
		PuythaneRato							
	Onion	Red Kriole	High	High	High	Medium	Medium	High	Medium
		Nashik 53							
	Peas	Arkel	High	High	Medium	High	High	Medium	Medium
		Sikkim							
		New line perfection							
	Potato	Cardinal	High	Low	High	Low	Medium	Medium	Medium
December- May	Sponge guard	New Narayani	Low	Low	Medium	Medium	Medium		
		Gita							
		Kantipure							

Growing Period	Name	Variety	Feasibility in the Study District (High/ Medium/ Low)						
			Dailekh	Jajarkot	Kalikot	Rolpa	Western Rukum	Eastern Rukum	Salyan
		PusaChillo							
		Kathmandu Local							
	Cucumber	Bhaktapur Local	Low	Low	Low	High	High	Medium	Medium
		Green Long							
		Malini							
		Kusule							
	Bittergourd	Pali	Low	Low	Low	High	High	Medium	Medium
		Pari							
		Green							
		Jhalari							
	Bean	Chaumase	High	High	High	Medium	Medium	High	Medium
		Trisuli							
		Jhyanje							
		Double Harvest							
		F1 324							
		Contender							
		Khumal.Tane							
	Bottlegourd	Anmol	Low	Low	Low	High	High	Medium	Medium
		Faijabadi							
		Pusa Long							
		G-2							
	Tomato	Srijana	Low	Low	Low	High	High	High	High
		Madhuri							
		Winsari							
		Manisha							

Growing Period	Name	Variety	Feasibility in the Study District (High/ Medium/ Low)						
			Dailekh	Jajarkot	Kalikot	Rolpa	Western Rukum	Eastern Rukum	Salyan
	Chilli	PusaJwala	Medium	High	High	High	High	Medium	High
		NS 1701							
		Goli							
		Suryamukhi							
	Capsicum	California Wonder	Low	Low	Low	Medium	High	Medium	Low
		Sagar							
		NS 632							
	Brinjal	Pusa Purple long	Medium	Medium	High	High	High	Medium	Medium
		NS 797							
	Pumpkin/ Squash	Asare	High	High	High	Low	High	Medium	High
		Green ball							
		Sonar 022							
		Gray							
		Black Beauty							
	Ladisfing	Parbati	Low	Low	Medium	Medium	High	Medium	Medium
		ArkaAnamika							
	Garlic	Thulolasun	High	High	High	Medium	Medium	Medium	Medium
		Sano lasun							
	Ginger	Salyane	High	High	Medium	Medium	Medium	High	Medium
		Illame							
		Kapurkote-1							
		Suruchi							
		Suravi							
		Kochin							
		Himgiri							
March-October	Ground nut	B-4 (Virginia bunch)	High	Low	Medium	Low	Medium		

Growing Period	Name	Variety	Feasibility in the Study District (High/ Medium/ Low)						
			Dailekh	Jajarkot	Kalikot	Rolpa	Western Rukum	Eastern Rukum	Salyan
		Janak (Virginia semi spreading)						Low	Low
		Jyoti or A.H.-44 (Virginia bunch)							
		Jayanti (Spanish bunch)							

Source: Field Survey 2018; DADO's annual report from ASHA project 2017

The distribution of costs and net profit of different crops is important in the business of the farmers. In this line, study team has conducted survey with different farmers in different district of ASHA project to identify the cost of production.(net profit , yield and others) . Based on analysis, potato, tomato and onion performance are seen the best.

In summary, Table 4 presented the most potential high value crops (Cabbage, Chilli, Cucumber, Ginger, Onion, Potato, Radish and Tomato) and staple crops (wheat and rice) suggests that high value crops are most potential than grain crops. The recommendation of cropping pattern and crop verities was based on expert analysis, microclimate according to altitude, existing cropping pattern and potential, availability of water resources, labor and access to the market.

From the study, it is also conclude that vegetables appear to be more labor intensive than grain crops. This is largely because they require much higher levels of individualized care, weeding. Watering, pollination and harvest. Although, vegetables are more input-intensive than cereals grains, they result in higher returns. Thus, in the study area cultivation of high value crops would be an excellent way to absorb the migration towards India and produce higher returns.

Different Coping Strategy adopted by farmers

2.8.1 Adaptation and coping strategy

Adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation (UNFCC, 2009). However, at the study sites, there are some local coping and adaptation strategies adopted by farming communities in response to potential/observed risks and hazards related to climatic and non-climatic factors. From the perspective of poverty reduction, adaptation is already necessary as people's lives and livelihoods face an increasing burden of broader shocks and stresses. Communities have been using traditional methods of adaptation for generations based on local knowledge and innovations. There is a need of investigation regarding the existence of local knowledge and livelihood assessments enabling the villages to cope with climate change. It further examines how local knowledge and innovations are important in designing research and for development interventions targeted among the vulnerable communities.

Picture 8: Farmers of Rolpa practicing local method for maintaining moisture in soil

Farmers have tradition of worshipping the nature as god and loving the land as mother. They play with nature and try to adjust with it rather than going against it. Farmers are innovators as well. Traditional farming system management practices and farmers' innovations are clearly a key element in local adaptation to climate change. According to Reid and Swiderska, 2008, while scientists and policymakers worked to find out solutions, local farmers have already amassed considerable experience of coping, based on their observation and experimentation in the field. Searching and exchanging drought-resistant seeds and other abiotic stress-tolerant crop varieties and adopting and practicing specific soil and water management practices for marginal areas have long been core activities of the farming communities. Farmers are already adapting to changing conditions by using traditional seed exchange practices that are part of established seed systems. Farmers can also use their knowledge of abiotic stress tolerance and adaptability in their materials and work with plant breeders to develop varieties that are adapted to changing local conditions and possess improved yields and quality (Jarvis et al, 2007).

Picture 9: Vegetable seed production practiced underplastic tunnel

A higher risk of food insecurity during abnormal rainfall years in the ASHA project area has also been noted due, perhaps, to vulnerability of modern varieties. Through farming practices farmers are able to keep traditional varieties adapted to changing growing conditions and social preferences. Farmers of Dailekh reported the shift in planting time of vegetables in accordance with the change in climate. The winter season crops has shifted some days before and the rainy season crops were found shifted some days after.Construction of rain water harvesting tank and demand for drought tolerant varieties were increasing. Similarly, minimum tillage of soil to resume soil moisture and use of mulching materials were also found practiced by the farmers. Staking of the plants to prevent from winds and storms was also practiced by farmers. Provide irrigation was a common practice adopted to prevent from water stress to plants. Drip irrigation and sprinkler irrigation were practiced. Use of plastic bags for germination of cucurbits seeds was an effective method for producing seedlings. Similarly, the uses of plastic tunnels help in maintaining temperature and prevent crop from hailstones and heavy rainfall. In some areas of Dailekh, farmers started to use riverbanks for vegetable cultivation. This riverbank used to be cultivated land before. Due to riverbank erosion and change in river routes, the land was converted into sand fields. Farmers learned to cultivate this type of land to grow tomato, bitter gourd, watermelon, sweet potato, sponge gourd, bottle gourd, and pumpkin.

Chapter Three: Overview of the farming system in ASHA project sites

Farming system in the hills go hand in hand with elevation as proxy for differences of resource availability and its use. Former Mid Western development region is divided into three parts as Terai, mid hills and hills according to its geographical condition. Every geographical areas has its own and different social and climatic diversity which has wide opened the possibility of producing different types of agricultural commodities. Villages on the bottom of the hill and near the bank of the river have relatively more irrigated flat as well as leveled terrace land usually cut into the valley side slopes. Tar is the land which is large in size and more flat having year round irrigation facilities. Relatively alluvial flat terraces having irrigation facilities during the dry season are known as khet, rice in grown in both the types. Normally they are located below 1500 masl. In such surroundings fewer livestock are seen which tend to be tethered and grazed within the vicinity of the households and farmers make compost with animal bedding and forest litter. One can see the fodder trees on the edges of the terraces, in a few cultivated holdings and also on the edges of the terraces in their courtyard. Overgrazed pastures and shrublands can be seen. Rotations in the cropping pattern which have two to three crops per year are found and there is little access to forest.

In the high elevations villages have few irrigated lands known as ' Khet", but more widely dispersed rain fed terraces, known as "Bari". The "Bari" terraces, in most of the instances, are outward sloping not properly leveled and relatively more sloppy rain fed terraces suitable only for maize and millet. Every year farmers grow two crops of maize, millet, barley, wheat, and a variety of other crops on rain fed Bari below 2300 m. In a very small scale, wheat can be seen in a few Baris. However, wheat even in the "Khet" is found only in a few instances, because wheat farming in the Hills is relatively a recent phenomenon. There is a fourth type of agricultural sloppy land (30' to 35' slopes) known as "Pakho" sometimes "Pokho-Bari" which is suitable only for maize. Farmers usually plant one crop of potatoes or barley buckwheat in the fields above 2300 m because of the cooler climate, steeper slope, stonier soils. Here, as compared to lower elevation, agriculture is more marginal. Here terraces are often scattered, fragmented, having more parcels and are located at a distance of three or more hours of walking from the farmer's house. Area (surroundings) located above 2500 m is known as "Lekh", as it is covered by monsoon cloud and has broad leaf evergreen forest. Higher villages have a larger number of livestock and used to keep their livestock on harvested fields for several weeks prior to planting of the new crops, which provide ample of nutrient supplement for the crops being cultivated. Forest in the area provides firewood, forage and fodder, bedding materials for the animals etc and is supporting the agricultural system of an area. Also, forest in the hilly area produces different medicinal and aromatic plants, herbs which could be utilized to establish industry in an area that could enhance the income generation and improve the livelihood status of an area.

Factors determining farming systems

Farming system is a unique and reasonably stable arrangement of farming enterprises that a household manages according to well defined practices in response to the physical, biological and socio-economic environment and in accordance with the household goals preferences and resources. These factors combine to influence the output and production methods. More commonalities will be found within system than between systems.

The determinants of farming system can be grouped into the natural and the socio-economic factors. The natural factors are comprised of the physical and the biological factors. Physical factors include external conditions and influences affecting the life and development of an organism whereas socio-economic factors include endogenous and exogenous. Major factors determing farming system of ASHA project district are:

- Natural resources and climate
- Science and technology
- Trade liberization and market linkages
- Policies, institution and public goods
- Information and human capital
- Indigenous technological knowledge
- Soil and climatic feature of the selected areas
- Availability of the resources, land, labor and capital
- Present level of utilization of resources
- Economics of proposed farming system
- Managerial skill of a farmer

Constraints and challenges

Low productivity

The agricultural inputs are the major role player in productivity of a certain commodity. A right input on a right time at a right amount could boost the production. Nepalese agriculture is dependent on monsoon. A longer drought period could reduce the production drastically. Low use of fertilizers, lack of appropriate production technologies and agricultural extension services are other causes hindering the production.

Inadequate infrastructure

Rural agricultural infrastructure, especially road connectivity is a key factor in raising agricultural production. All of the project districts fall in hilly and mountainous regions. Lack of physical access hampered the delivery of agricultural inputs on a regular basis, creates difficulties in the supply of commodities produced increasing the production loss, thereby deepening poverty level.

Commercialization of agriculture

As majority of the population in the project districts are engaged in agriculture their economy is largely remittance driven. Agriculture in an area is being done on a subsistence basis. Though, in

some areas people are more interested to continue their agriculture as a business for which regular technical support, financial support and materials subsidies has to be given.

Climate change impacts and its adaptations

In the recent years, several changes have been observed in the climatic condition in Nepal. The monsoon rainfall has been increasingly erratic, increased landslides in the hilly and mountainous districts, increase in the temperature, drought for a longer period, hailstorm etc have several impact on agricultural production and food security in the project districts.

Human resource scarce

Vast majority of Nepalese youths migrating to foreign countries in search of better jobs and livelihoods has left the communities with old aged, womens and children and created the labors scarcity.

Farming system

Farming system is a set of agri economic activities that are interrelated and interact with themselves in a particular agrarian setting. It is a mix of farm enterprises to which farm families allocate its resources in order to efficiently utilize the existing enterprises for increasing the productivity and profitability from the farm. Farming system is a mix of farm enterprises such as crop, livestock, aquaculture, agroforestry and fruit crops to which farm family allocate its resources in order to efficiently manage the existing environment. (Pandey et al 1992).

Farming systems suitable for ASHA project districts

Organic farming system

Organic agriculture is a holistic production management system that avoids the use of synthetic fertilizer, pesticides and genetically modified organisms. It minimizes nitrogen pollution, conserves soil and water, and optimizes the health and productivity of interdependent communities of plants, animals and people. Organic agriculture farmers need to implement a series of practices that optimize nutrient and energy flows and minimize risk. These include: crop rotations and enhanced crop diversity; different combinations of livestock and plants; symbiotic nitrogen fixation with legumes; application of organic manure; and biological pest control, such as 'push-pull'. All these strategies seek to make the best use of local resources.

Organic agriculture with its emphasis on closed nutrient cycles, biodiversity, and effective soil management has the potential to be more conducive to food security as well as sustainable in study area than most conventional production systems and has the capacity to mitigate and even reverse the effects of climate change.

All of six project district, majority of area is located in the hilly regions which has not been yet depleted by the excessive use of the chemicals and pesticides. The areas in these hilly districts are by default organic. And, in the current world scenario, organic products are getting good attention and values in the market. Same is the case in Nepal. People are more aware and conscious about their health and have understood the impact of pesticides used agricultural commodities. The

project districts thus could be developed as an organic commodity production hub. If we could produce agricultural commodities organically, it will have a great chance of exporting to the foreign countries.

Advantage of Organic Agriculture

Better for health: By providing safe and nutritious food and income-generating opportunities for rural communities it can contribute to combating escalating rates of non- communicable diseases and to improving food security.

Better for the environment: The use of environmentally friendly farming methods can contribute to addressing the environmental challenges of adapting to climate change, maintaining biodiversity, conserving soil and water and managing waste.

Better for the economy: The global market for organic produce is growing rapidly with international retail sales. It represents an opportunity for the ASHA proejctc region to capitalize on its traditional agricultural practices and its image of clean, green to boost livelihoods, incomes, exports and foreign exchange earnings, and reduce rural-urban migration.

Rural livelihoods, niche markets and rural-urban migration: Organic agriculture, underpinned by the principles of social justice, can provide income generation and employment opportunities for rural farmers and access to external niche markets.

Permaculture Farming system

Permaculture is a farming technology more or less similar to the organic farming. It is a permanent agriculture practices practiced without deteriorating the resources. This farming system includes the optimum use of the resources available locally. It encourage working with nature not against or in competition to them and learning from them. ASHA can promote permaculture practices through establishing permaculture farms as the learning center and promote relevant practices using participatory action researches.

Integrated farming system

Integrated farming system refers to the agricultural system that integrates livestock and crop production. Integrated farming system has revolutionized conventional farming of livestock, aquaculture, horticulture, agro industries and allied activities. The major objective of the integrated farming system is to integrated different production system like dairy, poultry, livestock, fishery, horticulture, sericulture, apiculture etc with agricultural crops production as a base. A combination of one or more enterprises with cropping, when carefully choosen, planned and executed gives greater dividends than single enterprises especially for small and marginal farmers. The project sites consists of the farmers who are poor and marginal and couldn't risk on one single business, this farming system seems perfect. Crop- Livestock farming system, crop-Livestock-Fishery farming system, Crop-poultry-fishery-mushroom farming system, Crop-fishery-duckery farming system, Crops-Livestock-fishery-Vermicomposting farming system, Crop-Livestock-Forestry

farming system, Agri- Silvi-Apiary farming system, Agri-Horti-Silvi-Pastoral farming system are some example of integrated farming system.

Commercial farming system

Farms that are operated with a goal of producing more than the owners need for personnel use. This excess in outputs is sold for profit. In commercial farming, single commodity in a large area or multiple commodities in a large area could be cultivated. The project sites has so many such commodities which could be grown commercially. For example; apple, mandarin orange, citrus, vegetables, vegetable seeds etc.

Terrace Cultivation farming system

All of the project districts consists of majority of hilly areas where the land aspects is sloppy. The hills and mountains are cut to form terraces and the land is used in the same way as in permanent agriculture. With this cultivation technology, barren/marginal land could be utilized by planting with fruits trees and other timber trees. Since the availability of flat land is limited terraces are made to provide small patch of level land. Also, terrace forming will help to check soil erosion. It has been realised that, the maximum soil loss during summer is from the poorly managed terraces. The ASHA project can invest its large effects to educate people in terrace improvement and management with incorporation of following practices;.

- ***Intercropping***

Intercropping is an effective weed control technique. It involves growing legumes as cover crops. The legumes act by: restricting the access of weeds to light, suppressing the weeds (e.g. striga), and disposing of trap roots (e.g. of striga). The legumes dispose of trap roots, stimulating for examples striga seeds to germinate. However, unlike cereal crops, striga cannot attach its roots to the roots of the legumes. The germinated striga seeds die. Other examples of trap crops that can be grown as intercrops are: tobacco, sesame and cotton. General tips to intercrop legumes with cereals are as follows:

  - Grow separate rows of legumes and cereals with close spacing, e.g. one row with sorghum followed by two rows of soybean.
  - Apply organic and mineral fertilizer on the soil.
  - Apply compost to the soil

- ***Alley cropping***

Alley cropping is the cultivation of food, forage or specialty crops between rows of trees. It is a larger version of intercropping or companion planting conducted over a longer time scale. Alley cropping can provide profitable opportunities for row crop farmers, hardwood timber growers.

- ***Contour strip cropping***

Contour strip-cropping is the planting alternative strips (15 - 45 m wide) of grasses or grain with other crops along a contour on gentle slopes to conserve moisture and reduce erosion.

- ***Crop rotation***

Crop rotation is the repetitive planting of a sequence of crops in the same field following a defined order in a year or years of cropping. The practiceis necessary in order to avoid the built-up of pests, weeds or diseases, and chemicals, and to ensure that root systems explore the soil to different depths.

The main practices involve planting cereals (high feeders) first, followed by legumes (nitrogen-fixing) and finally plant root crops (cover crops). Examples of crops used in a crop rotation system include planting maize first, then beans (intercrops and pure stands), and finally potatoes.

Crop rotation as a means to control to insect pests is most effective when the pests are present before the crop is planted have no wide range of host crops; attack only annual/biennial crops; and do not have the ability to fly from one field to another. For examples: Rice-Vegetable- Legume; Rice-Legume-Vegetable; Leguminous vegetable-Wheat-Vegetable

Benefit of crop rotation:

- Prevents soil depletion
- Reduce soil erosion
- Controls insect/mites pests
- Help control weeds
- Maintain soil fertility
- Reduces reliance on synthetic chemicals
- Reduces the pests build-up
- Prevent diseases

- ***Improved crop varieties***

Improved crop varieties are crops that have been researched on, bred and tested to have special qualities e.g. of fast-maturing, dry spell tolerant, high-yielding, high quality, and pest and disease tolerant. Some particular crops can also withstand the effects of climate change and increase organic carbon or residues that can be managed to store carbon in the soil for a long period of time.

High-yielding crops also provide more biomass or residues can be returned back to the soil. However, certain improved crop varieties need to be used with caution; not all are suitable for all climates and soils.

Integrated farming system

An integrated livestock system usually consists of different mixed components, for example, livestock with crops, or livestock with bees and crops, or livestock with crops and fish. These components work together in a natural cycle to maximise resource use. The products or by-products of one component (e.g. manure from livestock) are used as a resource for another component (e.g. crops).

Several components: land or soil, water, crops/vegetation, feeds, livestock, manure and waste are considered to achieve efficient livestock production.

• **Example 1:** Integrating bees with crops and livestock	Bees cross-pollinate crops, increasing yields naturally. Bees also provide many useful products such as medicine (propolis), honey, and wax, which can be processed and sold for extra income.
• **Example 2:** Integrating fish with crops and livestock	Fish ponds can be used to irrigate vegetables. The by-products of the vegetables can be used as livestock food (suitable for a variety of animals including pigs, goats and rabbits, and the fish). The livestock provide manure.

Benefits of integrated livestock management

- Increased livestock productivity.
- Sustainable intensification.
- Reduced GHG emissions and pollution.
- Adaptation to climate risks and hazards.
- Resources are used efficiently (land, water, soil).
- No land use change as a result of land expansion
- Reduced land degradation.
- Restoration and rehabilitation of degraded or eroded land.

- Reduced cases of pests and diseases.
- Conservation of biodiversity

Integrated Pest Management farming system

Integrated pest management (IPM) farming system is to focus plant protection measures integrating different practices in pest management. Participatory action researches on different combinations against the particular pests can be tested. IPM can be define as the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms

Conservation farming system

Conservation Agriculture (CA) is a farming system that conserves, improves and makes more efficient use of natural resources through integrated management of soil, water and biological resources. It is a way to combine profitable agricultural production with environmental concerns and sustainability. The three fundamental principles behind the CA concept are: minimum soil disturbance, permanent soil cover, and crop rotation. Each of the principles can serve as an entry point to the technology; however, only the simultaneous application of all there results in full benefits. CA covers a wide range of agricultural practices based on no-till (also known as zero tillage) or reduced tillage (minimum tillage). These require direct drilling of crop seeds into cover crops or mulch. Weeds are suppressed by mulch and / or cover crops and need to be further controlled either through herbicide application or pulling by hand.

CA has been proven to work in a variety of agro-ecological zones and farming systems: high or low rainfall areas; in degraded soils; multiple cropping systems; and in systems with labour shortages or low external-input agriculture. CA has good potential for spread in dry environments due to its water saving ability, through the major challenge here is to grow sufficient vegetation to provide soil cover.

Principles and types of CA

- *Minimal soil disturbance*

The main principle of conservation agriculture is minimal soil disturbance through reduced or no tillage. This favours soil life, and build up of soil organic matter (less exposure to oxygen and thus less soil organic matter mineralization). Compared to conventional tillage, CA increases the organic matter content of soils, increasing their porosity and hence improving their ability to absorb and retain water and this has two positive effects: first, there is more water to support crop growth and the biological activity that is so important for productivity, and second, less water accumulates and thus doesn't flow across the surface, causing floods and erosion.

Seeding is done directly through the mulch (usually residues of previous crops), or cover crop (specially grown legumes). Although small-scale farmers can apply CA using a standard hoe or

planting stick to open planting holes, appropriate machinery such as direct seed drills (large- or small-scale motorised or animal drawn) or jab-planters (hand tools) are normally required to penetrate the soil cover and to place the seed in a slot. Prior sub-soiling is often required to break-up existing hard pans resulting from ploughing or hoeing to a constant depth. Compacted soils may require initial ripping and sub-soiling to loosen the soil.

- *Permanent soil cover*

Permanent soil cover with cover crops or mulch has multiple positive effects: increased availability of organic matter for incorporation by soil fauna, protection from raindrop splash, reduced soil crusting and surface evaporation, better micro-climate for plant germination and growth, reduced run- off and soil erosion, and suppression of weeds. In the initial years of CA, a large weed seed population requires management through use of herbicides or hand weeding to reduce the seed bank. Use of herbicides and weeding then falls to a minimum level after a few years, as the number of seeds is reduced and their growth hindered by crop cover.

- *Crop rotation*

In order to reduce the risk of pests, diseases and weed infestation a system of rotational cropping is beneficial. Typical system of rotation cereals followed by legumes and cover / fodder crops. However, for small-scale farmers it is often difficult to become accustomed to growing crops in rotation, when this goes against tradition and dietary preference. One solution is intercropping which allows permanent cover and also replenishment of nutrients when nitrogen-fixing legumes are include in the mixture.

For successful adaptation in ASHA project districts, CA needs to evolve to suit the biophysical and socio-economic conditions, in other words there need to be trade-offs. This implies being flexible regarding soil cover and crop rotation, and emphasizing the role of water harvesting in dry regions.

Benefits of CA

CA is considered a major component of a 'new green revolution' in ASHA project district which will help to make intensive farming sustainable through increased crop yields / yield reliability and reduced labour requirements; will cut fossil fuel needs through reduced machine use; will decrease agrochemical contamination of the environment through reduced reliance on mineral fertilizers; and will reduce greenhouse gas emssions, minimise run-off and soil erosion, and improve fresh water supplies. CA can thus increase food security; reduce off-site damage; reduce foreign exchange required to purchase fuel and agrochemicals; and create employment by producing CA equipment locally. The potential to mitigate and to adapt to climate change is high.

Climate smart farming practices

Climate-smart agriculture (CSA) approach is for transforming and reorienting agricultural development under the new realities of climate change. The CSA helps in agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development

goals. CSA is important for the following purpose.

- **CSA maintains ecosystems services:** Ecosystems provide farmers with essential services, including clean air, water, food and materials. It is imperative that CSA interventions do not contribute to their degradation. Thus, CSA adopts a landscape approach that builds upon the principles of sustainable agriculture but goes beyond the narrow sectoral approaches that result in uncoordinated and competing land uses, to integrated planning and management.

- **CSA has multiple entry points at different levels:** CSA should not be perceived as a set of practices and technologies. It has multiple entry points, ranging from the development of technologies and practices to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains and the strengthening of institutional and political enabling environments. As such, it goes beyond single technologies at the farm level and includes the integration of multiple interventions at the food system, landscape, value chain or policy level.

- **CSA is context specific:** What is climate-smart in one-place may not be climate-smart in another, and no interventions are climate-smart everywhere or every time. Interventions must take into account how different elements interact at the landscape level, within or among ecosystems and as a part of different institutional arrangements and political realities. The fact that CSA often strives to reach multiple objectives at the system level makes it particularly difficult to transfer experiences from one context to another.

- **CSA engages women and marginalised groups:** To achieve food security goals and enhance resilience, CSA approaches must involve the poorest and most vulnerable groups. These groups often live on marginal lands which are most vulnerable to climate events like drought and floods. They are, thus, most likely to be affected by climate change. Gender is another central aspect of CSA. Women typically have less access and legal right to the land which they farm, or to other productive and economic resources which could help build their adaptive capacity to cope with events like droughts and floods. CSA strives to involve all local, regional and national stakeholders in decision-making. Only by doing so, is it possible to identify the most appropriate interventions and form the partnerships and alliances needed to enable sustainable development.

Impact of climate change on agricultural lands and agri eco zones

Changes in cropping pattern/ crop suitability

Changes in agri-zones lead to the change in cropping pattern of the zone. Climatic parameters have potential impact to change the ecological distribution of agricultural crops. If shifting of climatic zones occurred rapidly due to climate change, extinction of biodiversity might be severe. Effects are mainly on cold-water fish, herbs, pasturelands, tree lines (apple trees) and livestock (Chauri). Increase in temperature cause more damage on agricultural sectors in Terai region and will be more favorable to agriculture in the hills and mountains. As temperature increases, cropping pattern as well as vector born disease of human and livestock's can be expected to shift in higher eco zones too. Some lands, which are presently undesirable due to different weather factors, may be desirable in near future. For example: maize, chilly, tomato and cucumber are now being adopted in mountainous district of the country.

Soil fertility and water availability

Increase in temperature may lead to reduce the level of soil organic carbon, micronutrients and enhance decomposition by activating the microbial population in the soil. Variability in climate and weather is major reason for change in moisture availability in the soil. The rapid evapo-transpiration due to increase in temperature, will demand more water to reduce drought. Water availability governs the physiological active period and crop production. Probable vulnerabilities due to increase in atmospheric temperature are decrease in water table, increase in evapotranspiration, soil erosion, landslides, floods, inundation of standing crops and reduction of soil fertility.

Pests and diseases emergence

Climate change parameters: temperature, rainfall pattern and humidity have an impact on the development and distribution of pests and diseases. Increase in temperature and CO_2 will lead to an increase in population of pests and severity of diseases in presence of host plant. It increases the rate of reproductive cycle of insect and pest. The increase in insect population leads to demand for more use of pesticide, which unknowingly causes lots of harm to ecosystem as well as human society. Incidence of pest and diseases would be most severe in tropical region due to climate

change. Pest and disease of plain ecosystem may gradually shift to hills and mountains and hampers the production.

Coping with climate change

- Improvement of heat, drought and pest resistant crops
- Improvement in resources for irrigation efficiencies: drip and sprinkler irrigation
- Research in water and nutrient management in various agro-ecologies to meet the climate change
- Research in green manuring crops, cover crops, to preserve soil moisture, soil organic matter and micronutrients
- Research on climate prediction related models and their application
- Research works on new technologies towards low carbon economy
- Research on land use planning, watershed management, vulnerability assessment and resource management.
- Research on yield gap analysis to analyze the factors responsible to climate change

Chapter Four: Strategies and Recommendations for ASHA project districts

Strategies for sustainable agriculture production

- Promote seminar, workshops, training and general education to rural population dependent on agriculture
- Identification of present issues of climate change related to agricultural sectors
- Strengthen Agricultural Research Station and commodity program to run effective researches related to climate change
- Interactive communication for transfer technologies to farmers about climate change and its impacts on agriculture
- Preservation of genetic materials to reduce extinction of biodiversity
- Crop insurances for social securities and food securities
- Change in national policies towards farmers incentives such as subsidy in agricultural inputs and agricultural investment

Strategies for Climate change resilient

- Building Climate Resilience of Watersheds in Mountain Eco-Regions. Addresses the problem of too little or unreliable access to freshwater resources by communities in mountain eco-systems of Kalikot and Rukum for drinking, irrigation, and other uses.
- Building Resilience to Climate-Related Hazards. Addresses the priority risk of floods and droughts that take human lives and undermine progress on economic growth and poverty alleviation.
- Mainstreaming Climate Change Risk Management in Development. Facilitates the integration

of climate change risk management into development planning and practices.

- Building Climate Resilient Communities through Private Sector Participation. Addresses some of the key agricultural productivity constraints including
    - Climate-induced stress conditions
    - Access to finance for agri supply chain including farmers
    - Climate proofing of some vulnerable infrastructure such as the hydropower sector
    - Explores private sector opportunities and challenges in climate resilient housing for vulnerable communities.
- Enhancing Climate Resilience of Endangered Species. Addresses the risks of climate variability and change on the habitats of endangered wildlife species.

Recommendations

ASHA project area has always been considered close to nature because of its unique location and huge bio diversity. More than 75% of total population from ASHA project district is actively engaged in agriculture and agriculture depends on situation of weather to a greater extent. A slight change in climatic condition might have higher impact in production and hence to economic condition of the country as a whole. Impact of climate change on farming system and overall agriculture production is a burning issue which affects food security, employment and livelihoods. The condition of ASHA project districts is even more vulnerable with problems like: insufficient investment, weak infrastructure, inefficient irrigation, low productivity, fragile geology, lack of trained manpower weak policy etc. Thus, to minimize such vulnerabilities in farming system; water, seed and soil management should be implemented with focus on sustainable production and livelihood by applying following recommendations and climate smart farming practices.

- Develop mechanism to assess the effects of climate change on farming system to identify the vulnerable pocket in ASHA project area.
- Enhance adaptive capacity of climate change to increase a mechanism for agricultural production.
- Enhance climate smart cropping system to reduce GHG emissions for mitigating climate change.
- Initiate activities related to climate modelling on the farming system in all eco-zone assessing climate effects.
- Develop cooperation and coordination with neighboring country to cope with vulnerabilities.
- Develop climate-forecasting system and aware farmers well in advance for reducing climate hazards.
- Develop irrigation infrastructure for reducing drought hazards and promote rainwater harvest and micro irrigation systems in ASHA districts.

- Enhance locality specific research activities so as to develop crop varieties suitable to heat resistant, drought resistant, insect pest resistant, submerged varieties.
- Identify safe agrochemicals like organic or bio-pesticides to reduce human/ animal health hazards.
- Increase mechanism of IPM (Integrated Pest Management) to minimize pest and disease damage in agriculture production.
- Develop quality seeds and planting materials in all agro-ecological regions to improve the productivity of Agriculture and Forest based products. ¬
- Communicate with farmers' intensively in all eco- regions regarding impact of climate change on overall production and its importance on improving people livelihoods.
- Encourage farmers to adopt climate resilient practices like water smart practice, nutrient smart practice etc. to improve soil health.
- Develop crop insurance schemes in all eco zones to enhance farmers' interest on the agriculture production.
- Initiate plans for medium-term adaptation measures like policy development also the longterm adaptation measures like strengthening of research institutions

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Annexs

Annex 1: List of farmers group visited

S.N.	Name of Farmers groups	District	Location
1	Himali Bakhra Palan Samuha	Kalikot	Rashkot Municipality
2	Pragatishil Bakhra Palan Samuha	Kalikot	Rashkot Municipality
3	Shree Pragatishil Tarkari Kheti Krishak Samuha	Jajarkot	Bheri Municipality
4	Namuna Krishak samuha	Jajarkot	Bheri Municipality
5	Bheri Samudayik Sanstha	Jajarkot	Bheri Municipality
6	Dafla Bakhrapalan tatha tarkari kheti LAPA samuha	Rolpa	Tribeni Rural Municipality
7	Khugrobot Bakhrapalan LAPA Samuha	Rolpa	Tribeni Rural Municipality
8	Munal Sudhariyeko Chulo	Salyan	Tribeni Rural Municipality
9	Chringe Sinchai Kulo Star Unnati	Salyan	Tribeni Rural Municipality
10	Deuti Bajjai Krishi tatha pashupalan Samuha	Dailekh	Bhagawatimai Rural Municipality
11	Shikhardwari Krishi Tatha Pashupalan Samuha	Dailekh	Bhagawatimai Rural Municipality
12	Magarranja Sudhariyeko Matoko Chulo Samuha	Rukum	Sanibheri Rural Municipality

Annex 2: Name of the Key Informant Interviewrs (KIIs)

S.N.	Name of KIIs	District	Location
1	Laxmi Bogati	Kalikot	Rashkot Municipality
2	Raspura Rokaya	Kalikot	Rashkot Municipality
3	Rati Nepali	Jajarkot	Bheri Municipality
4	Dal Bdr. Khatri	Jajarkot	Bheri Municipality
5	Jaya Bdr. Shahi	Jajarkot	Bheri Municipality
6	Laxmi Buda Magar	Rolpa	Tribeni Rural Municipality
7	Chandra Singh	Rolpa	Tribeni Rural Municipality
8	Krishna Bdr. Khadka	Salyan	Tribeni Rural Municipality
9	Khemraj regmi	Salyan	Tribeni Rural Municipality
10	Pushpa Thapa	Dailekh	Bhagawatimai Rural Municipality
11	Nagendra Buda	Dailekh	Bhagawatimai Rural Municipality
12	Amrita Kunwar	Rukum	Sanibheri Rural Municipality