Climate Change, Agriculture, & Food Security in Nepal

Developing Adaptation Strategies and Cultivating Resilience

Report prepared for Mercy Corps Nepal

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Terms

Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.[i]

Adaptive Capacity – The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.[ii]

Climate Change – Refers to any change in climate over time, whether due to natural variability or as a result of human activity.[iii]

Climate Variability - Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also climate change.[iv]

Coping Capacity – The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. (In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards.)[v]

Disaster –- Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.[vi]

Extreme weather event – An event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called "extreme weather" may vary from place to place. An "extreme climate event" is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season).[vii]

Maladaptation – Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead.[viii]

National adaptation programs of action (NAPAs) – Documents prepared by least developed countries (LDCs) identifying urgent and immediate activities useful for coping with climate change. The NAPAs are then presented to the international donor community for support.[ix]

Resilience – The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.[x]

The IPCC distinguishes several types of adaptation:[xi]

Anticipatory Adaptation—Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.

Autonomous Adaptation—Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.

Planned Adaptation—Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Private Adaptation—Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.

Public Adaptation—Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs.

Reactive Adaptation—Adaptation that takes place after impacts of climate change have been observed.

Vulnerability – The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.[xii]

Acronyms

AIDFI	Alternative Indigenous Development Foundation, Inc.
CCAFS	Climate Change, Agriculture, and Food Security
CCVI	Climate Change Vulnerability Index
CGIAR	Consultative Group on International Agricultural Research
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization
GLOF	Glacial Lake Outburst Flood
HARITA	Horn of Africa Risk Transfer for Adaptation
ICIMOD	International Center for Integrated Mountain Development
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
IWMI	International Water Management Institute
LDC	Least Developed Country
NAFSCOL	Nepal Agroforestry Seed Cooperative Ltd
NAPA	National Adaptation Programs of Action
NARC	Nepal Agricultural Research Council
R4	Rural Resilience Initiative (Risk reduction, Risk transfer, prudent risk taking, and risk reserves)
SNV	Netherlands Development Organization
SOFI	State of Food Insecurity
UMN	United Mission to Nepal
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VDC	Village Development Committee

Executive Summary

Changes in temperature, precipitation, and the frequency with which extreme weather events occur are just a few of the many manifestations of Climate Change. Although predictions regarding the impact of climate change on specific ecosystems and population groups are imprecise, it is unquestionable that variations in weather patterns will have negative implications for agriculture and food security.

Nepal will be particularly hard by climate change.[xiii] Atmospheric temperature in Nepal is rising at a rate higher than the global average, with a 1.8°C increase between 1975 and 2006, while precipitation has become increasingly unpredictable. Furthermore, threats to biodiversity, deforestation, and increased frequency of extreme weather events have affected 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 Nepalese farmers, have limited the coping ability of the rural poor and increased the percentage of those who are food insecure.

Climate change will affect people of different genders, ethnicities, caste, and geographical regions differently. Nepalese women who depend on subsistence farming for their livelihoods are likely to be disproportionately affected by climate change. Not only are their workloads increasing as a result of male migration, but water scarcity and deforestation that result from climate variability necessitate that women walk longer distances in search of water, fuelwood, and fodder.

In order to cope with current stresses to livelihood, Nepalese farmers have adopted several strategies for coping with climate change and food insecurity, many of which are unsustainable over the long term. Many methods exist that offer great potential for improved community based adaptation to occur in Nepal. These include incorporation of agroecology and agroforestry into current farming systems, improvement of water management, livelihood diversification, and climate risk management.

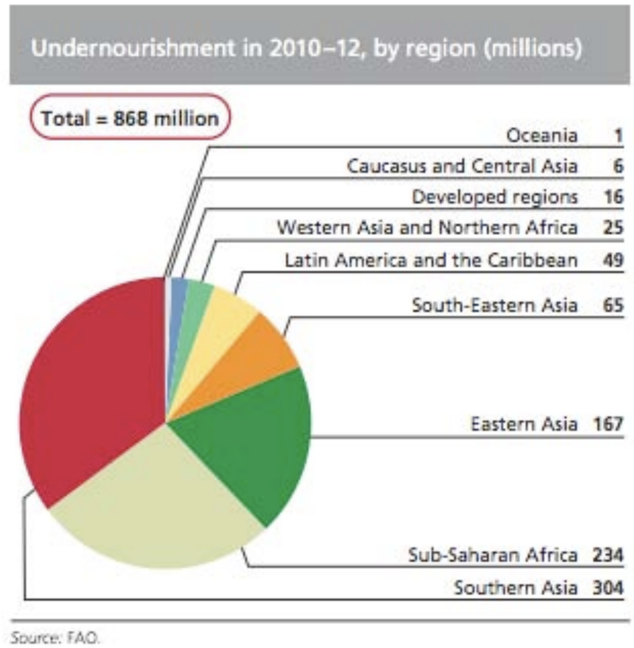
Introduction

According to the Intergovernmental Panel on Climate Change (IPCC) the mean global surface temperature increased 0.74°C during the 20th century. Since 1971, rates of land surface temperature have been increasing at the alarming rate of between 0.23 and 0.28°C per decade.[xiv] This continuing trend, coupled with changes in rainfall patterns and greater frequency of extreme weather events, are likely to have adverse effects on the world's population.

Evidence increasingly indicates that developing countries may be more at risk from climate change. Maplecroft, a global risks advisory firm, developed the Climate Change Vulnerability Index (CCVI) in 2010 to evaluate countries on 42 social, economic, and environmental variables. They assessed national vulnerabilities across three core areas: 1) exposure to climate-related natural disasters and sea-level rise; 2) Human-sensitivity in terms of population patterns, level of development, natural resources, agricultural dependency, and conflicts; and 3) future vulnerability which was analyzed according to the capacity of a country's government and infrastructure to adapt to climate change. Maplecroft found that countries most at risk to climate change tend to have higher levels of poverty, dense populations, greater exposure to climate-related events, and less agricultural resilience to floods or drought.[xv]

Food insecurity and malnutrition are perhaps the most important consequences of climate change.[xvi,xvii] Indeed, between 1970 and 2000, climate change is estimated to have caused at least 160,000 deaths and 5 million disability-adjusted life years from four factors alone: malnutrition, malaria, diarrhea, and flooding.[xviii] According to the Food and Agriculture Organization's (FAO) 2012 "The State of Food Insecurity in the World" (SOFI) report, approximately 868 million people were undernourished between 2010 and 2012.[xix] 852 million of these undernourished people live in developing countries with over sixty percent residing in South Asia and Sub-Saharan Africa.[xx] These numbers are expected to increase as food yields potentially decline and production patterns shift as a result of climate change.

Cohen et al. predict that agricultural output could decrease by 10 – 20 percent by 2080.[xxi] Limited production will in turn cause food prices to rise and will further impede the ability of the poor to access sufficient, safe, and nutritious food. It is therefore highly probable that limited food availability from decreased production as well as higher food prices will worsen undernutrition. The United Nations Development Program (UNDP) estimates that approximately 600 million more people could be afflicted by hunger by 2080 as a consequence of climate change.[xxii]



Although least developed countries (LDCs), such as Nepal, are culpable for a relatively small proportion of greenhouse gas emissions, they often are most vulnerable to the negative effects of climate change. Nepal, responsible for just 0.025 percent of global greenhouse emissions, is one of the lowest emitters in the world. Yet Nepal ranks fourth among the 170 countries rated for vulnerability to climate change in Maplecroft's Climate Change Vulnerability Index.[xxiii] Atmospheric temperature in Nepal is rising at a rate higher than the global average, with a 1.8°C increase between 1975 and 2006. Precipitation has become increasingly unpredictable, while biodiversity depletion, deforestation, and increased frequency of extreme weather events have all negatively impacted agricultural production. As the majority of Nepalese citizens engage in smallholder farming, a sector that is particularly susceptible to weather volatility, a great portion of the population will find itself directly affected by climate change. High levels of poverty will restrict the adaptive capacity of Nepali farmers.

Climate Change Vulnerability Index 2011

Legend	
Extreme risk	
High risk	
Medium risk	
Low risk	
No Data	

Rank	Country	Rating
1	Bangladesh	Extreme
2	India	Extreme
3	Madagascar	Extreme
4	Nepal	Extreme
5	Mozambique	Extreme

Rank	Country	Rating
6	Philippines	Extreme
7	Haiti	Extreme
8	Afghanistan	Extreme
9	Zimbabwe	Extreme
10	Myanmar	Extreme

Source: Maplecrof.com/about/news/ccvi.html;

This report discusses some of the major threats Nepal faces from climate change, focusing primarily on its impact on the livelihoods of rural farmers. Section I outlines some of the main observations of temperature and precipitation changes throughout Nepal's distinct geographical regions. The report continues with a discussion of the impact of climate change on livelihoods, with a specific focus on gender. This section relies exclusively on information taken from academic journals, research consortiums, and publications from major multilateral and non-governmental organizations working in Nepal. Section II provides a brief overview of how Nepalese communities have been coping with changing threats to their livelihoods. The section concludes with some proposals for community based adaptation strategies. Finally, Appendix 1 summarizes the major observations of farmers from Hill and Terai communities in the Far West. It is followed by a proposed plan for agroforestry and a chart of the benefits of rainwater harvesting.

Section I
Climate Change in Nepal

1. Climate Change in Nepal

Nepal is a landlocked country located between China and India. Spanning the central part of the Himalayas, Nepal's total area is 147,181 km^2. Five distinct physiographic regions with unique altitudinal and climatic conditions give the land its splendid diversity. These regions consist of the High Himal, High Mountain, Middle Mountain, Siwalik, and the Terai. 35 percent of the total area is made up of mountains, 42 percent is hills, and 23 percent is Terai .[xxiv]

Climate Characteristic in Different Ecological belts of Nepal[xxv]				
Physiographic zone	**Ecological belt**	**Climate**	**Average annual precipitation**	**Mean annual temperature**
High Himal	Mountain	Arctic/alpine	Snow/150mm-200mm	<3°C-10°C
High Mountain				
Middle Mountain	Hill	Cool/warm	275mm-2300mm	10°C-20°C
Siwalik	Terai	Tropical/sub-tropical	1100mm-3000mm	20°C-25°C
Terai				

Nepal's population is primarily concentrated in the rural areas, with over 60 percent dependent on farming for their livelihood and 6.4 million people food insecure.[xxvi,xxvii] Per capita GDP of Nepal, at USD$ 470, is the lowest in South Asia. Smallholder and subsistence farmers make up 78 percent of all agricultural holdings with an average holding size of 0.7 ha. The lowland Terai, bordering India, is the sole region in agricultural surplus, and thus is the principal area of production relied upon to supply the less productive hill and mountain areas.[xxviii] Given the sensitivity of agricultural systems to changes in temperature, precipitation, and natural disasters, climate change poses a significant threat to the wellbeing of the majority of the population. The exact nature and extent of this threat remains unclear, however, as a) there are insufficient meteorological stations in Nepal, particularly at higher altitudes, and b) the sheer complexity of Nepal's geographical and climatic zones makes it difficult to build accurate or precise climate predictions.

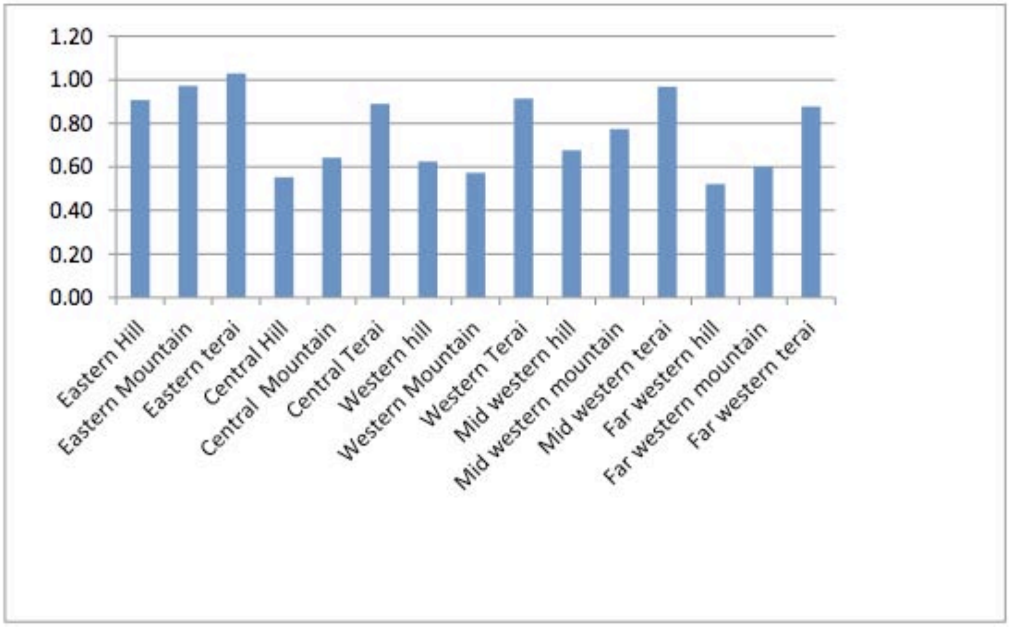


Figure 37 Land holding size in 15 eco-regions of Nepal (source: statistical year book, 2009, CBS, GON)

1.1 Temperature

There is general agreement that average temperatures in Nepal increased at an annual rate of .06°C between 1977 and 2000, with a 0.04°C increase in the Terai and 0.08°C increase in the Himalayas.[xxix, xxx] Warming patterns have been most pronounced at higher altitudes and more so during the winter months as opposed to the monsoon season.[xxxi] Warming has also been greater in the western half of the country than in the eastern half.[xxxii]

1.2 Precipitation and Water Availability

While there is evidence that more intense precipitation events have been occurring, there are currently no definitive trends in precipitation or reliable projections for the future. This is largely due to a lack of data from the few functioning meteorological and hydrological stations scattered across the country. Despite this significant dearth of data, a few general observations have been made: 1) the Western half of Nepal is considerably drier than the eastern half; 2) Regions that receive less average rainfall have shown a higher degree of warming; 3) the timing of monsoon, when Nepal receives 75-80 percent of its annual rainfall, has become increasingly unpredictable.[xxxiii] Although the effects of rainfall variation tend to be site-specific, delayed onset of monsoon pushes back plantation and typically has an adverse impact on crop yields.[xxxiv]

1.3 Other Effects of Climate Change in Nepal

Climate change creates new ecological niches that permit the entry, establishment and spread of pests and diseases into new geographical areas. Higher temperatures speed up the lifecycle of some pests and disease vector insects so that populations grow faster. Rainfall variability, carbon dioxide concentration in the atmosphere, extreme weather events, and the characteristics of hosts and ecosystems (e.g. Monoculture, biodiversity, natural enemies) further impact the spread of plant pests.[xxxv] This occurrence can negatively affect crops and the availability of food of appropriate quality by increasing production volatility.[xxxvi] In Nepal, the Nepal Agricultural Research Council's (NARC) entomology department is currently researching how pest populations are changing in relation to climate change. Many outbreaks of fungal diseases such as potato late blight and ascochyta blight have already been directly related to climate change, however, no predictive models have yet been developed.

Biodiversity loss is also occurring and is expected to continue if the effects of climate change intensify. Since different plant and animal species are suitable to specific ecosystems, changes in soil, temperature, humidity, sunshine, and water availability will alter a particular specie's ability to survive in its environment. Additionally, modern and hybrid seed varieties are increasingly replacing local traditional varieties as they often provide greater drought resistance or higher yields. Cold-water fish, herbs, pasture lands, apple trees and livestock are expected to be most at risk in Nepal.[xxxvii]

2. Diverse Geography

Nepal's geography is divided into three distinct geographic areas: The Mountains, Hills, and Terai. Each region has unique biophysical and socioeconomic characteristics that vary significantly from one another. Such rich diversity within a relatively small area makes it difficult to distinguish patterns related to climate change, and location-specific approaches are necessary for adaptation strategies to be successful.

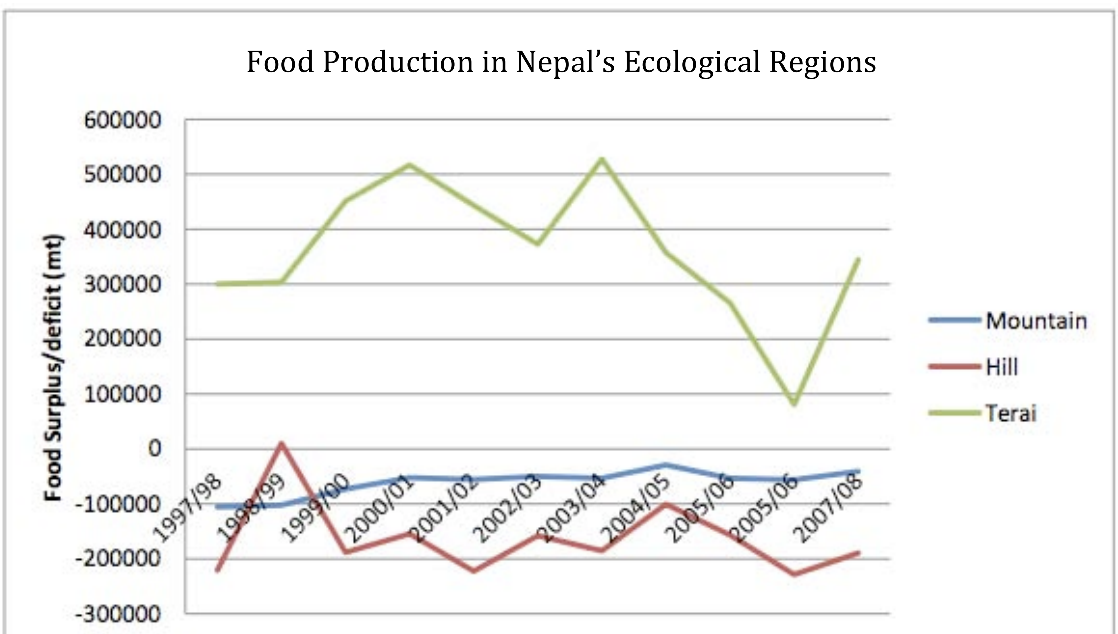
- The Mountain region, as part of the Himalayan range, spans the northern part of the country and accounts for 35 percent of the total area of Nepal. The region's "glaciers and snow breath life into the regional monsoon system and feed the headwaters of 10 major river systems that stretch across 8 Asian countries—Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan."[xxxviii] In Nepal specifically, there has been a 21 percent depletion of glacial area over the past 30 years.[xxxix] Mass losses from glaciers and accelerating reductions in snow cover are expected to reduce water supplies and hydropower potential. Also, temperatures are increasing much more rapidly in the high Himalayas, particular in the higher altitudes.[xl] Tree lines and species are migrating to higher elevations and species already living at the highest elevations may have nowhere to go.[xli] The mountain region is home to about 8 percent of the population and only produces about three-fourths of its food requirements.[xlii]

- The Hill region, located between the Mountain and the Terai regions, accounts for 42% of Nepal's total land area.[xliii] This region is home to 44 percent of the population and produces about 16 percent less food than it needs.[xliv] Farmers in the hills have observed changes in the intensity and timing of rainfall as well as a rise in both summer and winter temperatures. Snowfall has both changed in timing and decreased in volume while frosts have been occurring later. Farmers have also noticed greater incidence of pest and crop diseases that were not present in the past.[xlv]

- The Ganges Plain extends into the southern part of Nepal and makes up the Terai region. Covering 23 percent of the total land area, the Terai's fertile soil, flat terrain, and proximity to India have led the region to become the most densely populated area of the country.[xlvi] This region is known as the granary of Nepal, as it produces an overall grain surplus of almost 125 percent.[xlvii]

Monsoon rains, snow melt, and glacial melt run downstream from highland regions making the Terai the most at-risk area for flooding. While seasonal flooding is expected each year and is important for irrigation of crops, farmers have noticed changes in the timing and intensity of flooding in recent years. People in the Eastern Terai have observed that the timing of the flooding season has been delayed, floods have been less intense but more frequent, and occur much sooner after rain events even when there is less volume of rain.[xlviii]

In addition to a change in rainfall patterns, crop production in the Terai has also suffered from an increase in temperature extremes. More intense cold waves that persist for longer periods of time have destroyed winter vegetables.[1][xlix,l]



1 Cold waves are periods of fog, high humidity, low visibility and little sunshine.

3. Food and Nutrition Security, Climate Change and Livelihoods

The 1996 World Food Summit defined food security as "existing when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life."[li] At present, approximately 3.4 million Nepalese require food assistance and a staggering 6.4 million are chronically food insecure.[lii] As domestic food production is insufficient to meet per capita caloric needs, Nepal has become a net importer of food. Reliance on imports has made the poor increasingly vulnerable to price shocks and has exacerbated food insecurity.

The majority of Nepal's population depends on smallholder farming for its livelihood. Many households operate on landholdings that are inadequate to produce enough annual food for survival. Certain families, particularly those from lower caste groups, manage landholdings within the *adhiya* (sharecropping) system and are obliged to turn over a significant portion of their harvest to the wealthier or higher caste members holding the land.

Poverty and a lack of purchasing power limit the poor's ability to access food. Even if the poor are able to consume enough calories, diseases and a lack of micronutrients may compromise their bodies' ability to absorb and synthesize nutrients.[liii]

Table 1 illustrates the groups most vulnerable to food insecurity in Nepal. Within these groups, women, children, and members of lower castes are typically the most food insecure. As an example, strict socio-cultural practices wherein women typically are the last members of the household to eat, make them inherently more food insecure.

Table 1: Vulnerable groups in Nepal[1]		
Vulnerable group	**Number of people**	**Share of national population (%)**
Marginal farm households in the Mountains	691,100	3
Marginal farm households in the Hills	3,415,600	14
Marginal farm households in the Terai	2,644,000	11
Agricultural labor households in the Terai	934,054	4
Rural service castes	1,337,667	6
Porters	167,498	1
Urban poor involved in the informal conomy in the Kathmandu Valley	8,919	0
Total vulnerable population	**9,198,838**	**38**

As rising temperatures and the effects of climate change are felt more intensely, food insecurity in Nepal is expected to become more acute. Already disaster-prone and the 30th most at-risk country to flooding, Nepal has experienced a steady rise in the occurrence of floods, droughts, and landslides.[liv] Between 1998 and 2002, floods and landslides affected about 24,264 people annually and left over half a million people food insecure in 2007 alone.[lv]

Heavy reliance on rainfed farming, limited irrigation facilities, and a significant lack of water conservation and harvesting practices mean that extreme events can prove disastrous for agricultural output.[lvi, lvii] Furthermore, rising temperatures will have a significant impact on the moisture and nutrient level of soil through rapid evapo-transpiration, soil erosion, and landslides.[lviii]

The development and spread of crop diseases, pests and weeds will also have an adverse impact on agriculture, human health, and the environment.[lix] Several pathogens, such as rust and foliar blight, have already adapted to the hills and mid-hills. Mosquitoes that once only populated the Terai region, are now able to survive in the mid and high hills.

Indicator	1995/96	2009/2010
Agricultural GDP	$3.4 billion	$5.2 billion
Productivity of Agricultural Labor ($/person)	$466/person	$700/person
Agricultural Land per Household (ha/hh)	1.1	0.7
Percentage of holdings operating less than 0.5 ha	40.1%	51.6%
Productivity of Agricultural Land ($/ha)	$1,118/ha	$1,700/ha
Agricultural Land Use (cereal as percentage of cultivated land)	80%	80%
Seed turnover	8%	8%
Employment in Agriculture	66%	60%
Agricultural Exports	$32million	$248 million
Agricultural Imports	$157 million	$621 million
Poverty (2010 preliminary)	42%	25%
Percentage of households reporting inadequacy of food consumption	50.9%	15.7%
Stunting of Children (less than 5 years)	60%	42%
Irrigation cover (% of cultivated area)	39.6%	54%
Infrastructure (Rural Road Network km and Strategic Road Network km)	SRN = km 10,000	RRN = 40,000 km SRN = 20,000 km
ICT reach	Less than 10% connected	46% connected

Source: MOAC

Nepalese Agriculture at a Glance:

- Almost 76 percent of agricultural land is rain fed, and therefore highly vulnerable to weather conditions
- The largest share of total crop production comes from the Central Region (nearly one-third), followed by the Eastern and Western Regions.
- The Terai contributes about 56 percent of annual cereal production

Source: Hem R. Regmi. "Effect of Unusual Weather on Cereal Crop Production and Household Food Security." *The Journal of Agriculture and Environment*. (2007) : 24.

3.1 Gender and Climate Change

Climate change will affect people of different genders, ethnicities, caste, and geographical regions differently. Rising temperatures, unpredictable precipitation patterns, and an increase in extreme-weather events will have a disproportionate impact on women who depend on subsistence farming for their livelihoods. In a traditionally patriarchal society such as Nepal, there is a restrictive opportunity structure and livelihood options are limited.[lx] Upholding their gendered roles, women maintain responsibility for domestic functions such as housekeeping, child rearing, cooking, and fetching water and firewood. Access to education, economic independence and fair remuneration practices are typically enjoyed more by men than women.

The stresses to agriculture and food and nutrition security that have accompanied changing weather patterns in recent years have necessitated that men and women adopt different methods of coping. Many men and boys are migrating seasonally in search of off and on-farm work. Migration is typically scheduled around agricultural patterns, with men departing after planting season and returning in time for the harvest. In the Terai, men are able to remain closer to home, as there is an abundance of agricultural work in neighboring India and other parts of Nepal. Conversely, men residing in the hills are obligated to migrate for longer periods of time because of the greater distance they need to travel in search of work.[lxi]

While men are absent, women and children manage the household, taking on both domestic and productive roles. These include maintaining the home, tending to livestock and crops, and occasionally taking on work outside the home as laborers, domestic workers, or porters.[lxii] Not only are their workloads increasing as a result of male migration, but water scarcity and deforestation related to climate variability are obligating women to walk longer distances to fetch water, fuel, and fodder.

Section II

Adaptation

4. Adaptation

The IPCC defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."[lxiii] In order to enhance resilience and manage current and expected stresses to their livelihoods, people make both tangible and intangible alterations in their decision-making environments.[lxiv,lxv]

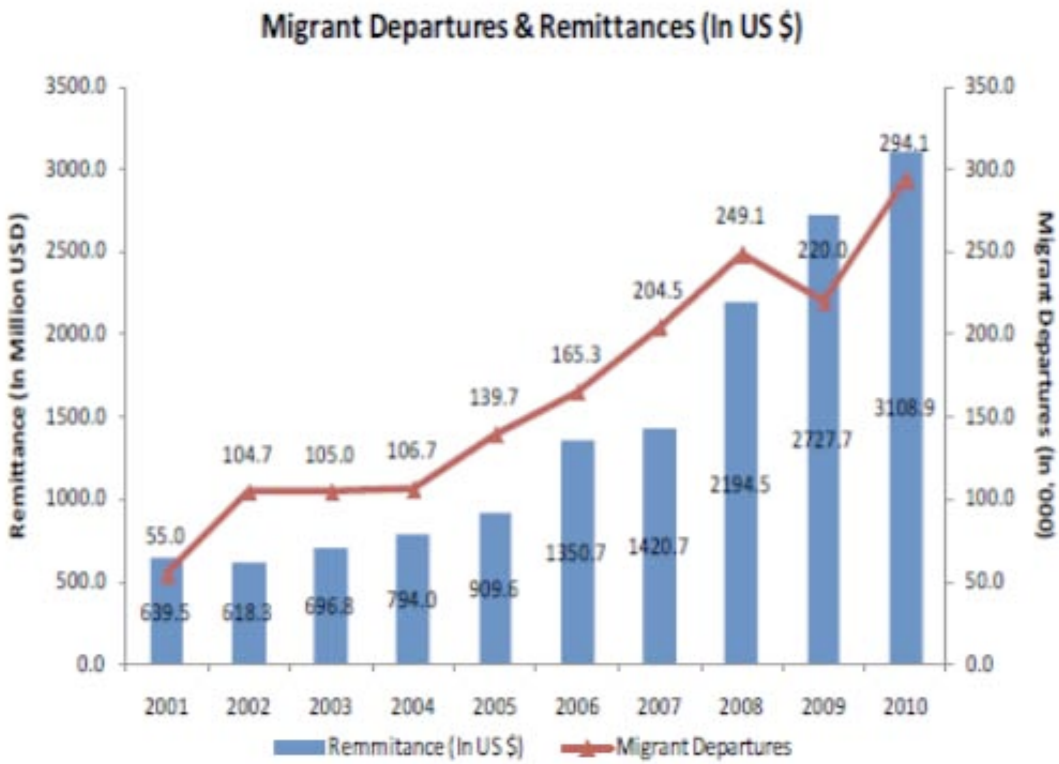
Climate change adaptation strategies can be autonomous or planned, anticipatory or reactionary. Autonomous adaptation draws on existing knowledge and technology to respond to climate variability whereas planned adaptation mobilizes institutions and policies in order to increase adaptive capacity and invest in new technologies and infrastructure.[lxvi]

Characteristics such as wealth, equality, political and social stability, infrastructure, access to natural resources, and social capital determine a person's or a community's adaptive capacity.[lxvii] Developing countries have limited faculty to implement comprehensive climate change adaptation initiatives. Policies and funding are often inadequate to allow for early warning of oncoming threats and disasters, or alleviation after impact.[lxviii] Left largely to their own devices, impoverished people try to minimize irreversible losses of livelihood by devising their own means of survival. These coping mechanisms, however, are often reactionary and insufficient.[lxix]

5. Current Adaptation Strategies in Nepal

Subsistence farmers have adopted several strategies for coping with climate change and food and nutrition insecurity, many of which are unsustainable over the long term. Vulnerable households often respond to food insecurity by skipping meals, harvesting wild plants, reducing food intake, relying on food aid, selling assets such as livestock, and changing sanitation practices (cleaning, showering, and washing less frequently).[lxx,lxxi,lxxii]

Temporary migration and permanent resettlement have also become common coping strategies adopted by people in rural areas. While women have fewer opportunities to migrate, men often leave in order to search for employment and to lessen the burden on households of feeding one more person. At present, approximately 40 percent of Nepalese households have one or more family members absent pursuing labor opportunities outside their home communities.[lxxiii] Food insecurity and poor harvests have impelled farmers to also explore cash-generating activities such as cross-border trade and day labor.[lxxiv]



Source: World Bank (2011)

The threat of bad weather often limits economic growth. Poor farmers frequently choose not to invest in new agricultural technologies, preferring both lower risk, lower return crops and coping strategies. Despite the potential for higher returns, the rural poor are reluctant to invest limited resources in farm improvements, education, or new endeavors that either have an uncertain return or could fall victim to unpredictable weather events. Many households manage losses and emergency expenses by selling livestock in times of need. If losses are widespread across the community, however, too many households sell their livestock on the market at once. This causes price deflation and the livestock, in turn, fetches a drastically lower price. Moreover, the vulnerability of livestock to weather risks, such as droughts and floods, means that they are not a reliable method of managing losses.

Financial institutions recognize the high risks associated with lending to climate-vulnerable communities and either limit the amount of credit available to farmers or provide it at higher interest rates.[lxxv,lxxvi] This makes farmers more vulnerable to both disasters and poor harvests, and less willing to invest in new technologies or assets that could boost production over the long term.

The introduction of new technologies for irrigation, water and soil conservation, and new seed varieties, can allow farmers to adapt to climate stresses. The United Mission to Nepal (UMN), in collaboration with the Nepal Agricultural Research Council (NARC), is currently working with farmers to experiment with different varieties of seeds, particularly rice, that require varying amounts of water or that can be sown at myriad dates according to shifts in precipitation patterns.[2] Farmers are testing new varieties for characteristics such as drought tolerance, suitability of grains for specific purposes, and insect and pest resistance.[lxxvii] It should be noted, however, that replacing traditional varieties with modern or external varieties may threaten biodiversity by replacing local species of plants and changing the pollinating behavior of local insects. Over the long term, this could potentially decrease yields.[lxxviii] It is therefore essential to balance potential innovations for addressing food insecurity and climate change with a critical analysis of potential harm to long term agro-ecological stability in order to find solutions which enable adaptation without undermining the inherent resilience of food production systems.

6. Possible Adaptation Strategies

Over the long term, adaptation strategies will need to take on a more integrated approach to improving resilience to climate change. It will become

[2] The majority of the seeds are developed by NARC or imported from India.

increasingly crucial that these strategies do not serve as short-term coping mechanisms but instead incorporate sustainable and judicious planning that will enable communities to manage climate-related threats to food security and overall livelihood. Such strategies might be as diverse as improving water management, diversifying cropping strategies, improving access to markets, or developing community insurance schemes. This section will explore several options for longer-term adaptation. These options have either been adapted from countries with similar contextual environments to Nepal, have potential for adoption in Nepal, or are already being experimented with in Nepal.

6.1 Agroecology - Enabling Ecological Resilience for Food & Nutrition Security

Agroecology is the sustainable management of agricultural systems through the application of ecological principles.[lxxix] It is premised on the idea that ecosystem services can be improved through an understanding of ecological relationships and processes while using fewer external inputs and causing fewer negative environmental or social impacts. An agroecological approach attempts to replicate the structure and function of natural ecosystems so that plants and animals may coexist in harmony with local ecosystems and thrive accordingly.[lxxx]

Agroecology employs sustainable practices that can significantly improve yields with relatively few external inputs. As an example, a survey of over 1800 neighboring agroecological and conventional farms in Nicaragua, Honduras and Guatemala found that sustainable plots had 20-40 percent more topsoil, greater soil moisture, less erosion and also lower economic losses than conventional neighbors.[lxxxi]

One of the primary principles behind agroecology is nutrient cycling. Nutrient cycling refers to the various processes through which nutrients are transferred from one organism to another. A nutrient cycle functions when plant residues and animal waste are returned to the soil. In the soil, organic matter becomes food for bacteria, fungi, and other decomposers. These decomposers, in turn, break down the organic matter into simpler compounds that can serve as plant nutrients. As the roots of a plant take up nutrients from soil organic matter, the cycle begins again.

Farms that incorporate both livestock and crops into the same system can recycle a great proportion of nutrients. Vegetative biomass (i.e. trees, crops, grasses) can be converted into plant-derived products such as building materials, paper, fuels, animal fodder, or firewood. If animals are included in the farming system, biomass is cycled back into the system when they excrete the phosphorous, potassium, and nitrogen contained in their feed. Animal excrement not only re-fertilizes the soil, it can serve energy purposes as well.

At present, firewood accounts for approximately 90 percent of the biomass energy consumed in Nepal.[1] Firewood is not a sustainable source of energy because once it is burned, it cannot be cycled back into the farming system. Methane digesters that convert animal dung into biogas, offer a more sustainable substitute. Biogas can serve the cooking and lighting purposes of rural families. Once the gas is consumed, the slurry used to fuel the digesters can be re-used as a natural fertilizer and be cycled back into the farming system.[3]

Efficient recycling depends upon minimal losses of nutrients. Farming practices that support the development of healthy, vigorous root systems result in more efficient uptake and use of available nutrients*.* Farming practices that help minimize nutrient losses while building up root systems include crop rotations, reduced tillage, maintaining crop residue, growing cover crops, composting and using available organic waste or byproducts, and maintaining soil pH*.*[lxxxii] Several of these soil management practices will be discussed in further detail in this section*.*

One way to prevent nutrient losses from the soil is through minimal disturbance. Minimal tillage is an effective and sustainable means of reducing erosion, retaining organic matter in the soil, increasing crop resilience to weather variability, and improving levels of soil moisture while requiring less labor, time,

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[3] The Netherlands Development Organization (SNV), in partnership with the Government of Nepal, the Dutch Development Cooperation, the German Development Bank, the Agricultural Development Bank of Nepal, and the Gober Gas Company, successfully installed 111,395 biogas systems between 1992 and 2003.[3]

and material inputs. It is also useful to reduce the carbon losses that occur when plowing and to increase levels of carbon sequestration.

Miguel Altieri's Principles of Agroecology:

Enhance the recycling of biomass, with a view to optimizing nutrient availability and balancing nutrient flows over time.

Provide the most favorable soil conditions for plant growth, particularly by managing organic matter and by enhancing soil biotic activity.

Minimize losses of energy and other growth factors within plants' microenvironments above and below ground. These losses result from unfavorable flows of solar radiation, air and water. Reduction is accomplished through microclimate management, water harvesting, and better soil management and protection through increased soil cover.

Diversify species and genetic resources in the agroecosystem over time and space.

Enhance beneficial biological interactions and synergies among the components of agrobiodiversity, thereby promoting key ecological processes and services.

Source: Miguel A. Altieri, "Agroecological Principles and Strategies for Sustainable Agriculture," Chapter 3 of forthcoming publication edited by Norm Uphoff : 2-3.

Conservation tillage includes zero tillage, strip or zonal tillage, and ridge tillage. With zero tillage, seeds are sown in unplowed fields. This conserves soil fertility, requires less water, and lowers production costs. Zero-tillage rice and wheat cultivation has had tremendous success in South Asia where over half a million farmers in India, Pakistan and other countries have benefitted from this technology. In Pakistan, for example, this practice led to water savings of 15 - 20 percent and increased yields as a result of reduced evaporation and runoff and deeper percolation.[lxxxiii] Strip or zonal tillage systems, in which the seeding zones are prepared only where seeds will be planted and left unplowed in other sections, have similar benefits.

Another salient characteristic of agroecology is the preservation of agricultural diversity. Increased diversity allows for beneficial synergies between organisms that promote greater ecological sustainability. Diversity can also reduce risk for farmers working in areas with unpredictable environmental conditions. Several different techniques enhance agricultural diversity. These include rotating crops from one season to the next, incorporating multiple complementary crop species within spatial proximity (companion planting), integrating animals whose biomass output can return nutrients to the soil, using reduced tillage practices, planting cover crops, and applying compost, green manures, or animal manures.[lxxxiv]

Cover crops are a particularly important strategy for maintaining agricultural diversity. A cover crop is any plant that is used to improve soil fertility and moisture, prevent erosion, or control weeds and pests.[lxxxv] Cover crops are either planted on the field post-harvest or are inter-cropped with the main crop. They can help alleviate weed problems without the use of herbicides and ensure that the soil is not left barren after harvest. Cover crops can also reduce erosion and improve soil moisture. It has been estimated that cover crops can decrease water runoff losses by 2- 6 fold.[lxxxvi] Moreover, cover crops enrich soil organic matter. Organically rich soils are usually more resistant to drought and weather variability. Nitrogen-fixing legumes such as soybean, cowpea, azola, and mung beans are ideal cover crops that help increase the percentage of biomass in the soil as well as improve soil nutrients. Compost, crop residues, and animal manure also contribute to levels of soil organic matter.

The use of local resources with minimal dependence on external inputs is yet another important aspect of agroecology. As stresses on water and energy resources are expected to worsen, the dependence of poor farmers on external, nonrenewable agricultural inputs becomes increasingly unsustainable and unviable. By incorporating local and indigenous resources into farming systems, farmers can reduce their need for imported energy and agrochemical materials. Systems that rely less on heavy application of chemical fertilizer, pesticides, herbicides, and imported seed varieties are often more resistant to pests and nutrient depletion of the soil, and less vulnerable to climate fluctuations.[lxxxvii]

Although sustainable agriculture improves soil quality and water retention, ultimately leading to increased productivity in the medium to long run, yields can decline initially until farmers adjust to new techniques.[lxxxviii]

6.2 Agroforestry

As a key strategy within agroecology, agroforestry takes an integrative approach to farming by combining the production from annual agricultural activities (i.e. crops and pasture) with the long-term production of trees or other perennials (i.e. fruits, timber, resins). Tree-based systems can be established either by planting trees on agricultural land or by cropping forested areas. Serving as both an adaptation and mitigation measure, these systems offer countless benefits to the environment and food and nutrition security.

Agroforestry can contribute to greenhouse gas mitigation by sequestering carbon in trees and soil. Integrating trees and agroforestry into farming systems helps to improve overall soil health through reducing soil erosion, sinking and storing soil nutrients and water, providing a source of mulch and fixing nitrogen. While the overstory moderates soil evaporation, the roots increase water infiltration in the soil, building up the water table and protecting crops from low precipitation.[lxxxix] Trees also act as a defense in harsh climates, shield crops from the wind, sun, and rain. Microfauna and microflora in the soil flourish as soil organic matter from tree litter and dead roots becomes enriched.[xc] As a whole, agroforestry systems are less susceptible to weather fluctuations and weather extremes such as droughts or floods.[xci]

People benefit from tree-based systems from the numerous products that they yield, namely, fruits, fodder, fuel, timber, medicines, and resins, which can either be consumed or sold for cash. Agroforestry can therefore benefit household food and nutrition security by affording both a more varied diet and greater income diversification. Deforestation has impelled women to travel greater distances in search of fodder and firewood. Agroforestry can help regenerate deforested lands and provide sustainably managed wood sources, thus reducing the labor and time demands on women. Integrating agroforestry into food production systems improves the resilience of the agricultural production system as well as households which survive off of these systems.

Developing an Agroforestry System

While agroforestry is an attractive and sustainable system for climate change preparedness and adaptation, up-front financing and opportunity costs can preclude people from adopting these measures. Benefits are delayed and food security can suffer during the process of converting land from pure crop production to an integrated tree-based system. One solution, currently being pursued by the Nepal Agroforestry Seed Cooperative Limited (NAFSCOL), is to integrate crops and livestock rearing into community forests. NAFSCOL trains farmers in nursery management, biodiversity conservation, seed harvesting, etc. and orients groups on resource sharing. Farmers then form committees to formulate policies governing the use of resources produced from community forests. As participants realize the benefits derived from the integrative systems, they have begun to reshape their own landholdings using similar approaches.

6.3 Water Management

In developing countries, agriculture consumes 70 - 90 percent of total water use.[xcii] As farmers witness the water level in local aquifers and streams decrease, it is becoming evident that better management of water resources is crucial. While irrigation can help to alleviate some of the problems of water scarcity and assist farmers in adapting to climate shocks, the majority of subsistence farmers depend almost entirely on rainfed agriculture. Hence, one method of expanding access to water and reducing the need for expensive irrigation infrastructure is through rainwater harvesting.

Rainwater harvesting uses different technologies to collect and store rainfall in order to meet the demands of human consumption or human activities.[xciii] By harvesting rainwater, communities can improve their access to water and sanitation, increase food production, and reduce their vulnerability to droughts, floods, and other natural disasters at a relatively low cost. The potential of rainwater harvesting to help communities cope with water stresses should not to be underestimated. Indeed, it has been calculated that approximately 350 million liters of water could be collected daily if just 10 percent of households in Kathmandu were to harvest water.[xciv]

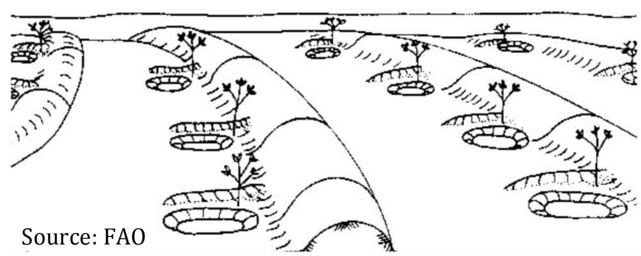
There are a variety of methods to collect rainwater through either the soil or man-made dams and containers. Building small ponds, installing rainwater tanks to collect water for domestic consumption and to irrigate kitchen gardens, constructing check dams, and reforesting catchment areas are useful methods to both reduce the stress placed on surrounding surface and groundwater sources and decrease flood risks.

Rainwater harvesting can take shape through both in situ and ex situ systems. In situ systems improve rainfall infiltration and reduce surface runoff. The rainwater catchment area is typically located within the same area where crops are grown or water infiltration is needed. The soil itself acts as the storage medium for the water and many in situ methods of rainwater harvesting serve the dual purpose of soil conservation. These technologies include contour bunds, gully plugs, and conservation tillage. In situ water harvesting has proven very successful in increasing soil moisture, preventing erosion, and improving harvests over the long term. In the Central Plateau of Burkina Faso, for example, stone bunds and gully control structures led to a doubling of crop yields over 20 years, greater forage production (and ultimately increased livestock numbers), regeneration of fauna species diversity, and a noticeable rise in the groundwater table.[xcv]

Ex situ systems capture rainwater in areas that are external to the point of water storage. The capture area can either consist of a natural soil surface with infiltration capacity or an artificial surface with low or no infiltration capacity (for example, rooftops or roads). Because ex situ systems typically involve storing water in wells, dams, ponds or cisterns, water can be extracted easily for uses such as irrigation or domestic consumption.[xcvi]

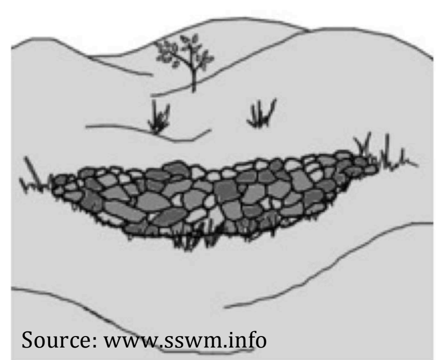
Several low-cost in situ and ex situ technologies exist that can assist in both water and soil conservation:

- **Contour bunds**: Contour bunds are stone or earthen walls built along the contours of a slope to act as a barrier to runoff. They help to reduce soil erosion and increase the water retention capacity of soil. In Fanya Jun, Kenya, contour bunds improved maize and bean yields by 50 – 60 percent. Crop yields in Ethiopia were 30 – 40 percent higher in fields with contour bunds than without.[xcvii] This practice could be applied to both the Terai and Hill regions of Nepal.


Source: FAO

- **Gully plugs**: Gully plugs are stones that are placed across gullies or valleys for the purpose of capturing nutrients, silt, and moisture. This technology is appropriate for capturing runoff from a broad catchment area in places where there is low rainfall or limited soil moisture. By slowing the flow of moisture, gully plugs help to generate organically rich and fertile soil where high value crops and trees can be grown.[xcviii]

  Gully plugs are also referred to as check dams. Small, low-cost barriers may be built across shallow rivers and streams for the purpose of water harvesting.[xcix] Check dams retain excess water flow during monsoon in a catchment area behind the structure. Pressure in the catchment area forces the stored water into the ground to recharge nearby groundwater reserves.[c] Thus, check dams can provide irrigation when monsoon season ends and


Source: www.sswm.info

accelerate the recharging of surrounding wells and groundwater. In Gujarat, India, beneficiaries of the Aga Khan Rural Support Program (AKRSP) reported that after check dams were constructed in Surendranagar District, farmers became more confident about water availability and increased their spending on inputs by 10 – 20 percent. The gross cropped area rose 40 – 50 percent and beneficiary crop yields were higher and more resilient to rainfall variability than non-beneficiaries.[ci] As already enumerated, rainwater harvesting has numerous advantages for improving household sanitation and health, increasing domestic water supplies, lessening the burden on women of fetching water, preventing erosion, and enhancing agricultural output through greater moisture and nutrient content in soil. These benefits can be maximized when there are structures in place that allow for proper distribution of the water.

Several cost effective methods for water distribution and irrigation exist. As an example, drip irrigation is a technique that allows a fixed amount of water to be delivered directly to the roots of plants via perforated pipes or tubes. These systems can double the productivity per drop of water over conventional irrigation.[cii] The International Water Management Institute (IWMI) has rigged drip irrigation systems for as little as US $5 in southern Africa through which farmers are able to apply just enough water to protect harvests.[ciii]

Another way to distribute water is through Hydraulic Ram Pumps. Alternative Indigenous Development Foundation (AIDFI) has built these pumps in the Philippines, Afghanistan, Colombia, and Nepal utilizing the energy of flowing water to pump it to higher elevations without electricity or fuel.[4]

[4] AIDFI has installed these pumps in Nepal for approximately USD$ 40 per person. Costs depend on the price of local materials as well as the pumping capacity of the hydram.

6.4 Climate Risk Management

Access to information on water resources, agricultural markets, and weather forecasting has helped farmers across the world adapt to rainfall and temperature variability. Accurate, timely, and location-specific forecasts give farmers greater capacity to make decisions that will reduce their vulnerability to unfavorable climate conditions.[civ] In Sakai, Kenya for example, farmers were provided with regional scientific weather forecasts and information about the implications of those predictions for agriculture. Information was transmitted through local radio stations and town meetings, and included the expected dates of the arrival and cessation of rain, the duration and amount of expected rainfall, recommendations for suitable crops, and the ideal dates to sow or harvest said crops. Additionally, farmers participated in training workshops on identification, retrieval, selection, bulking and storage of seeds, pest control, and post-harvest storage and management. Since the project began, farmers have reported that access to information has helped them to improve yields over the last four cropping seasons.[cv]

Monitoring tools, such as the South Asia Drought Monitor (developed by the International Water Management Institute IWMI), can help farmers adapt to threats to productivity. The South Asia Drought Monitor uses free and available satellite data to monitor ground vegetation and track drought progression. Farmers in Afghanistan, Pakistan and the western part of India receive reports in near real time. Such tools can include water level and rainfall monitoring, weather forecasts, and other information to provide communities with an early warning system in order to react quickly and reduce the impacts of extreme climate events.[cvi]

Index insurance presents another tool with great potential for managing climate variability. Index insurance links insurance to an index, such as rainfall or temperature. According to the United States Agency for International Development (USAID), insurance can help minimize the economic impact of unpredictable weather and "be an important step in supporting the agricultural growth, poverty alleviation, and development of rural finance."[cvii]

As noted earlier, farmers often choose low-risk, low-return activities to reduce their exposure to weather risk. Financial institutions recognize the high risk involved with lending to rural farmers who are prone to weather variability and therefore charge higher interest rates and restrict access to credit. Insurance can help facilitate the development of rural finance.[cviii] Households who have insurance to buffer against potential losses from extreme weather events are more willing to invest in economic activities that offer higher expected returns while appearing less risky to banks and microfinance institutions.[cix]

EXAMPLE: Here is an example from USAID for a drought risk plan that begins payments at 100 mm or less of rainfall. The maximum indemnity payment can be received when rainfall is at or below 50 mm)

Index Variable: *Total accumulated rainfall measured at a local weather station for the cropping season.*

Threshold: 100 mm of rainfall

Limit: 50 mm of rainfall

Liability purchased by the policyholder: $50,000

Payment rate: *Difference between threshold value and actual realized value of the index divided by the threshold minus the limit*

=(100 – actual)/(100-50)

Indemnity payment: *Payment rate x total liability*

= (100 – actual)/(100-50) x $50,000

Source: GlobalAgRisk, 2006 14.

Rather than base indemnity payments on the individually assessed losses of each policyholder, index insurance rates indemnity payments on objective measures, such as rainfall, temperature, or wind speed, that correlate with a variable such as crop yields. The plan typically defines a threshold at which indemnity payments begin and establishes a range of values over which the payments can be made. Regardless of the actual losses sustained, all policyholders holding the same contract receive the same payment rates, depending on the amount of liability purchased.

Advantages of Index Insurance:

- Low administrative costs: There is no need for the insurance provider to conduct individual risk assessments or make loss adjustments
- Involves simple, uniform contracts that can be easily understood by the policyholders
- Insurance provider does not need to assess losses. If rainfall is scarce, for example, the provider can simply check a community's rain gauge or look at satellite imagery
- Payouts can be made more quickly, allowing policyholders to manage losses and avoid selling assets such as livestock
- Insurance can be provided at a lower cost or in exchange for work. Work can be dedicated toward projects that further help to make communities resilient to changing climate patterns.

While the notion of index insurance as an adaptation strategy for climate change is a relatively new concept, some organizations have already successfully piloted and implemented weather insurance programs. Oxfam initiated its "Horn of Africa Risk Transfer for Adaptation" (HARITA) program in Ethiopia in 2007. Partnering with Swiss Reinsurance, Ethiopian farmers, the Relief Society of Tigray, the International Research Institute for Climate and Society, Nyala Insurance, and several other organizations, the aim of HARITA was to increase resiliency to climate change. Drought insurance was made available to farmers of myriad economic backgrounds who were given the option of paying for their premium or working on community projects such as building structures for water harvesting or planting trees. Additionally, farmers received information on planting dates, water management, how to make and use compost, and using plants for erosion as part of the Disaster Risk Reduction (DRR) component of the project. Today the project has over 13,000 households enrolled and is spreading across the Horn of Africa under Oxfam's Rural Resilience Initiative (R4).

The International Livestock Research Institute (ILRI) also provides index-based insurance to herders in Kenya to protect against drought. Using freely available satellite imagery, ILRI partners with UAP Insurance, Equity Bank, Cornell University and the Index Insurance Innovation Initiative program at the University of California Davis to assess the conditions of pastures and insure for forage losses. Herders receive payouts when forage is scarce.

Index insurance has many advantages and offers great potential for the establishment of public-private partnerships.

6.5 Other Adaptation Measures

The ability to generate an income outside of traditional agricultural practices will become increasingly important as water variability, disasters, and rising temperatures continue to impact farm productivity. It will be necessary to develop off-farm skills and explore alternative employment opportunities. By diversifying sources of income, people can become more resilient during periods of food insecurity.

One way to generate extra income on (or off) the farm is through aquaculture. Fisheries have a limited environmental impact, can fetch competitive prices in the market, and provide an excellent source of high-quality protein. It is estimated that Nepal has approximately 395,000 ha of rivers, 5,000 ha of small and medium sized lakes, 410,000 ha of paddy fields and marginal swamp areas, and 1,500 ha of manmade reservoirs. At present, most of these water sources are largely under-utilized.[cx] The majority of fish production in Nepal is concentrated in the Terai region, where the warmer climate is conducive to higher growth. Polyculture systems, in which different species of fish with different feeding habits cohabitate the same pond, are the most common and viable aquaculture production system to be adopted in the Terai.[cxi] These ponds typically house combinations of the 7 commercially valuable carp species.[5] Cage fish culture and capture fisheries with herbivorous carps, such as silver carp and bighead, are practiced in the lake area around Pokhara and in the Indrasarober reservoir in the central hills. These systems have been popular with rural communities where it has been found to improve livelihoods and the ecology of local water bodies. Fish culture can also be practiced in the marginal agricultural land along irrigated areas, ditches, flood plains, and swamps (gholes). As of 2003, only about 1,215 ha of the 12,500 available ha of *gholes* were being used for aquaculture .[cxii]

The best way to address climate-induced threats to food security and agriculture is to take an integrated, location-specific approach. Below are a few more strategies that might complement the measures already discussed:

Bioengineering from Mercy Corps Nepal's DRR program

- Problems of new pests, pathogens, and weeds should be dealt with sustainably using integrated pest and pathogen management as well as by adopting pest and disease resistant varieties
- Synthetic fertilizers, pesticides, and herbicides should be avoided when possible, and bio-pesticides such as neem oil, titepati, tobacco, and asuro should be promoted
- Disaster risk reduction (DRR) through flood mitigation and early warning systems
- New varieties of seeds with diverse properties, such as drought-resistance and flood-resistance, can sometimes help farmers become more resilient to weather extremes and weather variability, however these seeds should be used with caution as crops could be less nutritious and require greater inputs.[cxiii]

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[5] These include three indigenous species: rohu (*Labeo rohita*), naini (*Cirrhus mrigala*) and bhakur (*Catla catla*) and four exotic species: common carp (*Cyprinus carpio*), silver carp (*Hypopthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon idella*).
http://www.fao.org/fishery/countrysector/FI-CP_NP/en

Conclusion

This report has discussed some of the many ways climate change is affecting food security in Nepal and how rural farmers are coping. Temperatures are rising at an average annual rate of 0.06°C, rainfall has become increasingly erratic, and new pests, pathogens, and diseases are all affecting agricultural output, and ultimately, food and nutrition security. To cope, rural farmers often reduce food intake, rely on food aid, sell their assets, or migrate in search of employment. Women have had to shoulder a great portion of this burden by walking longer distances in search of fodder, fuelwood, and water, while maintaining the household during the absence of the males. A limited opportunity structure often precludes these women from pursuing livelihood options outside of agriculture.

Several practices exist to reduce vulnerability and enhance resilience of households and the agro-ecological system to climate change. These include adopting agroecological strategies, improving water management through rainwater harvesting and farming techniques that reduce runoff and soil erosion, integrating tree-based systems into farming, giving farmers better access to information, index insurance, and diversifying livelihood options. These strategies are guided by the principle that development assistance in climate change adaptation should 'do no harm' to local agro-ecological systems. Addressing the threat of climate change requires maximizing inherent energy and productivity potential by enhancing biodiversity, recycling energy and strengthening the natural balance in agro-ecological systems, as well as regenerating this balance where it has been disturbed.

Though many of the current strategies adopted by farmers to cope with climate change are not sustainable over the long term, expertise at the community level should not be discounted as this is exactly where potential solutions will be found. On the farm, responses to water scarcity and other climate related stresses have led farmers to maintain or revert back to traditional methods of adaptation. Farmers have a rich indigenous knowledge of the land and surrounding environments. A long tradition of rainfed agriculture enables some to predict rainfall and plan their farming operations accordingly without the assistance of precise meteorological data.[cxiv] Practices such as water harvesting, integrated pest management, diversifying crops, changing the cropping calendar, changing crop-varieties, and soil conservation methods such as minimum tillage farming, have allowed many to become more resilient to changes in weather patterns.[cxv,cxvi] Some farmers, for example, are expanding and diversifying vegetable cultivation in recognition of the fact that vegetables can be both sold and consumed, require less water, and can be harvested quicker than grains.[cxvii] Adaptation strategies that continue to build on traditional practices and that draw on indigenous knowledge will prove more sustainable, be less harmful to biodiversity, and require fewer resources over the long term.

Despite the usefulness of the above strategies for reducing food insecurity, much remains unknown. While it is certain that climate change has a disproportionate and adverse effect on subsistence farmers, the full extent of the present and future impact in Nepal is yet to be completely understood. There is an acute lack of reliable metrological and hydrological data. It is therefore difficult to depict trends in weather patterns over time within Nepal because many of the records for temperature and rainfall are incomplete. There are also few reliable weather stations scattered across the country, particularly at higher altitudes. Improved data collection and dissemination from a conclusive sample of Nepal's many geographical and climatic zones is crucial for location-specific adaptation strategies. This will need to be complemented by greater investigation into the social and cultural limits to adaptation. Nepal is a complex country with numerous population groups interacting in elaborate and multifarious ways. Social and cultural norms can either limit or enhance resilience to climate change, but greater research is needed in order to develop effective and appropriate adaptation strategies.

Lastly, given the critical nature of climate change in Nepal, all interventions should be conscientious to both "do no harm" and to maintain accountability to *all* involved stakeholders. When designing all programs, aid workers will need to remain vigilant that they are not unconsciously increasing vulnerability, harming biodiversity, of extracting more resources from the water, soil, or forests than is ecologically sustainable. Principles of agro-ecology should be integrated into all spheres of programming so that we do not compromise the ability of future generations to meet their own needs, but rather promote the preservation and regeneration of resilient food systems. Fostering greater mutual understanding, maintaining rigorous data collection and collaborating with all members of society will allow Nepal to become a more resilient and food secure country.

Appendix 1: Perceptions and Observations of Rural Farmers in the Far West

Far Western Hills (Dadeldhura and Bhaitadi):

Residents of this region observed that rainfall patterns and rain distribution have changed. It either does not rain at all or it rains very heavily. Correspondingly, monsoon does not arrive when it is expected and is more irregular. Drought frequency is increasing while springs are drying up. Also, people have noticed more landslides occurring. Limited resources have precluded them from formulating a plan to escape or from fortifying slopes and their homes.

Small farmers are affected the most. Production is too low to feed the household for the entire year. Because there is not enough food, many migrate to India. Seasonal migration has been occurring for generations and is not a new phenomenon, however, it is uncertain whether more members of these communities are migrating or whether the duration of seasonal migration has changed. Many earnestly pointed out their desire to stay in the community year round and for more diversified employment options at home. However, with very few skills outside of agriculture, they would need training. In addition to seasonal migration, families sell assets such as gold when they need extra cash to purchase food.

Households typically consume what they sow. This includes rice, wheat, legumes, maize, millet, soya, lentils, chili, eggplant, gourds, potato, onion, cabbage, cauliflower, cucumber, carrot, mango, banana, guava, peach, walnut, and limes. Some noted that greenhouses that were built as a part of Mercy Corps' SNAP project have helped them to create enough of a surplus to be able to sell a bit of the yields in the market.

Food insecurity generally occurs during the two months before the rice harvest in the rainy season and the two months before wheat harvest in the winter. Cereals production is insufficient to store for times of food scarcity.

Diseases have been afflicting more people, more frequently. They specifically listed Jaundice, Malaria, Hepatitis A and B, bloody stools, diarrhea, and Typhoid and noted that the closest health post is located about 5 hours away by foot. While these may or may not be indirectly related to climate change, they affect food security by hampering people's ability to work and to properly utilize nutrients.

In order to cope with rainfall variability, people in the far western hills have changed the timing of planting. They wait for the arrival of the rains, which has led to a decrease in yields. Several have access to canal irrigation and take turns irrigating. While farmers believe irrigation is key to adapting to rainfall irregularity, they note that water is scarce and is usually insufficient to meet everyone's irrigation needs. They also stated that they thought a rainwater harvesting tank or pond could help with water scarcity issues.

Although weather information is presented on the news, it is generally specific to bigger cities and at best, the district. While people believe that more information would help them to adapt to unpredictable weather patterns, they need forecasts that are particular to their VDC. They mentioned that neighboring communities have benefited from hailstorm predictions.

Banks provide credit to local communities but typically ask for a lot of collateral, such as a house. Only people who live near the roads with easy access tend to use bank services.

Finally, one woman, who identified herself as a Dalit, said that there has been an increase in the number of single women in her village. Although she identified the Maoists' People's War that occurred between 1996 and 2006 as one of the reasons for so many single women rather than changing weather conditions, climate change's disproportionate impact on lower caste women is concerning. Without the ability to remarry or migrate, it is likely that these women will become increasingly vulnerable to climate change.

Far Western Terai (Kailali and Kanchanpur):

Farmers in the Far Western Terai have noticed drastic changes in weather patterns. Monsoon has become unpredictable, sometimes arriving late and sometimes arriving early. When late, the rice transplantation is delayed and production decreased. Farmers would not have to delay transplantation if there was more water available for irrigation. Most members of the community use either a canal or a well pump to irrigate. Over the last 10 years they have noticed that water levels in the local aquifer has decreased from about 20 feet to about 50 feet.

Community members have also observed that the temperature has gotten warmer. Fruits are now maturing more quickly. Rice, wheat, etc. are maturing 15-20 days earlier. Warmer temperatures often create a more hospitable environment for pests. Farmers have noticed that new types of insects and diseases are damaging crops. Some claimed that the pests have become epidemic, while others did not seem concerned. A few have tried using pesticides, but without much success.

There is riverbank erosion and rivers are becoming wider.

Deforestation has increased over the last 10 – 20 years. Fruit trees are diminishing and very few orchards remain in the village. For example, where there were over 20 orchards around the village a couple decades ago, only 2 remain. Farmers blame deforestation on the splitting of households. Families are increasingly living together as nuclear units rather than sharing with the extended family. This has created a greater demand for land and left little extra land for fruit trees. Furthermore, population increases have led to increased demands for timber, and firewood. There is little law and order governing the use of community natural resources.

With forestland being converted for crop plantation, there has been a drastic decrease in the number of livestock raised. This is largely due to a lack of available fodder. Also, increased migration of the male labor force to Gulf countries has left very few to take care of the animals. Fewer livestock has led to increased dependence on chemical fertilizers because there is not enough manure to fertilize the fields.

Farmers in the Western Terai use more agricultural inputs than those in the Hills As noted, many use chemical fertilizer but do not know how to properly apply it and in what dosage. They are also increasingly using new varieties of seeds, which give higher yields but require more fertilizer and water than traditional local varieties. Furthermore, these new seeds cannot tolerate drought.

About 20 percent of households in the village lack enough food during the 2 – 3 months leading up to the harvests. Many seek casual labor employment in Dhangadhi, India, or Malaysia for survival. Community members estimated that approximately 40 percent of the population only consumes what they grow, while 60 percent have enough of a surplus to both consume and sell. This is specific to vegetable production.

Because of their proximity to Dhangadhi, community members can access loans in banks. The bank charges a 12-18 percent interest rate plus a 1 percent service charge. Another option providing loans are Savings Credit Cooperatives. There is a 24 percent interest rate in the cooperative. Farmers use loans to buy seeds and fertilizer, and occasionally, fertilizer.

Like the community members who were interviewed in the hills, farmers in the Terai believe greater access to forecasting and information would be useful, though they currently do not receive news specific to the VDC.

Terai women work in the house washing, cleaning, child raising, and in the field, transplanting and fetching fodder. Men plow the fields, migrate, and pursue non-agricultural income where possible. Both sexes tend to the livestock

Appendix 2: NAFSCOL'S Proposed Plan for Agroforestry

Appendix 3: Benefits of Rainwater Harvesting

(source: *Ecosystems Functions and the Effect of Rainwater Harvesting*, UNEP)

Ecosystem services	**Effect of rainwater harvesting intervention:**
Provisioning	• Can increase crop productivity, food supply and income • Can increase water and fodder for livestock and poultry • Can increase rainfall infiltration, thus recharging shallow groundwater sources and base flow in rivers • Can regenerate landscapes increasing biomass, food, fodder, fiber and wood for human consumption • Improves productive habitats, and increases species diversity in flora and fauna
Regulating	• Can affect the temporal distribution of water in landscape • Reduces fast flows and reduces incidences of flooding • Reduces soil erosion • Can provide habitat for harmful vector diseases • Bridges water supply in droughts and dry spells
Cultural	• Rain water harvesting and storage of water can support spiritual, religious and aesthetic values • Creates green oasis/mosaic landscape which has aesthetic value
Supporting	• Can enhance the primary productivity in landscape • Can help support nutrient flows in landscape, including water purification

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