Community Driven Climate Resilient Hill Farming in Village Ecosystems of NW Himalayas (Uttarakhand)

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(USNPSS) Almora

Summary

This research highlights the importance of community, especially strategizing gender needs, in initiatives focused on agriculture and climate change in Uttarakhand. Participatory rural Appraisal (PRA) techniques were used to assess community perceptions about the changes occurring in villages and the impact on the local livelihoods. The findings revealed that women are the most affected. The close relationship between the forests and agriculture in the hills has been earlier conceptualized to create a model of the village ecosystem. It is shown how the health of the ecosystem can be quantified by simple measurements. In addition, the concept of resilience of the ecosystem is introduced and simple ways of calculating the resilience index are shown. A healthy system will be more resilient and be able to withstand the impacts of climate change. Village specific ecological and socio-economic variants that were found significant in acceptance and use of modern agricultural innovations have been illustrated by action research in all the four sites chosen for the study. All this work gives a clear direction for future activities related to hill farming and climate change.

The project

The National Initiative on Climate Resilient Agriculture (NICRA) was launched during February 2011 by the Indian Council of Agricultural Research (ICAR) with funding from Ministry of Agriculture, Government of India. The country wide project has three major objectives – (i) strategic research, (ii) technology demonstrations and (iii) capacity building. The primary approach of 'strategic research' is an assessment of the impact of climate change simultaneous to the formulation of adaptive strategies across all sectors of agriculture, dairying and fisheries. Evolving climate resilient agricultural technologies that would increase farm production and productivity *vis-à-vis* continuous management of natural and manmade resources constitutes an integral part of sustaining agriculture in the era of climate change. Along with this endeavour is envisioned enhancement of capacity of all stakeholders.

Commissioned by NICRA, the project titled 'Community driven climate resilient hill agriculture in the village ecosystem of North-West Himalayas (Uttarakhand)' was jointly awarded to the Uttarakhand Seva Nidhi Paryavaran Shiksha Sansthan (USNPSS) Almora, Doon University (Dehradun) and GBPIHED (Srinagar Garhwal) in September 2011. The main objectives of USNPSS were concerned with understanding community perceptions about climate change, exploring health of the village ecosystem leading to the concept of a resilience index and action oriented research in villages of Uttarakhand. Doon University was concerned with studies on carbon sequestration and climate change dynamics, whilst GBPIHED was concerned with research and documentation of the local and traditional knowledge of communities regarding climate change and agriculture. Whilst USNPSS and Doon University worked together in data collection at the same sites, subsequently the nature and analysis of the work diverged. Therefore, the final reports are presented separately.

Contents

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Chapter 1

Introduction

As a part of the North-Western Himalayas, the state of Uttarakhand exhibits a unique socio-ecological system. The Himalayas, recognized as one of the thirty four global biodiversity hotspots on the earth, determine the variations in climate and weather conditions in India and the rest of the Asian subcontinent. In particular, the rivers originating from the higher Himalayas nurture diverse agricultural systems with different agro-ecological zones in upland and lowland areas of the country.

Though climate change is recognized as an issue with implications for the global community, not all people in the world are affected equally by it. The impact of disasters and extreme weather conditions is mostly experienced by areas inhabited by the poor, marginalized communities that have contributed the least to the problem of global warming and climate change (Ban Ki Moon 2009). The Himalayas, being the youngest and the most fragile mountains in the world constitute one such region which is highly sensitive to climate change. Uttarakhand, an ecologically rich yet geologically fragile state, is currently facing the effects of unpredictable extreme weather conditions. Cloud bursts, erratic rains, hail-storms, floods, debris-flow and landslides have become common, causing considerable damage to land, property, human and animal lives. The recent incidents of disasters (cloudbursts in Almora, Bageshwar districts-2011, heavy rains/cloudbursts and landslides in Chamoli, Rudraprayag districts-2012 and heavy rains, lake burst, floods in Rudraprayag, Chamoli, Uttarkashi and Bageshwar districts-2013) are indicative of the increasing frequency and severity with which climate change is affecting Uttarakhand. Besides damage to property and resources, the human and animal deaths have been recorded in the thousands.

As climate change continues to affect communities, increase in temperature, short but heavy spells of rains and hail storms can cause a change in the local livelihoods. For example, the current difficulties in meeting the daily requirements of water in villages can increase the problems of uphill cultivation, and in the very near future, the lowlands are also likely to face problems, even for domestic supply. The centrality of agriculture in rural areas can place thousands of people in a vulnerable position. In particular, rural women will be the most affected by changes in the local climatic conditions.

To be more specific to this research, Uttarakhand forms a unique site to study the effects of climate change because the region is extremely sensitive to increases in temperature and variations in rainfall and snowfall. The region hosts many glaciers that nourish rivers, and therefore human life in India and its neighbouring countries including Nepal, Bhutan, Bangladesh and Pakistan. Further, communities in Uttarakhand have long been facing the effects of natural disasters including avalanches, cloud-lake bursts, landslides etc. Within the limits of their own resources, communities have always responded to natural disasters. There exist knowledge systems that have evolved as a result of communities adapting to changes in climate and extreme weather conditions. However, their experiences and knowledge systems are rarely heard and shared at national and international levels. Therefore, the scope of this research is not determined by the boundaries of environmental (for example, scientific studies of receding glaciers, landslides etc.) and anthropological changes. The research does transgress these two fields by exploring the socio-ecological dimensions of climate change, particularly in relation to rural communities in Uttarakhand.

Objectives

- To enhance the capacity of farming communities, especially women, in climate resilient agricultural research and its application
- To enhance the resilience of agricultural systems covering crops and livestock to climate change through development of the concept of ecosystem health and resilience
- To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks

Scope and the core concepts

As the title of the project related to climate change and agriculture in Uttarakhand indicates, three crucial issues were addressed in this study:

a. Community participation and gender
b. Village ecosystem and its health
c. Resilience

a. This action-based research is one of the few attempts in Uttarakhand that have focused on incorporating communities and gender on climate change analyses. The research is important not only as a matter of relevance to policy, but also from the view point of promoting community, especially women's voices on climate change issues. The study recognizes the fact that climate change is a human phenomenon with implications for global and local

politics and promotes the idea that communities who have been facing the effects of climate change have a right to speak up. Also, the researchers have a moral obligation to include their voices in analyses, both as a recognition of their contribution to research (communities provide information and help to a majority of researchers) and to facilitate the process of making policies relevant to the lives of communities. Incorporating community perceptions in research is also important because the causes and effects of climate change are extremely skewed. Often, people in remote villages/localities who have contributed the least towards the problem are affected the most by rising temperatures, cloud-bursts, floods etc.

In addition, communities have not been just passive recipients of changes in climate and weather conditions. They have responded to recent changes not only by changing cropping patterns (communities in Galla village, district Nainital, have shifted their apple orchards uphill) but also by uniting themselves to promote solidarity. In Uttarakhand, women's groups and youth groups have been active in discussing climate change issues and also in promoting ways to network, to share information and develop knowledge to be better equipped to face the challenge.

b. Agriculture in the hills of Uttarakhand is dependent on forests and this relationship has been conceptualized in creating the village ecosystem model. This report presents an approach which enables the researchers to visualize each village as a unique ecosystem with specific relationships between non-living components and living organisms. This relationship, portrayed as an ecosystem, is used to examine the status and trends of change in villages. Ecosystem services identified as provision of fuel wood, fodder, water, animal bedding, and nutrition to soil (manure) are mapped in relation to consumption patterns in villages. The data, so obtained, is used to describe the health of the village ecosystem.

c. The third aspect is that the health of a village ecosystem would determine its resilience, and hence its ability to withstand the changes caused by climate change. Both the physical and the social aspects of resilience are explored. While the physical aspects focus on mapping of ecological services of the village ecosystems, the social resilience is viewed from the angle of a sense of solidarity, community co-operation and ability to respond to climate change. The study promotes the idea that ecological resilience is related to social resilience and vice-versa, particularly in Uttarakhand where communities are dependent on their surrounding natural resources to meet the daily requirements of fodder, water, soil nutrition etc. Changes in agriculture, caused by extreme weather conditions would therefore be related to the ecological health of the ecosystem and the rate and patterns of natural resource-use by

communities. Better land management practices (of forests, cultivated areas, grasslands, barren and "wasteland") would ensure healthy ecosystems which would lead to ecosystem resilience.

Centrality of community, especially women

This research would challenge the conventional methods by which climate change responses are framed and stress the need of incorporating community voices into analyses. Therefore, moving beyond the boundaries of pure scientific, technical analysis of causes and effects of climate change, this study has adopted a holistic approach with a focus on the following issues:

(i) Follow and promote a research methodology that enables intermixing of scientific, technical data with needs and perceptions of community on climate change issues

(ii) Ensure all research methods and action, informed by the findings of the research, are gender sensitive

(iii) Ensure that all research processes and activities are sensitive to caste and other forms of stratifications (age, education, locality etc.) within and between communities

(iv) Challenge the myth of women being passive recipients of programmes and aid, promote their agency as active forms of organizations and as agents of change

(v) Document and learn from community-based approaches, particularly from areas experiencing extreme weather conditions, and apply these insights to enrich analyses of quantitative, scientific research

(vi) Incorporate experience and voices of women's groups, youth groups and village committees, such as the panchayats, in village activities

(vii) Address the structural causes of inequality and injustice by raising awareness on economic, socio-cultural and environmental causes and effects of climate change. Build up networks of rural communities and scientists, voluntary agencies, women's groups, youth groups and children

In the context of the feminization of agriculture in Uttarakhand, the centrality of women's role in forests and farming is recognized. From the outset, the research has looked at the issue of gender with multiple angles:

- The first and foremost concern was to establish the fact that climate change is a gender issue. With limited economic resources and choices available to them, rural women form a vulnerable group, particularly because their dependence on natural resources is high

- The second issue was to examine how within communities men and women have been affected and responded differently to climate change. An examination of gender relations within communities and at the household level was imperative to develop an understanding of underlying causes of inequality
- The design and use of agricultural tools/equipment developed by the *Vivekananda Parvatiya Krishi Anusandhan Sansthan* (VPKAS), Almora, an ICAR Institute, was examined from a gender lens. The study explores to what extent the design and use of agricultural tools has been women friendly in villages.
- The analysis incorporates the issue of how limited access to agricultural tools and machines could be a double burden to the scheduled castes, widows, deserted women and female headed households. On the one hand, women from these sections of the community struggle with the norms of patriarchy and on the other hand, face the problem of limited resources available to them. Taking into account their low social status and relatively higher dependence on natural resources, this study has made an attempt to assess women's access to governmental agricultural services.

Collaborative approach

Climate change is not just a physical phenomenon that would alter physical processes and cause damage to natural resources. With its socio-political nuances climate change could be considered as a process which has deep rooted economic and environmental implications. Research on climate change issues, therefore, requires collaborative efforts.

In addition to involving scientists from the VPKAS, Almora, G. B. Pant Institute of Himalayan Environment and Development (GBPIHED), Almora and Srinagar, The Doon University and ICIMOD, Kathmandu (for training of SRFs on participatory rural appraisal), a group of community-based organizations, women's groups, youth groups from Kumaon and Garhwal regions of Uttarakhand were engaged in the research process. While bringing the government employees, professors, community-based organizations and women's groups together, the challenge was to build consensus on the impacts of climate change on agriculture and to arrive at a collective approach to address the issue.

From the outset, the findings of the survey were used to design workshops for women's groups and community-based organizations at USNPSS, Almora. In addition, meetings in villages were conducted with a particular focus on knowledge gaps that had

emerged from the initial results of socio-economic survey in villages regarding climate change and agriculture.

In the initial stages of project implementation, door to door visits by USNPSS staff to build trust and to spread awareness about climate change had proven very useful, particularly in initiating action-based research in villages.

Structure and the stages of research

1. Chapter 1, Introduction, is followed by a chapter on literature survey. Literature Survey indicates that there is not much research available on agriculture and climate change in the Himalayas, particularly in relation to gender and community participation in Uttarakhand.
2. The next stage was the identification of the four sites, which cover a wide range of agricultural and altitudinal locations. Geographical mapping and the socio-economic status of these villages is described in Chapter 3.

3. Participatory Rural Appraisal (PRA) was carried out to map and understand the responses of communities to climate change. The results have been documented in Chapter 4. One of the important findings was the unequal distribution of labour between men and women engaged in land-based livelihoods. The other finding was that horticulture-based (orchards of apples, peaches, apricots, pears etc.) villages are more affected, and therefore, exhibit relatively greater readiness to adapt to climate change conditions. Communities practicing traditional agriculture are not so affected partly due to the fact that some local varieties of cereals are more resilient to climate change.

Since the current generation of educated youth is losing interest in agriculture, sustainability of traditional methods remains an area of concern. This issue is very important for states like Uttarakhand, where frequency of natural disasters is increasing with immediate and drastic effects on communities, land and property. Another aspect driving people away from agriculture is the damage being caused by wild animals, mostly monkeys and wild boar. The extent to which this trend is related to climate change is not known.

4. The study then goes on to develop the concept of a village ecosystem (Chapter 5). The village ecosystem shows the interconnections between people, livestock, forests and agriculture. Where there is a balance between the requirements and production of commodities, the ecosystem is more stable and healthy. Degraded ecosystems, which cannot meet the daily requirements of fuel wood, fodder and water cause ecological poverty. Areas

facing ecological poverty, or deprivation in terms of ecological services, would be more vulnerable to changes caused by extreme weather conditions.

While developing the concept of resilience, the study focused on both physical and social dimensions of village ecosystems. Agricultural resilience is an important issue to be dwelled upon. Normally the word "resilient crops" implies the existence of hardy varieties that could grow under varying climatic and soil conditions. In the hills of Uttarakhand, *mandua* (local millet), that grows at different altitudes and requires least labour during cultivation and harvesting would represent a resilient crop. In that context, *mandua* (local millet) will be the appropriate choice for cultivation on a large scale. However, the current demand to meet the cash requirements of people results in both the government and large aid agencies introducing and promoting cash crops in villages. The conflict, therefore, is whether to grow traditional or cash crops, for example, grow *soyabean* instead of *mandua*. If, however, our aim would be to make the ecosystem healthy and then choose the appropriate variety of crops, the whole process would be different.

Similarly, a significant increase in the population of the white grubs (kurmula) in Uttarakhand is attributed to be a sign of degradation of the village ecosystem. While light traps to kill the grub have been developed by VPKAS, research is required to address the cause of the unprecedented growth of this particular species in the agricultural fields. Why this pest has spread in the first place is a question that climate change researchers, agricultural scientists and extension workers need to ponder upon. Conceptualising the village as an ecosystem helps us to think in this direction. Merely killing the pest is not a solution to the problem.

5. Chapter 6 describes the action research carried out in all the four sites selected for the study. Drawing on the PRA and the assessment of the village ecosystem health and resilience data, and discussions with communities, the project developed a range of activities that could be introduced in villages. Agricultural tools and technologies were introduced in villages with a gender sensitive approach. As described earlier, the horticulture-based village of Galla, facing problems of water shortage and low apple production was the most ready to accept and adapt new techniques. With water shortage being the most pressing problem, introduction of polythene lined water tanks in Galla has been one of the most successful activities. The community has also accepted a variety of tools, and equipment to initiate some income generation activity in the village. For example, apiculture has been adopted in the village.

The community has also explored alternative sources of energy. Currently, some households have been using solar dishes to cook food at Galla.

Shama and the surrounding villages in Bageshwar district have propagated the use of protected agriculture on a large scale. Another initiative has been to make efforts to develop the local varieties of seeds of vegetables, especially radish. Lamudiyar village, district Almora, demonstrates how water tanks and poly-houses could be introduced in a socially disadvantaged community. Kendul talla and Kendul malla, district Pauri Garhwal, exhibit the range of initiatives possible in areas where land is irrigated, communities are homogeneous and relatively richer than the rest of the selected sites. Though water is not a pressing issue in Kendul area, the need of community cohesiveness and cooperation cannot be undermined, particularly because the villages are not yet connected by motorable roads.

Chapter 2

Literature review

Climate change is the most significantly emerging global issue across the environment and development agenda. The Intergovernmental Panel on Climate Change (IPCC) defines climate change broadly as "any change in climate over time whether due to natural variability or as a result of human activity." Such a phenomenon can have widespread effects on many dimensions of natural resources and related human activities such as agriculture across the world. ICIMOD (2009) reports that rural farmers living in South Asia whose livelihoods depend on the use of natural resources are mostly affected by the environmental, economic, and social impacts resulting from climate change.

Additionally, it is reasonable to expect developing country agriculture to face even greater difficulties in adaptation. Incomplete capital markets, poor transmission of information, and low levels of human capital are all pervasive and likely to slow adaptation (Foster and Rosenzweig 1995). According to Ligon and Sadoulet (2007) the negative impact of climate change on agriculture is likely to have a serious impact on poverty. The implication is that climate change could significantly slow the pace of poverty reduction in India.

Heltberg et al. (2009) conclude that wherever the livelihood of the rural communities is based on natural resources, variability in the relevant ecosystem has a debilitating impact. He further stated that in order to improve the adaptive capacity of the community towards climate change we need to improve their understanding of the underlying risk. Hence for the survival of the rural communities, assessment of potential climate change impacts on livelihood is needed.

A study on 'Climate Change Impacts on Global Food Security' by Wheeler and Braun (2013) reported that the stability of whole food systems may be at risk under climate change because of short-term variability in supply. However the potential impact is less clear at regional scale, but it is likely that climate variability and change will exacerbate food insecurity in areas currently vulnerable to hunger and under nutrition. They supported the need for considerable investment in adaptation and mitigation actions towards a 'climate-smart' food system that is more resilient to climate change influences on food security.

Nijssen et al. (2001), Parmesan (2006), Bates et al. (2008) and Ma et al. (2009) conducted a study on the negative impacts of ongoing climate change and concluded that the major areas affected were mountains, river flows, groundwater recharge, natural hazards, and biodiversity; ecosystem composition, structure, and function; and human livelihoods. In case of the Himalayan mountain system, a study by Tenzing and Bawa (2010) indicates that climate change has significantly impacted biodiversity and adaptability to the induced effects of climate change.

Hill agriculture covers all land-based activities such as cropping, animal husbandry, horticulture, forestry, and is a prime source of sustenance for most mountain communities (Kamal 2003 in SAPCC 2012). The MoEF's 4 x 4 Assessment report (2010) discusses some observed and expected changes in agricultural sector in context of Himalayan region. With regard to grassland, the MoEF (2010) states that they may be lost to arable cultivation due to upward shifts in agriculture, which in turn can 'adversely affect livestock sector and agriculture'. Other changes that the MoEF (2010) reports are the ones related to changing cropping and productivity patterns -

Off-season vegetables have shared more than 84% of the area under field crops in Theog Region (above 2000m). The area under cereals has declined to the extent of 80%. In this region, the total area under apple and other fruits has recorded no change over the period; however, across different categories of farmers, the decline in area was more in marginal farms (33.33%) than small (5.59%) and large farmers (4.91%). (MoEF 2010)

Sharma et al. (2009) state that socioeconomic status of the Himalayan region can be influenced by climate change in a number of ways such as economy (e.g., agriculture, livestock, forestry, tourism, fishery, etc.) as well as human health. Though limited data is available on human well-being, but it is clear that the effects of climate change will be felt by people in their livelihoods, health, and natural resource security, among other things.

According to Malla (2008) study of climate change and its impact on Nepalese agriculture, even though early maturity of the crops due to increase in temperature may help to have more crops in the same crop cycle, extinction of natural vegetation - local basmati rice varieties, some local wheat, maize and other agricultural crops was also observed. Malla (2008) also states that enriched carbon dioxide levels have shown positive impact on yield of major crops in all geographical zones in Nepal including livestock, which is an important component of agriculture –

> Increase of atmospheric CO2 will increase the greenery of the land or fodder and pasture for the livestock. Increase in amount of green fodder helps to boost up meat and milk production. It will ultimately help in improvement of economic status of Nepalese livestock farmers. (Malla 2008)

Basannagari and Kala (2013) conducted a study on climate change and apple farming in Indian Himalayas (Himachal Pradesh), based on local perceptions. Majority of the farmers reported that there was increase in atmospheric temperature; at low hills 72% farmers believed that this increase in temperature was responsible for decline in fruit size. Thirty five percent farmers at high hills and 30% at mid hills perceived frost as a major cause for damaging apple farming whereas at low hills 24% farmers perceived hailstorm as the major deterrent for apple farming. About 73–83% farmers admitted delay in apple's harvesting period. Additionally it was also reported that the change in land use practices was attributed to climate change and in many areas the land under apple farming was substituted for production of coarse grains, seasonal vegetables and other horticulture species.

Being a hill state, Uttarakhand is more sensitive to and probably more affected by climate change. Patwal (2010) in his study on Uttarakhand indicates that climate change is being experienced by the community in the form of rising temperature, extreme climatic events, change in rainfall pattern and increase of drought like situation. He also states that forest soil and water conservation are some important issues highlighted by community to reduce future risks. As per a case study of Bajeena village of Uttarakhand conducted by Dev (2010), it was found that climate change has severely affected the natural resources particularly water resources in hilly regions of Uttarakhand.

As per Uttarakhand State Action Plan on Climate Change (SAPCC), Indian Hill Region (IHR) is predominantly rural and highly dependent on climate sensitive sectors. The action plan highlights the pre-existing vulnerability of Himalayan region due to geological reasons, anthropogenic stress and related challenges. Hill agriculture is marked by fragmented holdings, predominantly rain-fed irrigation, high levels of soil erosion and inadequate infrastructure and connectivity. Climate change may further exacerbate these challenges "through increased temperature, altered precipitation patterns, episodes of drought, and biotic influences" (SAPCC 2012). Certain indicators such as warming, changes in rainfall pattern and increase in cloud burst events point to increasing vulnerability of hill agriculture.

> "Here, for example, increasing variation in precipitation (both rainfall and snow), and temperature can change soil moisture availability, plant phenology and their viable altitudinal range, pest susceptibility" (SAPCC 2012)

For instance, evidence of changes in vegetation pattern has been observed with success of cabbage/pea/tomato cultivation in high elevations and shortening of maturity period of winter crops in recent years. A shift in peak rainfall timing from July/August to August/September has also been observed, making damage to mature crops a risk.

According to Negi and Palni (2010) agriculture is linked with climate change in the Himalayan region especially in Uttarakhand; reduced availability of water for irrigation, extreme drought events and shifts in the rainfall regime result in failure of crop germination and fruit set, increased frequency of insect-pest attacks and a decline in crop yield.

Tripathi's (2010) study in Uttarakhand reveals that people perceive a significant change in temperature distribution and a definite reduction in the number of winter months, which now last only for two months; almost 100% respondents felt the changes in the winter season. Respondents in the community also reported changes in intensity and duration of rainfall; rainy season at times, would last till September due to delay in the onset of monsoon, which was harmful for the maturing paddy.

A study on 'Climate Change Influence on Phenological Events and Socio- Economic Status of Village Communities in Garhwal Himalaya' (Dhani Arya 2010) demonstrates that the flowering time, fruiting time and new leaf formation time has shifted from February-April to December- February, which is a fall-out of climate change. Additionally, he also reports that the main reason for the occurrence of climate change effects is due to the disturbance of forest eco-system (encroachment, forest fire, heavy lopping), increasing human population, lack of communities' awareness, disturbances in the monsoon pattern and a loss of nutrients etc.

A participatory research study on climate change in Uttarakhand in five river valleys in the Garhwal region undertaken by Navdanya and the Research Foundation for Science, Technology and Ecology points out that 'the overall pattern of rainfall in both seasons has changed considerably in the last decade' which has significant implications for the availability of water for agricultural purposes –

> “Raining continuously for seven days during monsoon, popularly known as 'Sagain' has become a thing of past, which according to the people was very common phenomenon and vital for ground water recharge” (Shiva and Bhatt 2009)

Moitra and Kumar (2011) also substantiate the understanding that variations in rainfall are seen as one of the most prominent aspect of climate change in the villages, especially by women in the community, for less and scanty rains bring with them drought like conditions whereas excessive rains bring destruction. Furthermore, women in the village reported that due to a drop in the level and frequency of rainfall, fodder was scanty and only available in the villages near a water source such as a spring or river.

The participatory research undertaken by Navdanya also states that one of the outcomes of degraded forest cover including ‘depletion of forest density especially of the broadleaved ones and rapid encroachment of chirpine’ has led to drying of seasonal springs; the consequent change in forest structure has also led to loss of forest habitation and destruction which has abetted an increase in the entry of wildlife in the villages and on agricultural land, which has adverse effects for the rural agricultural communities –

> “A preliminary survey reveals that displaced wild animals are causing 30% to 70% damage to the agricultural crops. In many of the villages, farmers have stopped cultivating vegetables due to the monkey menace” (Shiva and Bhatt 2009)

On similar lines, as per the study conducted by Moitra and Kumar (2011) respondents felt that due to increasing deforestation and use of forestland for agricultural purposes, there is increasing threat to agriculture from wild animals.

In the context of climate change, two emerging concepts that are discussed next are –

(i) Ecosystem services theorized in Constanza (1997), Daily (1997), Ruhl and Salzman (2007) etc., which focuses on the benefits that people derive from ecosystems, including the flows of economically valuable services to human populations and

(ii) Resilience theory theorized in Gunderson and Holling (2002) and Gunderson et. al.(2010), which explores how natural and social systems withstand disturbances over time.

As per Daily (1997) ecosystem services are “the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfil human life.” In other words, these are the benefits people obtain either directly or indirectly from ecological

systems. As per the Millennium Ecosystem Assessment (2005), there are broadly, four categories of ecosystem services that are enjoyed by humankind:

(i) Supporting services (underlying natural processes due to which ecosystems exist such as nutrient and water cycling, photosynthesis, soil formation etc.)

(ii) Provisioning services (benefits extracted from nature such as food, water, fodder, medicinal resources, raw materials for construction and energy needs etc.)

(iii) Regulating services (processes that work together to make ecosystems clean, sustainable, functional and resilient to change) and

(iv) Cultural services (nature has guided the social, cultural and spiritual development of communities from time immemorial and been a source of inspiration, healing and recreation).

The Millennium Ecosystem Assessment (2005) reports that ecosystems have changed more swiftly and extensively over the past 50 years than in any comparable period of human history, largely to meet growing demands of an ever-increasing population. Approximately 60% (15 out of 24) of the ecosystem services evaluated in the assessment are being degraded or used unsustainably. Furthermore, this may even be a barrier to meeting Millennium Development Goals and hence have significant implications for human well-being in times to come.

Resilience and health of ecosystems services are inextricably linked. Resilience as per Millennium Ecosystem Assessment (2005) refers to the amount of disturbance or stress that a system can absorb and still remain capable of returning to its pre-disturbance state. According to Gunderson (2000) and Drever et al (2006), resilience is an emergent property of ecosystems that is conferred at multiple scales by genes, species, functional groups of species and processes within the system. Maintaining or restoring forest resilience is often cited as a necessary societal adaptation to climate change.

Millennium Ecosystem Assessment (2005) reports significance of biodiversity (variability among living organisms and the ecological complexes of which they are part) in maintaining resilience-

> "There is established but incomplete evidence that changes being made in ecosystems are increasing the likelihood of non- linear and potentially high-impact, abrupt changes in physical and biological systems that have important consequences for human well-being"

WRI (2000) also substantiates the same, by stating that for effective conduct of ecosystem processes, such as water purification to cycling of carbon requires a variety of plant species. Furthermore, it is stated that diversity strengthens resilience by “offering “insurance” against climate change, drought, and other stresses”. Hence, this is a significant implication in light of the several literature sources that have hinted at changes in patterns of biodiversity or species range.

Ruhl and Salzman (2007) and Benson and Garmestani (2011) state that ecosystem services theory and resilience theory have both gained tremendous stock in ecosystem management policy over the past decade. Benson and Garmestani (2011) substantiate resilience theory, which as stated, studies the social-ecological interface to gain a better understanding of how dynamic forces in nature affect social systems, and vice versa. As per WRI (2000), it is suggested that to meet the ecological challenges of 21st century, it is imperative to understand the vulnerabilities and resilience of ecosystems, in order to find pathways to “reconcile the demands of human development with the tolerances of nature”. To achieve this, an ecosystem oriented approach to natural resource management is required, which would “respect the natural boundaries of ecosystems and takes into account their interconnections and feedbacks”.

Chapter 3

Introduction to study villages

The study was conducted in four different sites spread over Kumaon and Garhwal regions of the state of Uttarakhand, located in the North Western Himalayas in India. Of the four study sites**,** Galla village (Nainital district) represents horticulture-based economy. Maichun and Lamudiyar form two adjoining villages in Bhasiachana block of Almora district. Kendul talla and Kendul malla are two adjoining hamlets of Kendul village in district Pauri Garhwal. Along with Shama (Kapkot block, district Bageshwar), Maichun, Lamudiyar and Kendul village practice subsistence agriculture.

The study villages are located between the latitudes of 29 37-30 00 N and the longitudes of 78 37-80 02 E representing temperate and sub-tropical agro-climatic zones in Uttarakhand (Table 1). All the study sites are located in the mid Himalayas with the *tarai* (the foothills) in the South and the higher Himalayas (snow covered peaks) in the North. All villages, except Lamudiyar, represent mixed-caste population. Lamudiyar village is totally - inhabited by socially disadvantaged sections (scheduled caste) of society.

Table 1. The Study villages.

Village/hamlet	Latitude	Longitude	Altitude (m)	Soil type	Agro-climatic zone
Kendul talla	N 30 00	E 78 37	573	Loam	Subtropical
Kendul malla	N 30 00	E 78 37	813	Loam	Subtropical
Lamudiyar	N 29 37	E 79 45	1620	Loam	Temperate
Maichun	N 29 37	E 79 46	1664	Loam	Temperate
Galla	N 30 00	E 78 37	1884	Sandy loam	Temperate
Shama	N 29 58	E 80 02	2177	Loam	Temperate

As elsewhere in India, all the study villages experience three distinct seasons and six sub-seasons. However, depending on the altitude, the duration of the three main seasons (summer, monsoon and winter) may vary (Table 2). In Galla and Shama villages, for example, the duration of the winters is much longer than in the other villages. This micro-climatic variation has allowed communities to grow two crops in a year at Shama and Galla while Kendul talla and Kendul malla villages exhibit an agricultural cycle of three crops a year.

Table 2. Agricultural cycle depends on microclimatic variations.

Season	Kendul talla, Kendul malla	Lamudiyar	Maichun	Galla	Shama
Winter	November-March	November-March	November-March	October-April	October - April
Dry	April-June	April-June	April-June	May-June	May-June
Rainy	July-September	July-September	July-September	July-September	July-September

Though agriculture is the dominant occupation, the land is largely rain-fed. Land holdings are small and fragmented, irrigation facilities are minimal and crop yields are low. Further, lack of adequate infrastructure in fruit-belts and in agriculture-based villages remains a constraint. A majority of communities in villages practice mixed-crop and livestock based farming. Men migrate to the cities in search of jobs leaving women and children behind in villages. All agricultural work (except ploughing) is carried out by women. The peak agricultural/horticultural seasons would vary with the altitude of the villages (Table 3).

Over the last few decades, changes in climate and local weather conditions have affected the state to a great extent. While nature is resilient to normal range of changes in climate, extreme weather events have caused irreparable damage to the land, property and lives of people and animals. Further, the mean annual temperatures for the state of Uttarakhand are projected to increase from 0.9 degree Celsius to 2.6 degree Celsius by 2030. Further from 1970, the annual precipitation is expected to increase by 5-13% by 2030 (GIZ, 2011).

The study not only looks into a village as a physical space but also as a social construct. A village has by and large definite administrative boundaries but within this territory, the hamlets may not necessarily follow strict demarcation of areas. This is particularly true for the community in Lamudiyar that shares arbitrary administrative boundaries with two revenue villages, Chanoli and Kumoli. Recognition of such arbitrariness in defining the village would pose several challenges from an anthropological and social point of view, especially if the research attempts to consider communities as cohesive yet dynamic units where people live and work. For example, concerns could be raised about how the community in Lamudiyar would promote better land management practices when the residents do not even have legal possession of the land over which they work. However, the fact that the state authorities have not objected, and in fact have allowed possession of the land to the community without any resistance, now for several generations, also remains true.

Since the impacts of erratic rains and snowfall, increase in temperature, floods caused by cloud-bursts and lake bursts, landslides and debris flow transgress village boundaries, this research would blur the distinction between the village as a physical (administrative unit) and the socio-cultural (organization of community) entity by situating the analysis in a socio-ecological space.

Table3. Agriculture/horticulture peak seasons in study villages.

Village	peak seasons	main work
Galla	May-June	harvesting of plum, apricot, peach, packing
	July-August	Pears, apple harvesting and packing
	December-January	harvesting of dry grass
Kendul malla and Kendul talla	March-April	Harvesting of mustard, wheat
	July-August	Weeding of ragi and paddy
	September-November	Harvesting of paddy, pulses, millets, dry grass
Maichun	April-May	Harvesting of mustard, wheat
	July-August	Weeding of ragi, and barnyard millet
	September-November	Harvesting of ragi and barnyard millet, dry grass
Lamudiyar	May-June	Harvesting of wheat and barley
	July-August	Weeding of ragi and barnyard millet
	September-November	Harvesting of ragi and barnyard millet, dry grass
Shama	May-June	Harvesting of crops
	September-November	Harvesting of crops, grass

Climate change and the village as a socio-ecological space

Uttarakhand is characterized by steep micro-climatic variations in temperature, precipitation and soil moisture. Variability in the micro-climate has led to acclimatization of certain species to restricted altitudinal zones. Sensitive to changes in land-use and hydrology these species face high risks of loss and extinction. Traditional agriculture in Uttarakhand is also adapted to suit the local climatic variations. Growing diverse crops at different altitudes, keeping land fallow in winters, cultivating photophilic crops on the southern slopes, growing

certain varieties of pulses and fruits (for example, *gurunsh*, apple) on the colder sides of the mountain, migrating with cattle and livestock to the high hill pastures during summer, growing tuberous vegetables in sunny, irrigated land and cultivating turmeric, millets in un-irrigated terrace are a few examples of adaptation strategies traditionally used to exploit variations in the local climate.

With the pre-existence of methods that have already been used to adapt to local environment, direct negative effects of climate change on traditional crops may not be significant but the extreme weather events can certainly threaten production beyond the limits of past experiences. The idea of a predicted rise in production of certain crops due to increase in temperature in high altitude villages might collapse altogether by extreme climatic events such as cloudbursts and huge landslides. Less snow and intense rainfall for smaller duration may induce debris flow, mud flows and less ground water recharge affecting soil moisture and availability of drinking water in villages.

Land-based livelihoods, access to and use of water and sanitation facilities, community health and education are issues affected by extreme climatic events. Further, a perceived sense of emotional insecurity may induce migration to other areas. Men may respond to challenges caused by climate change with fatigue and depression and increase their intake of liquor causing socio-economic insecurity to their families.

Livelihood issues are complex and it is difficult to establish a direct link between shifts in production patterns with impacts of climate change. For example, the changing productivity of the village land and shifting values towards traditional occupations in higher altitude villages (Shama) are perceived by communities as reasons for progressive reduction in the number of shepherds and their flocks of sheep and goats. Further, in low altitude villages, (Maichun and Danya), communities no longer keep rice fields fallow in winter. Wheat is cultivated to meet the growing demands of increasing population and changing food consumption patterns. These shifts in livelihoods are not solely related to climate change because factors other than extreme weather conditions are perceived by communities as equally important. Similarly, the recent trend of cultivating ginger and turmeric in place of millets and pulses is not to cope with climate change issues but to save crops from the growing menace of monkeys and other animals including wild boar. The shift, however, is more perceptible in case of horticulture. The orchardists are promoting peach over apple because the duration and intensity of snowfall in winters has declined and precipitation in the

form of hailstorm and sleet mixed with rain in late spring disturbs budding and flowering of apples.

Land use/land cover mapping

Using RS and GIS, with the help of GPS, ERDAS and ARC GIS tools, land use/land cover maps of all the villages/hamlets were prepared based on digital classification.

Data used

Quick bird satellite data of the year 2004, downloaded from Google earth was juxtaposed with the Cadastral maps obtained for the year 1966 from the *patwari* (village level revenue officer) of each site.

In this study, six LULC classes were established as Agriculture, Barren, Settlement, Forest, local pathway and Water body. Descriptions of these land use/land cover classes are presented in the Table 4.

Table 4. Land use/land-cover classification for the study sites.

Class of the land	Galla	Lamudiyar	Maichun	Shama	Kendul talla	Kendul malla
	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)
Agriculture/Horticulture	64.12	6	69.02	20	70.56	17.75
Barren	5.93	3	25.5	4	30.80	8
Settlement	13.34	4	15.05	9.5	20.25	6
Forest	51.31	8	24.41	15	104.52	18
Village pathway	10.52	3	8.01	3	15.40	4.32
Water body	1.51	2	5.54	1	18.79	5.00
Road	-	-	-	3.5	15.60	4.50
Total	147.97	26	147.53	66	275.92	64.57

Socio economic status

The socio-economic status of villages was obtained by using a two-pronged strategy. The first part of the study included administration of structured questionnaires along with interviews with the members, including women, of each household in all study sites. Table 5 exhibits the profile of villages covered by the study.

Table 5. Institutional/service based profile of villages covered by the study.

Institutions/services	Distance from the village (approximate)					
	Kendul malla	Kendul talla	Lamudiyar	Maichun	Galla	Shama
Forest	500 m					
Water source	1 Dhara, 14 Stand Posts	35 Stand Posts, 1 tank	4 naulas, 1 tank, 8 stand posts	1 km naula (Maniagar)	4 Dharas, 5 Stand Posts, River (3 Km)	1 Dhara, 25 Stand Posts, 2 tanks
Public distribution system	Thangar (4km)	Thangar (2km)	Barecheena (7 km)	Maniagar (1 km)	Nathuvakhan (6 km)	Shama bazaar (1 km)
Road	Kacchi road (Inside the village under construction), Pakka Road (5 Km)	3km	*Kacchi* (0.5 km), *Pakki* Road (3 km)	Maniagar (1 km)	Kacchi (in the Village), Pakki Road (3 km)	In the village
Government health care service	Kendul Talla (2km.), Satpuli (20km), Pauri (40km)	In the village, Badiyun (5km), Satpuli (20 km.)	Maniagar (3.5 km), Barecheena (7 km), Almora (35 km)	Maniagar (2 km), Barecheena (5 km), Almora (33 km)	Nathuvakhan (6 km), Ramgarh (17 km), Nainital (70 Km)	In the village, Kapkot (35km), Bageshwar (52km.)
Primary school	Kendul Talla (1km)	In the village	Chanoli (1km), Kumoli (2 km)	In the village	In the village	In the village
High school	Thangar (3 km)	Thangar (2 Km)	Barecheena (7 km)	Panuwanaula (4 km,) Barecheena (7 km)	Lodh (1 km)	In the Village
Intermediate college	Thangar (3 km)	Thangar (2 Km)	Barecheena (7 km)	Panuwanaula, (4 km), Barecheena 7 km (	Supi (6 Km)	In the Village
College for higher studies	Satpuli (20km)	Satpuli (20 Km)	Almora (35 km)	Almora (33 km)	Nainital (70 Km)	Bageshwar (52 km)
Anganwadi	Kandul Talla(1km)	In the village	In the village	In the village	In the village	In the village
Bank	Satpuli (20km)	Satpuli (20 Km)	Barecheena (7 km)	Barecheena (4 km)	Nathuvakhan (6 Km)	Shama Bazaar (1km)
Patwari chowki	Dwarikhal 12km by foot and 68km by road	Dwarikhal 12km by foot and 68km by road)	Barecheena (7 km)	Barecheena (4 km)	Supi Malla 10 Km by foot, 20 Km by road	In the village
Panchayat ghar	In the village	In the village	In the village	1 km (Maniagar)	in the village	In the village
Nearest market	Badiyun (2.5km)	Satpuli (20 km)	Maniagar (3.5 km)	Maniagar (1 km)	Nathuvakhan , (6 km)	Shama bazaar (1km.)
Post office	Badiyun (2.5km)	Badiyun (2km.)	Maniagar (3.5 km)	Barechina (6 km)	Nathuvakhan (6 km)	Shama bazaar(1km.)
Meteorological service centre	Pauri (40km)	Pauri (40km)	Almora (35 km)	Almora (33km)	Mukteshwar (45km)	Almora (125 km)

Demography

The average number of households in a village is 46 with a family size of 4.41. The average population of villages is 201. With a total population of 324, Galla is the most populated and Kendul malla at 134, the least populated village (Table 6).

Table 6. Population distribution in study villages.

Village	Households	Total population	Male	Female	Male children	Female children
Kendul talla	50	191	43	81	32	35
Kendul malla	45	134	35	59	21	19
Lamudiyar	32	169	44	60	32	38
Maichun	50	210	50	87	34	39
Galla	54	324	110	95	68	51
Shama	43	182	60	72	23	27
Average	45.66	201.66	57	75.66	35	34.83

Source: USNPSS Survey, 2012.

Literacy

All study sites demonstrate high male literacy rates. Kendul talla, Galla and Shama villages exhibit 99% literacy among men. The female literacy rate is also high in these villages (73-75%).

Table 7. Literacy status in villages.

Serial number	Village	Male literacy	Female literacy
1	Kendul talla	99	75
2	Kendul malla	89	67
3	Lamudiyar	79	48
4	Maichun	82	50
5	Galla	99	73
6	Shama	99	73

Source: USNPSS Survey 2012.

Lamudiyar village exhibits the lowest rates both in terms of male and female literacy. Given the low economic status and the socially disadvantaged situation of the population in Lamudiyar, the low literacy rate is understandable. The encouraging fact has been that in all villages, including Lamudiyar, every child below the age of 18 years is attending school.

Occupation

Agriculture/horticulture is the main occupation in study villages. In Kendul Malla, about 51% men are involved in land-based activities, including agriculture. However, the uneven ownership of agricultural land in the village has pushed about 26% men (majority

scheduled caste) to supplement their income from daily wage labour. About 23% men in Kendul malla are engaged in off farm activities such as in shops, ferrying goods by mules, priesthood etc. In Kendul Talla, out of the 71% male involved in agriculture, 29% are retired servicemen. Also, the community makes and sells baskets and ropes in nearby villages.

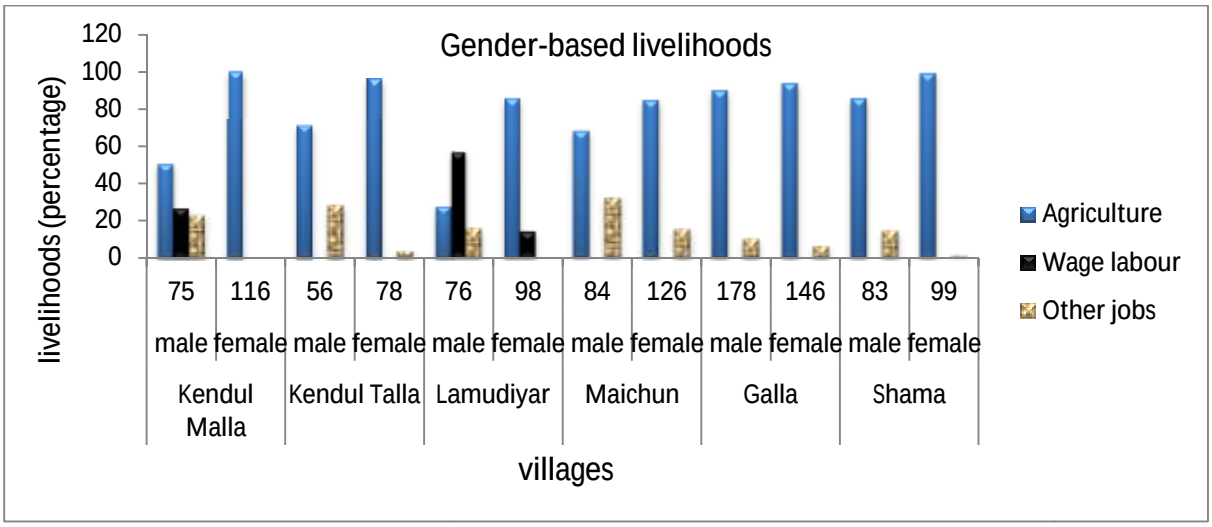
Table 8. Main occupation of communities in study villages.

Village	Category	Occupation		
		Agriculture	Wage labour	Other jobs
Kendul malla	Male	51 %	26%	23 %
	Female	100 %	0	0
Kendul talla	Male	71 %	0	29 %
	Female	97 %	0	3 %
Lamudiyar	Male	27	56	15
	Female	86	14	0
Maichun	Male	68	0	32
	Female	85	0	15
Galla	Male	90	0	10
	Female	94	0	6
Shama	Male	85	0	15
	Female	99	0	1

About 68% male and 85% female of the total population in Maichun are involved in agriculture. The production of some seasonal vegetables in kitchen garden has started under the project. In Lamudiyar, more than half of the total population of adult male is engaged in daily wage labour (56%) whereas 86% women cultivate the fields.

Agriculture became the main form of occupation at Shama when communities left the traditional occupation of rearing herds of goats and sheep. Employment in the army has been very high. Currently, the proportion of ex-servicemen, now involved in agriculture at Shama, is about 32% of the total male population. Communities make and sell baskets, mats made of high altitude variety of bamboo. More recently, horticulture and apiculture has been promoted in the area.

Horticulture is the main occupation in Galla village. Besides growing apple, peach, apricot, pears and other local fruits, the community is a supplier of a variety of vegetables (cabbage, corn, radish, potato, capsicum, cucumber gourds etc.) to the urban-based market in the foothills of Uttarakhand. Apples were introduced by the British, comparatively recently, 100-150 years ago. About 90% men and 94% women of the total population are involved in agriculture/horticulture related activities.



All villages receive their regular quota of rations from the Government public distribution system. Though food production is sufficient for the whole year in Kendul talla (the land is irrigated and fertile), the community receives its quota to feed cattle at home. In all other sites, ration received from the PDS is used to supplement their staple diet.

Lamudiyar exhibits the maximum number of BPL (below poverty line) card holders (97%) while Kendul village with more than 94% APL (above poverty line) card holders represents a relatively prosperous community (Table 10).

Housing

In all the study sites**,** majority of houses represent a mix of traditional and modern architecture. While mud, wood and slate (stone slabs) were used as construction materials in traditional houses the modern design uses a flat cement concrete roof with iron frames for doors and windows. The old housing design included construction of toilet facility, if available, outside the main structure.

Table 9 indicates an interesting issue regarding attitudes of communities towards installation of sanitation facilities at home. As mentioned earlier, Kendul malla and Kendul

talla villages record the highest number of APL card holders, the land is relatively fertile and the percentage of retired ex-servicemen is high. In addition, 88% of the households have been renovated. In this context, the assumption would be that the coverage of sanitation facility should be the highest in Kendul. However, the data indicate otherwise. One of the possible explanations for this discrepancy could be the availability of forest in and around Kendul. Since the forest provides ample space for defecation, community does not feel the need for installing sanitation facility at home (September 2013, personnel communication with Sarveshwari Juyal, a resident of Kendul village).

Table 9. Type of housing.

Village	Percentage of population comprising		Sanitation facility
	Cement and traditional	Traditional	Percentage of population having no toilet facility
Kendul malla	88	12	56
Kendul talla	74	22	52
Lamudiyar	47	31	46
Maichun	64	36	8
Galla	62	37	18
Shama	81	19	10

Access to water

In addition to the traditional sources of water (springs and seepages), piped water supply meet the needs of communities. In Shama, some of the households have cement water tanks for storage. In Maichun, two cement tanks and two springs constitute the main water source. In Lamudiyar, eight stand posts are available in the village but the water distribution system is irregular. In Kendul talla**,** communities use water from springs whereas the canal forms the main water source in Kendul malla. Besides, a network of thirty five stand posts and a tank provide continuous supply of water to the village.

Energy

The main requirement of energy is for cooking and heating of rooms during winters. Fuel wood is collected from the forests and the edges of the terraced fields.

Though all villages are connected by electricity, regular supply remains an issue. The number of households using cooking gas was high in Maichun, Galla, and Kendul talla villages (Table 10).

Table 10. The socio-economic status of communities at a glance.

Parameter	Village					
	Kendul malla	Kendul talla	Lamudiyar	Maichun	Galla	Shama
Households	45	50	32	50	54	43
Total population	134	191	169	210	324	182
Male literacy (%)	89	99	79	82	99	99
Female literacy (%)	67	75	48	50	73	73
Average land holding/household	0.4 ha (20 naali)	1.4 ha (60-70 naali)	0.1 ha (5 naali)	1.9 ha (94 naali)	0.7 ha (35 naali)	0.4 ha (22 naali)
BPL (%)	6	2	97	48	75	21
Toilet facility (%)	56	52	46	8	18	10
Electricity (%)	98	84	91	100	92	90
LPG gas connection (%)	56	60	1	76	63	40
Total livestock	171	208	197	304	235	237
Average dung production per day/household	15	14	12	15	12	21
Expenditure on agriculture/horticulture/season/ household(Rs.)	325	276	141	325	38,407	4,427
Average income/season/household (Rs)	*	*	*	*	70,333	10,525

*****No surplus Note: I hectare = 50 nalis (local measure of land)

Livestock

Communities rear a variety of animals at home to meet the requirements of milk and meat. While Maichun records the highest number of livestock population, Lamudiyar marks the least with a total of 197 animals in the village. Galla, the horticulture-based village shows no bullock population whereas Maichun records the highest number of goats.

In all villages, animals are sent off for open grazing to nearby forests and grasslands. In Kendul malla and Kendul talla, cattle are allowed to graze on the wheat fields after harvesting is carried out. The average grazing time is about 6 hours every day. While

Maichun sent off 86% of the total animal population for open grazing, Kendul malla follows by 83% of animals going to the forest every day. In Lamudiyar, 77% and in Kendul talla 68% of the total animals are let loose for open grazing. Stall feeding in Shama and Galla villages has resulted in about 66% and 79% animals feeding at home.

Average Dung Production

Communities mix the residues from animal bedding, waste fodder and dung together to form farm **y**ard manure. Average dung production in all the study sites is exhibited in Table 10.

Expenditure on horticulture/agriculture

Estimates were made of the approximate expenditure incurred in the agricultural/horticultural activities. In all places, labour is provided by the family itself. So costs refer to items purchased from the market.

The total expenditure per season per household at Galla was estimated to be about Rs. 38,407. It does not include any labour cost. All family members are involved in horticultural activities (harvesting, packaging, loading etc.). The expenditure, therefore, covers the costs of seeds, saplings/plants, packaging material and transportation expenses.

In agriculture-based sites, the overall expenditure is lower than that of in orchards. In Kendul talla and Kendul malla, the expenditure covers the costs of seeds and fertilizers, particularly urea. It was estimated to be Rs. 325 and Rs. 276 per season per household in Kendul malla and Kendul talla respectively. In addition, communities cooperate with each other and share labour during ploughing, sowing and harvesting of crops. Locally called ‘batai’, this practice helps the farmers save costs incurred in cultivation.

In Maichun, farmers use local seeds and do not use chemical fertilizers. Thus, the actual expenditure incurred in cultivation is limited to the costs of ploughing by bullocks, if the household does not have its own bullocks.

Shama records the least expenditure in agriculture (except for ploughing fields in some cases). Farmers cultivating vegetables record the average per season per household expenditure of Rs. 4427. This estimation does not include any labour cost incurred in harvesting, packaging, loading etc. since all this work is carried out by family members. Both men and women and the adolescent children/youth work in the fields.

Income from Agriculture/horticulture

The average yearly cash income from horticulture and agriculture was estimated for Galla and Shama villages as Rs 70,333 and Rs 10,525 respectively. In Kendul talla and Kendul malla, there is no income from agriculture as the community consumes the home-grown food and does not sell it in the market or to surrounding villages. Agriculture production is low and there is nothing to sell in the market in Lamudiyar. Occasionally, the farmers in Maichun sell their agricultural products (horse gram, soya bean and vegetables) in nearby bazaar but the quantity is low and timings irregular.

Milk and dairy products

In Maichun, all the households and in Galla, only two households, sell milk to the dairy. Expenditure on animal care includes the expenses incurred in stall feeding, new buy, medical treatment, vaccination etc.

Table 11: Dairy products.

Village	Average production of dairy products	
	Milk/day/household (litres)	Ghee/month/household (kg)
Kendul malla	1	0.5
Kendul talla	1	0.5
Lamudiyar	1	0
Maichun	2.5	1.5
Galla	1.5	1
Shama	3	2

Wild Fauna and Birds (the local and the scientific names)

Table 12 exhibits the listing of the main species of wild animals and birds found in selected villages.

Table12. The main varieties of wild animals and birds found in study villages.

Villages	Wild animals	Common birds
Kendul malla and Kendul talla	Baanar (Catrol vancliechin) Sungar (***Sus scrofa)*** Gunee (***Semnopithecus entellus***) Baagh (*Panthera pardus*) Saul (*Hystricomorph hystricidae*), Bhalu (***Ursidae***) Goh (***Vairanes bengalensis***) Ajgar (python moluras) Various types of insects	Lampuchadiya (Urocissa caerulea), Sitola (*Acridotheres tristis*), Ghughutia (*Columbidae*), Kauwa (*Corvus brachyrhynchos)*, Cheel (***Aetobatus narinari)*** Titar (***Francolinus pondicerianus)***, Chakor (**Alectoris chukar)** Jungli murgi(*Grifola frondosa)*, Bulbul(*Pycnonotusbarbatus*) Mor (***P. Cristatus)***
Lamudiyar	Baanar(Catrol vancliechin) Sungar(***Sus scrofa)*** Gunee (***Semnopithecus entellus***) Tendua (*Panthera pardus*) Geedagh, Ghurad Kakad	Lampuchadiya (***Urocissa caerulea***) Sitola (*Acridotheres tristis*), Ghghuta(*Columbidae*), Cauwa(*Corvus brachyrhynchos)*, Cheel(***Aetobatus narinari)***, Titar(***Francolinus pondicerianus)***, Junglimurgi(Grifola frondosa), Gautai Bulbul (*Pycnonotusbarbatus*), Musbakudi, Kawcuhni, Bansera
Maichun	Baanar (*Catrol vancliechin*) Sungar(***Sus scrofa)*** Gunee (***Semnopithecus entellus***) Baagh (*Panthera pardus*) Saul (*Hystricomorph hystricidae*),	Lampuchadiya (Urocissa caerulea) Sitola (***Acridotheres tristis***) Ghghuta(***Columbidae***) Cauwa(***Corvus brachyrhynchos)*** Cheel (***Aetobatus narinari)*** Titar(***Francolinus pondicerianus)*** Junglimurgi (***Grifola frondosa)*** Geen (***Passer domesticus)***
Galla	Fan kukura (***Cuon alpines)*** Baanar(*Catrol vancliechin*) Sungar (***Sus scrofa)*** Gunee (***Semnopithecus entellus***) Baagh (*Panthera pardus*) Saul(*Hystricomorph hystricidae*)	Lampuchadiya (***Urocissa caerulea***) VanSariya Sitola (*Acridotheres tristis*) Ghghuta (*Columbidae*) Kaafalpako Cauwa (*Corvus brachyrhynchos)* Cheel (***Aetobatus narinari)*** Titar (***Francolinus pondicerianus)*** Chakor (**Alectoris chukar)** Junglimurgi (***Grifola frondosa)*** Geen (*Passer domesticus*) Gautai Bulbul(*Pycnonotus barbatus*), Chadh
Shama	Baanar(*Catrol vancliechin*) Sungar(***Sus scrofa)*** Gunee (***Semnopithecus entellus***) Baagh (*Panthera pardus*) Saul(*Hystricomorph hystricidae*) Ghurad Kakad (***Muntiacus muntjac)*** Syal(*Vulpini sp.)* Khargos (*L.nigricollis sp.)*	Lampuchadiya (***Urocissa caerulea***) Sitola (*Acridotheres tristis*) Ghghuta(*Columbidae* sp.) Kauwa (*Corvus brachyrhynchos)* Cheel(***Aetobatus narinari)*** Titar(***Francolinus pondicerianus)*** Chakor (**Alectoris chukar)** Junglimurgi(*Grifola frondosa)* Geen(*Passer do mesticus*) Gauta, Bulbul (*Pycnonotus barbatus)*

Gender division of labour

This part of the study was conducted in three phases using well-structured interviews, informal discussions with men and women and observations of USNPSS staff while living in villages. Owing to the existence of active women's groups in all study sites, the researchers did not receive any hostile reaction from communities while prompting questions of unequal division of labour and its impact on gender relations at home and in the community.

Though adult women and men of different ages with different educational-economic status were involved in eliciting information on gender division of labour, particularly in the context of the land-based livelihoods, same indicators were used in all villages to deconstruct relations of gendered dominance in activities that form a part of daily routine.

The work participation of men and women was found to be different in horticulture and agriculture-based villages. This study is also useful to analyse the non-monetary labour cost of women in villages.

Key findings

i. The gender division of labour at home and in the community affects the patterns of production (engagement in commercial activities) and consumption (engagement in subsistence activities). Since, women bear the major responsibility of subsistence agriculture that meets the daily requirements of food, energy and water at home, their contribution to household economy (though in kind, not money) needs to be recognized at all levels of planning and implementation of projects, especially in view of promoting gender equality in society. Involvement of women in subsistence agriculture would leave them with very little time to engage in other activities and for leisure. Men are found to be more involved in productive, commercial activities (daily wage labour, retired service-men getting pension from the state, teachers and the panchayat representatives) but their share in agriculture related activities, except ploughing, sowing and grazing of animals, continues to be lower than that of women.

Table 12. The issue-matrix. Gender-based percent distribution of work as perceived by communities.

Activity	Gender-based percent distribution of work in agriculture		
	Male	female	Both
Selection of crops, seeds	29.8	65.9	4.4
Ploughing /digging	100	00	00
Cleaning of field	00	96.4	3.5
Levelling of field	5.7	94.2	00
Nursery making	10.3	82.6	7.1
Sowing	77.1	16.6	6.2
Transplanting	9.2	84.1	6.6
Manure application	00	100	00
Weeding	8.1	84.7	7.1
Irrigation	00	00	00
Plant protection	00	100	00
Harvesting	9.1	84.7	6.2
Winnowing	00	00	100
Cleaning of grains	00	100	00
Storage	00	100	00
Grinding	49.4	50.7	00
Processing	45.9	50.1	4
Fuel wood collection	27.5	69.5	3.1
Fodder collection	18.4	76.8	4.8
Fetching water	13.7	86.2	00
Leaves for animal bedding	00	100	00
Cleaning of cow shed	00	100	00
Milking	10.3	89.8	00
Sale and purchase of animals	00	00	100
Traditional animal health care	8.1	92	00
Cleaning of animals	00	100	00
Sale and purchase of dairy products	33.3	56.5	10.2
mating, delivery	12.6	87.6	00
Grazing of animals	72.5	27.5	00
Vaccination and visit to hospitals	55.1	44.9	00

Table 13. Average working hours of men and women in agriculture related activities.

Village	Working hours (men)		Working Hours (women)	
	Normal Days	Peak season	Normal Days	Peak season
Galla	8:45	15:45	12:15	11:30
Maichun	4	9	11:30	13
Kendul	3	8	13:45	14
Lamudiyar	5	5	13	14
Shama	6	7.15	11	13

ii. Eliciting information on gender relations requires time and lots of patience because at first the respondents would emphasize the need of change at the community level and in village institutions/committees rather than talking about gender relations at home. For example, women may emphasize the availability of healthy forests near the village to reduce their work load but would find it very difficult to consider a change in traditional gender roles that have made them as responsible for collection of fuel wood, fodder from the forest. Similarly, men would be more assertive than women while selling animals and animal-generated products (ghee, meat etc.), though the basic responsibility for animal care would lie on women. Developing an understanding of these issues, as a precondition to initiate the process of change in gender relations, is a multistep and time consuming process that could not be hurried in villages.

iii. In the context of gender division of labour, resistance to change may be registered by both the adult men and women. During the course of this research, the elderly women would ridicule men who tried to share responsibility for domestic chores. In addition, adolescent girls may consider it their responsibility to perform certain household chores (washing clothes, cooking food, making bed, cleaning utensils for their brothers) after school. Similarly, the male members of the household may resist change in traditional division of labour by getting angry and harassing women. The spatial variation in this perception is, however, recognized. For example, remote villages practicing subsistence agriculture may record more equitable sharing of household work than the villages located near the towns/roads and growing cash crops to sell in the market.

iv. Due to climate change, time has shortened for horticulture activities. Earlier pruning of the trees was carried out in three months, from December to February. However, the pattern has changed as a majority of farmers finish pruning before the end of February. The common perception among the orchardists has been that due to

increase in temperature, peach shows early flowering. In case the peach is just about to ripe and rain falls, the fruits spoil in no time. Therefore, the orchardists would start plucking well before the time of ripening, even though the fruit has not matured enough and appears smaller in size. Small size peach would fetch low-price in the market.

v. Since rural women are often seen as passive recipients and victims of climate change, open village meeting were organized to enable women to assert their role in knowledge building towards climate change research. Gender division of labour formed an integral part of the process while new opportunities were sought to challenge the forms of dominance over women. The finding of this process has been that the gender roles and responsibilities can be worked out again to enable women to seek more opportunities to empower themselves. Changes in climate and on agriculture/horticulture could be used as a basis of initiating such action-based research in villages. The attempt could, therefore, be to not perceive climate change as a burden but to use it as an opportunity to initiate changes that would make communities better prepared for future impacts. Recognition of this issue is particularly useful in the context of the global causes and impacts of climate change in the face of which communities in developing countries are helpless.

Conclusion

This part of the research addresses the issue of how climate change and agricultural planning can be made responsive to gender-specific needs of communities. Along with its action research component this analysis attempts to turn the perceptions about communities as “disempowered” to “capable of making informed and right choices” to face the impacts of climate change in future.

Chapter 4

Impacts of climate change

The findings in this section are based on community perceptions of climate change. The objective is to improve an understanding of community vulnerabilities and adaptation strategies to strengthen resilience of communities.

Methodology

Perceptions of climate change were taken in three successive years, 2011, 2012 and 2013 by adopting three different approaches re Participatory Rural Appraisal (PRA). In the first year (2011), a PRA tool kit developed by ICIMOD Nepal (Trainers' workshop GBPIHED Kosi Katarmal, Uttarakhand 12-14 December 2011) was used. In the second phase (Year 2012), a structured questionnaire developed by USNPSS Almora was administered. Open and closed-ended questions were used to collect information from households. In the year 2013, "community based climate change vulnerability assessment-tools and methodologies; enhancing community adaption to climate change" (Gurung 2012) was used. A detailed description of the methodology and results based on the above mentioned approaches is as follows:

Approach I

Participatory Rural Appraisal (PRA)

Participatory rural appraisal (PRA) methods were used to elicit the community's views on the impacts of climate change on livelihoods and socio-economic systems. A total of 260 people including men and women took part in the PRA sessions and focus group discussions. A total of five tools, as described below, were used during the PRA:

PRA Toolkit

- Weather perceptions (*Seasonality, duration, change*)
- Hazard Ranking *(Weather & weather induced*)
- Seasonal Calendar (*Seasonal activities*)
- Venn diagram (*Institutional dependency*)
- Seasonal Dependency (*Support systems, resource diversity & availability–assessing adaptive capacity*)

Forty men and one hundred five women took part in the PRA sessions only. Often, people in remote villages, especially elderly women, were not aware of the term "climate change". However, given time and space to react and navigate through their experiences, both men and women were able to filter their thoughts and put them across as impacts of climate change.

Unlike men, women were more likely to make a reference of an event in their own life as the baseline for observing patterns in climatic events. During the PRA sessions, similar perceptions were echoed in almost all villages under study.

Approach II

1. Questionnaire

Structured questionnaires were administered with communities, especially women, in all study sites. Open and closed-ended questions were used to collect information from households. This study was conducted in three parts**.** Part I consisted of documenting the perceptions of respondents on various aspects of climate change in all the study sites. Part II included an assessment of the impacts of climate change on various crops and horticultural products. Part III dealt with a listing of observations of communities about climate change.

2. Focus group discussion and interviews with key informants

Both men and women were involved in focus group discussions. The key informants were the village elders, both men and women, and the representatives of the community-based organizations in all the study sites.

Approach III

Climate change vulnerability tool

(R*eference: Community based climate change vulnerability assessment–Tools and methodologies" (Gurung, 2012***)** was used for this study. According to this method, climate vulnerability (V) is a function of

- The character, magnitude and rate of climate variations to which a system is exposed (E)
- Its sensitivity (S)
- Its adaptability (A)

Based on perceptions of communities, the value of E, S and A was categorised as:

I. Low- 1
II. Medium- 2
III. High- 3
IV. Very high- 4

Numerical values were used in the following equation:

$$V = \frac{E*S}{A}$$

The study focused on three interlinked aspects of climate change:

- Local climate change and variability
- Effects of climate change at the local level
- Adaptive capacity and livelihood assets

Results and discussion

Approach 1. Participatory Rural Appraisal

Documentation of the perceptions was carried out to map the perceptible impacts of climate change on livelihoods and the coping response of communities at all study sites. People in remote villages, especially elderly women, were often not aware of the term "climate change". However, given adequate time and space to react and navigate through their experiences, both men and women were able to filter their thoughts and put them across as impacts of climate change. Unlike men, women were more likely to make a reference of an event in their own life as the baseline for observing patterns in climatic events. "When I got married, we used to have much snowfall in *poosh-magh* (December-February) but now we hardly get snow in the winters. It snows in March-April but it is a mixture of sleet and rains....doesn't stay." said Kamla Arya of Lamudiyar village. Pushpa Arya adds to this conversation by saying, "Why do we have pests in the fields now? When it snows, pests die due to cold but now the weather has changed." The following section provides details of the PRA using five assessment tools to elicit information from communities on climate change issues:

Assessment tool I
Seasonal calendar–weather events

The seasonal calendar is a participatory tool to explore changes in season and to document perceptions of communities on climate change. During this study the perceptions of communities on the appearance of extreme weather conditions, variations in the climatic events in a month, intensity of events (high, medium, low) and changes therein were documented. Major weather events were documented with 25 years as a reference point for time.

The seasonal variation across a set of weather events including weather induced hazards (pests, landslides, shortage of food, water etc.) is exhibited in Table 15. During PRA both men and women were able to recall duration and intensity of rainfall over the last twenty five years and their perceptions had matched. However, women were more likely to link the changes with agricultural utility and the variations in the availability of drinking water in the village. The numbers of indicators varied depending on the perceptions of participants but all

villages had reported a fall in the duration of the rain over the past ten years. The change seemed more perceptible in low altitude villages (Lamudiyar, Danya) than the high altitude areas (Shama).

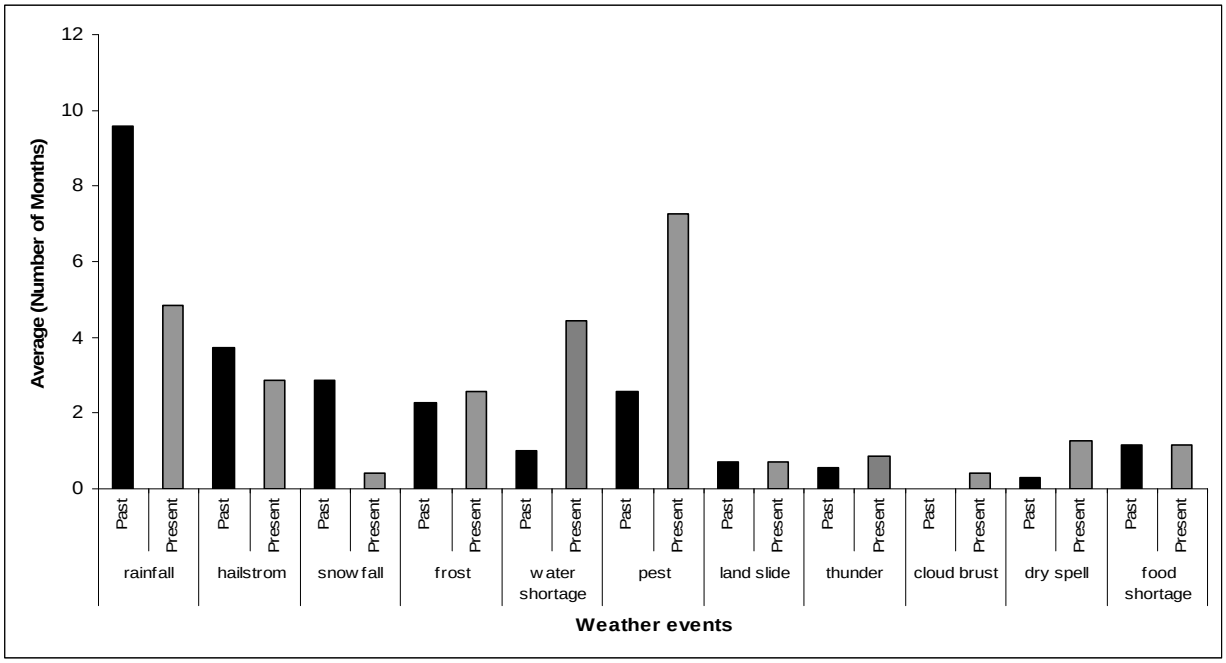
Table15. Seasonal calendar and weather events.

Village	Weather events including weather induced	Intensity variations								
		Low			Medium			High		
	Hazards	Past	Present	Change	Past	Present	Change	Past	Present	Change
Lamudiyar	Rainfall	4	1	-3	3	1	-2	1	2	+1
	Hailstorm	4	1	-3	0	2	+2	0	1	+1
	Snow fall	1	0	-1	1	0	-1	1	0	+1
	Frost	2	2	0	0	2	+2	0	0	0
	Water shortage	0	6	+6	0	1	+1	0	1	+1
	Pest	2	9	+7	0	2	+2	0	1	+1
Maichun	Rainfall	7	0	+7	3	1	+2	0	2	+2
	Hailstorm	3	2	+1	1	1	0	0	0	0
	Frost	0	0	0	2	0	+2	0	2	+2
	Snowfall	1	0	+1	0	0	0	2	0	+2
	Dry spell	0	0	0	0	6	+6	0	0	0
	Landslide	0	1	+1	0	0	0	0	1	+1
	Pest	2	9	+7	0	2	+2	0	1	+1
Galla	Rainfall	5	1	-4	4	2	-2	0	1	+1
	Snowfall	2	0	-2	1	0	-1	1	0	-1
	Hailstorm	1	1	0	2	0	-2	0	0	0
	Frost	0	0	0	0	2	+2	3	1	-2
	Landslides	0	0	0	2	0	-2	0	0	0
	Water shortage	0	9	+9	2	0	-2	0	3	+3
	Pests	1	9	+8	2	1	-1	0	2	+2
Shama	Rainfall	8	4	-4	0	2	+2	3	2	-1
	Snowfall	1	2	+1	0	0	0	3	0	-3
	Hailstorm	0	3	0	4	1	+3	0	0	0
	Landslide	0	0	0	0	0	0	3	3	0
	Thunderstorm	0	1	-1	0	2	-2	0	0	0
	Cloudburst	0	0	0	0	1	+1	0	0	0
	Water shortage	2	4	+2	0	4	+4	0	0	0
	Food shortage	8	8	0	0	0	0	0	0	0

All villages report an increasing trend of high intensity rainfall spread over two-three months in a year. In all the villages, the duration of the low to medium intensity rainfall has reduced leading to several ecological and social disorders especially in relation to the availability of drinking water and of secure livelihoods. The high intensity rainfall received by the sloping terrain for short durations hinders absorption in soil with a consequent

shortage of water. In addition, top soil is eroded much faster than it would have been with low intensity rainfall often causing mud flows, landslips and damage to agricultural fields. A variation in weather events over a period of 25 years is shown in the following graph:

Graph 1: Changes in weather events.

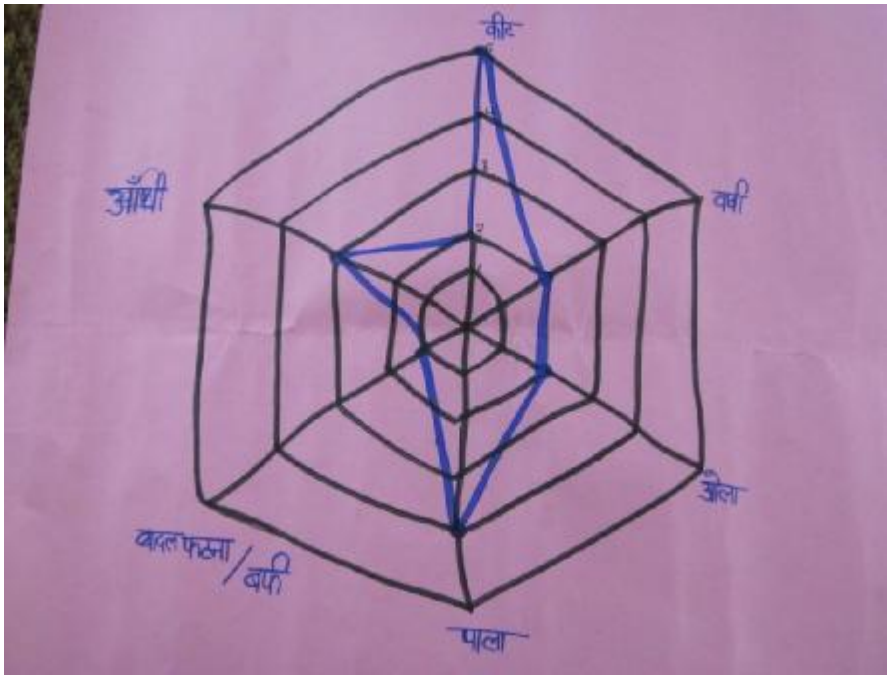


Assessment Tool II
Spider web-Community hazard ranking

The spider web gives an idea of which events have an impact on communities and their livelihoods and at what severity. The ranking was done on a scale of 1 to 5 depending on the degree of severity of impact.

The exercise revealed that damage to property and resources (human lives, cattle and livestock, fields and houses) caused by cloud-bursts, droughts and floods is a widely shared perception of climate change. Further, the changing weather pattern has led to situations where agriculture is severely affected by erratic rainfall, hailstorms and frost. However, the most “visible” change has been an outbreak of pests. Increase in the number and varieties of pests were perceived to be one of the most important reasons for reducing crop production in the fields. This phenomenon may increase the women’s workload without any significant increase in production in the future. In addition, damage to crops by pests may significantly reduce the household income, especially in Maichun, Shama (vegetable growing area) and in Galla village (horticulture and vegetables). Communities have also reported damage to grass

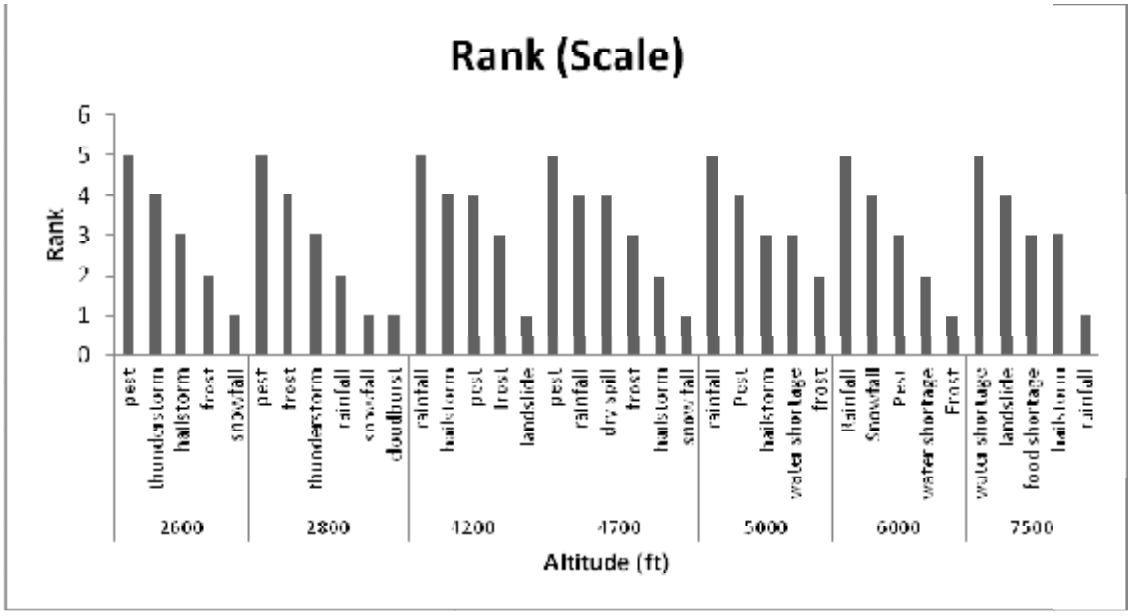
by pests which has led to reduced quantities of fodder to animals affecting milk and meat production.



A hazard ranking map.

Access to water, fodder for cattle, fuel wood and sanitation facilities is an indicator of community well-being. Due to heavy rains and landslides, the village water supply can be damaged causing long-term shortage of water in villages. As a result, communities may revert to traditional sources of water or begin to explore new sources. In both the cases, women's work load would increase as they would have to spend more time and energy in collecting water. Also, due to scarcity of water, sanitation facilities would be under-utilized exposing communities to risks of water-borne diseases like jaundice, typhoid, diarrhoea and dysentery.

In villages around Danya and Shama which were affected by cloud-bursts in 2011, women wanted to restore sanitation facilities as quickly as possible, probably because their preference to privacy is greater than men. Further, due to damage caused by landslides on houses and fields, families may take temporary shelter in schools or in community centres such as *Panchayat ghar, Jan Milan Kendra, barat ghar* etc., exacerbating pressure on a limited space.



Graph 2: Hazard ranking.

Assessment Tool III
Seasonal activity calendar

The seasonal activity calendar portrays information on the type of livelihoods activity for each month in a year. Convergence of activities and labour demands was also carried out. Table 18 shows that dependency of communities on public distribution systems (ration shops) has increased due to unfavourable crop-growing conditions in fields. However, this phenomenon has not led communities to think of changes in traditional agriculture cycle which had revolved around a weather calendar based on undisturbed climatic events. The reason for the perceived hesitation in changing the duration and sowing-harvesting patterns of crops is the uncertainty and frequent fluctuations in weather conditions waiting for any definite pattern to emerge. The fruit growing areas, however, seem to be more sensitive to changes in temperature and outbreak of pests. The fact, however, remains that the fruit orchards are managed by relatively affluent men while agriculture is largely based on women's work.

Reduced agricultural productivity is one of the major reasons forcing communities to migrate to cities and to explore new sources of earning. However, this shift from agriculture to off-farm activities is also gendered. Migration of the whole family from the village to cities may force rural women to take up domestic jobs such as cleaning, housekeeping etc. which may have both positive and negative impacts on their status in the family.

Table 18: Impact on resources, activities, immediate effect and coping responses.

Weather event	Impact		Immediate affect	Implication	Coping response
Erratic rainfall	Wheat	Sowing, harvesting	reduced rate of germination	low yield, food shortage	Increased dependency on ration shops
	Pulses	Sowing, harvesting	reduced rate of germination	low yield	
	Vegetables	Growing, collection	Spoilage	Low production	
	Local rice	Climate resilient	None	Better than paddy	Increase growing local varieties
Food resources	Paddy	Harvesting	Long plants, less grain	Food shortage	Increased dependency on ration shops
	Milk	Less fodder	Low income	Increased dependency on market	
	Meat	Reduced number of livestock at home	Low income	Increased dependency on market	
	Wage labour	Difficult access	No income	Poverty	
	Apple	Flowering, pruning	Delayed flowering	Less production	Replacing apple with peach trees
Income resources	Peach	Flowering, pruning	Delayed flowering	Less production	New varieties of peach
Pest	Cereal	Rooting and growth	Damaged roots, seeds	Food shortage	Increased dependency on ration shops
	Vegetables	Rooting, flowering	Damaged roots, flowers, leaves	No production	
Food resources	Black soya bean	Roots eaten by pests	Crop damage	Food shortage	Increased dependency on ration shops
	Grass	Roots eaten by pests	Less fodder	Reduced number of cattle and livestock	Less compost put in fields which aggravates food shortage
income resources	Fruits	Flowering, fruiting	Low production, size of fruits reduced	Less income	upward (towards the north) movement of apple orchards
	Vegetables	Rooting, flowering	Damaged roots, flowers, leaves	Less production, no income	--
Hailstorm	Cereals	Flowering, fruiting	Crop damage	Food shortage	dependency on ration shops
	Pulses	Flowering, fruiting	Crop damage	Food shortage	dependency on market
Food resources	Vegetables	Flowering, fruiting, harvesting	Crop damage	Food shortage	--
Income resources	Wage labour	Difficulty in access to work	No income	Poverty	--
Water shortage (due to dry spell and intensive rainfall which goes off the slopes)	Cereal, pulses, vegetables	Sowing, harvesting, more weeds due to frequent rainfall	Low crop production	Food shortage, increased work of women in the fields	dependency on ration shops
	Milk	Less fodder	Shortage of milk	Malnutrition	--
Food resources Income resources	Meat	Less fodder		Less income, low consumption causing nutrient deficiency	--
	Vegetables	Low production	Shortage	Malnutrition	--
Landslides	Wheat, ragi, maize	Damage to crops, fields	Field repairs, declined fertility of soil	No or low production	dependency on ration shops
Food resources Income resources	Wage labour	Difficulty in transportation, travel due to road blocks	No work/income	Poverty	--
Increase in winter temperatures,	Wheat, millet	Sowing	Roots eaten by pests	Low yield	--
less snowfall	Beans	Sowing	Roots eaten by pests	Low yield	
Food resources Income resources	Apple, peach, apricot	Flowering, rooting	Low yield, small sized fruits	Low income	Selling orchards, initiating off-farm activities
Frost food resources income resources	paddy, pulses, vegetables, barley, wheat	late germination, wilting	low germination,	less production	dependency on ration shops
	onion, garlic, urad	week seedling, wilting	low germination,	less production	dependency on market

Source: USNPSS Field Survey, December 2011- January 2012.

Assessment Tools IV
Institutional Dependency

The Venn diagram was used to identify key institutions and their roles and importance in supporting communities' decision-making with regard to agriculture, livestock rearing in the context of variability in climate. Which institutions do households turn to during their times of need was considered an important aspect that would influence decisions of communities re climate change.

Table 19. Seasonal resource (food and income) availability.

Village	Resources	Months											
		April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Lamudiyar	Food resources	2	2	4	3	2	4	7	6	6	5	4	3
	Income resources	2	2	2	2	0	0	2	2	2	2	2	2
	Total resources/month	4	4	6	5	2	4	9	8	8	7	6	5
	Vulnerable months*	*	*			*	*						
Maichun	Food resources	10	9	10	10	11	10	10	11	12	12	10	10
	Income resources	-	2	2	4	4	2	2	4	3	2	2	2
	Total resources/month	10	11	12	14	15	12	12	15	15	14	12	12
	Vulnerable months*	*	*										
Shama	Food resources	4	4	6	7	7	6	11	11	9	6	4	4
	Income resources	6	6	5	6	6	4	5	6	5	5	5	5
	Total resources/month	10	10	11	13	13	10	16	17	14	11	9	9
	Vulnerable months*	*	*									*	*
Galla	Food resources	3	3	5	3	4	4	6	3	4	4	3	3
	Income resources	0	0	1	1	1	1	0	0	1	1	1	0
	Total resources/month	3	3	5	3	4	4	6	3	5	5	4	3
	Vulnerable months*	*	*		*	*	*		*			*	*

The exercise on mapping of the institutional dependency of communities revealed that Their relevance of the public distribution system (ration shops) has increased in villages. Though the unfavourable crop-growing condition in the fields is the most commonly cited reason for this change, the phenomenon has not led communities to think of changes in traditional agriculture cycle which had revolved around a weather calendar based on undisturbed climate patterns. The uncertainty and frequent fluctuations in weather conditions were perceived as the main reasons for hesitations in changing duration and sowing-

harvesting cycles of crops. The fruit growing areas, however, seem to be more sensitive to changes in temperature and outbreak of pests. The fact remains that the fruit orchards are managed by relatively affluent men while agriculture is largely based on women's work.

Assessment Tool V
Seasonal Dependency Matrix

The seasonal dependency matrix was used to learn the type of resources that would provide the community/household food and income security over a period and the number of months the perceived sense of security lasts in terms of food and income. The exercise also included information on whether the community/household have income during food insecure months and for how many months the community survives on its own resources. An attempt was also made to document the trends, if any, of communities' involvement in off-farm activities during agricultural lean period.

Table 20. Duration of availability of resources (food and work).

Altitude (feet)	Resources	Availability		Non-availability		Dependency on alternate sources
		Duration	Months	Duration	Months	Months
Lamudiyar	Rice	November	1	December-October	11	11
	Wheat	June	1	July-May	11	11
	Millet	September-May	8	May-August	4	00
	Vegetable	May-August	4	September-May	8	8
	basket, rope	April-August September-May	4	May-July, October-February	8	00
	meat, milk	April-March	12	00	00	00
	Labour	December-July	8	August-November	4	00
Maichun	Millet	November-February	4	March-October	8	00
	Wheat	July	1	July-May	11	11
	Pulses	October-December	3	January-September	9	9
	Vegetable	July-March	9	April-June	3	2
	Milk	April-March	12	00	00	00
	Meat	April-March	12	00	00	00
	Labour	April-March	12	00	00	00
	Labour	December-July	8	August-November	4	00
Galla	Wheat	January	1	July-May	11	11
	Millet	October	1	November-September	11	11
	Potatoes	August-October	3	November-July	9	9
	Beans	All	12	November-July	0	0
	Apple	June-September	4	October-May	8	0
	Apricot	June-September	4	October-May	8	0
	Peach	June-September	4	October-May	8	0
Shama	wheat	June-August	3	September-May	9	9
	Paddy	October-December	3	January-September	9	9
	Pulses	April-March	12	00	00	00
	Vegetable	April-March	12	00	00	00
	Potato	July-September	3	00	00	00
	Cabbage	June-August	3	00	00	00
	dairy product	April-March	12	00	00	00
	Labour	November-July	9	August-October	3	3

In terms of availability of food and income for communities, the winters and monsoons are the most vulnerable month. During winters, agricultural production is low and availability of grass (fodder for animals) is limited. Though work dealing with cattle and livestock, is seen as a tried and promising income generating activity due to ample production of fodder during monsoons, access to wage labour is low.

Approach II. Community perceptions based on the questionnaire

Impacts on agriculture/horticulture

In all the study sites, communities talked about the phenomenon of the increase in temperature, higher intensity rains spread over shorter periods and the unpredictability of weather. All the regions have recorded a decline in the availability of water. Winter cold has become severe and uncertain winter rains/snowfall has resulted in the growth of pests. Changes in climate have affected the cultivation patterns and duration of crops as well.

Women have also reported that for the last two years they were spending more time in weeding the fields. Due to frequent pre-summer rains, weeds grow back quickly and in abundance. Crops which would have required one-time weeding now need it two-three times. Further, the women of Maichun village had reported a shift in their livelihoods by saying that they used to sell garlic, ginger and other vegetables in nearby markets but now it has changed due to low yields, particularly over the last five years.

The shift in cropping pattern is more perceptible in case of horticulture. The farmers are promoting peach over apple because the duration and intensity of snowfall in winters had decreased and precipitation in the form of hailstorm and sleet mixed with rain in late spring would disturb budding and flowering in apple trees. Further, increasing temperatures have led to early or off-season flowering of fruit trees such as in ***kafal*** (a local berry). The delayed budding in apples is a good indicator of late spring. The colour and size of fruits is also an indication of variation in weather. In cloudy weather, apples become smaller in size and fade in colour. Similarly, with the early onset of rains, peaches lose their pinkish-peach colour, ripen early and have a smaller size resulting in low market value.

Due to no/lower rain fall at the time of sowing, germination is delayed. Climate change has also resulted in crop destruction as young seedlings wilt due to high temperatures and reduced availability of water in villages.

Communities have also reported damage by pests to fodder plants leading to low milk production. Reduced agricultural productivity is one of the major reasons for forcing

communities to migrate to the cities. In Galla village the community has reported that in comparison to the last year, the production of peach and apples was better in 2013 but occurrence of the heavy rains during the harvesting time had damaged all the roads causing spoilage of plum, peach and apples.

The sensitivity matrix of crops reveals that millets, especially mandua, are the most resilient varieties re climate change. Pulses and vegetable were found to be highly sensitive to changes in the local/global climate (Table 21).

Table 21. Sensitivity matrix of crops towards climate change.

Village	**Sensitivity of crops towards climate change**		
	High	**Medium**	**Low**
Lamudiyar	Pulses	Cereals	Millets
Maichun	Pulses	Cereals	Millets
Galla	Vegetables	Fruits	Millets
Shama	Vegetables	Pulses	Millets
Kendul	Pulses	Cereals	Millets

Table 22 shows the rain fall requirements of crops during their different stages of growth and the variations that have occurred in the wake of climate change. The most perceptible change is the occurrence of low rainfall/snow during the winter months followed by hailstorms and sleet during spring time that may affect flowering in fruit trees. Further, heavy rainfall in September-October which has been the harvesting months in agricultural areas would damage crop yield. Further, availability of dry grass, which communities store for the winters, would also be affected because of the rains in the autumn season.

Communities have also reported to have some positive impacts of climate change on livelihoods. Introduction of new varieties of peach and *malta* (a citrus fruit) has occurred at Galla due to increase in temperature. Also some harmful arthropods such as leaf cater and snails that destroy the crops have been reported to be dying due to the changing rainfall pattern.

Vegetation in the forests

Relatively warmer climate during the autumn is linked to un-seasonal flowering and fruit bearing in the local varieties of trees such as kafal, *Myrica esculenta.* Further, the community in Galla and Shama had reported a decline in the yield of edible varieties of mushrooms in the forests during the rainy season. The residents of Galla village have also

noticed growth of lichen on the bark of young trees of apple, an unusual phenomenon because earlier only the old trees would be infected.

In addition, increasing attack of pests on oak trees has been reported. The seeds were reported to be infected and rotten by pests leading to low germination of oak in the forests. In Lamudiyar village, Ficus species found earlier in the forest has now disappeared.

Table 22. Climatic requirements of crops.

Village	Crop	Month	Requirement	Reason	Current State
Lamudiyar	Ragi	April /May	Rain	Water needed for germination	No rainfall
		July	-	Flowering	Heavy rain
		August	Slow rain	Fruiting time	Heavy rain
		September	No rain	Harvesting	Heavy rain
Maichun	Ragi and barnyard millet	April /May	Rain	Water needed for germination	No rainfall
		July	-	Flowering	Heavy rain
		August	Slow rain	Fruiting time	Heavy rain
		September	No rain	Harvesting	Heavy rain
Galla	Apple	January-February	Snow/cold/rain	Water needed after pruning	Less snow and rain fall
		March-April	Slow Rain	Flowering in peach (March) Flowering in apple (April)	Hailstorm and sleet
		May-June	Rain	Fruit maturation-water needed to increase the size of the fruit	No rains
Shama	Ragi	May	Rain	Water for germination	No rainfall
		August	Slow rain	Flowering	heavy rain
		September	Rain	Fruit bearing	Heavy rain
		October-November	No rain	harvesting	Rain
Kendul malla and Kendul talla	Ragi	Early April	Rain	Water for germination	No rainfall
		Late June	Slow rain	Flowering	heavy rain
		July	Slow rain	Fruit bearing	no rain
		Late August-early September	No rain	harvesting	Heavy rain

Water yield

All communities have reported a decline in the water yield from sources in and around their villages. The residents of Lamudiyar village have observed a gradual decline of water level in a nearby rivulet so much so that now the community faces water scarcity all through the year. The same trend was found in Galla. Though, it is difficult to differentiate whether the impact on water sources is due to climate change or other anthropogenic

activities, the decline is significant. Furthermore, communities have also noticed gradual changes in their surroundings hills in the last couple of decades in Galla. Earlier mountains that once used to be covered by snow are now dry.

The dependency of communities on the public distribution system (ration shops) has increased due to insufficient crop production in the fields. Earlier, production was sufficient for the whole year for a family and dependency on PDS was not high. At that time people also consumed millets, which also turn out to be the climate resilient crops. At present, farmers produce millets but prefer to eat cereals grown outside their villages, available either in the government ration shops or in the market.

Approach III. Vulnerability index

Community vulnerability and its variables based on the community perceptions and evidence were assessed using the vulnerability tool. Values of climate variable (E), sensitivity (S) and adaptive capacity (A) which resulted from the PRA exercise and well-structured questionnaire were categorised at four groups and the numerical values so obtained were used in the following equation. This gives a way of classifying different villages, as shown in Table 23.

$$V = \frac{E*S}{A}$$

Table 23. Vulnerability index.

Vulnerability	Grouping
Low	<1
Medium	1-2
High	2-4
Very high	>4

Observations for values of climate variable (E), sensitivity (S) and adaptive capacity (A) for the different study sites are given in the following Tables (Tables 24a, 24b and 24c).

Table 24a. Climate variables (E).

Parameter	Indicator	Village							
		Galla		Lamudiyar		Maichun		Shama	
	Hot days summer season increased by days/months/week	3	3.3	4	3.2	4	2.5	2	2.2
	Cold days/winter season becomes shorter	3		3		3		3	
	Cold wave intensity decreasing	4		2		2		3	
	Fog is reduced	-		4		1		1	
Precipitation	Monsoon rainfall with high intensity and short duration	3	2.5	4	3.5	4	3.5	3	3
	Decreased winter rain fall	2		3		3		3	
Climate induced disasters	Land slide	-	2.6	3	2.1	1	1.5	0	0.8
	Wind	-		1		1		0	
	Hail storm	4		1		1		1	
	Lightening	1		1		1		2	
	Drought	3		3		3		2	
	Fire	-		4		2		0	
Livelihood activities	Change in planting date of crops	4	4	1	1	3	3	2	2
Indicator plant and animal	Flowering and fruiting behaviour of indigenous plant	4	3.5	3	2.5	3	2.5	2	2
	Appearance and disappearance of species	3		2		2		2	
Physical information	Volume of water bodies(increased during rainy season and decreased during winter and summers	2	2	4	4	4	4	2	2
Average exposure index		HIGH	2.9	HIGH	2.7	HIGH	2.8	Medium	2

Table 24b. Sensitivity assessment (S).

Parameter	Hazard	Indicator	Village							
			Galla		Lamudiyar		Maichun		Shama	
			Perceived change	Score index	Perceived change	Score index	Perceived change	Score index	Perceived change	Score index
Agriculture and food security	Land slide	Loss of agriculture land	1	2.6	3	2.5	1	1.6	1	1.8
	Drought	Loss of crop production	2		2		1		2	
	Wind and hailstorm	Crop destruction	3		1		1		1	
	Outbreak of disease	Production decline	4		2		2		3	
	Outburst of pest	Production decline	3		4		3		2	
Forest and Bio diversity	Landslide	Loose of forest area	3	2.3	3	2	2	1.3	2	1.3
	Draught	Loss of forest diversity	2		2		1		2	
	Forest fire	By invasive species	2		1		1		0	
Human settlement and infrastructure	Land slide	Settlement at risk	1	1	2	1.3	1	1	2	1.3
	Wind hailstorm	Roof of house taken away	1		1		-		1	
	Lightening	Electric goods damage	1		1		1		1	
Water resources and energy	Land slide	Loose water sources	2	3	1	2.5	1	2	2	1.3
	Drought	Shortage of water	4		4		3		0	
	Wind /hailstorm	Solar system damage	-		-		-		2	
Health	Rain/flood	Water born disease	2	1.5	3	2	1	1	1	1.5
	Drought	Disease by taking contaminated water	1		1		1		2	
Crossing cutting issues	Land slide /flood/heavy rain	Mobility to children, elderly and women and affected diseased victims	2	3	-	4	-	3	1	1.5
	Draught	Access to water and burden	4		4		3		2	
Average sensitivity index			HIGH	2.2	HIGH	2.2	MEDIUM	1.7	MEDIUM	1.4

Table 24c. Adaptive capacity (A).

Parameter	Hazard	Indicator	Village							
			Galla		Lamudiyar		Maichun		Shama	
			Perceived change	Score index	Perceived change	Score index	Perceived change	Score index	Perceived change	Score index
Human assets	Demography	Old age and children population	3	3	1	1	3	2	3	3
	Education and literacy	Awareness on climate change	3		1		1		3	
Natural assets	Water	Availability of drinking water	3	2.3	1	1.3	3	2	1	1.5
	Forest	Availability of fodder, forage, fuel wood and animal bedding	1		1		2		3	
	Land	Productivity	3		2		2		2	
Social assets	Social institution	Community affiliation	2	2	1	1.5	1	1.5	1	1.5
	Service providers	Engagement of GOs, NGOs with community	2		2		2		2	
Financial assets	Financial institutions	Bank, cooperative, Credit groups	2	2	2	2	2	2	2	2
Physical assets	Infrastructure for services	Access to school, house, road, bridge, electricity etc	2	3	2	2.5	2	2.5	2	3
	Information and communication source	Access to mobile ,radio, TV and papers	4		3		3		4	
Average adaptive capacity index			High	2.4	Medium	1.6	Medium	2	High	2.6

Putting the values of the above variables in vulnerability formula,

$$V = E*S*1/A$$

Vulnerability of different villages came out as:

Lamudiyar	3.4	High vulnerability
Maichun	2.3	High vulnerability
Galla	2.6	High vulnerability
Shama	1	Medium vulnerability

Lamudiyar, Maichun and Galla villages have high vulnerability indexes. As compared to Shama, the impact of climatic change will be more on these villages. Increased summer season and shortening of winter were the factors common to all the sites. High intensity rainfall during the monsoons, decreased and uncertain winter rainfall also appeared common to all the sites. Fog, fire and wind were not reported by communities as significant factors. Changes in flowering and fruiting patterns were also experienced.

Outbreak of pest and diseases was the major problem in all villages while hailstorm and wind impacted more on horticulture dominated areas. Landslides and drought were perceived as factors affecting the forest biodiversity.

Conclusions

Changing climatic conditions are adversely affecting the components of the village ecosystem forest, land, livestock and village community. Village communities understand the concept of climate change but lack ideas about how they must cope with these changes. The rise in temperature, reduced snowfall, erratic rainfall, outbreak of pests and landslides are the most pronouncedly perceived climatic events but their impacts are unevenly distributed. The global climatic events have threatened the micro-climatic balance in traditional subsistence agriculture causing material and emotional insecurity to communities.

This study shows that community perceptions on climate change are determined by changes in seasonal and long term interactions of crops, property and assets with variations in temperature and precipitation (snowfall, rain and frost). Weather induced hazards such as pests, landslides, mud-flows, floods and dry spell influence crop production and increase

community dependence on alternative sources of food and income. Winter and the monsoons appear to be the vulnerable months when communities need maximum support from outside. As food insecurity and shortage of drinking water emerge as major areas of concern, more research linking climate change issues with agriculture and hydrological cycle is required.

Since the adaptation to changes caused by climatic events would take time, regeneration of biomass and water, building up a sense of community and enhancing capacity to understand the order and magnitude of vulnerability and need of adaptation could be an effective community-managed strategy to cope with climate change issues.

Receiving timely and relevant information on predictions for climatic events could be an effective measure to prepare community to face immediate challenges and to mitigate problems. Access to and use of assets such as mobile phones, television and radio could be a central issue in building up knowledge-base to meet challenges accruing from climate change.

Chapter 5

Village Ecosystem health and resilience index

The concept of the village ecosystem is central to the development of a resilience index being described in this chapter. The village ecosystem is an outcome of dynamic interactions between geographical (availability of water, soil fertility, type of forests etc.) biological (human population, animals, vegetation composition etc.) and socio-economic components (life style, livelihoods, diseases etc.) that act as a whole by constantly confronting and resolving tensions among themselves to achieve balance or equilibrium at a particular time. The village ecosystem is a dynamic entity. Every village is unique in terms of its physical features and depending on the number of consumers utilizing natural resources and the consumption pattern involved, health of the ecosystem would vary.

The inherent potential of developing the resilience index as a tool to understand the scope and impacts of climate change using the ecosystem health as an indicator relies on the fact that the conflicts and complementarities of interests within the system could be portrayed by measuring production and consumption patterns over time. For example, in a village, the production of food items from the fields can be quantified, the consumption rates could also be measured. Besides being a reliable, simple indicator for determining human health or the level of malnutrition in the village, this data could be used to assess the health of the ecosystem. Similarly, the consumption patterns of fuel wood, fodder, water, milk and other commodities could be estimated to (a) situate the local environmental problems in their broader contexts of climate change and (b) indicate activities in a village to solve these problems. The guiding principle of this exercise is the idea that healthy ecosystems are more resilient to changes brought about by climate change and should be better equipped to absorb shocks and disturbances in the system.

Within the village ecosystem conflicts and complementarities as described in this and the earlier chapter are not issues arising directly as a consequence of recent changes in climate all over the world. Rather, these issues are rooted in historical approaches to environmental, economic and political developments in Uttarakhand and beyond. Climate change is one of the key issues that can increase poverty and social vulnerability, especially in the hills of Uttarakhand, where subsistence farming is practiced. As farming becomes more challenging due to erratic rainfall, floods, temperature variations, the local livelihoods are threatened. As a consequence, dependence on outside sources for food and other household

necessities would increase causing economic stress on communities, especially among low-income households.

The relationship between socio-economic and environmental issues is complex. Our own interactions with communities of Uttarakhand, especially the hill women, have validated the assumption that a relative improvement in the economic condition of the households does not reduce dependence on natural resources. For example, fuel wood from the forests. However, under existing patterns of energy consumption, economic status can change the locus of the problem. Thus, migration to the cities may lead to more energy consumption in the urban areas unless the residents there adopt new methods of energy generation and savings.

Given the current popularity of climate change issues all over the world, it is tempting to conduct studies either on a pure scientific or socio-economic basis but such a study would present a fragmented view of the problem. The approach of developing a resilience index has to move beyond the boundaries of conventional methods of assessing ecosystem health. In doing so, scientific methods are to be integrated with social theory and environmental perspectives with a twin fold objective of (a) grounding research holistically and pragmatically on the current situation (b) demonstrate how ecosystem health indicators can be infused with community perspectives to inform issues of climate change planning and policies.

The aim is to develop a new set of simple, measurable assessment tools for ecosystem health to create resilience indicators that would provide a holistic, interdisciplinary view of foregrounding climate change research in planning. Recognition of the need of developing the resilience indicators using ecosystem health data with an integration of community values is an important input in this direction, especially in the context of the inherent tension between scientific rigour and community values that constantly pose challenges to policy makers.

The study recognizes the fact that determining the resilience of an ecosystem would require complex and advanced scientific and social science research methods. However, given the time and resource constraints for this particular project, an attempt has been made to initiate work in this direction. While the focus of this study remains on quantification of various components of the village ecosystem (ecological resilience), the social construct of resilience is used to enrich the analysis.

The village ecosystem

The concept of a village ecosystem helps to understand the current status of natural and other resources available to the community and suggests ways to improve the management methods to increase the productivity of the cultivated areas, the forests and water. Each village could be considered a unique system, made up of different components, dependent on each other. Within the system, each component is important and works in collaboration with others. Any change in any of these components would make the ecosystem function differently. Three steps to understand an ecosystem have been recognized:

1. Identify and explain the components of the ecosystem
2. Determine the position and function of each component
3. Visualize each ecosystem as a part of a bigger ecosystem

In Uttarakhand, a village ecosystem could be visualized to have four main components. These are (i) the forest land (ii) the cultivated land (iii) livestock and (iv) the community

The current village ecosystem has evolved from the natural ecosystem which existed earlier. An ecosystem is alive and dynamic like all living beings; it becomes mature and can die eventually. It may sometimes deteriorate or otherwise remain healthy. If any component of the village ecosystem is weak or sick, the whole village would be affected. Today most of the village ecosystems in Uttarakhand are unhealthy and some have even died. Bad management, overuse of natural resources due to increase in population, clearing of forests for commercial purposes, use of pesticides and insecticides in the fields could be cited as the most obvious reasons for degradation of ecosystems in the hills of Uttarakhand (UEEC, 2008). A degraded ecosystem is less resilient and it is ill equipped to tolerate the impacts of climate change.

Determining the health of the village ecosystem

Each village ecosystem is characterized by particular structural and functional properties. A natural ecosystem is productive, resilient and organized. These properties could be used to develop the health indicators of an ecosystem where health is defined in terms of an optimum condition of well-being at a particular time. Health is not a property but an abstract concept that could capture properties of an ecosystem. Since ecosystems are dynamic, ever changing entities, the notion of the optimum condition as a measure of good health would also vary with time. Further, the relationship between the properties and

function of ecosystem may vary. For example, the relationship between resilience and productivity is not a linear, progressive measure. Diversity or rich organization of a particular species may not necessarily make the ecosystem resilient. There will always be other factors at play that would determine these relationships especially in terms of the physical (for example, topography) and socio-ecological locus (for example, ecological integrity defined in terms of minimum human impact on nature) of ecosystems at a particular time.

Nevertheless, ecosystem health could be an important indicator of ecosystem resilience. Determining health of the ecosystem could be one of the ways to achieve an overall comprehensive picture of the village and to estimate resilience particularly in the context of climate change. The health of a village ecosystem can be measured by taking the following parameters and quantifying their production and consumption for all seasons in a year:

1. Land area	2. Human population	3. Water consumption
4. Water production	5. Crop production	6. Compost application rate
7. Fuel wood consumption	8. Animal numbers	9. Fodder consumption
10. Milk production	11. Animal bedding	

Simple weighing and measuring techniques were used to determine production and consumption patterns of resources mentioned above. Spring-balance and litre measures were used. Random sampling techniques were employed to collect data in all study sites. 27% of the total households of each village were taken for the study. For the selection of sample households the lottery system was followed. Season-based measurements on production and consumption of natural resources were taken during 2012 and 2013 (Table 1). This follows the methods developed and analyzed in Pande (2004).

Table 25 exhibits no substantive difference in ecosystem health data during 2012 and 2013 but the need for further research and documentation of changes occurring at the local level by collecting data for a longer period is recognized. Two issues that could be highlighted at this point are as follows:

1. In the context of climate change, capacity to ensure and sustain the processes of environmental protection would become weak. Communities will be vulnerable and the village ecosystems be threatened. Healthy village ecosystems would, for example, deteriorate due to continuous occurrence of landslides, soil-erosion or mud and debris flow over the mountain slopes and in the agricultural fields

2. The issue of sustainability of natural resources as a pre-condition to survival is of utmost importance not only from the community point of view but also as a part of planning at national level and beyond. How to improve and sustain the ecological health to protect the economic and emotional concerns of communities is the most challenging question, especially in villages directly affected by climate change. The problem cannot be solved only by economic improvements because the capacity to ensure environmental protection would rely on the health of the ecosystem of which humans form a small part.

Table 25. Ecosystem health indicators in study villages.

Parameters	Galla		Shama		Kendul talla		Kendul malla		Maichun		Lamudiyar	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Fuel wood consumption (kg/day)	17.3	17.4	10.6	13.1	14.8	15	11.5	12	12	13	12	13
Animal bedding consumption (kg/day)	10.5	10.7	13.1	14.2	0.5	0.5	0.7	0.9	8.7	9.5	7.8	7
Fodder consumption (kg/day)	15.1	13.7	17	17.5	22	23	15.7	17.6	24	27	18	21
Water consumption (litres/ day/ household)	274	342	280	287	138	131	81	79	100	98	259	262
Fetching time (min)	45	30	3.25	4	23	23	11.8	12.5	2.5	2.5	9.6	9.4
Distance (meter)	1062	733	995	955	64.2	64.2	193	193	72.1	72	158	147
Filling time (min)	2.2	1.5	4	2	0.69	0.7	1.2	1.2	0.6	0.41	1.6	8
Dung production (household/day)	15	16	22	20	21	20	21.7	20	12.3	12.7	14.1	13
Animal number (per household)	4	4	6	6	4	3	4	3	8	8	7	8
Milk prodn (lit/household)	2.5	2	3	3.5	2	1	2	1.5	2.2	2.4	2	2.2
Cereal prodn (wheat and paddy) (kg/hh)	4.3	13	51.2	90	333	381	183	225	116	209	7.5	41.6
Millets (kg/hh)	18.4	32.4	136	177	52	62	39	48	57	124	28.9	90.4
Vegetables (kg/hh)	422	539	190	239	98	109	30	30	45	175	79	105
Pulses (kg/hh)	10.9	13.8	36	55	20	32	30	22	30	45	11	16
Oil seeds kg/hh	-	-	1.3	1.2	1.6	5	4	6	5	6	3.5	5.5
Average family members	7	7	4	4	4	4	3	3	4	4	6	6

This data can be used to calculate the sustainability for different situations. For example, based on this data one can plan the requirements of the forest area in terms of number of plants and species, as the demand for fuel wood, fodder or timber may indicate.

Ecosystem resilience

Ecosystem resilience is the capacity of an ecosystem to tolerate disturbances. A resilient ecosystem can withstand shock and rebuild itself when necessary.

The concept of ecosystem health is similar and is defined as a social-ecological unit that is stable and sustainable, maintaining its characteristic composition, organization, and function over time while remaining economically viable and sustaining human communities (Costanza 1992, Rapport 1998). A healthy ecosystem is more resilient and tolerates the impact of climate change to a greater extent. If any part of the village ecosystem is weak, then the whole system is affected.

Ecosystem resilience index

Let us define an index of ecosystem resilience (R) as follows:

$$R = A_1X_1 + A_2X_2 + A_3X_3 + \ldots\ldots$$

Where A_1, A_2, A_3 are constants and X_1, X_2, X_3 are variables as outlined below:

A variable X1 relates to water and defined as the ratio of the average water fetched to a household per day to the average requirement per household. The average requirement is taken as 35 liters for household use and 15 liters for kitchen use per person per day and 20 liters per animal per day.
Source:WHO (www.who.int/water_sanitation_health/monitoring/jmp2012/.../en)

For simplicity of measurement, X_1= water consumption/requirement

The variable X_2 is defined as the ratio of average fuel wood consumption per day per person to the average requirement of 500-1000 kg per person per year.

(Ref *FAO CORPORATE DOCUMENT REPOSITORY: TITLE:-Fuel wood supplies in the developing countries* (www.Fao.org)

Thus, X_2 = fuel wood consumption/requirement

The variable X_3 is defined as the ratio of the average cereal production per person per year to the average requirement per person per year.

As per National Institute of Nutrition, Hyderabad

Requirement of cereals in a day/member - 300 gm (cereals include wheat, rice, millets)

Requirement of pulses in a day/member - 21 gm

Requirement of milk in a day/member - 300gm

Thus,

X_3 = average cereal production per person per year/requirement

Let us first tabulate the values for water, fuel wood and cereals.

Table 26. Water consumption pattern.

Village	Average members in a household	Average number of animals / household	Total consumption/l/ household*	Optimum consumption (litre)	Water sources
Shama	4	6	197	320	1spring, 25 stand posts, 2 tanks
Maichun	5	6	347	370	14 stand posts, 2 cement tanks, 2 seepage and 1 ravine
Galla	6	5	315	400	4 springs, 5 stand posts, river
Kendul talla	4	4	144#	280	35 stand posts, 1 tank
Kendul malla	3	4	64#	230	1 spring, 14 stand posts, river
Lamudiyar	6	6	191	420	4 seepages, 1 tank, 8 stand posts

*water fetched to household

In Kendul, residents do not fetch all water requirements, but use water at source or from the canal.

Table 27. Fuel wood consumption pattern.

Village	Average members in family	Average fuel wood requirement /year/household (kg)*	Average consumption of fuel wood /year/ household (kg)	No. of households	Total consumption in the village/year (kg)
Shama	4	2000-4000	4100	43	176300
Maichun	5	2500-5000	5110	50	255500
Galla	6	3000-6000	5840	54	315360
Kendul talla	4	2000-4000	4781	45	212310
Kendul malla	3	1500-3000	4562	50	228100
Lamudiyar	6	3000-6000	5986	32	191552

Table 28. Consumption pattern of cereals, pulses, milk.

Village	Average member	Average requirement in kg/year/household			Average production in kg/year/household			Average land area under ragi cultivation (naali)	Average Production per naali	Average FYM applied /naali
		Cereals	pulses	Milk	Cereals	Pulses	Milk			
Shama	4	438	30.6	438	275	38	1095	2	20	74 kg
Maichun	5	547.5	38.3	547.5	350	35	635	5	8	24 kg
Galla	6	657	45.9	657	60.1	25	620	7	15	54 kg
Kendul talla	4	438	30.6	438	582	30	876	3	10	80 kg
Kendul malla	3	328.5	22.9	328.5	408	28	657	3	16	45 kg
Lamudiya	6	657	45.9	657	87	5	547	5	13	21 kg

Note: 1 hectare = 50 nalis (local land measure)

If we tabulate the above values for Shama village, we obtain the following values. It can be noted that fuel wood consumption is slightly more than average requirement. This is true in all the sites, implying that people are not facing shortage. However, the sustainability of this from the local forest is questionable.

Item	Average requirement	Average consumption
Energy (fuel wood) Kg/household/year	2000-4000	4100
Water lit/household/year	116800	71905
Food (cereals) kg/household/year	438	275 (Average production)

By using the above formula, we can calculate the Resilience Index (R) of an ecosystem especially in terms of food, energy, and water.

$$R = A_1X_1 + A_2X_2 + A_3 X_3$$

If we give the same weightage to all variables A_1, A_2, A_3=1/3

Then, Resilience (R) =1 (in case the village is self-sufficient in water, energy and food)

The ratios X_1 X_2 X_3 should lie between 0 and 1. If it is greater than 1, it implies that the community is consuming more than the requirement. (This is the situation with respect to fuel wood in many villages and the ratio has been taken as 1).

Using the above formula the resilience index of all study sites was calculated. The following table exhibits the resilience index for the study villages:

Table 29. Resilience index of the study villages.

Village	Water X_1	Energy X_2	Food grain X_3	Resilience index R	Ranking
Shama	0.6	1	0.6	0.73	3
Maichun	0.9	1	0.6	0.83	2
Galla	0.7	0.9	0.1	0.57	4
Kendul talla	0.9	1	1	0.96	1
Kendul malla	0.9	1	1	0.96	1
Lamudiyar	0.4	0.9	0.1	0.46	5

While each site is characterized by its own historical account of socio-ecological resource base located at that particular geographical setting, the resilience index, exhibited in Table 29 is a measure of the selected core components available across these villages in the current times.

With the resilience index of 0.96, Kendul malla and Kendul talla emerge as the most ecologically balanced villages. The finding is also supported by our observations during field visits over the last two years. The area enjoys good water supply, both from the in-situ natural sources and through pipe line facilities made available by the government development plans. Unlike other villages studied under the project, the land is irrigated enabling communities to grow different kinds of cereals. Also, the warm climate has enabled communities to grow three seasonal crops in a year. The village seems self-sufficient in terms of energy and food. Huge tracts of forests around the villages have for long facilitated high consumption of wood. Further, availability of irrigation facility has enabled communities to make use of chemical fertilizers and hybrid seeds. How sustainable the practice would be in future, however, remains a matter of concern.

Lamudiyar village ranks low in the resilience scale optimized at 1 as a standard of measurement. Home for socially disadvantaged sections of population (SC community), the village suffers from inadequate supply of water, low grain production due to small land holdings available to each household and lack of irrigation.

Dependent on horticulture, the community in Galla village is relatively better off economically but dependence on the market for basic household needs is very high. As a result, the cash generated by selling fruits and vegetables is exhausted every year, well before

the season of ripening of fruits. Dependence on money lenders is therefore high, though a short term phenomenon every year. In the ecological resilience scale, Galla village does not emerge as resilient as Maichun and Kendul villages do. However, inclusion of the social construction of resilience might alter the scale, given the eagerness of the community and the enthusiasm to innovate and introduce new activities in Galla village.

Let us now try to see what happens if we give different weightages to the different commodities.

A_1=2/3, A_2 =1/6, A_3=1/6

The values do not change significantly and the ranking remains same.

Table 30. Resilience index with greater weightage to water.

Village	Variables			Resilience index	Ranking
	Water X_1	Energy X_2	Food grain X_3	R	
Shama	0.6	1	0.6	0.6	3
Maichun	0.9	1	0.6	0.8	2
Galla	0.7	0.9	0.1	0.6	3
Kendul talla	0.9	1	1	0.93	1
Kendul malla	0.9	1	1	0.93	1
Lamudiyar	0.4	0.9	0.1	0.4	5

When energy is given more weightage than the other components in the same formula i.e. A_1=1/6, A_2 =2/3, A_3=1/6, we find that:

Kendul malla and Kendul talla retain their position as villages with high resilience in terms of energy specified in terms of consumption of fuel wood at home. Another significant development that took place during the project was introduction of solar cookers to cook food in Galla village. However, the initiative could only reach 18 households (out of 54) in the first phase. No significant alteration was recorded in fuel wood consumption pattern and therefore the resilience index was not altered.

Table 31. Resilience index with greater weightage to fuel wood.

Village	Variables			Resilience index	Ranking
	Water X_1	Energy X_2	Food grain X_3	R	
Shama	0.6	1	0.6	0.86	3
Maichun	0.9	1	0.6	0.91	2
Galla	0.7	0.9	0.1	0.7	4
Kendul talla	0.9	1	1	1	1
Kendul malla	0.9	1	1	1	1
Lamudiyar	0.4	0.9	0.1	0.6	5

The low resilience index of Lamudiyar is comparable to the village Galla, when food grain (cereal) component is given more weightage than the others in the same formula:

$A_{1=}1/6$, $A_{2\ =}1/6$, $A_3=2/3$

While Kendul talla and Kendul malla appear as the most resilient in terms of food production, Shama and Maichun villages are comparable having roughly the same access to food specified in terms of cereal production in the village.

Table 32. Resilience index with greater weightage to food (cereal) in study villages.

Village	Variables			Resilience index	Ranking
	Water X_1	Energy X_2	Food grain X_3	R	
Shama	0.6	1	0.6	0.6	3
Maichun	0.9	1	0.6	0.7	2
Galla	0.7	0.9	0.1	0.3	4
Kendul talla	0.9	1	1	1	1
Kendul malla	0.9	1	1	1	1
Lamudiyar	0.4	0.9	0.1	0.2	5

In every case, the resilience index of Kendul malla and Kendul talla villages emerge as the best and of Lamudiyar village the weakest. The detailed socio-economic survey of households confirms this trend. While the differences are less clear-cut in case of Shama and Maichun villages, the analysis does confirm the general trend suggested earlier in this report that healthy village ecosystems are a prerequisite for developing tolerance to disturbances caused by climate change in the hills of Uttarakhand.

Degradation of forests is a serious issue in all study sites. The lowest resilience index of Lamudiyar village is directly linked to the low availability of forest, thin canopy cover and relatively low area of land available for cultivation to each household. The village suffers from chronic water shortage and the problem has aggravated over time. The principal water sources for Lamudiyar have been the local springs and seepages. Dominance of the *Chir* pine forest is related to less infiltration of the rain water in the soil, leading to less ground water recharge.

Similarly, water shortage is a problem in Galla village which can be acute during summer. Both of these villages are the least resilient in terms of food security and depend on outside sources for their daily household needs for food.

At present Kendul malla and Kendul talla appear to be the most resilient ecosystems in terms of energy security while Galla and Lamudiyar exhibit consumption slightly below the required rate. The most obvious explanation for variation in usage could be the availability of a variety of tree species in the forests.

Further, the least resilient ecosystems are concentrated in areas where pressure on the agricultural land is the maximum. In other words, villages with relatively small share of population cultivating larger landholdings emerge as the most resilient ecosystems. The situation, however, may change with changing cultivation patterns, migration to the urban areas, inclusion of off-farm activities as a part of village livelihood strategy and interest of communities in agriculture. The carrying capacity of the village ecosystem will change accordingly.

Table 33. Availability of land in study villages.

Villages	Land (ha)	Total population	Availability of land/person (ha)
Galla	147.97	324	0.4
Lamudiyar	26	182	0.1
Maichun	147.53	210	0.7
Shama	66	169	0.3
Kendul talla	275.2	191	1.4
Kendul malla	64.57	134	0.4

Though availability of land appears as an important determinant of ecosystem resilience for communities dependent on agriculture, inclusion of other variables in the resilience scale might alter the situation. Table 8 exhibits the resilience index with

calculations based on the production of milk, cow dung and fodder consumption. Interestingly, with addition of more variables, Kendul malla loses its position of the most resilient ecosystem to acquire the third rank and Maichun village steps up to gain the better position. Therefore, it can be concluded that the resilience index of an ecosystem would depend on a careful selection of the variables. Further, these variables, as presented here, reflect their ecological value and exclude the calculations based on the level of stress that women experience during collection of commodities from the forests.

Table 34. Adding more variables to resilience index.

Village	Water X_1	Energy X_2	Food X_3	Milk X_4	Fodder X_5	Dung production X_6	Resilience index R	Ranking
Shama	0.6	1	0.6	1	0.7	.3	0.70	3
Maichun	0.9	1	0.6	1	0.4	.6	0.75	2
Galla	0.7	.9	0.1	0.9	0.3	.3	0.53	4
Kendul talla	0.9	1	1	1	0.7	.5	0.85	1
Kendul malla	0.9	1	1	1	0.7	.5	0.85	1
Lamudiyar	0.4	.9	0.1	0.8	0.3	.5	0.50	5

Table 35. Fodder consumption.

Village	Average number of animals (cows and buffalos) /household	Average dung produced/ day/ household	Optimum production of dung /day	Average supplied fodder kg/day /animal		Average supplied water in litres
				GG	DG	
Shama	5	21	65	10	4	10
Galla	3	12	39	5	2	20
Maichun	2	18	26	6	3	21
Lamudiyar	3	12	39	4	2	8
Kendul malla	2	15	26	11	3	10
Kendul talla	2	14	26	12	2	11

GG=green grass, DG= dry grass

Source- Singh Kamal and Singh H.S. *"Forage resource development in Uttarakhand Experiences and observations". Uttarakhand livestock development board* *http://www.uldb.org/pdf/Forage%20Resources_FDP_.pdf*

The average need of fodder (Kg/day) Dry grass 4-6, Green grass-15,

The average dung production /day/animal - 13kg, Need of water – 25-30lit /day

A different approach to ecosystem resilience

Another method could be developed to acquire a better understanding and broader description of villages. The same formula, as applied earlier could be used for this purpose, though with a different set of variables.

$$R = A_1X_1 + A_2X_2 + A_3 X_3$$

Where,

X_1= Rain water infiltration rate

X_2=canopy cover of the forest/support area

X_3= Food security in terms of productivity (actual production/optimum yield)

Infiltration rate (X1)

The infiltration rate is the velocity or speed at which water enters into the soil. It is usually measured by the depth (in mm) of the water that can enter the soil in one hour. Infiltration rate of 15 mm/hour, for example, means that in one hour a water layer of 15 mm will go into the soil. The infiltration rate depends on the texture of the soil (the size of the particles) and soil structure (the arrangement of the soil particles). It is a useful way of categorizing soils from an irrigation point of view. The infiltration rate varies depending on the type of the soil.

- **Clayey soils**: The infiltration rate for clay, in millimetres per hour, is 1 to 5. Clay loam generally sees an infiltration rate between 5 and 10 millimetres per hour
- **Loamy soils**: It can encompass a variety of infiltration speeds. These soils have an infiltration rate ranging from 4 to 7 millimetres per hour
- **Sandy or gravelly soil**: These soils have a high infiltration rate and low runoff. The infiltration rate of especially sandy or gravelly soils can range from 25 to 200 millimetres per hour

Other factors that can influence infiltration rate are as follows:

- Compact soils will have lower infiltration.
- Soils with strong aggregates, like those with granular or blocky structures, have a higher infiltration rate than soils with weak structures.

- Infiltration rate is usually higher when soil is dry.
- Frozen soil surfaces can completely prevent infiltration.
- High organic matter and continuous pores can enhance the soil water infiltration rate.

Method used for determining the infiltration rate

- Dig a hole of 15cm depth on the ground
- Fill the hole with water to moisten the soil and allow it to drain completely
- Fill the hole with water a second time, and place a ruler or stick in the hole. Note the water level and the time. After 15 minutes check the water level again, record the value so obtained
- Multiply the recorded value by 4 to get the number of centimetres or millimetres of infiltration in an hour
- Multiply the rate of infiltration for the soil in m/hour by 24 hours to get the rate of infiltration of soil in one day (to compare with the average rainfall over one day)

R = Rate of infiltration (m/hr)
I = Infiltration in one day (m)

$$R \times 24 = I$$

By using the land-use map of the village, we took five samples from different classes of land i.e. the agricultural land, barren land, forest and the land near the water source (ravine and seepage). The average value for the total infiltration rate was calculated.

Table 36. Water infiltration rate.

Village	Soil type	**Basic infiltration rate (mm/hour)	Average infiltration rate	Minimum absorption rate in mm/hour	Measured Infiltration rate of crop fields	X_1 (measured infiltration/Average infiltration rate
Shama	Loam	10-20	15	15	17.7 or 18	0.8
Galla	Sandy loam	20-30	25	25	14.25 or 14	0.6
Maichun	Loam	10-20	15	15	15.5 or 16	1
Lamudiyar	Loam	10-20	15	15	13	0.8
Kendul malla	Loam	10-20	15	15	16	1
Kendul talla	Loam	10-20	15	15	18	1.2

** (www.nbsslup.in)

2. Forest canopy cover measurement (X2)

Forest and agro-forestry analysis was done by using the methods developed by Curtis and McIntosh (1950). Quadrates of 10X10 square meters were randomly placed in the forest. The circumference of each tree that fell within the quadrate was measured. The number of trees was counted.

For shrubs, the quadrate size of 5X5 square meters was used. For herbs and grasses 1X1 square meters size of quadrates were taken. The study was done for occurrence of different species of trees, sapling and seedling circumference at breast height of all trees (CBH-1.37c.m). Computation of the data was done using the following formulas:

$$\text{Density} = \frac{\text{Total number of individual species occurring in all quadrates}}{\text{Total number of quadrates studied}}$$

$$\text{Frequency (\%)} = \frac{\text{Total number of quadrates in which species occur}}{\text{Total number of quadrate studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individual species occurring in all quadrates}}{\text{Total number of quadrates in which species occur}}$$

- Density is defined as the number of individual per unit area of length.
- Frequency is the dispersal of a species expressed in terms of percentage.
- Abundance is defined as the number of individuals per unit quadrate of occurrence.

Stages of growth of trees in the forest were determined using the following criteria:

1. **Seedling**: The above-ground part of the embryo that sprouts from the seed
2. **Sapling**: the seedling attains the height of 1 m and becomes 7 cm in diameter
3. **Pole**: Young trees with 7–30 cm diameter
4. **Mature tree**: Over 30 cm diameter, reproductive years begin
5. **Old tree**: Dominate old forests. Growth slows down, productivity manifests in the form of seed production
6. **Over mature**: decaying begins, eventually die.

In addition, the size class distribution for different species was obtained to construct the population structure diagrams and interpret their status to indicate the future growth trends in the forests.

$$\text{Relative density (\%)} = \frac{\text{Density of individual species}}{\text{Total density of all species}} \text{ X } 100$$

Kendul malla and Kendul talla

The mixed forest of Kendul malla is characterized by Gadmehu (local name) as the dominant species and Mehal (*Pyrus pashia*) as co-dominant species, while in Kendul talla, Dhaud (*Zizyphus rugosa*) is dominant and Haldu (*Adina cordifolia*) is the co-dominant species. Out of the ten different varieties of trees that flourish in the area, edible varieties of fruits are obtained from jamun, bilangoor, *Punica species* (Dadim) and bankakadi. There are thirteen varieties of shrubs and twelve varieties of herbs and grass found in Kendul malla whereas the forest in Kendul talla is characterized by thirteen tree species, eight varieties of shrubs and herbs each. Dominant varieties of shrubs include *Murraya koenigii* (curry patta), *Carissa carandas* (karonda) and *Ziziphus mauritiana* (ber).

Communities report that the recent spread of *Parthenium hystrophorous* (*gajar ghaas*) and *Lantana camara* (*laalten*) has retarded the growth of natural vegetation. Ground vegetation viz. moss, Pteridophytes and lichens were hardly seen in the forest.

Lamudiyar

The three patches of forests found around Lamudiyar are located in the eastern, southern and western direction. The south facing mountain slope is covered by pine trees while oak grows in the northern side of the village. The canopy cover of the pine forest was chosen for this study. Besides, pine a few trees of *kafal* and three different varieties of shrubs are also found in the forest. Spread of forest fires is a common phenomenon in Lamudiyar, especially during the summers when dry pine leaves catch fire very quickly.

Maichun

The van panchayat of Maichun village consists of two varieties of forests. The *Quercus leucotrichorhora* (Oak) forest is dominated by old mixed varieties of broad leaf

trees while the pine forest represents a mono-cultural patch of trees. The oak forest is dense with seven varieties of trees, four types of shrubs and thirteen varieties of herbs and grasses. It is inhibited by a variety of wild animals including wild boar, leopard, monkeys, apes etc.

Galla

The forest in Galla village is expanding because the distribution and growth of seedlings and saplings is more than the other trees. *Quercus leucotrichorhora* (*Baanj*) is the dominant and *Pyrus pashia (Mehal*) is the co-dominant species in Galla In addition to thirteen different varieties of trees and sixteen shrubs along with forty four herbs and grasses, the forest appears dense and productive. Common wild berries include *Rubus ellipticus (hisalu*) and *B. asiatica* (*kilmora*). *Pyracantha sp.* (*ghingharu*) is common and extensively used for making agricultural tools. The number of mother trees in the forest is decreasing due to overcutting by the community.

Shama

The forests around Shama village include the reserve forests owned by the government as well as the community owned areas. We took a patch for our study which is mostly used by villagers. The expanding forest of Shama consists of Quercus leucotrichorhora *(Baanj*) as the dominant species followed by *Quercus floribunda (tilonj*) as the co- dominant species. Nine different varieties of trees are interspersed with the same number of shrubs including *Barbaris* species (*kilmora*) and *Rubas elliptica (hisalu*). Lichens (Leptogium *and Usnea)*, mosses and other lower plants found in abundance.

Canopy cover

Canopy cover is defined as the fraction of ground covered by the vertically projected crown envelopes. Canopy cover is directly related to tree density and stand basal area. For any area, the total canopy cover can exceed 100% because plants can overlap. Canopy cover, when combined with other indicators, can provide valuable information of structural condition of forest. Forests can be divided on the basis of canopy cover as follows:

1. Open forest - 10-39% canopy cover
2. Moderately closed - 40-69% cover
3. Closed forest - 70-100% cover

Canopy cover of forests in all the study sites was studied using the following method:

Line-intercept method

This method relies on establishing transects and then recording the plant crown that overlaps or intercept the tape measure. Intercept distance is recorded. The distance between where the canopy begins on the tape measure and where it ends is recorded for each species. The total distance for each species is then divided by the length of the tape measure for the percent cover for that particular species. Standing dead canopies were not recorded.

$$\text{Percentage of canopy cover} = 100 \times \frac{\text{(Total transect length \_ Total length without canopy)}}{\text{Total transect (length)}}$$

Kendul talla and Kendul malla villages exhibited dense canopy while in Maichun and Lamudiyar the forest canopy was thin.

Table 37. The forest canopy in study villages.

Village	Forest canopy (%)	Type of forest
Kendul malla	72	Closed forest
Kendul talla	71	Closed forest
Lamudiyar	15	Open forest
Maichun	15	Open forest
Galla	30	Open forest
Shama	24	Open forest

Based on the percent distribution of the canopy cover, averages were calculated for all the forests. Based on this value the resilience could be estimated.

Table 38. Canopy cover measurement: (Average canopy cover).

Village	Measured Forest canopy (%)	Type of forest	X_2 (forest canopy/100 % canopy)
Kendul malla	72	Closed forest	0.7
Kendul talla	71	Closed forest	0.7
Lamudiyar	15	Open forest	0.1
Maichun	77	Open forest	0.7
Galla	30	Open forest	0.3
Shama	24	Open forest	0.2

Average optimum production (crops)

Table 39. Average optimum production.

Crop	Production in kg/ha*	Production in kg./naali	Actual production/naali in kg					
			Shama	Galla	Maichun	Lamudiyar	Kendul malla	Kendul talla
Wheat	5000	100	20	15	60	0	80	82
Maize	6000	120	90	40	0	0	0	0
Barley	8000	160	80	70	100	50	120	130
Jhingura	600	12	0	0	10	8	9	10
manduwa	1500	30	20	8	15	10	16	13
peas(mixed)	600	16	15	13	0	0	0	0
peas(pure)	1800	36	30	32	0	0	0	0
Potato	20000	400	250	200	0	0	100	100

*based on ICAR Agricultural handbook.

Village	X_3 (Actual production/optimum production)
Kendul malla	0.5
Kendul talla	0.4
Lamudiyar	0.3
Maichun	0.5
Galla	0.2
Shama	0.6

Formula $R = A_1X_1 + A_2X_2 + A_3 X_3$

If we give same weightage to all variables A_1, A_2, A_3=1/3, Then, Resilience (R) would be as follows:

Table 40. Resilience index based on ecological components.

Village	Water infiltration X_1	Forest canopy X_2	production X_3	R	Ranking
Kendul malla	1	0.7	0.5	0.7	1
Kendul talla	1.2	0.7	0.4	0.7	1
Lamudiyar	0.8	0.1	0.3	0.4	2
Maichun	1	0.7	0.5	0.7	1
Galla	0.8	0.3	0.2	0.4	2
Shama	0.6	0.2	0.6	0.4	2

Conclusion

Both men and women are affected by variations in climate. However, gender inequalities in household work and in agriculture, unequal access to opportunities, differentiated rights and responsibilities mean that women are more vulnerable. For example, collecting fuel wood from the forest is one of the roles that women take up as a part of their daily routine. Across villages, fuel wood consumption was recorded to be the highest in January. Though, a few families in Galla village have diversified their source of energy by using solar cookers, cooking gas (LPG) etc. but this usage has not altered the fuel wood consumption patterns in any significant way.

In areas affected by climate change, the conflict between economic utility and ecological importance finds a new ground as communities begin to supplement their cash income by diversifying the use of natural resources. For example, selling dry grass to nearby villages has emerged as a livelihood diversification strategy in Lamudiyar and Galla villages. The change also underscores the key issue of conservation of forests and grasslands for immediate use during the vulnerable periods caused by natural disasters such as earthquakes, cloudbursts, floods etc.

One of the most positive aspects of this research has been the involvement and participation of communities, especially women, in knowledge building and action in villages. Women's groups, active in natural resource management issues in all the sites, are aware of the fact that developing and strengthening resilience of the village ecosystem is not a complex environmental issue that requires advance science. Rather, simple conservation measures and better land management practices could help improve the health of the village ecosystem. In other words, women's groups do not see these issues as unsolvable problems but treat them as areas whose solution is known, given the little encouragement and financial support to initiate and nurture activities in their respective villages. As a result, a variety of activities aimed at improvement in the village ecosystem to increase resilience have already been completed in study villages.

Box 1 suggests some measures to make ecosystems healthier and resilient to the impacts of climate change.

Box 1. Developing resilience of village ecosystems

- Plantation of indigenous varieties of fodder and fuel wood trees
- Protection, regeneration, conservation of forests
- Maintenance of agricultural diversity by mixed cropping systems
- Growing and promoting the use of the resilient crops such as *mandua*
- Rainwater harvesting (trenches on the mountain slopes, cheap polythene lined tanks)
- Stall feeding of animals
- Maintaining population in terms of carrying capacity of the ecosystem
- Installing green houses to grow off season vegetables to improve income
- Developing and nurturing community co-operation and cohesion
- Researchers, policy makers listening to communities, to people who have already been facing the consequences of climate change
- Sharing information, developing knowledge and skills, building networks of people

Chapter 5

Action research with communities

Introducing agricultural tools and technologies with gender-aware processes

In Uttarakhand, 58% of the main workforce (farmers and agricultural workers) directly draw their livelihoods from agriculture (Report code 016-GBP-IIT-SEC-ANL-02- ver 1-Dec 2011). The occupational distribution of the main workforce shows higher proportion of the agricultural workers in the hills (61.8%) than in the plains (48.7%), though the contribution of agricultural labourer is just 3.3% in the hills and 22% in the plains. Although, the decadal variance in the income trajectory reveals a shift from agricultural and allied activities to non-farm work, agriculture continues to be the major source of rural livelihoods in the state (Report code 016-GBP-IIT-SEC-ANL-02- ver 1-Dec 2011).

The low engagement of wage labourers in agriculture could be attributed to the relative homogeneity in land ownership in the hills and also to the disproportionate gender division of labour in which women carry out all work in the cultivated fields, except ploughing. The feminization of agriculture persists because the men migrate to the cities and women and children take up diverse tasks at home (FAO 1995a). The patriarchal composition of society ensures that men, even when at home, do not take up responsibility for agricultural work. Besides cultivation, women are responsible for taking care of their livestock, child care and care for the elderly, collection of fuel wood, fodder from the forest, cooking, cleaning and maintenance of the house. Thus, the role of women goes beyond agricultural production to cover activities that could be described as “management of the village ecosystem” (see chapter 5 for details). However, high engagement of women in ecosystem management also presents the risk of confirming to traditional gender roles and responsibilities, a practice that poses structural barriers to women wanting to expand choices in a rural setup.

The rugged terrain and the occurrence of small size, fragmented landholdings available to communities have prevented them from adopting modern agricultural practices. Bullocks are used for ploughing the fields. Mechanized methods (tractors, power tillers, pump-sets) are not used. Further, unlike the plains, the bullocks are not used for transportation of crops and goods but raised exclusively for the purpose of ploughing. Rain-fed agriculture is practiced.

The types of livelihoods that men and women seek are influenced by sexual division of labour and gender relations at home and in communities. In the case of women farmers, their unequal status, limited access to information and institutions, lack of property rights at home and degradation of common resources (forests, water, grasslands etc.) are factors that would make them more vulnerable than men. The capacity to cope with changes brought about by climate change is, therefore, gendered. However, women are not just passive recipients of changes caused by climate change in the village ecosystem. During a disaster, communities may adopt gender-differentiated coping mechanisms and their livelihood strategies might differ, organized groups of women seem to be better equipped to handle stress and manage the shock at the community level. For example, during the course of this study, several anecdotes were mentioned by communities that would demonstrate how women can exercise their agency and deal with stress more efficiently in a collective manner, rather than addressing the challenges on an individual basis. Immediately after the disaster caused by cloud-bursts in Ukhimath, Kedarnath valley, district Rudraprayag (2012), the women's groups in Mangoli, Chunni, Dungar-Semla, Painj and Kimara villages called upon each other to provide support and to share information. Since the disaster struck at night, women shared flashlights, cell phone etc. and for days took care of the livestock of families who had lost their cowsheds due to landslides and flooding in the area. They provided emotional and economic support to each other and managed to sustain their household and community responsibilities through collective action. Therefore, in contrast to the widely recognized perception of much deeper erosion of women's capabilities than those of men in disaster hit areas (Masika and Baden 1997), this study shows that the whole village women's groups (all women of the village are part of a single group) are better equipped to address issues brought about by climate change.

Further, the need for collective action by women farmers became apparent when communities had reported the limited reach of the government extension services to villages. None of the villages studied under this project had received or purchased even minor agricultural implements such as rakes, threshers and sprayers from the government agricultural extension services. The female farmers had no contact with the department in the region and had not received any direct benefit from the government, except for some seeds and fertilizers at subsidized rates from the local block office. Further, the farmers were not trained and informed about the schemes offered by government through extension services.

In this context, an attempt was made to identify the need of agricultural tools and machines the use of which could be beneficial to communities, especially the women farmers. In a patriarchal society, where tools and technologies are regarded as the domain of men, machines designed by agriculture experts could be taken as a reference point to assess needs and to validate their acceptability and friendliness to women farmers.

Need assessment and acceptability validation of agricultural tools and technologies:

An important aspect of enhancing ecosystems resilience is to strengthen the existing systems by introducing new ideas, tools and technologies to improve the local livelihoods. In general, agricultural implements are considered gender neutral but a deeper probe into the issue of how men and women use the tools and technologies would not only reflect the differentiated needs but also varying dependence.

As mentioned earlier, all the villages selected for this study practice subsistence farming. It was interesting to note that in all villages, communities were receptive of the idea of introducing new tools and technologies in the fields both in order to (a) improve the agricultural yield and (b) to reduce drudgery of daily work in relation to cultivation. Communities were aware of the fact that new methods can be used to improve the production in the fields, though the "readiness to adopt the new" was mixed with fear of technology and scepticism.

Women were keen to understand the use and the long-term benefits of application of new agricultural technologies on the land. Further, the use of new tools and technologies was not perceived as an intervention in conflict with their customary beliefs and values. The following tools and technologies (Table 41, Table 42) were introduced in villages under the project:

Table 41. Distribution of small tools to women farmers during 10.5.2012-23.2.2013.

Serial number	Location	Tools					
		Serrated sickle	Kutla	Garden rake	Hand fork	Hand hoe	Khurpi
1	Shama	25	25	25	25	25	25
2	Galla	37	37	37	37	37	37
3	Kendul malla, Kendul talla	25	25	55	45	25	25
5	Lamudiyar	12	12	12	12	12	12
6	Almora USNPSS	1	1	1	1	1	1
Total		100	100	130	120	100	100

Table 42. New technology/machines introduced in villages till 20th March 2014.

Serial number	Item	Dimensions	Location-wise distribution (includes adjoining villages)				Total	Total numbers of installations
			Galla,	Shama	Kendul talla kendle malla	Lamudiyar		
1	Kurmula trap	in numbers	55	00	00	30**	55	Galla=55 (VPKAS) Lamudiyar=30 (USNPSS)
2	Root trainer	12 cells (in numbers)	128	102	50	32	312	Used to g row seedlings
3	Root trainer	25 cells (in numbers)	128	104	50	32	314	Used to grow seedlings
4	Poly house sheet 120 GSM	50m x18ft (one bundle)	5	17	5 3 bundles returned	00	24+	Galla =10 , Shama=46 polyhouses
	Poly house sheet 150 GSM	50m x18ft (one bundle)	00	2	00	2 bundles +5 m	4 bundles + 5 m	Lamudiyar = 14 polyhouses +1 each USNPSS, Kasardevi
5	Tank sheet 200 GSM	50m x18ft (one bundle)	12	1	00	3 bundles + 13m	16 bundles + 13 m	Galla= 68 Lamudiyar= 24 tanks
6	Tank sheet 200 GSM	18 ft x18ft (one piece)	24	20	4	None	48+2***=50	Galla= 24 Shama=19 Paudhar=1 Saklana=1
7	Shade net 50%	3mx50m (one bundle)	30 bundles+ 20m	16	2	5 bundles+ 12m	53 bundles+ 32m	Used in tanks and poly-houses
8	Millet thresher	00	2	1	2	1	6	Used for threshing
9	Rice thresher	00	00	1returne	4	00	5	Used for threshing
10	Insect net	3mx50 m (one bundle)	1	1	00	00	2	Prevent cross pollination
11	VL *syahi* plough (iron)	00	00	1	00	00	1	Wood saving device
12	Bee keeping boxes	50	50	00	00	00	00	Galla =50
13	Bee veil	6	6	00	00	00	00	Galla= 6
14	Honey extractor	2	2	00	00	00	00	Galla= 2
15	Swarm trap	2	2	00	00	00	00	Galla= 2
16	gloves	2	2	00	00	00	00	Galla= 2
17	Plastic pipe	10 bundles 40 kg	1 set	00	00	00	00	Galla= 1 set
18	barbed wire	202.84 kg	00	00	00	202.84 kg	202.84 kg	fencing village commons
19	Spray machine	4	4	00	00	00	00	Galla= 4
20	Water pump	1	1	00	00	00	00	Galla= 1
21	Fruit crate	collection crates	150	00	00	00	00	Galla= 150
22	a. Bamboo frame b. Iron frame	Thin poles Thick poles 18x26 ft	00	00 1	00	215 123		used in making 16 poly houses 1 polyhouse

*extra pieces supplied to villages are not included in the numbers of bundles,

**designed by USNPSS. Out of 33 traps 30 were supplied to Lamudiyar, 2 traps to Chausali village and alight trap to VPKAS (ICAR), Almora

*** Two sheets were supplied to Paudhar and Saklana village each.

A common finding across the villages is that in order to design inclusive and community-responsive agricultural machines and hand–operated tools, it is crucial to question the common assumptions about farmers and agriculture. For example, the rice thresher, developed by VPKAS Almora, an ICAR lab does not suit the needs of those households that continue growing long, local varieties of paddy. Similarly, ***khurpi*** has little use in terraced fields. Millet thresher that operates using electricity is useful only for the electrified households and cannot be used by socially marginalized families (poor, low-income widows etc.) that lack access to electricity.

Gender-friendly tools

Since, systematic research in the area of designing and using gender friendly tools is not available in Uttarakhand, this study focused on two areas:

1. Whether the tools available at the local agricultural research institute (ICAR) are women friendly and
2. To what extent the tools meet the need of female farmers

Table 43. Agricultural tools and technologies introduced under the project.

Tools and technology	Main motive for acceptance	Most preferred	Comments
Polyhouse	Production of off season vegetables viz capsicum, Tomatoes for increased income	Shama	Some farmers have reported that a poly-house may decrease fertility of soil and fertilizers and insecticides must be used, though Uttarakhand is declared as an organic state by Government
Polythene-lined tank	Shortage of water	Galla and Lamudiyar	use poly-tanks for irrigation and domestic purpose
Shade net	protection of plant nursery	Galla and Shama	Framework required to install a shade net is expensive. Farmers have reported that long time use to retain moisture causes powdery mildews in peas
Light trap	Protection from white grub	Galla and Lamudiyar	Community coordination is required to capture grubs in light traps. communities have developed methods to kill the grubs using water, not insecticides, feed the dead grubs to birds
Tool set (Rake, Hoe, Khurpi, Kudal etc)	Increase efficiency and reduced labour input	All sites	Rake, hoe, hand fork, sickle and Kudal are popular in all villages. Sickle is popular only in Kendul village. Khurpi was not in demand
Thresher	Increase efficiency, reduced labour input	Galla, Kendul	In Shama millet thresher is not accepted because the harvesting pattern is different and millet is moistened before threshing. In Kendul village, farmers had difficulties in threshing long-stem paddy.
Seeds, saplings	Improved crop-yield	All sites	By and large all seeds were found to be good

Since, the use of tools and introduction of new technologies is heavily biased towards men and rich farmers the need of designing cheap tools to which women can have access becomes apparent. Farm machines that are designed in consultation with women by taking into account their different needs and capacities are needed across the villages in Uttarakhand. For example, widows and the female headed households found it very difficult to transport the rice/millet thresher (designed by VPKAS Almora, ICAR) from one field to the other. Since the fields are small and scattered, transportation would require energy and time causing difficulties to single and old women living in villages. The need of machines that take into account women's lower body mass and muscle strength and age-wise postural differences is apparent.

Further, the low outreach of government extension services to villages, especially to areas where women work on the fields, has been a matter of concern. The state needs to spread extension services keeping women farmers in mind. For example, the serrated sickle, designed by VPKAS Almora, ICAR was much appreciated by women farmers but this was the first time they came to know that such an implement exists. Table 4 exhibits the ranking of acceptability of agricultural tools and technologies along with their major drawbacks cited by communities after using them for almost a year. Installation of cheap, polythene-lined plastic tanks is an initiative that was perceived by communities the most desirable in terms of making livelihoods resilient in the context of water shortages and unpredictable weather conditions. 24 and 68 tanks were installed respectively in Lamudiyar and Galla villages. 16 tanks were installed in villages near Galla i.e. two each in Lodh, Talla Supi, Supi Bhateliya, Len Pokhara, one in Kaafli and seven tanks at Pata. Although, water tanks are considered gender-neutral in that both men and women need water, consultation with women's groups on how and where to install water tanks were considered central to the processes of building up social resilience in villages.

Introduction of machines such as millet and rice threshers was another activity that was considered important by communities, especially in Kendul talla village, where irrigation has made it possible for the community to grow modern varieties of paddy and wheat.

The low acceptability of root trainers in communities engaged in agriculture was in contrast to horticulture-dominated areas. In Galla village, the root trainers were used to grow fruit tree saplings that needed protection from snow and cold. Similarly, the community at Shama had raised seedlings of vegetables in root trainers during the winters. In other villages

the low acceptability of the root trainers was related to their "newness" and low use in cultivation of crops.

Acceptability of tools also depends on socio-economic status of communities and amenities available in the village. For example, white grub causes a great deal of damage to crops in Lamudiyar village (SC population resides in the village) but due to erratic supply of electricity light traps could not be used on a regular basis.

Table 44. Ranking of the degree of acceptability of agricultural tools and technologies in study villages.

Tools	Village-wise ranking				Drawbacks
	Kendul	Lamudiyar	Galla	Shama	
Polyhouse	8	3	4	1	Not suitable for villages located in valleys (for example, Kendul talla 500-700 m above the mean sea level), in orchards and in areas where the land is rocky
Polythene lined water tanks	Not supplied	1	1	2	Seasonal, not suitable for long time storage
Light trap	Not supplied	2	2	Not supplied	Not useful for low income households in socially disadvantaged villages –the costs of CFL bulbs prevent families replacing t he old ones with the new bulbs
Garden Rake	2	4	5	3	loose welding
Millet thresher/paddy thresher	1	-	3	4	Conflict with the traditional methods of threshing. a. In Shama, prior to threshing manduva is soaked in water. Hence, the thresher was not used b. In Kendul, long traditional variety of paddy could not be used in threshers supplied under the project
Hand hoe	4	5	6	5	loose welding
Hand fork	5	6	7	6	loose welding
Kudal	6	8	9	7	-
Serrated sickle	3	7	11	8	Most suitable for harvesting of dry grass and crop residue (seasonal use)
Root trainer	9	10	8	9	In all the villages people had seen the root trainers for the first time in their lives. Adaptation was slow
Khurpi	7	9	10	10	Not used in terraced fields

A total of 6555 saplings of fruit trees were distributed to famers in all selected sites, (Table 45). Trees were transplanted and the beneficiaries have taken up the responsibility of looking after the trees.

Tree saplings were purchased from the horticulture department, Almora and Pauri Garhwal and distributed to women farmers during 31.8.2012-3.9.2012 in Kumaon and in September 2013 in Pauri Garhwal. In addition, 300 saplings of kiwi fruit were purchased from NBPGR, Bhowali on 16.1.2013 and transplanted in Galla and Shama villages.

Further, farmers from Shama had demanded seeds of vegetables and improved varieties of wheat and pulses. Therefore, seeds of vivek peas (4 kg), wheat VL 832 (40 kg), Mansoor black VL126 (20 kg), and Australian green pumpkin (0.250 kg) were purchased from the VPKAS Almora on 8.10.2012 and distributed on 16.10.2012.

Table 45. Saplings of fruit trees distributed to women farmers.

Serial number	Location				Type of tree saplings						Total
		Oranges	Malta	Lemon (local variety)	lime	Mango	litchi	amla	Guava	Kiwi	
1	Shama	250	250	400	180	00	00	00	70	50	1200
2	Galla	200	200	135	160	00	00	00	7	250	952
3	Kendul talla	00	00	00	25	170	30	40	15	00	280
4	Lamudiyar and Maichun	750	750	665	860	00	00	00	1123	00	4148
Total		1200	1200	1200	1200	170	30	40	1215	300	6555

Purchase and distribution of improved varieties of seeds

Improved varieties of seeds were purchased by USNPSS from VPKAS, Almora and distributed to women farmers in all the selected sites (Table 6). All the farmers were members of the women's groups. They were encouraged to sow cereals and vegetables seeds on an experimental basis. The results were promising and the women have demanded more seeds for the coming years but there is a problem for farmers to purchase the quality seeds by themselves. VPKAS produces breeder seeds and other government agencies have the responsibility of mass production and distribution but due to limited outreach seeds are not available in villages. In 2013, the community-based organization at Shama exhibited considerable interest in developing a seed bank of its own in the village. Good quality seed of radish (the local variety) has already been developed in the area.

Evidence shows that agriculture dominated areas were less receptive of the ideas of introducing new varieties of seeds in their fields while the horticultural dominated areas showed considerable interest in improved varieties of vegetables. However, the finding is not surprising because communities in horticultural areas have for long been practicing cash crop based livelihoods and a system of marketing is in place at Galla and the surrounding villages. It was, however, interesting to learn that communities in Galla were resistant to the idea of installing polyhouses in their fields, while the agricultural communities, especially in Shama (high altitude village) and Lamudiyar (Socially disadvantaged section of society) exhibited considerable interest in this technology.

Table 46. Purchase of improved variety of seeds and their distribution in villages.

Serial number	Type of seed	Seeds		Distribution (kg)					Total distri Bution (kg)
		Date of purchase	Quantity (kg)	Maichun	Galla	Shama	Kendul malla, Kendul talla	Lamudiyar	
1	V. L. Madua-149	VPKAS 5.4.2013	20	10	10	00	00	00	20
2	V. L. Madua-315	VPKAS 5.4.2013	10	00	5	00	5	00	10
3	V. L. Madua-324	VPKAS 5.4.2013	10	00	00	10	00	00	10
4	V. L. Dhan-85	VPKAS 5.4.2013	8	00	00	00	8	00	8
5	V. L. Beans-2	VPKAS 5.4.2013	2	00	1	1	00	00	2
6	V. L. madira-207	VPKAS 5.4.2013	8	00	00	00	8	00	8
7	Bhindi Vivek-2	VPKAS 5.4.2013	3	0.5	1	1	0.5	00	3
8	Lahi Haatikan	VPKAS 19.10.2013	1	00	00	00	00	1	1
9	Methi PEB	VPKAS 19.10.2013	1	00	00	00	00	1	1
10	Coriander PD	VPKAS 19.10.2013	5	00	00	00	00	5	5
11	Vivek pea	VPKAS 19.10.2013	10	00	00	00	00	10	10
Total			61	10.5	17	12	21.5	17	78

Gender-sensitive, bottom-up response to climate change and agriculture

The disconnect between the global scientific research and policies on climate change and the local impacts already being felt by communities calls for new frameworks for agenda formation that could focus on bridging the gap by being participatory and inclusive of ideas and experiences emerging from the realities of people's lives. Climate change negotiations would be more meaningful and relevant to societies when informed by gender, class, and caste, rural–urban, institutional, political, legal and cultural specificities. One way of achieving this goal is to initiate a bottom–up approach by involving communities, especially women, in planning and implementation of village-based projects to build up resilience. By creating an enabling environment for women and poor people to participate and in the process learn and develop capabilities to achieve greater control over resources and their own lives, resilience could be improved both at ecological and social levels. Attitudinal change is part of this endeavor and so is development of collective responsibility to overcome ecological, economic and social disparities that typically aggravate during crisis and disasters.

The process of building up ecosystem resilience in the study villages has relied heavily on our earlier work with communities in Uttarakhand, particularly with women's groups in the hill districts of the state. Building on the existing network of women's groups, youth groups and the community-based organizations, an attempt was made to introduce new ideas, provide and share information re climate change to address those challenges that people face in their daily lives and also if struck by a disaster.

In Kendul malla and Kendul talla villages, for example, women's groups have already conserved the forest by (a) regulated lopping of trees and (b) putting a ban on the traditional practice of herds of goats and sheep grazing through the forest every winter once the shepherd had made a payment towards the village fund. The decision to stop this practice was taken in an open village meeting organized by the members of the women's group. Further, the members of the women's groups have been acting as the elected representatives in local committees (panchayat, forest protection committee etc.) and voicing their concerns.

In Galla village, the community has developed strategies to overcome shortages of fruit production by shifting apple orchards to higher altitudes. In Shama, the community-based organization has successfully introduced production of multiple varieties of vegetables and fruit trees that would enable communities to take advantage of rising temperatures due to

climate change. The women of Lamudiyar village have strengthened social resilience by organizing themselves as an active group and exercising agency, especially on issues of natural resource management and agriculture. In all these villages, the members of the women's groups are aware of the role of broad leaf tree forests in conserving water and have already taken steps to preserve the forests. Plantation, allowing regeneration by protection from grazing animals, regulated harvesting are some of the strategies that have been adopted by women to improve the status of the forests and other natural resources in villages.

Examples, cited above, reflect on the fact that climate change programmes and policies need not always portray women as a group of homogeneous victims. A shift in development thoughts and planning is required not only as a measure to acknowledge contribution of women's groups in building and strengthening ecosystem resilience in Uttarakhand but also to promote an environment where women can exercise their agency and continue to strengthen activities that have been started under their leadership. In addition, new groups could be organized and activated in villages that trail behind, especially in areas that are marked as prone to disaster by the government.

Building social resilience as a step towards ecological resilience

Capacity building of communities is an integral part of planning in those areas that are prone to disaster and in those villages where disaster has already struck. This study took the capacity building approach with an additional dimension of addressing gender concerns in communities because under patriarchy women and men tend to face and address the challenges of climate change differently. Further, capacity building of women is central to the issue of developing social resilience which is considered a step towards building ecosystem resilience in villages.

Community capacity building is an issue that could easily be sidelined by scientific and large climate change projects, especially those which target either developing infrastructure or create large data-base that are visible and can easily be quantified (Emmeline Skinner, 2011). Knowledge building, developing skills at community level are issues that are not easy to quantify and suffer from the "invisibility syndrome". Yet, it is the poor, local communities that bear the brunt of climate change and feel the impacts more directly than the global community. A combination of approaches was used to organize women and the rest of the community around the issue of climate change and its impacts on agriculture and the local livelihoods (Table 47).

Table 47. Meetings with communities in study villages.

Serial number	location	Duration	Issues discussed	Suggested solutions to problems	Number of participants
1	Kosi, Katarmal	12-13.12.2011	PRA training of the SRF and USNPSS staff	--	4 from USNPSS
2	Shama	14-16.12.2011	Pilot test PRA, soil sampling	Map making exercises, testing of soil	17
3	Lamudiyar,	20.12.2011	Pilot test PRA	Map making exercises, discussion	19
4	Rautiliya	21.12.2011	Pilot test PRA	Map making exercises, discussion	22
5	Maichun	22.12.2011	Pilot test PRA	Map making exercises, discussion	13
6	Galla	29.12.2011	Pilot test PRA	Map making exercises, discussion	27
7	Kheti, seraghat, ganai, Muvani, Nayarghati, Ukhimath pati dhunga, shama,	12.2.2012 - 18.3.2012	Women's congregations	Feminization of agriculture, climate change	1993
8	Maichun	6.1.2012	Household survey	Introducing the project	
9	Galla	11.1.2012	Household survey	Introducing the project	
10	Shama	27-28.1.2012	Household survey	Introducing the project	
11	Maichun	4.3.2012	Impact of frost re climate change	Polyhouse, knowledge building	45
12	Moni	7.3.2012	Hailstorms, snowfall changing weather	Knowledge building, polyhouse	23
13	Lamudiyar	9.3.2012	Unavailability of seeds, plants, changing cropping patterns	Saving indigenous seeds, supplying seeds, tools, training	19
14	Kendul malla and Kendul talla	12.3.2012	Damage to crops by wild animals, low availability of manure, frost	Women watch guards on a rotation basis, local preventive measures, vermicompost	88
15	Galla	14.3.2012	Hailstorm, water shortage, damage by pests, rats	Shade net, cheap tanks, tree oil lime sulphur	70
16	Maichun	15.5.2012	Horticulture	Planting fruit trees	16
17	Mauni	11.6.2012	Horticulture	Planting fruit trees	18
18	Gwar	13.6.2012	Horticulture	Planting fruit trees	22
19	Lamudiyar,	19.6.2012	Horticulture	Planting fruit trees	21
20	Nayarghati	20.6.2012	Agriculture	Women's meeting	17
21	Lamudiyar	24.7.2012	Production from improved seeds	Assessment of yield	23
22	Lamudiyar	22.8.2012	Damage to crops	Social fencing through women's group	8
23	Lamudiyar	29.8.2012	Damage to crops	Social fencing through women's group	19
24	Kendul	19.11.2012	tools to improve production	Introducing to tools by VPKAS	29
25	Shama	15-16. 5. 2013	Impact on agriculture	Improved tools, poly house	27
26	Galla	20-22 5. 2013	Ecosystem health data	Collection of data and discussion with communities	66
27	Kendul malla and Kendul talla	26-27. 5 2013	Improved seeds, use of millet-rice threshers and tools	Introduction of new tools and technologies	30
28	Lamudiyar	3-4. 6. 2013	Polythene lined tank		23
29	Maichun	6-7.6. 2013	Ecosystem health data	Collection of data, house to house visits	17
30	Lamudiyar	2.7. 2013	Damgem to crops, seeds by grubs	Light trap, root trainer	22
31	Lamudiyar	7.8. 2013	Water shortage, seed problems	Polyhouse and polytanks	25
32	Almora	9.8. 2013	Exposure tour	Polytanks and polyhouse	13
33	Galla	10.8. 2013	Shift of trees, water shortage	Horticulture polytanks polyhouse	80
34	Lamudiyar	18.8. 2013	how to improve crop, water yield	Polythene lined tank	10
35	Lamudiyar	23.8. 2013	Income generation	Fruit trees and polythene lined tanks	35
36	Lamudiyar	12.9. 2013	Damage to crops by animals	Polytanks, light trap and fencing	18
37	Lamudiyar	14.9. 2013	Damage to crops by animals, pests	Light trap, fencing	12
38	Lamudiyar	16.9. 2013	Fencing	Execution of fencing	16
39	Lamudiyar	23.9. 2013	Improving crop yields	Seed distribution	34
40	Lamudiyar	30.9. 2013	Village meeting	Women's solidarity, participation	30
41	Lamudiyar	1.10. 2013	Ecosystem health data	Collection of data	20
42	Lamudiyar	2.10. 2013	Ecosystem health data	Collection of data	15
43	Galla, Supi, Paata	9–13.10. 2013	Polytank, light trap and ecosystem health	Visits to all villages to disseminate information, assess the impact of light traps and tanks	90
44	Maichun	18– 20.11. 2013	Ecosystem health data, meeting	Collection of data	9
45	Lamudiyar	6.12. 2013	Polyhouse	Introducing the concept	18
46	Lamudiyar	25.12. 2013	Exposure tour	Visit to villages to learn	50

47	Shama and Naamik	26-30.12.2013	Meetings on climate resilient crops	Sharing information, awareness	80
48	Lamudiyar	7.12.2013	Polyhouse meeting	Practical benefits of poly houses	10
49	Kendul malla, kendul talla	9–16.12.2013	Ecosystem health data meetings	Dissemination of information, review of work	22
50	Lamudiyar	24.12. 2013	Polyhouse	Installation	30
51	Lamudiyar	1.1.2014	Polyhouse installed	Installation	8
52	Lamudiyar	17.2.2014	Polyhouse installed	Preparation for poly house, assessment of work done so far	17
53	Lamudiyar	19.2.2014	Polyhouse	Material for polyhouse was taken to the village, open village meeting with USNPSS staff	10
54	Lamudiyar	20.2.2014	Polyhouse	Polyhouse installed,	5
55	Lamudiyar	22.2.2014	Polyhouse	Assessment, feedback	20
56	Lamudiyar	24.2.2014	Polyhouse	Material for polyhouse was taken to the village	14
57	Lamudiyar	25.2.2014	Polyhouse	Polyhouse installed	6
58	Lamudiyar	26.2.2014	Polyhouse	Polyhouse installed	2
59	Lamudiyar	28.2.2014	Polyhouse	Material for polyhouse was taken to the village	9
60	Lamudiyar	2..3.2014	Polyhouse	Polyhouse installed	5
61	Lamudiyar	3.3.2014	Polyhouse	Polyhouse installed	6
62	Lamudiyar	6.3.2014	Polyhouse	Polyhouse installed	6
63	Lamudiyar	7.32.2014	Polyhouse	Polyhouse installed	7
64	Lamudiyar	8.32.2014	Polyhouse	Polyhouse installed, monitoring of work done so far, feedback from the community	33
65	Galla	19.3.2014	sheets for water tanks, bamboo poles were taken to the village	Monitoring and assessment of work done so far	10

Creating institutional networks to strengthen women's capacity:

The women's groups in the study villages are part of a larger network of rural women's groups spread over eight districts of Uttarakhand. The network, created in 2001, is called the Uttarakhand Mahila Parishad (Uttarakhand Women's Federation). It is the largest network of rural women's groups in the state of Uttarakhand. The network provides a forum to rural women to raise their voices at village, regional and the state level. Depending on their needs, organized groups take up diverse projects for their villages. Protection, conservation and regeneration of natural resources (forests, water, grasslands), plantation, nursery-raising, providing access to safe drinking water and sanitation facilities, organized action against alcoholism and gambling among men, active participation and representation in panchayats, female literacy are some of the issues that women's groups have been working on over time. In the process of implementing these activities in villages, issues of gender, caste-class differences are addressed with the twin fold objectives of (a) strengthening solidarity among women and (b) mainstreaming gender in all programmes implemented by the network.

By and large the sequence of initiatives exhibited in box 2 was followed in building up ecosystem resilience through active participation of communities, especially women's groups, in study villages.

Box 2. Building community capacity to improve ecosystem resilience

- Open village meeting to introduce the project
- Meetings of women's groups in all villages
- Participatory rural appraisal (PRA) on issues of climate change and agriculture
- Continue with meetings of women's groups in villages
- Women's participation in regional congregations of women's groups
- Build up capacity in villages (open discussions, house to house visits, meetings etc.)
- Strengthen women's earlier work by providing support, weave climate change issues with that
- Distribution and plantation of fruit trees
- Distribution of agricultural tools and seeds developed by VPKAS, Almora to assess their reach and gender friendliness as women do all agricultural work, except ploughing
- Distribution and installation of light traps (VPKAS) to catch white grub
- Installation of polythene lined tanks started at Galla
- Exposure tours for women to
- A. extension services of ICAR- Doonagiri and Hawalbagh field research centres, Almora
  B. to see the orchards, rain water harvesting tanks in Galla and meet the members of the youth network
- Women attend workshops at Almora
- Meeting with women's groups in villages (Kendul, Shama, Maichun, Lamudiyar, Galla)
- Women from study villages attend the UMP meetings at Almora
- Designing the light trap at USNPSS, Almora
- Installing light traps in Lamudiyar village- feedback from the community
- Installation of polythene-lined water tanks in all villages
- Barbed wire fencing at Lamudiyar to prevent damage of crops by wild and grazing animals
- Installation of poly houses in all the sites
- Installation of polythene lined tanks and poly houses continues
- Preparation of report

All the study villages are a part of the aforesaid network of women's groups and took part in workshops organized at Almora on building up women's leadership to facilitate their equal participation in activities at village, regional levels and beyond. Listening to the experiences of women from villages where disasters have occurred in recent years has been a revealing experience for women from Galla, Kendul, Lamudiyar, Maichun and Shama. For example, the women from these villages could interact with the disaster struck villages of the Kedarnath valley to develop an understanding of the pressing issues and the solutions that women's groups had sought immediately after the disaster.

Modifying the designs of the poly-house based on the feedback from communities

In response to the feedback that USNPSS had received from communities at Shama where poly-houses were installed earlier under a different project, a change in the design was made. The feedback from the community had raised the following issues:

1. Poly-houses at Shama were totally covered with plastic sheets. Lack of any ventilation facility had posed problems of survival of seeds inside the structure
2. When transplanted, the germination rate of seedlings was much lower than those of the plants grown outside the poly-house
3. Closed poly-houses were not suitable for valleys and in areas where temperature fluctuations were high. For example, along the river banks and near the ravines

To overcome these practical problems, USNPSS modified the design of the poly houses. To facilitate ventilation, use of the shade-nets was promoted. The roll over doors in the new design could add to the facility of providing adequate ventilation inside the structure. Further, the use of the 50% net was found ideal to facilitate entry of fog and rain water inside the polyhouse. The women farmers too found it better suited for growing vegetables than the old designs that would become suffocating during the summers.

The width of the terraced fields was a major determinant of the size of the poly-house which, on an average, was kept to 20ft x 10ft in dimension. Proximity to the household was another consideration in selecting the site for installation. Since growing seeds/saplings require regular watering and care, poly-houses were installed near home. In Shama and neighbouring villages 48 poly-houses were installed. In Lamudiyar 14 and 8 poly-houses were made in villages surrounding Galla. The farmers of Galla did not make any polyhouses, because their past experience had been unsatisfactory.

During the course of the research, it was observed that the poly-houses installed earlier at Shama, Galla and the neighbouring villages had torn with age. Although the farmers

said that it was useful to have poly-houses at home, they had not been able to replace those with new sheets. Since the frame was intact, we gave them new sheets but the problem of replacement would emerge again after a few years.

C**apacity building of the USNPSS staff and the community-based organizations**

Capacity building of the USNPSS staff and the community-based organizations was carried out to enable them to understand the nuances of gender in climate change issues, especially in relation to changing livelihoods, both in agricultural and horticultural sectors.

Table 48. Capacity building workshops and meetings for the staff at USNPSS.

Serial number	duration	Location	Participants
1	1-2.10.2011	USNPSS Almora	Investigators, Co.P.I. and from USNPSS Doon University and GBPIHED, Facilitators from different sites
2	15-16.11. 2011	USNPSS Almora	Facilitators, project investigators
3	10-11.12. 2011	USNPSS Almora	The staff of USNPSS and the representatives from all the sites
4	23-24.12 2011	USNPSS Almora	The staff of USNPSS and the representatives from all the sites
5	20-21.1. 2012	USNPSS Almora	The staff of USNPSS and the representatives from all the sites
6	2-3.4. 2013	USNPSS Almora	The staff of USNPSS and the representatives from all the sites
7	25.4.2013	USNPSS Almora	The staff of USNPSS and the representatives from all the sites
8	9.8.2013	USNPSS Almora	The staff of USNPSS, representatives from the sites and selected residents of Lamudiyar village
9	25.12.2013	USNPSS Almora	The staff of USNPSS and the representatives from all the sites and a group of women and men from Lamudiyar village

Advocacy

Providing opportunities to rural women and communities to speak up and raise their concerns in public forums is an essential component of advocacy promoted by USNPSS throughout the study. Twice, the women's groups were invited to Almora to participate in discussion-workshops called the "*SAMVAD*" and raise issues of gender in climate change. Women were encouraged to speak up and inform the elected representatives in the state legislative assembly and the members of parliament and senior Government officials about their concerns.

Uttarakhand Mahila Parishad took up issues of climate change at the state and the national level by documenting the situations and experiences of women in disaster struck areas. Articles were published in the local and national newspapers and information was shared with women's groups, youth groups and the community-based organizations on issues related to climate change and agriculture.

Chapter 7

Conclusion and recommendations

It is suggested that a new paradigm for research be initiated, particularly on issues where the findings of the research are to be used by farmers located in remote villages of the Himalayas. During the course of this study, the researchers worked *with* the community, not for them, and from the beginning became conversant with the community perceptions of climate change issues.

During analyses inclusion of both the descriptive and the inferential data had helped. The descriptive data analysis exposed the factors and the impacts of climate change on communities whereas the inferential data analyses made explicit the relationships between those factors. Further, gender disaggregation of data was useful to interpret participation and labour share of men and women in local livelihoods, especially in agriculture related work. In addition, quantitative measures were used to interpret gender representation in community institutions. However, quantitative measures are not so transparent, that they could encapsulate relational objectives, especially in the context of gender and caste-based disparities in communities. For example, the quantitative measures may highlight success of the programme by the number of green-house or water storage tanks installed in villages but this indicator may totally hide the quality of participation of communities. In addition, it may fail to capture the issue of women's participation in the process of installation. Though, this activity is important not only as a measure of building up ecological resilience re climate change but also because of its "technical nature" to which women are expected to be silent observers, quantitative data will not be sufficient to capture the nuances of the process. Collection of qualitative data is therefore useful in capturing communities' perceptions and experiences regarding climate change. A mix-bag of qualitative and quantitative data would provide the researcher with more nuanced analysis of the situation particularly when communities have already been facing the impacts of climate change.

Besides, focus group discussions, informal interactions with communities by living in villages for several days in a stretch and oral testimonies, PRA techniques were used to build up this dialogue. PRA tools included mapping, scoring, ranking, seasonal calendars and web diagrams. Administered in the beginning of the project, this exercise helped to raise

awareness and build up rapport with communities. In addition, as a process, PRA is an empowering exercise in itself.

Collection of gender-disaggregated data regarding agriculture-based roles and responsibilities relied on discussions with rural men and women separately. However, after documentation and analyses, the findings were shared with mixed-group (both men and women of different castes, age, education etc.) of communities in villages and at USNPSS Almora to raise awareness about the need of gender-equitable share of labour. In particular, this exercise was carried out to initiate change and spread awareness about the issue of how women's workload increases during and after a disaster caused by climate change. This is in contrast to the mainstream methods, wherein the researchers would develop the ideas and products in the laboratories/offices, isolated from the social, economic and environmental conditions prevailing in villages. In addition, when scientists, researchers, civil society organizations and communities, especially women, interact with each other to develop knowledge and find solutions to problems confronting them, social resilience of the ecosystem would improve. Decisions will then be the outcome of informed choices, not just from closed or outdated systems. It is only in such an environment that a product, scientifically tested, will also be acceptable and successful in communities.

In the hills of Uttarakhand, cultivation depends on the status of the surrounding natural resources in villages. The close relationship between agriculture and the health of the forests needs to be recognized. The conceptualisation of the village as an ecosystem provides a range of ecological indicators that were used to assess the health and resilience of agriculture-based communities and their environment. Values gained from the quantification of the production and consumption patterns of crops, fuel wood, fodder (leaves as well as grass), manure, milk etc. were used to determine health of the ecosystem. Inherently, an ecosystem which is healthy will be more resilient and therefore, be better equipped and able to withstand the shocks created by climate change. The measurements were simple and involved commodities which everyone (including illiterate women) could understand.

The concept of carrying capacity gave an indication of the number of the people the village ecosystem could support and how degraded the ecosystem was. Due to time limitations, the data could not be extrapolated to calculate the future production and requirement values. The issue of sustainability of environmental services provided by the forests could, however, be calculated using a longer time frame. For example, at present

communities have been receiving all their fuel wood requirements from the forests but how long it will continue is the issue that requires more research. Another important issue regarding the village as an ecosystem relates to its conceptualization of a closed system, isolated from external interventions and politics. However, there would be several interactions occurring within and between ecosystems that need to be measured to get an overall picture of the situation. For example, in a village, food may be coming from outside (the ration shop) or external water supply systems would exist, mobility of people could also be a factor affecting production and consumption patterns. Though, computer models could be developed to elicit information on all these issues, the present research fell short of this exercise, particularly due to lack of time and resources. However, by considering the commodities which do not have a monetary value, e.g. water, fodder, fuel wood, even at the present stage, the research elaborates certain useful concepts that are relevant to issues of climate change and its impact on agriculture.

To further the concept of ecosystem health, this research has defined it in an additional manner. The ratio of the actual production per unit of land to the optimum production possible from that unit was used to determine health of the village ecosystem. Used in combination of other indicators such as the infiltration rate of water in the soil and the canopy cover of the forests, this exercise gave a measurement of the resilience index of the village. However, more work and refinement of the concept is required.

Villages were ranked using the concepts of ecosystem health and resilience index and the major vulnerabilities so emerging were found to be very similar to the perceptions that had resulted from PRA exercises conducted with the communities.

An important contradiction which came up related to the crops and the adaptive response from villages. Those villages growing mandua were not much affected and showed little interest. Moreover, the young in these villages, were moving away from cultivation and looking for jobs in the cities. In the cash cropping area, the affects of warming are already being felt (apples moving to higher altitudes) and the communities were eager to try new ideas. Thus traditional agriculture and comparatively newer cash cropping areas exhibit different behaviours. Which is to be encouraged: why and how?

By combining the results arising from these two approaches of (a) quantitative (ecosystem health, resilience index) and (b) qualitative data analyses (PRA, focus group, oral

testimonies, informal discussions with groups of women), a holistic framework had emerged which was then used to initiate action in villages.

Finally, several activities have been carried out in study villages and surrounding sites to build up socio-ecological resilience. The acceptance of tools and technologies varied from community to community. For example, the low–altitude villages, such as Kendul, exhibited no interest in installing green houses. Further, the requirement varied even in those villages that were interested in the activity. For example, the high altitude villages in Shama preferred closed types (maximum area covered by plastic) while the design at Lamudiyar village was different from Shama. Thus, a single standard design of poly-house would fail to capture the requirements of communities. Micro-climatic conditions, both social and ecological, need to be studied prior to initiating any such activity in villages.

Enabling communities to learn and experiment with tools and technologies was an important criterion for development of social resilience. As an example of how learning occurs, consider the widespread increase of the *kurmula* (white grub) pest in the villages of Uttarakhand. Scientists have developed a trap to control the pest in the agricultural fields. While introducing the trap in the village two important issues emerged. (i) Farmers, especially women, were not aware of the existence of such a device that could help them get rid of the pest and (ii) When introduced questions were raised about the social and economic access to the device. Further regular supply of electricity emerged as an important determinant of its use in villages. Other issues that were discussed during meetings in villages were whether the households would cooperate in switching off lights at home during night, what would be the disposal method for the captured pests, why had the pests increased in recent decades and what if they always did exist and the unprecedented growth is not related to climate change but to some other factors were discussed.

We purchased some traps, but soon realised that a much cheaper alternative which could be made in the village itself was possible. In one of the villages, community cooperation was high and everyone agreed on the ways to use it. To dispose the captured pests, the scientists had suggested insecticides. However, the village residents, particularly women, thought of other means, like feeding the dead to the birds. The strong beak of the blue magpie was found to be suitable for the purpose. The experiment succeeded in stimulating a lot of interest in the community over the origin, growth, life stages of the kurmula pest in Uttarakhand. To the question of why these pests have increased, the farmers

themselves recalled that earlier they used to live in the forest but have now come to the agricultural fields. They realised that the solution was to improve the biodiversity of the forest. (Field activities in village Galla and Lamudiyar see also Jackson 2005).

The above examples illustrate the need of long term research involving scientists thinking holistically in collaboration with the community.

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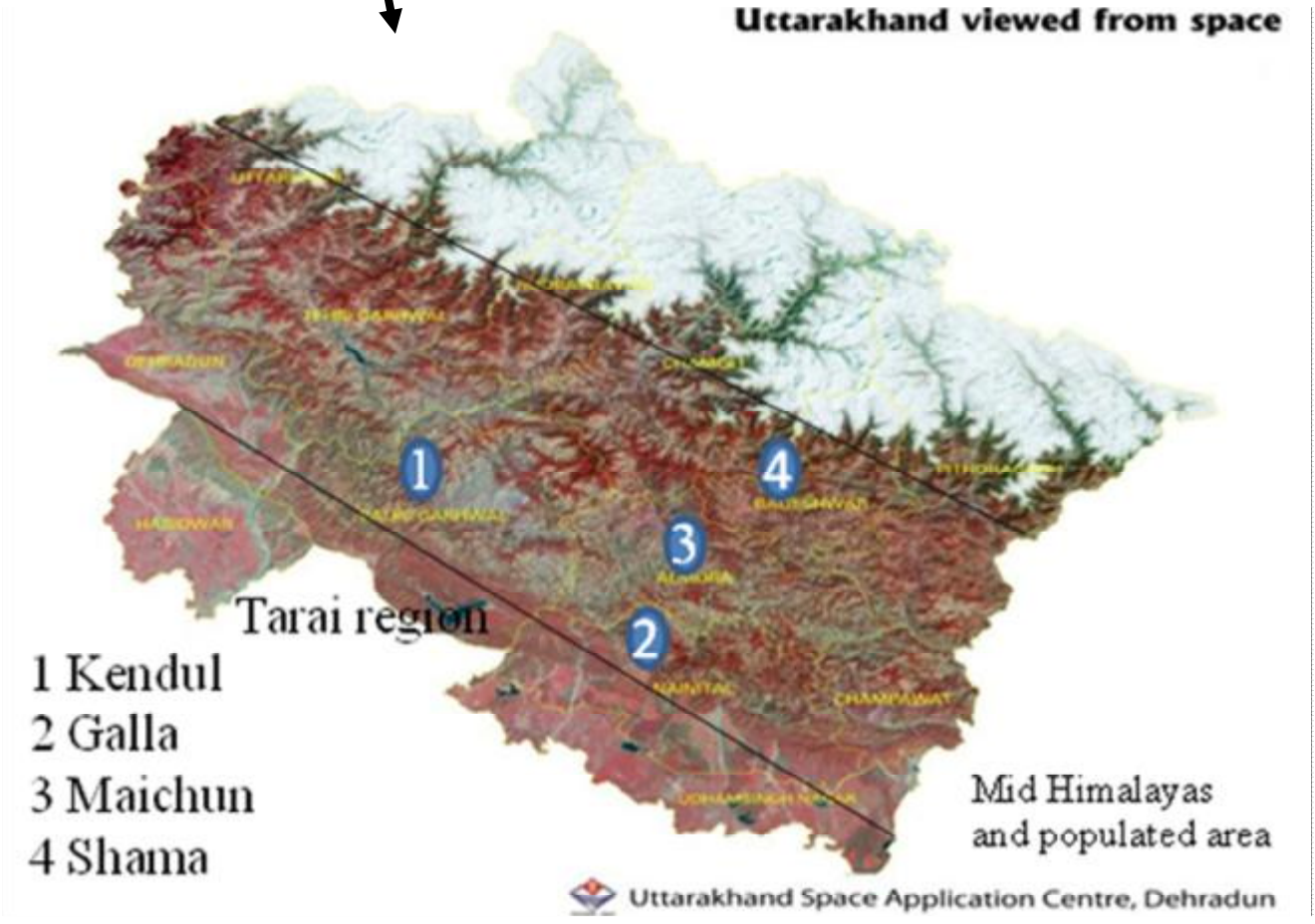
Appendix 1: Expenditure under different heads.

Serial number	Item	2011-12	2012-13	2013-14	Total
	Operational expenses (OE)				
1	SRF	137600	422400	369600	929600
2	Field workers	72500	238600	282000	593100
3	Polythene sheets for poly house/water tank, shade net/insect net	452005	144110	361505	957620
4	Seeds/planting stock	98532	17324	5870	121726
5	Tools	163500	35485	6090	205075
6	Bee keeping	0	0	53480	53480
7	Other(pipe/barbed wire/crate/pump/ bamboo/root trainer etc	57719	0	123629	181348
8	Transportation of materials	18216	50171	39444	107831
9	Educational tours/ meetings	0	29567	4030	33597
10	POL	15380	25910	39230	80250
11	Software	15150	0	5700	20850
12	Misc/contingency	30404	33775	40180	104359
13	Total OE (1-12)	1061006	997342	1330758	3389106
14	Travel	63818	66250	118488	248556
15	HRD	27956	0	0	27956
16	IT	99900	0	0	99900
17	IC	122000	108000	145000	375000
18	Exp (14-17)	313674	174250	263488	751412
19	TOTAL budget	1437000	1188000	1595000	4220000
20	Total release	1437000	1125680	1578592	4141272
21	TOTAL EXP(13+18)	1374680	1171592	1594246	4140518
22	Balance (19-21)	62320	16408	754	

Balance Rs. 754/- returned to CRIDA vide dd no 000103 dated 09/04/2014


Uttarkashi
Dehradun
Rudraprayag
Tehri Garhwal
Chamoli
Pithoragarh
Kendul Malla
Kendul Talla
Shama
Haridwar
Garhwal
Bageshwar
Almora
Lamadiyar
Galla
Nainital
Champawat
Udham Singh Nagar


Uttarakhand viewed from space
Tarai region
1 Kendul
2 Galla
3 Maichun
4 Shama
Mid Himalayas
and populated area
Uttarakhand Space Application Centre, Dehradun

A meeting with the members of the women's group at Galla village, district Nainital.

Inter-village meeting with the members of the women's group at Galla, district Nainital.

Inter-community meeting with the members of the women's groups of Lamudiyar, Maichun and Banthok, district Almora.

A meeting with the scientists, voluntary organizations, orchardists and farmers, including women, at USNPSS Almora

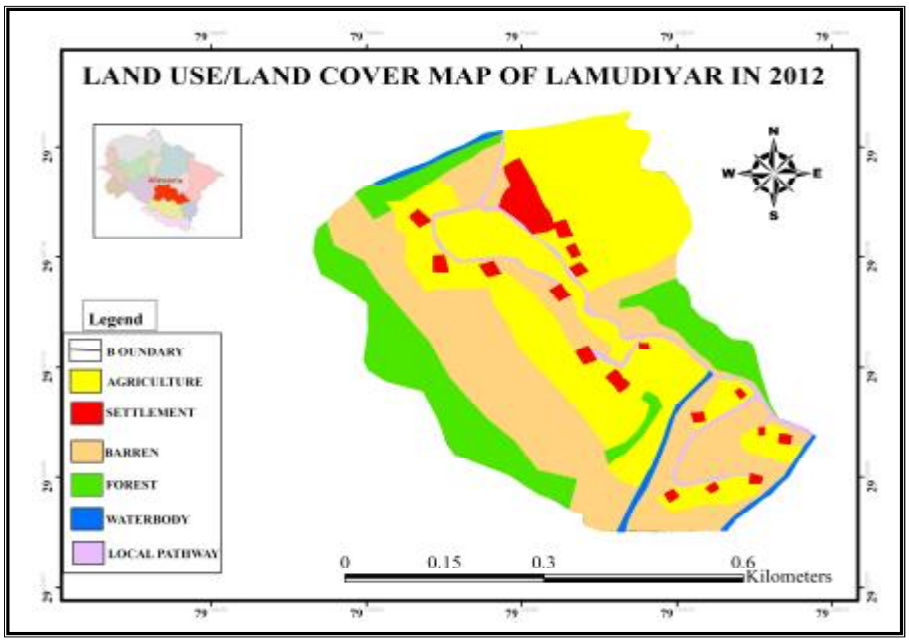
A meeting with the scientists, voluntary organizations, orchardists and farmers, at USNPSS Almora.

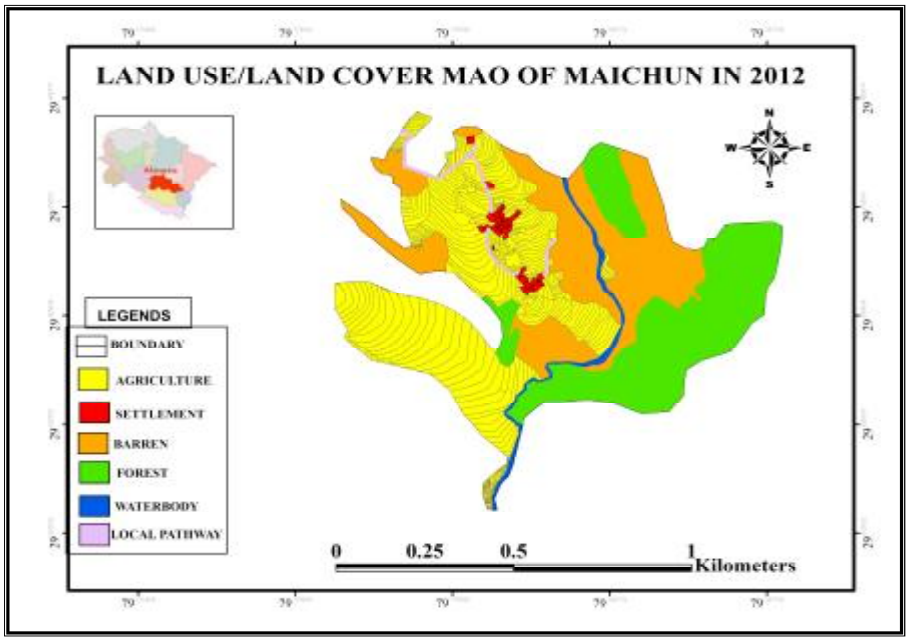
Group discussions on issue of climate change at USNPSS, Almora.

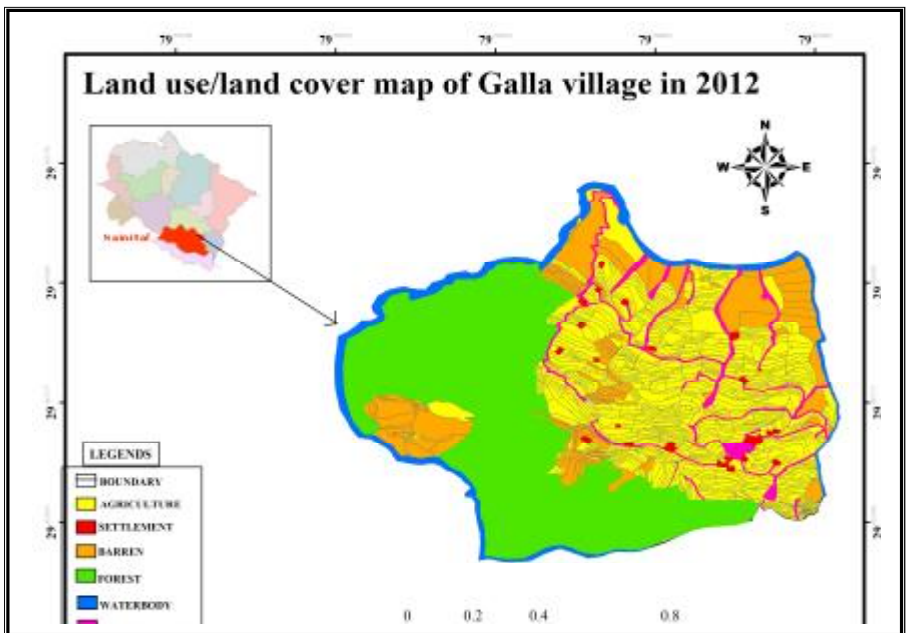
View of Shama village, district Bageshwar.

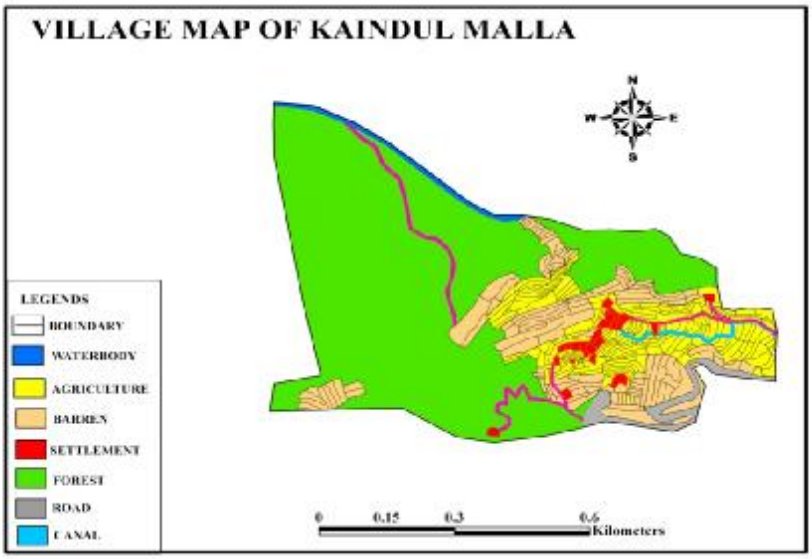
View of Galla village, distri Nainital.

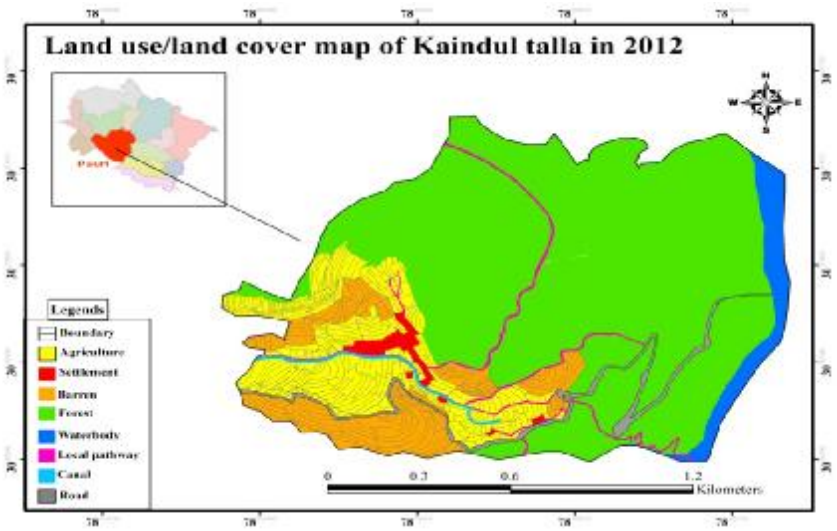
View of Lamudiyar village district Almora.

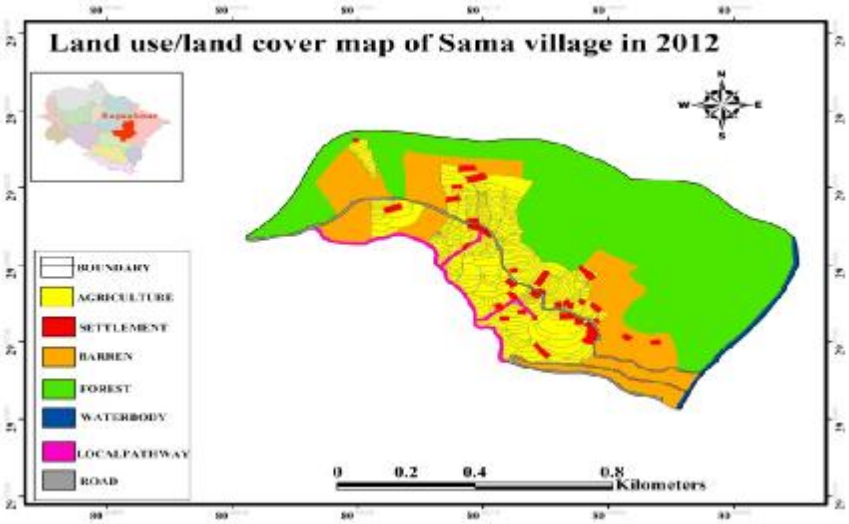

LAND USE/LAND COVER MAP OF LAMUDIYAR IN 2012
Legend
BOUNDARY
AGRICULTURE
SETTLEMENT
BARREN
FOREST
WATERBODY
LOCAL PATHWAY
N
W
E
S
0
0.15
0.3
0.6
Kilometers


LAND USE/LAND COVER MAO OF MAICHUN IN 2012
LEGENDS
BOUNDARY
AGRICULTURE
SETTLEMENT
BARREN
FOREST
WATERBODY
LOCAL PATHWAY
N
W
E
S
0
0.25
0.5
1
Kilometers


Land use/land cover map of Galla village in 2012
LEGENDS
BOUNDARY
AGRICULTURE
SETTLEMENT
BARREN
FOREST
WATERBODY
N
W
E
S
0
0.2
0.4
0.8


VILLAGE MAP OF KAINDUL MALLA
LEGENDS
BOUNDARY
WATERBODY
AGRICULTURE
BARREN
SETTLEMENT
FOREST
ROAD
CANAL
0 0.15 0.3 0.6
Kilometers


Land use/land cover map of Kaindul talla in 2012
Legends
Boundary
Agriculture
Settlement
Barren
Forest
Waterbody
Local pathway
Canal
Road
0 0.3 0.6 1.2
Kilometers


Land use/land cover map of Sama village in 2012
BOUNDARY
AGRICULTURE
SETTLEMENT
BARREN
FOREST
WATERBODY
LOCALPATHWAY
ROAD
0 0.2 0.4 0.8
Kilometers

Village eco system

Farmers harvesting paddy
Kendul Talla village, distric
Pauri Garhwal.

In Lamudiyar village, grass production has doubled in year after the land was protected from grazing animals, district Almora.

Fencing of the village commons to prevent damage to vegetation fron wild animals. Selling grass a livelihoods option at Lamudiyar, district Almora

Traditional method of threshing of paddy at Kendul talla village, district Pauri Garhwal.

Traditional method of threshing of paddy at Kendul talla village, district Pauri Garhwal. All this work is carried out by women.

Paddy thresher was provided by USNPSS to Kendul talla and kendul malla villages to reduce the drudgery of women.

Women using paddy thresher at Kendul talla village, district Pauri Garhwal.

An old couple using paddy thresher at Kendul talla village, district Pauri Garhwal.

The residents of Lamudiya village using millet threshe district Almora.

Root trainers were supplie to communities, especiall to the members of the women's groups. Village Lamudiyar, district Almor

Saplings of off-season vegetables were successfully cultivated by women using root trainer Village Shama, district Bageshwar.

The Director, USNPSS an the head of the voluntar organization at Shama looking at the apple nurse and the green house, district Bageshwar.

Saplings of fruit trees wer
supplied to women farme
of Maichun and Lamudiya
villages, district Almora.

Women farmers receive
agricultural tools. Here, th
members of the women's
group at Lamudiyar villag
(dominated by Schedule
caste families) receive
rakes, sickles and other
tools, district Almora.

Saplings of fruit trees
received by the women o
Mouni-Banthok villages,
district Almora.

Saplings of fruit trees ke
for distribution at Mania
village, district Almora

Saplings of fruit trees a
tools kept for distributio
Galla, district Nainital

Members of the youth
group (*Jan Maîtri*
Sangathan) at Galla carry
fruit tree saplings to th
village, district Nainita

Women save the indigenous varieties of seeds at Galla village, district Nainital.

Saving local varieties of seeds at Shama, district Bageshwar.

Farmers have been saving the local varieties of seed at Galla, district Nainital.

A polythene lined water tank at Galla village. Early morning in December, the land is covered by frost, district Nainital.

Polythene lined water tanks at Galla village, district Nainital.

A panoramic view of the orchards of Galla village. The green patches show the water tanks, district Nainital.

Installing a polythene line
water tank at Lamudiyar
village, district Almora.

All activities were carriec
out under the leadership
the women's groups in
villages. Here, women of
Lamudiyar village install
polythene lined water tan
district Almora.

Communities use water
from polythene-lined tank
for domestic purposes,
except drinking and
cooking. Village Lamudiya
district Almora.

The design of the green houses installed earlier could not ensure proper ventilation, village Shama district Bageshwar.

A fully covered green-hous (previous design) at shama district Bageshwar.

Modified design- green house at Lamudiyar village district Almora.

Installing a green-house a
Lamudiyar village, district
Almora.

Women farmers were
encouraged to grow off-
season vegetables in the
green house, Lamudiyar
village, district Almora.

Men, especially youth, we
involved in the programm
Lamudiyar village, district
Almora.

A green house and a water tank owned by a female headed household at Lamudiyar village, district Almora.

A green house (design modified by USNPSS) at Shama village, district Bageshwar.

Vegetable production in the green house at Shama village, district Bageshwar.

Light traps, developed by VPKAS, Almora were supplied to Galla village district Nainital.

Low cost, light traps designed by USNPSS were supplied to Lamudiyar village, district Almora.

Tools related to horticultu and apiculture were supplied by USNPSS to village Galla, district Nainital.

Women at Galla village hav learnt to do grafting on fru trees, district Nainital.

An orchardist at Galla village. He has coordinate all activities under the project at Galla, district Nainital.

Bee keeping has emerged a livelihood option at Gall village, district Nainital.

Galla : Fodder

Household	Dry grass						Green grass						Green tree leaves						Crop residue					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	28	20	3	6	0	0	4	5	0	4	30	35	15	10	4	2	0	0	0	0	0	2	0	0
2	20	22	3	3	0	0	0	3	0	5	45	40	5	8	0	2	0	0	0	0	0	2	0	0
3	15	14	5	6	0	0	0	3	0	0	25	30	0	5	0	0	0	0	0	0	0	0	0	0
4	15	13	4	5	0	0	4	3	0	0	50	45	0	5	0	0	0	0	0	0	0	0	0	0
5	20	19	6	5	0	0	10	5	0	3	60	46	4.5	5	8	2	0	0	0	0	4	6	0	0
6	30	29	0	3	0	0	2	3	0	3	35	42	0	0	0	4	0	0	0	0	0	0	0	0
7	22	20	8	6	0	0	0	4	0	0	40	38	0	4	4	3	0	0	0	5	4	7	0	0
8	40	30	0	3	0	0	10	7	10	5	60	52	8	4	0	3	0	0	0	4	0	2	0	0
9	8	10	0	3	0	0	10	8	0	3	45	48	0	5	0	0	0	0	0	0	0	3	0	0
10	8	10	2	3	0	0	5	4	0	0	46.5	45	0	5	5	0	0	0	0	0	0	0	0	0
11	11.5	10	4	3	0	0	3	5	0	0	48.2	45	0	0	0	0	0	0	0	0	0	0	0	0
12	8	9	0	5	0	0	2	5	0	0	37.8	35	4	0	6	0	0	0	0	2	0	4	0	0
13	20	18	2	3	0	0	10	6	0	0	38	35	0	0	0	3	0	0	0	0	0	5	0	0
14	0	5	2	3	0	0	2	5	0	3	56	50	0	3	0	3	0	0	16	0	0	0	0	0
15	17	16	5	3	0	0	0	3	0	0	50	40	0	0	0	3	0	0	0	0	0	0	0	0
AVERAGE	17.50	16.30	2.90	4.00	0.00	0.00	62.00	69.00	0.60	1.7 (0.5)	44.4 (14.8)	41.7 (13.9)	2.43	54.00	1.8 (0.9)	1.6 (0.8)		0.00	1.07	0.70	0.50	2.00	0.00	0.00
TOTAL	262.50	245.00	44.00	60.00	0.00	0.00	4.1 (1.3)	4.6 (1.5)	10 (3.3)	26.00	666.50	626.00	36.5 (18.25)	3.6 (1.8)	27.00	25.00	0.00	0.00	16.00	11.00	8.00	31.00	0.00	0.00
CONSUMPTION OF THE VILLAGE	945.00	880.00	156.00	216.00	0.00	0.00	221 (73)	248 (82)	32 (10)	91 (30.5)	2397 (799)	2251 (750)	131.22 (65.61)	194 (64)	97.2 (48.6)	86.4 (43.2)	0.00	0.00	57.24	37.80	27.00	108.00	0.00	0.00

Household	Fuel wood					
	Jan		May		Sept	
	2012	2013	2012	2013	2012	2013
1	20	18	15	16	16	15
2	12	15	10	12	13	14
3	18	20	15	14	15	14
4	16	19	12	15	15	16
5	18	18	13	14	16	18
6	17	19	15	15	16	12
7	20	18	14	13	15	14
8	16	20	12	15	15	14
9	20	21	15	14	15	13
10	21	20	19	20	21	20
11	20	18	16	18	19	18
12	24	20	20	20	19	18
13	25	26	14	15	16	15
14	32	30	25	26	24	20
15	15	20	18	20	18	16
AVERAGE	19.6	20.1	15.5	16.4	16.8	15.8
TOTAL	294	302	233	247	253	237
CONSUMPTION OF THE VILLAGE	1058.4	1085	820	885	907	853

Household	Animal bedding					
	Jan		May		Sept	
	2012	2013	2012	2013	2012	2013
1	15	14	10	8	15	10
2	14	15	5	5	15	10
3	12	15	5	6	7	8
4	7	10	8	7	5	9
5	12	15	5	7	5	10
6	13	15	10	9	8	5
7	20	18	10	9	10	12
8	9	10	10	10	15	10
9	18	20	6	8	15	10
10	10	13	8	8	10	13
11	13	15	5	7.5	9	5
12	10	15	10	10.5	13	10
13	12	15	8	8.8	8	9
14	14	14.5	10	11	15	10
15	10	11	13	12	12	10
AVERAGE	12.60	14.30	8.20	8.40	10.80	9.40
TOTAL	189.00	215.50	123.00	126.80	162.00	141.00
CONSUMPTION OF THE VILLAGE	680.00	772.00	442.00	453.00	583.00	507.00

Galla : Animal number

Household	May																Sept													
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	Jul-05	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	0	0	0	1	0	3	0	0	1	0	1	1	2	3	0	0	0	0	0	1	0	1	0	3	1	0	0	0	1	1
2	0	0	1	0	0	1	1	2	0	0	0	0	0	0	0	2	1	2	0	0	1	0	0	1	1	2	0	0	0	0	0	0
3	0	0	1	1	0	0	1	1	1	0	0	1	1	0	0	0	3	0	0	0	1	1	0	0	1	1	1	0	0	1	1	0
4	0	0	1	0	0	0	1	1	0	0	0	0	0	0	2	7	1	3	0	0	1	0	0	0	1	1	0	0	0	0	0	0
5	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	2	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
6	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0	0	3	5	0	0	1	0	0	0	1	1	0	0	1	0	1	0
7	0	0	0	2	1	0	1	1	1	1	1	0	0	0	40	25	2	5	0	0	0	2	1	0	1	1	1	1	1	0	0	0
8	0	0	1	2	1	1	2	0	1	1	1	0	0	0	0	0	3	3	0	0	0	2	1	1	2	0	1	1	1	0	0	0
9	1	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	2.5	1	1	0	1	1	0	1	1	0	0	0	0	0	0	1
10	0	0	0	1	0	0	3	2	0	0	1	0	0	0	0	2	0	1.5	0	0	0	1	0	0	3	2	0	0	1	0	0	0
11	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	2	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0
12	0	0	0	1	2	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	0	1	2	0	0	1	0	0	0	0	0	0
13	0	0	2	1	0	2	2	1	0	0	0	0	0	0	0	0	3	2	0	0	2	1	0	2	2	1	0	0	0	0	0	0
14	0	0	0	1	0	1	1	2	0	1	1	0	1	0	0	0	0	2	0	0	0	1	0	1	1	2	0	1	1	0	1	0
15	0	0	1	2	0	1	3	2	0	0	0	0	0	0	2	0	2	3	0	0	1	2	0	1	3	2	0	0	0	0	0	0
Total	1	0	10	14	5	9	19		2	3	5	1	3	2	47	40	25	31	1	0	10	15	5	9	19		2	3	5	1	3	2

Galla : Animal number

Household	November																					
	Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	2	3	0	4	0	0	0	0	0	1	0	3	0	0	1	0	1	1	2	3	0	0
2	0	2	2	2	0	0	1	0	0	1	1	2	0	0	0	0	0	0	0	2	1	2
3	0	0	3	0	0	0	1	1	0	0	1	1	1	0	0	1	1	0	0	0	2	0
4	2	7	2	3	0	0	1	0	0	0	1	1	0	0	0	0	0	0	2	7	2	3
5	0	0	2	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	2	0
6	0	0	3	4	0	0	1	0	0	0	1	1	0	0	1	0	1	0	0	0	1.5	2
7	40	25	2	4	0	0	0	2	1	0	1	1	1	1	1	0	0	0	40	25	2	3
8	0	0	3	3	0	0	0	2	1	1	2	0	1	1	1	0	0	0	0	0	3	3
9	0	0	2	1.5	1	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	2	1
10	0	2	0	2	0	0	0	1	0	0	3	2	0	0	1	0	0	0	0	2	0	1.5
11	0	1	3	1	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	2	1
12	1	0	0	2	0	0	0	1	2	0	0	1	0	0	0	0	0	0	1	0	0	2
13	0	0	3	2	0	0	2	1	0	2	2	1	0	0	0	0	0	0	0	0	2	1.5
14	0	0	0	2	0	0	0	1	0	1	1	2	0	1	1	0	1	0	0	0	0	2
15	2	0	2	3	0	0	1	2	0	1	3	2	0	0	0	0	0	0	2	0	2	2
Total	47	40	27	34	1	0	10	14	5	9	19		2	3	5	1	3	2	47	40	22	24

Galla : Water Cosumption

Household	May								November							
	Household		Animal		Bathroom		Irrigation		Household		Animal		Bathroom		Irrigation	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	50	55	25	30	200	190	30	0	55	50	20	25	250	190	0	0
2	70	60	60	50	180	150	35	15	60	70	30	25	160	170	0	0
3	60	62	100	80	145	160	0	0	65	60	60	35	155	160	0	0
4	40	35	60	55	80	95	0	0	45	50	35	40	100	95	0	0
5	60	35	200	120	50	60	0	0	50	60	60	30	50	60	0	0
6	40	20	135	130	90	85	15	0	45	40	90	45	90	85	0	0
7	40	30	80	60	100	120	20	0	35	45	50	48	90	120	0	0
8	60	62	200	160	60	100	25	15	55	60	30	35	85	100	0	0
9	35	40	90	100	200	180	0	0	40	35	40	35	200	190	0	0
10	30	35	60	75	160	150	0	0	35	35	40	35	200	210	0	0
11	50	40	60	80	300	290	0	15	45	50	30	35	190	200	0	0
12	65	60	100	120	200	250	0	0	60	65	30	40	220	190	0	0
13	70	80	180	150	70	95	50	0	65	60	30	35	70	95	0	0
14	100	110	60	70	120	100	60	0	120	100	60	55	90	80	0	0
15	80	90	120	110	80	50	0	0	90	95	75	70	80	95	0	0
Total	850	814	1530	1390	2035	2075	235	45	865	875	680	588	2030	2040	0	0
Average	56.60	54.20	102.00	92.60	135.00	138.00	15.60	3.00	57.60	58.30	45.30	39.20	135.30	136.00	0.00	0.00
Village cosumption	3056.00	2926.00	5508.00	5000.00	7326.00	7469.00	842.00	162.00	3078.00	2716.00	2448.00	2116.00	7306.00	7344.00	0.00	0.00

Galla : Water Cosumption

Household	May							November					
	Fetching time (min)		Distance (meter)		Filling time (min)			Fetching time		Distance (meter)		Filling time (min)	
	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013
1	90	60	1260	850	3	2		90	60	1260	850	1.5	1.08
2	1	1	93	93	3	2		1	1	93	93	1.5	1.08
3	1	1	64	64	3	2		1	1	64	64	1.5	1.08
4	3	4	700	710	3	2		3	4	700	710	1.5	1.08
5	3	2.5	585	580	3	2		3	2.5	585	580	1.5	1.08
6	5	10	600	600	3	2		5	10	600	600	1.5	1.08
7	8	20	800	810	3	2		8	20	800	810	1.5	1.08
8	30	50	1000	1000	3	2		30	50	1000	1000	1.5	1.08
9	90	95	1200	1200	3	2		90	95	1200	1200	1.5	1.08
10	90	90	1400	1400	3	2		90	90	1400	1400	1.5	1.08
11	15	15	630	630	3	2		15	15	630	630	1.5	1.08
12	90	20	1500	500	3	2		90	20	1500	500	1.5	1.08
13	65	16	2300	800	3	2		65	16	2300	800	1.5	1.08
14	80	15	1800	760	3	2		80	15	1800	760	1.5	1.08
15	110	60	2000	1000	3	2		110	60	2000	1000	1.5	1.08
Total	681.00	459.50	15932.00	10997.00	45.00	30.00		681.00	459.50	15932.00	10997.00	22.50	16.20
Average	45.00	30.00	1062.00	733.00	3.00	2.00		45.00	30.00	1062.00	733.00	1.50	1.08

Galla : crop production

Household	Production (kg)																			
	Pear		Apple		Peach		Ragi		Plum		Wheat		Vegetable		Pea		Kidney bean		Barley	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	50	300	7000	11000	2500	3000	0	15	2000	2500	0	5	100	90	500	400	10	20	0	5
2	100	600	2400	5000	500	1500	10	20	200	350	0	4	70	80	100	300	5	15	0	6
3	40	100	500	1000	3000	5000	0	0	200	400	0	0	50	60	200	250	10	18	0	0
4	40	150	400	625	600	1200	35	30	50	200	5	25	60	55	600	500	8	10	5	4
5	20	50	640	820	600	1000	30	35	100	350	20	40	60	65	70	100	6	10	25	30
6	150	200	8000	1260	1400	2000	25	40	50	400	3	10	70	80	200	160	10	12	5	10
7	200	500	2000	3500	1000	1500	25	40	0	100	25	40	80	90	400	400	10	15	25	18
8	40	100	4500	9000	8000	5000	0	0	200	300	0	5	30	50	2000	3000	15	10	0	0
9	120	400	1500	2500	0	100	0	0	100	250	0	0	25	60	200	500	10	15	0	5
10	30	100	350	900	250	400	15	20	50	100	5	6	60	100	150	300	15	15	0	6
11	50	100	500	1400	400	600	20	30	100	400	4	10	75	80	100	150	10	15	0	5
12	40	200	950	1800	1000	1200	10	25	100	400	0	0	90	50	100	200	12	18	4	10
13	10	300	4000	5000	700	1500	15	30	100	500	3	20	250	250	150	100	8	10	3	6
14	20	100	6000	10000	2000	2200	20	40	20	90	0	15	100	150	300	280	15	10	5	8
15	30	200	700	1500	600	1000	0	45	50	200	0	20	80	90	60	100	20	15	0	5
Total	940.00	3400.00	39440.00	55305.00	22550.00	27200.00	205.00	370.00	1320.00	6540.00	65.00	200.00	1200.00	1350.00	5130.00	6740.00	164.00	208.00	72.00	118.00
Average	62.60	226.00	2629.00	3687.00	1503.00	1813.00	13.60	24.60	88.00	436.00	4.30	13.30	80.00	90.00	342.00	449.00	10.90	13.80	4.80	7.80
Village Total	3380.00	12204.00	141966.00	199098.00	81179.00	97902.00	734.00	1328.00	4752.00	23544.00	232.00	718.00	4320.00	4860.00	18468.00	24264.00	590.00	748.00	259.00	421.00

Household	Galla : Dung production (kg)/day			
	May-June		November	
	2012	2013	2012	2013
1	10	12	15	14
2	12	15	14	14
3	15	13	16	15
4	14	15	15	15
5	12	17	15	16
6	20	18	18	14
7	22	15	20	13
8	18	15	18	20
9	15	20	18	18
10	15	22	16	20
11	13.5	18	15	16
12	15.5	19	15	18
13	16	16	15.5	15
14	19	16	18	16
15	16	18	16	18
Total	233.00	249.00	244.50	242.00
Average	15.50	16.60	16.20	16.10
Village Total	838.00	896.00	874.00	871.00

Galla : Demography		Population		Migrants	
		2012	2013	2012	2013
1	Digar Singh	11	11	0	1
2	Bahadur Singh	8	8	0	0
3	rajender Singh	6	6	0	0
4	Ramesh Singh	3	3	0	0
5	Gopal Singh	8	8	0	0
6	Ganga Singh	6	6	0	0
7	Bhuraj Singh	5	5	0	0
8	Padam Singh	7	7	0	0
9	Kunti Devi	11	11	0	0
10	Paan Singh	12	12	0	0
11	Kishan Singh	7	7	0	0
12	Lala Singh	9	9	0	0
13	Ramesh Singh	7	7	0	0
14	Harak Singh	10	10	0	0
15	Mahesh Singh	5	5	0	0
16	Bhagwat Singh	4	4	0	0
17	Ramesh Lala	5	5	0	0
18	Anandi devi	10	8	0	2
19	Nanadan Singh	4	4	0	0
20	Nagmal Singh	1	1	0	0
21	saraswati Devi	5	5	0	0
22	Sher Singh	8	8	1	1
23	Paan Singh	7	7	0	0
24	Jeevan Lala	3	3	0	0
25	Inder Singh	6	6	0	0
26	Bhagvat Singh	6	6	0	0
27	Diwan Singh	6	6	0	0
28	Harish Singh	4	4	0	0
29	Mohan Ram	6	6	0	0
30	Krishna Chandra	3	3	0	0
31	Virender Singh	4	3	0	0
32	Daan Singh	5	5	0	0
33	Kundan Singh	4	4	0	0
34	Bhagvati Devi	3	3	0	0
35	Jagdish Singh	5	5	0	0
36	Bhagvat Singh	6	6	0	0
37	Suresh Singh	4	4	0	0
38	Harish Singh	4	4	0	0
39	Bhopal Singh	8	8	4	4
40	Govindi Devi	6	6	0	0
41	Madan Singh	6	6	0	0
42	Ganesh Singh	6	6	0	0
43	Bhagvat Singh	3	3	0	0
44	Bhagvant Singh	4	4	0	0
45	Himmati Devi	6	6	0	0
46	Kunwar Singh	11	11	0	0
47	ganga Singh	4	4	0	0
48	Jagat Singh	14	14	0	0
49	Mohan Singh	4	4	0	0
50	Sher Singh	11	11	0	0
51	Tara Singh	6	6	0	0
52	Harender Singh	4	4	0	0
53	Virender Singh	4	4	1	1
54	Kunti Devi	9	9	0	0
Total		334	331	6	9

Kendul malla : Fuelwood and fodder consumption

Household	Fuelwood						Dry grass						Green grass					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	24	22	10	9	13	12	18	16.5	10	8	3	4	0	0	0	0	20	25
2	15	16	12	8	9	8	20	22	16	15	3	4	0	0	0	0	25	30
3	5	6.5	2	3	5	4	3	4.5	0	0	0	2	0	0	0	0	0	0
4	4	4.5	3	3.5	4	3	0	2	0	0	0	0	0	0	0	0	15	18
5	12	13	10	9	9	9.5	0	0	0	0	0	0	0	0	0	4	20	25
6	19	18	15	13	13	16	26	15	0	7	3	4	0	0	0	5	25	22
7	16	18	13	14	15	20	14	10	0	6	0	0	0	10	0	0	40	35
8	16	15	10	13	16	25	10	7	0	0	0	0	0	14	0	0	35	40
9	15	16.5	12	9.5	16	16	6	0	9	5	3	5	12	8	0	7	42	40
10	10	11	8	6	8	9	12	14	4	0	3	3	10	0	0	6.5	30	35
11	32	30.5	22	19	15	12	10	8	0	6.5	0	0	0	0	0	0	25	30
12	10	13	3	4	2	4	10	12.5	3	0	6	6	5	8	5	0	30	32
Total	178	184	120	111	125	139	129	112	42	47.5	21	28	27	40	5	22.5	307	332
Average	14.3	15.3	10	9.25	10.4	11.5	10.8	9.29	3.5	3.95	1.75	2.3	2.25 (0.75)	3.33 (1.11)	0.41 (0.1)	1.87 (0.60)	25.58 (12.7)	27.6 (13.8)
Total village consumption	607	689	450	416	469	519	441	418	158	178	78.8	105	31.5	49.9	4.5	27	571	621

Kendul malla : Fuelwood and fodder consumption

Household	Green tree leaves						Crop residue						Animal bedding					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	18	16.5	5	3	2	4	2	4	5	8	6	5	0	0	0	0	0	0
2	10	12	8	6.5	0	6	15	14	12	14	3	4	0	0	0	0	2	3
3	4	5	2	0	0	0	0	5	0	4	3	3	0	0	0	0	0	0
4	0	3	0	0	0	0	0	4	0	5	3	4	0	0	0	0	0	0
5	5	6.5	0	4	5	0	0	3	5	7.5	0	5	0	0	0	0	0	0
6	12	10	7	5.5	0	0	4	3.5	7	8.5	0	4	0	0	0	0	4	4.5
7	9	8	5	0	0	0	3	4	5	7	0	3	0	0	0	0	0	0
8	4	5.5	0	4.5	0	2	2	2.5	8	8.5	0	2.5	0	0	0	0	0	0
9	6	5.5	0	3	0	0	3	4.5	9	13	9	0	0	0	0	0	0	0
10	10	8	6	0	3	0	8	10	4	8	0	0	0	0	0	0	3	4
11	6	8	20	16	0	3	3	0	5	7.5	0	5	0	0	0	0	0	0
12	12	7	3	4	0	4	5	6.5	7	10	0	3	0	0	0	0	0	0
Total	96	95	56	46.5	10	19	45	61	67	101	24	38.5	0	0	0	0	9	11.5
Average	8 (4)	7.9 (3.9)	4.6 (2.3)	3.8 (1.9)	0.8 (0.4)	1.5 (0.7)	3.75	5.08	5.5	8.4	2	3.2	0	0	0	0	0.7	0.9
Total village consumption	180	178	105	87.1	18.7	35.6	154	228	251	378	90	144	0	0	0	0	31.5	40.5

Kendul malla : Water Consumption

Household	May									November							
	Household		Animal		Bathroom		Irrigation			Household		Animal		Bathroom		Irrigation	
	2012	2013	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013	2012	2013
1	32	35	60	55	0	0	0	0		25	25	50	45	0	0	0	0
2	30	25	50	55	0	0	0	0		28	25	45	45	0	0	0	0
3	22	25	30	25	10	12	0	0		20	18	35	40	8	10	0	0
4	15	20	55	50	15	15	0	0		15	20	35	32	18	20	0	0
5	20	18	15	20	20	18	0	0		18	20	10	10	15	15	0	0
6	30	25	60	50	0	0	0			25	20	45	40	0	0	0	
7	30	28	90	82	20	25	0	0		28	30	70	65	15	20	0	0
8	50	45	45	50	20	22	0	0		45	42	40	40	22	20	0	0
9	30	35	45	55	0	0	0	0		25	20	45	40	0	0	0	0
10	30	32	50	45	30	28	0	0		25	28	40	38	25	20	0	0
11	20	22	40	38	30	30	0	0		15	15	35	32	25	22	0	0
12	10	14	45	35	15	20	0	0		10	12	25	20	12	15	0	0
Total	319	324	585	560	150	170	0	0		279	275	475	447	150	142	0	0
Average	26	27	48.75	47	12.5	14	0	0		23.25	22	39.5	37	12.5	11.8	0	0
Village consumption	1196	1215	2193.75	2126	562	637	0	0		1046	1031	1781	1676	562	532	0	0

Kendul malla : Water, distance travelled and time spent for water

Household	May							November					
	Fetching time (sec)		Distance (meter)		Filling time (sec)			Fetching time		Distance (meter)		Filling time (sec)	
	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013
1	10	12	6	6	70	70		10	12	6	6	70	70
2	11	10	8	8	60	60		11	10	8	8	60	60
3	20	20	15	15	50	50		20	20	15	15	50	50
4	10	10	30	30	6	6		10	10	30	30	6	6
5	10	10	25	25	130	130		10	10	25	25	130	130
6	15	16	25	25	130	130		15	16	25	25	130	130
7	10	12	20	20	130	130		10	12	20	20	130	130
8	8	10	25	25	130	130		8	10	25	25	130	130
9	15	15	5	5	50	50		15	15	5	5	50	50
10	20	20	15	15	30	30		20	20	15	15	30	30
11	6	8	15	15	130	130		6	8	15	15	130	130
12	12	12	10	10	50	50		12	12	10	10	50	50
Total	147	155	199	199	966	966		137	143	193	193	896	896
Average	12.25	13	16.5	16.58	80.5	80.5		11.41	12	16	16	74.6	74.6

Kendul malla : Animal number

Household	May-June																September																	
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat	
	2012	2013	2012		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	Jul-05	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	3	0	0	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0
2	2	2	1	0	0	1	0	1	0	1	1	0	1	0	0	0	1	2	2	2	1	0	0	1	0	1	0	1	0	0	1	0	0	0
3	1	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	2	1	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0
4	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	2	2	2	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	2
5	1	1	0	0	0	0	0		0	1	1	0	0	0	1	2	0	2	0	1	0	0	0	0	0		0	1	0	0	0	0	1	2
6	2	2	1	1	0	0	2	1	0	0	1	1	1	0	14	12	2.5	2.5	2	2	1	1	0	0	2	1	0	0	0	1	0	0	14	12
7	0	0	2	1	0	1	3	2	1	0	0	1	0	0	0	0	4	2	0	0	2	1	0	1	3	2	1	0	0	1	0	0	0	0
8	2	2	1	0	0	1	1	0	0	1	1	0	0	0	0	0	1	2	0	2	1	0	0	1	1	0	0	1	0	0	0	0	0	0
9	0	0	1	0	1	0	1	0	1	0	0	1	0	0	1	0	2	0	0	0	1	0	1	0	1	0	1	0	0	1	0	0	1	0
10	0	0	1	0	1	0	2	1	0	1	0	0	0	0	0	4	3	1.5	0	0	1	0	1	0	2	1	0	1	0	0	0	0	0	4
11	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	3	1	0	1	1	1	1	0	1	1	1	0	0	0	0	1	0	0
12	0	0	0	1	0	1	2	1	1	0	0	0	0	0	0	0	2	1.5	0	0	0	1	0	1	2	1	1	0	0	0	0	0	0	0
Total	9	9	9	6	3	4	13	9	7	4	4	4	3	1	17	20	26	18	4	9	9	6	3	4	13	9	7	4	0	4	1	1	16	20
Average	0.8	0.8	0.8	0.5	0.3	0.3	1	0.8	0.6	0.3	0.3	0.3	0.3	0.1	1.4	1.6	2.1	1.5	0.3	0.8	0.8	0.5	0.3	0.3	1	0.8	0.6	0.3	0	0.3	0.1	0.1	1.3	1.6
Village consumption	34	34	34	23	11	15	45	34	26	15	15	15	11	3.8	64	75	96	66	15	34	34	23	11	15	45	34	26	15	0	15	3.8	3.8	60	75

Kendul malla : Animal number

Household	November																			
	Milk production (l)		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	3	0	0	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	3	0
2	1	2.5	2	2	1	0	0	1	0	1	0	1	1	0	1	0	0	0	1	2
3	2	2	1	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	2	1
4	2	2	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	2	2	2
5	0	2	1	1	0	0	0	0	0		0	1	1	0	0	0	1	2	0	2
6	2.5	3	2	2	1	1	0	0	2	1	0	0	1	1	1	0	14	12	2.5	2.5
7	4	2	0	0	2	1	0	1	3	2	1	0	0	1	0	0	0	0	4	2
8	1	2	2	2	1	0	0	1	1	0	0	1	1	0	0	0	0	0	1	2
9	2	0	0	0	1	0	1	0	1	0	1	0	0	1	0	0	1	0	2	0
10	3	1.5	0	0	1	0	1	0	2	1	0	1	0	0	0	0	0	4	3	1.5
11	3	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	3	1
12	2	2	0	0	0	1	0	1	2	1	1	0	0	0	0	0	0	0	2	1.5
Total	26	20	9	9	9	6	3	4	13	9	7	4	4	4	3	1	17	20	26	18
Average	2.1	1.6	0.8	0.8	0.8	0.5	0.3	0.3	1	0.8	0.6	0.3	0.3	0.3	0.3	0.1	1.4	1.6	2.1	1.5
Village consumption	96	75	34	34	34	23	11	15	45	34	26	15	15	15	11	3.8	64	75	96	66

Kendul malla : Crop and dung production data

Households	Dung production/day				Production in kg											
	May-June		November		Wheat		Barley		Paddy		Vegetables		Mustard		Ragi	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	18	20	20	22	50	90	25	35	45	30	25	22	5	8	30	35
2	22	18	20	20	300	350	45	55	60	70	15	20	4	5	35	40
3	30	30	32	28	50	100	8	15	50	75	30	32	6	8	40	30
4	14	18	15	14	40	90	5	10	30	20	22	25	8	10	25	30
5	20	22	22	20	55	75	8	10	20	22	20	25	10	15	20	25
6	25	20	20	18	125	185	32	30	55	30	10	12	5	10	10	15
7	15	17	18	15	50	80	10	15	25	15	15	10	0	3	5	8
8	20	18	22	16	115	145	4	12	45	20	30	22	3	3	0	5
9	25	20	20	22	285	360	50	65	70	50	28	20	0	4	0	0
10	30	25	28	22	90	150	35	45	60	90	25	28	2	3	15	12
11	20	22	22	20	120	180	10	15	90	35	32	30	3	0	0	0
12	25	22	20	20	300	400	55	60	70	40	22	30	4	5	8	10
Total	264	252	259	237	1580	2205	287	367	620	497	274	276	50	74	188	210
Average	22.00	21.00	21.50	19.75	131.60	183.75	23.90	30.58	51.60	41.41	22.80	23.00	4.10	6.16	15.60	17.50
Village Consumption	990.00	945.00	971.25	888.75	5925.00	8268.75	1076.25	1376.25	2325.00	1863.75	1027.50	1035.00	187.50	277.50	705.00	787.50

Kendul talla : Fuelwood and fodder consumption

Household	Fuelwood						Dry grass						Green grass					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	16	17	6	5	15	16	10	12	0	0	0	0	10	8	0	0	25	30
2	35	32	22	18	32	30	12	13.5	12	5	0	0	0	4	5	5	30	32
3	20	22	15	14.5	22	23	20	18.5	10	8	0	0	0	3	2	0	35	30
4	32	30	20	18	31.5	32	10	12	0	3	0	0	5	6	8	5	32	35
5	14	12	8	5	15	14	8	9	2	3	0	0	2	7	6	5	22	25
6	6	8	5	6	7	8	0	0	0	0	0	0	0	4	5	4	25	30
7	5	7	4.5	5	6	7.5	0	7	0	0	0	0	0	0	0	0	40	35
8	20	18	12	10	22	23	12	10	12	0	0	0	0	0	7	0	38	40
9	25	28	15	14.5	22	20	21	17.5	6	7.5	0	0	0	3.5	0	5.5	35	40
10	6	8.5	5	5	7.5	8	0	0	0	0	0	0	0	4	0	6	32	30
11	10	13.5	7.5	6	12	14	10	11	3	0	0	0	0	0	8	0	25	25
12	10	12	7	6.5	13.5	15	18	16.5	5	8.5	0	0	0	0	8	0	22	25
13	18	20	10	11	20	18.5	10	12.5	0	4	0	0	0	5	0	7	30	28
Total	217	228	137	125	226	229	131	140	50	39	0	0	17	44.5	49	37.5	391	405
Average	16.6	17.5	10.5	9.5	17.3	17.6	10.1	10.7	3.84	3	0	0	1.3	3.4 (1.1)	3.7 (1.2)	2.8 (0.9)	30.07 (10.02)	31.15 (10.3)
Village Consumption	747	875	525	475	875	880	453	535	192	150	0	0	58.5 (19.5)	56.6	61.6	46.6	501	519

Kendul talla : Fuelwood and fodder consumption

Household	Green tree leaves						Crop residue						Animal bedding					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	30	25	0	0	0	4	6	7	20	22	0	0	0	0	0	0	0	0
2	12	10	5	0	0	5.5	12	14.5	3	5	0	0	0	0	0	0	2	0
3	15	18	5	0	0	0	12	15	2	7	0	0	0	0	0	0	0	0
4	20	18.5	15	8.5	0	0	14	13	8	9.5	0	0	0	0	0	0	0	0
5	12	13.5	0	4	0	0	3	7	4	5.5	0	0	0	0	0	0	4	5
6	0	5	0	5	4	5.5	0	8	0	0	0	0	0	0	0	0	5	6
7	0	6.5	0	0	0	0	0	5	0	6	0	0	0	0	0	0	0	0
8	32	30.5	10	0	0	0	4	6	4	5	0	0	0	0	0	0	0	0
9	24	18	20	9	5	3	2	0	15	18	0	0	0	0	0	0	0	0
10	0	0	0	10	0	4	0	0	0	7	0	0	0	0	0	0	4	5
11	22	0	0	0	6.5	0	2	0	2	5	0	0	0	0	0	0	0	4
12	36	25	0	0	0	0	2	5	8	9.5	0	0	0	0	0	0	0	0
13	35	32	6	12.5	0	0	2	8	8	10	0	0	0	0	0	0	0	0
Total	238 (119)	202	61	49	15.5	22	59	88.5	74	110	0	0	0	0	0	0	15	20
Average	18.3	15.53 (7.7)	4.6 (2.3)	3.7 (1.85)	1.19 (0.59)	1.69 (0.8)	4.5	6.8	5.6	8.4	0	0	0	0	0	0	1.15	1.53
Village Consumption	823 (411.5)	388	115	92.5	29.7	42.2	204	340	280	420	0	0	0	0	0	0	57.6	76.9

Kendul talla : Water Cosumption (litre)

Household	May							November							
	Household		Animal		Bathroom			Household		Animal		Bathroom		Irrigation	
	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013	2012	2013
1	85	75	60	65	15	20		75	70	50	55	20	18	0	0
2	45	40	30	35	60	65		40	45	32	35	50	45	0	0
3	40	45	32	35	60	70		30	35	30	28	55	50	0	0
4	45	50	120	100	25	28		38	30	95	85	20	18	0	0
5	40	50	35	40	45	40		35	30	40	42	42	45	0	0
6	25	30	40	35	45	42		22	20	35	30	40	38	0	0
7	20	22	55	50	65	55		18	20	50	45	60	55	0	0
8	65	55	120	110	45	50		55	48	110	95	40	38	0	0
9	60	50	30	32	80	79		50	50	32	35	75	70	0	0
10	20	18	35	40	20	22		55	55	30	35	18	20	0	0
11	30	28	45	40	60	50		15	20	42	40	55	50	0	0
12	30	32	30	35	10	12		25	28	35	32	12	10	0	0
13	60	50	95	85	80	65		22	20	90	80	70	60	0	0
Total	565	545	727	702	610	598		480	471	671	637	557	457	0	0
Average	43.46	41.92	55.9	54	46.92	46		36.92	36.23	51.61	49	42.8	35.15	0	0
Village cosumption	2173	2096	2796	2700	2346	2300		1846	1811	2580	2450	2142	1757	0	0

Kendul talla : Water Cosumption (litre)

Household	May						November					
	Fetching time (min)		Distance (meter)		Filling time (sec)		Fetching time		Distance (meter)		Filling time (min)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	55	50	180	180	40	42	52	51	180	180	38	40
2	30	29	70	70	40	42	32	31	70	70	38	40
3	14	15	30	30	35	35	15	15	30	30	32	30
4	50	52	160	160	35	35	48	50	160	160	32	30
5	45	45	130	130	40	42	45	45	130	130	38	40
6	10	11	28	28	45	48	10	12	28	28	45	42
7	5	8	18	18	45	48	6	8	18	18	45	42
8	25	28	65	65	32	33	25	24	65	65	30	32
9	15	13	26	26	32	33	14	13	26	26	30	32
10	10	9	22	22	40	42	10	9	22	22	40	38
11	20	20	55	55	55	55	18	21	55	55	50	50
12	5	7	18	18	55	55	6	7	18	18	50	50
13	16	16	32	32	50	52	15	14	32	32	50	48
Total	300	303	834	834	544	562	296	300	834	834	518	514

Kendul talla : Animal number

Household	May-June															
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat	
	2012	2013	2012		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	1	0	0	1	2	1	0	1	1	0	1	0	0	0
2	2	0	0	1	2	1	0	0	1	0	0	1	1	0	0	0
3	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0
4	1	1	1	0	1	1	2	2	0	0	0	0	0	0	3	2
5	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	0
7	1	1	0	1	0	0	0	0	1	0	0	1	1	0	0	1
8	0	0	1	1	1	0	3	2	0	1	1	0	0	1	2	1
9	2	2	2	1	0	1	2	1	0	0	0	0	0	0	0	0
10	1	1	0	1	0	0	0	0	1	0	0	1	0	1	1	0
11	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
12	2	2	1	0	0	1	0	1	1	0	0	1	0	0	1	2
13	1	1	1	1	0	0	2	1	0	1	1	0	0	0	0	0
Total	10	8	10	7	4	8	14	9	5	3	3	5	4	3	8	6
Average	0.7	0.6	0.7	0.5	0.3	0.6	1	0.6	0.38	0.2	0.2	0.38	0.3	0.2	0.6	0.4
Village consumption	38.5	30.8	38.5	26.9	15.4	30.8	53.8	34.6	19.2	11.5	11.5	19.2	15.4	11.5	30.8	23.1

Kendul talla : Animal number

Household	November																					
	Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	1	2.5	3	0	0	1	0	0	1	2	1	0	1	1	0	1	0	0	1	2	3
2	0	0	3	2	2	0	0	1	2	1	0	0	1	0	0	1	1	0	0	0	2.5	1.5
3	1	0	1.5	2	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	1	2
4	3	0	1.5	0	1	1	1	0	1	1	2	2	0	0	0	0	0	0	3	0	1.5	0
5	0	1	2	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	1	2	0
6	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	0	0	0
7	0	1	2	1.5	1	1	0	1	0	0	0	0	1	0	0	1	1	0	0	1	2	1
8	2	1	2	2.5	0	0	1	1	1	0	3	2	0	1	1	0	0	1	2	1	2	2
9	0	1	3.5	1.5	2	2	2	1	0	1	2	1	0	0	0	0	0	0	0	1	3	2
10	1	0	1.5	2	1	1	0	1	0	0	0	0	1	0	0	1	0	1	1	0	1	2
11	0	0	1.5	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1.5	0
12	1	0	2	0	2	2	1	0	0	0	0	1	1	0	0	1	0	0	0	0	2	0
13	0	2	0	3	1	1	1	1	0	0	2	1	0	1	1	0	0	0	0	2	0	3
Total	8	5	23	14.5	10	8	10	7	4	7	14	9	5	3	3	5	4	3	7	5	20.5	13.5
Average	0.6	0.38	1.79	1.11	0.7	0.6	0.7	0.5	0.3	0.5	1	0.6	0.38	0.2	0.2	0.38	0.3	0.2	0.5	0.38	1.57	1.03
Village consumption	30.8	19.2	88.5	55.8	38.5	30.8	38.5	26.9	15.4	26.9	53.8	34.6	19.2	11.5	11.5	19.2	15.4	11.5	26.9	19.2	78.8	51.9

Kendul talla : Dung and crop productionm

Households	Dung production, kg/day				Production, kg											
	May-June		November		Wheat		Bnarley		Paddy		Vegetables		Mustard		Ragi	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	20	22	19	20	250	300	50	60	220	180	80	95	0	5	15	20
2	18	20	17	15	200	170	45	50	240	220	120	100	5	4	10	15
3	32	30	28	22	180	240	45	65	260	210	110	100	0	4	10	15
4	16	15	14	15	230	280	70	80	200	210	70	100	6	5	12	10
5	22	18	19	16	160	200	65	80	180	150	60	120	0	6	8	11
6	22	20	20	16	100	140	30	45	140	180	80	110	6	6	10	10
7	18	22	20	17	50	70	35	50	120	140	85	120	0	6	0	5
8	22	20	17	14	250	280	20	25	220	250	90	105	3	7	0	5
9	28	30	26	22	190	220	15	10	240	350	150	97	5	5	5	5
10	28	32	25	23	60	80	25	20	80	145	120	95	0	5	10	10
11	24	22	20	23	120	150	30	45	150	140	95	120	10	4	12	12
12	28	25	22	25	140	160	55	65	110	130	105	130	0	4	16	8
13	16	15	14	15	150	210	75	85	100	160	110	125	0	5	15	12
Total	294.00	291.00	261.00	243.00	2080.00	2500.00	560.00	680.00	2260.00	2465.00	1275.00	1417.00	35.00	66.00	123.00	138.00
Average	22.61	22.38	20.07	18.60	160.00	192.30	43.00	52.30	173.80	189.60	98.07	109.00	1.60	5.07	9.40	10.61
Village Consumption	1130.00	1119.00	1003.00	934.00	8000.00	9515.00	2153.00	2615.00	8692.00	9480.00	4903.00	5405.00	134.60	253.80	473.00	530.70

Kendul talla : Demography					
Sl	Hedad of the Household	Total		Migrants	
		2012	2013	2012	2013
1	Gajender Singh	6	5	0	1
2	Kiashan Singh	4	4	0	0
3	Shiv Singh	5	6	0	1
4	Rajender Singh	2	2	3	0
5	Jamotri Devi	4	5	0	0
6	Surmaan Singh	4	4	1	0
7	Manohar Singh	3	3	9	10
8	Gabbar Singh	5	6	1	2
9	Makan Singh	4	4	0	0
10	Prem Singh	6	5	0	1
11	Sahdeyi Devi	7	7	2	2
12	Urmila Devi	2	2	2	2
13	Arjun Singh	6	5	1	2
14	Savitri Devi	2	3	5	5
15	Sarojni Devi	2	2	1	1
16	Shekhar Singh	3	3	1	1
17	Sohan Lal	2	2	2	2
18	Rampyari Devi	3	2	3	3
19	Genda Lal	8	7	4	5
20	Bajari Lal	2	2	0	0
21	Madan Lal	8	7	1	2
22	Ram Lal	1	1	4	4
23	Kishan Singh	2	2	1	1
24	Teerath Singh	5	5	5	5
25	Praveen Singh	2	2	1	1
26	Jaikrit Singh	5	5	0	0
27	Hilasi Devi	4	5	5	5
28	Balbeer Singh	3	3	0	0
29	Shanti Devi	5	5	2	2
30	Mahidhar Prasad	2	3	2	2
31	Jasvant Singh	4	4	2	2
32	Dikka Devi	6	5	6	7
33	Anandi Devi	3	3	2	2
34	Uday Singh	5	6	2	2
35	Tota Singh	6	6	4	4
36	Komal Singh	2	2	2	2
37	Thaan Singh	4	5	2	2
38	Dhyan Singh	5	5	0	0
39	Darshan Singh	5	5	1	1
40	Fateh Singh	2	2	0	0
41	Bheem Singh	4	4	0	0
42	Kamla Devi	2	2	7	7
43	Dheeraj Singh	2	2	4	4
44	Vidhaydutt Juyal	5	5	1	1
45	Ranjeet Singh	3	3	2	2
46	Maharaj Singh	6	7	2	2
47	Ramesh Chanra	4	4	2	2
48	Vijay Singh	1	1	4	4
49	Pradeep Singh	3	3	2	2
50	Narender Singh	1	1	3	3
Total		190	192	104	109

Lamudiyar Village Fuelwood and fodder consumption

Household	Fuel wood						Dry grass						Green grass					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	30	35	22	20	19	16	20	22	18	15	0	0	0	3	4	5	30	35
2	20	25	15	16	17	15	10	13	8	9	0	0	0	2	5	6	20	25
3	14	20	10	9	15	14	18	20	11	12	0	0	0	3	10	12	36	35
4	22	25	12	10	20	18	18	19	8	9	0	0	0	0	8	9	35	30
5	17	20	12	12	20	18	10	13	4	9	0	0	0	3	5	5	22	25
6	16	18	10	11	15	15	15	14	5	6	0	0	0	0	4	5	29	30
7	30	32	25	20	18	16	20	18	5	6	0	0	0	3	5	6	34	35
8	25	20	20	20	20	17	10	15	6	9	0	0	0	0	4	5	22	25
9	17	20	15	16	14	15	30	25	6	9	0	0	0	3	15	15	32	35
Total	191	215	141	621.8	158	144	151	159	71	84	0	0	0	17	60	68	260	275
Average	21.2	23.8	15.6	14.8	17.5	16	16.7	17.6	7.8	9.3	0	0	0	1.8 (0.6)	6.6 (2.2)	7.5 (2.5)	28.8 (9.6)	30.5 (10.1)
Village consumption/day	678	761	499	473	560	512	534	563	249	297	0	0	0	57.6 (19.2)	211 (70)	240 (80)	921 (307)	976 (325

Household	Green tree leaves						Crop residue						Animal bedding					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	4	6	16	15	0	0	0	5	0	5	3	5	10	12	10	5	9	10
2	5	9	13	12	0	0	5	6	0	5	3	6	10	9	5	5	9	5
3	10	12	12	12	0	0	7	6	4	6	3	6	10	12	5	5	6	5
4	8	10	18	15	0	0	7	6	2	3	3	3	10	9	3	5	6	5
5	5	6	18	15	0	0	5	6	4	3	3	6	5	6	3	5	6	5
6	4	5	11	12	0	0	5	3	3	6	2	5	10	9	3	5	6	6
7	4	5	5	9	0	0	5	3	3	3	2	5	10	9	5	6	9	4
8	5	9	12	10	0	0	5	3	3	3	1.5	3	5	9	3	9	5	5
9	15	13	20	15	0	0	10	6	3	6	6	9	20	15	9	9	9	5
Total	60	75	125	115	0	0	49	44	22	40	26.5	48	90	90	46	54	65	50
Average	6.6 (3.3)	8.3 (4.1)	13.8 (6.9)	12.7 (6.3)	0	0	5.4	4.8	2.4	4.4	2.9	5.3	11.1	10	5.1	6	7.2	5.5
Village consumption/day	211 (105)	265 (132)	441 (220)	406 (203)	0	0	172	153	76	142	92.8	170	355	32	163	192	231	176

Lamudiyar : Animal number

Household	May																Sept															
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalow		Dry buffalow		B calf		Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalow		Dry buffalow		B calf	
	2012	2013	2012		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	Jul-05	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	1	4	4	0	0	1	1	0	1	1	1	1	1	0	0	0	0
2	1	2	1	1	0	1	2	2	0	0	1	1	0	0	4	5	2	3	1	2	1	0	1	1	2	2	0	0	0	0	0	0
3	0	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	2	3	0	0	0	1	1	0	0	0	1	1	0	0	0	0
4	1	1	0	0	1	1	1	1	1	1	1	1	0	1	4	2	3	2	1	1	1	1	0	1	1	1	1	1	0	0	0	1
5	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	1	0	1	0	0	0	0	1	1	0	0
6	2	2	0	0	1	0	0	0	1	1	0	0	0	1	0	2	3	3	2	2	1	1	0	0	0	0	1	1	0	0	0	1
7	0	0	0	0	0	1	1	1	0	0	0	1	0	0	3	5	0	0	0	0	0	1	2	2	1	1	0	0	0	1	0	0
8	0	0	1	1	0	1	0	0	0	0	0	0	0	0	2	2	2	2	0	0	1	1	0	1	0	0	0	0	0	0	0	0
9	2	2	1	1	1	0	0	0	0	0	1	1	1	1	25	30	2	2.5	2	2	1	1	0	0	0	0	0	0	0	0	1	1
Average	6	7	4	5	6	6	5	5	4	4	3	4	1	3	38	47	20	19.5	6	7	7	8	4	7	5	5	4	4	1	2	1	3
Total																																

Lamudiyar : Animal number

Household	November																					
	Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalow		Dry buffalow		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	1	5	4	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	4	4.5
2	4	5	3	0	1	2	0	0	1	1	2	3	0	0	1	1	0	0	4	5	0	0
3	0	0	0	4	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	1	4.5	5
4	4	2	3	3	1	1	1	1	0	0	1	1	0	1	1	1	0	1	4	2	2	2
5	0	0	2	3	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0
6	0	2	4	3	2	2	0	1	0	0	1	0	1	1	0	0	0	1	2	2	3	3
7	3	3	0	2.5	0	0	1	1	0	0	1	1	0	0	0	1	0	0	3	5	2	3
8	2	2	2	2	0	0	0	0	1	1	0	1	0	0	0	0	0	0	5	2	0	0
9	25	28	3	3	2	2	0	0	2	1	0	1	0	0	1	1	1	1	25	30	0	0
Average	38	43	22	24.5	6	7	4	5	7	6	6	7	3	4	4	4	1	3	43	48	15.5	17.5

Lamudiyar : Water Consumption														
Household	May								November					
	Household		Animal		Bathroom		Irrigation							
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	60	55	32	30	200	200	0	10	50	50	35	30	150	0
2	30	35	30	30	211	190	0	0	35	35	30	30	150	0
3	50	50	70	60	225	230	15	15	50	45	60	65	190	0
4	30	35	60	50	225	226	0	5	35	40	55	50	210	0
5	20	25	20	25	80	90	0	10	20	25	30	25	100	0
6	30	25	90	80	70	75	15	20	20	20	50	45	75	0
7	40	40	80	60	200	180	0	10	45	40	30	45	150	0
8	45	40	30	35	225	230	10	0	38	40	35	35	200	0
9	35	40	85	80	225	200	0	15	35	30	50	40	200	0
Total	340	345	497	450	1661	1621	40	85	328	325	375	365	1425	0
Average	37.7	38.3	52.22	50	184.5	180	4.4	9.4	36.4	36.1	41.6	40.5	158	0
Village consumption	1208	1226	1767	1600	5905	5763	140	302	1164	1155	1333	1297	5066	0

Household	May						November					
	Fetching time (min)		Distance (meter)		Filling time (min)		Fetching time		Distance (meter)		Filling time (min)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	5	5	100	100	2	1.3	5	5	100	100	1	1
2	8	8	150	150	2	1.3	8	8	150	150	1	1
3	15	15	300	200	3	2	15	15	300	200	1	1
4	15	14	290	290	3	2	15	14	290	290	1	1
5	10	10	100	100	3	3	10	10	100	100	1.5	1
6	20	20	300	300	2	1	20	20	300	300	1.2	0.8
7	1	1	50	50	2	1	1	1	50	50	1	0.8
8	5	5	50	50	2	1.5	5	5	50	50	1	0.8
9	8	7	90	90	2	1.5	8	7	90	90	1	0.6
Total	87	85	1430	1330	21	14.6	87	85	1430	1330	9.7	8
Average	9.6	9.4	158	147	2.3	1.6	9.6	9.4	158	147	1	0.8

Lamudiyar : demography					
Sl	HOUSEHOLD	POPULATION		MIGRATION	
		2012	2013	2012	2013
1	KISHAN RAM	8	7	2	3
2	MOHN RAM	4	3	2	3
3	GUSAI RAM	8	8	0	0
4	SURESH LAAL	7	7	1	1
5	SHER RAM	6	6	14	14
6	JAMAN RAM	7	7	1	1
7	JENULI DEVI	6	7	0	1
8	KAMAL RAM	7	7	0	0
9	KISHNI DEVI	7	6	1	2
10	KISHAN RAM	2	3	1	1
11	MADAN RAM	2	2	7	7
12	BAL RAM	8	8	1	1
13	LACHHI RAM	3	4	2	2
14	GOVINDI DEVI	5	4	0	0
15	TRILOK RAM	6	6	6	7
16	JANKI DEVI	5	5	0	0
17	HARISH RAM	4	4	0	0
18	AANI RAM	5	5	1	1
19	MALTI DEVI	3	3	0	0
20	BASANT RAM	8	8	0	0
21	GANGA RAM	8	8	0	0
22	KISHNI DEVI	5	4	1	2
23	JUGULI DEVI	6	6	2	2
24	GANESH RAM	5	6	1	0
25	DEEWAN RAM	2	2	0	0
26	DEVKI DEVI	8	7	1	2
27	BHUPAL RAM	4	4	0	0
28	JAIT RAM	5	5	2	2
29	DEEWAN RAM	4	4	3	3
30	ISHWAR RAM	3	3	2	2
31	RAMESH RAM	4	4	0	0
32	BACHULI DEVI	4	5	1	1
Total		169	168	52	58

Maichun : Fuelwood and fodder consumption

Household	Fuel wood						Fodder											
							Dry grass						Green grass					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	6	10	4	5	10	9	5	10	10	8	0	0	0	0	0	3	20	30
2	32	35	12	10	10	12	60	50	20	15	0	0	0	0	0	3	55	60
3	18	15	2	5	15	12	24	20	18	15	0	0	0	0	0	0	30	50
4	15	16	4	5	10	10	10	15	4	5	0	0	0	0	0	0	22	30
5	20	18	8	10	15	15	12	15	8	5	0	0	0	0	0	3	25	30
6	18	15	12	10	16	14	23	20	18	15	0	0	0	0	8	5	45	40
7	25	28	8	5	20	18	32	30	20	25	0	0	0	0	3	5	35	40
8	32	30	9	5	10	11	30	30	15	20	0	0	0	0	0	0	45	50
9	23	25	8	10	15	16	10	15	10	12	0	0	0	0	3	3	40	35
10	15	20	7	10	15	13	14	15	20	15	0	0	0	0	0	0	35	40
11	25	22	3	5	9	10	8	10	12	15	0	0	0	0	2	3	40	42
12	11	13	5	5	10	10	16	15	10	13	0	0	0	0	2	3	35	38
13	15	18	10	5	12	15	9	10	8	5	0	0	0	0	0	0	20	30
14	21	20	4	5	14	10	30	25	15	10	0	0	0	0	0	5	56	50
15	18	20	7	5	10	10	30	28	18	15	0	0	0	0	0	5	60	58
AVERAGE	294	305	103	100	191	185	313	308	206	193	0	0	0	0	18	38	563	623
TOTAL	19.6	20.3	6.8	6.6	12.7	12.3	20.9	20.5	13.7	12.8	0	0	0	0	1.2 (0.4)	2.5 (0.8)	37.5 (12.5)	41.513.8)
CONSUMPTION OF THE VILLAGE	1078	1015	343	330	636	616	1040	1026	686	643	0	0	0	0	60 (20)	125 (41.6)	1875 (625)	2076 (692)

Maichun : Fuelwood and fodder consumption

Household	Fodder												Animal bedding					
	Green tree leaves						Crop residue											
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	8	10	0	5	0	0	5	10	2	3	6	9	5	5	5	9	10	12
2	20	12	25	10	0	0	24	30	2	3	6	9	30	30	8	9	15	12
3	10	10	4	6	0	0	20	25	6	9	3	9	15	20	7	9	12	10
4	5	9	4	5	0	0	5	15	2	9	3	6	12	20	2	5	10	10
5	8	9	0	4	0	0	4	9	0	6	5	6	9	10	0	3	15	10
6	8	9	20	18	0	0	16	9	3	6	3	5	10	10	0	3	15	10
7	16	15	0	3	0	0	10	9	10	9	3	6	17	15	10	3	10	9
8	4	5	18	9	0	0	14	15	4	6	3	7	10	15	4	5	10	9
9	5	5	5	6	0	0	9	10	3	6	3	9	10	15	2	3	12	9
10	10	6	0	5	0	0	3	9	0	3	3	9	10	13	9	6	10	9
11	3	9	2	9	0	0	0	6	8	9	6	6	5	9	5	6	10	12
12	6	9	8	6	0	0	5	6	3	9	6	6	4	5	5	6	9	12
13	5	6	0	3	0	0	6	9	3	6	6	9	6	9	0	3	9	9
14	0	5	2	5	0	0	5	10	4	6	6	9	12	10	3	3	9	10
15	15	17	15	6	0	0	0	9	8	9	6	9	10	12	5	6	10	10
AVERAGE	123	136	103	100	0	0	126	181	58	99	68	114	165	198	65	79	166	153
TOTAL	8.2 (4.1)	9.06 (4.5)	6.8 (3.4)	6.6 (3.3)	0	0	8.4	12.1	3.8	6.6	4.5	7.6	11	13.2	4.3	5.2	11.1	10.2
CONSUMPTION OF THE VILLAGE	410 (136)	453 (226)	340 (170)	330 (165)	0	0	462	603	193	330	226	380	605	660	216	260	553	510

Maichun : Water Cosumption

Household	May								November							
	Household		Animal		Bathroom		Irrigation		Household		Animal		Bathroom		Irrigation	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	80	75	24	30	0	0	0	5	50	40	20	30	10	15	0	0
2	36	36	90	100	20	0	15	20	30	35	50	40	20	15	0	0
3	10	15	40	50	30	35	20	30	15	20	35	40	20	10	0	0
4	24	25	45	50	20	25	15	10	20	15	40	30	20	10	0	0
5	52	50	20	25	10	0	0	10	45	40	20	35	10	15	0	0
6	60	60	50	45	30	0	0	10	50	45	30	30	20	15	0	0
7	50	50	60	60	40	45	0	5	50	45	40	30	30	20	0	0
8	40	40	60	70	30	30	0	5	40	35	40	35	20	25	0	0
9	50	5	50	55	10	0	0	5	45	30	35	30	10	15	0	0
10	20	25	30	35	50	60	30	10	30	30	35	35	30	20	0	0
11	12	15	60	55	43	45	0	10	15	20	40	35	20	15	0	0
12	20	25	60	50	0	0	15	0	15	20	40	30	10	10	0	0
13	40	35	5	10	30	50	15	25	20	25	10	10	25	15	0	0
14	20	25	50	40	25	30	15	30	15	20	30	35	20	20	0	0
15	60	50	45	50	30	35	0	15	50	40	30	30	15	15	0	0
Total	574	531	689	725	368	355	125	190	490	460	495	475	280	235	0	0
Average	38.2	35.4	45.9	48.3	24.5	23.6	8.3	12.6	32.6	30.6	33	31.6	18.6	15.6	0	0
Village cosumption	1913	1770	2296	2416	1226	1183	416	633	1633	1533	1650	1583	933	780	0	0

Maichun : Water Cosumption

Household	May							November					
	Fetching time (min)		Distance (meter)		Filling time (min)			Fetching time		Distance (meter)		Filling time (sec)	
	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013
1	6.6	6.5	200	200	40	30		6.6	6.6	200	200	30	30
2	1.4	1.5	30	30	60	45		1.4	1.5	30	30	50	45
3	1.4	1.6	35	35	32	20		1.4	1.6	35	35	25	20
4	1.2	1.2	20	20	32	20		1.2	1.2	20	20	25	20
5	2	2	45	45	32	20		2	2	45	45	25	20
6	3.6	3.8	93	93	60	32		3.6	3.8	93	93	50	42
7	3	2.9	75	75	32	15		3	3	75	75	25	15
8	5	5	143	143	40	14		5	5.1	143	143	20	14
9	3.7	3.7	100	100	60	32		3.7	3.7	100	100	50	32
10	2.5	2.5	75	75	32	20		2.5	2.5	75	75	25	20
11	1.5	1.5	80	80	32	20		1.5	1.6	80	80	25	20
12	1	1	10	10	50	18		1	1	10	10	40	35
13	1.8	1.8	94	94	60	32		1.8	1.8	94	94	50	42
14	2	2	50	50	32	20		2	2.1	50	50	25	20
15	1.4	1.5	32	32	32	20		1.4	1.8	32	32	25	20
Total	38.1	38.5	1082	1082	626	358		38.1	39.3	1082	1082	490	395
Average	2.5	2.6	72.1	72.`1	41.7	23.8		2.5	2.6	72.1	72.`1	32.6	26.3

Maichun : Animal number

Household	May																		September																	
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	Jul-05	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	1	1	0	0	0	0	0	0	0	0	1	1	2	2	3	3	0	0	1	1	0	1	0	0	0	0	0	0	1	1	2	2	3	4
2	2	2	1	1	0	0	0	0	1	1	1	1	2	1	5	6	5	6	2	2	1	1	1	1	0	1	1	1	1	1	2	1	5	6	4	4
3	1	1	0	1	0	1	0	0	1	0	0	0	1	1	3	3	4	2.5	1	1	0	1	0	0	0	0	1	0	0	0	1	1	3	3	4	3
4	0	0	1	1	0	0	1	1	0	0	0	0	1	1	3	3	3	3	0	0	1	1	0	0	1	1	0	0	0	0	1	1	3	3	3	3.5
5	1	1	0	1	1	1	1	1	0	0	0	0	0	0	1	1	0	2.5	1	1	0	1	1	1	1	1	0	0	1	1	0	0	1	1	0	3
6	1	1	1	0	0	1	0	0	1	1	0	0	1	1	10	8	6	4	1	1	1	0	0	1	0	0	1	1	0	0	1	1	10	8	6	4
7	3	3	1	0	0	1	1	1	1	1	1	0	1	1	2	2	3	3	3	3	1	0	0	1	1	1	1	1	1	0	1	1	2	2	3	3
8	1	1	1	0	1	1	1	1	0	0	1	1	1	1	3	3	2	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1	3	3	2	0
9	2	2	0	0	0	1	0	0	1	1	0	0	0	0	9	9	3	4	2	2	0	0	1	1	0	0	1	1	0	0	0	0	9	9	3	4
10	1	1	0	1	0	0	0	0	0	0	1	1	0	0	2	5	2	3	1	1	0	1	0	0	0	0	0	0	1	1	0	0	2	5	2	4
11	2	2	1	1	1	0	1	1	0	0	0	0	0	0	1	3	1.5	3	2	2	1	1	1	0	1	1	0	0	0	0	0	0	1	3	1.5	3
12	1	1	0	1	0	0	0	0	1	1	0	0	1	1	6	6	1	2.5	1	1	0	1	0	1	0	0	1	1	0	0	1	1	6	6	2	3
13	2	2	0	1	1	0	0	0	1	1	0	0	1	0	9	9	3	4.5	2	2	0	1	1	0	0	1	1	1	0	0	1	0	9	9	3	4.5
14	1	1	1	0	1	1	1	1	0	0	1	1	1	0	3	3	0	0	1	1	1	0	0	1	1	1	0	0	1	1	1	0	3	3	0	0
15	1	1	1	0	1	0	1	1	0	0	1	1	1	1	2	2	0	0	1	0	1	1	1	0	1	1	0	0	1	1	1	1	2	2	0	0
Total	19	19	9	9	6	7	7	7	7	6	6	5	12	9	61	65	37	41	19	18	9	10	7	9	7	9	7	6	7	6	12	9	61	65	36.5	39

Maichun : Animal number

Household	November																	
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	0	0
2	2	2	1	1	0	0	0	0	0	0	1	1	0	0	5	11	3	2
3	1	1	0	1	0	1	0	0	0	0	1	1	0	1	3	3	0	1
4	0	0	1	1	0	0	1	1	0	0	0	0	0	0	3	3	2	2
5	1	1	0	1	1	1	1	1	0	0	1	1	0	0	1	3	0	2
6	1	1	1	0	0	0	0	0	1	1	0	0	1	1	7	8	2	2
7	2	1	1	1	0	1	1	1	0	0	1	1	0	0	2	2	3	2
8	2	1	1	0	1	0	1	1	0	0	1	1	1	1	3	3	1.5	0
9	2	2	0	0	0	1	0	0	1	1	0	0	0	0	9	7	0	3
10	1	2	0	1	0	0	0	0	0	0	1	1	0	0	2	5	2	2
11	2	2	1	1	1	0	1	1	0	0	0	0	0	0	3	3	2	2
12	1	1	1	1	0	0	0	0	0	0	1	1	1	1	6	5	1.5	2
13	2	2	0	0	1	0	0	1	1	1	0	0	0	0	5	9	3.5	3
14	1	1	1	0	1	1	1	1	1	1	0	0	1	1	3	3	4	4
15	2	2	1	0	1	0	1	1	1	1	0	0	1	1	4	3	5	4
Total	20	19	9	8	6	5	7	8	5	5	7	7	6	7	58	70	29.5	31

Maichun : Crop and dung production

Household	Dung production/day				Production (kg)																	
	May-June		November		Wheat		Paddy		Ragi		Jhingura		Gahat		Soyabean		Barley		Vegetable		Oil seeds	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	10	12	9	12	30	60	60	120	40	50	20	30	5	10	10	20	0	10	100	140	0	5
2	8	11	8	10	150	200	210	300	50	100	10	15	10	15	18	25	14	15	120	130	15	5
3	15	18	12	15	100	150	160	310	30	120	0	10	15	15	20	30	0	30	210	200	0	5
4	20	15	20	10	10	40	60	100	40	60	5	13	20	25	25	40	0	50	97	210	0	5
5	12	15	12	10	5	50	50	120	30	70	15	20	0	30	30	35	2	60	60	250	0	5
6	14	15	13	12	25	60	50	90	20	75	20	30	0	10	30	30	8	55	140	200	2	8
7	12	16	12	13	20	80	40	110	45	48	10	10	5	15	20	35	2	40	90	120	1	6
8	10	13	10	10	15	45	50	80	45	50	5	10	10	20	22	45	8	50	80	160	4	9
9	9	10	9	10	20	60	65	130	50	60	5	15	20	14	25	35	2	30	110	175	4	10
10	13	12	11	10	40	50	50	120	55	65	5	15	30	12	20	40	3	60	90	185	5	9
11	15	14	15	12	50	90	60	90	30	70	6	17	5	16	15	20	10	50	75	182	8	6
12	20	19	18	15	30	80	50	80	35	50	10	18	6	15	15	20	5	40	105	125	3	5
13	12	15	12	12	10	75	65	90	45	55	15	20	9	13	10	20	5	20	110	213	1	5
14	11	15	11	9	100	120	100	110	56	65	20	30	10	15	10	20	15	30	80	165	25	7
15	9	12	10	10	25	75	42	60	50	70	5	30	12	20	10	25	4	35	75	173	1	3
Total	190	212	182	170	630	1235	1112	1910	621	1008	151	283	157	245	280	440	78	575	1542	2628	69	93
Average	12.6	14.1	12.1	11.3	42	82.33	74.1	127	41.4	67	10.6	18.8	10.4	16.3	18.6	29.3	5.2	38.3	102	175	4.6	6.2
village consumption	630	705	605	565	2100	4116	3705	6366	2070	3350	503	943	523	816	930	1466	260	1916	5140	8760	230	310

Shama : Fuelwood and fodder consumption

Household	Fuelwood						Dry grass						Green grass					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	18	20	8	10	14	12.6	10	7	8	12	0	0	10	12	4	5	40	35
2	18	25	10	8	16	12.5	6.5	10	12	10	0	0	12	8	5	6	32.5	30
3	15	18	7	5	12	9.6	6	8	4	5	0	0	8	10	4	3.5	42	40
4	3	14.5	1	2	2.5	1	9	8	8	9	0	0	6	5	3	4	20	25
5	12	13.6	6	8	12	8.6	7	6	6	8	0	0	10	8	5	6	40	38
6	15	19	8	9	10	11	6	7.8	10	8	0	0	8	5	7	5.6	34	35.6
7	12	30	8	11	15	12	9	10	8	9	0	0	10	5	4.4	5	26	28
8	15	22	12	13.6	12	15	6	12	4	5	0	0	8	5	4.5	5	30	32
9	15	28	10	15	13	12	9	5	6	7	0	0	15	6	3.5	4	35	34
10	15	18	10	13	10	9	8	5.5	8	9	0	0	10	3	4	3	30	28
11	14	15	6	14.8	11	9	12	10	8	8	0	0	8	4	2	3.5	42	30
12	12	10	7	15	8	10	15	17	8	10	0	0	15	3.5	5	6	30	35
Total	164	233.1	93	124.4	127.5	122.3	8.625	106.3	90	100	0	0	120	74.5	51.4	56.6	401.5	390.6
Average	13.6	19.4	7.7	10	10.5	10	103.5	8.8	7.5	8.3	0	0	10 (3.3)	6.2 (2)	4.2 (1.4)	4.7 (1.5)	33.4 (11.1)	32.5 (10.8)
Total village consumption	587.4	834	331	447	451	434	371.1	378	322	356	0	0	430 (143)	266 (88)	180 (60)	202 (67)	1436 (478)	1397 (465)

Shama : Fuelwood and fodder consumption

Household	Green tree leaves						Crop residue						Animal bedding					
	Jan		May		Sept		Jan		May		Sept		Jan		May		Sept	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	10	8	7	8	2	0	0	0	4	5	6	5	14	16	12	11.6	20	22
2	12	7	5	6	0	0	0	0	3	4	3	6	15	13.5	13.5	14	19	20
3	8	9	4	8	0	0	0	0	6	7	4	3	12	10	9	10	15	16
4	6	4	8	5	0	0	0	0	3	3.5	1.5	3	8	10	8	10	10	12
5	10	12	10	12	0	0	0	0	3	6	4.5	6	7	12	8.5	11	15	14
6	8	10	7	12	3	0	0	0	5	6	6	9	10	13	12	15	16.9	17
7	10	9	12	13	4	5	0	0	4	5	3	6.5	10	13	10	13.5	18	15
8	8	9.5	12	10	0	4	0	0	4	3.5	5	5.5	12	14	12	13	15	16
9	15	12	8	9	0	6	0	0	4	6	5	6	15	10	12	14	17	15
10	10	9	4	5	0	0	4	0	4	3	6	5	12	15	12	15	14	15.6
11	8	9	12	10	0	0	0	0	4	3	6.5	9	10	15	9	10.5	20	18
12	15	13	20	15	5	0	0	0	4	3	5.5	5	20	18	15	16	19	20
Total	120	111.5	109	113	14	15	4	0	48	55	56	69	145	159.5	133	153.6	198.9	200.6
Average	12 (6)	9.2 (4.6)	9 (4.5)	9.4 (4.7)	1.1 (0.5)	1.2 (0.6)	0.3	0	4	4.5	4.6	5.7	12	13.2	11	12.8	16.5	16.7
Total village consumption	516 (258)	395 (197)	387 (193)	404 (202)	47.3 (23)	51.6 (25.8)	12.9	0	172	193.5	197	245	516	567	473	550	709	718

Shama : Animal number

Household	November																		May-June																	
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production		Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	Jul-05	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	2	2	0	0	4	2	0	0	0	0	0	0	0	0	4	3	0	0	2	2	0	0	4	2	0	0	0	0	0	0	0	0	3	3
2	0	0	1	1	1	1	2	2	0	1	0	0	0	0	2	0	3	3.5	0	0	1	1	1	1	2	2	0	1	0	0	0	0	2	0	4	3.5
3	2	2	1	2	1	0	1	2	0	0	0	0	0	0	0	0	3	3	2	2	1	2	1	0	1	2	0	0	0	0	0	0	0	0	3.5	3
4	0	0	1	1	0	0	1	2	0	0	0	0	0	0	0	0	2.5	2	0	0	1	1	0	0	1	2	0	0	0	0	0	0	0	0	3	2
5	0	0	1	2	1	0	1	2	0	0	0	0	0	0	0	0	3	3	0	0	1	2	1	0	1	2	0	0	0	0	0	0	0	0	3	3
6	0	0	1	2	1	0	2	2	0	0	0	0	0	0	0	0	3	3.5	0	0	1	2	1	0	2	2	0	0	0	0	0	0	0	0	3	3.5
7	0	0	0	1	2	1	1	2	0	0	0	0	0	0	0	0	0	2	0	0	0	1	2	1	1	2	0	0	0	0	0	0	0	0	0	2
8	2	2	1	1	1	1	2	2	0	0	0	0	0	0	3	0	3.5	1.5	2	2	1	1	1	1	2	2	0	0	0	0	0	0	3	0	4	1.5
9	2	2	0	2	1	1	1	1	0	0	0	0	0	0	0	4	0	4	2	2	0	2	1	1	1	1	0	0	0	0	0	0	0	4	0	4
10	2	2	1	2	1	0	2	1	0	0	0	0	0	0	3	2	2	3	2	2	1	2	1	0	2	1	0	0	0	0	0	0	3	2	3	3
11	0	0	1	1	1	0	2	2	0	0	0	0	0	0	1	0	3	1.5	0	0	1	1	1	0	2	2	0	0	0	0	0	0	1	0	3	1.5
12	2	2	1	1	1	0	1	1	0	0	0	0	0	0	3	2	3.5	2	2	2	1	1	1	0	1	1	0	0	0	0	0	0	3	2	3	2
Total	10	10	11	18	11	4	20	21	0	1	0	0	0	0	12	8	31	32	10	10	11	18	11	4	20	21	0	1	0	0	0	0	12	8	33	32
Average	0.8	0.8	0.9	1.5	0.9	0.3	1.6	1.7	0	0.1	0	0	0	0	1	0.6	2.6	2.7	0.8	0.8	0.9	1.5	0.9	0.3	1.6	1.7	0	0.1	0	0	0	0	1	0.6	2.7	2.7
Village consumption	34	34	39	65	39	13	69	73	0	3.4	0	0	0	0	43	26	111	116	34	34	39	65	39	13	69	73	0	3.4	0	0	0	0	43	26	116	116

Shama : Animal number

Household	September																	
	Bullocks		Miking cow		Dry cow		Cow calf		Milking buffalo		Dry buffalo		B calf		Goat		Milk production	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	0	0	1	1	1	1	3	2	0	0	0	0	0	0	0	0	4	4
2	0	0	1	1	1	1	2	2	0	1	0	0	0	0	2	0	4	4
3	2	2	1	2	1	0	1	2	0	0	0	0	0	0	0	0	3	3.5
4	0	0	1	1	0	0	1	2	0	0	0	0	0	0	0	0	3.5	3
5	0	0	1	2	1	0	1	2	0	0	0	0	0	0	0	0	2.5	3
6	0	0	1	2	1	0	2	2	0	0	0	0	0	0	0	0	3	3
7	0	0	0	1	2	1	1	2	0	0	0	0	0	0	0	0	0	2.5
8	2	2	1	2	1	0	2	1	0	0	0	0	0	0	3	0	3	4
9	2	2	1	1	0	2	1	1	0	0	0	0	0	0	0	4	0	4
10	2	2	1	1	1	1	2	1	0	0	0	0	0	0	3	2	3	3
11	0	0	2	1	0	0	2	2	0	0	0	0	0	0	1	0	3.5	4
12	2	2	1	1	1	0	1	1	0	0	0	0	0	0	3	2	4	4
Total	10	10	12	16	10	6	19	20	0	1	0	0	0	0	12	8	34	42
Average	0.8	0.8	0.9	1.5	0.9	0.3	1.6	1.7	0	0.1	0	0	0	0	1	0.6	2.8	3.5
Village consumption	34	34	39	65	39	13	69	73	0	3.4	0	0	0	0	43	26	120	150

Shama : Water Consumption

Household	May									November							
	Household		Animal		Bathroom		Irrigation			Household		Animal		Bathroom		Irrigation	
	2012	2013	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013	2012	2013
1	30	35	90	50	200	180	20	35		35	35	30	35	110	100	25	10
2	40	40	30	40	500	300	30	40		40	45	40	40	300	250	30	15
3	30	35	120	90	180	150	25	30		35	40	70	70	160	150	30	30
4	20	25	25	30	20	22	150	100		25	30	30	35	20	30	150	200
5	35	35	35	40	200	160	30	50		25	30	35	35	120	140	30	35
6	30	30	30	35	100	90	50	70		35	35	30	40	90	50	50	100
7	30	30	60	50	200	180	20	30		50	45	40	38	200	150	20	50
8	25	30	40	50	30	35	100	120		25	30	20	25	35	40	100	200
9	50	40	40	45	40	45	120	150		30	35	20	28	40	30	120	250
10	50	50	60	50	70	75	100	130		30	35	30	32	30	35	300	400
11	40	45	20	30	40	40	120	110		50	50	35	35	30	40	120	100
12	20	35	120	100	50	40	100	120		40	35	30	35	40	50	190	120
Total	400.00	430.00	670.00	610.00	1630.00	1317.00	865.00	985.00		420.00	445.00	410.00	448.00	1175.00	1065.00	1165.00	1510.00
Average	33.30	35.80	55.80	50.80	135.00	109.00	72.00	82.00		35.00	37.00	34.10	37.30	97.00	88.70	97.00	125.00
Village consumption	1431.00	1539.00	2399.00	2184.00	5805.00	4687.00	3096.00	3526.00		1505.00	1591.00	1466.00	1603.00	4171.00	3814.00	4171.00	5375.00

Shama : Water, distance travelled and time spent for water

Household	May							November					
	Fetching time (sec)		Distance (meter)		Filling time (sec)			Fetching time		Distance (meter)		Filling time (sec)	
	2012	2013	2012	2013	2012	2013		2012	2013	2012	2013	2012	2013
1	22	23	7.8	7.8	180	100		20	24	7.8	7.8	120	100
2	18	20	6.4	6.4	900	500		20	20	6.4	6.4	600	300
3	45	40	13.2	13.2	600	500		40	35	13.2	13.2	600	300
4	20	22	12.4	12.4	30	30		20	25	12.4	12.4	20	15
5	130	131	62	62	300	200		100	130	62	62	250	190
6	900	900	80	80	900	500		800	850	80	80	500	200
7	150	152	9.5	9.5	300	200		160	160	9.5	9.5	250	180
8	120	118	9.5	9.5	300	200		125	125	9.5	9.5	250	150
9	320	300	250	250	300	200		300	320	250	250	250	150
10	600	600	502	502	300	200		550	600	502	502	250	150
11	96	95	21	21	900	500		90	97	21	21	520	150
12	80	80	22	22	480	250		70	85	22	22	300	200
Total	2501.00	2481.00	995.80	995.80	5490.00	3380.00		2295.00	2471.00	995.80	995.80	3910.00	2085.00
Average	208 (3.4)	206 (3.4)	83.00	83.00	457 (7.6)	281 (4.6)		191 (3.1)	3.5 (205)	82.00	82.00	325 (5)	173 (2.8)

Shama : Production data 2012 and 2013

	Dung production/day				Production (kg)															
	May-June		November		Wheat		Barley		Maize		Lentil		Kidney bean		Vegetables		Mustard		Manduwa (Ragi)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1	15	14	18	20	30	90	80	90	30	35	20	15	35	40	55	125	0	2	30	40
2	20	18	20	18	50	80	30	50	25	60	9	20	40	35	64	150	0	0	50	60
3	25	20	28	25	80	100	150	120	20	50	15	20	40	40	75	145	0	0	40	75
4	12	8	10	15	50	90	100	90	15	30	4	15	30	20	20	40	0	0	60	50
5	26	22	25	26	40	78	42	50	20	55	8	20	32	40	102	125	0	2	35	56
6	23	20	22	25	80	120	100	90	35	48	10	22	25	35	95	160	5	2	40	58
7	15	14	14	16	40	65	40	65	22	50	6	15	20	30	120	175	0	2	50	70
8	20	18	20	22	0	40	100	64	10	35	6	20	35	45	95	128	4	3	30	55
9	28	25	30	28	50	75	50	45	12	40	8	25	15	35	60	156	0	0	20	40
10	30	25	30	28	60	90	60	80	30	60	6	35	20	40	110	130	0	0	35	60
11	25	20	32	35	25	50	50	75	25	30	7	20	20	40	115	140	3	0	45	90
12	20	18	21	20	110	200	100	90	20	25	5	22	25	15	130	200	4	3	40	60
Total	259.00	222.00	270.00	278.00	615.00	1078.00	902.00	909.00	264.00	518.00	104.00	249.00	337.00	415.00	1041.00	1674.00	16.00	14.00	475.00	714.00
Average	21.50	18.50	22.50	23.10	51.20	90.00	75.10	75.70	22.00	43.10	8.60	20.70	28.00	34.50	86.70	139.00	1.30	1.20	39.50	59.00
Village consumption	924.00	795.00	967.50	993.00	2201.00	3870.00	3229.00	3246.00	946.00	1853.00	369.00	890.00	1204.00	1483.00	3728.00	5977.00	56.00	52.00	1698.00	3537.00

Demography - Shama				
Name of household head	Total		Migrants	
	2012	2013	2012	2013
Mohani Devi	2	2	1	0
Paruli Devi	2	1	1	1
Pratap Singh	6	6	0	0
Pushkar Singh	5	5	0	0
Lacham Singh	4	4	0	0
Khadak Singh	4	4	1	0
Parvati Devi	1	0	2	0
Jaspal Singh	6	4	2	0
Bhagat Singh	4	3	0	2
Bisan Singh	10	6	1	4
Gabur Singh	2	2	2	1
Vijaya Singh	3	2	1	0
Yashpal Singh	7	2	0	5
Durga Devi	2	1	0	1
Bhawani Devi	1	3	0	1
Maan Sing	3	3	0	0
Johar Singh	9	9	1	1
Laal Singh	3	7	1	2
Laal Singh*	4	5	1	1
Bahadur Singh	2	2	0	0
Chandra Singh	2	7	0	2
Himmat Singh	6	4	0	2
Darbaan Singh	5	5	0	0
Raam Singh	4	3	1	2
Motima Devi	5	5	3	0
Raam Singh*	5	2	2	4
Kesar	4	5	1	1
Sher Singh	11	6	1	0
Lacham Singh*	6	5	2	1
Hayat Singh	5	4	3	1
Kishan Singh	3	3	1	0
Diwan Singh	4	4	0	0
Balwant Singh	3	4	2	1
Kunwar Singh	2	4	1	1
Nain Singh	7	7	0	0
Darpaan Singh	6	6	0	0
Madoo Singh	6	7	0	0
Naveen	2	3	0	0
Diwan Singh	1	4	0	1
Dev Singh	1	3	0	1
Ganga Singh	4	4	0	0
Sher Singh*	6	10	0	0
Pratap Singh*	2	5	0	1
Total	182	181	31	37

Village wise Canopy cover (CC)

Kendul malla

Canopy cover class (quadrate)	Range of Coverage
1	60%
2	70%
3	70%
4	80%
5	80%
6	75%
7	60%
8	60%
9	70%
10	80%
Average CC	**70%**

Kendul talla

Canopy cover class	Range of Coverage
1	80%
2	85%
3	70%
4	80%
5	70%
6	60%
7	65%
8	60%
9	80%
10	70%
Average CC	**72%**

Lamudiyar

Canopy cover class	Range of Coverage
1	20%
2	15%
3	10%
4	10%
5	20%
6	20%
7	30%
8	10%
9	10%
10	10%
Average CC	**15%**

Maichun (patch of pine forest)

Canopy cover class	Range of Coverage
1	20%
2	10%
3	10%
4	30%
5	10%
6	15%
7	20%
8	10%
9	10%
10	20%
Average CC	**15%**

Galla

Canopy cover class	Range of Coverage
1	40%
2	30%
3	30%
4	45%
5	20%
6	20%
7	40%
8	35%
9	15%
10	30%
Average CC	**30%**

Shama

Canopy cover class	Range of Coverage
1	20%
2	25%
3	15%
4	30%
5	40%
6	20%
7	10%
8	20%
9	25%
10	35%
Average CC	**24%**

Infiltration rate:

Crop fields

Village/Site	Sample 1	Sample 2	Sample 3	Sample 4	Average
Shama	16.8	14.5	18	16	16.3
Galla	12.6	18	20.5	20	17.7
Maichun	15.5	16	15	16	15.6
Lamudiyar	16	13	14	15	14.5
Kendul Talla	16	14.5	18	16	16.1
Kendul Malla	16.8	17	18.5	18.2	17.5