KNOWLEDGE AND PERCEPTION OF LIVESTOCK OWNERS ON CLIMATE CHANGE

THESIS

Submitted in partial fulfilment of the requirements for the degree

of

Master of Veterinary Science

in

VETERINARY EXTENSION EDUCATION

By

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To

DEEMED UNIVERSITY

INDIAN VETERINARY RESEARCH INSTITUTE

IZATNAGAR - 243 122 (U.P.)

2011

DIVISION OF EXTENSION EDUCATION
INDIAN VETERINARY RESEARCH INSTITUTE
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Dated : 29.8.2011

Certificate

Certified that the research work embodied in this thesis entitled **"Knowledge and Perception of Livestock Owners on Climate Change"** *submitted by* **Dr. Subodh Kumar Singh,** *Roll No.* **4802,** *for the award of* **Master of Veterinary Science** *degree in* **Veterinary Extension Education** *at Indian Veterinary Research Institute, Izatnagar, is the original work carried out by the candidate himself under my supervision and guidance.*

It is further certified that **Dr. Subodh Kumar Singh**, *has worked for more than 21 months in this Institute and has put in more than 150 days attendance under me from the date of registration for the degree of* **Master of Veterinary Science** *of the Deemed University, as required under the relevant ordinance.*

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We have carefully gone through the contents of the thesis and are fully satisfied with the work carried out by the candidate, which is being presented by him for the award of **Master of Veterinary Science** *of this Institute.*

It is further certified that the candidate has completed all the prescribed requirements governing the award of **Master of Veterinary Science** *of Indian Veterinary Research Institute.*

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Acknowledgements

I have no words to express my profound regards and deep sense of gratitude to my advisor **Dr. Hans Ram Meena**, Senior Scientist, Division of Extension Education, Indian Veterinary Research Institute, Izatnagar, for his worthy guidance, untiring help, valuable suggestion, keen interest and constant inspiration throughout the course of research work and in preparation of manuscript.

My acknowledgments are many times more than what I am expressing here to the members of advisory committee **Dr. Mahesh Chander**, Principal Scientist and Head, Division of Extension Education, and **Dr. Raj Narayan**, Principal Scientist and In charge Quail farm, Central Avian Research Institute and my thanks are also due to **Dr. Sanjay Kumar**, Senior Scientist, LES& IT for being the member of my advisory committee.

I express my gratitude and sincere thanks to **Dr. Triveni Dutt**, Joint Director Extension Education, IVRI, **Dr. (Mrs.) Hema Tripathi**, Principal Scientist and Programme Coordinator, Krishi Vigyan Kendra, IVRI, **Dr. (Mrs.) Rupasi Tiwari**, Senior Scientist, In charge ATIC and **Dr. B.P. Singh**, Senior Scientist for their help and cooperation during the course work and research.

I sincerely thanks to The **Director** and The **Joint Director** (Academic) for providing necessary facilities to complete this work. I thank ICAR, New Delhi for the financial assistance in the form of ICAR Junior Research Fellowship for my study.

I am very much thankful to all the staff of Division of Extension Education, Joint Directorate Academic and Fellowship section of IVRI for their cooperation and help in need.

No words are enough to express my sincere sense of gratitude to my divisional seniors **Dr(s) Thilaker, Bikas Borthakur, Rakesh roy, Doni Jini, Vijay Gupta, Pankaj Seth, Rajesh Kumar, S. Hamdani, Rajesh Maurya, Niraj Narayan , Punit Kumar, Indra Subba** and **Rashmi** for their constant encouragement, moral support and timely help.

Stay at IVRI was pleasant and memorable due to my divisional mates **Adarsha**, **Kolekar** and **Ponnusamy** for homely atmosphere with them and that

would remain green forever in my mind. I am grateful to all my divisional juniors **Arbind, Dana Ji, Jyoti, Mausami** and **Dilip** for their timely help and for providing friendly and unforgettable company.

It is difficult to cap my bubbling feeling to express few words for my buddies, **Arun, Rajesh, Dohare, Rajauriya, Sunil** and many more for their persistent support, cooperation and timely help.

It is great pleasure to extend my thanks to **Chachu, Javed** for their efforts in typing and printing of this manuscript.

Thanks would only disparage my love for my parents who are my soul. Words can never express my gratitude to them for their infinite love, blessing, silent prayer and selfless sacrifices made for my better and bright future. I have no words to express my thanks to my sweet wife **Urmila**, sweet sons- **Himanshu** and **Priyansu** for their cooperation and sacrifices without their cooperation my study would never complete. The most difficult task for me to finds words to extend my thanks to **Mithilesh, Shweta, Punam, Neetu, Vinay** and **Chhote Chacha** for their cooperation and best wishes.

I am very much thankful to **Er. O.P. Singh** without his support my study would never complete.

I take the opportunity to thank the **almighty** for being the perennial source of health whenever I felt dejected and low during the entire period of my study.

Finally before I put my pen down, I beg apology to those whom I could not acknowledge by words.

Date:

Place: (Subodh Kumar Singh)

Abbreviations

CRED	Centre for Research on Epidemiology of Disease
CSO	Central Statistical Organisation
DHAD	Department of Animal Husbandry and Dairying
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistics
FMD	Foot and Mouth Disease
GDP	Gross Domestic Production
GEAG	Gorakhpur Environmental Action Group
GHG	Green House Gas
ICAR	Indian council of Agricultural Research
IFAD	International Fund for Agricultural Development
IMD	Indian Meteorology Department
IPCC	Intergovernmental Panel on Climate Change
LEO	Livestock Extension Officer
MGPR	Middle Gangetic Plain Region
MT	Million tones
NGO	Non Government Organization
SD	Standard Deviation
SPSS	Statistical Package for Social sciences
THI	Temperature humidity index
UK	Uttarakhand
UNEP	United Nation Environmental Programme
UNISDR	United Nation International Strategy for Disaster Reduction
UP	Uttar Pradesh
WHR	Western Himalayan Region

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Introduction

The Intergovernmental Panel on Climate Change (IPCC) defines climate change as 'change in state of the climate that can be identified by change in the mean and/or variability of its properties that persist for an extended period, typically decade or longer'. Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate change is real. The International Fund for Agricultural Development (IFAD) acknowledges climate change as one of the factors affecting rural poverty and as one of the challenges it needs to address. Rural poor communities rely greatly for their survival on agriculture and livestock keeping that are amongst the most climate-sensitive economic sectors. The IPCC predicts that by the end of 21st century increase in global average surface temperature may be between 1.8 ^{0}C and 4.0 ^{0}C. With increases of 1.5 ^{0}C to 2.5 ^{0}C temperature, approximately 20 to 30 percent of plant and animal species are expected to be at risk of extinction (FAO, 2007b) with severe consequences for food security in developing countries. Thus, it is clear that climate change will, in many parts of the world, adversely affect socio-economic sectors, which include agriculture, animal husbandry, forestry, fisheries, water resources, ecological systems and human health and settlements.

The earth's climate is dynamic and always changing through a natural cycle. What the world is more worried about is that the

changes that are occurring today have been speeded up because of man's activities. These changes are being studied by scientists all over the world who are finding evidence from tree rings, pollen samples, ice cores, and sea sediments. Natural factors which are responsible for climate change are many; prominent ones are continental drift, volcanoes, ocean currents and, the earth's tilt, etc. There are some other factors that are responsible for the climate change. A phenomenon known as the greenhouse effect is believed to be one of the major causes of climate change. The greenhouse effect occurs when certain gases, such as carbon dioxide, water vapour, methane and nitrous oxide are heavily concentrated in the atmosphere. It is believed that these gases absorb radiations emitted from the Earth's surface. This causes that radiation to be trapped in the atmosphere. As a result, the Earth's temperature rises. The atmosphere surrounding the earth is made up of nitrogen (78%), oxygen (21%) and the remainder, 1%, is made up of other gases that include the greenhouse gases carbon dioxide, methane, ozone, water vapour and nitrous oxide. These greenhouse gases act as a blanket and protect it from the harmful ultra violet rays of the sun. They can also be regarded as natural controllers of the earth's temperature system.

According to the Intergovernmental Panel on Climate Change (IPCC) with temperatures continuing to rise globally in the future, sea levels will rise, snow and ice coverage will decrease, and precipitation will increase in certain areas while droughts increase elsewhere. Also heat waves and cyclone activities will increase (IPCC 2007a.), nine out of ten disasters are now climate related, and so it is increasingly crucial to pay attention to rising natural disasters and their impacts (Brown 2008b).

CLIMATE CHANGE SCENARIO IN INDIA

The Maplecroft Climate Change Vulnerability Index (2011) ranks India as the world's most vulnerable country apart from Bangladesh. With climatic zones ranging from the Himalayas to the humid sub-tropics of South India, with 5,700 km of mainland coastline and 400 million people living in conditions of extreme poverty, India is fully exposed to the hazards of global warming.

Throughout the 21st century, India and other countries in south eastern Asia are projected to experience warming above the global mean. India will also begin to experience greater seasonal variation in temperature; with more warming in winter than summer (Christensen, 2007). Analysis of data for the period 1901-2009 suggests that annual mean temperature for the India as a whole has risen by 0.56^{0}C (IMD,2009). Further, significant long-term trend has been observed in the frequencies of large-scale droughts or floods in the summer monsoon season and glaciers in Himalayas are receding at a rapid pace. At the same time, it may also be admitted that as per the Geological Survey of India, glaciers worldwide are passing through a phase of recession as a natural cyclic process. There is a projected increase in rainfall by 15-40 percent by the end of the 21st century with high regional variability besides increase in mean annual temperature by 3°C to 6°C by the end of the 21st century. The warming is projected to be more pronounced over plain areas, with the maximum increase over northern India. The warming is also relatively greater in winter and post-monsoon seasons.

Three different figures for the increase in the mean temperature in India during the 20th century is reported. The World Bank (2009) reported no change, the Government of India (2004) a

0.4 percent increased and the IPCC Fourth Assessment a 0.68 percent increased. The Government of India (2004) further concluded that, "On a seasonal scale, the warming in the annual mean temperatures is mainly contributed by the post-monsoon and winter seasons". Also, data analyzed in terms of daytime and nighttimes temperatures indicate that the warming was predominantly due to an increase in the maximum temperatures, while the minimum temperatures remained practically constant during the past century.

Lal (2003) reported that temperatures in India have recently increased in two phases: the first half of the 20th century and the period since the mid 1970s. The average annual temperature during approximately quarter century between 1950 and 1975 exhibited no trend. The warming in India is concentrated in the post- monsoon and winter seasons and in the maximum daytime temperatures rather than nighttimes' minimum temperatures. In the monsoon season, temperatures exhibit a declining trend in northwest India and no trend in the rest of the country. Increases in surface air temperatures relative to climatologically normal temperatures have been observed at most of the locations in India.

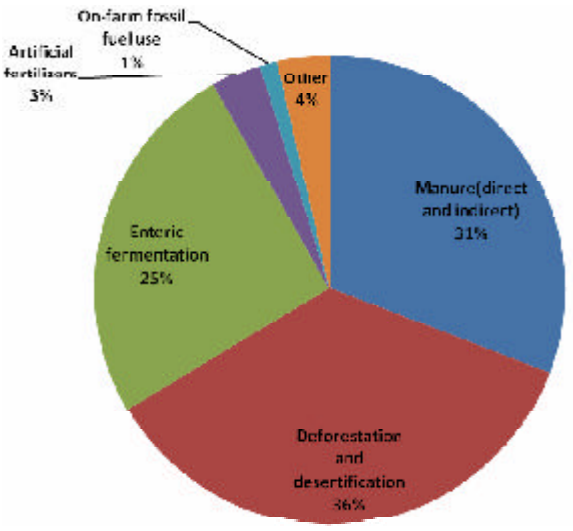
Extreme rise in maximum and minimum temperatures is also expected and similarly extreme precipitation is also projected, particularly over the West Coast of India and West Central India. It is projected that on an average there will be a 20 per cent rise in all India summer monsoon rainfall over all states except Punjab and Rajasthan in the North West and Tamil Nadu in the South, which show a slight decrease (IMD,2009). As regards the extreme rainfall events, an overall increase in the rainy day intensity by 1-4 mm/day may occur in most areas in India, except for small areas in northwest

India where the rainfall intensities may decrease by 1 mm/day. Using the climate model, it is projected that there will be an overall decrease in the number of rainy days over major parts of India. This decrease may be more pronounced in the western and central parts of India (by more than 15 days) while near foothills of Himalayas (Uttaranchal) and in northeast India the number of rainy days may increase by 5-10 days (anonymous, 2010).

CLIMATE CHANGE AND INDIAN LIVESTOCK

Role of Livestock in climate change

Livestock production is major contributor to climate change, accounting for almost one fifth of total global anthropogenic green house emission (FAO, 2006). Livestock production contributes to climate change in numerous ways, including deforestation to create pasture for grazing and crop land for fodder crops and the production of enteric methane: an important Green house gas. In India, although emission rate per animal is lower than that in the developed countries, due to vast livestock population the total annual methane emission are about 9-10 Tg from enteric fermentation and animal manure (Sirohi and Michaelowa, 2007). According to FAOSTAT (2008), globally, approximately 56 billion land animals are reared and slaughtered for the



Proportion of GHG emissions from different parts of livestock production

Source: The Lancet, 2007

human consumption annually, and livestock population is expected to double by 2050,with most maximum increase in the developing world (Steinfeld *et al.*,2006) with increase in number of farm animals total Green house gas emission rise. Livestock's Long Shadow: Environmental Issues and Option (FAO, 2006) highlighted the substantial role of the farm and animal production sector and identifying it as "a major threat to the environment". The animal agriculture sector emits 18% of human induced GHG emissions, more than that by the transportation sector (Steinfeld *et al.,* 2006).

Table 1.1 : Methane emission from Indian Livestock

Species of ruminants	Methane emission (MT/animal/year)	Total %
Cattle	5.35	53
Buffalo	3.93	39
Goat	0.47	4.7
Sheep	0.18	1.8
Others*	0.14	1.4
	10.08	**100.00**

*Camel, horses, ponies, donkeys, and pig; Source: Singhal *et al*. (2005)

EFFECTS OF CLIMATE CHANGE ON LIVESTOCK SECTOR

Livestock sector both contributes to and is affected by climate change. India possesses the largest livestock population in the world (485 million), and accounts for the second largest number of cattle (199 million), largest number of buffaloes (105 million), second largest number of goats (140 million) and third largest number of sheep (71 million) (DHAD, 2007). Climate change affects livestock both directly and indirectly. Houghton *et al.* (2001) concluded that direct effects from air temperature, humidity, wind speed and other climate factors influence animal performance: growth, milk production, wool

production and reproduction**.** The impact of climate change on animal production has been categorized by Rotter and Van de Geijn (1999) as: a) availability of feed grain, b) pasture and forage crop production and quality, c) health, growth and reproduction and, d) disease and their spread. Animal health may be affected by climate change in four ways: heat-related diseases and stress, extreme weather events, adaptation of animal production systems to new environments, and emergence or re-emergence of infectious diseases, especially vector-borne diseases which are critically dependent on environmental and climatic conditions.

The livestock production is an integral part of mixed farming systems practiced in the entire length and breadth of India. Furthermore while vulnerability to climate change has hardly been documented in the context of India; experimental studies have been conducted on effects of season and climate on production, performance and other physiological parameters of dairy animals. These studies have revealed that milk yield of crossbred cows in India (e.g., Karan Fries, Karan Swiss and other Holstein and Jersey crosses) are negatively correlated with temperature-humidity index (Shinde *et al.* 1990; Kulkarni *et al.* 1998; Mandal *et al.* 2002a). The average daily milk yield of the crossbred animals in the hot–humid eastern part of India was significantly reduced by the rise in minimum temperature and not maximum temperature, as rise in minimum temperature crossed the critical temperature of comfort while the maximum temperature was already above the comfort zone (Kale and Basu 1993). The influence of climatic conditions on milk production has been also observed for local cows which are more adapted to the tropical climate of India. The rising temperature

decreased the total dry matter intake and milk yield in Haryana cows (Lal *et al.* 1987). The productivity of Sahiwal cows also showed a decline due to increase in temperature and relative humidity (Mandal *et al.* 2002b). The estimated annual loss at present due to heat stress among cattle and buffaloes at the all-India level is 1.8 million tonnes, that is nearly two per cent of the total milk production in the country, amounting to a whopping over Rs 2,661 crore (Upadhaya, 2010).

According to Kaur and Arora (1982); Tailor and Nagda (2005) heat stress has detrimental effects on the reproduction of buffaloes, although buffaloes are well adapted morphologically and anatomically to hot and humid climate. Upadhyay *et.al, (*2007) stated that thermal stress on Indian livestock particularly cattle and buffaloes has been reported to decrease oestrus expression and conception rate. Maurya (2010) concluded that the length of service period and dry period of all dairy animals was increased from normal during drought. Given the spatial and seasonal variations in the expected temperature increase, some positive impacts can also be associated with climate change, since a moderate increase in temperature in high altitudes (hilly region) or winter months may decrease the maintenance requirement of animals. Possible benefits of climate change during cooler seasons, though not well documented, are likely to be less than the consequential negative hot weather impacts (Hahn *et al.* 1992), especially if the cold season is much shorter than the hot one.

Research studies from India have found that meteorological parameters like temperature, humidity and rainfall explain 52 % and 84 % variations in the seasonality of Foot and Mouth Disease (FMD) in cattle in hyper-endemic division of Andhra and meso-endemic region of Maharashtra states, respectively (Ramarao 1988).

The outbreak of the disease was observed to be correlated with the mass movement of animals which in turn is dependent on the climatic factors (Sharma *et al.* 1991). Singh *et al.* (1996) reported that higher incidence of clinical mastitis in dairy animals during hot and humid weather due to increased heat stress and greater fly population associated with hot–humid conditions. In addition, the hot–humid weather conditions were found to aggravate the infestation of cattle ticks like: *Boophilus microplus, Haemaphysalis bispinosa and Hyalomma anatolicum* (Singh *et al.*, 2000; Basu and Bandhyopadhyay, 2004; Kumar *et al.*, 2004).

The extreme significance of impacts related to climate variability were demonstrated in the 1999 tropical cyclone that hit the state of Orissa, which resulted in a death toll of about 55,000 cattle (CSO 2000). Every year thousands of animal are lost due to heavy rains (cloud burst), floods and cyclones in various parts of the country. During 1953–1997, about 93.7 thousand cattle were lost on an average each year due to floods. In 2000, heavy rains and flooding during the Southwest monsoon caused the death of nearly 93 thousand cattle, of which 83.6 thousand died in the state of West Bengal, (CSO 2000). Thus, the broad impact of climate change on animal production will follow the general trend of unequal distribution of changes, with both positive and negative impacts depending upon the region and season. Besides the direct effects of climate change on animal health and animal production, there are profound indirect effects as well, which include climatic influences on quantity and quality of feed and fodder resources, water resources, etc. (Seo and Mendelsohn, 2006a). In India, the demand for fodder greatly outpaces the supply, leaving million of emaciated, unproductive cattle (Sathe, 2005). Dinar *et al.* (1998) concluded that the predicted negative impact

of climate change on Indian agriculture would adversely affect livestock production in the country and further limit the possibility of rearing the animals economically**.** Geevan *et al.* (2003) found that in Banni grassland region of Gujarat state 45% pastoral families migrate with livestock during draught. According to United Nation International Strategy for Disaster Reduction (UNISDR) and Centre for Research on Epidemiology of Disease (CRED,2007), the number of reported climate related disasters (e.g. drought, flood, wind storms, forest fires, etc) significantly increased from an average of 195 per year from 1987 to 1998 to an average of 365 per year from 2000 to 2006.

STATEMENT OF THE PROBLEM

Livestock sector has a very important role to play in the economic progress of the country as it contributes over one-fourth (26%) to the agricultural GDP and provides employment to 18 million people in principal or subsidiary status. As livestock is and will play very important role in rural economy, it is necessary to find suitable solution to reduce the ill effect of climate change on livestock production.

Responding to the challenge of climate change requires basic knowledge and perception of farmers in climate change to formulate an appropriate adaptation and mitigation options for the livestock sector. Improved understanding of livestock owners' knowledge and perceptions about climate change can contribute to inform scientific and policy discussions of climate change. Researcher need to know how the farmers are likely to respond to climate impacts, because those responses can attenuate or amplify the impacts. Policy makers need to know what the farming community wants, in order to design policies that will be supported or at least

tolerated. The farming communities need to adapt to everyday changes in patterns of rainfalls, temperature, crops and livestock pests and diseases and also deal with the disasters when they occur. Therefore, while developing any strategies or formulating policies in respect of adaptation and mitigation to climate change, the interest of the farmers at grass-root level must be kept in the forefront. We will, therefore, require scientific knowledge to identify and implement strategies for climate change mitigation and adaptation. Without a doubt, climate proofing of ecological, economic and social infrastructure is definitely going to be a knowledge-intensive effort.

Under the circumstances discussed above there arise a need for a study which focuses on the knowledge and perception of livestock owners in hilly as well as in plain region that would bring about the understanding of livestock owners experience of climate variability and responses made to overcome the impacts of climate change. With this perspective, the present study entitled “Knowledge and Perception of livestock owners on climate change” was conducted with the following objectives:

OBJECTIVES

1. To study the personal, socio-economic and psychological characteristic of livestock owners.
2. To understand the knowledge and perception of livestock owners towards climate variability.
3. To contrast livestock owners' perception with secondary data on climate variability.
4. To document livestock management strategy adopted by farmers under climatic change.

NEED AND SCOPE OF THE STUDY

- The findings of the present study reveal the knowledge, perception and experience of livestock owners on climate variability in livestock farming. It may be of immense use to the researcher, extensionists, policy makers and animal husbandry personnel to mitigate the problems and formulate new strategies for improving the production and productivity of livestock in climate change scenario.
- Farmers' opinion is critical because it is a key component of the socio-political context within which policy makers operate. Farmers' opinion can fundamentally compel political, economic and social action to address particular risks. For example, farmers' support or opposition to climate policies (e.g., treaties, regulations, taxes, subsidies, etc.) will be greatly influenced by farmer's perceptions of the risks and dangers of climate change. Further, successfully mitigating or adapting to climate variability will require changes in the behaviour of farming community, who each day make individual choices that collectively have enormous impacts on the Earth's climate.
- Scarcity of research and credible evidence on the impacts of climate change on animal husbandry is a major challenge. There is limited understanding on such basic issues as the nature and scale of impacts of climate change on livestock production system the present study generate basic information on this aspect.
- Livestock owners adopt various type of management strategy during adverse climatic conditions. This study will help in documenting those strategies which will reveal their traditional knowledge and coping methods etc. Thus, findings of the study may help scientists to develop some of the alternate livestock management strategy considering the available resources under specific climatic conditions.

LIMITATIONS OF THE STUDY

Single academic and researcher investigation had inherent limitation of time and resources. The study was conducted on climate change in socio economic aspect and there is very little study which is available for reference in Indian context. The finding are based on the respondents to recall and on the verbal opinions expressed by them. Hence, the objectivity of the study is confined to both their ability to recall and also their honesty in providing the necessary information. The respondents in villages were sometimes hesitating in disclosing information regarding their economic status; moreover, it was based on their expressed information and options of the respondents which may not be free from individual bias and prejudices. Researcher faced similar problem with recording of age, in most cases it was not possible to record an exact age as many respondents, especially women who did not want their age to be known and some of the older people only had a rough idea of their age. Further, the study is based on the responses of limited farmers hailing from limited area thus, the finding of the study could be generalized only in the area having similar agro-climatic and socio-cultural setting, and therefore careful investigation in other part of the country would be required.

Inspite of these limitations, efforts were given to make the study as objective and systematic as possible.

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Review of Literature

Comprehensive review of literature is an essential component of any research endeavour. The major function of the review of literature is to get acquainted with the past and contemporary research in the particular field of investigation. Keeping in view the objective of the study the review of literature has been presented in the line with objectives of the study, under following heads.

2.1 SOCIO-ECONOMIC AND PSYCHOLOGICAL PROFILE OF RESPONDENTS

Koteswaram (1982) revealed that in a developing country like India where literacy rate is low, the coastal farmers need to be educated properly to protect themselves against onslaught of cyclones.

Igoden *et al.* (1990); Lin, (1991) reported that there is a positive relationship between the education level of the household head and the adoption of improved technologies.

According to Environment Protection Agency (1994) young people are more concerned for environmental issues in general, and global environmental issues in particular.

Thammi *et al.*(1996) reported that majority of the respondents rearing crossbred in Krishna district of Andhra Pradesh were belonged to middle age category, medium socio economic status, medium level of mass media exposure and medium information seeking behaviour.

Riley and Meadows (1997) examined the flow of information during and after a disaster and considered a problem from various agencies involved might encounter in acquiring and disseminating information. He confirmed that information plays a major role in disaster preparedness planning.

According to National Greenhouse Strategy, Commonwealth of Australia(1998) information and education programs can foster broad community understanding of climate change issues. This understanding is prerequisite for informed community and individual action to reduce greenhouse gas emissions and adapt to climate change, as well as building community support for actions initiated by governments.

Croppenstedt *et al.* (2003) argued that households with a larger pool of labour should be more likely to adopt agricultural technology and use it more intensively because they have fewer labour shortages at peak times. Here it is expected that households with large family size to be more likely to adapt to climate change.

Tenge *et al.* (2004) argued that female- headed households may have negative effects on the adoption of soil and water conservation measures because they have limited access to information, land and other resources due to traditional social barriers.

Bradshaw *et al.* (2004) concluded that farm size is associated with grater wealth and it is hypothesized to increase adaptation to climate change.

Leiserowitz (2006) concluded that American risk perceptions and policy support are strongly influenced by experiential factors, including affect, imagery, and values, and demonstrates that public responses to climate change are influenced by both psychological and socio-cultural factors.

Maddison (2006) revealed that farmers with higher levels of education are more likely to better adaptation to climate change.

Maddison (2006); Nhemachena and Hassan (2007) showed that access to information through extension increase the chance of adapting to climate change.

According to Yirga (2007) extension on crop and livestock production and information on climate represent access to the information required to make decision on adaptation to climate change. Various studies in developing countries including Ethiopia reported a strong positive relationship between access to information and the adoption behaviours of farmers.

Swaminathan (2009) said that climate awareness at the grassroot level could help local communities to manage better the adverse impact of climate change. He also introduces the concept of 'Local Level Climate Risk Managers' who can spread both climate and genetic literacy and create awareness about climate change among the people of grassroot level.

Billett (2010) revealed that communication of climate change from scientists and policy-makers to the public via the mass media has been a subject of major interest because of its implications for creating national variation in public understanding of a global environmental issue.

2.2 KNOWLEDGE AND PERCEPTIONS TOWARDS CLIMATE VARIABILITY

Dhavan (1993) reported that the encroachment into the flood zone of the rivers, especially in Gangetic plain, has been occurring ever since the density of the population has been rising excessively.

This population pressure related encroachment of the flood zones is the root cause of rising flood related losses in India.

Govinda Rao *et al.* (1993) concluded from their studies that an increasing trend in mean temperature in most parts of Indian subcontinent has been observed most strongly in post monsoon and winter seasons.

Thulasidas (1995) opined that recent advances on knowledge of cyclonic storm and cyclone warning system have been helpful in forecasting and early of cyclones, hence, greater loss of life and property could be reduced.

Tolia (1997) reported that, on average, two to five minor/major landslides occur every kilometer in Garhwal Himalaya.

Globe Scan (2000) surveyed 34 countries and asked respondents, "How serious a problem do you consider climate change or global warming, due to the greenhouse effect?" They found that majorities in each country said that climate change was a somewhat to very serious problem. It is interesting to note that many developing countries viewed this global risk as more serious than most developed countries.

Lal *et al.* (2001) reported that an annual mean area-averaged surface warming over the Indian subcontinent will range between 3.5 and 5.6 ^{0}C over the region by 2080.

Vedwan and Rhoades (2001) found that Western Himalayas' people perceived a definite reduction in the intensity and changes in the timing of snowfall and rainfall over time.

Leiserowitz (2003) pointed out in National survey on Americans to identify the primary cause of global warming. A large plurality (47%) said that damage to the ozone layer is the primary cause.

Sahni (2003) reported that 19% of India's total land area, with 12% of the population, is draught prone. According to him 68% of the total cultivated area of the country is prone to draught.

According to Sen and Chander (2003) the Indian sub-continent is affected by cyclones more than any other area in the world. They also reported that in recent times, the frequency and instability of landslides and the mass wasting have increased substantially in the Himalayan mountain belt.

Kothawale and Rupa Kumar (2005) reported that while all India mean annual temperature has shown significant warming trend of 0.5 ^{0}C10 yr^{-1} during the period 1901-2003, the recent period 1971-2003 has seen a relatively accelerated warming of 0.22 ^{0}C10 yr^{-1} which is largely due to the unprecedented warming during the last decade.

In 2006, Globe Scan resurveyed many of the same countries and found that the percent of respondents saying climate change was a "very serious problem" had increased significantly in many countries. This may be for a variety of reasons, ranging from increased scientific certainty, media and policymaker attention, observed impacts around the world, or the diffusion of basic awareness of the problem worldwide.

Maddison (2006) noted that perception of climate change appears to hinge on farmer experience and the availability of free extension advice specifically related to climate change.

Pew Global Attitudes Survey (2006) found that large majorities of respondents from developed countries had heard of global warming, while awareness remained quite low in several developing countries.

Sethi (2006) concluded that scarcity of fodder, scarcity of potable water, spread of disease, increased disease susceptibility and impact on livestock and market was the high risk areas in flood prone district of Orissa while in draught prone district scarcity of fodder, potable water and increased feed price was the high risk areas.

Nhemchena and Hassan (2007) tried to assess farmers' perception to climate change in South Africa. The result indicated that 51.4percent farmers perceive the increase in temperature, 26.94 percent perceived that there is no change and 4.05 percent said that they don't have any idea. On other hand, the perception of farmers (45.01%) on long term changes in precipitation is that the region is getting drier and that there are pronounced change in the timing of rain and frequency of draught.

Kellstedt *et al.* (2008) concluded that the large gap between the scientists and general public in terms of understanding, awareness and perception of risk about climate change is one of the barriers to adaptation and mitigation of climate change.

According to UN human development report (2007-08) the effect of rising temperature across the earths' surface will lead to changes in average temperature, rain fall pattern and monsoon timing.

Gbetibouo (2009) argued that farmers with access to extension services are likely to perceive changes in the climate because extension services provide information about climate and weather. Consequently, awareness and perceptions of a problem shapes action or inaction on the problem of climate change (Speranza 2010).

According to Chaudhary and Bawa (2011) there is a widespread feeling that weather is getting warmer, the water sources are drying

up, the onset of summer and monsoon has advanced during last 10 years and there is less snow on mountains than before. Local perceptions of the impact of climate change on biodiversity included early budburst and flowering, new agricultural pests and weeds and appearance of mosquitoes. People at high altitudes appear more sensitive to climate change than those at low altitudes.

Alexander (2011) observed that perception about climate change and weather patterns played a key role in determining whether a household prepares adequately for a harsh weather event. For instance, 57 percent of households believed that storms today are more intense than they were five to ten years ago, the household is more likely to prepare when weather forecasters predict threatening weather.

In 2011, Yale Project on Climate Change Communication and George Mason University Centre for Climate Change Communication conducted a survey in America and concluded that roughly half of all Americans say that global warming is already causing or making the following events worse in the United States: coastline erosion and flooding (52 percent); droughts (50 percent); hurricanes (49 percent); rivers flooding (48 percent); and wildfires (45 percent).

Mengistu (2011) stated that most farmers, about 75%, perceived that the temperature of Adiha (Ethiopia) is increased in the last two decades (temporal trend not indicated). Only 8 percent of them noticed the contrary, decrease in temperature. Very few of the respondents (less than 5%) have not noticed any change in temperature. On the other hand, 90% of the respondents observed change in rainfall patterns in the last two decades in the area, and 70% have noticed a decrease in the amount of rainfall. About 20% of the informants noticed no change in the total amount of rainfall but in the timing of the rains, with rains coming either earlier or later than expected.

2.3 CLIMATE VARIABILITY AND MAJOR IMPACTS OF CHANGING CLIMATE IN LIVESTOCK SECTOR

Livestock production both contributes to and is affected by climate change. Climate change affects livestock both directly and indirectly. Houghton *et al.* (2001) concluded that direct effects from air temperature, humidity, wind speed and other climate factors influence animal performance: growth, production and reproduction. Indirect effects felt via ecosystem changes that alter the distribution of animal diseases and affect the supply of feed.

Lal *et al.* (1987) found that the rising temperature decreased the total dry matter intake and milk yield in Haryana cows.

According to Ramarao (1988) research studies from India have found that meteorological parameters like temperature, humidity and rainfall explain 52 % and 84 % variations in the seasonality of Foot and Mouth (FMD) disease in cattle in hyper-endemic division of Andhra and meso-endemic region of Maharashtra states, respectively.

UNEP (1989) identified India among the 27 countries that are most vulnerable to sea level rise and warns that the impacts of any increase in the frequency and intensity of extreme events, such as storm surges, could be disproportionately large, not just in heavily populated coastal areas, but also in terms of the paralyzing devastation in low-income rural areas.

Shinde *et al.* (1990); Kulkarni *et al.* (1998); Mandal *et al.* (2002a) concluded that milk yield of crossbred cows in India (e.g., Karan Fries, Karan Swiss and other Holstein and Jersey crosses) to be negatively correlated with temperature-humidity index.

Hahn *et al.* (1992) pointed out that, in the United States, summer weather already reduced production of high-producing dairy

cows and beef animals in feedlots. Also the conception rate of dairy cows was reduced by as much as 36% during summer season.

Bharara and Seeland (1994) identified traditional social indicators of drought prediction in an arid region of Rajasthan, India and compare their accuracy with that of rainfall data as a contribution to the discussion of the relevance of indigenous knowledge to the development process in a predominantly rural society. The study was carried out in three different ecological areas: pastoral nomadic, mostly rainfed and rainfed with irrigation. The comparison showed minor differences in the way a year was perceived on the basis of folk memory and actual rainfall but the holistic approach, taking account of a number of indicators, gave a more accurate picture of the real situation than mere figures on precipitation.

Singh *et al.* (1996) reported that higher incidence of clinical mastitis in dairy animals during hot and humid weather due to increased heat stress and greater fly population associated with-humid conditions.

Dinar *et al.* (1998) concluded that the predicted negative impact of climate change on Indian agriculture would adversely affect livestock production in the country and further limit the possibility of rearing the animals economically.

According to Central Statistical Organization (2000) the extreme significance of impacts related to climate variability were demonstrated in the 1999 tropical cyclone that hit the state of Orissa, on the eastern coast of the country, which resulted in a death toll of about 55,000 cattle.

Houghton *et al.* (2001) concluded that direct effects from air temperature, humidity, wind speed and other climate factors influence animal performance: growth, milk production, wool production and reproduction.

According to Mandal *et al.* (2002b) the productivity of Sahiwal cows showed a decline due to increase in temperature and relative humidity.

Geevan *et al.*(2003) found that in Banni grassland region of Gujarat state,45% pastoral families migrate with livestock during draught.

Sivakumar and Kerbart (2004) concluded that drought may be a one-time occurrence but the effects are far-reaching and deep.

According to Kaur and Arora (1982); Tailor and Nagda (2005) the morphological and anatomical characteristics of buffaloes make them well-suited to hot and humid climates, but heat stress has detrimental effect on the reproduction of buffaloes.

Baylis and Githeko (2006) concluded that cycles of drought followed by heavy rainfall provide breeding sites for midge and mosquito vectors and are associated with outbreaks of vector-borne livestock disease.

According to Seo and Mendelsohn, (2006a) the indirect effects of climate change include climatic influences on the quantity and quality of feedstuffs such as pasture, forage, grain and the severity and distribution of livestock diseases and parasites.

Easterling *et al.* (2007) reported that the vector-borne pathogens which respond rapidly to climate changes are likely to be rapidly

evolving promiscuous agents, transmitted by rapidly reproducing, highly mobile and habitat-generalist vectors. Examples of diseases influenced by climate change and variability includes: Rift Valley, Bluetongue, as well as tick-borne diseases.

Upadhyay *et al.* (2007) revealed that thermal stress on Indian Livestock particularly cattle and buffaloes has been reported to decrease oestrus expression and conception rate

UNISDRE/CRED (2007) concluded that the number of reported climate related disasters (e.g. drought, flood, wind storms, forest fires etc) significantly increased from an average of 195 per year from 1987 to 1998 to an average of 365 per year from 2000 to 2006. Of the 262 million people affected annually by climate disaster from 2000 to 2004, more than 98 percent lived in developing countries.

According to Sanghi and Mendelsohn (2008) global warming by the end of the next century could cause annual damages in Brazil between 1% and 39% and between 4% and 26% in India.

Rajan (2008) indicated that, if global temperatures rise as much as 4–5 degrees Celsius following business-as usual growth in greenhouse gas emissions, about 125 million people could be homeless in India and Bangladesh by the end of the century due to sea level rise and drought, associated with shrinking water supplies and monsoon variability.

According to FAO (2008c) climate change will be especially important to vector- borne diseases and macro parasites of animal and may also result in new transmission modalities and change in host species. Change in species composition and interactions will augment the emergence of unexpected events, including the emergence of new disease and pests.

According to Panda (2009) the impact of climate change on the lives and livelihoods of people in India is now widely recognized. The states of Bihar, Rajasthan, Gujarat, Punjab, Haryana, Madhya Pradesh, Maharashtra, Andhra Pradesh and Karnataka have the lowest adaptive capacity. The areas of greatest climate sensitivity are Rajasthan, Madhya Pradesh and Uttar Pradesh.

Maurya (2010) reported increased service period and dry period of all dairy animals from normal during drought.

According to Upadhaya (2010) the estimated annual loss at present due to heat stress among cattle and buffaloes at the all-India level is 1.8 million tonnes, which is nearly two per cent of the total milk production in the country, amounting to a whopping over Rs. 2,661 crore.

2.4 ADAPTATION AND MITIGATION ACTIVITIES

Dewan (1986) suggested some measures for increasing preparedness. The suggestions were given as recommendations for increasing preparedness for flood and draughts by the governmental and voluntary agencies and all others who are interested in this important field. They were (a) identification of areas (b) disaster research (c) contingency plan (d) organization and operation (e) banking of materials (f) crop insurance (g) training (h) good weather code (i) special funds (j) warning service (k) peoples participation (l) information exchange (m) regional co-operation (n) international assistance.

Mohanty (1987) stated that dissemination of early warnings play a vital role in disaster management. He opined that a cyclone warning has to evoke desired immediate response, need to be short, precise, devoid of technical jargons, easily understandable by public and must indicate what to do.

Mukhopadhyay and Das (1992) found that's huts and houses should have higher foundation so as to avoid inundation in flood waters. The government and NGO's officials should be trained so that they can act immediately when a disaster strikes.

Narasimham (1992) stated that primary focus of relief programmes in the Indian context has been on the restoration of income to the affected population and rehabilitation of the productive assets of the vulnerable group.

Teague *et al.*(1993) suggested rotational grazing where can be reduce the deterioration and may improve both short and mid grass patches during draught in large grassland paddock.

Anderson (1994) stated that development agencies and NGOs are increasingly focusing their attention on understanding the relationships between disaster and development and this has been motivated by an increased number of disasters worldwide and a reduction in overall aid budgets in many donor countries.

Ganguli *et al.* (1994) stated that the country will have to pay more attention towards public awareness and preparedness in respect to people residing in known disaster prone areas. Special training is required to medical, paramedical, voluntary workers in relief and rescue works.

Chan (1995) reported that in Malaysia, majority of flood victims living on the flood plains have developed some traditional flood mitigation and flood loss reduction methods. Among these are stilt house, clustered houses, raft house and portable house. Other traditional forms of architecture built to defend against flooding are as follows: the raising of the floors by successively building higher levels over existing ones, planting trees in front of houses, building livestock barn(e.g. chicken coops) in the path of river current.

Dirie and Mohammed (1999) observed that Somali pastoralists usually rear two or more species of livestock as a buffer against losses during draught, and clan members helps out less fortunate members by collecting a voluntary donation of an animal, if not more, from all members who can afford it.

Noelle O'Brien (2001) observed that farmers of Cambodia build platform for their animals whilst others move to the safe areas with them during the flooding.

Chatterjee *et al.* (2005) concluded that new adaptation strategies have been introduced by local non-governmental organizations that build on existing knowledge and expertise about water, agriculture and livestock management. These include: growing new crops such as vegetables, fodder and higher value medicinal crops for commercial sale; use of environmentally sound fertilizers (vermiculture); improved storage for fodder and food grains; and improved water conservation and harvesting techniques through bunding of fields, construction of *anicuts* and digging and deepening ponds and wells.

According to Bradshaw *et. al.* (2004); Nhemachena and Hassan (2007) common adaptation methods in agriculture include: use of new crop varieties and livestock species that are more suited to drier conditions, irrigation, crop diversification, mixed crop livestock farming systems and changing planting dates.

According to Maddison (2006) adaptation to climate change is a two-step process, which initially requires the perception that climate is changing and then responding to changes through adaptation.

According to Seo and Mendelsohn (2006b) farmers in Africa reduced the amount of beef cattle and chicken managed but increase the number of dairy cattle, goats and sheep per firm as adaptation strategies for climate change.

Kurukulasuriya and Mendelsohn (2006) used multinomial logit models to analyze crop and livestock choices as adaptation options. The results from choice models showed that farmers in warmer temperature tend to choose goat and sheep as opposed to beef, cattle and chicken .Goat and sheep can do better in dry and harsher conditions than beef and cattle.

According to Sathaye *et al.* (2006) climate change is one of the most important global environmental challenges, with implications for food production, water supply, health, energy, etc. Addressing climate change requires a good scientific understanding as well as coordinated action at national and global level. The adaptive capacity of communities likely to be impacted by climate change is low in developing countries. The most effective way to address climate change is to adopt a sustainable development pathway by shifting to environmentally sustainable technologies and promotion of energy efficiency, renewable energy, forest conservation, reforestation, water conservation, etc

According to Kabubo-Mariara (2008) farmers are likely to take adaptation measures to counter the impact of rising temperatures through keeping more livestock and reducing reliance on crops or by adapting species mix to more drought resistance breeds.

According to Herrero *et al.*, (2009) animal numbers is one of the biggest factors contributing directly to GHG emissions from livestock. In the developing world, replacing a large number of low-producing animals with fewer but better-fed animals of higher potential would reduce total emissions while maintaining or increasing the supply of livestock products. This will require changing breeds or implementing crossbreeding schemes.

Alexander (2011) observed that vulnerable and more secure households differ in coping strategies when dealing with weather-related events. Forty-nine percent of vulnerable households turn to their faith, 43 percent to their family, and 36 percent turned to their friends for emotional support. Only 19 percent turned to financially-based responses and only 8 percent made attempts to secure credit to gain resources to make repairs rebuild. Households that have the highest levels of security are more likely to use their savings or sell their assets to engage in a financially based response by repairing and rebuilding, many times finding emotional support through this work.

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Research Methodology

This chapter deals with various methods and procedures used with respect to the selection of locale of the study, sampling design, variables and their empirical measurements, tools of data collection and statistical methods employed for the analysis and interpretation of the data collected. It is presented under following subheads:

3.1 Research design

3.2 Sampling procedure

3.3 Theoretical orientation

3.4 Tools for data collection

3.5 Statistical methods for analysis of data

3.1 RESEARCH DESIGN

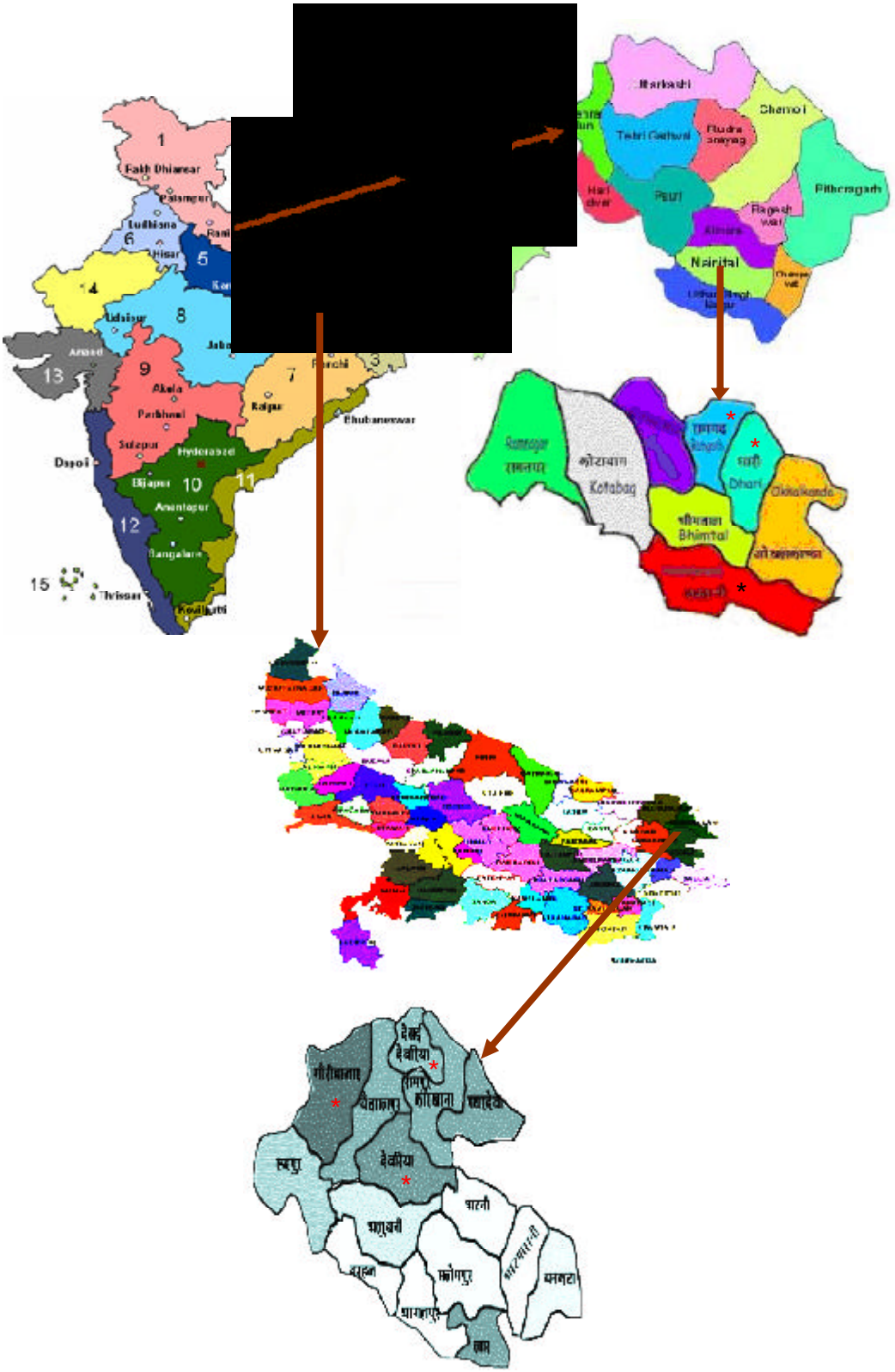
Considering the nature of the problem, an ex-post facto research design was used for the present study. “Ex post facto research is systematic empirical enquiry in which the scientist does not have direct control on independent variables because their manifestations have already occurred or because they are inherently not manipulated. Inferences about relations among variables are made, without direct intervention, from concomitant variation of independent and dependent variables” (Kerlinger, 2000).

3.2 SAMPLING PROCEDURE

3.2.1 Locale of the study

An agro-climatic zone refers to a land unit in terms of its major climates and suitability for a certain range of crops and cultivars, whereas, an agro-ecological region is defined as an area of the earth's surface characterized by the distinct ecological responses to macroclimates as expressed by the soil, flora, fauna and aquatic systems. The most comprehensive and widely accepted agro-climatic zoning of the country is the one developed under the auspices of the Planning Commission of India. The country has been divided into 15 agro- climatic regions based on similarities in cropping conditions; like rainfall, temperature, topography, cropping and farming systems, water resources etc. Planning Commission has demarcated the geographical area of India into 15 agro-climatic regions. These are further divided into more homogenous 72 sub-zones. The 15 agro-climatic zones are:

1. Western Himalayan Region : J&K,HP,UP, Uttarakhand
2. Eastern Himalayan Region : Assam, Sikkim, W. Bengal and all North Eastern states
3. Lower Gangetic Plains Region : West Bengal
4. Middle Gangetic Plains Region : U.P, Bihar
5. Upper Gangetic Plains Region: U.P.
6. Trans-Gangetic Plains Region : Punjab, Haryana, Delhi and Rajasthan
7. Eastern Plateau and Hills Region: Maharashtra, UP, Orissa and West Bengal
8. Central Plateau and Hills Region: MP, Rajasthan and UP.
9. Western Plateau and Hills Region: Maharashtra, MP and Rajasthan



LOCALE OF THE STUDY

10. Southern Plateau and Hills Region: AP, Karnataka and Tami Nadu
11. East Coast Plains and Hills Region: Orissa, AP, Tamil Nadu and Pondicherry
12. West Coast Plains and Ghat Region : T N, Kerala, Goa, Karnataka and Maharashtra
13. Gujarat Plains and Hills Region: Gujarat
14. Western Dry Region: Rajasthan
15. The Islands Region : Andaman & Nicobar, Lakshya Deep

3.2.2 Selection of agro-climatic zones

The study was conducted in two agro-climatic zones i.e. Western Himalayan Region (WHR) and Middle Gangetic Plain Region (MGPR).

Western Himalayan Regions

This Comprises of the western Himalayan provinces of Himachal Pradesh and Jammu and Kashmir, the hilly regions of northern Punjab, and Uttarakhand. Depending on altitude and topography this agro-climatic region is further divided into 11 zones. The climate is predominantly temperate with the high ranges experiencing snowfall in winter and remaining lush green in summer. Maximum and minimum temperature of this agro-climatic zone is 30°C and - 40°C, respectively. Monthly mean temperature is around 10^0C and annual rainfall 250-280 mm. the main soil types of them are skeletal soils of cold region, podsolic soils, mountains meadow soils and hilly brown soils. Soils are generally silty loams with altitudinal variations. They are prone to erosion hazards and slides and slips are quite common. Being hilly area lands of the region have steep slopes in undulating terrain.

Among all the livelihood activities operating in the Western Himalayas, dairying is considered creamy activity, which has lots of potential for household protein security as well as economic up-liftment of the inhabitants. In the low hills areas (Doon vally, Tarai, Bhabar and Shivalik areas), animal husbandry plays a crucial role for milk and meat. The region is therefore abundance in high milk yield cattle and buffaloes. In the mid hills regions, cattle are reared for milk as well as drought power, buffaloes and goats arte reared for milk production. In the high altitude of Western Himalayas sheep and goat are predominated due to abundant availability of alpine pasture. The livestock enterprise contributes 20-40 percent of the farms level incomes; the herd size per family is 1-2 buffaloes, 0.6 cows, 1.4 bullocks and 3.5 goats.

Important breeds of livestock found in this region are

- Buffalo breeds- Tarai , Cross of Murrah and Bhadawari
- Cattle breeds- Not any descript cattle breed
- Goat breeds- Changthangi, Chegu, Gaddi, Bakharwal, White Himalayan, Kangan
- Sheep breeds- Changthangi, Gaddi, Gurez, Karnah, Poonchi, Bhakharwal, Kashmir Merino, Rampur Bushir
- Horse breeds- Zaniskari, Spiti, Chummarti
- Other livestock are-Kiang Ass, Double humped camel, Yak and Rabbit.

Cynodon dactylon (doob) and *Ischoemum angustifolium(bhabar)* are major green forage source for ruminants. In addition to that, farmer families also own trees/shrubs like *Grewia optiva* (bhimal), *Quercus leucotrichophora* (oak),*Celtis australis* (khari), *Melia azaderach* (Meetha Neem) on the rise of the crop fields to augment the green fodder

supply during lean period (Mittal and Rai, 2002). The commonly cultivated fodder in western Himalayas include Berssem (*Trifilium alexandriunum*), Lucerne (*Medicago sativa*), Oats (*Avena sativa*), jowar (*Sorghum Bicolar*), Maize (*Zea mays*) etc.

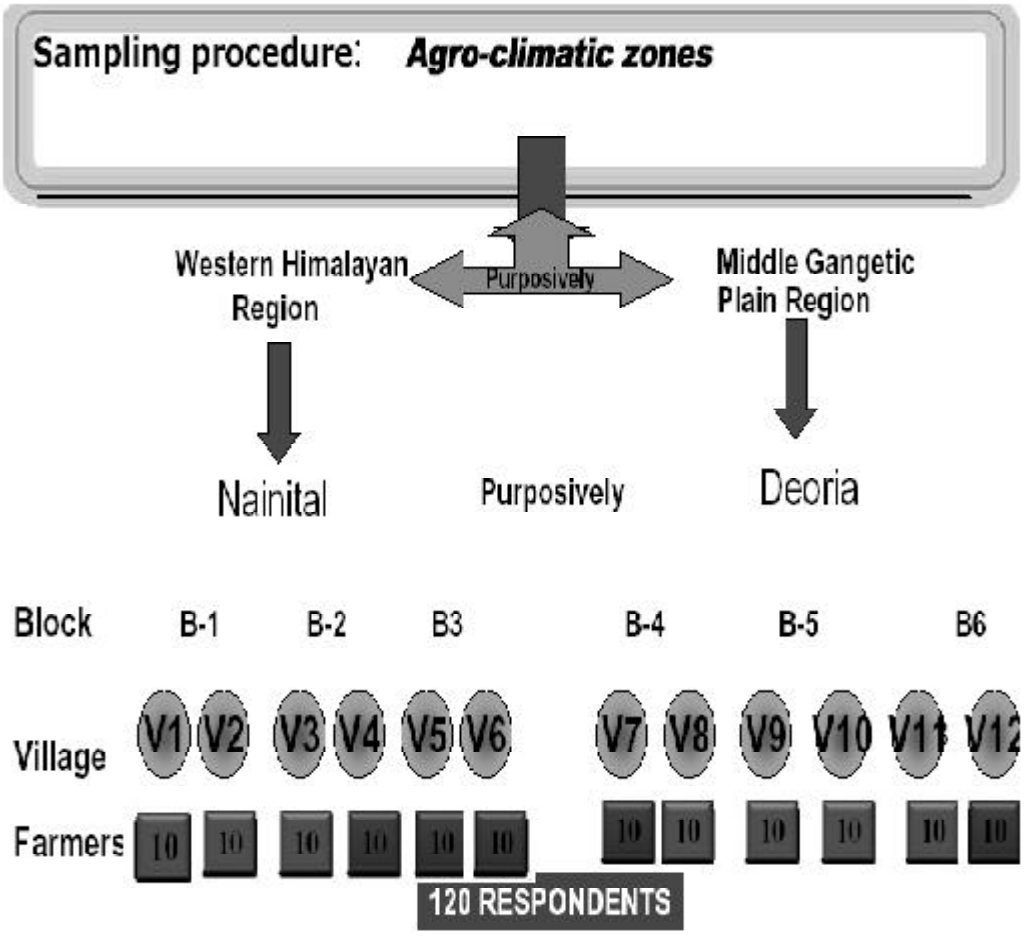
Middle Gangetic plain region

This region comprises of the plains of Bihar (27 districts) and eastern Uttar Pradesh (12 districts) and further divided into six zones, three in UP and three in Bihar depending on differences in soil, land use, terrain and climate. Maximum and minimum temperature of this agro-climatic zone is 49ºC and 4ºC respectively and annual rain fall is 803-1,470 mm. Inundation by recurrent floods is the greatest problem of this region that calls for implementation of flood safety measures. Rice in *Kharif* (summer) and maize and wheat in *Rabi* (winter) are the main crops. The commonly cultivated fodder include Berssem (*Trifolium alexandriunum*), Jowar (*Sorghum bicolar*), Bajra(*Hordeum vulgare*) Maize (*Zea mays*) etc.

Important breeds of livestock found in this region are-

- ☞ Cattle breeds- Bachaur
- ☞ Sheep breed- Sahawadi
- ☞ Goat breed-Non descript
- ☞ No other significant livestock breeds found in this region.

The preference of the livestock is in the order of buffalo followed by cattle and goat. The people of this region reared Murrah buffaloes. The native cattle stain of Bihar is *Purnea, Sitamarhi.* Crossbred animals are widely distributed throughout the region. The concentrate mixture is mixed with wheat straw and water to make "Sani" and


Sampling procedure: Agro-climatic zones
Western Himalayan Region
Purposively
Middle Gangetic Plain Region
Nainital
Purposively
Deoria
Block
B-1
B-2
B3
B-4
B-5
B6
Village
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
Farmers
10
120 RESPONDENTS

offered to animal at the time of milking. The straw of wheat / paddy constitutes the basal dry roughage of the animals. Keeping in view the relatively higher productivity of the animals, advanced farmers cultivate green fodder like maize sorghum, bajra, berseem, hybrid napier, etc.

3.2.3 Selection of States

From Western Himalayan region Uttarakhand state and from Middle Gangetic plain region Uttar Pradesh state was selected purposively for this study.

Geography and demography of Uttarakhand

Uttarakhand - the land of gods, the home of Himalayas and truly a paradise on earth, allures everyone from everywhere. The fresh air, the pure water, the chilling snow, the mountains, the scenic beauty, the small villages, the simpler people and a tougher lifestyle is what that distinguishes Uttaranchal from rest of the world.

Uttarakhand formerly Uttaranchal, is a state located in the northern part of India. It is often referred to as the Land of Gods due to the many holy Hindu temples and cities found throughout the state, some of which are among Hinduism's most spiritual and auspicious places of pilgrimage and worship. Known for its natural beauty and wealth of the Himalayas, the Bhabhar and the Terai, the state was carved out of the Himalayan and adjoining north-western districts of Uttar Pradesh on 9 November 2000, becoming the 27th state of the Republic of India. It borders the Tibet Autonomous Region on the north, Nepal on the east and the Indian states of Uttar Pradesh to the south, Haryana to the west and Himachal Pradesh to the north west.

In January 2007, the name of the state was officially changed from Uttaranchal, its interim name, to Uttarakhand. The provisional capital of Uttarakhand is Dehradun, which is also a rail-head and the largest city in the region. The High Court of the state is in Nainital.

Uttaranchal is broadly divided into two zones Kumaon and Garhwal. Kumaoni and Garhwali are the respective bolis of Kumaon and Garhwal widely used in day to day communication by the people living therein. However the city culture has too much extent swallowed up Kumaoni and Garhwali, and the people prefer to use Hindi instead.

Geographical Data

Latitude	: 28°43' N to 31°27' N
Longitude	: 77°34' E to 81°02' E
Geographical Area	: 53483 sq kms
Forest Area	: 35394 sq kms

Metrological Data

Average Rainfall	: 1523 mm
Temperature	
(i) Minimum (Mukteshwer)	: 0.1°C (2001)
(ii) Maximum (Dehradun)	: 40.1°C (2001)

Administrative Units

Divisions	: 2 (Garhwal & Kumaon)
Districts	: 13 (View Districts)
Tehsils	: 78
Development Blocks	: 95
Nyaya Panchayats	: 670
Gram Panchayats	: 7227
Census Villages (As per 01 census)	: 16826

Inhabited Village	: 15761
Un-inhabited Village	: 1065
Municipal Corporation	: 01 (Dehradun)
Nagar Palika Parishads	: 32
Nagar Panchayats	: 30
Cantonment Boards	: 09
Census Towns	: 12
Industrial Townships	: 02
Development Authority	: 06

Source: http://uttara.in 2007

According to 2001 India census, Uttarakhand had a population of approximately 8.48 million. Hindus form the majority of the population at 85.0%, Muslims from 10.5%, Sikhs 2.5% and Christians, Buddhists, Jains and others about 0.5%. It has male-female ratio of .964 and has a literacy rate of 72%. The largest cities in the state include Dehradun (530,263), Haridwar (220,767), Haldwani (158,896), Roorkee (115,278) and Rudrapur (88,720). The state government recognizes 15,620 villages and 81 cities and urban areas. Historians of Kumaon and Garhwal say that in the beginning there were only three castes: Rajput, Brahmin and Shilpkar.

Agriculture, land holding, crops and livestock in Uttarakhand

The recently carved out Uttarakhand state falls under Western Himalayan Region of India and has five distinct agro-ecological sub-regions based mainly on altitude varying from 300m to 3600m. Lower Dun and Tarai sub-region constituting the plains, has wheat, rice and sugarcane as the major crops. Upper Dun, Bhabar, lower Shivaliks cultivate wheat, rice, finger millet, jhangora, chaulai and maize crops. Middle Garhwal-Kumaon and Upper Garhwal-Kumaon subregions with altitude of 1200-1800m and 1800-2400m respectively raise wheat, rice finger millet, jhangora,

cheena, potato, barley, and chaulai. Cold Zone having an altitude of 2400-3600m has wheat, barley, potato, phaphra, chaulai, kauni, ogal, kodo and uva crops in summer season only. Various pulses (Masur and Kulat) are intercropped during the two harvest seasons — early winter after the rainy season. Dry and wet rice, taro, pumpkins, beans, corn, ginger, chilli, cucumbers, leafy vegetables, and tobacco are also grown. Potato has become an important cash crop, grown in areas unsuitable for other plants.

It has a geographical area of 53,483 square kilometres, of which 65 per cent is forest land and only 776 thousand ha (15 per cent of the total land area) is net cultivated. The cropping intensity has steadily increased to 166.1 per cent. About 44.6 per cent of cultivated area is irrigated mainly by canals and tube wells. Over hundreds of years, many of the slopes have been cut into field terraces, a common 9 characteristic of mountain agriculture throughout the world. The region's farmers have also developed advanced manure, crop rotation, and intercropping systems. Most land on the slopes is unirrigated.

Agriculture along with Animal husbandry is still the principal occupation and source of livelihood for over 70% of its population. Uttarakhand is well endowed with a variety of livestock. Large population and low productivity are the hallmark of livestock in the state, across all species.

Livestock Demography

The recent livestock census 2007 shows that the total population of the livestock in the state is 79.95 lakhs including poultry. The detailed species wise breakup is as below –

Table 3.1 Species wise livestock population (2007)

S.No.	Species	Population (Lakhs)
1	Cattle	22.35
2	Buffalo	12.19
3	Sheep	2.90
4	Goat	13.35
5	Horse/Pony/Mule/Donkey	0.39
6	Pig	0.20
7	Others (Yak/Dog/rabbit)	2.56
8	Poultry	26.01
	Total	**79.95**

Cattle are most popular species; however, buffaloes are the premier milch animal and the main stay of the state dairy industry, while goat and sheep are the popular species among marginal, sub-marginal and landless farmers of the state. Nearly half of the arable farming in Uttarakhand takes place in the hilly slopes, on tiny terraced plots of land, often as small as 100 sq.m., almost all of it rainfed. Arable farming in the hills depend entirely on the small nondescript working bullocks for farm power and no mechanization of agriculture in this area is possible in the foreseenable future. In the state, animal husbandry plays a vital role in the rural economy largely based on different land base interventions.

Livestock production in Uttarakhand is the endeavour of the small holders and takes place in millions of tiny and small holdings scattered across the state. The predominant farming system in the state is mixed crop-livestock farming system, most of it rainfed. Ownership of livestock is equitable, over 80 percent of all species are owned by the marginal and small farmers, with some by the landless.

Geography and demography of Uttar Pradesh

Uttar Pradesh often referred to as U.P. or Uttam Pradesh is a state located in the northern part of India. With a population of over 199 million people, it is India's most populous state, as well as the world's most populous sub-national entity. Uttar Pradesh would be the world's fifth most populous country ahead of Pakistan. Uttar Pradesh is the second largest state-economy in India contributing 8.34% to India's total GDP in the financial year 2010.

With an area of 93,933 sq m. (243,290 km^2), Uttar Pradesh covers a large part of the highly fertile and densely populated upper Gangetic plain. It shares an international border with Nepal to the north along with the Indian state of Uttarakhand, Himachal Pradesh to the north-west, Haryana, Delhi and Rajasthan on the west, Madhya Pradesh on the south, Chhattisgarh and Jharkhand on the south east and Bihar on the east.

The larger Gangetic Plain region is in the north: it includes the Ganges-Yamuna Doab, the Ghaghra plains, the Ganges plains and the Terai. It has highly fertile alluvial soils and flat topography (slope 2 m/km) broken by numerous ponds, lakes and rivers. The smaller Vindhya Hills and Plateau region is in the south: it is characterised by hard rock strata and varied topography of hills, plains, valleys and plateau; limited availability of water makes the region relatively arid.

The climate of Uttar Pradesh is predominantly subtropical, but weather conditions change significantly with location and seasons:

Temperature: Depending on the elevation, the average temperatures vary from 12.5–17.5 °C (55–64 °F) in January to 27.5–

32.5 °C (82–91 °F) in May and June. The highest temperature recorded in the State was 49.9 °C (121.8 °F) at district Gonda on 8 May 1958.

Rainfall: Rainfall in the State ranges from 1,000–2,000 mm (39–79 inch) in the east to 600–1,000 mm (24–39 inch) in the west. About 90% of the rainfall occurs during the southwest Monsoon, lasting from about June to September. With most of the rainfall concentrated during this four-month period, floods are a recurring problem and cause heavy damage to crops, life, and property, particularly in the eastern part of the state, where the Himalayan-origin rivers flow with a very low north-south gradient.

Agriculture, land holding, crops and livestock in Uttar Pradesh

Uttar Pradesh is a major contributor to the national food grain stock. Partly this is due to the fertile regions of the Indo-Gangetic plain and partly owing to irrigation measures such as the Ganges Canal and tube-wells. Lakhimpur Kheri is a densely populated sugar producing district in the country. It is also home to 78% of national livestock population. It has been the most common producer of food grains in India since the 1950s due to high-yielding varieties of seed, greater availability of fertilizers and increased use of irrigation. Western Uttar Pradesh is more advanced in terms of agriculture as compared to the other regions in the state. Majority of the state population depends upon farming activities. Wheat, rice, pulses, oil seeds and potatoes are the major agricultural products. Sugarcane is the most important cash crop throughout the state. Uttar Pradesh is one of the most important states in India so far as horticulture is concerned. Apples and mangoes are also produced in the state. According to a Gorakhpur Environmental Action Group (GEAG) survey "U.P.'s agriculture is characterized by very small size of land holdings;

around 90 percent of the farmers in the state are small and marginal farmers. Some 73.8 percent of the total operational holdings in the state are marginal (below 1.0 ha) and another 15.5 percent holdings are small (between 1 and 2 ha).

Livestock Demography

The recent livestock census 2007 shows that the total population of the livestock in the state is 63.26 million excluding poultry. The detailed species wise breakup is as below –

Table 3.2 Species wise livestock population (2007)

S.No.	Species	Population (Millions)
1	Cattle	18.95
2	Buffalo	26.12
3	Goat	14.59
4	Sheep	1.37
6	Pig	1.97
7	Others (Yak/Dog/rabbit)	2.56
8	Poultry	10.58
	Total	**63.26**

During the last one decade, Uttar Pradesh state has witnessed to many climatic changes. Eastern Uttar Pradesh has faced severe floods, while Bundelkhand region has faced one of the worst famines of the last decade. Thus, the impact of climate change has adversely affected agricultural production resulting in huge loss of paddy and corn crops in eastern districts and regional crops in Bundelkhand. Climate-related disasters have brought widespread misery and huge economic losses to Uttar Pradesh, adversely affecting public health, food security, agriculture, water resources and biodiversity in the state. Floods are the most common annual occurrences in Uttar Pradesh, affecting one or the other part of the state; the most affected being the districts of the eastern U.P. and terai region.

3.2.4 Selection of districts

The present study was conducted in Nainital district of Uttrakhand state (Western Himalayan region) and Deoria district of Uttar Pradesh state (Middle Gangetic plain region).

Background information of the Nainital District

A small town in the hills of Kumaon surrounded by mountains by three sides. Once this area had many lakes and it was called the City of 60 lakes or 'Chakta'. Most of the lakes in the region have disappeared and whatever remains is just a glimpse of what they might have been in the past. Today the life of Nainital revolves around the lake of Naini. But there are few other lakes around Nainital which are equally beautiful and attractive as the Naini Lake. River Ramganga originates from the Doodha Tauli ranges in district Pauri Garhwal. It enters into district Nainital, before re-entering into district Pauri Garhwal. Nainital was discovered in 1841 by a Britisher called Lord Barron. The weather, the surrounding and the mesmerizing beauty of this area attracted the British administrator who turned this place into the summer capital of the United Province.

In Uttarakhand, district of Nainital lies in the Kumaun division. To its north is Almora district and to its south lies the Udham Singh Nagar district. Champawat district flanks it in the east and district of Pauri Gahwal is in the west. It is located approximately in between 80º14' and 78º 80' east longitudes and 29º00' and 29º05' north latitude. On the northern side lies the Himalayan ranges while on the southern side lies the plains making the resultant climate of the district enjoyable one. As of 2001 Indian census, the Nainital district has a population of 762,909.

The total geographical area is 3422 Kms. Geographically the district is divided in to 2 zones viz. Hilly and Bhabar. The hilly region in outer Himalayas is known to geologist as Krol. The highest peak of the district is Baudhansthali 2623 mts. high near Binayak adjoining Nainital town. The hilly region of the district used to have big & small lakes. Bhimtal ,Sattal, Naukuchiatal,Khurpatal, Nainital, Malwatal, Harishtal , Lokhamtal etc. are known lakes of bigger size. The foothill area of the district is known as Bhabhar. The name Bhabhar is derived from a tall grass growing in the region. The underground water level is very deep in this region. Kosi is the main river of the district .River Kosi arising out of Koshimool near Kausani flows on the western side of the district. There are number of smaller rivulets like Gaula , Bhakra , Dabka , Baur etc . Most of these have been dammed for irrigation purposes. The weather of Nainital is very pleasant throughout the year except during winter months. The temperature is not very high at any time but in winters it becomes very cold. The climate of Nainital is regulated by the lake here which showers rain almost every afternoon. The months of January to March are marked by the snowfall which is for a very short time.

Background information of the Deoria District

Geographical area of Deoria district is 2527 square km. This district is located between 26 degree & 28 degree north latitude and 83 degree & 85 degree east longitude out of which district Kushinagar was created in 1994 by taking north & east portion of Deoria district. Deoria is surrounded by district Kushinagar in North, district Gopalganj & Siwan (Bihar state) in East, district Mau & district Ballia in south and district Gorakhpur in West. Deoria district headquarter is situated at 53 km from Gorakhpur by road towards east. As of 2001 India census,

Deoria had a population of 104,222. Males constitute 53% of the population and females 47%. Deoria has an average literacy rate of 60%, higher than the national average of 59.5%: male literacy is 62% and, female literacy is 60%. The district is at 14th place according to area in the state & at 6th place according to population in the state; about 90% people live in rural areas. There is 14.9% SC & 0.01% ST population in the district. There are 1990 populated villages, 1016 Gram Sabhas, 176 Nyay Panchayat 16 Blocks, 2 Nagar Palika Parishads, 8 Nagar Panchayats, 5 Tehsils &18 Police stations in the district. Ghaghara, Rapti & Chhoti Gandak are the main rivers in this district. Soil of different types is found in the district Domat, Bhat, Matiyar & Balui Domat is found commonly. Currently,Deoria district has five tehsils namely Deoria Sadar, Salempur, Rudrapur, Berhaj & Bhatparrani.

Selection of blocks

The Nainital district comprises of eight blocks. Out of these Ramgarh, Haldwani and Dhari block was selected randomly for the study. However, the Deoria district comprises of fifteen blocks out of these Desahi Deoria,Gauribajar and Deoria Sadar block was randomly selected for the study

3.2.5 Selection of Villages

Villages from each block were selected randomly at an appropriate distance to cover the large and distinct area. Two villages from each block i.e. Hariapar and Pipra Madan Gopal from Desahi Deoria block; Keshaw bari and Devtaha village from Gauri bajar block; Chakasroy Badaldas and Persia Mishra from Deoria Sadar block of the Deoria distric and Darim and Pangraripokhari from Ramgharh block; Udaipur and Khera from Haldwani block; Satbani and Dhanachaully from Dhari block of Nainital district were selected randomly.

3.2.6 Selections of the respondents

From each selected village ten livestock owner having at least two large animals were selected randomly to make 120 total respondents for the investigation.

3.3 THEORETICAL ORIENTATION

It describes broadly the concepts and variables used in the present study for empirical investigation.

3.3.1 Variables and their measurements

The relevant variables for the present study were selected on the basis of extensive review of literature and consultation with experts. Keeping in the view the objectives of the study and the variables to be measured, an interview schedule was developed.

Table 3.3 Variables along with empirical measurement

S. No.	Variables	Measurements
I.Independent variables:		
1	Age	Chronological age in complete years
2	Family size	Through Schedule
3	Education	Through Schedule
4	Occupation	Through Schedule
5	Land holding	Through Schedule
6	Herd size	Through Schedule
7	Gross income	Through Schedule
8	Experience in livestock rearing	In complete years
9	Financial returns from livestock farming	Through Schedule
10	Extension agency contact	Through Schedule
11	Mass media exposure	Through Schedule
12	Weather	Through Schedule
13	Climate	Through Schedule
14	Livestock rearing pattern	Through Schedule

15	Productive performance of dairy animals	Through Schedule
16	Reproductive performance of dairy animals	Through Schedule
17	Animal diseases pattern	Through Schedule
18	Cropping pattern of fodder	Through Schedule
19	Insect pest and diseases pattern of fodder crop	Through Schedule
20	Changes in community grazing land	Through Schedule
21	Availability of farm labour	Through Schedule
22	Preparedness to act	Through Schedule
Dependent variables		
23	Knowledge about climate change	Through Schedule
24	Perception about climate change	Modified scale of Leiserowitz (2006)

3.3.2 Empirical measurements of the variables

Age

It is one of the basic characteristics of an individual linked with his maturity, physical well being, productivity level and work efficiency. Age was operationalised as the number of years completed by the respondent at the time of enquiry or investigation. The result of (Mean-S.D.) and (Mean+ S.D.) was also rounded to the nearest whole number.

Respondents were categorised into following three categories.

Young	:	Less than (Mean-S.D.)
Middle	:	(Mean-S.D.) to (Mean+ S.D.)
Old	:	More than (Mean+ S.D.)

Family size

The size of family refers to the number of individuals of both sexes living together in a household. Family members away on the date of interview for a short period were included, while guests who had joined the family for a short period were excluded. It was assumed

that more the number of dependent in a family, more will be share in the income and ultimately the lesser would be the socio-economic status of the family. In the present study, the respondents were placed into three categories on the basis of equal class interval viz. small (4-8), medium (8-12) and large (12-16).

Respondents' Education

It denotes the formal education acquired by the respondent through systematic school and training at the time of the interview. The educational level used in this study is, Illiterate, Primary school, Middle school, High school, and intermediate or above. The respondents were assigned scores according to their educational level as;

S.N.	Educational level	Score
i	Illiterate	1
ii	Primary school	2
iii	Middle school	3
iv	High school	4
v	Intermediate or above	5

Occupation

Main occupation refers to respondent's principal work or business especially as means of earning. It is operationalized as the main source of income of the respondents. This referred to the family's major economic activities to earn a livelihood. The households were categorized on the basis of their primary occupation.

Land holding

This refers to the land possessed by the family. This includes their own land either cultivated by them or rented out on lease or on share cropping. Land holding for this study categorized as per the standards of the state government. It will be categorized into four

groups according to land holding as landless (no land), marginal (< 2.5 acres), small (2.5 to5.0 acres), and large (>5 acres) on the basis of equal class intervals between minimum and maximum scores and expressed in the frequency and percentage accordingly.

Herd size

It referred to the actual number of cows, buffaloes, goat, sheep, pig and poultry owned by respondent's family at the time of investigation. All the animals owned by the respondents either large or small were assigned weightage and converted into Cattle Equivalent score using method of Gadgil, 1947; National Accounts Statistics, 1961 and Lalwani, 1981.These were then categorized as small, medium and large size of herds on the basis of equal intervals between maximum and minimum achieved scores.

Gross income

It included earning of family from farm activity, nonfarm activity or both by farm and nonfarm activity. The result of (Mean-S.D.) and (Mean+ S.D.) was also rounded to the nearest whole number.

Respondents were categorised into following three categories.

Low	:	Less than (Mean-S.D.)
Medium	:	(Mean-S.D.) to (Mean+ S.D.)
High	:	More than (Mean+ S.D.)

Financial returns from livestock farming

The earning of family from all type of livestock related activities and produce. It was calculated in the form of percentage of total gross income. These were categorized as low, medium and high return on the basis of equal intervals between maximum and minimum financial return.

Experience in livestock farming

It referred to the number of years; a farmer was rearing livestock as a component for primary or subsidiary occupation. It was then classified into low, medium and high categories on the basis of equal class intervals between maximum and minimum number of years of experience in livestock farming by the respondents.

Extension personnel contact

Extension personnel contact refers to the both acquaintance and frequency of contact with Livestock extension officer, Para veterinarian, Veterinary officer, Block Development Officer, Bank officials, NGOs personnel and ICAR employees. To measure the extension contact, a schedule was developed. The 4, 3, 2 and 1 score were assigned to four point continuum viz. most often, often, some time and never respectively. Frequency and Total score was calculated for the pattern of extension agency contact.

Mass Media exposure

Mass Media exposure refers to the acquaintance with radio, television, news paper, bulletin, Pasu mela, kisan mela, etc. To measure the mass media exposure, a schedule was developed. The 4, 3, 2 and 1 score were assigned to four point continuum viz. most often, often, some time and never respectively. Frequency and Total score was calculated for the use pattern of information source.

Weather

It is operationally defined as how respondents felt that change of temperature and precipitation from day to day / months to month / year to year at the time of investigation. A schedule was developed and frequency and percentage was calculated.

Climate

It is operationally defined as any unusual pattern in climate (unusual heat waves/cold waves, unusual snowfall/rainfall, change in wind pattern) felt by the respondents.

Livestock rearing pattern

It is operationally defined as the different livestock i.e. large animal (cattle, buffaloes) and small animal (goat, sheep and poultry) reared by the respondents at their farm at the time of investigation.

Productive performance of dairy animals

It is operationally defined as production performance of a dairy animal in term of milk production at the time of investigation.

Reproductive performance of dairy animals

It is operationally defined as reproductive performance (length and intensity of oestrous, conceptional rate, parturition interval) of livestock at the time of data collection.

Animal diseases pattern

It is operationally defined as the nature, type and incidence of disease among livestock.

Cropping pattern of fodder

It is operationally defined as the type of fodder crop cultivated by the farmers of selected study area in different season.

Pattern of insect pest and fodder crop diseases

It includes nature, type and incidence of fodder crop diseases.

Availability of farm labour

It is operationally defined as the availability of man power for farm activities. A schedule was developed; frequency and percentage was calculated.

Changes in community grazing land

It is operationally defined as the changes in area/extent of grazing/biomass of community grazing land.

Preparedness to act

It is operationally defined as action/ readiness of an individual to change something in his/her behaviour to overcome the effect of climate change.

Knowledge

Knowledge refers to the information possession of the respondents. Operationally knowledge is defined here as the information possessed by the respondents about climate change. The knowledge about climate change is supposed to directly affect the efficiency of adaptation and mitigation activity by the respondent. Livestock owners' knowledge about climate change can be divided into general and specific category. General category include common knowledge about climate change i.e. awareness of the issue, belief that climate change exists and is happening, causes, source of information on climate change, etc. Specific categories include- knowledge of the projected impacts of climate change on livestock, in general and knowledge about impact of climate change on livestock production, reproduction, health, feed and fodder resources and water resources, in particular. An interview schedule that assessed livestock owners' knowledge on climate change was developed and a number of questions that assessed the above parameters were asked to respondents.

Variables related to livestock production, reproduction and health:

- **Milk production**: It referred to the average milk yield per day (in litres) in a household from the dairy animals.
- **Lactation length**: A number of days, an animal secrets milk following parturition.
- **Dry period:** It referred to the non-lactating days between two lactations.
- **Productive life**: It referred to the number of calving in whole life of an animal/ a number of years, animal produce milk.
- **Oestrous period**: It is a period of oestrous cycle in which female shows signs of heat and become receptive to male animal.
- **Conception rate:** It is referred as number of service required by an animal to conceive.
- **Parturition (calving) interval**: The parturition interval is an interval between two lactations.
- **Disease incidence:** It is referred as occurrence of any new cases of disease.
- **Change in timing of occurrence of diseases:** It is referred as any visible change in timing of occurrence of a specific disease.
- **Emergence and re emergence of diseases:** it is referred as incidences of any new disease or the disease which was eradicated earlier.
- **Incidences of parasitic infestations:** It is referred as presence of parasites either external or internal or both (for e.g. tick, lice, mites, fasciola, etc.) on or in the body of an animal.

Variables related to feed and fodder resources

- **Feed and fodder resources:** It is referred as various type of green, dry fodder composed of entire plants or the leaves and stalks of a cereal crop.
- **Shortage of dry fodder:** It is referred as decrease availability of dry fodder for animals.

- **Pasture land**: It is referred as grassy land suitable for grazing livestock.
- **Self grown fodder/grasses:** It is referred as natural grown shrubs/herbs/grasses.
- **Fodder tree:** It is referred as a tree which leaves or other parts used as fodder for livestock.

Variables related to water resource

- **Water resource:** It is referred as water sources utilized for the livestock and irrigation including ponds, rivers, spring, lake, canal, well, hand pump, tube well.
- **Ground water level:** It is referred as depth at which water is present under the ground and can be used for drinking and irrigation purpose.
- **Availability of water for irrigation:** It is referred as availability of various water resources for irrigation.
- **Availability of pond and other natural water resources for livestock:** It is referred as availability of various water resources for livestock.

Perceptions

Perceptions refer to the process of receiving information or stimuli from our environment and transform it into physiological awareness. Individual's perception about climate change was measured by using the modified scale of Leiserowitz (2006). The scale is of sixteen statements, (eight positive and eight negative) and the response for each statements was rated over a five point continuum which ranged from strongly agree to strongly disagree. The scoring procedure was as follows.

Response	Positive item	Negative item
Strongly agree	5	1
Agree	4	2
Undecided	3	3
Disagree	2	4
Strongly disagree	1	5

Climate Change

For this research definition given by Intergovernmental Panel for Climate Change (IPCC) was used, which defines climate change as a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity.

Climate variability

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Climate variability refers to fluctuations that occur from year to year, including extreme events.

Impacts

The effects of climate change on natural and human systems (IPCC, 2007). Depending on the consideration of adaptation, it is of two types

i. Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation.

ii. Residual impacts: the impacts of climate change that would occur after adaptation.

Adaptation

Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects

(IPCC, 2007) various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned.

Adaptation strategies

Entail a long-term change in behaviour; they refer to efforts to improve livelihoods sustainably in response to such given or anticipated stimuli.

Agro-climatic Zone

An agro-climatic zone refers to a land unit in terms of its major climates and suitability for a certain range of crops and cultivars.

3.3.3 Tools of data collection

3.3.3.1 Developing Schedule

An interview schedule was developed on the basis of objectives by incorporating all the variables required for the study. The required information for the schedule was collected from the relevant available literature on the subject and in consultation with the members of the advisory committee. Before using the final interview schedule with the actual respondent, pre-testing of the schedule was conducted with non sample respondent. On the basis of the experience gained the appropriate modification was done to improve the clarity and understandably, of instrument.

3.3.3.2 Data Collection

Data was collected through modified interview schedule. The respondents were interviewed in the selected villages using the interview schedule from December 2010 to May 2011. The results are supported with help of observations, beside this secondary data was also collected.

Fig. : Researcher taking interview of respondents

3.4 STATISTICAL METHODS FOR ANALYSIS OF DATA ANALYSIS

The data after collection, compiled, tabulated and analysed in view the objectives of the study. Frequency distribution, Percentage, Mean score, Standard deviation and Cattle equivalent score were computed by using Statistical Package for Social sciences (SPSS) software and Microsoft excel for analysis of data. Qualitative information such as farmers' experiences regarding climate change and adaptation measures taken on their farmland collected from farmers' interviews were analyzed manually, both by the researcher and in conjunction with other farmers, and interpreted to complement and supplement the quantitative information collected from household interviews and secondary data on climatic variability.

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Results & Discussion

This section summarises socio-economic and psychological profile of the respondents, farmers' knowledge and perceptions on climate change and the adaptation that they considered suitable to these changes. The inferences have been drawn on the basis of analysis of data collected by semi - structured interview and secondary data from different available sources. The results and discussion are presented under the following subheading:

4.1 Socio-economic and psychological characteristics of livestock owners.

4.2 Knowledge and perception of livestock owners about climate change.

4.3 Contrasting of livestock owners' perception with secondary data on climate variability.

4.4 Livestock management strategy adopted by farmers under climatic change.

4.1 SOCIO-ECONOMIC AND PSYCHOLOGICAL CHARACTERISTICS OF LIVESTOCK OWNERS

There are different socio-economic and psychological characteristics of the respondents that affect their involvement in animal husbandry which ultimately generate the income and employment among the family members and help in sustaining the income generating activity during adverse climatic vagaries. It was therefore, intended to study the age, family size, education,

occupation, land holding, herd size, gross income, financial return from livestock farming, experience in livestock rearing, extension personnel contact, mass media exposure, preparedness to act.

4.1.1 Age

The age of selected livestock owners in the study area ranged between 25 and 75 years. The average age of the livestock owners was found as 44.77 years (S.D. =11). Respondents were categorised in to three categories as young, middle and old. It is evident from the table 4.1 that majority of livestock owners (52.5%) belonged to middle age group, followed by (33.33%) old age group and (14.16) young age group. The table further indicates that the ratio of livestock owners with respect to age group was more or less similar in both Middle Gangetic plain region and Western Himalayan region. Shah *et.al*, (2002) also reported that majority of dairy farmers in hilly area of Uttarakhand had middle age. Sharma *et al.* (2010) also concluded that majority of the farmers (79.74%) of Kochariya (Rajasthan) belonged to age group 21-50 years.

Table 4.1: Distribution of respondents according to their age group:

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Young (<34 yrs)	8	13.33	9	15	17	14.16
Middle (34-56 yrs)	31	51.66	32	53.33	63	52.5
Old (>56 yrs)	21	35	19	31.66	40	33.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.2 Family size

Family size i.e. total number of human being in a family considerably influence animal husbandry practices. Table 4.2 indicates that majority of respondents (79.16%) had medium size

family followed by large (13.33%). Only 7.5 % of respondent had small size family. Ganguli (2004) also reported that majority of livestock farmers had middle size family.

Table 4.2 : Distribution of respondents according to their family size

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Small (4-8)	14	23.33	25	41.67	39	32.5
Medium (8-12)	33	55.00	32	53.33	65	54.16
Large (12-16)	13	21.66	3	5.00	16	13.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.3 Respondent's educational status

Educational level of respondents is an important consideration in decision making process. The distribution of respondents as per their educational level is presented in table 4.3. It can be observed from the table that majority of the respondents (34.16) were educated upto primary level of education, followed by illiterate (21.66), middle school (15.83) and high school (20.83). Only 7.5% of the respondents were found to be educated upto intermediate and above. Sharma *et al.* (2010) also concluded that majority of the farmers (74.33%) of Kochariya village (Rajasthan) had of primary and middle education while 4.05% was illiterate.

Table 4.3 : Distribution of respondents according to their educational status:

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Illiterate	14	23.33	12	20.00	26	21.67
Primary school	23	38.33	18	30.00	41	34.17
Middle school	8	13.33	11	18.33	19	15.83
High school	9	15.00	16	26.67	25	20.83
Intermediate and above	6	10.00	3	5.00	9	7.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.4 Occupation

The respondents were distributed into four categories on the basis of their primary occupation, which refers to the major source of income. Table 4.4 indicates that majority of respondents (75.83%) had agriculture as their primary occupation followed by 9.16% as animal husbandry whereas 8.33% of them were having occupations neither related to agriculture nor animal husbandry(e.g. Business, private jobs, etc.) only 6.66 % were having agriculture labour as their primary occupation.

Table 4.4: Distribution of respondents according to their primary occupation

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Agriculture	42	70	49	81.66	91	75.83
Animal husbandry	6	10	5	8.33	11	9.16
Ag labour / Non-Ag labour	6	10	2	3.33	8	6.66
Other occupation	6	10	4	6.66	10	8.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.5 Land holding

Farmers' land holding indicate their social status and progressiveness. It is evident from table 4.5, that most of the respondents (76.66%) were marginal farmers, followed by small (20 percent). Equal percentage (1.66) of respondents was found to be large and landless farmers. According to a Gorakhpur Environmental Action Group (GEAG) survey "U.P.'s agriculture is characterized by very small size of land holdings; around 90 percent of the farmers in the state are small and marginal farmers. Some 73.8 percent of the total operational holdings in the state are marginal (below 1.0 ha) and another 15.5 percent holdings are small (between 1 and 2

ha). Climate change is impeding agricultural production in Uttar Pradesh (Dwivedi, 2008). Majority of hill farmers are small holders and they depend on the diversification of agriculture to reduce risks and derive economic benefits from the limited resources they posses (Singh *et al.*, 200l).

Table 4.5: Distribution of respondents according to their land holding

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Landless(0 acres)	2	3.33	00	0.00	2	1.66
Marginal (<2.5 acres)	41	68.34	51	85.00	92	76.66
Small (2.5-5 acres)	15	25.00	9	15.00	24	20.00
Large (>5 acres)	2	3.33	00	0.00	2	1.66
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.6 Herd size

It is evident from table 4.6 most of the respondents (75 percent) of Middle Gangetic plain region have small herd size, followed by 16.66 percent medium herd size. Only 8.33 percent of respondents have large herd size.

Table 4.6 : Distribution of respondents according to their herd size

Category (cattle equivalen score)	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Small (2.40-4.62)	45	75.00	24	40.00	69	57.50
Medium (4.62-6.84)	10	16.66	27	45.00	37	30.83
Large (6.84-9.06)	5	8.33	9	15.00	14	11.66
Total	**60**	**100**	**60**	**100**	**120**	**100**

It is also evident from table 4.6 most of the respondents (45 percent) of Western Himalayan region have medium herd size, followed by 40 percent small herd size. Only 15 percent of respondents

have large herd size. Thus, it can be observed that most of the respondents (75%) of Middle Gangetic plain region had small herd size while most of the respondents (45%) of Western Himalayan region had medium herd size. Overall majority of the respondents had small herd size followed by medium herd size.

4.1.7 Gross income

It included earning of family from farm activity, nonfarm activity or both by farm and nonfarm activity. Majority of respondents depended on agriculture and animal husbandry which is highly affected by adverse climatic condition. The annual gross income of the selected livestock owners in the study area ranged between Rs.0.40 lakh to 3.00 lakh. The average gross income of the livestock owners was found as Rs. 1.125 lakh (S.D. =0.375). Table 4.7 indicates that majority of the respondents (58.33 percent) amongst low income group (upto Rs.75000), followed by (27.50%) medium income group. Only 14.16 percent of the respondents belonged to high income group. Sharma *et al.* (2010) also concluded that majority of the farmers (94.59%) of Kochariya (Rajasthan) had an annual income upto Rs. 50000 per household.

Table 4.7: Distribution of respondents according to their gross income

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Low (< Rs.0.75lakhs)	36	60.00	34	56.67	70	58.33
Medium (Rs.0.75-1.5 lakhs)	15	25.00	18	30.00	33	27.50
High (>1.5 lakhs)	9	15.00	8	13.33	17	14.17
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.8 Financial return from livestock sector

Livestock sector plays a major role in economy of the farming community which is highly affected by adverse climatic condition.

Table 4.8 revealed that majority of respondents (54.16 %) falls under the low financial return category, followed by (31.66 %) medium financial return category. Only 14.16 percent of the respondents belonged to large financial return category.

Table 4.8 : Distribution of respondents according to their financial return from livestock rearing

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Low (10-25%)	30	50.00	35	58.33	65	54.16
Medium (25-40 %)	18	30.00	20	33.33	38	31.66
High (40-55 %)	12	20.00	5	8.33	17	14.16
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.9 Experience in livestock rearing

Experience plays a major role in the livestock management and help in maintaining good returns from livestock. Experience also helps the livestock owners in adaptation and mitigation of climate change. On the basis of their experience famers know how to manage adverse climatic condition, which type of animal kept in their farm and how fulfil the nutritional requirement of their livestock. Table 4.9 shows that majority of the respondents (52.5 percent) belonged to low experience group (10-25 years), followed by (35 percent) medium experience group. Only 12.5 percent of the respondents had high experience. Jain *et al.*, (2010) reported that the farmers of Madhya Pradesh had 10-60 years experience in the field of agriculture and allied. The group of Malwa Plateau's farmers consisted of about 51 per cent farmers had 11 to 30 years experience of agriculture, followed by, 31 to 50 years experience (41%). 0 to 10 years experience (6%) and 51 to 60 years experience (2%).

Table 4.9 : Distribution of respondents according to their experience in livestock rearing

Category	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Low (10-25 yr)	26	43.33	37	61.66	63	52.50
Medium (25-40 yr)	22	36.67	20	33.33	42	35.00
High (40-55 yr)	12	20.00	3	5.00	15	12.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.10 Extension personnel contact

Extension contact refers to the both acquaintance and frequency of respondents contact with Livestock extension officer, Para veterinarian, Veterinary officer, Block Development Officer, Bank officials, NGOs personnel and ICAR personnel. The extension personnel contact pattern was classified into four category i.e. most often, often, sometimes and never according to the opinion of livestock owners about frequency of contact with extension personnel. Total score was calculated for the contact pattern of each of the extension personnel. Table 4.10 shows that on the basis of total score only two extension personnel i.e. Para veterinarian and Veterinary officer had high frequency of contact, where as rest of the sources had low frequency of contact.

The extension personnel contacted with highest frequency in Middle Gangetic plain region was Veterinary officer (score 274), followed by Para veterinarian (score 206) whereas in Western Himalayan region, it was ICAR personnel (score 170), followed by Veterinary officer (score 132), Livestock extension officer (score 132) and NGOs personnel (score 70). The respondent of Middle Gangetic plain region had no contact with ICAR personnel.

Table 4.10: Distribution of respondents according to their extension personnel contact

Extension Personnel Contact	MGPR (n=60)				S. Range (60-240)	WHR (n=60)				S. Range (60-240)	Pooled (N=120)				S. Range (120-480)
	Most Often	Often	Some times	Never	Score	Most Often	Often	Some times	Never	Score	Most Often	Often	Some times	Never	Score
L.E.O	2	0	0	58	66	20	2	8	30	132	22	2	8	88	198
Paravet	48	0	2	10	206	5	6	27	32	124	53	6	29	42	330
V.O.	30	9	6	15	274	10	15	12	23	132	40	24	18	38	306
B.D.O.	0	0	0	60	60	0	0	2	58	62	0	0	2	118	122
NGOs personnel	0	7	3	50	77	10	5	8	50	70	10	12	11	87	185
Bank official	0	0	8	52	78	0	0	10	37	108	0	0	18	102	138
ICAR institute	0	0	0	0	0	30	5	10	15	170	30	5	10	15	170

Scores- most often-4, often-3, sometimes-2 and never-1
Individual score -60-240, Pooled score 120-480
Total score range 120-210- low 210-300- moderate
300-390- high 390-480-very high

4.1.11 Mass media exposure

Mass Media exposure refers to the acquaintance with radio, television, news paper, bulletin, Pasu mela, kisan mela, etc. The mass media exposure pattern was classified into four category i.e. most often, often, sometimes and never according to the opinion of livestock owners about frequency of exposure with mass media. Total score was calculated for the mass media exposure. Table 4.11 indicates that on the basis of total score only three mass media i.e. radio, television and news paper had moderate frequency of exposure; whereas rest of the sources had low frequency of exposure.

The mass media used with highest frequency in Middle Gangetic plain region was radio (score 174), followed by news paper (score 124) whereas in Western Himalayan region, it was television (score 147), followed by radio (score 118). Thammi *et al*.(1996) reported that majority of the respondents rearing crossbred in Krishna district of Andhra Pradesh were belonged to middle age category, medium socio economic status, medium level of mass media exposure and medium information seeking behaviour.

According to data furnished in table the utilization of other mass media like pamphlet or bulletin, krishi mela and pashu mela are very low. So, to increase awareness and knowledge about climate change and its impacts among the people of Middle Gangetic plain region radio could be used as mass media more effectively supplemented with news paper whereas for the people of western Himalayan region, it was television supplemented with radio. The media used by farmers for gaining agricultural information are television and radio, newspapers etc (Jain *et.al*, 2010).

Table 4.11: Distribution of respondents according to their mass media exposure

Mass Media Exposure	MGPR (n=60)				S. Range (60-240)	WHR (n=60)				S. Range (60-240)	Pooled (N=120)				S. Range (120-480)
	Most Often	Often	Some times	Never	Score	Most Often	Often	Some times	Never	Score	Most Often	Often	Some times	Never	Score
Radio	12	18	15	15	147	6	14	12	28	118	18	32	27	33	255
T.V.	6	14	12	28	118	12	18	15	15	147	16	34	25	35	251
News paper	8	16	8	28	124	6	13	11	30	115	14	29	19	58	239
Bulletins/ Pamphlet	0	0	0	60	60	2	1	2	55	70	2	1	2	115	132
Kisan mela	0	0	6	54	66	5	2	6	57	95	5	2	12	111	161
Pashu mela	0	2	8	50	72	6	3	8	53	102	6	5	16	103	174

Scores- most often-4, often-3, sometimes-2 and never-1
Individual score -60-240, Pooled score 120-480
Total score range 120-210- low 210-300- moderate
300-390- high 390-480-very high

4.1.12 Weather

It is operationally defined as how respondents felt that change of temperature and precipitation from day to day /months to month/ year to year at the time of investigation. Table 4.12 shows that majority of the respondents (71.66 %) were perceived that there were increased environmental temperature while only 15.83 percent perceived decreased environmental temperature. According to 7.5 percent respondents there were no change in environmental temperature whereas 5 percent respondents told that they do not know. Table 4.12 further indicates that majority of the respondents (85 %) were perceived that there was decreased precipitation while 11 percent perceived an increased precipitation. Only 3.3 percent respondents told that they do not know. These findings are supported by the study conducted by Agrarwal *et al.* (2008). According to him India is facing unpredictable weather for last few years. Analysis of different meteorological variables available from weather stations in the country showed an upward trend in mean temperature in the country and downward trend in relative humidity, annual rainfall and number of wet days in years.

Table 4.12 : Distribution of respondents according to their perceived change in weather (temperature and precipitation)

Parameter	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Temperature						
Increased	36	60.00	50	83.33	86	71.67
Decreased	15	25.00	4	6.66	19	15.83
Stayed constant	6	10.00	3	5.00	9	7.50
Do not know	3	5.00	3	5.00	6	5.00
Precipitation						
Increased	6	10.00	8	13.33	14	11.66
Decreased	54	90.00	48	80.00	102	85.00
Stayed constant	00	10.00	00	0.00	00	0.00
Do not know	0	0.00	4	6.66	4	3.33

4.1.13 Climate

When I asked a question "Have you noticed any unusual pattern in the climate? (e.g. unusual heat waves/ cold waves, unusual snowfall/rainfall, change in wind pattern)" Majority of respondent (83 percent) told that "yes" whereas about 12.5 percent respondents were told that "no". Only about 4 percent told that they "Do not know". Jain *et.al* (2010) reported that farmers of Malwa Plateau of Madhya Pradesh was experiencing extreme temperatures (both day and night temperature), erratic distribution of rains, more number of events of high intensity of rains, frequent occurrence of prolong dry spell etc.

Table 4.13 : Distribution of respondents according to their perceived usual pattern in the climate (e.g. unusual snowfall/rainfall, heat waves, change in wind pattern)

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	45	75.00	55	91.66	100	83.33
No	15	25.00	00	0.00	15	12.50
Do not know	00	0.00	5	8.33	5	4.16
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.14 Livestock rearing pattern

The overall picture of livestock rearing pattern presented in the table 4.14 which shows that large animals (cattle and buffaloes) were reared by Cent per cent of the respondents followed by goat (40 percent) and poultry (15 %). It was very interesting to note down that none of the respondent either of Middle Gangetic plain region or of Western Himalayan region reared sheep and pig.

Table 4.14: Distribution of respondents according to livestock rearing pattern

Livestock	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Large animal						
Cattle, buffalo	60	100.00	60	100.00	120	100.00
Small animal						
Goat	12	20.00	36	60.00	48	40.00
Sheep	00	0.00	00	0.00	00	0.00
Pig	00	0.00	00	0.00	00	0.00
Poultry	15	25.00	3	5.00	18	15.00

4.1.15 Productive performance of dairy animals

When I asked "do you know that Global warming and climate change are likely to impact negatively on milk production?" Majority of respondents (58.33 %) replied that "yes" whereas 27.5 percent were told that "no". Only 16.16 percent respondents told that they "cannot say anything". This finding indicate that now majority of the livestock keepers perceived the negative effect of climate change on livestock.

Table 4.15 : Distribution of respondents according to their knowledge about impact of climate change on productive performance of dairy animals

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	36	60.00	34	56.66	70	58.33
No	18	30.00	15	25.00	33	27.50
Cannot say any thing	6	10.00	11	18.33	16	14.16
Total	**60**	**100**	**60**	**100**	**120**	**100**

Houghton *et al.* (2001) also concluded that direct effects from air temperature, humidity, wind speed and other climate factors influence animal performance: growth, milk production, wool production and reproduction.

4.1.16 Reproductive performances of dairy animals

When I asked a question "do you know that climatic stress has negative impact on reproductive performance of livestock?" Majority of respondents (63.33 %) replied that "yes" followed by 33.33 percent were told that they "cannot say anything". Only 3.33 percent respondents told that "no". Excessive heat during summer months decreased thyroid activity indirectly and reduced reproductive efficiency in animals (Kumar, 2005b).

Table 4.16 : Distribution of respondents according to their knowledge about effect of climate change on reproductive performance of dairy animals

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	39	65.00	37	61.66	76	63.33
No	00	0.00	4	6.66	4	3.33
Cannot say any thing	21	35.00	19	31.66	40	33.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.17 Animal disease pattern

When I asked a question "have you noticed that any effect of climate change on nature, type and incidence of disease among livestock?" Majority of respondents (60.83 %) replied that "yes" followed by 24.16 percent were told that "no". Only 15 percent respondents told that they "cannot say anything" about effect of climate change on incidences of animal diseases. Adverse climatic conditions creates a lot of stress on livestock and make them lean, thin and weak, thus they become more susceptible to various diseases. Alterations of temperature and precipitation regimes may result in a spread of disease and parasite into new regions or produce an increase in the incidences of diseases (Stem *et al.*, 1989).

Table 4.17 Distribution of respondents according to their knowledge about effect of climate change on nature, type and incidence of disease among livestock

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	39	65.00	34	56.66	73	60.83
No	12	20.00	17	28.33	29	24.16
Cannot say any thing	9	15.00	9	15.00	18	15.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.18 Cropping pattern of fodder crop

It was operationally defined as the type of fodder crop cultivated by the farmers of selected study area in different season. Table 4.18(a) clearly indicates that majority of the respondents (88.33 percent) of Middle Gangetic plain region were grown berseem as major fodder crop in *Rabi* season while in *Kharif* season Sorghum (46 percent) and Bajra (36 percent) was the major fodder crop. Table number 4.18(a) further indicates that about 8 percent respondents did not cultivate any fodder crop. Saran *et al.* (2008) revealed berseem as green fodder and wheat and peas straw (dry fodder) during *Rabi* were used in Bundelkhand region of Uttar Pradesh. Similar finding was also reported by Maurya (2010).

Table 4.18(b) clearly indicates that in *Rabi* season majority of the respondents (63.33 %) of Western Himalayan Region were used fodder tree leaves as fodder for livestock whereas about 28 percent of the respondent used grasses as fodder collected from forest. About 8.33 percent of the respondents used vegetable leaves and stem (e.g. potato, pea etc.) In *Kharif* season also, majority of the respondents (53.33%) used fodder tree leaves followed by 25percent grasses collected from forest. About 20 percent of the respondents cultivated

sorghum. Only 1.66 percent of the respondents had grown maize as fodder crop. Besides these famers of western Himalayan region purchased wheat straw from plain area and feed block from dairy cooperatives.

Table 4.18.1(a) Distribution of respondents of MGPR according to their type of fodder cultivation

Season	Fodder Crop	MGPR (n=60)	
		Frequency	%
Ravi	Berseem	50	88.33
	Barley+ mustard	3	5.00
	Maize	2	3.33
	No cultivation	5	8.33
Kharif	Sorghum	32	46.00
	Bajra	22	36.00
	Maize	1	1.66
	No cultivation	5	8.33

Table 4.18.2(b) Distribution of respondents of WHR according to their type of fodder crop cultivation and fodder tree leaves, grasses collected from the forest

Season	Fodder Crop	MGPR (n=60)	
		Frequency	%
Ravi	Fodder tree	38	63.33
	Vegetable leaves and stem	5	8.33
	Grass collected from forest area	17	28.33
Kharif	Fodder tree	32	53.33
	Sorghum	12	20.00
	Maize	1	1.66
	Grass collected from forest	15	25.00

Meena *et al.* (2007) reported that farmers in hilly region was totally dependent on the locally available feed resources like oak tree leaves, unclassified grasses grown in the forest area for the feeding of their animals round the year.

4.1.19 Insect pest and disease pattern of crops including fodder crop

When I asked to comment on the incidence of crop pests and diseases in relation to the change in climatic conditions, the response varied based on altitudinal differences. The respondents reported a definite increase in disease incident in crops. Majority of the respondents (70.83%) perceived an increased insect pest and disease on crops whereas about 21 percent did not say anything.

Table 4.19 Distribution of the respondents according to their perceived effect of climate change on insect pest and disease pattern

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Increased	40	66.66	45	75.00	85	70.83
Decreased	5	8.33	5	8.33	10	8.34
No change	00	0.00	00	0.00	00	0.00
Cannot say any thing	15	25.00	10	16.33	25	20.83
Total	**60**	**100**	**60**	**100**	**120**	**100**

The reason was linked directly to warmer climate, especially during winter in recent years. One respondent pointed out that increased rainfall causes more disease. A list of prevailing fodder crop diseases was provided by the interviewees. These include a big sized pest on grass, vegetables and wheat; lojomi (disease in which holes form in potato crop); lom / shor (pest in which leaves dry up due to less rain), lomboroney (disease in which the stem turns yellow and the crop falls or limps), oludumi (pest on potato crop), jhulsa (disease in which crop turns yellow and fallen down), tana bedhak (disease in which stem become porous. Since the past 5-10 years, all fruit trees (apple, apricot, pear and walnut) catch disease and also cause itching in humans. An insect locally known as, Kurmula, was damaging paddy, potatoes and chilies. Pulses were also affected and their leaves have numerous holes in them.

Majority of respondents of Middle Gangetic plain region told that in the field of sugarcane there was an insect which causes a very burning pain whenever touched to human body; local people called it “current wala kira”.

4.1.20 Change in community grazing land

There are many factors which are responsible for the change in community grazing land e.g. industrialization, encroachment of community grazing land for residential purpose, adverse climatic condition, etc. Table 4.20 reveals that majority of respondents (95.83 percent) told that there were decreased in grazing land area and also 95 percent of the respondents told that there were overgrazing on remaining pasture land. Table 4.20 further indicates that Cent per cent of the respondents perceived decreased pasture biomass.

Table 4.20 : Distribution of respondents according to perceived changes in community grazing land

Perceived change	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Grazing land area						
Decreased	60	100.00	55	91.66	115	95.83
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	00	0.00	06	10.00	06	5.00
Over grazing						
Yes	60	100.00	54	90.00	114	95.00
No	00	0.00	00	0.00	00	0.00
Do not know	00	0.00	06	10.00	06	5.00
Pasture biomass						
Decreased	60	100.00	60	100.00	120	100.00
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	00	0.00	00	0.00	00	0.00

4.1.21 Availability of farm labour

Availability of man power is very essential for the success of any enterprise. There are many factors which are responsible for decreased availability of farm labour for e.g. urban migration in search of better job, less job opportunities in rural areas, damage of crop leads to decrease income from farming due to repeated adverse climatic condition (draught, flood, etc). Table 4.21 clearly indicates that about 66 percent of the respondents told that there was decreased availability of farm labour whereas about 31 percent of the respondents perceived an increased farm labour it was due to increased frequency of draught, and flood, which leads to decreased source of income and increased unemployment. On the basis of analysis of qualitative data provided by respondent it was concluded that in villages mostly women and old men were available for farm activity. A higher percentage of the large farmers reported non availability of agricultural labourers as a cause of grave concern.

Table 4.21: Distribution of respondents according to availability of farm labour

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Increased	25	41.67	12	20.00	37	30.83
Decreased	44	73.33	35	58.34	79	65.83
Stayed constant	00	0.00	00	0.00	00	0.00
Cannot say any thing	00	0.00	04	6.67	04	3.34
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.1.22 Preparedness to act

It is operationally defined as action / readiness of an individual to change something in his / her behaviour to overcome the effect of climate change. Table 4.22 (a, b & c) clearly indicates that about 73 percent of the respondent were ready to implement any new adaptation and mitigation activities if initiated by the government

and also about 83 percent of the respondents were ready to change something in their behaviour to overcome climate change. About 61percent of the farmers were ready to pay (in cash money) for any adaptation measure. Prasad (2010) also found that peoples of Almora district of Uttarakhand were agreed to contribute to the adaptation activities, upto Rs.200/.

Table 4.22(a) : Distribution of respondents according to their preparedness to act

"Are you ready to implement any new adaptation/mitigation activity if initiated by government?"

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	40	66.67	48	80	88	73.33
No	00	0.00	00	00	00	00
Cannot say any thing	20	33.33	12	20	32	26.67
Total	**60**	**100**	**60**	**100**	**120**	**100**

Table : 4.22(b) "Are you ready to change something in your behaviour?"

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	46	76.67	54	90	100	83.33
No	14	23.33	06	10	20	16.67
Total	**60**	**100**	**60**	**100**	**120**	**100**

Table 4.22(c) "Are you ready to pay (in cash money) for any adaptation measure?"

Response	MGPR (n=60) Frequency	WHR (n=60) %	Pooled (N=120) Frequency	MGPR (n=60) Frequency	WHR (n=60) %	Pooled (N=120) Frequency
Yes	28	46.67	46	76.67	74	61.67
No	32	53.33	14	23.33	46	38.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2 KNOWLEDGE AND PERCEPTION OF LIVESTOCK OWNERS ABOUT CLIMATE CHANGE

4.2.1 Livestock owners' knowledge about climate change

Knowledge refers to the information possession of the respondents. Operationally knowledge is defined here as the information possessed by the respondents about climate change. The knowledge about climate change is supposed to directly affect the efficiency of adaptation and mitigation activity by the respondent. Livestock owners' knowledge about climate change can be divided into general and specific category. General category include general knowledge about climate change i.e. awareness of the issue, belief that climate change exists and is happening, causes, source of information on climate change, etc. Specific categories include- Knowledge of the projected impacts of climate change on livestock, in general. Knowledge about impact of climate change on livestock production, reproduction, health, feed and fodder resources and water resources, in particular.

4.2.1.1 General knowledge of livestock owners about climate change:

4.2.1.1.1 Climate change exists and is happening

It can be observed from table 4.23 that 97.5 percent of the respondents believed that climate change is happening. Only 2.5 percent respondents told that they cannot say anything about climate change**.** People of Western Himalayan region appear more sensitive to climate change than those of Middle Gangetic plain region. Chaudhary and Bawa (2011) also concluded that people at high altitudes are more sensitive to climate change than those at low altitudes. Rawat (2010) stated that 100percent population in the villages of Kunjapuri Hills (Garhwal), who had little knowledge about

environmental awareness, suggested that the climate was indeed changing; the temperatures were rising and indicated changes in rainfall and snow fall patterns. Over 81percent of Alaskans were convinced that global warming is happening (Leiserowitz, A., & Craciun, J., 2006).

Table 4.23 Distribution of respondent according to their conviction in climate change

"Do you think that climate change is happening (Has the Climate changed)?"

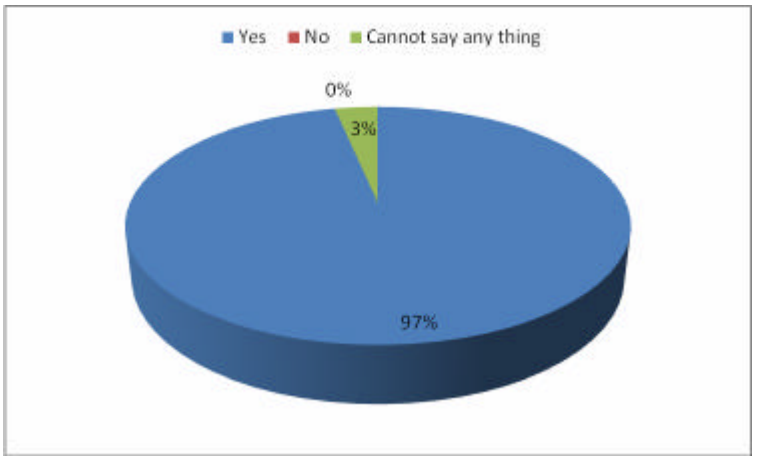
Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	58	96.67	59	98.33	117	97.50
No	00	0.00	00	0.00	00	0.00
Cannot say any thing	02	3.33	01	1.67	03	2.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.1.2 Extent of surety about climate change

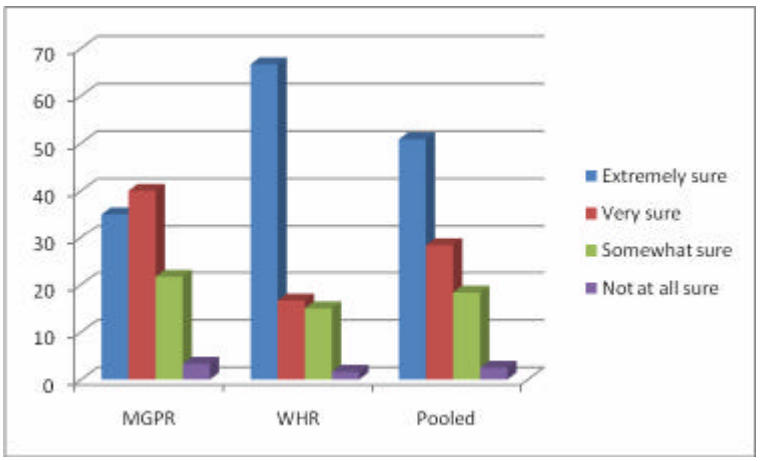
Table 4.24 Distribution of respondents according to their extent of surety about climate change

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Extremely sure	21	35.00	40	66.67	61	50.84
Very sure	24	40.00	10	16.66	34	28.33
Somewhat sure	13	21.67	9	15.00	22	18.33
Not at all sure	2	3.33	1	1.66	3	2.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

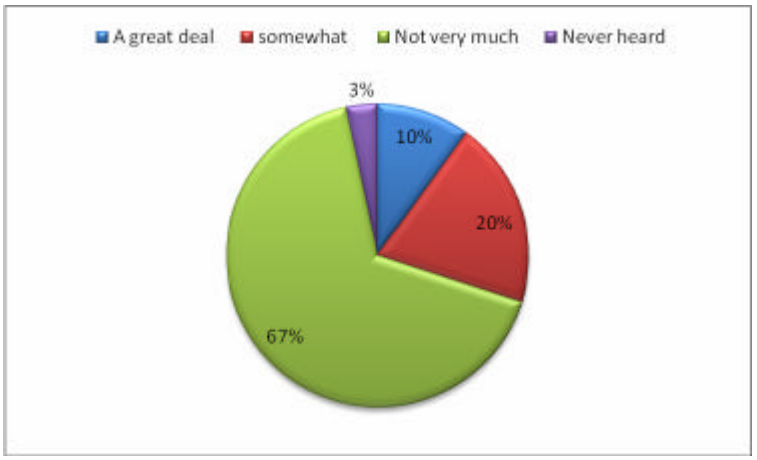
When I asked a question "how sure you are that climate change is happening?"About 51 percent respondent told extremely sure followed by 28 percent very sure and 18 percent somewhat sure. Only 2.5 percent respondents were not at all sure about climate change. There is a worldwide accord that Climate change



Distribution of respondent according to their conviction in climate change



Distribution of respondents according to their extent of surety about climate change



Distribution of respondents according to their familiarity about climate change word

is a real, rapidly advancing and widespread threat facing humankind this century. Scientists have presented evidence and tested models to substantiate this truly alarming fact (Chaudhary and Aryal, 2009).

4.2.1.1.3 Familiarity about climate change

It can be concluded from above table that majority of the respondents (61%) had not much heard or read about global warming or climate change followed by 21.66 percent somewhat and 15 percent a great deal. Only 2.5 percent told that they never heard about climate change. Sharma (2010) also concluded that majorit of farmers (85%) of Kinnaur (H.P.) were aware about changes in climate.

Table 4.25 : Distribution of respondents according to their familiarity about climate change word

"How much have you heard or read about global warming or climate change?"

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
A great deal	6	10.00	12	20.00	18	15.00
Some	12	20.00	14	23.33	26	21.67
Not very much	40	66.66	33	55.00	73	60.83
Never heard	02	3.33	01	1.66	3	2.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

Scottish Environmental Attitudes and Behaviours Survey (2008) reported that around half of respondents to know a great deal (5%) or a fair amount (43%) about climate change, while two fifths (40%) said they did not know very much and 10% said that they had heard of climate change but knew nothing about it. Only 1% of respondents in Scotland said that they had never heard of climate change.

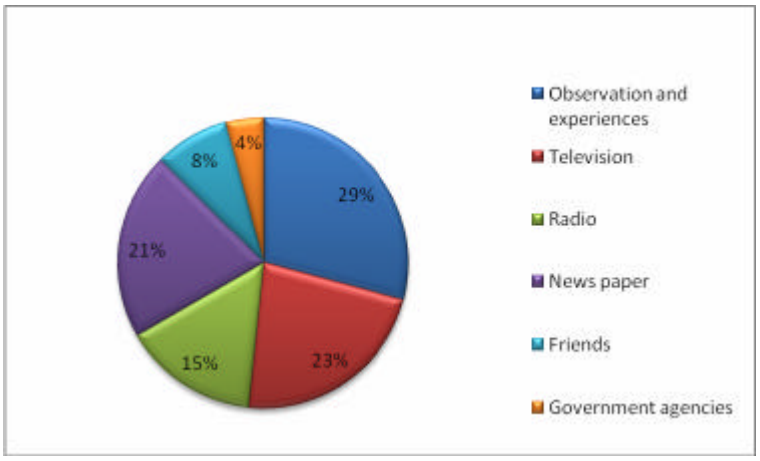
4.2.1.1.4 Source of information about climate change

According to data furnished in table 4.26 it can be observed that about 29% of the respondents got information on climate change from observations and experience followed by 22.5 percent from television, 20.83 percent from news paper and 15 percent from radio.

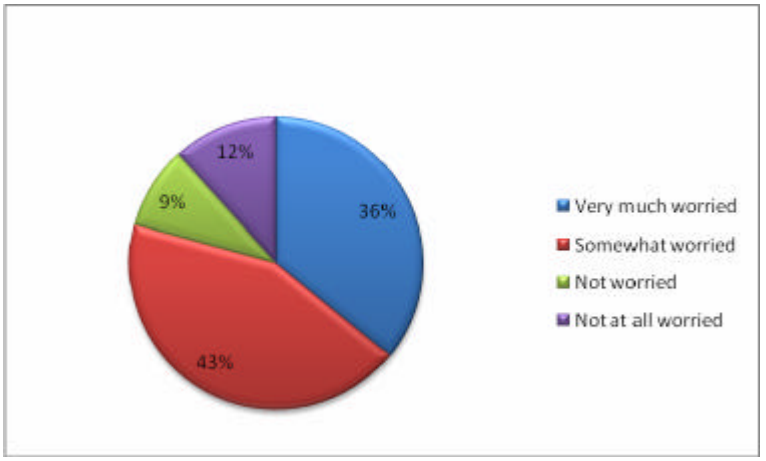
Farming community members did not have adequate information on climate variability and change. The limited information accessible to communities was through the television, local radio and news paper in the form of daily weather forecast. The information was found to be inadequate and of a very short term remedy. The feeling of the communities was that weather forecast should provide medium to long-term information. The weather prediction focused on major towns, and was of less relevance to many communities in rural areas.

Table 4.26 : Distribution of respondents according to their sources of information about climate change

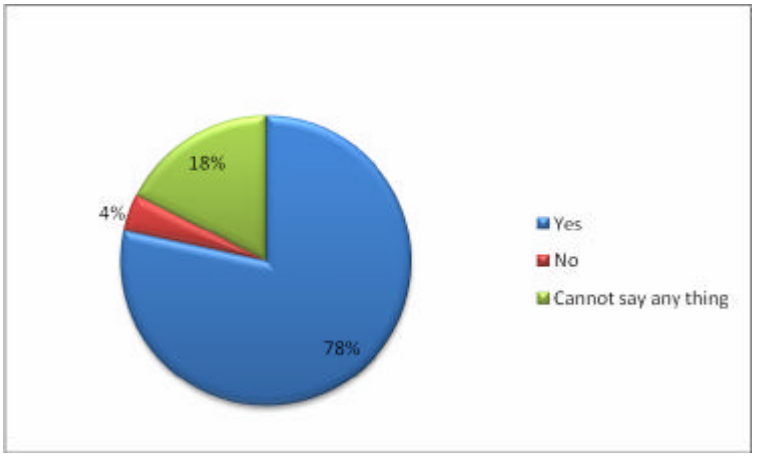
Source	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Observation and experiences	15	25.00	20	33.33	35	29.16
Television	12	20.00	15	25.00	27	22.50
Radio	10	16.67	8	13.33	18	15.00
News paper	15	25.00	10	16.67	25	20.84
Friends	8	13.33	2	3.33	10	8.33
Government agencies	00	0.00	5	8.33	5	4.16
Specialist publication/ academic journals	00	0.00	00	0.00	00	0.00
Internet	00	0.00	00	0.00	00	0.00
School/collage / university	00	0.00	00	0.00	00	0.00
Total	**60**	**100**	**60**	**100**	**120**	**100**



Distribution of respondents according to their sources of information about climate change



Distribution of respondents according to their anxiousness about climate change



Distribution of respondents according to their knowledge about effects of climate change on agriculture and animal husbandry

According to data furnished in table 4.26 the utilization of other sources like Government agencies, friends, etc are very low. In the US, television has been identified as the primary source of knowledge about climate change for the general public (Wilson, 1995, cited in Wilson, 2000).

4.2.1.1.5 Causes of climate change

Table 4.27 shows that majority of respondents (52.5 percent) were believed that climate change was caused by both human activity and natural changes followed by 21.5 percent due to natural changes. Only 17.5 percent of respondents believed that it is caused by human activity. It was very interesting to note down that about 8.33 percent respondents were believed that occurrence of adverse climatic condition depend on God's will.

Table 4.27 : Distribution of respondents according to their perceived cause of climate change.

Parameter	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Human activity	15	25.00	11	18.33	26	21.66
Natural changes	6	10.00	15	25.00	21	17.50
Both human activity and natural changes	33	55.00	30	50.00	63	52.50
God's will	6	10.00	4	6.66	10	8.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.1.6 Anxiousness about climate change

From the table 4.28 it can be easily concluded that about 43 percent respondent were somewhat worried about climate change followed by about 36 percent very worried and 11.66 percent not at all worried. Only 9.16 percent respondents told that they were not very worried about climate change.

Table 4.28 : Distribution of respondents according to their anxiousness bout climate change.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Very worried	18	30.00	25	41.66	43	35.83
Somewhat worried	30	50.00	22	36.66	52	43.33
Not very worried	3	5.00	8	13.33	11	9.16
Not at all worried	9	15.00	5	8.33	14	11.66
Total	**60**	**100**	**60**	**100**	**120**	**100**

Globe Scan (2000) reported that majorities in each country (34) said that climate change was a somewhat to very serious problem. It is interesting to note that many developing countries viewed this global risk as more serious than most developed countries.

4.2.1.1.7 Knowledge about gas produces by the burning of fossils fuel

When I asked a question "which gas is produce by the burning of fossil fuels?" About 54 percent respondent told that carbon dioxide (not clearly carbon dioxide, mostly told that carbon). It was very interesting to note down that about 40 percent respondents were told that they do not know which gas will produce on burning of fossils fuel.

Table 4.28: Distribution of respondents according to their knowledge about gas produced by the burning of fossil fuels.

Gases	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Carbon dioxide	27	45.00	38	63.33	65	54.17
Carbon mono oxide	00	0.00	00	0.00	00	0.00
Both CO_2 & CO	03	5.00	04	6.66	07	5.83
Don't know	30	50.00	18	30.00	48	40.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.1.8 Knowledge about adaptation qualities of indigenous breeds:

When I asked a question "do you know that indigenous livestock breeds are better survive during adverse climatic conditions? Majority of respondent (73 %) told that "yes" whereas about 27 percent respondents were told that they "cannot say anything" about this statement.

Table 4.29 : Distribution of respondents according to their knowledge about adaptation qualities of indigenous breeds.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	42	70.00	46	76.67	88	73.33
No	00	0.00	00	0.00	00	0.00
Cannot say any thing	18	30.00	14	23.33	32	26.67
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.1.9 Knowledge about effects of climate change on agriculture and animal husbandry

When I asked a question "do you know that climate change affects agriculture and animal husbandry?" Majority of respondents (88 percent) replied that "yes" whereas 7.5 percent were told that they "cannot say anything" about effect of climate change on farming practices. Only 4.16 percent respondents told that "no", it means they were not agree with the statement. Sharma *et al.* (2010) also concluded that majority of the farmers (94.59%) of Bhilwara district (Rajasthan) had knowledge about reduction in crop yield due to climate change.

Table 4.30 : Distribution of respondents according to their knowledge about effects of climate change on agriculture and animal husbandry.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	45	75.00	49	83.67	94	78.33
No	3	5.00	2	3.33	5	4.17
Cannot say any thing	12	20.00	9	15.00	21	17.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.2 Knowledge about impact of climate change on livestock production

Livestock sector both contributes to and is affected by climate change. Climate change affects livestock both directly and indirectly. Upadhaya (2010) reported that Uttar Pradesh had high temperature humidity index (THI), the largest producer of milk in the country, lose 25.4 million tonnes a year, Tamil Nadu was losing 23.8 million tonnes followed by Rajasthan, Bihar, Gujarat, Andhra Pradesh and Haryana.

4.2.1.2.1 Milk production

Majority of respondents (56.66%) told that climate change had negative impact on milk production whereas 31.66 percent respondents told that climate change had no impact on milk production. Only 6.66 percent respondents told that climate change had positive impact on milk production while 5 percent respondents did not give any response. Du *et al.* (2004) observed increases in animal production related to warming in summer and annual temperature in Tibet. Shinde *et al*. (1990); Kulkarni *et al.* (1998); Mandal *et al.* (2002a) concluded that milk yield of crossbred cows in India (e.g., Karan Fries, Karan Swiss and other Holstein and Jersey crosses) to be negatively correlated with temperature-humidity index. According to Upadhaya (2010) the estimated annual loss at present due to heat stress among cattle and buffaloes at the all-India level is 1.8 million tonnes, which is nearly two per cent of the total milk production in the country, amounting to a whopping over Rs 2,661 crore. Maurya (2010) also reported that milk yield was decreased due to increased environmental stress and lack of the required amount of the nutrient and dry matter for the dairy animals.

Table 4.31 : Distribution of respondents according to their knowledge about effect of climate change on milk production

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	36	60.00	32	53.33	68	56.66
Increased	3	5.00	5	8.33	8	6.66
Stayed constant	18	30.00	20	33.33	38	31.66
Do not know	3	5.00	3	5.00	6	5.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.2.2 Effect of climate change on lactation length

Majority of respondents (58.33%) told that climate change had negative impact on lactation length whereas 31.66 percent respondents told that climate change had no impact on lactation length. Only 10 percent respondents did not give any response. Maurya (2010) found significant change in average lactation length yield of dairy animals due to the effect of draught.

Table 4.32 : Distribution of respondents according to their knowledge about effect of climate change on lactation length

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	33	55.00	37	61.66	70	58.33
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	18	30.00	20	33.33	38	31.66
Do not know	9	15.00	3	5.00	12	10.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.2.3 Effect of climate change on dry period

Majority of respondents (50.83%) told that climate change had positive impact on dry period whereas 33.33 percent respondents told that climate change had no impact on dry period. About 8.33 percent respondents did not give any response about effect of climate

change on dry period and about 7.5 percent respondents perceived decreased dry period due to climate change. Maurya (2010) concluded that there were increase in the length of service period and dry period of all dairy animals from normal during drought.

Table 4.33 : Distribution of respondents according to their knowledge about effect of climate change on dry period

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	09	15.00	00	0.00	09	7.50
Increased	27	45.00	34	56.66	61	50.83
Stayed constant	18	30.00	22	36.66	40	33.33
Do not know	6	10.00	4	6.66	10	8.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.2.4 Effect of climate change on productive life of livestock

Majority of respondents (69.16%) told that climate change had no impact on productive life of their animals whereas 22.5 percent respondents told that climate change had negative impact on productive life. About 8.33 percent respondents did not give any response about effect of climate change on productive life of livestock

Table 4.34: Distribution of respondents according to their knowledge about effect of climate change on productive life of livestock

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decrease	12	20.00	15	25.00	27	22.50
Increase	00	0.00	00	0.00	00	0.00
Stayed constant	42	70.00	41	68.33	83	69.16
Do not know	6	10.00	4	6.66	10	8.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.3 Knowledge about impact of climate change on reproductive performance of livestock

Heat stress has detrimental effects on the reproduction of livestock, although Indian livestock are well adapted morphological and anatomical to hot and humid climate. Given the spatial and seasonal variations in the expected temperature increase, some positive impacts can also be associated with climate change, since a moderate increase in temperature in high altitudes (hilly region) or winter months may decrease the maintenance requirement of animals.

4.2.1.3.1 Effect on length and intensity of the oestrus period

Majority of respondents (59.16%) told that there were decreased in length and intensity of oestrous period of their animals whereas about 30 percent of the respondents did not give any response. Oestrous behaviour was less intense during adverse climatic condition. Maurya (2010) also reported that the length and intensity of oestrous period of dairy animal was decreased during draught.

Table 4.35: Distribution of respondents according to their knowledge about effect of climate change on length and intensity of the oestrus period

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	40	66.66	31	51.67	71	59.17
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	00	0.00	13	21.67	13	10.83
Do not know	20	33.33	16	26.66	36	30.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.3.2 Effect on conception rate

Majority of respondents (57.5%) told that there were decreased in conception rate of their animals whereas about 31 percent respondents told that it stayed constant. Many farmers told that there were increased cases of repeat breeding in their animals.

During adverse climatic condition dairy animals are unable to conceive, especially buffaloes those are very sensitive to increased temperature. Upadhyay *et al, (*2007) stated that thermal stress on Indian Livestock particularly cattle and buffaloes has been reported to decrease oestrus expression and conception rate.

Table 4.36 Distribution of respondents according to their knowledge about effect of climate change on conception rate of dairy animals

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	36	60.00	33	55.00	69	57.50
Increased	00	00.00	00	0.00	00	0.00
Stayed constant	16	13.33	21	35.00	37	30.83
Do not know	08	0.00	06	10.00	14	11.66
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.3.3 Effect of climate change on parturition interval

When I asked a question "have you noticed that any effect of climate change on parturition interval?" Majority of respondents (52.5 %) replied that "yes" followed by 35 percent were told that they "cannot say anything". Only 12.50 percent respondents told that "no". Parturition interval is the period between parturition which is affected by service period. Adverse climatic conditions leads to anoestrous and lowing down the rate of conception resulted in increase service period and ultimately parturient interval.

Table 4.37: Distribution of respondents according to their knowledge about effect of climate change on parturition interval of dairy animals.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	32	53.33	31	51.67	63	52.50
No	6	10.00	9	15.00	15	12.50
Cannot say any thing	22	36.67	20	33.33	42	35.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.4 Knowledge about impact of climate change on livestock health:

Animal health may be affected by climate change in four ways: heat-related diseases and stress, extreme weather events, adaptation of animal production systems to new environments, and emergence or re-emergence of diseases, especially vector-borne diseases. Climate may have a direct or indirect influence on the susceptibility of animals to disease. For example, exposure to intense cold, draught, excessive humidity or heat may predispose livestock to many diseases.

4.2.1.4.1 Effect of climate change on livestock disease incidences

When I asked a question "have you noticed that any effect of climate change on livestock disease incidences?" Majority of respondents (60.83 %) replied that yes and it increased followed by 24.16 percent were told that "no". Only 15 percent respondents told that they "cannot say anything" about effect of climate change on incidences of animal diseases. Adverse climatic conditions creates a lot of stress on livestock and make them lean, thin and weak, thus they become more susceptible to various diseases. Alterations of temperature and precipitation regimes may result in a spread of disease and parasite into new regions or produce an increase in the incidences of diseases (Stem *et al.*, 1989).

Table 4.38: Distribution of respondents according to their knowledge about effect of climate change on livestock disease incidences

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	39	65.00	34	56.66	73	60.83
No	12	20.00	17	28.33	29	24.17
Cannot say any thing	9	15.00	9	15.00	18	15.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.4.2 Effect on incidence of Mastitis and Foot and Mouth Disease (FMD)

Majority of respondents (65%) told that there were increased incidences of mastitis and FMD whereas about 20.83 percent respondents told that it stayed constant. Only 8.33 percent respondents told that they do not know about occurrence of specific disease in livestock due to climate change. Singh *et al.* (1996) reported that higher incidence of clinical mastitis in dairy animals during hot and humid weather due to increased heat stress and greater fly population associated with-humid conditions. According to Ramarao (1988) research studies from India have found that meteorological parameters like temperature, humidity and rainfall explain 52 % and 84 % variations in the seasonality of Foot and Mouth (FMD) disease in cattle in hyper-endemic division of Andhra and meso-endemic region of Maharashtra states, respectively.

Table 4.39: Distribution of respondents according to their knowledge about effect of climate change on incidence of Mastitis and Foot and Mouth Disease (FMD)

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	06	10.00	4	3.33	10	8.34
Increased	43	71.67	35	58.34	78	65.00
Stayed constant	8	13.33	17	28.33	25	20.83
Do not know	3	5.00	4	3.33	7	5.83
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.4.3 Change in timing of occurrence of diseases

When I asked a question “have you noticed that any change in timing of occurrence of diseases?” Majority of respondents (59.16 %) replied that “yes” whereas 25.83 percent were told that “no”. Only 15 percent respondents told that they “cannot say anything”

about change in timing of diseases. Climate change is one of several 'global change' factors driving the emergence and spread of livestock diseases.

Table 4.40 : Distribution of respondents according to their knowledge about change in timing of occurrence of diseases

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	37	61.67	34	56.67	71	59.17
No	14	23.33	17	28.33	31	25.83
Cannot say any thing	9	15.00	9	15.00	18	15.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.4.4 Emergence of new diseases or re-emergence of diseases

When I asked a question "have you noticed that there is an emergence of new diseases or re-emergence of diseases?" Majority of respondents (54.16 %) replied that "yes" followed by 31.66 percent were told that "no". Only 14.16 percent respondents told that they "cannot say anything. Most of the respondents of western Himalayan region (Nainital) reported that increased cases of Heamaturia whereas respondents of Middle Gangetic Plain region reported increased cases of Surra (A protozoan disease) in their animals. Easterling *et al.*, (2007) reported that the vector-borne pathogens which respond rapidly to climate changes are likely to be rapidly evolving promiscuous agents, transmitted by rapidly reproducing, highly mobile and habitat-generalist vectors. Examples of diseases influenced by climate change and variability includes: Rift Valley, Bluetongue, as well as tick-borne diseases. According to FAO (2008c) climate change will be especially important to vector- borne diseases and macro parasites of animal and may also result in new transmission modalities and change in host species. Change in species composition and interactions will augment the emergence of unexpected events, including the emergence of new disease and pests.

Table 4.41 Distribution of respondents according to their knowledge about emergence of new diseases or re-emergence of diseases

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	31	51.66	34	56.66	65	54.16
No	17	28.33	21	35.00	38	31.66
Cannot say any thing	12	20.00	5	8.33	17	14.16
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.4.5 Effect of climate change on incidences of parasitic infestation in livestock

Majority of respondents (83%) told that there were increased incidences of parasitic infestation in livestock whereas about 11.67 percent respondents told that it stayed constant. Only 1.16 percent respondents told that they do not know. Baylis and Githeko (2006) concluded that cycles of drought followed by heavy rainfall provide breeding sites for midge and mosquito vectors and are associated with outbreaks of vector-borne livestock disease. Changes in precipitation may also affect the range and distribution of arthropods vectors, and there is evidence of ticks expanding their range with decreasing rainfall (Trape *et al.*, 1996). Conversely, increased precipitation increases the abundance of snail hosts for livestock parasites. Parasitism has been considered as single most entity for morbidity in livestock in hill region (Jithendran 1998).

Table 4.42 : Distribution of respondents according to their knowledge about effect of climate change on incidences of parasitic infestation in livestock

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	02	3.33	00	0.00	02	1.66
Increased	46	76.66	54	90.00	100	83.33
Stayed constant	10	16.66	04	6.66	14	11.67
Do not know	02	3.33	02	3.33	4	3.33
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.5 Knowledge about impact of climate change on feed and fodder

Besides the direct effects of climate change on animal health and animal production, there are profound indirect effects as well, which include climatic influences on quantity and quality of feed and fodder resources such as pastures, parasites (Seo and Mendelsohn 2006a). Dinar *et al.* (1998) concluded that the predicted negative impact of climate change on Indian agriculture would adversely affect livestock production in the country and further limit the possibility of rearing the animals economically.

4.2.1.5.1 Feed and fodder resource

When I asked a question "Do you know that due to climatic variability feed and fodder resources are decreasing?" Majority of respondents (79.16 %) replied that "yes" followed by 17.5 percent were told that "no". Only 2.5 percent respondents told that they "cannot say anything" about effect of climate change on feed and fodder.

Table 4.43: Distribution of respondents according to their knowledge about decreasing feed and fodder resources due to climate variability.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	47	78.33	48	80.00	95	79.16
No	4	6.66	00	0.00	4	3.33
Cannot say any thing	9	15.00	12	20.00	21	17.50
Total	**60**	**100**	**60**	**100**	**120**	**100**

Research suggests that changes in climate would affect the quality and quantity of forage produced (Topp and Doyle, 1996a). In India, the demand for fodder greatly outpaces the supply, leaving million of emaciated, unproductive cattle.

4.2.1.5.2 Effect of climate change on dry fodder

When I asked a question "do you know that due to climatic variability there is shortage of dry fodder?" Majority of respondents (95 percent) replied that "yes". Only 5 percent respondents told that they "cannot say anything about shortage of fodder.

Table 4.44: Distribution of respondents according to their knowledge about effects of climate change on dry fodder

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Yes	58	96.66	56	93.33	114	95.00
No	00	0.00	00	0.00	00	0.00
Cannot say any thing	2	3.33	4	6.66	6	5.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.5.3 Effect of climate change on pasture land, self grown fodder / grasses and fodder trees

When I asked a question "what type of effect you perceived on pasture land, self grown fodder crop/grasses and fodder trees?" Respondents gave very mixed answers.

4.2.1.5.3.1 Pasture lands

Majority of respondents (95.83 %) replied that there were decreased areas of pasture lands over a period of time. Only 4.16 percent respondents told that "stayed constant".

4.2.1.5.3.2 Self grown fodder /grasses

Majority of respondents (95.83 %) replied that there was decreased quantity of self grown fodder crops/grasses followed by 3.33 percent respondents told that "stayed constant". Only about 1 percent respondents told that they "do not know" much about self grown fodder/grasses.

Table 4.45: Distribution of respondents according to their knowledge about effects of climate change on pasture land, self grown fodder / grasses and fodder trees

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Pasture lands						
Increased	00	0.00	00	0.00	00	0.00
Decreased	60	100.00	55	91.66	115	95.83
Stayed constant	00	0.00	5	8.33	5	4.16
Do not know	00	0.00	00	0.00	00	0.00
Self grown fodder /grasses						
Increased	00	0.00	00	0.00	00	0.00
Decreased	56	93.33	59	98.33	115	95.83
Stayed constant	4	6.66	00	0.00	4	3.33
Do not know	00	0.00	01	1.66	1	0.83
Availability and growth of fodder trees						
Increased	00	0.00	00	0.00	00	0.00
Decreased	00	0.00	52	86.66	52	43.33
Stayed constant	00	0.00	8	13.33	08	6.66
Do not know	60	100	00	0.00	60	50.00

4.2.1.5.3.3 Availability and growth of fodder tree

Cent per cent respondents of Middle Gangetic plain region told that they “do not know” whereas majority of the respondents (86.66 %) of Western Himalayan region told that there was decreased in availability and growth of fodder trees followed by 13.33 percent told that it stayed constant.

Pastures and fodder crops are vulnerable to the climate variability, particularly increased variability of precipitation; seasonal water availability and chronically low soil-nutrient availability, which appear to be the most limiting factors for the fodder crops in India (Somvanshi *et al.*, 2010).

4.2.1.6 Knowledge about impact of climate change on water resources

Water scarcity is increasing at an accelerated pace and affects between 1 and 2 billion people. Climate change will have a substantial effect on global water availability in the future. Not only will this affect livestock drinking water sources, but it will also have a bearing on livestock feed production systems and pasture yield (Thornton *et al*., 2008).

4.2.1.6.1 Effect of climate change on water resources

When I asked a question "Have you noticed that any effect of climate change on water resources?" Majority of respondents (95 %) replied that there were decreased water resources followed by 3.33 percent respondents told that "stayed constant". Only about 1.67 percent respondents told that they "do not know" it increased or decreased.

Table 4.46: Distribution of respondents according to their knowledge about effects of climate change on water resources

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	58	96.66	56	93.33	114	95.00
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	00	0.00	04	6.66	4	3.33
Do not know	02	3.33	00	0.00	2	1.67
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.6.2 Effect on underground water level

Majority of respondents (82 %) replied that there were deplete ground water level whereas 16.67 percent respondents told that "stayed constant". Only about 1.66 percent respondents told that the "do not know" about water level. Prasad (2010) also found that depletion of ground water level in Uttarakhand.

Table 4.47 : Distribution of respondents according to their knowledge about effects of climate change on underground water level.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Depleted	48	80.00	50	83.34	98	81.67
Raised	00	0.00	00	0.00	00	0.00
Stayed constant	12	20.00	08	13.33	20	16.67
Do not know	00	0.00	02	3.33	2	1.66
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.6.3 Effect on availability of water for irrigation

About 69 percent respondents told that there was decreased availability of water for irrigation whereas about 16 percent respondents told that it "stayed constant". Only 15 percent respondents told that they "do not know" about status of irrigation water. In general irrigation water resources were deceased in all agro-climatic zones.

Table 4.48 : Distribution of respondents according to their knowledge about effects of climate change on availability of water for irrigation.

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Reduced	40	66.66	43	71.67	83	69.17
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	8	13.33	11	18.33	19	15.83
Do not know	12	20.00	06	5.00	18	15.00
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.1.6.4 Effect on availability of ponds and other natural water resources for livestock

Majority of respondents (77.5 %) replied that there was decreased number of natural water resources for livestock followed by 15.83 percent respondents told that it stayed constant. Only about 6.66 percent respondents told that they do not know. In

case of Western Himalayan region main source of water for human as well as livestock are natural spring which are running round the year but in recent years farmers perceived that more than 50% of natural springs became dry or running only for few months of rainy season

Table 4.49 : Distribution of respondents according to their knowledge about effects of climate change on availability of natural water resources for livestock

Response	MGPR (n=60)		WHR (n=60)		Pooled (N=120)	
	Frequency	%	Frequency	%	Frequency	%
Decreased	51	85.00	42	70.00	93	77.5
Increased	00	0.00	00	0.00	00	0.00
Stayed constant	09	15.00	10	16.66	19	15.83
Do not know	00	0.00	08	13.33	8	6.66
Total	**60**	**100**	**60**	**100**	**120**	**100**

4.2.2 Livestock owners' perception about climate change phenomenon

Rural people may not understand the science of climate change but they rightly observe and feel its effects. Livestock farming communities' perceptions of climate change was constructed by the relationships that individuals share with their environment, the nature in which communities were structured, and the rate at which climate variables change over time. Perceptions played a crucial role in the ability of a community to adapt to climate change.

Climate change poses new and highly uncertain risks, chiefly in terms of changing rainfall. Recent research suggests that rainfall changes at the national level may be perceived differently at local scales either because of local variations or because rainfall records fail to capture key factors such as intensity or timing. Perceptions are affected by factors such as culture, knowledge and access to information.

Climate change perception helps the farmer to adjust his crop planting patterns to the forthcoming rains. Climate change perception is the means by which farmers seek to understand climate change phenomena in order to arrive at a better use of climate change resources and a more effective response to climate change hazards. The processes by which farmers arrived at these decisions include direct experience of the environment and indirect information from other people, science, and the mass media. They were mediated by own experience, observations and attitudes.

Individual's perception about climate change was measured by using the modified scale of Leiserowitz (2006).

According to data furnished in table 4.50 the following inferences can be drawn:

- The climate change is real has been strongly endorsed by about 33 percent and was agreed by 52.5 percent of the respondents. The statement obtained a mean score of 3.95 out of 5.
- About 70 percent of respondents were agreed that climate change was very urgent and serious problem; the mean score of the statement was 3.63.
- 99 percent (50% SA & 49% A) of respondents believed that there was significant change in weather pattern; the mean score of the statement was 4.51.
- About 72 percent (24% SA & 48% A) of respondent perceived an increased environmental temperature; the mean score of the statement was 3.64.
- About 85 percent of respondents perceived that an increased extreme rainfall events but overall decreased rainfall; the mean score of the statement was 3.75.

Table 4.50: Distribution of respondents according to their perception about climate change

Statements	Pooled (N=120)						
	SA (%)	A (%)	UD (%)	D (%)	SD (%)	TS	Mean score
Climate change is real	33.33	52.50	0.00	4.17	10.00	474	3.95
Climate Change is urgent &serious problem	26.67	43.33	5.83	15.00	9.17	436	3.63
Significant change in weather pattern	50.83	49.17	0.00	0.00	0.00	541	4.51
Increase environmental temperature	24.17	48.33	0.00	22.50	5.00	437	3.64
Decrease precipitation	55.00	30.00	0.00	10.00	5.00	450	4.2
Change in timing of precipitation	70.83	26.67	2.50	0.00	0.00	562	4.68
Increase frequency of extreme weather conditions.	72.50	27.50	0.00	0.00	0.00	567	4.73
Change in season length	87.50	12.50	0.00	0.00	0.00	585	4.88
Climate Change is nearly a hoax	8.33	17.50	0.00	40.00	34.20	271	2.26
Climate Change is not a problem	6.67	15.83	0.00	53.33	24.20	273	2.28
Climate Change is more beneficial than harmful	0.00	0.00	7.50	24.17	68.33	167	1.39
No role of human in Climate Change	0.00	0.00	0.00	12.50	87.50	135	1.13
No effect of Climate Change on Ag	0.00	4.17	0.00	11.67	84.20	149	1.24
No effect of Climate Change on AH	3.34	8.34	4.18	55.84	28.30	243	2.03
No effect of Climate Change on water resources	0.00	4.17	0.00	75.00	20.80	225	1.88
No effect of climate change on biodiversity	0.00	0.00	0.00	50.83	49.20	181	**1.51**

SA-strongly agree-5, A-agree-4, UD- undecided-3, D-disagree-2, SD- strongly disagree-1, TS- total score

- About 96 percent of respondents perceived that change in timing of precipitation the mean score of this statement is 4.68 out of 5.
- Cent per cent respondents perceived an increased frequency of extreme weather conditions the mean score of the statement was 4.73.
- Cent per cent respondents perceived that change in season length; the mean score of the sentence was 4.88
- About 74 percent (40%D&34%SD) of respondents was disagreed that climate change is merely a hoax; the mean score of this statement is 2.26.
- About 77 percent of respondents was disagreed that climate change is not a problem; the mean score of this statement was 2.28.
- About 92 percent of respondents was disagreed that climate change is more beneficial than harmful; the mean score of this statement was 1.39.
- About 99 percent of respondents were disagreed that no roles of human in climate change; the mean score of this statement was 1.13.
- About 95 percent of respondents were disagreed that no effects of climate change on agriculture; the mean score of this statement was 1.24.
- About 83 percent of respondents were disagreed that no effects of climate change on animal husbandry; the mean score of this statement was 2.03.
- About 95 percent of respondents were disagreed that no effects of climate change on water resources; the mean score of this statement was 1.88.
- About 99 percent of respondents were disagreed that no effects of climate change on biodiversity; the mean score of this statement was 1.51.

The mean score of the positive statements to climate change phenomenon were fairly high, whereas, mean score of negative statements were very low indicating that respondents did not affirmed them positively. These findings revealed that people realized the change in climate. However, awareness programme needs to be launched for increasing knowledge among people in order to promote practical adaptation activities. Thus, it can be concluded that in general the respondents perceived the climate change phenomenon.

4.3 CONTRASTING OF LIVESTOCK OWNERS' PERCEPTION TO SECONDARY DATA ON CLIMATE VARIABILITY

Livestock owners' perceptions towards climate change parameters

The perception of climate parameters was assessed at household level. Interviewed livestock owners were asked about their perception of long term changes in climate. Specifically livestock owners were asked "Have you noticed any long term changes in the average temperature, rainfall, snowfall, season length and extreme weather conditions in recent years?"

4.3.1 Livestock keeper's perceptions about environmental temperature

There was a perception that the temperature distribution has undergone a significant shift in addition to an overall increase in temperatures. The result shows that majority of farmers (71%) perceived an increased in average temperature and about 80 percent of the respondents also perceived that an increased in length of hot period over the last 20 years (Table 4.51). Majority of respondents told that hot month was shifted ahead; as people believe that the hottest period of the year is month of Jeth (15 May to 15 June), but not now.

Table 4.51: Distribution of respondents according to their perceptions towards climate change parameters

Parameter	Particulars	Increased	Decreased	Stayed constant	No answer
Temperature (N=120)	Annual	86(71)	19(15)	9(7)	6(5)
	Length of hot periods	97(80)	10(8)	8(7)	5(4)
Precipitation (N=120)	Annual	14(11)	102(85)	0(00)	4(3)
	Length of rainy season	5(4)	112(93)	0(00)	3(3)
	Erratic rainfall	107(89)	0(00)	6(5)	7(6)
Snow fall (N=60)	Annual	0(00)	60(100)	0(00)	0(00)
Season length(N=120)	Summer	116(97)	0(00)	0(00)	4(3)
	Winter	0(00)	116(97)	0(00)	4(3)
Extreme weather condition	Annual	111(92.5)	0(00)	9(7.5)	0(00)

Figure in bracket indicate percentage. Percentages are rounded to 0 decimals; hence, the sum is not always 100.

Indian Meteorological Department (IMD) maintains a well distributed network of more than 500 stations in the country. The salient findings of the IMD studies (IMD Annual Climate Summary, 2009, Tyagi and Goswami, 2009, Attri, 2006) were summarized as under.

Analysis of data for the period 1901-2009 suggested that annual mean temperature for the country as a whole had risen by 0.56 ^{0}C over the period. This warming was primarily due to rise in maximum temperature across the country. However, since 1990, minimum temperature is steadily rising and rate of its rise is slightly more than that of maximum temperature (IMD Annual Climate Summary, 2009). Warming trend over globe of the order of 0.74 ^{0}C has been reported by IPCC (2007).

The annual mean temperature for India was +0.91 ^{0}C above average, making the year 2009 the warmest year on record since 1901. This superceded the previous five warmest years, which have all occurred since the turn of the century, notably 2002(0.71), 2006(0.60), 2003(0.56), 2007(0.55), and 2004(0.51) (IMD, Annual climate summery, 2009)

Spatial pattern of trends in the mean annual temperature shows significant positive (increasing) trend over most parts of the country except over parts of Rajasthan, Gujarat and Bihar, where significant negative (decreasing) trends were observed (IMD Annual Climate Summary, 2009). Season wise, maximum rise in mean temperature was observed during the Post-monsoon season (0.77 ^{0}C) followed by winter season (0.70 ^{0}C), Pre monsoon season (0.64 ^{0}C) and Monsoon season (0.33 ^{0}C). During the winter season, since 1991,

rise in minimum temperature is appreciably higher than that of maximum temperature over northern plains. This may be due to pollution leading to frequent occurrences of fog.

Lal (2003) reported that temperatures in India have recently increased in two phases: the first half of the 20th century and the period since the mid 1970s. The average annual temperature during approximately quarter century between 1950 and 1975 exhibited no trend. The warming in India is concentrated in the post- monsoon and winter seasons and in the maximum daytime temperatures rather than night time minimum temperatures.

4.3.2 Livestock owners' perceptions about precipitation (rainfall, snowfall)

Majority of interviewees mentioned that due to climate change monsoon and precipitation patterns have changed, especially, winter and monsoon had experienced delays.

Majority of respondents (85%) perceived that an increased extreme rainfalls event but overall decreased average rainfall whereas about 93 percent of respondents told that there was decreased length of rainy season. About 89 percent of respondents reported that erratic rainfalls (Table 4.51). There was a shift reported in the distribution of rain across time. Most of the respondents said that monsoon rains were slightly displaced to the period beyond mid-August. Local perceptions further indicated that the incidence of early rainfall had increased, coinciding with a significant increase in the number of cloudy days during that period. GEAG (2010) also concluded that timing of rain has become very unpredictable; August-September was the usual period of the flood, today it is not.

Cent percent of the respondents perceived a definite reduction in snowfall over the last 20 years (Table 4.51). More specifically, most of the respondents said that; there were reductions in the intensity, changes in the timing and quicker melting of snowfall. Recollection of memorable events, such as the largest snowfall in a decade, was the most common method used to discuss reductions in the intensity of snowfall. Majority of the respondents felt that the timing of the snowfall had undergone a change. For them, the onset of early snow in December and January had occurred more infrequently over time and the period of snowfall now shifted to the months of February and March. These findings are in line with the report by the Indian Meteorological department. Vedwan and Rhoades (2001) also reported that Western Himalayas' people perceived a definite reduction in the intensity and changes in the timing of snowfall and rainfall over time.

The country as a whole, annual and monsoon rainfall for the period 1901-2009 do not show any significant trend. Similarly rainfall for the country as whole for the same period for individual monsoon months also does not show any significant trend. The alternating sequence of multi-decadal periods of thirty years having frequent droughts and flood years were observed in the all India monsoon rainfall data. The decades 1961-70, 1971-80 and 1981-90 were dry periods. The first decade (1991-2000) in the next 30 years period already experienced wet period (Tyagi and Goswami, 2009).

However, during the winter season, rainfall is decreasing in almost all the subdivisions except for the sub-divisions Himachal Pradesh, Jharkhand and Nagaland, Manipur, Mizoram & Tripura. Rainfall is decreasing over most parts of the central

India during the pre-monsoon season. However during the post-monsoon season, rainfall is increasing for almost all the sub-divisions except for the nine sub-divisions. The trend analyses of the time series of contribution of rainfall for each month towards the annual total rainfall for each year in percentages suggest that contribution of June and August rainfall exhibited significant increasing trends, while contribution of July rainfall exhibited decreasing trends.

There were 13 Excess monsoon years and 20 deficient monsoon years during the period 1901-2009. A year is said to be excess (deficient) monsoon year when the all India seasonal rainfall departure is more than 10% (less than -10%) (IMD 2010).

4.3.3 Livestock owners' perceptions about season length

Majority of the respondents (97 percent) felt that there was increased summer length (Table 4.51). It means shorten *Rabi* season than *kharif* season which leads to decreased production of Rabi season crops.

4.3.4 Livestock owners' perceptions about extreme weather events

Extreme weather includes weather phenomena that are at the extremes of the historical distribution, especially severe or unseasonal weather. The increase in phenomena such as draught, flood, cloudbursts and landslides was widely noted over time. Majority of respondents (92.5%) perceived an increased frequency of extreme weather conditions whereas about 7.5 percent respondents perceived no change in frequency of extreme weather conditions. According to Chaudhary and Bawa (2011) there is a widespread feeling that weather is getting warmer, the water sources are drying up, the

onset of summer and monsoon has advanced during last 10 years and there is less snow on mountains than before. Sen and Chander (2003) also reported that in recent times, the frequency and instability of landslides and the mass wasting have increased substantially in the Himalayan mountain belt. A large amount of the variability of rainfall is related to the occurrence of extreme rainfall events. Country's highest observed one day point rainfall (156.3 cm) and also world's highest 2-day point rainfall (249.3cm) occurred in Cherrapunji of northeast India in the year 1995 (IMD 2006).

Significant increasing trend was observed in the frequency of heavy rainfall events over the west coast (Sinha Ray & Srivastava, 2000). Most of the extreme rainfall indices have shown significant positive trends over the west coast and northwestern parts of Peninsula. However, two hill stations considered (Shimla and Mahabaleshwar) have shown decreasing trend in some of the extreme rainfall indices (Joshi & Rajeevan, 2006).

Increase in heavy and very heavy rainfall events and decrease in low and moderate rainfall events in India have been reported by Goswami *et al.* (2006). Rao *et al.* (2010) have assessed the role of Southern Tropical Indian Ocean warming on unusual central Indian drought of summer monsoon – 2008.

India is among the top 10 countries most affected by extreme weather changes linked to climate change, according to the Global Climate Risk Index 2010. According to the index released by NGO Germanwatch, 3,255 people in India died annually because of extreme weather changes. India has witnessed 325 "extreme weather" events in the last 18 years, the report released said, urging rich countries to take deeper emission cuts.

4.4 LIVESTOCK MANAGEMENT STRATEGY ADOPTED BY FARMERS UNDER CLIMATIC CHANGE SCENARIO

Over centuries, livestock producers have traditionally adapted to climatic changes by building on their in-depth knowledge of the environment in which they live. Farmers own perception and local traditional knowledge help them in evolving measures and technique to deal with situations arising due to climatic vagaries. These measures and techniques are locale specific, require no external help and are inherently scientific. Documentation of such practices and techniques, farmer to farmer dissemination and sharing such innovative approaches at large platforms have helped in influencing research agenda of academic institutions and setting the priorities.

Climate change consequences would substantially add to existing vulnerabilities of poor and indigenous grassroot communities in India who are inadequately prepared for adapting to unforeseen changes in their economic, social and environmental context. Evidence of these vulnerabilities is already visible in the Bundelkhand region of Uttar Pradesh, India, which has faced extreme weather events over the last ten years and witnessed a decrease in food grain production. Likewise, repeated flood have adversely affected marginalised agricultural communities of the Indo-Gangetic belt, especially in Eastern Uttar Pradesh (Gorakhpur, Deoria, Bahraich, Maharajganj, etc).

A number of questions were asked to assess the strategies adopted by the local communities to cope with climate change.

The respondents reported a diversity of coping strategies that included both modern and traditional methods. From table 4.52 following inferences can be easily drawn: Majority of the farmers

Table 4.52 : Distribution of livestock owners according to their coping strategy towards climate change

Strategy	MGPRN=60		WHRN=60		PooledN=120		Rank	References
	Yes	No	Yes	No	Yes*	No		
Change in livestock / herd composition (large animal vs. small animal) during adverse climatic conditions	21(35)	39(65)	32(53)	28(46)	53(44)	67(56)	X	Seo & Mendelsohn(2006b) Kurukulasuriya & Mendelsohn (2006; Kabubo-Mariara (2008),
Reduction in livestock number	10(16)	50(84)	36(60)	24(40)	46(38)	74(62)	XI	Batima (2006); Herrero *et al*. (2009);Clark (2008)
Replacement of exotic breeds to local breeds	3(5)	57(95)	9(15)	51(85)	12(10)	108(90)	XIV	Bradshaw *et al*. (2004); Nhemachena and Hassan (2007); Hoffmann, 2008
Keeping more livestock and reducing reliance on crops	22(36)	38(64)	36(60)	24(40)	58(48)	62(52)	IX	Kabubo-Mariara (2008); Maurya (2010)
Preservation of fodder	48(80)	12(20)	60(100)	00	108(90)	12(10)	I	Chatterjee *et. al.* (2005)
Crop diversification	30(50)	30(50)	48(80)	12 (20)	78(65)	42(35)	V	Chatterjee *et. al.* (2005)
New fodder crop variety / type	33(55)	27(45)	39(65)	21(35)	72(60)	48(40)	VI	Bradshaw *et. al*. (2004); Nhemachena and Hassan (2007)
Change planting dates	55(92)	5(8)	52(87)	8(13)	107(89)	13(11)	II	Bradshaw *et. al*. (2004); Nhemachena and Hassan (2007); Joshi (2010)
Provide bedding for livestock during extreme winter / cold	52(86)	08(14)	43(70)	17(29)	95(79)	25(21)	IV	Meena *et.al*. (2008)
Plantation fodder tree lines around animal shed / house to reduce effects of cold / heat waves	20(33)	40(67)	46(77)	14(23)	66(55)	54(45)	VII	Chan (1995); Valtorta *et al*., (1996)

Table 4.52 : Contd...

Strategy	MGPRN=60		WHRN=60		PooledN=120		Rank	References
	Yes	No	Yes	No	Yes*	No		
Selling of livestock in order to buy food	23(38)	37(62)	18(30)	42(70)	41(34)	79(66)	XII	Dirie and Mohammed (1999); Swaminathan(2009b); Manyatsi *et al.* (2010)
Migration along with livestock during adverse climatic conditions	43(72)	17(28)	21(35)	39(65)	64(53)	56(47)	VIII	Geevan *et. al.*(2003); Pathan(2009)
Livestock insurance	09(15)	51(85)	23(38)	37(62)	32(27)	88(73)	XIII	Dewan (1986); Swanson *et al.* (2008); Shanker Ravi.K.(2010)
Livestock farming to non- farming (Business)	10(16)	50(84)	00	60(100)	10(08)	110(92)	XV	Bradshaw *et al.*(2004); Kurukulasuriya and Mendelsohn (2006a); Maddison (2006); Nhemachena and Hassan(2007)
Rain water harvesting	02(3)	58(97)	04(7)	56(93)	6(5)	114(95)	XVI	Holger Hoff (2004), Tiwari *et al.* 2010)
Traditional Prayer	48(80)	12(20)	49(81)	11(9)	97(81)	23(19)	III	Alexander (2011); Manyatsi *et al.*(2010);

* multiple response; Figures in parentheses indicate percentage, Percentage are rounded to '0' decimal hence, the sum is not always 100.

(90%) preserve fodder crop in form of hay for adverse climatic condition; They also stored wheat straw, paddy straw, and crop residues to feed their animals in lean period; Majority of the respondents (89%) changed the planting dates; It was very interesting to note down that majority of farmers (81%) did traditional prayer to get rid of adverse climatic conditions; Majority of respondents (79%) told that they provide bedding for livestock during extreme winter/ cold to prevent them from cold stress; Majority of farmers (65%) were grown variety of crops (crop diversification) in their field, for e.g. vegetables, fruit, flower and other cash crop; Majority of farmers (60%) told that they sown new crop varieties which required less water(draught resistant), less time to mature(early maturing), pest resistant and well adopted for water logging area (flood resistant); Plantation fodder tree lines around animal shed/ house to reduce effects of cold/ heat waves was an important coping strategy adopted by most of the farmers (55%); Migration along with livestock was one of the coping strategies of many of the framers (53%) during adverse climatic conditions; about 48 percent of the respondents kept more livestock and reduced reliance on crops; Majority of the respondents (44%) told that they destock their large animals during adverse climatic conditions and keep smalls animal those are well survive in above said conditions, required less water and feed; About 38 percent of the respondents told that they destock their livestock during adverse climatic condition; About 34 percent of the respondents told that they sold their animals to fulfil their daily requirement (food, clothes, school fee etc.); Only about 27 percent of the respondents insured their livestock; About 10 percent respondents told that they replaced exotic breeds (Holstein Frisian, Jersey) to indigenous/local breeds (Sahiwal, Haryana, Red Sindhi, Tharparker etc.) which were

well adapted to native climatic conditions; Farmers told that local breeds required less water, resistant to many of the diseases and well survive in adverse climatic condition; About 8 percent of the respondents leaved livestock farming and start business/other occupation (carpentry, Tailor, etc.); About 5 percent of the respondent did rain water harvesting.

4.4.1 Other coping strategy adopted by farmers of MGPR

1. Provide cold water during hot and humid climate.
2. Provision of shade to reduce heat stress.(FAO, 2008)
3. Provide fresh air/ fan/cooler during extreme hot condition.
4. Kept their animal outside during night during summer.
5. Loose housing system.
6. Freed their animal during adverse climatic condition in search of feed and safe place.
7. Elevated animal house/shed/shelter.(Mukhopadhyay and Das ,1992, Chan 1995, Noelle O'Brien 2001)
8. Constructing "Manchans"(hanging bamboo platforms inside houses)

Coping strategies of farmers to various climate vagaries vary from household to households and region to region based existing support system and their indigenous knowledge.

4.4.2 Other coping strategy adopted by farmers of WHR

1. Provision of alaw (fire) in animal shed during extreme cold (Meena *et al.*, 2008).
2. Rotational lopping of vegetative biomass of fodder trees, shrubs, herbs and grasses.
3. To minimize landslide, they were started to conserve forest, promote plantation and safe landing of running water during the rainy period.

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Summery & Conclusions

This chapter deals with the summary of the major findings, conclusions, implications and recommendations as well as extension strategy and suggested area of future research.

5.1 SUMMARY

India is an agrarian country and livestock sector is an important part of it. It possesses the largest livestock population in the world (485 million), and accounts for the second largest number of cattle (199 million), largest number of buffaloes (105 million), second largest number of goats (140 million) and third largest number of sheep (71 million) (DHAD,2007).

According to Maplecroft Climate Change Vulnerability Index (2011) India is the world's most vulnerable country apart from Bangladesh. In India, 25 states out of 35 states and Union territories prone to various disaster except volcanic activity. Out of them flood and draught are most abundant and most frequent causing severe loss to economy every year.

Climate change affects livestock both directly and indirectly. The direct effects of climate change on livestock sector manifest in the form of decrease productive and reproductive performances, increases incidences of diseases, especially parasitic diseases. Besides the direct effects of climate change on animal production

and animal health, there are profound indirect effects as well, which include climatic influences on quantity and quality of feed and fodder resources, water resources, etc.

Livestock sector has a very important role to play in the economic progress of the country as it contributes over one-fourth (26%) to the agricultural GDP and provides employment to 18 million people in principal or subsidiary status. Responding to the challenge of climate change requires basic knowledge and perception of farmers about climate change to formulate an appropriate adaptation and mitigation options for the sector.

Improved understanding of livestock owners' knowledge and perceptions about climate change can contribute to inform scientific and policy discussions of climate change. Researcher need to know how the farmers are likely to respond to climate impacts, because those responses can attenuate or amplify the impacts. Policy makers need to know what the farming community wants, in order to design policies that will be supported or at least tolerated. The farming communities need to adapt to everyday changes in patterns of rainfalls, temperature, crops and livestock pests and diseases and also deal with the disasters when they occur. Therefore, while developing any strategies or formulating policies in respect of adaptation and mitigation to climate change, the interest of the farmers at grass-root level must be kept in the forefront. We will, therefore, require scientific knowledge to identify and implement strategies for climate change mitigation and adaptation. Indeed, climate proofing of ecological, economic and social infrastructure is definitely going to be a knowledge-intensive effort.

Under the circumstances discussed above their arise a need for a study which focuses on the knowledge and perception of livestock

owners in hilly as well as in plain region that would bring about the understanding of livestock owners experience of climate variability and responses made to overcome the impacts of climate change. With this perspective, the present study entitled "Knowledge and Perception of livestock owners on climate change" was conducted with the following objectives:

OBJECTIVES

- To study the personal, socio-economic and psychological characteristic of livestock owners.
- To understand the knowledge and perception of livestock owners towards climate variability
- To contrast livestock owners' perception by analyzing secondary data on climate variability
- To document livestock management strategy adopted by farmers under climatic change

The present study was conducted in two Agro-climatic zones namely Middle Gangetic plain region and Western Himalayan region of India. From Middle Gangetic plain region Uttar Pradesh state and from Western Himalayan region Uttarakhand state was selected purposively. From each selected states one district was selected randomly. Three blocks from each district and two villages from each selected block were selected randomly at an appropriate distance to cover the large and distinct area. From each selected village ten livestock owners was selected randomly to make 120 total respondents for the investigation.

Variables selected under the study were; age, education, family size, occupation, land holding, herd size, gross income, income from livestock sector, experience in livestock rearing, extension personnel

contact, mass media exposure, weather , climate, livestock rearing pattern, productive performance of dairy animals, reproductive performance of dairy animals, animal disease pattern, cropping pattern of fodder crop, insect pest and disease pattern of fodder crop, changes in community grazing land, availability of farm labour, preparedness to act, knowledge and perception about climate change. Semi structured interview schedule were used for the purpose of data collection. Besides primary data, some necessary secondary data were also collected. The data after collection, compiled, tabulated and analysed in view the objectives of the study. Frequency distribution, percentage, mean score and Cattle equivalent score etc. were computed by using Statistical Package for Social sciences (SPSS) software and Microsoft excel. Qualitative information such as farmers' experiences regarding climate change and adaptation measures taken on their farmland collected from farmers' interviews were analyzed manually, both by the researcher and in conjunction with other farmers, and interpreted to complement and supplement the quantitative information collected from household interviews.

MAJOR FINDINGS

Socio-economic and psychological characteristics of the respondents:

- Majority of livestock owners (52.5%) belonged to middle age group, followed by (33.33%) old age group and (14.16) young age group,79.16% had medium size family followed by large (13.33%). Majority of the respondents (34.16 %) were educated upto primary level and agriculture as their primary occupation (75.83%) followed by 9.16% as animal husbandry. Most of the respondents (76.66%) were marginal farmers, followed by small (20 %). Equal percentage (1.66) of respondents was found to be large and landless farmers.
- Most of the respondents (75 %) of Middle Gangetic plain region had small herd size while most of the respondents (45 %) of western Himalayan region had medium herd size.

- Majority of the respondents (58.33 %) amongst low income group (upto Rs.75000), followed by (27.5 percent) medium income group. Only 14.16 percent of the respondents belonged to high income group. In case of financial return majority of respondents (54.16 %) falls under the low financial return category (10-25 percent), followed by (31.66 percent) medium financial return category (26-40 percent). Only 14.16 percent of the respondents belonged to large financial return category (41-55 percent). Majority of the respondents (52.5 percent) belonged to low experience group (10-25 years), followed by (35 percent) medium experience group and 12.5 percent of the respondents had high experience.
- The extension personnel contacted with highest frequency in Middle Gangetic plain region was Veterinary officer (score 274), followed by Para veterinarian (score 206) whereas in Western Himalayan region, it was ICAR personnel (score 170), followed by Veterinary officer (score 132) and Livestock extension officer (score 132) and NGO's personnel (score 70).
- The mass media used with highest frequency in Middle Gangetic plain region was radio (score 174), followed by news paper (score 124) whereas in Western Himalayan region, it was television (score 147), followed by radio (score 118).
- Majority of the respondents (71.66 %) were perceived an increased environmental temperature. About 7.5 percent respondents felt that there were no changes in environmental temperature and 5 percent respondents told that they do not know about variations in temperature.
- About 85% of the respondents were perceived decreased precipitation. Only 3.3 percent respondents told that they do not know.
- Majority of respondent (83 %) perceived an unusual pattern of rainfall, snowfall, heat waves cold waves, changed wind pattern.

- Majority of respondents (58.33 %) perceived negative impact of climate change on productive performance of livestock whereas 27.5 percent were perceived no effect. Only 16.16 percent respondents cannot say anything.
- Majority of respondents (63.33 %) perceived negative impacts of climate change on reproductive performance of livestock whereas about 33percent were told that they "cannot say anything". Only 3.33 percent respondents perceived no effect of climate change on livestock.
- Majority of respondents (60.83 %) perceived an effect of climate change on livestock diseases whereas about 24 percent did not perceive any effect.
- Majority of the respondents (88.33 %) of Middle Gangetic plain region were grown berseem as major fodder crop in *Rabi* season while in *kharif* season Sorghum (46 percent) and Bajra (36 percent) was the major fodder crop. In both seasons majority of the respondents (63.33 %) of Western Himalayan Region used fodder tree leaves and grasses as fodder. It was very interesting to note that the farmers of Western Himalayan region never choff the fodder. Besides these farmers of Western Himalayan region purchased wheat straw from plain area and feed block from dairy cooperatives. It was also found that majority of the respondents (70.83%) perceived an increased insect pest and disease on crops whereas about 21 percent did not say anything.
- Majority of respondents (95 %) perceived decreased grazing land area and 95 percent of the respondents told that there were overgrazing on remaining pasture land. It was further concluded that Cent per cent of the respondents were perceived decreased pasture biomass.
- About 73 percent of the respondents were ready to implement any new adaptation and mitigation activities if initiated by the government and also about 83 percent of the respondents

were ready to change something in their behaviour to overcome climate change. About 61percent of the farmers were ready to pay (in cash money) for any adaptation measure.

Knowledge and perception of livestock owners about climate change

General knowledge of livestock owners about climate change:

- About 97.5 percent of the respondents believed that climate change is happening. Only 2.5 percent respondents told that they cannot say anything**.** People of Western Himalayan region appear more sensitive to climate change than those of Middle Gangetic plain region.
- About 51 percent respondent told that they were extremely sure that climate change is happening followed by 28 percent very sure and 18 percent somewhat sure. Only 2.5 percent respondent told that they were not at all sure.
- Majority of the respondents (61 %) were not very much heard or read about global warming or climate change followed by 21.66 percent were somewhat and 15 percent a great deal.
- About 29% of the respondents got information on climate change from observations and experience followed by 22.5 percent from radio, 20.83 percent from news paper and 15 percent from television.
- Majority of respondents (52.5 %) were believed that climate change is caused by both human activity and natural changes.
- About 43 percent respondent told that they were somewhat worried about climate change followed by 36 percent very worried.
- Majority of respondent (73 %) were agreed that indigenous livestock breeds were better survive during adverse climatic condition than exotic breeds.

- Majority of respondents (78 %) told that climate change affects agriculture and animal husbandry.

Knowledge about impact of climate change on livestock production

- Majority of respondents (56.66 %) told that climate change had negative impact on milk production and lactation length (58.33 %).
- Majority of respondents (50.83%) told that climate change had positive impact on dry period whereas 33.33 percent respondents told that climate change had no impact on dry period.

Knowledge about impact of climate change on reproductive performance of livestock

- Majority of respondents (59.16%) told that there were decreased length and intensity of oestrous period of their animals.
- Majority of respondents (57.5%) told that there were decreased conception rate of their animals. Many farmers told that there were increased cases of repeat breeding in their animals.
- Majority of the respondents (52.5 %) replied that climate change had an effect on parturition interval and it increased.

Knowledge about impact of climate change on livestock health

- Majority of respondents (60.83 %) replied that climate change have an effect on livestock disease incidences whereas 24.16 percent were told that “no effect”. Most of the respondents of western Himalayan region (Nainital) reported increased cases of Heamaturia whereas respondents of Middle Gangetic Plain region reported increased cases of Surra (A protozoan disease) in their animals.
- Majority of respondents (65%) perceived an increased incidence of Mastitis and Foot and Mouth disease (FMD) and majority of respondents (59.16 percent) told that there was change in timing of occurrence of diseases in animals.

- Majority of respondents (83%) told that there were increased incidences of parasitic infestation in livestock whereas about 11.67 percent respondents told that it stayed constant.

Knowledge about impact of climate change on feed and fodder

- Majority of respondents (79.16 %) told due to climate variability feed and fodder resource are decreasing and also majority of the respondents (95.00 %) perceived shortage of dry fodder.
- Majority of respondents (95.83 %) replied that there was decreased quantity of self grown fodder/grasses whereas 3.33 percent respondents told that "stayed constant".
- Majority of respondents (86.66 %) of Western Himalayan region told that there was decreased availability and growth of fodder trees whereas 13.33 percent observed it stayed constant.

Knowledge about impact of climate change on water resources

- Majority of respondents (95 %) replied that there were decreased water resources. Majority of respondents (82 %) replied that there were depletion ground water level.
- About 69 percent respondents told that there was decreased availability of water for irrigation. Majority of respondents (77.5 %) replied that there was decreased number of natural water resources.

Livestock owner's Perception about climate change

- The climate change is real has been strongly endorsed by about 33 percent and was agreed by 52.5 percent of the respondents. About 70 percent of respondents were agreed that climate change was very urgent and serious problem.
- 99 percent of respondents believed that there was significant change in weather pattern and about 72 percent of respondent perceived an increased temperature.

- About 85 percent of respondents perceived an increased extreme rainfall events but overall decreased average rainfall.
- About 96 percent of respondents perceived change in timing of precipitation.
- Cent per cent respondents perceived an increased frequency of extreme weather conditions and change in season length.
- About 74 percent (40%D&34%SD) of respondents were disagreed that climate change is merely a hoax.
- About 77 percent of respondents were disagreed that climate change is not a problem.
- About 92 percent of respondents were disagreed that climate change is more beneficial than harmful and 99 percent of respondents were disagreed that no roles of human in climate change.
- About 95 percent of respondents were disagreed that no effects of climate change on agriculture; animal husbandry (83%) water resources (95%) and biodiversity (99%).

Contrasting of livestock owners' perception to secondary data on climate variability

- Majority of farmers (71%) perceived an increased average temperature and length of hot period (80%). Majority of respondents told that summer month was shifted ahead; as people believe that the hottest period of the year is month of Jeth (15 May to 15 June), but it is not happening now. These findings are in line with findings of IMD while World Bank (2009) reported no change in mean environmental temperature in India during 20th Century.
- Majority of respondents (85%) perceived that an increased extreme rainfalls event but overall decreased average rainfall whereas about 93 percent of respondents observed that there was decreased length of rainy season. About 89

percent of respondents reported erratic rainfalls. Most of the respondents said that monsoon rains were slightly displaced to the period beyond mid-August. Local perceptions further indicated that the incidence of early rainfall had increased, coinciding with a significant increase in the number of cloudy days during that period. These findings are in line with findings of Indian Meteorology Department (IMD).

- Cent per cent of the respondents perceived a definite reduction in snowfall over the last 20 years in Western Himalayan region. More specifically, most of the respondents said that; there were reductions in the intensity, changes in the timing and quicker melting of snowfall. These findings are in line with findings of Indian Meteorology Department (IMD).
- Majority of the respondents (97%) felt that there was increased summer length. These findings are in line with findings of Indian Meteorology Department (IMD).
- Majority of respondents (92.5 %) observed an increased frequency of extreme weather conditions whereas about 7.5 percent of the respondents observed no change in frequency of extreme weather conditions. These findings are in line with findings of Indian Meteorology Department (IMD).

Livestock management strategy adopted by farmers under climatic change scenario

The respondents were reported a diversity of coping strategies that included both modern and traditional methods.

- Majority of the farmers (90%) preserve fodder crop in form of hay for adverse climatic condition; They also stored wheat straw, paddy straw, and crop residues to feed their animals in lean period;
- Majority of the respondents (89%) changed the planting dates;

- Majority of respondents (79%) told that they provide bedding for livestock during extreme winter/cold to prevent them from cold stress;
- Majority of farmers (65%) were grown variety of crops (crop diversification) in their field, for e.g. vegetables, fruit, flower and other cash crop;
- Majority of farmers (60%) told that they sown new crop varieties which required less water(draught resistant), less time to mature(early maturing), pest resistant and well adopted for water logging area(flood resistant);
- Plantation fodder tree lines around animal shed/ house to reduce effects of cold/ heat waves was an important coping strategy adopted by most of the farmers (55%);
- Migration along with livestock was one of the coping strategies of many of the framers (53%) during adverse climatic conditions;
- About 48 percent of the respondents kept more livestock and reduced reliance on crops;
- Majority of the respondents (44%) told that they destock their large animals during adverse climatic conditions and keep smalls animal those are well survive in above said conditions, required less water and feed;
- About 38 percent of the respondents told that they destock their livestock during adverse climatic condition;
- About 34 percent of the respondents told that they sold their animals to fulfil their daily requirement (food, clothes, school fee etc.);
- Only about 27 percent of the respondents insured their livestock; About 10 percent respondents told that they replaced exotic breeds (Holstein Frisian, Jersey) to indigenous/local breeds (Sahiwal, Haryana, Red Sindhi, Tharparker etc.) which were well adapted to native climatic conditions;

Farmers told that local breeds required less water, resistant to many of the diseases and well survive in adverse climatic condition;

- About 8 percent of the respondents leaved livestock farming and start business/other occupation (carpentry, Tailor, etc.);
- About 5 percent of the respondent did rain water harvesting;

5.2 CONCLUSION

There is a serious threat of climatic changes (in the form of severe droughts, floods, intense rainfall, and landslides) undermining development programmes and millennium development goals aimed at reducing poverty. Climate induced disasters directly affect the livelihood of the farmers. Since livelihood of the farmers is based on agriculture and animal husbandry, all of the respondents said that decrease in the animal- agricultural production weakened the economic condition. Currently India is spending 2.5% of its total GDP on measures to control the adverse impact of climatic change, which is a big amount for any developing nation (Dwivedi, 2008). As livestock is and will play very important role in rural economy, it is necessary to find suitable solution to reduce the ill effect of climate change on livestock production.

- Climate change impacts are both socio-economic and bio-physical. Bio-physical impacts include physiological effects on livestock and crops; changes in grazing land, water resources; increased pest challenges; shifts in spatial and temporal distribution of livestock/crop diseases, etc. These will, in turn, bring socio-economic stresses with decline in production and yields; reduced profits from animal-agriculture.

- The study has shown that majority of respondent belonged to middle age group, had medium family size and educated upto primary level. Most of the respondents were marginal and agriculture was their primary occupation.
- Most of the respondents of Middle Gangetic plain region had small herd size while most of the respondents of Western Himalayan region had medium herd size. Majority of the respondents had 10-25 year of experience of livestock rearing. Annual income of majority of the respondents found to be less than Rs.75000 out of which livestock sector contributing about 10-25% only.
- Veterinary officer, Para veterinarian, livestock extension officer, ICAR personnel and NGO's personnel were the extension personnel contacted with highest frequency. The mass media used with highest frequency in Middle Gangetic plain region was radio whereas in Western Himalayan region, it was television. So, to increase awareness and knowledge about climate change and its impacts among the people of Middle Gangetic plain region radio could be used as mass media more effectively whereas for the people of Western Himalayan region, it could be television.
- Majority of the respondents perceived increased environmental temperature, decreased precipitation, increased extreme weather events and an unusual pattern of snow fall/rainfall.
- Study revealed that majority of the respondents were extremely sure that climate change is happening, although, they had not very much heard or read about climate change. Majority of the respondents perceived climate change by their own observation and experience and they think that climate change is caused by both natural and human activities. They did think that it is natural process but fasten by human activities and they were somewhat worried about it. A fair proportion of the respondents told that they do not know which gas will produce on burning of fossils fuel.

- Majority of the respondents agreed that climate change has negative impact on Agriculture and animal husbandry. Majority of the respondents had knowledge about adaptation qualities of indigenous breeds.
- Majority of the respondents told that climate change has negative impact on milk production lactation length whereas positive impact on dry period which is undesirable.
- Heat stress has detrimental effects on the reproduction of livestock, although Indian livestock are well adapted morphologically and anatomically to hot and humid climate. Majority of the respondents told that climate change had negative impact on reproductive performance which is manifested by decreased length and intensity of oestrus period, decreased conception rate and increased parturition interval.
- Majority of the respondents were perceived an increased incidences of livestock diseases for e.g. mastitis, FMD, and parasitic diseases due to climate change. Many of the vectors borne diseases emerged out.
- One of the most evident and important effects of climate change on livestock production is mediated through changes in feed resources. Majority of the respondent perceived decreasing trend of feed and fodder resources, especially, dry fodder and self grown fodder/grasses. Majority of the respondents also told that community grazing land area and pasture biomass are decreasing.
- Majority of the respondents told that climate change has negative impact on water resources which leads to depletion of underground water level, less availability of natural water resources for irrigation and livestock.
- Majority of the respondents believed that climate change is real, urgent and serious problem. Majority of the respondents agreed that there was significant change in

weather pattern i.e. increasing trend of temperature, decreasing trend of precipitation, increasing trend of extreme rainfall events and untimely precipitation, most of the respondents perceived that their area get less rain fall and snowfall during recent years.

- Majority of farmers perceived an increased average temperature and an increased length of hot period. Majority of respondents told that hot month was shifted ahead; as people believe that the hottest period of the year is month of Jeth (15 May to 15 June), but not now.
- Majority of respondents perceived that an increased extreme rainfalls event but overall decreased average rainfall, decreased length of rainy season and erratic rainfall. Most of the respondents said that monsoon rains were slightly displaced to the period beyond mid-August.
- Cent percent of the respondents were perceived a definite reduction in snowfall. More specifically, most of the respondents said that; there were reductions in the intensity, changes in the timing and quicker melting of snowfall.
- Majority of respondents perceived an increased frequency of extreme weather conditions. These findings are in line with findings Indian Meteorological department.
- Majority of the respondents felt that there was increased summer length. These finding show positive relationship to secondary data analysis.
- Most of the farmers preserved fodder crop in form of hay for adverse climatic condition. They also stored wheat straw, paddy straw, and crop residues to feed their animals in lean period.

- Majority of the farmers followed mixed livestock farming and diversifying farming practices-they had grown vegetables, fruits and other cash crop. A changed planting date was one of the coping strategies of many of the farmers. Besides these majority of the respondent did traditional prayer to get rid of adverse climatic conditions i.e. farmers believed more in God of rain –Endra and other e.g. Kali, Brahm, etc. for safety against adverse climatic conditions.
- Most of the respondents were provided bedding and warmth to their animals to protect them from extreme cold, while during hot days farmers were provided clean and cold water, fresh air and shed to protect their animals.
- Majority of respondents were destocked large animals during adverse climatic condition because they required more water and feed and keep smalls animal (goat, sheep, poultry, etc) those are well survive in above said conditions, required less water and feed. Most of the farmers also replaced exotic animals to well adapt indigenous breeds which required less water, capable to tolerant heat and resistant to many of the diseases.
- About half of the total respondent told that they keep more livestock and reducing reliance on crop. Climate change adversely affects the agriculture which diminishing the source of income and employment.

5.3 RECOMMENDATIONS

Climate change cannot be stopped but can be controlled. Based on the study, the following recommendations have been developed. Although farmers had knowledge about projected impact of climate change but they did not know what it is and they seemed confused. Farmers can do something to overcome climate change if they understand what it is.

- Knowledge and perception of farmers about climatic changes need to be managed with extension campaign using handout, mass media as well as field demonstration.

- Traditional knowledge about the community's coping strategies should be documented and used in training programs with necessary modification to address the uncertainties of climate change.
- Climate change adaptation funding body should focus on extension systems and programs that incorporate a good understanding of what practices and skills are needed to promote activities that help in the climate change effort and on increasing the capacity of extension agents and farmers.
- A large scale Climate Change Literacy programme must be developed to prepare farmers, farmers can only do something about climate change if they understand what it is. Now, their traditional knowledge does not help them to manage these recent anthropogenic climatic changes.
- The farmers of Western Himalayan region fed fodder to their animals as whole i.e. they did not chopped which decrease digestibility, acceptability and more residues. Chopping increases digestibility, acceptability of fodder and reduce residues. So, it is necessary to aware the farmers about advantages of chopping and also encourage for chopping of fodder.

5.4 EXTENSION STRATEGY

Among farming communities, low levels of awareness and poor understanding of climate change risks, combined with significant knowledge gaps about climate change processes, have hindered effective societal decision making about climate change adaptation and mitigation. Hence, it is very essential to raise awareness of climatic variability, and improve capacity of farmers to understand and deal with climatic changes. There are several ways that extension systems can help farmers to cope with climatic variability. These include adaptation and mitigation for what cannot be prevented. Extension systems and advisory services, both public and private, have a major role to play in providing information, technologies and education on how to cope with climate change.

Extension can help farmers to prepare for greater climate variability. Based on the study the extension strategy which can be taken to lessen the impact of climate change are as follows:

1. Raise awareness among farmers by using mass media like radio (for middle Gangetic plain region) and television (for western Himalayan region) as these are the particular media in that areas supplement by field demonstration.
2. Diffusion of local cultivars of drought /flood tolerant crop varieties with information about the crops' advantages and disadvantages.
3. Motivate the farmers to rear local well adapted livestock breeds and grow fast growing high yielding nutritious fodder crop.
4. Development and distribution of literature related to climate change coping strategy at nominal price or free of cost.
5. Link farming communities and other people directly with voluntary, private and public institutions that disseminates mitigation technologies and provide fund for adaptation activities. Increase access to meteorological information will be vital.

5.5 SUGGESTED AREA OF FUTURE RESEARCH

1. In depth study can be conducted with larger samples in same/other agro-climatic zones.
2. Assessments of impacts and adaptations to climate change among farming community with reference to their socio economic, psychological, and social culture status.
3. Evaluation of indigenous varieties and animal breeds for valuable traits like tolerance to drought and flood, feed conversion efficiency and disease resistance.

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Abstract

The present study was conducted in two Agro-climatic zones viz. Middle Gangetic plain region and Western Himalayan region of India. From Middle Gangetic plain region Uttar Pradesh state and from Western Himalayan region Uttarakhand state was selected purposively. From each selected state one district was selected randomly. Three blocks from each district and two villages from each selected block were selected randomly at an appropriate distance to cover the large and distinct area. From each selected village ten livestock owners having at least two large animals was selected randomly to make 120 total respondents for the investigation. Data was collected through semi-structured interview schedule. The data after collection, compiled, tabulated and analyzed in view of the objectives of the study by using the appropriate statistical method. The study revealed that majority of respondent belonged to middle age group, had medium family size, educated upto primary and agriculture was their primary occupation. Most of the respondents of Middle Gangetic plain region had small herd size while most of the respondents of Western Himalayan region had medium herd size. Study revealed that majority of the respondents was extremely sure that climate change is happening, although, they had not very much heard or read about climate change. Majority of the respondents perceived climate change by their own observation and experience and they think that climate change is caused by both natural and human activities. Majority of the respondents told that climate change has negative impact on productive and reproductive performance of livestock. Majority of the respondents told that due to climate change an increased incidence of livestock diseases for e.g. Mastitis, FMD, and parasitic diseases. Majority of the respondent perceived decreasing trend of feed and fodder resources, especially, dry fodder and self grown fodder/grasses. Majority of the farmers told that climate change has negative impact on water resources which leads to depletion of underground water level, less availability of natural water resources for irrigation and livestock. Most of the respondents perceived an increased environmental temperature, decreased precipitation, increased frequency of extreme weather conditions, and increased summer season length. Most of the farmers preserved fodder crop in farm of hay for adverse climatic condition. Majority of the farmers followed mixed livestock farming, diversifying farming practices and changed planting date. Most of the respondents provided bedding and warmth to their animals to protect them from extreme cold, similarly during hot days farmers provided cold water and shed to protect their animals.

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वर्तमान अध्ययन भारत के दो कृषि जलवायु क्षेत्र मध्य गंगा का मैदानी क्षेत्र तथा पश्चिमी हिमालयी क्षेत्र में किया गया है। इस अध्ययन का उद्देश्य जलवायु परिवर्तन पर पशुपालकों का ज्ञान तथा धारण का आकलना करना था। मध्य गंगा के मैदानी क्षेत्र से उत्तर प्रदेश तथा पश्चिमी हिमालयी क्षेत्र से उत्तराखण्ड राज्य उद्देश्यतः चुने गये। प्रत्येक चयनित राज्य से एक जिला बेतरतीब ढंग से चुना गया। प्रत्येक चयनित जिले से तीन विकासखण्ड तथा प्रत्येक विकासखण्ड से दो–दो गांव एक उचित दूरी पर बेतरतीब ढंग से चुने गये। प्रत्येक चयनित गांव से दस पशुपालकों को बेतरतीब ढंग से चुना गया। एक अर्ध संरचित साक्षात्कार अनुसूची के माध्यम से आकड़े संग्रहित किये गये। संग्रहित आंकड़ों को संकलित तथा सारणीबद्ध करने के बाद उपयुक्त सांख्यिक पद्धति का उपयोग करके अध्ययन के उद्देश्य के दृश्य में विश्लेषण किया गया। अध्ययन से पता चला कि ज्यादातर पशुपालक मध्यम आयु, मध्यम परिवार तथा प्राथमिक तक पढ़े हुये थे और कृषि उनका प्रधान व्यवसाय था। मध्य गंगा मैदान क्षेत्र के पशुपालकों के पास छोटे पशु झुंड आकार तथा पश्चिमी हिमालयी क्षेत्र के पशुपालकों के पास मध्यम पशु झुंड आकार थे। अध्ययन से पता चला कि ज्यादातर पशुपालक विश्वास करते हैं कि जलवायु परिवर्तन हो रहा है हांलाकि वे जलवायु परिवर्तन के बारे में ज्यादा पढ़े तथा सुने नहीं थे। ज्यादातर पशुपालक अपने प्रेक्षण तथा अनुभव के द्वारा जलवायु परिवर्तन को महसूस करते हैं तथा उन्हें लगता है कि जलवायु परिवर्तन दोनों प्राकृतिक तथा मानव गतिविधियों के कारण हो रहा है। ज्यादातर पशुपालकों ने कहा कि जलवायु परिवर्तन से पशुओं के उत्पादक तथा प्रजनन क्षमता पर नकारात्मक प्रभाव पड़ रहा है। अधिकांश पशुपालकों का कहना था कि जलवायु परिवर्तन से जानवरों में होने वाली बीमारियों में वृद्धि हुई है जैसेकि :– थनैला, खुरपका, मुंहपका तथा परजीवी रोग। अधिकांश पशुपालक मानते थे कि जलवायु परिवर्तन के कारण से चारों की उपलब्धता में कमी आयी है विशेष रूप से शुष्क चारा तथा स्वयं उगने वाली घासों में। अधिकांश पशुपालकों का मानना था कि जलवायु परिवर्तन का जल संसाधनों पर नकारात्मक प्रभाव पड़ा है जिसके कारण भूमिगत जल स्तर में घटाव तथा सिंचाई और पशुओं के लिये प्राकृतिक जल संसाधनों की उपलब्धता में कमी आयी है। अधिकांश पशुपालक बढ़ा हुआ वातावरणीय तापमान, कम वर्षा, कम बर्फबारी, चरम मौसमीय स्थिति की आवृत्ति में वृद्धि तथा ज्यादा दिन तक गर्मी महसूस कर रहे थे। अधिकांश पशुपालक जलवायु परिवर्तन के प्रतिकूल प्रभाव से बचने के लिये विभिन्न प्रकार की रणनीति अपनाते हैं। जैसेकि मिश्रित पशुपालन, बड़े पशुओं की संख्या में कमी करना, फसलों का विविधीकरण, रोपड़ की तारीख को बदल देना, चारा संरक्षित करना, अधिक ठंड से बचाव के लिये पत्तियों या पुवाल का बिस्तर तथा अलाव (आग) की व्यवस्था करना, अत्यधिक गर्मी के दौरान पशुओं को ठंडा पानी पिलाना तथा छाया की व्यवस्था करना इत्यादि। इन सबके अलावा अधिकांश पशुपालक प्रतिकूल जलवायुकी परिस्थितियों से छुटकारा पाने के लिये देवी–देवताओं की पूजा भी करते हैं।

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❖❖❖

Annexure I

Case Study

When I was a teenager, I remember we started wearing our warm clothes by near the beginning of October. But now, we took them out only in December. Winters' months have reduced and it is not as cold as it used to be. We feel that the summers have advanced by at least two months in our region. There is also a visible and evident change in the rainfall pattern. It usually rains in our region in the last week of May when we planted nursery of paddy, but this time it rained in July. We were waiting for the rains to come in May, so that we could plant nursery of paddy, but it did not rain at all in May, June and July. In August we had very scanty rains and we have sown paddy just for the sake of it. In the year 2010 there was very less rain so we lost our entire paddy crop which needs good rains to grow. We did not even get enough rice to fulfil our requirement for quarter of the year. The underground water level further depleted in summer season, pumpsets were unable to pump water. We also had a lot of problem in getting feed and fodder for livestock, especially dry fodder. The price rate of wheat straw was up to Rs.800/quintal whereas price rate of wheat was Rs.1100/quintal. Lack of rains had further reduced fodder and grazing grass for our cattle and we women have to walk long distances to get the fodder.

A 46 years old Lady, Chakasray Badaldas village, Deoria Sadar, Deoria, Uttar Pradesh

Annexure JJ

Cattle equivalent scores for different categories of livestock

S.No	Categories	Cattle equivalent
1	Cattle in milk	
	Indigenous	1.00
	Crossbred	1.19
2.	Cattle heifer	
	Indigenous	0.65
	Crossbred	0.85
3.	Dry cattle adult	
	Indigenous	0.80
	Crossbred	0.85
4.	Cattle young stock	
	Indigenous	0.40
	Crossbred	0.48
5.	Oxen and Bulls	1.26
6.	Buffalo in milk	1.26
7.	Buffalo heifer	0.69
8.	Dry adult buffalo	1.01
9.	Buffalo bulls and working stock bovines	1.26
10	Sheep / goat	0.10
11.	Pig	0.10
12.	Horse/ponies/camel	2.67
13.	Poultry(100 adult bird)	0.005

Source:

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Annexure-III

Division of Extension education

Indian Veterinary Research institute

Izatnagar-243 122(U.P.) India

Interview Schedule

On

Knowledge and perception of livestock owners on climate change

S. No…….. **Date…….**

Name ……

1. Address: Village ……Block …… District ……State……
2. Sex ……..
3. Age (in complete year)……..
4. Marital status Married …….. Not married …… other specify ……
5. Educational level? Illiterate…… Primary school … Middle school ….. High school…….Intermediate or above
6. Family size …… ……....
7. Occupation
   i. Primary…… ii Subsidiary……
8. Land holding (in acres)……
9. Herd size:

Name	Type	Descriptive	N.D./Desi	Exotic/Crossbred
Cattle	Milch			
	Heifer			
	Male calf			
	Female calf			
	Dry cow			

	Pregnant			
	Lactating			
	Bull/male			
Buffalo	Milch			
	Heifer			
	Male calf			
	Female calf			
	Dry cow			
	Pregnant			
	Lactating			
	Bull/male			
Goat	Adult/nanny			
	Dry			
	Pregnant			
	Lactating			
	Buck			
	Kids			
Sheep				
Pigs				
Poultry				

10. Gross annual income (in Rs.).....

11. Financial return from livestock farming (%).....

12. Experience in livestock rearing (in year).....

13. Extension personnel contact

Extension Personnel contact	Most often	Often	Sometimes	Never
L.E.O				
Para vet				
V.O.				
B.D.O.				
NGOs personnel				
Bank official				
ICAR personnel				

14. Mass media exposure:

Mass media exposure	Most often	Often	Sometimes	Never
Radio				
T.V.				
News paper				
Bulletin/ Pamphlet				
Kisan mela				
Pashu mela				

15. Weather:

Have you noticed any change in temperature and precipitation from day to day /months to month/ year to year?

Parameter	Increased	decreased	Stayed constant	Do not know
Environmental Temperature				
Precipitation(Rain fall, snowfall)				

16. Climate:

Have you noticed any unusual pattern in the climate? (e.g. unusual heat waves/ cold waves, unusual snowfall/rainfall, change in wind pattern)

a) Yes b) No c) Don't Know/no response

17. Livestock rearing pattern

Animal	**No.**
Large animal (Cattle, Buffalo)	
Small animal(Sheep, Goat, Pig)	
Poultry	

18. Productive performance of dairy animals

Do you know that Global warming and climate change are likely to impact negatively on milk production?

a) Yes b) No c) cannot say anything

19. Reproductive performances of dairy animals

Do you know that climatic stress has negative impact on reproductive performance of livestock?

a) Yes b) No c) cannot say anything

20. Animal disease pattern

Have you noticed any effect of climate change on nature, type and incidence of disease among livestock?

a) Yes b) No c) cannot say anything

21. Cropping pattern of fodder crop

Season	**Fodder crop**
Rabi	
Kharif	

22. Insect pest and disease pattern of crops including fodder crop

Have you noticed any effect on incidence of crop pests and diseases in relation to the change in climatic conditions?

a) Yes b) No c) Cannot say anything

If yes then what happen

a) Increased b) Decreased c) No change

23. Change in community grazing land

Parameter	Response	
Grazing land area	Decreased	
	Increased	
	Stayed constant	
Over grazing	Yes	
	No	
	Do not know	
Pasture biomass	Decreased	
	Increased	
	Stayed constant	

24. Availability of farm labour

a) Increased b) decreased c) stayed constant d) cannot say any thing

25. Preparedness to act

Are you ready to implement any new adaptation/mitigation activity if initiated by government?

a) Yes b) No c) Cannot say anything

Are you ready to change something in your behaviour to overcome climate change?

a) Yes b) No c) Cannot say anything

Are you ready to pay (in cash money) for any adaptation measure?

a) Yes b) No c) Cannot say anything

Knowledge about climate change:

Q1. What do you think? Do you think that climate change is happening? (Has the climate changed?)

a)Yes
b) No
c)Don't Know

Q2. How sure you are that climate change is happening?

a) Extremely sure

b) Very sure
c) Somewhat sure
d) Not at all sure

Q3. How much have you heard or read about global warming or climate change?

a. A great deal
b. Some
c. Not very much
d. Nothing at all
e. DK/NA

Q4. Where have you heard about climate change?

a) Television
b) Radio
c) News paper
d) Friends
e) Government agencies
f) Specialist publication/ academic journals
g) Observation and experience

Q5. Assuming climate change is happening, do you think it is…?

a) Caused by human activities
b) Caused by both human activities and natural changes
c) Caused by natural changes in the environment
d) None of the above because climate change isn't happening
e) Other
f) Don't know

Q6. How worried are you about climate change?

a) Very worried
b) Somewhat worried
c) Not very worried
d) Not at all worried

Q7. What gas is produced by the burning of fossil fuels?

a) Carbon dioxide
b) Carbon monoxide
c) Both
d) Don't know

Q.8. Do you know that indigenous livestock breeds are better survive during adverse climatic conditions?

a) Yes

b) No

c) Don't Know

Q9. Do you know that climate change affects agriculture and animal husbandry?

a) Yes

b) No

c) Don't Know

Q10. Knowledge about impact of climate change on livestock production

S.N.	Question	**Response**			
1	Effect of climate change on milk production	Deceases	Increases	Remain same	Don't know
2	Effect of climate change on lactation length(period)	Deceases	Increases	Remain same	Don't know
3	Effect of climate change on dry period	Deceases	Increases	Remain same	Don't know
4	Effect of climate change on productive life of livestock	Deceases	Increases	Remain same	Don't know

Q11. Knowledge about impact of climate change on livestock reproduction

S.N.	**Question**	**Response**			
1	Effect of climate change on length and intensity of the estrus period	Decrease	Increases	Remain Same	Don't know
2	Effect of climate change on conception rate	Decrease	Increases	Remain Same	Don't know
3	Effect of climate change on parturition interval	Decrease	Increases	Remain Same	Don't know

Q12. Knowledge about impact of climate change on Livestock Health

S.N.	Question	Response			
1	Have you noticed that any effect of climate change on livestock disease incidences?	Yes	No	Don't know	
2	Effect of climate change on incidence of Mastitis and Foot and Mouth Disease	Decrease	Increases	Remain Same	Don't know
3	Have you noticed any change in time of occurrence of diseases?	Yes	No	Don't know	
4	Have you noticed that there is an emergence of new diseases or re-emergence of diseases?	Yes	No	Don't know	
5	Effect of climate change on incidences of parasitic infestation in livestock	Decrease	Increases	Remain Same	Don't know

Q13. Knowledge about impact of climate change on feed/fodder resources

1	Do you know that due to climatic variability feed and fodder resources are decreasing?	Yes	No	Don't know	
2	Do you know that due to climatic variability there is shortage of dry fodder?	Yes	No	Don't know	
3	Effect of climate change on pasture land area	Decrease	Increase	Remain same	Do not know
4	Effect of climate change on Self grown fodder/grasses	Decrease	Increase	Remain same	Do not know
5	Effect of climate change on availability and growth of fodder trees	Decrease	Increase	Remain same	Do not know

Q14. Knowledge about impact of climate change on water resources

1	Effect of climate change on water resources	Decrease	Increase	Remain same	Don't know
2	Effect of climate change on underground water level	Deplete	Raise	Remain same	Don't know
3	Effect of climate change on availability of water for irrigation	Reduce	Increase	Remain same	Don't know
4	Effect of climate change on availability of ponds and other natural water resources for livestock	Reduce	Increase	Remain same	Don't know

Perception of livestock owners about climate change phenomenon:

Statements	Response				
	SA	A	UD	D	SD
Climate change is real					
Climate Change is urgent &serious problem					
Significant change in weather pattern					
Increase environmental temperature					
Decrease precipitation					
Change in timing of precipitation					
Increase frequency of extreme weather conditions.					
Change in season length					
Climate Change is nearly a hoax					
Climate Change is not a problem					
Climate Change is more beneficial than harmful					
No role of human in Climate Change					
No effect of Climate Change on Ag					
No effect of Climate Change on AH					
No effect of Climate Change on water resources					
No effect of climate change on biodiversity					

SA-strongly agree-5, A-agree-4, UD- undecided-3, D-disagree-2, SD- strongly disagree-1

Perception of livestock owners about climate change parameters

Parameter		Increased	Decreased	Stayed constant	No answer
Temperature	Annual				
	Length of hot periods				
Rainfall	Annual				
	Length of rainy season				
	Erratic rainfall				
Snow fall	Annual				
Season length	Summer				
	Winter				
Extreme weather condition	Annual				

Adaptation activities adopted by livestock owners

S.N.	**Strategy**	**Yes**	**No**
1	Change in livestock/herd composition (large animal vs. small animal) during adverse climatic conditions		
2	Reduction in livestock number during adverse climatic condition		
3	Replacement of exotic breeds to local breeds		
4	Preservation of fodder		
5	Keeping more livestock and reducing reliance on crop		
6	Crop diversification		
7	New fodder crop variety/type		

8	Change planting dates		
9	Provide bedding for livestock during extreme winter/cold		
10	Plantation fodder tree lines around animal shed/ house to reduce effects of cold/ heat waves		
11	Selling of livestock in order to buy food		
12	Migration along with livestock		
13	Livestock insurance		
14	Livestock farming to non- farming (Business)		
15	Rain water harvesting		
16	Traditional Prayer		
17	**Other coping strategy if any please specify**		

Place:

Sig. of respondent

Date:

Vitae

Name	:	**Dr. Subodh Kumar Singh**
Father's name	:	Shri Ramniwas Singh
Mother's name	:	Shrimati Eshrawati Devi
Date of birth	:	16th January 1982
State of domicile	:	Uttar Pradesh
Nationality	:	Indian
Language known	:	Hindi and English
Fellowship and Award	:	☞ ICAR-JRF (2009-2011) for M.V.Sc. ☞ Awarded certificate of Merit and Silver Medal - second position in B.V.Sc and A.H. programme ☞ Ch. Charan Singh Smriti Pratibha Purskar, Kisan Trust Delhi ☞ Neomec Project Shiksha Scholarship, Neovet Intas Pharmaceuticals Pvt. Ltd. ☞ M-ceft Merit award: Academic excellence award, Alembic Veterinary Division.
Qualification	:	☞ B.V.Sc. & A.H. DUVASU, Mathura, 2008 ☞ M.V.Sc. Deemed University, IVRI, Izatnagar, 2011
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