

**VULNERABILITIES AND ADAPTATION
STRATEGIES TO CLIMATE CHANGE IN
RAJASTHAN: A GENDER PERSPECTIVE**

राजस्थान में जलवायु परिवर्तन संबंधी सुभेदता एवं अनुकूलन
कार्यनीति: एक लिंग परिप्रेक्ष्य

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**VULNERABILITIES AND ADAPTATION
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RAJASTHAN: A GENDER PERSPECTIVE**

By

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The assistance and help availed during the course of investigation as well as source of information have been duly acknowledged.

(Dr. Premlata Singh)

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*Dedicated to My Beloved
Parents and Teachers...*



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CHAPTER 1

INTRODUCTION

“The trade-offs forced upon people by climate shocks reinforce and perpetuate wider inequalities based on income, gender and other disparities.”

UNDP 2007

Global agriculture will be under significant pressure to meet the demands of rising populations using limited, often degraded, soil and water resources that are predicted to be further stressed by the impact of climate change. Climate change is an important issue for the 21st century requiring renewed attention by all the stakeholders to address its adverse impact on agricultural productivity, the environment and its effect on food security. Climate change has been defined by the Intergovernmental Panel on Climate Change, IPCC (2001) as statistically significant variations in climate that persist for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. Climate change and variability (CC & V) is rapidly emerging as one of the most serious global problems affecting many sectors in the world and is considered to be one of the most serious threats to sustainable development with adverse impact on environment, human health, food security, economic activities, natural resources and physical infrastructure (IPCC, 2007; Huq et al., 2006).

The state of knowledge available at regional and sub-regional levels is still inadequate (INCAA, 2010). Now it is widely accepted that though climate change is a natural process, its pace of change has increased over the last 150-200 years, especially after industrial revolution in western world during 1970's (IPCC, 2007). The CO₂ concentration in the atmosphere is now about 31 per cent higher than two hundred years ago and if this continues to increase at the same rate it could nearly double by 2035 and may contribute significantly towards global warming (IPCC, 2001). The concentration of methane (CH₄) in the atmosphere has increased by 51 per cent during the same period; which is second to CO₂ regarding global warming (IPCC, 2001).

Developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt socially, technologically and financially. Climate change has become an important area of concern for India to ensure food and nutritional security for growing population. The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture. In India, significant negative impacts have been implied with medium-term (2010-2039) climate change, predicted to reduce yields by 4.5 to 9 percent, depending on the magnitude and distribution of warming. Since agriculture makes up roughly 14 percent of India's GDP, a 4.5 to 9 percent negative impact on production implies the cost of climate change to be roughly up to 1.5 percent of GDP per year.

The Government of India has accorded high priority on research and development to cope with climate change in agriculture sector. Warming of the climate system is unequivocal, as any increase in temperature, diurnal variations and changes in intensity, patterns and intensity of rainfall have massive effects on the productivity and livelihoods of large numbers of people who live in outer edge of socio-economic development. The climatic vulnerability assessment undertaken of agricultural regions show arid and semi-arid regions are extremely vulnerable. According to climate model analyses, the number of people at risk due to water scarcity increases rapidly with rising temperatures towards the second half of the century, with impacts in arid and semi-arid regions expected to be much larger than the global averages suggest (IPCC, 2001; Parry *et al.*, 2001).

However, there is variability within regions and localities, calling for more targeting of interventions and relief programs based on vulnerability assessments and prioritization of local spatial units. Agriculture sector, particularly in developing countries is more vulnerable to climate change (IPCC, 2007). Sensitivity to multiple stressors such as extreme weather events, increased climate variability, and the physiological function of plants combine to influence the vulnerability of the agricultural sector.

Furthermore, the negative trends in solar radiation and increase in minimum temperature would also result in declining trends of potential yields of rice and wheat in the *Indo-Gangetic* plains of India (Pathak *et al.*, 2003). Similarly accumulated increase in minimum temperatures increases maintenance respiration requirement of the crops and thus

further reduces net growth and productivity (Aggarwal, 2003). It is also observed that increase in temperature by 1 to 2 °C, the grain yield in sorghum decreases by 7 to 12 per cent, on an average and further increase in temperature drastically reduces the potential yield by 18 to 24 per cent on an average (Chatterjee, 1998). Excess moisture could cause 90 per cent more damage to maize crops due to and increased occurrence of extreme precipitation events. Agricultural scientists also suggest that changes in temperature and precipitation and their frequency of extreme events will influence disease and pest outbreak, distribution and spread as well as its economic damage.

Agriculture in India depends a lot on south west monsoon as it contributes 75 percent of the rainfall. In the last decade, the country witnessed two wide-spread drought years. In 2002, the advancement of monsoon witnessed intermittent delays and the coverage over the entire country could happen only by 15th August. In 2009, despite the early onset of monsoon and its coverage over the entire country by 15th July, the year recorded the lowest mean annual rainfall of less than 700 mm. Any deviation from the normal rainfall pattern seriously affects production of food grains, fodder availability to livestock, supply of raw materials to agro-industries, livelihoods of rural workforce and reduces food grain supplies to the central pool for public distribution. It leads to increase in prices and inflation and finally affects the share of agriculture in GDP.

The major cause to climate change has been ascribed to the increased levels of greenhouse gases like carbon dioxide (CO₂), methane (CH₄), nitrous oxides (N₂O), chlorofluorocarbons (CFCs) due to burning of fossil fuels, increased use of refrigerants, and chemical based agricultural practices. Most of the observed increase in global temperatures since the mid-20th century can now be attributed to the observed increase in anthropogenic greenhouse gas emissions. These human influences are exerting their impact on the other aspects of climate like ocean warming, rise in continental-average temperatures, temperature extremes and wind pattern changes. These activities accelerated the processes of climate change and increased the mean global temperatures by 0.6°C during the past 100 years. It has also induced increased climatic variability and occurrence of extreme weather events in many parts of the world. Studies indicate that the year's viz., 1997, 1998 and 1999 have been among the warmest during the past century and the process

continued into the 21st century and the year 2010 was declared as the third warmest year since 1860, the period for which instrumental records are available. According to IPCC (2007), the 21st century is projected to experience 1.8 to 4.0°C rise in surface air temperature together with very likely occurrence of frequent warm spells, heat waves and heavy rainfall and a likely increase in the frequency of droughts. Lal (2001) reported an annual mean area averaged surface warming over the Indian subcontinent to range between 3.5° and 5.5°c over the region by 2080. The projections indicate more warming in winter season over summer season. FAO (2007) reported that changing temperatures and rainfall in drought-prone areas are likely to shift populations of insect pests and other vectors and change the incidence of existing vector-borne diseases in both humans and crops.

According to IPCC (2007), increase in average temperature will adversely affect crops, especially in semi-arid regions, where already heat is a restrictive factor of production. Increased temperature also increase evaporation rates of soil and water bodies as well as evapotranspiration rate of plants, and increase chances of severe drought. It means that with warmer temperatures plants require more water. Singh (2008) said that different estimates by environmentalists indicate location specific uncertainties in the minimum and maximum temperatures which may have adverse impact on agricultural productivity in different agro climatic regions of the country. Such calculations for trends in monthly rainfall may be more during December, January and February in case of West Rajasthan, Punjab and Haryana. Surface temperature in North India probably rises by 3°C or more by 2050 and a marginal increase of 7 to 10 percent in rainfall is likely to occur over the subcontinent by 2080. Although analysis of 100-year rainfall data for the arid region of Rajasthan indicates an increasing trend of 0.5 mm/year, but increased evapo-transpiration demand due to global warming can put tremendous pressure on existing overstressed water resources of this region.

Climate change is the defining human development issue of the 21st century. The 2007 Human Development report recognizes that climate change threatens to erode human freedoms and limit choices and the report further underscores that gender inequality intersects with climate risks and vulnerabilities. As per the 2011 census the women work force in agriculture and allied sector is around 98 million which amounts to about 37

percent of the total agricultural workers in the country. Another trend that is being recently observed is how climate change is affecting men and women differently. Current literature on the gendered nature of vulnerability to past hazards and disasters illuminates how women and men are differently affected. Women are often more vulnerable to disasters than men through their socially constructed roles and responsibilities and because they are poorer (Mitchell et al., 2007). They are vulnerable not because of natural weakness (i.e. because of their sex) but rather because of the socially and culturally constructed roles ascribed to them as women (i.e. because of their gender). Given the severity of gender inequality, particularly in the developing world, climate change is likely only to magnify existing patterns of gender disadvantage (UNDP, 2007).

It is believed that men and women will be faced with different vulnerabilities to climate change impacts due to existing inequalities such as, their role and position in society, access to resources and power relations that may affect the ability to respond to the effects of climate change (WEDO, 2007; Commission on the Status of Women 2008; BRIDGE, 2008). The sexual division of labor, unequal access to both material and non-material resources, and women's diminished participation in decision-making at both political and private levels result in women's generally increased level of vulnerability to impacts from climate change. Climate change also increasing the workload of women (Leduc, et al., 2008; Brody, et al., 2008). The gender dimension of climate change is gaining visibility as the stakes of climate change become increasingly clear.

Women are expected to be more vulnerable than men to the impacts of climate change as they are reported to be the majority amongst the poorest and most disadvantaged groups in society (WEDO 2007; Brody et al. 2008; United Nations Commission on the Status of Women 2008). Post-disaster recovery efforts and economic development programmes have proven that women and men are affected differently by natural hazards and environmental stress because of differences in traditions, resource use patterns and gender specific roles and responsibilities. Women receive 70 percent of the wages paid to men for the same type of work, both in developed and less developed countries (Lara, 2004). Miscarriage in Uttaranchal, India, is 30 percent higher than the national average and is associated with the very heavy weights women in that rural zone have to carry to collect

water and firewood (Boender & Thaxton, 2004). Poor women's limited access to resources, restricted rights, limited mobility and quiet voice in shaping decisions make them highly vulnerable to climate change. The nature of that vulnerability varies widely, cautioning against generalization but climate change will expand existing patterns of inequality, including gender inequality. In the agricultural sector, rural women in developing countries are the primary producers of staple food, a sector that is highly exposed to the risks that come with drought and uncertain rainfall. Women and girls generally suppose to take primary responsibility for collecting water for drinking, cooking, washing, sanitation and raising small livestock, while men use water for irrigation or livestock farming and for industries (Fisher 2006; Khosla and Prabha 2003). In many countries, climate change means that women and young girls have to walk further to collect water, especially in the dry season. Women can be expected to contribute much of the unpaid labour that will go into coping with climate risks through soil and water conservation, the building of anti-flood embankments, and increased off-farm employment.

While underscoring the vulnerability of poor women to climate change, it should also be recognized that women play an important role in supporting households and communities to mitigate and adapt to climate change. Across the developing world, women's leadership in natural resource management is well recognized. For centuries, women have passed on their skills in water management, forest management and the management of biodiversity, among others. Through these experiences, women have acquired valuable knowledge that will allow them to contribute positively to the identification of appropriate adaptation and mitigation techniques, if only they are given the opportunity. But it is also worth remembering that public knowledge of the nature, causes and consequences of climate change is low and there are many common misconceptions regarding climate change (Whitmarsh, 2010).

Hence a gender-disaggregated approach is required in order to shed more light on the levels of vulnerability and coping mechanisms of different social groups and effectiveness of measures. These findings can be fed into the climate negotiation as well as national debates to enable decision makers to have a better understanding of how different groups of people are affected and what kind of capacity and support is needed. Analysis

needs to include vulnerability, adaptation, mitigation and a way forward, especially in a manner in which engagement can take place. The main decision makers involved in climate change initiatives, programmes and policy development have acknowledged that they do not know enough about the links between gender equality and climate change. One of the primary challenges faced by an institution or government in addressing gender equality is isolation from other similar efforts and lack of experience. So, it is very important to assess the climatic change from socioeconomic perspective to prepare a roadmap for capacity building of women and men farmers for effective adaptation and mitigation of undesirable effects for sustainable livelihood and development.

Therefore, intensive global action is needed to enable developing countries to adapt to the effects of climate change that are happening now and will get worse in the future and also focus on the gender sensitive strategies to manage with the effects of climate change. Hence this research study is proposed. To cope with the challenges of the 21st century, interdisciplinary education, research and cooperation in agricultural sector is required more than ever before. In agriculture sector, adapting to climate change will depend on improving farmers' access to information and actively involving them in decision-making along with diffusion of adaptation and mitigation technologies. Proper awareness, adoption and diffusion of suitable farm practices based on local needs and interests can reduce the farmer's vulnerability to the climate change. Similarly, in order to reduce vulnerability of agriculture sector to climate change it is necessary to improve farmers' adaptive capacity to such changes through diffusion of climate change adaptation and mitigation technology along with development of their skills to deal with climate change effectively. Thus, efforts are needed to enable them to cope with changing climate through provision of appropriate technology and skills.

An analysis of the development process made from the gender approach explains why and how the effects of climate change and gender inequality are closely linked with one another and how both women and men face risks relating to climate and vulnerability. Yet it is not sufficient to establish a direct relationship between inequality and vulnerability and the causes and effects of climate change. These relationships are unquestionably measured by taking account of environmental, social, economic, cultural and political

contexts, and, so, vary between regions and countries, as well as within countries. Social inequalities, in particular, have serious repercussions on many women's lives, limiting their access to land ownership, housing, education, health care and participation in policy-making and decision-making – in other words, limiting their human freedoms and options.

Statement of problem

Today, our country is facing the problems of rising temperature, melting of glaciers, rising of sea-level leading to outburst of the arid and semi-arid areas, changes in precipitation patterns leading to increased risk of recurrent droughts, threats to biodiversity, an expansion of plant diseases and a number of potential challenges for public health. Undesirable impact on agriculture due to climatic changes will have telling effect on national economy and livelihood. Several global studies have indicated that India is particularly vulnerable to climate change and is likely to suffer with damage to agriculture, food and water security, human health and cattle populations. Like most other developing countries, people in India are dependent to a large extent on its natural resources for livelihood and economy. Any adverse impacts on these natural resources will have effect on the nation's livelihood security and economy and widen the gap between the rich and the poor. Though research initiatives are taking place in physical and biological sciences, it is very important to assess the climatic change from socioeconomic perspective to prepare a roadmap for capacity building of people for effective adaptation and mitigation of adverse effects for sustainable livelihood and development. So, a gender focused approach is required to study the levels of vulnerability and coping mechanisms of different social groups. In this regard, various researchable issues in the area of climate change and gender, which need researchers' attention, could be enumerated as below:

Researchable Issues

The various researchable issues are:

1. What are the different roles and resources of women and men farmers with respect to climate change?
2. What are the differential perceptions and awareness of women and men farmers towards climate change?
3. What are the comparative vulnerabilities of men and women farmers to climate change?

4. What are the adaptive strategies followed by women farmers as compared to men farmers?
5. What are the institutional interventions for creating awareness among men and women farmers about climate change?

Objectives

1. To undertake gender analysis of roles and resources in crop and animal husbandry practices with respect to changing climate scenario
2. To study the perception and awareness of women and men farmers about climate change
3. To assess the relative vulnerabilities of women and men farmers to climate change
4. To document the adaptive strategies of women and men farmers towards climate change
5. To delineate the institutional interventions for climate change awareness and adaptation

Importance and scope of the study

In the present study an attempt has been made to throw light on the gender analysis, perception of the men and women farmers about climate change issues, their vulnerabilities, along with the understanding of various adaptive strategies related to climate change and agriculture. It has given an insight into the relationship between the farmer's perceptions about climate change and their demographic characteristics.

Besides this, the results of the study will also be useful to post-graduate students, researchers, and all those concerned with climate change issues in agriculture and education and rural development in India.

Limitations of the study

Single student investigation has the inherent limitations of time and financial resources. The study was conducted in the Bikaner district of Rajasthan state with limited number of respondents and the results are discussed in the specific context of the region. So, as such it is very difficult to generalize the findings to other areas. The findings are

based on the ability of 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. It assumes importance more so, in view of the diverse climate of India and varying impacts of climate change on agriculture in different parts of the country. Also the study is based on the expressed information and opinion of the respondents, which may not be free from individual biases and prejudices. Despite these limitations, no effort was spared to make the study as objective and systematic as possible.

Presentation of the thesis

The thesis is presented in five chapters. The first chapter deals with the introduction, giving the need, objectives, scope and limitations of the study. The second chapter, viz. review of literature, deals with the review of important studies related to the field of present study. In the third chapter, the research methodology used in the research work including operationalisation of the concepts, measurement procedure of the variables and the statistical tools used are presented. The fourth chapter deals with the results and discussions there on. The last chapter summarises the study with implications. The references and appendices are given at the end.

CHAPTER 2

BACKGROUND

Research in any field invariably requires a sound theoretical understanding of the problem under study. Climate change and adaptation are relatively new and emerging research areas in agricultural extension. Hence, there is a dearth of literature regarding various dimensions of human behaviour with respect to climate change. However, an attempt is made in this chapter to review the available related literature on theory and research in these and related areas and the same is presented appropriately in this chapter under the following heads:

2.1 Gender analysis

2.2 Awareness and perception to Climate change

2.3 Vulnerability to climate change

2.4 Adaptation strategies and Institutional Intervention

2.1 Gender analysis

Lambrou and Nelson (2010) found that men and women farmers stated clearly that the changes in key aspects of their farming activities over the past thirty years were linked to changes in climate variability. Men and women farmers described that the changes had led to increased workloads, but in different areas of work according to gender. Men and women farmers made different use of the available institutional support and it appeared that women had limited access to information relevant to farming in comparison to men. They also observed that decision regarding growing of different crop or to change cropping pattern was taken by husband (61%), wife (7%), joint (28%) and children (4%).

BRIDGE (2008) said that men and women will be faced with different vulnerabilities to climate change impacts due to existing inequalities such as, their role and position in society, access to resources and power relations that may affect the ability to respond to the effects of climate change.

Mehra and Rojas (2008) concluded that there is a gender gap and this gap persists, alongside a belief by many decision-makers across the developing world that women are only home producers or “assistants” in the farm households and not key economic agents.

FAO (2007) described that in urban areas, female-headed households are reported to have suffered a larger proportional drop in welfare than male-headed households as a result of the food price crisis.

Dercon (2005) have tried to assess the effect of drought on men and women farmers in Ethiopia. The result indicated that droughts were found to have a more severe effect on female-headed households in Ethiopia.

Mukhim (2000) observed that the recent introduction of formalized village management of the economy, which reinforces men's role as community managers, enables them to limit women's participation in community-level decision-making processes regarding natural resource management, including management of forests.

Bhatt (1998) described the focus group Participatory Evaluation Writing (PEW) method used by the Self Employed Women's Association (SEWA) in India to help poor women in explaining and analysing their vulnerability and the forces that influenced it. Particular focus was given on the capacity of women to assess and express their vulnerability.

Hence, the review of literature on gender analysis indicates that it is necessary to conduct a study on the different aspects of women's role in different activities related to crop husbandry, animal husbandry, daily household activities and their access to resources and control etc. especially in the changing context of climate change.

2.2 Awareness and perception to Climate change

CCAFS (2012) indicated that radio is the main communication source for the men respondents in Ghana to know about the weather information. Women do not generally own radio sets in the village setting and as such, receive the daily weather information through their husbands or sons when they are in the house and switch on their radio sets.

Osbahr *et al* (2011) reported that farmers perceived the regional climate to have changed in the past 20 years. Farmers also felt that temperatures had increased and seasonality and variability had changed. Farmers reported detailed accounts of climate characteristics during specific years, with droughts in the late 1990s and early 2000s, confirming local perceptions that there was a shift in climate towards more variable conditions that were less favourable to production.

A study conducted by Mubaya *et al* (2010) in Zambia and Zimbabwe, indicated that 80 per cent of farmers perceived a change in climate as they had noticed droughts and excessive rains in the past five years, which had both positive and negative impacts on farming. In the rural Sahel, local communities had a very clear memory of the years that were dominated by extreme climatic conditions and other significant events that affected production negatively. Households also perceived an increase in temperatures throughout the year with cold periods being shorter than warm and hot periods. Winds were also perceived to be stronger especially in dry seasons.

Rawat (2010) conducted a study on awareness about environmental issues and perceptions on climate change in Garhwal Himalaya region, Kunjapuri hills. The study revealed that about 50 per cent respondents were confused about environmental issues but they perceived a change in climate and increased temperatures. In addition, a majority perceived changes in temperature, erratic precipitation, and depletion of natural resources which had been taking place for the past 3 to 4 years.

Leiserowitz and Smith (2010) found that only 11 to 14 per cent respondents thought they were 'very well informed' about climate change (how the climate system works, causes, consequences, potential solutions to climate change), while 51 to 52 per cent said they were 'fairly well informed'.

Dhaka *et al* (2010) analysed farmers' perception and adaptation strategies to climate change in Bundi district of Rajasthan and concluded that most farmers perceived that the temperature distribution has undergone a significant shift in addition to an overall increase in temperatures. By contrast almost none believed they had decreased. The results for precipitation show a similar uniformity of opinion across the sample. A majority of farmers believed that the rainfall levels had decreased. Similarly, the overall perception on changes in precipitation is that the region is getting drier and that there are pronounced changes in the timing of rains and frequency of droughts. A

sizeable minority of respondent farmers also believed they had witnessed uneven distribution and unpredictable behaviour of the rains.

Patwal (2010) reported that the respondent's women farmers from Uttarakhand perceived that rainfall had become relentless with a decline in the overall rainfall for the past 10 to 15 years. At first, they thought that it was an act of God, and as a result they performed sacred rituals in order to normalise the weather patterns. Older women thought it was caused by increasing sins committed by the people. People even stopped worshipping traditional Gods and Goddesses which were mainly related to the natural resources around them. At a later stage, they understood that the problem was caused by changes in climatic patterns. Respondents also observed a snowfall that occurred 10 years after the regular annual feature and also less winter rainfalls, the rainfall cycle shift by 2 to 3 months. The people of Baunsari observed a significant decrease in major crops such as wheat, barley, pulses, and soybeans. The decrease in crop production was exacerbated by new diseases that destroyed crops. There was also an outbreak of insects that destroyed the crops. However, there were positive effects that were experienced by the people of the region. Ripening period for crops, especially wheat was shortened by 15 to 20 days.

Tripathi (2010) investigated perceptions of the local people on climate change in the *Indo-Gangetic* region. The study revealed that the people in the *Indo-Gangetic* region indeed perceived a significant change in temperature distribution and a definite reduction in the number of winter months, which then lasted for only two months. Almost cent per cent respondents perceived the changes in winter. However, these perceptions were not in line with traditional weather descriptions because temperatures were way above the normal. Rainfall patterns were perceived to be variable and declining from 1999 until 2008. The respondents observed that rains started later than normal and this was harmful for the maturing of crops. The respondents also observed a decrease in the number of cloudy days during the monsoon.

Bhushal (2009) conducted a study in Nepal, and observed that 92 per cent respondent's perceived long-term changes in temperatures of which 90 per cent respondents saw an increase in temperatures. The increase in temperatures was in line with statistical record of temperature data for the period between 1978 and 2007, which showed increasing trends, especially in winter. Although they observed irregular

climatic conditions such as malfunctioning of the ecosystem and biological system, they were not aware of climate change. Climate change was viewed in terms of increased warming throughout the year, reduced regular snowfalls, hail and rainfall when snow was expected, and irregular water-flow in the small rivers.

Nhemachena and Hassan (2007) tried to assess farmer's perception to climate change. The result indicates that 51.41 per cent farmers perceived that temperature is increasing, 26.94 per cent perceived that there was no change and 4.05 per cent said that they did not have any idea. On the other hand, the perception, 45.01 per cent of farmers on long term changes in precipitation is that the region is getting drier and that there are pronounced changes in the timing of rains and frequency of drought.

Meinke *et al* (2004) in a project study created a network among scientists and farmers by building partnership with stakeholders on climate change which helped to increase awareness.

Hence, the review of literature on awareness and perception about climate change indicates that it is necessary to conduct a study on the awareness level of men and women farmers to climate change and their perception about climate change.

2.3 Vulnerability to climate change

Sarkar (2010) concluded that majority of the farmer respondents, about 47 per cent, were in highly vulnerable group followed by about 37 per cent in vulnerable group, while about 17 per cent were in moderately vulnerable group in coastal region of West Bengal. The calculated vulnerability index revealed that a majority of the respondents belonged to highly vulnerable category due to climate change. Lack of knowledge and skills in technologies related to adaptive measures was observed, which further renders the people more vulnerable.

Akermann *et al* (2009) stated that water is scarce in India's semiarid zones of Rajasthan. Climate change is putting additional pressure on the rare resources. Irregular or no rainfall forces many small farmers to abandon their fields, at least temporarily, and seek work in the towns. Participative water management projects as practiced in Bhipur village, growing crops with low water requirements and more sustainable farming practices are adaptation strategies that allow farmers to continue their activities

despite climate risks. Such adaptation approaches are vital for the future in order to prevent the rural exodus and guarantee food security for the population.

Bhadwal *et al* (2007) opined that developing countries will be more affected by climate change because they depend more on climate sensitive sectors like agriculture, forestry, fishery etc. Under enhanced greenhouse conditions, the variability of monsoon is projected to increase resulting in recurring drought or flood which will affect agricultural production and increase the vulnerability of large agricultural population. Climate change also increases the stress on existing water resources.

O'Brien (2004) said that the areas with high to very high climate sensitivity for agriculture in India are located in the semi-arid regions of the country, including major parts of the Rajasthan, Gujarat, Punjab, Haryana, Madhya Pradesh, and Uttar Pradesh during the period 1961-1990. O'Brien also prepared the globalization vulnerability profile by combining the values of the adaptive capacity and import sensitivity indices for each district of India. The resulting map shows that high vulnerability is existing in most of the districts of the Rajasthan.

West (2002) created a vulnerability index for national level assessment of vulnerability based on a range of indicators taken mostly from published sources. He created a vulnerability index for each country.

Cannon (2001) developed a model of vulnerability analysis that subsumed all types of vulnerability of people to natural hazards into four headings- Initial well being (physical and mental condition, nutritional status); livelihood resilience (the ability to return to previous or new livelihood activities to secure needs); Self-protection (peoples' capacity and willingness to protect themselves from known hazards); Social protection (the presence of hazard precautions provided by levels of society above the household).

Bharara (1980) analysed the rainfall data for 78 years (1899-1976) of arid tract of Rajasthan and revealed that there were 43 mild drought years when 50 per cent of the crops reached maturity, 19 drought years (25 percent maturity) and 8 disastrous years (zero crop maturity). Social changes during drought years included a breakdown in the caste system and increased cooperation among people forced them to migrate to find a livelihood. Analysis of land use changes revealed a positive correlation between the

intensity of drought and the extent of the area damaged. Mean annual yield of kharif crops decreased from 90-100 per cent in a drought year and 30- 66 per cent in a moderately deficit year. Livestock losses ranged from 17 per cent for goats to 50 per cent for cattle during drought years.

Hence, the review of literature on vulnerability to climate change indicates that it is necessary to conduct a study on the relative vulnerability of men and women farmers to climate change.

2.4 Adaptation strategies and Institutional Intervention

CCAFS (2012) reported that a web based “Adaptation and Mitigation knowledge Network” platform is being established to share and exchange knowledge with the objective of linking gender differentiated farmers’ realities and experience on the ground with use of CCAFS research outputs.

Benedicta (2010) investigated farmers’ perception and adaptation to climate change in Ghana and reported that perceived rise in temperature was attributed to different causes by the respondent farmers. About 63.3 per cent of the farmers attributed it to deforestation, 18.9 per cent to bush burning, 3.3 per cent to increased population, and 8.9 per cent to other factors. 5.6 per cent respondents could not give any reason for the perceived change in temperature.

Lambrou and Nelson (2010) investigated and found that farming no longer entirely supports the needs of the farmers’. The farmers have come to rely largely on support from government employment and food distribution schemes as well as on loans and migration in order to earn additional income. While this support is accessed by all family members, it appears that services related to on-farm activities are available to men more so than women. The research has shown that farmers are getting by with this institutional support, but they are not thriving. In addition, there appears to be a gap between the advice provided and its uptake by farmers. Informal institutions, including traditional knowledge and neighbours, continue to be important sources of information for the farmers.

Kumar (2009) documented indigenous technological practices on rain-water management, soil and water conservation, wind erosion, tillage practices, crop and cropping systems, pests and disease management, soil fertility management, farm

implements, post-harvest technology, grain or seed storage, horticultural crops, veterinary and animal husbandry, fishery, ethno-botany and agro-biodiversity, weather forecasting, fuel management, thermal efficiency, waste water management, garbage disposal and management, food-product development, natural yarns, dyes, and weaves, low-cost housing material and ethnic food.

Nhemachena and Hassan (2007) conducted a study on various adaptation strategies used by farmers in response to changing climatic conditions in Southern Africa. The result indicated that less than 40 per cent of the respondents did not adopt any adaptation strategies. The result also showed that mixed crop and livestock farmers were associated with positive and significant adaptation to changes in climatic conditions and female headed households were more likely to take up adaptation options. It also found that households with access to electricity, tractors, heavy machines and animal power had better chances of taking up adaptation options.

Kurukulasuriya and Mendelsohn (2006) used multi nominal logit models to analyze crop and livestock choices adaptation options. The study on crop choice showed that crop choice is climate sensitive and farmers adapt to changes in climate by switching crops. The results from choice models from the livestock study showed that farmers in warmer temperatures tend to choose goats and sheep as opposed to beef, cattle and chicken. Goats and sheep can do better in dry and harsher conditions than beef and cattle.

Bradshaw (2004) assessed the adoption of crop diversification in Canadian prairie agriculture for the period 1994-2002, reflecting upon its strength and limitations for managing a variety of risks, including climatic ones. Result of study showed that individual farms have become more specialised in their cropping patterns since 1994 and this trend is unlikely to change in the immediate future, notwithstanding anticipated climate change and the known risk reducing benefits of crop diversification. The recommendation from the study was that there was a need to assess and understand the wider strength and limitations of various suitable and possible adaptations to change in climate.

Irland (2001) studied wood product market adaptation to ecological changes with particular focus on adaptation in land management.

Hence, the review of literature on adaptation and institutional intervention indicates that it is necessary to conduct a study on the adaptation strategies of men and women farmers to climate change. Review of literature indicates that institutions are very important means to increase the awareness of people to climate change and adapt to climate change in an effective manner.

CHAPTER 3**RESEARCH METHODOLOGY**

In this chapter various methodological components to achieve the objective of the study are outlined. Research methods and procedures followed in the present study are given. The choice of the methods was influenced by the nature of the study and the constraints of time. The various aspects included in the chapter have been given under the following sub heads:

- 3.1. Research design
- 3.2. Locale of the study
- 3.3. Sampling procedure
- 3.4. Variables and their measurement
- 3.5. Data collection tools and procedure
- 3.6. Statistical analysis

3.1. Research Design

According to Kerlinger (1964) a research design is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance.

According to Tripathi (1987) it is the general blueprint for the collection, measurement and analysis of data. It includes an outline of what the investigator will do from writing the hypotheses and their operational implications to the final analysis of the data.

An *ex-post facto* research design was adopted for the present study. According to Kerlinger (1964) an *ex-post facto* research is a systematic empirical enquiry in which the researcher does not have direct control over the variables because their manifestations have already occurred or because they are inherently not manipulable. The *ex-post facto* research design was used in the present study, as the manifestations of

the variables presumably had already occurred and there was no scope for manipulation of any variable.

3.2. Locale of the Study

In its 2004 initial communication to the United Nations Framework Convention on Climate Change (UNFCCC), India presented Rajasthan as one of the states in the country most vulnerable to the impacts of climate change. The First National Communication to the United Nations Framework Convention on Climate Change (UNFCCC, 2004) on vulnerability assessment to climate change reveals that Thar Desert is one of the most vulnerable regions in India. Although analysis of 100-year rainfall data for the arid region of Rajasthan indicates an increasing trend of 0.5 mm/year, but increased evapotranspiration demand due to global warming can put tremendous pressure on existing overstressed water resources of this region. The study was conducted in the hot arid region of Rajasthan as fourth assessment report of IPCC mentions that arid and semi-arid regions are more prone to devastating impact of climate change.

Rajasthan is a vibrant, exotic state where tradition and royal glory meet in a riot of colours against the vast backdrop of sand and desert. With the lofty hills of Aravali, one of the oldest mountain ranges of the world and the golden sand dunes of the Great Indian Desert, Rajasthan has the only desert of the sub-continent. Rajasthan is the largest state of India lying at the north-west of India and occupies an area of 342,239 square kilometer (comes to 10.4 per cent of India's land area). The state is surrounded by Punjab and Haryana State in the northern part, Uttar Pradesh and Madhya Pradesh State in the eastern part and Gujarat in the south-western part. The average annual rainfall is about 574 mm. About 76 percent of the state's population resides in rural regions. The forest cover of the state is 32,639 sq. Kilometres, contributes 4.19 percent to the national forest cover. 62,94,000 hectare of land is irrigated in the state, which is 10.45% of the net irrigated area of India and 38 percent of net sown area of the state of Rajasthan. Rajasthan produces 5.49 percent of the nation's total food grains production and 21.31 percent of its oil seeds. The state has 49 million livestock mainly cows, buffaloes, and goats comprising 10.13 percent of the country's livestock population. Administratively, the state comprises of 33 districts, 39,753 inhabited villages, 249 *Panchayat Samities* and 9168 gram *Panchayats*.

The study was conducted in Bikaner district of Rajasthan state which is selected, according to O'Brien *et al* (2004) most vulnerable map, purposively as it comes in the Thar Desert where impact of climate change is seen. Bikaner district is located in the north-western part of Rajasthan. It is bounded on the north by Ganganagar district, on the east by Churu and Nagaur districts, on south by Jodhpur and Jaisalmer districts and on the west by international border with Pakistan. The total geographical area of Bikaner district is 30,247.90 sq. kilometers with a population of about 2.36 million and sex ratio of 905. It has a very low literacy level of 65.13 per cent and male and female literacy were 75.90 and 53.23 respectively. Bikaner district consist of eight sub-divisions and eight *tehsils*. Total irrigated area and total rainfed area of Bikaner is 179000 hectares and 144324 hectares respectively. Total forest cover of the district is 81,262 hectares. Annual rainfall of Bikaner district is 263 mm and normal rainy days are 16. Main source of irrigation is canal (64%) followed by bore wells (36%). Major soil of the district is deep yellowish brown sandy soil and deep light yellowish brown loamy soils. Cropping intensity of the district is 112.6%.

Table No. 3.1 District Agriculture Profile

District Agriculture profile			
Agro-Climatic/Ecological Zone			
Agro Ecological Sub Region (ICAR)	Western Plain, Kachchh and Part Of Kathiawar Peninsula, Hot Arid Eco-Region		
Agro-Climatic Zone (Planning Commission)	Trans Gangetic Plain Region (VI)		
Agro Climatic Zone (NARP)	Irrigated North West Plain Zone (RJ-2)		
Geographic coordinates of district headquarters	Latitude	Latitude	Altitude
	28 ⁰ 01'20.30" N	73 ⁰ 18 57.64" E	245.7m

Almost 90 percent of the total annual rainfall is received during the southwest monsoon, which enters the district in the first week of July and withdraws in the mid of September. As the district lies in the desert area, extreme of heat in summer and cold in winter is the characteristic of the desert. Atmosphere is generally dry except

during the monsoon period. The humidity is highest in August with mean daily relative humidity is 71% in the morning and 52% in the evening.

3.3. Sampling Procedure

A survey approach was used. The two stage stratified random sampling technique was used for selection of the sample. The respondents selected randomly comprised the sample for the study. Out of the eight blocks of Bikaner district, two blocks were selected randomly. Thus, Nokha and Kolayat blocks were selected for the study. From each block two villages were selected randomly and from each village fifteen men farmers and fifteen women farmers were selected for the study. Thus, Gajsukhdesar and Salundia villages of Nokha block, Modayat and Mankasar villages of Kolayat block were selected for the study. Thus a total of sixty men and sixty women farmers constituted the sample size. These one hundred and twenty farmers were personally interviewed by the researcher for collecting data on the different aspects of climate change.

3.4. Variables and their Measurement

The appropriate variables for the present study were prepared based on the objectives of the study, review of literature, discussion with experts and also the observations made by the researcher.

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

According to Kerlinger (1964) an operational definition is a specification of the activities of the researcher in measuring a variable or in manipulating it. The operational definitions of the variables taken under study are given below:

3.4.1 Age: It is defined as the chronological age of the respondent at the time of interview expressed in terms of completed years. The respondents were classified into three categories.

Category	Score
1.Young (35 years and below)	1
2.Middle aged (36-59 years)	2
3.Old (60 years and above)	3

3.4.2 Education: Education refers to formal schooling of respondents measured in years of schooling completed by respondent. It was operationalized by using the criteria of functional literacy and the number of years of formal education of the respondents. Following scoring procedure was used in this study.

Education	Score
1. Illiterate	1
2. Functionally literate	2
3.Primary school passed	3
4. Secondary school passed	4
5. College graduates	5

3.4.3 Family type

It was measured in terms of cooking arrangements and pooling of income. The families that had pooled all their income and had common cooking arrangement despite the presence of more than a couple were considered joint family and otherwise, nuclear. Data were collected with interview schedule and the scoring pattern followed was as under:

Family type	Score
Nuclear	1
Joint	2

3.4.4 Occupational Status

Occupational status refers to the major activity of the respondent in which he or she was involved for most part of the day, and which generates the major part of family income. For this, an arbitrary scoring system was developed as follows:

Category	Code
Fulltime farmer	1
Farming and other occupation	2

3.4.5 Perception

Perception is the way of processing raw data which is perceived by the sensory organs from the environment into meaningful patterns. Perception is the feeling and understanding of the respondents towards climate change and its impacts on agriculture. Climate change perceptions of the men and women farmers assume greater significance as they provide behavioural foundation for climate change adaptation and mitigation in agriculture. So an attempt was made to study the respondent's perception towards present state of climate change and its impact on agriculture.

Individual's perception about climate change was measured by using the modified scale of Manohar (2013). The scale is of fifteen statements and the response for each statement was rated over a five-point continuum which ranged from strongly agree to strongly disagrees. 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

3.4.6 Gender analysis

The term 'gender' refers to the social construction of the concepts of woman and man, femininity and masculinity. The study of the different roles of women and men in crop husbandry, animal husbandry and in routine family activities was included to understand what they do and what resources they have (FAO, 2010).

3.4.7 Level of awareness of farmers

The level of awareness was operationalized as the degree to which the farmers had information related to climate change.

To measure the extent of awareness, a set of statements reflecting various activities of climate change were developed and the farmers' response was documented as yes or no to the statements and a corresponding weightage of one and two is given for yes and no responses, respectively.

3.4.8 Fatalism

Fatalism was operationalized as "a theoretical set of guidelines holding that all events are predetermined in advance for all time and men and women are powerless to change them". Fatalism was measured by using the modified scale of Leiserowitz (2006). Fatalism was measured on a five-point scale from strongly agree to strongly disagree with a scoring pattern of 5 to 1 for positive items and 1 to 5 for negative item.

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

3.4.9 Egalitarianism

Egalitarianism refers to a social and political beliefs asserting the equality of all men and women, especially in their access to the rights and privileges of their society.

Egalitarianism was measured by using the modified scale of Leiserowitz (2006). Egalitarianism was measured on a five-point scale from strongly agree to strongly disagree with a scoring pattern of 5 to 1 for positive items and 1 to 5 for negative item as there was a one negative statement.

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

3.4.10 Social participation

Social participation in any of the organization not only indicates a person's social

orientation but also provides an opportunity for the individual to have a wider contact and greater influence in the social system, which is very important for securing services from resource centre or any other organization for socio- economic and cultural development.

Social participation referred to the degree of involvement or participation of the respondents in formal organization either as a member or as office bearer. Modified scale of Trivedi (1963) was used for measurement. The score assigned for member and non member was two and one respectively.

3.4.10 Communication variables

3.4.10.1 Contact with personal localite channel

Personal Localite refers to both acquaintance and contact of respondents with local leaders and local people who belong to the respondents' own social system. To measure the extent of personal localite, a schedule was developed which is given in Appendix. The scores 4, 3, 2, 1 were assigned for the four-point continuum, viz., most often, often, sometime and never, respectively.

3.4.10.2 Contact with extension personnel

Extension contact refers to both acquaintance and frequency of respondents contact with village extension officer, Block Development Officer (B.D.O), stockman, veterinary surgeon, bank officials etc. To measure the extension contact, a schedule was developed. The 4, 3, 2 and 1 score were assigned to a four-point continuums, viz., most often, often, sometime and never, respectively.

3.4.10.3 Mass media exposure

Mass media exposure is the degree of utilization of mass media by the respondents. To measure this, a schedule was developed which is given in Appendix.

3.4.11 Vulnerability

Vulnerability refers to the inability of individuals or social groups to cope up with or adapt to climate change induced stresses placed on their livelihood and well being.

Considering the various dimensions of individual (attitudinal, knowledge and skills) as well as social participation, physical resources, and other livelihood support system, Vulnerability index was worked out to analyze farmers' vulnerability to climate change. Vulnerability index includes the degree of positive or negative

predisposition of individuals towards climate change and related issues, level of awareness and skill possessed by the individuals about adaptation, extent of social participation and possession of physical resources.

3.4.12.1 Adaptation strategies

De Chavez and Tauli-Corpuz (2008) defined climate change adaptation as the process by which ecological, social, or economic systems adjust to actual or expected climatic stimulus and their effects or impacts. Adaptation is widely recognized as a vital component of any policy response to climate change because it helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socioeconomic conditions, including climate variability extreme weather conditions such as droughts and floods, and volatile short-term changes in local and large-scale markets (Kandlinkar and Risbey, 2000).

Adaptation means “a process by which strategies to moderate, cope with, and take advantage of the consequences of climate events are enhanced, developed and implemented” (Selvaraju et al., 2006).

Adaptation refers to the adjustment made by the people in their behaviour or economic and livelihood patterns that reduce their vulnerability to climate change induced stresses. Needs of farmers and their suggestions were elicited with focus group discussion as well as with structure and semi structure schedule- based interviews with them. Adaptation strategy was documented with structured and semi-structured schedule based interview with the farmers.

3.4.12.2 Indigenous traditional knowledge

ITK is the knowledge that people in a given community have developed over time and continue to develop it. It is based on experience, often tested over long period of time, adapted to local culture and environment, dynamic and changing and lay emphasis on minimizing risks rather than maximizing profits.

Traditional ecological knowledge refers to the knowledge base of the community created, maintained and carried down the generation by the community for sustainable use of natural resources for livelihood and conservation of ecosystem in their area. Indigenous knowledge arises out of continuous experimentation, innovation and adaptation, blending many knowledge systems to solve local problems (UNFCCC, 2003).

Documentation of adaptation strategies and ITK was done through interviews, semi-structured schedule based interview and in-depth discussion with the farmers.

3.4.13 Institutional interventions

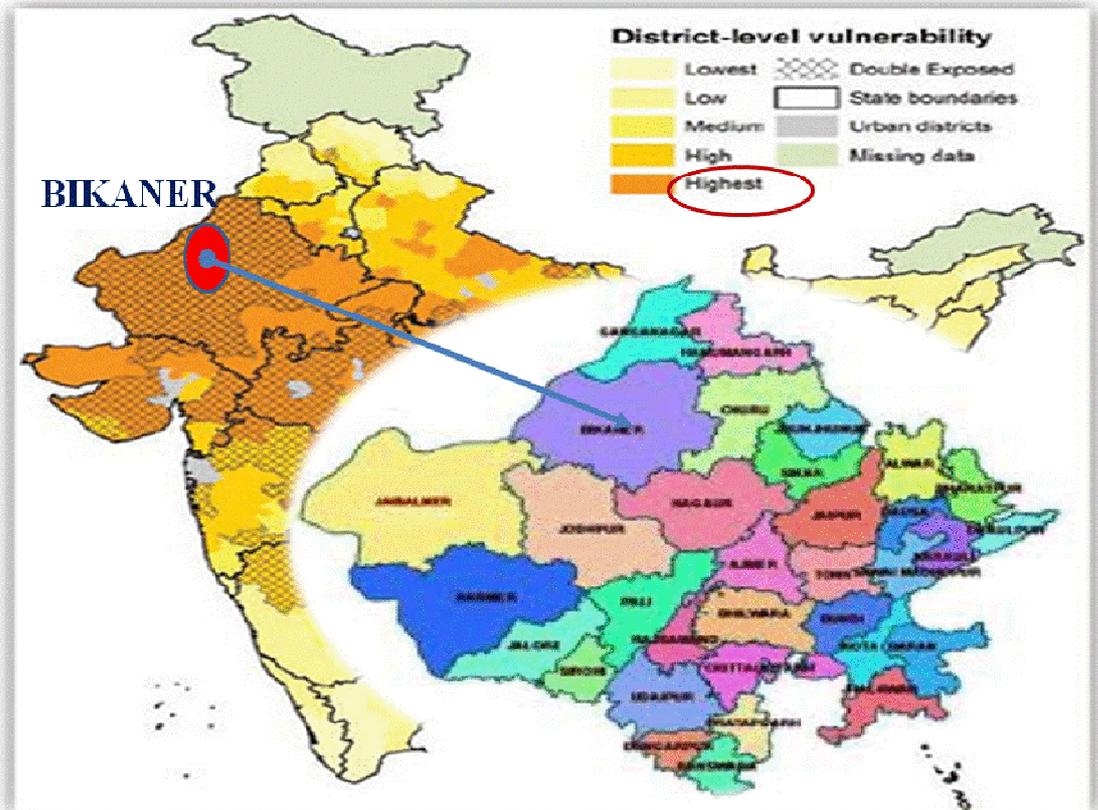
Documentation of institutional interventions was done through personal interviews and in-depth discussion with farmers and officials as well as use of secondary sources.

3.5. Method and tools of data collection

Taking into consideration the scope and objectives of the study a well structured interview schedule was prepared. The field survey was conducted during January-February, 2013. The collected data were coded and tabulated for statistical analysis. Survey, in-depth discussion and participant observation methods were used for collection of primary data. The secondary sources were also used for secondary data to enrich the primary data and analysis.

3.6. Analysis of Data and Application of Statistical Techniques

The quantification of qualitative data was done in accordance with the standards laid down and tabulated to draw meaningful inferences. The data were analysed using frequency tables, simple percentage, arithmetic mean, standard deviation, and test of significance wherever appropriate. SPSS (Statistical Package for Social Sciences, Version 17.0) was used to analyse the data. The non-parametric test like, Wilcoxon sign rank test and Mann-Whitney U test was used.



Source: O'Brien et al. (2004)



Plate-1: Map of the study area



Plate-2: The pictures of the study area taken by the researcher during data collection

Plate -3: Focused group discussion with men and women farmers during data collection



CHAPTER 4**RESEARCH PAPER - I****Gender analysis of roles and resources in crop and animal husbandry practices with respect to changing climate in arid ecosystem**

“Gender inequality is more pervasive than other forms of inequality. It cuts across other forms of inequality so that it is a feature of rich as well as poor groups, racially dominant as well as racially subordinates groups; privileged as well as ‘untouchable’ caste. Gender inequality intersects with economic deprivation to produce more intensified forms of poverty for women than men. Gender inequality is part and parcel of the processes of causing and deepening poverty in a society and must therefore constitute part and parcel of measures to eradicate poverty.”

(Kabeer, 2003)

4.1.1 Abstract

Women in rural India play a major role in shaping country’s economy. Gender refers to the roles that men and women play and the relationship that arise out of these roles, which are socially constructed, not biologically determined. It refers to those characteristics of men and women that are socially and culturally determined that is the different behaviour, roles, expectations and responsibilities all men and women learn in the context of their own society. The study focussed of the different roles of women and men in order to understand what they do in crop husbandry practices, their role in animal husbandry practices as well as in routine family activities. According to the FAO (2010) report, agriculture is under performing in many developing countries, in part because men plus women do not have equal access to the resources and opportunities they need to be productive. Across countries and contexts women have consistently less access than men to average assets, inputs, services and rural employment opportunities. Increasing women’s access to land, livestock, education, functional services, extension, technology in rural areas would increase their productivity and generate gains in agricultural output, food security, economic growth and social welfare. The gains in agricultural production alone could lift 100-150 million people out of hunger. This investigation was aimed at assessing different roles

and resources of men and women farmers in crop and animal husbandry practices with respect to changing climate scenario. The study was conducted in the Bikaner district of Rajasthan. Two stages Stratified random sampling procedure was followed in selection of respondents. Total sample size was 60 men and 60 women farmers. This study used gender analysis to document and interpret how men and women farmers ensured their livelihood and food security. The salient finding revealed that in crop husbandry activities, women were doing mainly field work like harvesting; intercultural operations and these activities are affected by climate change. Hence, their work load and drudgery needs to be addressed. Majority of the work in the animal husbandry activities and routine household activities were done by the women farmers as compared to men farmers. Closing the gender gap is not only the right thing to do, it is crucial for agricultural development and food security.

Key words: Gender analysis, Climate change, Crop and animal husbandry practices

4.1.2 Introduction

Climate change is posing to be the greatest challenge to mankind at global as well as local levels. Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (decades or longer). Development of strategies for supporting adaptation and responding to the consequences of climate change will require collaboration at local, regional and global level, across disciplinary boundaries and between different sectors of the economy.

Women's contribution to agriculture has been found to be considerable, the major contribution being in livestock based activities (60-90%). however their access to allocative resources and income is negligible. Gender and development approach proposed that in order to change the women's situation it is necessary to understand how it is maintained. This means examining the social and economic roles of women and men of different classes, age and ethnic groups. It is necessary to question the framework to which we refer in development interventions in terms of whether they support gender ideologies and power structure that exist in our society. Agriculture today is increasingly becoming a women activity. As per the 2011 census the women work force in agriculture and allied sectors is around 98 million which amounts to about 37 per cent of the total agricultural workers in the country. In the changing scenario, the

participation of women workforce in agriculture is going to increase by 50 per cent by 2020. Thus it is necessary to identify and address gender issues in agriculture especially in changing climate change scenario. The ratio between women and men agricultural labour and cultivators has gone up. Rural India is thus witnessing an intriguing process described as ‘feminization of agriculture’. With shrinking land holding size and decreasing family income, there are high men out migration to seek better jobs. This leaves the women who are already overburdened and not so well equipped with the technical knowhow due to lack of literacy and extension contacts, with greater responsibilities of managing both the household and farm. Better access to resources also allows women to devote more time to income-producing activities and to caring for their own needs as well as those of their families.

Understanding the concept of gender and being gender sensitive is important for food and nutritional security. We have to focus on the gender roles and relations of men and women, the primary decision-makers in the study households, while noting that gender roles are not static and are shaped over time by other differences such as age, class and caste. Furthermore, there is need to close the gender gaps. Two recent flagship reports, State of Food and Agriculture (2010-2011) report, World Development Report (2012), give attention to gender issues in agriculture and the need to close the gender gaps. This will be conducive to improve agriculture productivity, food security and nutrition. Delivering on this potential will require gender disaggregated data to improve an understanding of what works.

4.1.3 Methodology

The study was undertaken in the Bikaner district of Rajasthan state. Total sample size consisted of 60 men farmers and 60 women farmers, thus 120 respondents. Men and women respondents were selected through two stages stratified random sampling. The respondents’ perception was assessed through interview schedule covering different dimensions of their work in crop husbandry, animal husbandry and in routine family activities. The selected respondents were interviewed personally with the help of a well structured interview schedule and their responses were recorded. The data thus collected were tabulated and statistically analysed to interpret the results. Descriptive statistics were used to characterize respondents’ perceptions. Non-parametric test like Mann

Whitney U Test and Wilcoxon Signed Ranks Test were used to test the statistical significance.

4.1.4 Results

4.1.4.1 Socio-economic profile of men and women farmers

Age

Age is considered to be one of the important factors for taking decisions about adoption of new technology and taking up new enterprise to increase the income. Because of the mental maturity and psycho-physical energy associated with age, it plays vital role in decision making. Thus age has been considered as one of the variables in this study.

It was observed that a majority of the men and women farmers belonged to middle (46.6% and 53.3%), followed by young (30% and 25%) and old (23.3% and 21.6%) age categories respectively (Table 4.1.1).

Table 4.1.1: Distribution of respondents according to age (N=120)

Age Category	Men (n=60)		Women (n=60)	
	Frequency	Percentage	Frequency	Percentage
Young	18	30	15	25
Middle	28	46.67	32	53.33
Old	14	23.33	13	21.67

Education

Education is one of the important factors which accelerate growth and development. Since farming by and large is a family profession, all the members of the family perform various farm related task and so are capable of effective improvement in farming. The data collected regarding educational level of the respondents are presented in Table. 4.2. The data reveal that 10 per cent of men respondents and 51.6 per cent were illiterate, 23.3 per cent men and 6.66 per cent women farmers had primary school education, 31.6 per cent men and 6.66 per cent were having upper primary level education and 10 per cent men and 3.33 per cent women had secondary level education and only 10 per cent of the men and 3.33 per cent women respondents were graduate. However, that the more than 80 per cent of men farmers could read and write, was encouraging to note.

Table 4.1.2: Distribution of respondents according to education

(N=120)

Education	Men (n=60)		Women (n=60)	
	Frequency	Percentage	Frequency	Percentage
Illiterate	6	10.00	31	51.67
Functionally literate	11	18.33	17	28.33
Primary school	14	23.33	4	6.67
Upper primary school	19	31.67	4	6.67
Secondary school	6	10.00	2	3.33
College and above	4	6.67	2	3.33

Occupation

About 78.3 per cent of the men respondents and 80 per cent of women respondents had agriculture as the main occupation. However, only 21.6 per cent of the men respondents and 20 per cent respondents had agriculture as their major occupation and dairy as subsidiary occupation (Table 4.1.3).

Table 4.1.3: Distribution of respondents according to Occupation

(N=120)

Occupation	Men (n=60)		Women (n=60)	
	Frequency	Percentage	Frequency	Percentage
Full time farming	47	78.33	48	80
Farming plus other subsidiary	13	21.67	12	20

Family Type

About 43.3 per cent of the men respondents and 38.3 women respondents belonged to nuclear family while 56.63 per cent of men respondents and 61.6 per cent women respondents lived in a joint family system (Table 4.1.4). So, most of the respondents cultivated land together and had cooking and living etc. under common roof.

Table 4.1.4: Distribution of respondents according to Family type

(N=120)

Family type	Men (n=60)		Women (n=60)	
	Frequency	Percentage	Frequency	Percentage
Nuclear	26	43.33	23	38.33
Joint	34	56.67	37	61.67

Social participation

Participation in any of the social organizations not only indicates one's social orientation but also provides an opportunity for the individual to have wider contact and greater influence in the system, which is very important for securing services and supplies necessary to achieve success in this enterprise. Social participation is also very important for getting information of daily weather parameters and information related to climate change. People who have wider contact in the social system are getting information through the different communication sources. The data regarding social participation is presented in table 4.1.5.

Table 4.1.5: Distribution of the respondents according to their social participation (N=120)

Social participation	Men (n=60)		Women (n=60)	
	Frequency	Percentage	Frequency	Percentage
Gram panchayat	1	1.66	1	1.66
Credit cooperative society	0	0.0	0	0.0
Milk-cooperative society	41	68.33	46	76.66
Rural youth club	16	26.60	13	21.60
Religious committee	47	78.33	33	55.00
Political organisation	9	15.00	2	3.33
Anganwari	0	0.0	11	18.33
Self help group	0	0.0	23	38.3

The village organizations prevalent in the area were religious committee, milk cooperative society, rural youth club, political organization etc. Most of the men respondents were members of any of these organisations. Majority of the women were found to be members of milk co-operative society, religious committee, self help group, rural youth club, anganwari etc.

Communication variables

Personal localite channel

The study revealed that the men respondents maintained good personal localite contacts as 46.7 per cent of the men respondents most often got information from neighbours followed by opinion leader (23.3%) and friends or relatives (3.3%) (Table 4.1.6). The sources would be highly useful for promoting awareness about climate change and related adaptive measures.

Table 4.1.6: Distribution of the men respondents according to their personal local source of information

(N=60)

Source	Most often (%)	Often (%)	Some times (%)	Never (%)
Neighbours	28 (46.6)	11 (18.3)	21 (35)	0
Friends/ Relatives	2 (3.3)	14 (23.3)	40 (66.6)	4 (6.6)
Opinion leaders	14 (23.3)	11 (18.3)	12 (20)	23 (38.3)

The study revealed that the women respondents also maintained good personal localite contacts as 66.6 per cent of the women respondents most often got information from neighbours followed by opinion leader (6.6%) and friends or relatives (3.3%) (Table 4.1.7).

Table 4.1.7: Distribution of the women respondents according to their personal local source of information

(N=60)

Source	Most often (%)	Often (%)	Some times (%)	Never (%)
Neighbours	40 (66.6)	9 (15)	11 (18.3)	0
Friends/ Relatives	2 (3.3)	8 (13.3)	46 (76.6)	4 (6.6)
Opinion leaders	4 (6.6)	10 (16.6)	9 (15)	37 (61.6)

Extension personnel

Table 4.1.8: Distribution of the men respondents according to their extension source of information (N=60)

Source	Most often f (%)	Often f (%)	Sometimes f (%)	Never f (%)
V.L.W.	4 (6.6)	10(16.6)	19 (31.6)	27(45)
A.D.O.	4 (6.6)	2 (3.3)	19 (31.6)	35(58.3)
B.D.O.	0	0	2 (3.3)	58 (96.6)
Bank personnel	0	0	2 (3.3)	58 (96.6)
Cooperative official	0	0	2 (3.3)	58 (96.6)
Expert from research	0	0	2 (3.3)	58 (96.6)
Stockman/Input dealer	4 (6.6)	21 (35)	24(40)	11(18.3)
K.V.K.	2(3.3)	2(3.3)	4 (6.6)	52(86.6)

Hence the stockman was the major source of information for men farmers

Table 4.1.9: Distribution of the women respondents according to their extension source of information (N=60)

Source	Most often f (%)	Often f (%)	Sometimes f (%)	Never f (%)
V.L.W.	2 (3.3)	2(3.3)	19 (31.6)	35(58.3)
A.D.O.	0	0	6 (10)	54 (90)
B.D.O.	0	0	0	60 (100)
Bank personnel	0	0	0	60 (100)
Cooperative official	0	0	0	60 (100)
Expert from research	0	0	0	60 (100)
Stockman	0	0	9 (15)	51(85)
K.V.K.	0	0	0	60 (100)

Results show that women farmers have hardly any extension contact.

Mass media exposure

Radio (28.3%) was the main source of mass media for men respondents for seeking climate change information in research area followed by newspaper (10%) and T.V. (6.6%).

Table 4.1.10: Distribution of the men respondents according to their mass media exposure (N=60)

Source	Most often f (%)	Often f (%)	Sometimes f (%)	Never f (%)
News paper	6 (10)	11 (18.3)	12 (20)	3 (51.6)
Radio	17 (28.3)	18 (30)	20 (33.3)	5 (8.3)
T.V.	4(6.6)	8(13.3)	21(35)	27 (45)
Pamphlet/Bulletin	0	0	2(3.3)	58 (96.6)
<i>Krishimela/Pasu mela</i>	0	0	22 (36.6)	38(63.3)
Group meeting	0	9 (15)	19 (31.6)	32(53.3)
Film	0	0	2(3.3)	58 (96.6)

Table 4.1.11: Distribution of the women respondents according to their mass media exposure (N=60)

Source	Most often f (%)	Often f (%)	Sometimes f (%)	Never f (%)
News paper	4(6.6)	5 (8.3)	4(6.6)	47 (78.3)
Radio	5 (8.3)	7 (11.6)	11 (18.3)	37 (61.6)
T.V.	2(3.3)	8(13.3)	16(26.6)	24 (40)
Pamphlet/Bulletin	0	0	2(3.3)	58 (96.6)
<i>Krishimela/Pasu mela</i>	0	0	0	60 (100)
Group meeting	0	5 (8.3)	9 (15)	46 (76.6)
Film	0	0	2(3.3)	58 (96.6)

According to the data furnished in table 4.1.11, the utilization of other mass media like pamphlet or bulletin, *krishi mela/ pasu mela*, group meeting and films are very low. So, to increase awareness about climate change and its impacts among the men and women farmers radio, community radio could be used as a mass media more effectively supplemented with newspaper. Hence climate change communication and extension

education has to reach farmers in villages to enhance their awareness and knowledge in this area.

Gender analysis

Men and women farmers' role in the crop husbandry practices, animal husbandry practices and routine family activities were analysed. The results are presented in Table 4.1.12. to Table 4.1.14.

Table 4.1.12. Comparative participation and role analysis (%) in crop husbandry practices as perceived by men and women respondents (N=120)

Sr. No.	Activities	Perception of men		Perception of women		Overall Perception		Mann Whitney U Test
		Men	Women	Men	Women	Men	Women	
1	Land preparation	62	38	60	40	61	39	-4.454**
2	Sowing	84.25	15.75	60.83	39.16	72.54	27.45	-8.302**
3	Manure and fertilizer application	61.66	38.33	57.5	42.5	59.58	40.41	-3.814**
4	Inter-cultural operations	39.33	60.66	42.16	57.83	40.75	59.25	-5.693**
5	Irrigation	80	20	60.66	39.33	70.33	29.66	-6.899**
6	Plant protection measures	75	25	52.5	47.5	63.75	36.25	-5.720**
7	Harvesting	45	55	44.5	55.5	44.75	55.25	-2.229
8	Threshing	55.5	44.5	59.83	40.16	57.66	42.33	-2.716**
9	Winnowing	61	39	50.66	49.33	55.83	44.16	-2.851**
10	Storing grains	42	58	40.83	59.16	41.41	58.58	-5.476**
11	Marketing of produce	90	10	75	25	82.5	17.5	-9.659**

significant at $p < 0.01$ level, **Test Statistics Mann Whitney U Test

The result revealed that land preparation (61%), sowing (72.54%), manure and fertilizer application (59.58%), irrigation (70.33%), plant protection measures (63.75%), threshing (57.66%), winnowing (55.83%) and marketing of produce (82.5%) were the crop husbandry practices mainly done by the men members of the family. Activities like

inter-cultural operations (59.25%), harvesting (55.25%), and storing of food grains for consumption purpose (58.58%) were the crop husbandry activities mainly done by the women members of the family.

In the further analysis, researcher discarded the perception of men farmer's about the men and perception of women farmer's about the women. These findings show that there was significant difference in participation of men and women farmers in all the crop husbandry practices. Climate change can increase women farmer's work load in the field as they are mainly responsible for post harvest activities. Women farmers were mainly responsible for the storage of food grains. They have very less participation and access to the marketing practices. Since in future women farmers will play a greater role in agriculture, it is necessary to identify and address drudgery and farm mechanization issue so to reduce drudgery, enhance safety and increase earning and efficiency.

Table:4.1.13 Comparative participation and role analysis (%) in animal husbandry practices as perceived by men and women respondents (N=120)

Sr. No	Activities	Perception of men		Perception of women		Overall Perception		Mann Whitney U Test
		Men	Women	Men	Women	Men	Women	
1	Fodder cutting	45.66	54.33	43.5	56.5	42.8	54.08	-2.342**
2	Transportation of fodder	35	65	49.66	50.33	42.33	57.66	-2.562**
3	Offering fodder to the animals	30	70	29.07	70.93	29.5	70.46	-6.374**
4	Cleaning of sheds	15	85	31.5	68.5	23.25	76.75	-9.009**
5	Offering water to the animals	40	60	37	63	38.5	61.5	-4.444**
6	Milking	14	86	24.66	75.33	19.33	80.66	-7.452**
7	Livestock product selling	73.5	26.5	60.83	39.16	67.16	32.83	-7.185**
8	Raising of goats and sheep	70	30	60	40	65	35	-6.058**
9	Animal health care	45	55	40	60	42.5	57.5	-3.846**
10	Artificial insemination	65	35	58	42	61.5	38.5	-4.790**

**significant at $p < 0.01$ level

The data in the table 4.1.13 show that livestock product selling (67.16%), raising of goat and sheep (65%), and artificial insemination (61.5%) were the animal husbandry practices mainly done by the men members of the family. Activities like fodder cutting (54.08%), transportation of fodder (57.66%), offering fodder to the animals (70.46%),

cleaning of sheds (76.75), offering water to the animals (61.5%), milking (80.66%), and animal health care (57.5%), were the animal husbandry activities mainly done by the women members of the family.

In the further analysis, researcher discarded the perception of men farmer's about the men and perception of women farmer's about the women, and findings show that there was significant difference in all the animal husbandry practices between men and women farmers.

The data in the table 4.1.14 show all the routine family activities like collection of fuel and fire wood (72.25%), preparation of food (92.5%), child care (57.16%), care for elders and sick (62.5%), cleaning and repair (80%), collecting water for domestic purpose (73.5%) and collection of vegetables and fruits (61.58%) were performed by the women members of the family.

In the further analysis, researcher discarded the perception of men farmer's about the men and perception of women farmer's about the women and findings show that except for caring for elders and sick, there was significant difference in all the routine family practices.

The participation of women farmers in routine family activities was found to a greater extent in collection of water for food preparation, bathing, washing of cloths etc. they had major role in the caring of elders members of family but in economic activities their participation were very low. Verma (1989) also find that women had about equal participation in the crop husbandry activities, but in animal husbandry activities and in routine family activities their participation was very high.

Table: 4.1.14 Comparative role analysis (%) in routine family practices as perceived by men and women respondents

(N=120)

Sr. No	Activities	Perception of men		Perception of women		Overall Perception		Non-parametric test
		Men	Women	Men	Women	Men	Women	
1	Collection of fuel and fire wood	35.5	64.5	20	80	27.75	72.25	-7.226**
2	Preparation of food	10	90	5	95	7.5	92.5	-9.584**
3	Child care	47.83	52.16	37.83	62.16	42.83	57.16	-2.931**
4	Health services	40	60	35	65	37.5	62.5	-.096
5	Cleaning and repair	25	75	15	85	20	80	-7.997**
6	Collecting water	23	77	30	70	26.5	73.5	-5.858**
7	Collection of vegetables and fruits	40.33	59.66	36.5	63.5	38.41	61.58	-4.447**

significant at $p < 0.01$ level, **Test Statistics Mann Whitney U Test

The data in the table 4.1.15 shows that, for men farmers there is significant difference in the natural assets and social assets, while for human, physical and financial assets, there were no significant difference when compared with their role in these assets, a decade ago. Present livelihood security of men farmers in the human assets, when compared with their role a decade ago, shows non-significance. Wilcoxon Signed Ranks Test was used for comparison of result between earlier and changing livelihood security.

Livelihood security was assessed by through taking five essential components as human, social, physical, natural and financial assets. Women have very low access and control on the financial assets. In above findings we saw that women had high participation in livestock activities and substantial participation in the crop husbandry activities but in the

financial activities like marketing of produce, livestock product selling, their participation was low.

Table 4.1.15: Changes in Livelihood Security of men and women farmers (N=120)

Sr. No.	Livelihood Security Parameter	Men		Women	
		Z	Asymp. Sig. (2-tailed) ^a	Z	Asymp. Sig. (2-tailed) ^a
1	Human assets	-1.768	.07	-3.394**	.001
2	Natural assets	-2.463**	.01	-.354	.723
3	Social assets:	-2.633**	.00	-4.400**	.000
4	Physical assets	-.545	0.58	-4.228**	.000
5	Financial assets	-1.017	0.30	-3.099**	.00

**significant at $p < 0.01$ level

a. Wilcoxon Signed Ranks Test

The data in the table 4.1.15 show that, for women farmers there is significant difference in the human assets, social assets, physical assets and financial assets when compared with to a decade ago in terms of livelihood security. Present status of women farmers in the natural assets, when compared a decade ago, shows non-significance. Wilcoxon Signed Ranks Test was used for comparison of results between earlier livelihood security and changing livelihood security.

4.1.5 Discussion

Gender refers to the roles that men and women play and the relationships that arise out of these roles, which are socially constructed, not biologically determined. This investigation was aimed at assessing different roles and resources of men and women farmers in crop and animal husbandry practices as well as comparison between their roles in the livelihood security assets with respect to changing climate scenario. During the investigation it was observed that most of the work in the animal husbandry practices and routine family activities was done by the women farmers. In crop husbandry practices though men farmer's contribution was more in some activities like sowing and irrigation but women farmer's also had substantial contribution in it. Women farmer's had very less control over the revenue which was generated in either crop husbandry practices due to their insignificant participation in marketing. The findings of the study are consistent with the study of Lambrou and Nelson (2010) which

state that due to climate change, water scarcity is created which has increased the work load of women farmers as they are mainly responsible for collection of water. So, climate change can affect men and women farmers in differential way. Women farmers had major contribution in harvesting. They use traditional drudgery inducing tools as do manual work suit for women farmers. So, focus should be given to develop and disseminate and make valuable drudgery reducing tools. Further large scale research studies on this topic need to be undertaken using large size sample across the country.

4.1.6 Conclusion

During the investigation it was observed that men and women respondents played different roles in crop husbandry practices and animal husbandry practices and routine family activities. Their livelihood security assets were significantly changing. In this era of global competition, if we want to combat challenges of food security and climate change, we have to focus on the women farmers. This will help to bridge the gap between poverty and prosperity. Further research is needed in this direction using larger sample size and study area.

Fig. 1 Participation in crop husbandry activities as perceived by women and men farmers

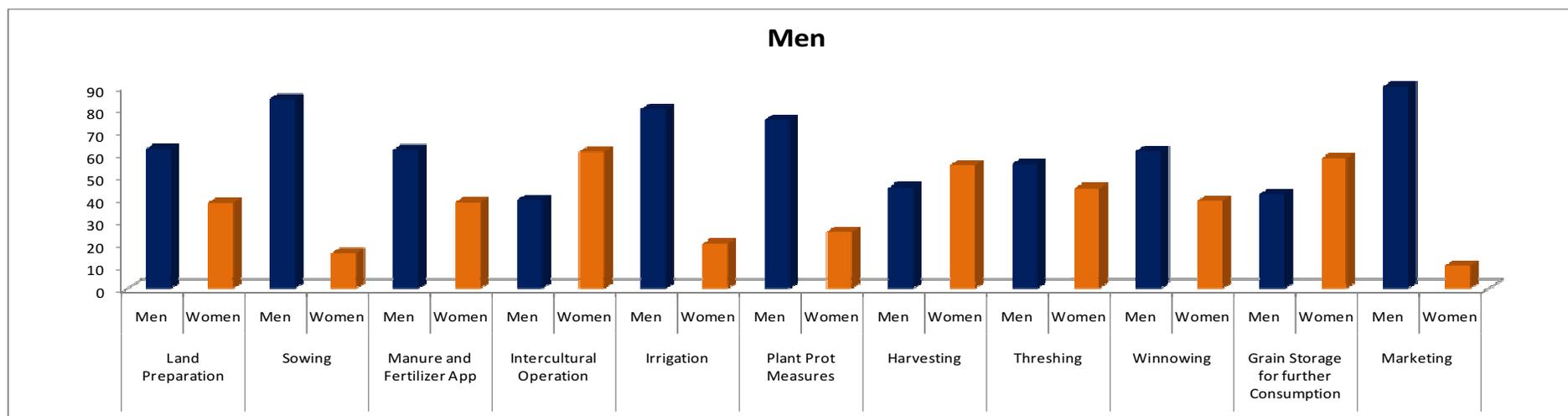
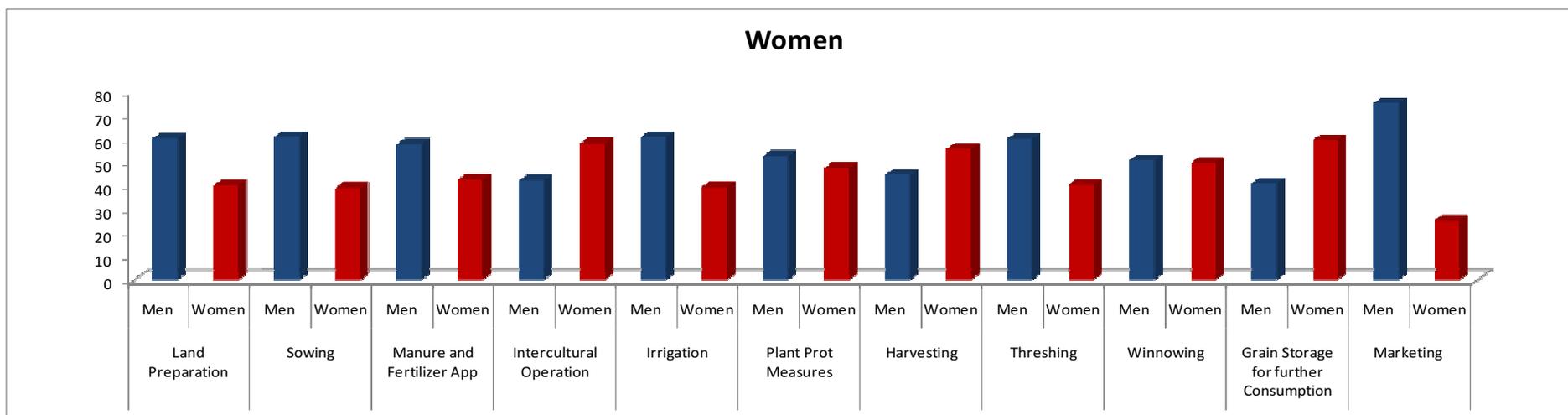


Fig. 2 Comparative participation in crop husbandry activities as perceived by men and women farmers

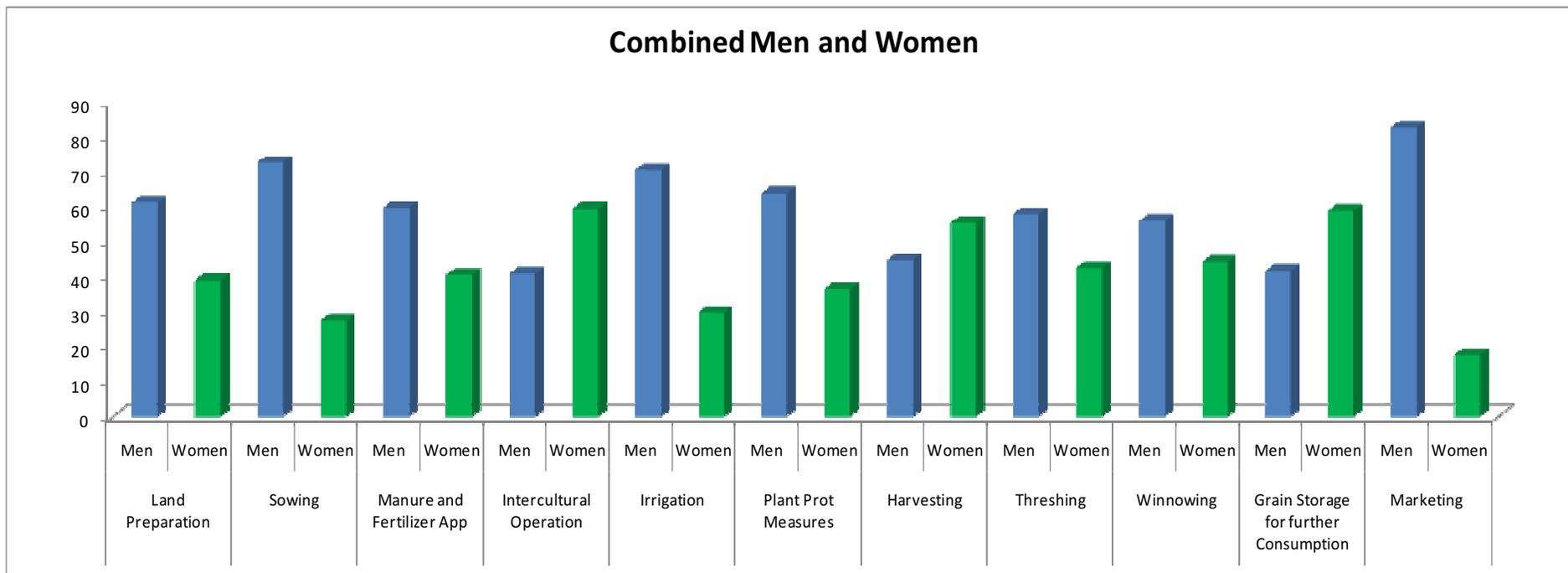


Fig. 3 Participation in animal husbandry activities as perceived by men and women farmers

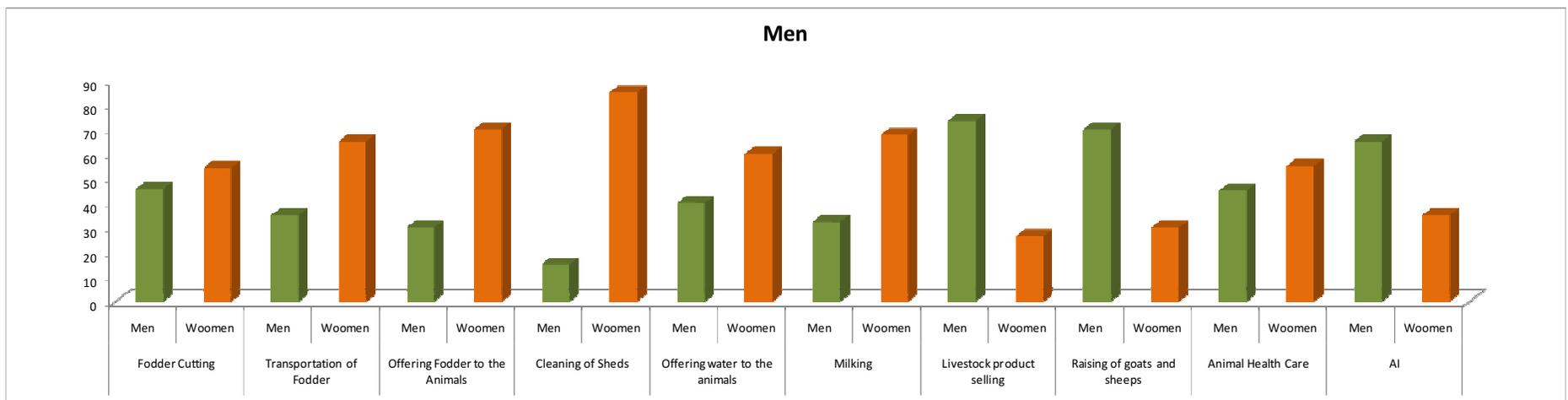
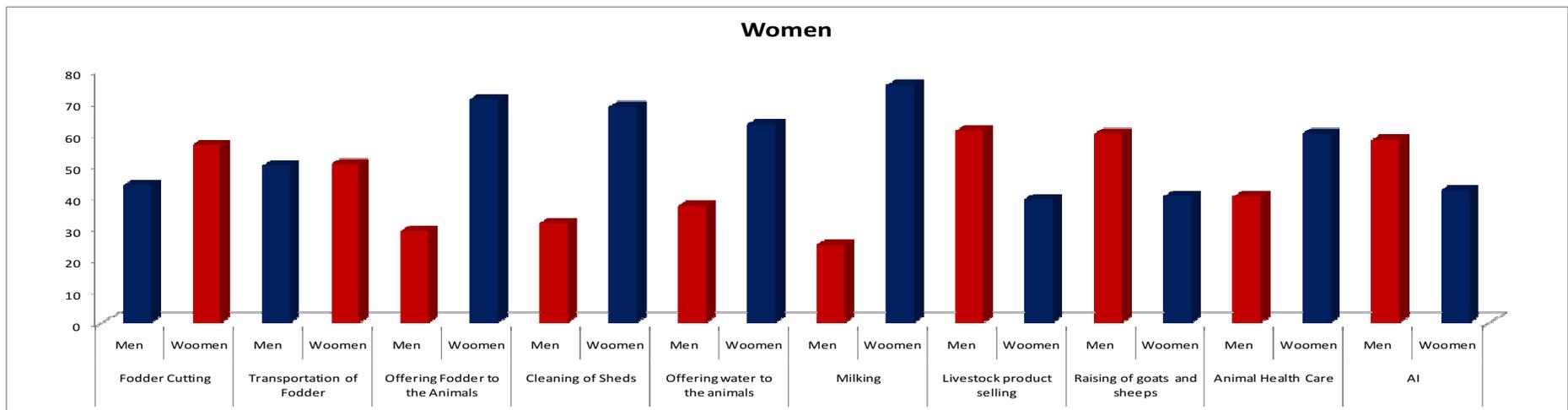


Fig. 4 Comparative participation in animal husbandry activities as perceived by men and women farmers

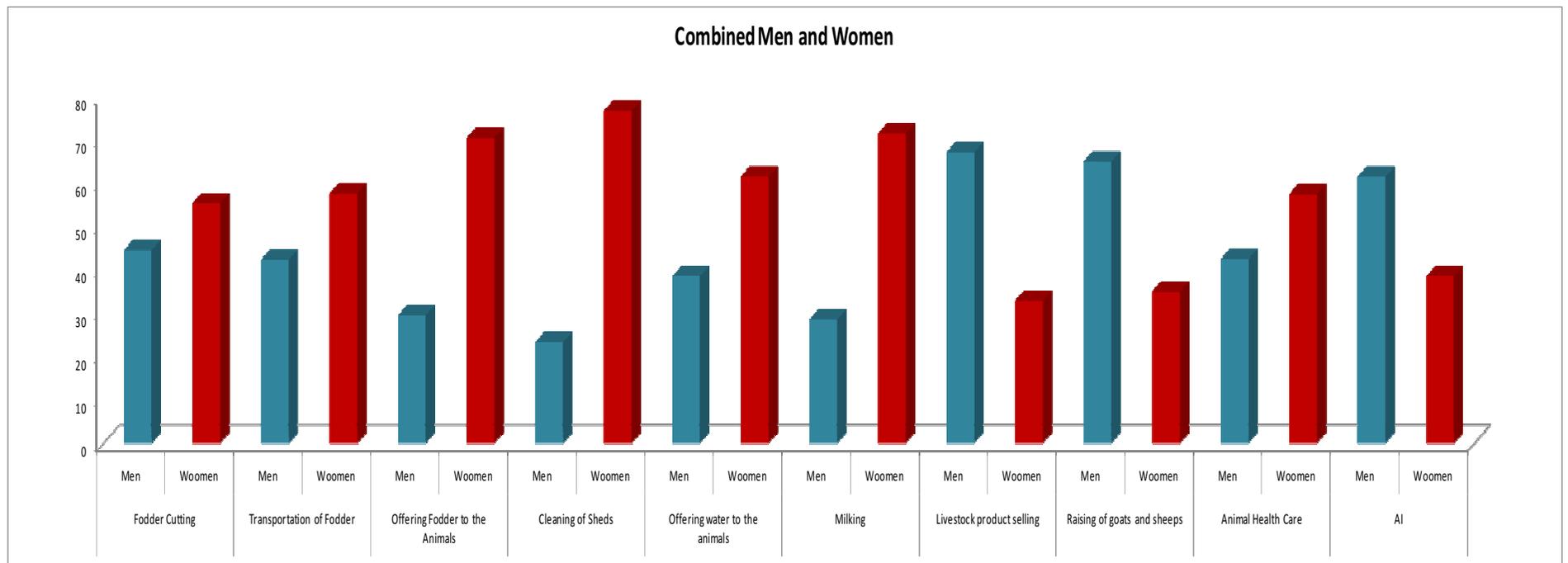


Fig. 5 Participation in routine household activities as perceived by men and women farmers

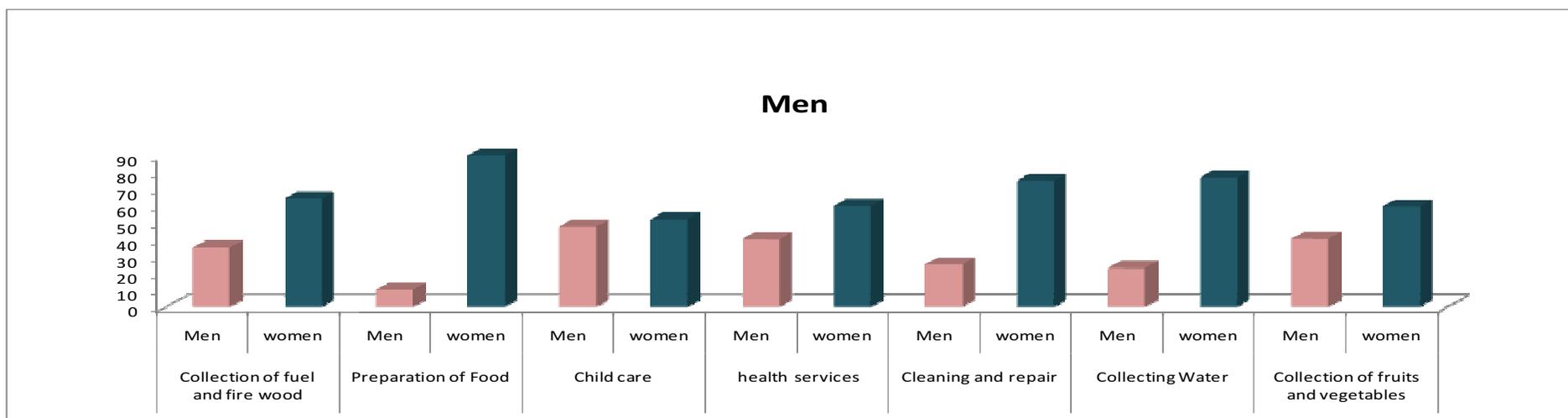
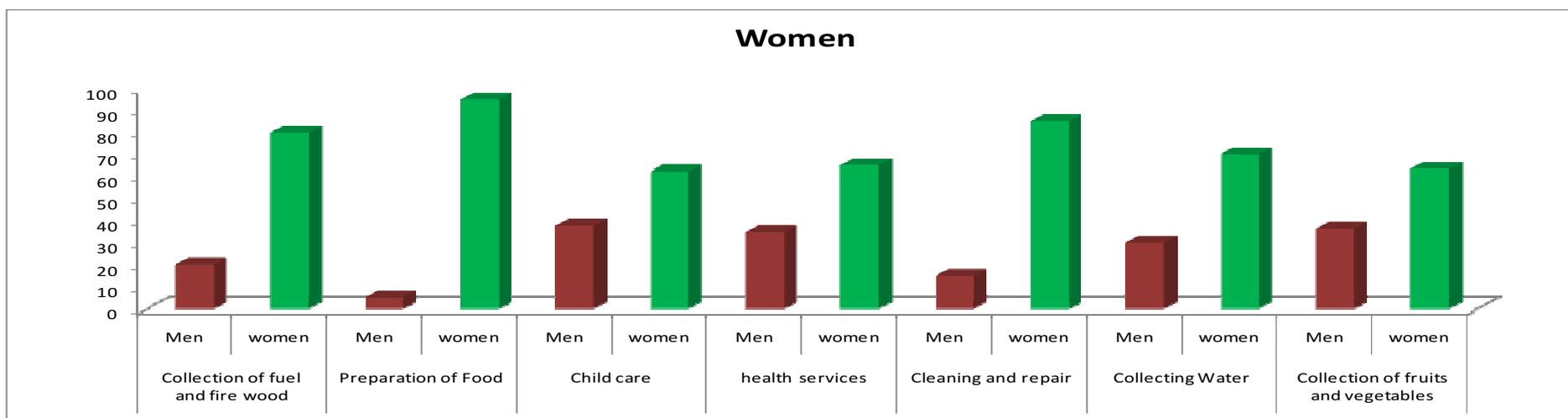
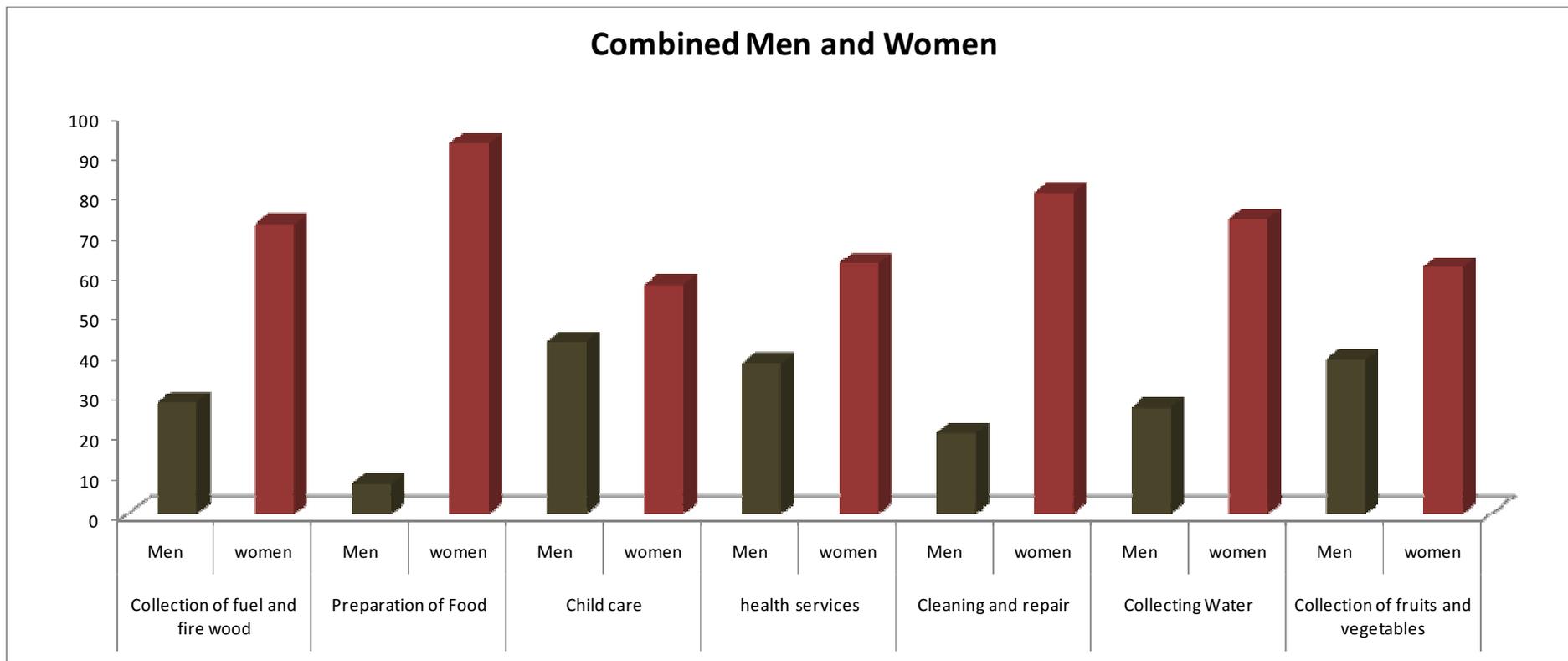
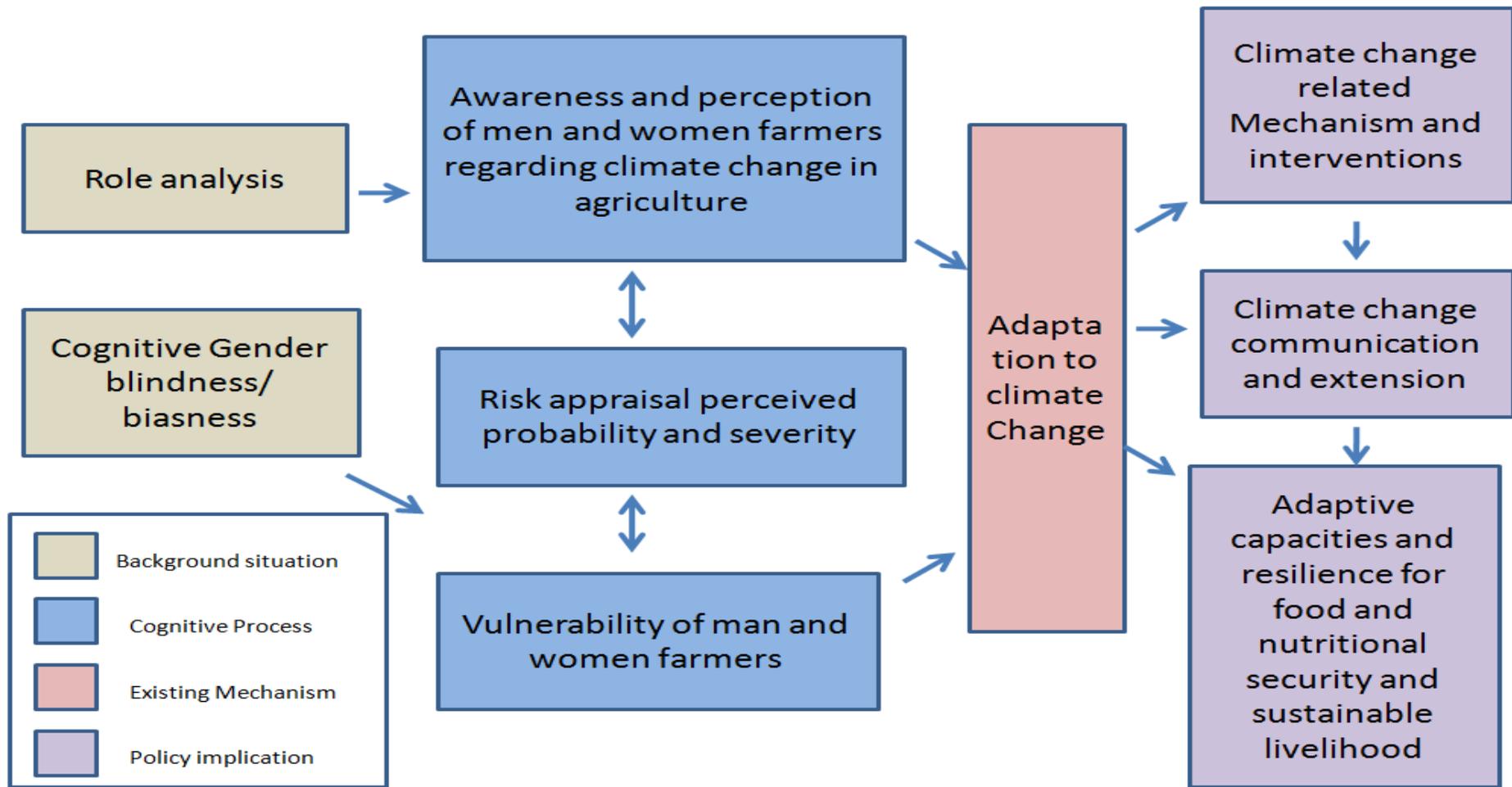


Fig. 6 Comparative participation in routine household activities as perceived by men and women farmers





Empirical Model of Climate and Gender Smart Agriculture

CHAPTER 4**RESEARCH PAPER - II**

Men and women farmers' perception about climate change in arid ecosystem**4.2.1 Abstract**

Climate change has become one of the major challenges in the present era of globalization. This investigation was aimed at assessing awareness and perceptions of men and women farmers regarding climate change in the context of agriculture. The study was conducted in the Bikaner district of Rajasthan. Two stages stratified random sampling procedure was followed in selection of respondents. Total sample size was 60 men and 60 women farmers. Interview schedule and focus group discussions were used in eliciting information from the farmers. The frequency count and item analysis method were used to analyse the data collected. The study observed that 31.66 percent men and 48.33 women farmers had never heard about the term climate change before. Furthermore, 39.02 percent men and 38.70 percent women farmers believed that deforestation was the main reason for climate change. Perceptions of the respondents were consistent with the climate change science but some of them had misperceptions about certain issues. Climate change communication, awareness campaigns and short term training programmes on climate change and gender in agriculture are important to bridge the gap between established science of climate change and the perception of the farmers.

Key words: Awareness, Perception, Climate change and Gender

4.2.2 Introduction

Climate change has become an increasingly salient public issue, with active policy debates. The ways in which climate change is represented, communicated, perceived, and responded to by different sections of society and across different regions have become important (Whitmarsh and Lorenzoni, 2010). Environmental perceptions are among key

elements influencing adoption of adaptation strategies (Smithers and Smit, 2009). Motivations and decisions to develop, innovate and adopt climate resilient agricultural technologies and strategies are often shaped by how the climatic changes and their effects on agriculture are being perceived and understood by policy makers, agricultural scientists, extension personnel and farming community. However, the climate change adaptation and mitigation research to date has tended to focus more on technological aspects than socio-psychological aspects and far too little attention has been paid to study perceptions of these key stakeholders. Moreover, whatever prior research in climate change awareness and perceptions had happened, they have only been carried out on men farmers. There is an urgent need for a better understanding of the changing climate pattern and how they affect extreme weather events (Tompkins, 2003 cited in Mba, 2009) and gender disaggregated data. In this context, this study investigates awareness and perceptions of men and women farmers regarding climate change and its impacts on agriculture.

4.2.3 Methodology

The study was undertaken in the Bikaner district of Rajasthan state, and among the two groups of respondents: men and women farmers. Total sample size was 120, that is, 60 respondents from each group. Two stages stratified random sampling procedure was followed in selection of respondents. Respondent's awareness about climate change was assessed through the interview schedule. The respondents' perceptions were assessed through a modified Likert-type perception scale developed by Manohar (2013) covering following dimensions of climate change: certainty, causes, changes in climatic parameters and impacts on agriculture. The selected men and women respondents were interviewed personally with the help of a well structured interview schedule and their responses were recorded on a five point continuum. The data thus collected were tabulated and statistically analysed to interpret the results. Descriptive statistics, frequency count and item analysis method and Mann Whitney test were used to analyse the data collected.

4.2.4 Results:

Climate change awareness is the aggregate of knowledge, attitudes or beliefs held by the men and women farmers in a community on climate change and global warming.

Awareness was operationalized as the degree to which the farmers had information regarding the wide range of climate change concerns, awareness about global warming and different causes of climate change. Concerns of men and women farmers about climate change are the direct outcome of their awareness and level of information. Awareness of climate change help farmers plan their production activities and reduces risks and uncertainties associated with farming.

Men and Women Farmers' awareness about climate change

Men and women farmers' awareness on the following dimensions of climate change were analysed. The results are presented in Table 4.2.1 through Table 4.2.2

Table 4.2.1 Distribution of respondents based on response about climate change awareness (N=120)

Sr. No.	Statements	Men farmers (n=60)			Women farmers (n=60)	
		Response	(f)	(%)	(f)	(%)
1	Heard about the term climate change	Yes	41	68.33	31	51.66
		No	19	31.66	29	48.33
2	Climate change is a very serious issue	Yes	35	58.33	21	35.00
		No	25	41.66	39	65.00
3	Awareness about different impacts of climate change	Yes	32	53.33	29	48.33
		No	28	46.66	31	51.66
4	Awareness about the global warming	Yes	20	33.33	13	21.66
		No	40	66.66	47	78.33

The results of the findings show that 68.33 per cent men farmers and 51.66 women farmers had heard about the term climate change while 31.66 per cent men farmers and 48.33 women farmers had not heard about it. When asked about 'climate change is a very serious issue', 58.33 per cent men farmers and 35 per cent women farmers responded in affirmative action while 41.66 per cent men farmers and 65 per cent women farmers responded to the contrary. When asked about the different impacts of climate change, 53.33 per cent men farmers and 48.33 per cent women farmers responded. Regarding awareness about global

warming 33.33 per cent men farmers and 21.66 women farmers were aware about it. Out of 68.33 per cent men farmers and 51.66 per cent women farmers who were aware of climate change, 39.02 per cent men farmers and 38.70 per cent women farmers believed that deforestation was the main reason for climate change.

Table 4.2.2 Reasons for the problems of climate change as perceived by farmers (N= 120)

Sr. No.	Respondent response	Men (n=41)		Women (n=31)	
		<i>f</i>	%	<i>f</i>	%
1	Natural	5	12.19	8	25.80
2	Intensified industrialized	7	17.07	3	9.67
3	Air pollution	9	21.95	5	16.12
4	Deforestation	16	39.02	12	38.70
5	No response	4	9.75	3	9.67
	Total	41	100	31	100

Hence it is revealed that the awareness about climate change is low in farmers. There is also difference in awareness among men and women farmer. The background profile of farm women also showed that farmers had very low contact with extension personnel.

Farmers' perceptions about climate change and its impacts on agriculture

Farmers' perceptions on the following dimensions of climate change were analysed, certainty and concern about climate change, changes in climatic parameters, causes of climate change, and impacts of climate change. The results are presented in Table 4.2.3 through Table 4.2.10. The maximum and minimum obtainable score on the climate change perception scale was 75 and 15 respectively.

Farmers' perceptions towards certainty and concern about climate change

The data in Table 4.2.3 show that more than half (51.66%) of the men respondents 'strongly agreed' that changes in temperature, wind velocity and rainfall were real over a period of time and another 48.79 per cent 'agreed' with the statement. Similarly, 41.66 per cent of the men farmers 'strongly agreed' that they were concerned because these changes are serious problem and another 55 per cent of them 'agreed' with the statement. Only, 3.33 per cent of the men farmers were unable to decide at their perceptual level that whether it is

a serious problem or not. A majority (65%) of the men farmers 'agreed' that they were concerned because changes in temperature, rainfall, wind velocity etc. were affecting agriculture in their region and another 31.6 per cent of them 'strongly agreed' with the statement. Only 3.33 per cent of the men farmers were unable to decide at their perceptual level that whether these changes were affecting agriculture in their region or not.

Table 4.2.3 Men farmers' perceptions towards certainty and concern about climate change (N= 60)

S.N.	Statements	SA	A	U	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	I am certain that changes in temperature, wind velocity and rainfall are real over a period of time	31 (51.66)	29 (48.33)	00 (0.0)	00 (0.0)	00 (0.0)
2	I am concerned because these changes are a serious problem	25 (41.66)	33 (55.00)	02 (3.33)	00 (0.0)	00 (0.0)
3	I am concerned because changes in temperature, rainfall, wind velocity etc. are affecting agriculture in my region	19 (31.66)	39 (65.00)	02 (3.33)	00 (0.0)	00 (0.0)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

The data in Table 4.2.4 show that more than half (55%) of the women respondents 'agreed' that changes in temperature, wind velocity and rainfall were real over a period of time and another 45 per cent 'strongly agreed' with the statement. Similarly, 38.33 per cent of the women farmers 'strongly agreed' that they were concerned because these changes are serious problem and another 55 per cent of them 'agreed' with the statement. Only, 6.66 per cent of the women farmers were unable to decide at their perceptual level that whether it is a serious problem or not. A majority (68.33%) of the women farmers 'agreed' that they were concerned because changes in temperature, rainfall, wind velocity etc. were affecting agriculture in their region and another 31.66 per cent of them 'strongly agreed' with the statement.

Table 4.2.4 Women farmers' perceptions towards certainty and concern about climate change (N= 60)

S.N.	Statements	SA	A	U	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	I am certain that changes in temperature, wind velocity and rainfall are real over a period of time	27 (45.00)	33 (55.00)	00 (0.0)	00 (0.0)	00 (0.0)
2	I am concerned because these changes are a serious problem	23 (38.33)	33 (55.00)	04 (06.66)	00 (0.0)	00 (0.0)
3	I am concerned because changes in temperature, rainfall, wind velocity etc. are affecting agriculture in my region	19 (31.66)	41 (68.33)	00 (0.0)	00 (0.0)	00 (0.0)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)
f= Frequency, and % = Percentage

Farmers' perceptions towards changes in climatic parameters

The men and women respondent farmers were asked about their feelings towards the present and future behaviour of climatic parameters compared to the past 10-20 years. Based on their past experience the respondents perceived that there was an increase in the intensity of heat waves, and arrival and distribution pattern of monsoon rainfall have changed. The results are presented in Table 4.2.5 through Table 4.2.6

Table 4.2.5 Men farmers' perceptions towards changes in climatic parameters

(N= 60)

Sr. No.	Statements (Compared to the past 10-20 years)	SA	A	U	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	Now days the monsoon rainfall occurs earlier.	09 (15.00)	12 (20.00)	00 (0.0)	25 (41.6)	14 (23.33)
2	The nature and intensity of rainfall have become more unusual in my region.	38 (63.33)	14 (23.33)	04 (6.66)	02 (3.33)	02 (3.33)
3	We have more droughts now than before	18 (30.00)	14 (23.33)	11 (18.33)	08 (13.3)	09 (15.00)
4	There is increase in heat waves (Loo)	12 (20.00)	25 (41.66)	19 (31.6)	02 (3.33)	02 (3.33)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

The data in the Table 4.2.5 show that as much as 41.66 per cent of the men respondents 'disagreed' that compared to the past 10-20 years, now a days the monsoon rainfall occurred earlier; and another 15 per cent of them 'strongly' agreed with this position. As much as 20 per cent of the men respondents 'agreed' that now a day's monsoon occurred earlier and another 23.3 per cent 'strongly disagreed' with the statement. More than half (63.33%) of the men respondents 'strongly agreed' that the nature and intensity of rainfall had become more unusual in their region compared to the past 10-20 years and 23.33 per cent agreed with this statement, while 6.66 per cent of the men respondents were 'undecided' and a minority of them either 'disagreed' (3.33%) or 'strongly disagreed' (3.33%) with this statement. While 30 per cent of the men respondents 'strongly agreed' that compared to the last 10-20 years, the number of occurrence of drought had increased, another 23.33 per cent of the respondents 'agreed' with this statement. However, 18.33 per cent of the men respondents were 'undecided' and another 13.3 per cent of them 'disagreed' and 15 per cent of men respondents 'strongly disagreed' with this position. Regarding increase in heat waves, 41.66 per cent of the men respondents 'agreed' that there is increase in heat waves and 20 per cent of the respondents 'strongly agreed' with this statement. About one-third (31.6%) of the men respondents were undecided and another minority of men respondents 3.33 per cent disagreed and 3.33 per cent strongly disagreed with the statement.

The data in the Table 4.2.6 show that as much as 45 per cent of the women respondents 'disagreed' that compared to the past 10-20 years, now a days the monsoon rainfall occurred earlier; and another 10 per cent of them 'strongly' agreed with this position. As much as 16.6 per cent of the women respondents 'agreed' that now a day's monsoon occurred earlier and another 21.66 per cent 'strongly disagreed' with the statement. More than half (56.66%) of the women respondents 'strongly agreed' that the nature and intensity of rainfall had become more unusual in their region compared to the past 10-20 years and 33.33 per cent agreed with this statement, while 3.33 per cent of the women respondents were 'undecided' and a minority of them either 'disagreed' (3.33%) or 'strongly disagreed' (3.33%) with this statement. Furthermore 40 per cent of the women respondents 'strongly agreed' that compared to the last 10-20 years, the number of occurrence of drought had

increased and another 46.6 per cent of the women respondents ‘agreed’ with this statement. However, 8.3 per cent of them ‘disagreed’ and 5 per cent of women respondents ‘strongly disagreed’ with this statement. Nearly half of the women respondents (48.33%) ‘agreed’ that there is increase in heat waves and 20 per cent of the respondents ‘strongly agreed’ with this statement. About one-fourth (26.6%) of the women respondents were undecided and another minority of women respondents 5 per cent disagreed with the statement.

Table 4.2.6 Women farmers’ perceptions towards changes in climatic parameters

(N= 60)

S.N.	Statements (Compared to the past 10-20 years)	SA	A	U	DA	SDA
		f (%)				
1	Now days the monsoon rainfall occurs earlier.	06 (10.00)	10 (16.66)	04 (6.66)	27 (45.00)	13 (21.66)
2	The nature and intensity of rainfall have become more unusual in my region.	34 (56.66)	20 (33.33)	02 (3.33)	02 (3.33)	02 (3.33)
3	We have more droughts now than before	24 (40.00)	28 (46.66)	00 (0.0)	05 (8.33)	03 (5.00)
4	There is increase in heat waves (loo)	12 (20.00)	29 (48.33)	16 (26.66)	03 (5.00)	00 (0.0)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

Farmers’ perceptions towards causes of climate change

The data in Table 4.2.7 show that about 46.66 per cent of the men respondents ‘disagreed’ that industrialisation was not responsible for changes in temperature, wind velocity, rainfall and other parameters, and another 20 per cent of the men respondents ‘strongly disagreed’ with this statement. However, 11.66 per cent of the men respondents were ‘undecided’ on the role played by industrialisation and 21.66 per cent of the men respondents ‘agreed’ that industrialisation was not responsible for changes in temperature, wind velocity, rainfall and other parameters. Furthermore, 41.66 per cent of the men respondents ‘agreed’ that heavy use of fossil fuel had led to rapid changes in temperature, wind velocity, rainfall and other parameters and another 30 per cent of the men respondents ‘strongly agreed’ with this

statement. But 21.66 per cent of the men respondents were ‘undecided’ and a minority (6.66%) of the men respondents ‘disagreed’ with it. Majority (73.33%) of the respondents ‘agreed’ that large-scale deforestation was a reason for the present changes in temperature, wind velocity, rainfall and other parameters, and another 21.66 per cent of them were ‘strongly agreed’ with this statement; whereas 5 per cent of the men respondents were ‘undecided’ and nobody ‘disagreed’ on this issue. Nearly half (48.33%) of the men respondents ‘disagreed’ and 18.33 per cent ‘strongly disagreed’ that changes in temperature, wind velocity, rainfall and other parameters is due to God’s curse on humanity, while 15 per cent men farmers were ‘undecided’ and 18.33 per cent men respondents ‘agreed’ to the statement.

Table 4.2.7 Men farmers’ perceptions towards causes of climate change (N= 60)

S.N.	Statements	SA	A	U	DA	SDA
		f (%)	f (%)	f (%)	f (%)	F (%)
1	Industrialisation is not responsible for changes in temperature, wind velocity, rainfall and other parameters	00 (0.0)	13 (21.66)	07 (11.66)	28 (46.66)	12 (20.00)
2	Heavy use of fossil fuels has led to rapid changes in temperature, wind velocity, rainfall and other parameters	18 (30.00)	25 (41.66)	13 (21.66)	04 (6.66)	00 (0.0)
3	Large-scale deforestation is a reason for the present changes in temperature, wind velocity rainfall and other weather parameters	13 (21.66)	44 (73.33)	03 (5.00)	00 (0.0)	00 (0.0)
4	To my mind, the present changes are due to God’s curse on humanity	00 (0.0)	11 (18.33)	09 (15.00)	29 (48.33)	11 (18.33)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

The data in Table 4.2.8 show that about 45 per cent of the women respondents ‘disagreed’ that industrialisation was not responsible for changes in temperature, wind velocity, rainfall and other weather parameters, and another 25 per cent of the women respondents ‘strongly disagreed’ with this statement. However, 18.33 per cent of the women respondents were

‘undecided’ on the role played by industrialisation in changes in temperature, wind velocity, rainfall and other parameters and 11.6 per cent of the women respondents ‘agreed’ that industrialisation was not responsible for changes in temperature, wind velocity, rainfall and other parameters. Regarding the statement, 45 per cent of the women respondents ‘agreed’ heavy use of fossil fuel had led to rapid changes in temperature, wind velocity, rainfall and other parameters and another 23.3 per cent of the women respondents ‘strongly agreed’ with this statement. But 18.33 per cent of the women respondents were ‘undecided’ and a minority (13.33%) of the women respondents ‘disagreed’ that heavy use of fossil fuel had led to rapid changes in temperature, wind velocity, rainfall and other parameters. While 61.66 per cent of the women respondents ‘agreed’ that large-scale deforestation was a reason for the present changes in temperature, wind velocity, rainfall and other parameters, 35 per cent of them ‘strongly agreed’ with this statement; whereas 3.33 per cent of the women respondents were ‘undecided’ and nobody ‘disagreed’ on this issue.

Table 4.2.8 Women farmers’ perceptions towards causes of climate change (N=60)

S.N.	Statements	SA	A	U	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
1	Industrialisation is not responsible for changes in temperature, wind velocity, rainfall and other parameters	00 (0.0)	07 (11.66)	11 (18.33)	27 (45.00)	15 (25.00)
2	Heavy use of fossil fuels has led to rapid changes in temperature, wind velocity, rainfall and other parameters	14 (23.3)	27 (45.00)	11 (18.33)	08 (13.3)	00 (0.0)
3	Large-scale deforestation is a reason for the present changes in temperature, wind velocity, rainfall and other weather parameters	21 (35.00)	37 (61.66)	02 (3.33)	00 (0.0)	00 (0.0)
4	To my mind, the present changes are due to God’s curse on humanity	00 (0.0)	09 (15.00)	06 (10.00)	31 (51.66)	14 (23.3)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

More than half (51.66%) of the women respondents ‘disagreed’ and 23.3 per cent ‘strongly disagreed’ that changes in temperature, rainfall and other weather parameters are due to God’s curse on humanity. While 10 per cent women farmers were ‘undecided’ and 15 per cent women respondents ‘agreed’ to the statement.

Farmers’ perceptions towards impacts of climate change on agriculture

The data in Table 4.2.9 show that 28.3 per cent of the men respondents ‘agreed’ and 11.6 per cent ‘strongly agreed’ that low yields of crops in recent past were due to changes in the temperature, rainfall, wind velocity etc., whereas 13.3 per cent of them ‘undecided’ and another 36.66 per cent men respondents ‘disagreed’ and 10 per cent of the men respondents ‘strongly disagreed’ with the statement. Regarding the statement of more and more desertification of arable land in the coming years, about 21.66 per cent of the men respondents ‘agreed’ and another 8.33 per cent of them ‘strongly agreed’ with this statement. Furthermore, 41.66 per cent of the men respondents ‘disagreed’ and another 18.33 per cent of them ‘strongly disagreed’ with this statement. About ten per cent of the men respondents ‘were undecided on this statement.

Table 4.2.9 Men farmers’ perceptions towards impacts of climate change on agriculture

(N= 60)

S.N.	Statements	SA	A	U	DA	SDA
		f (%)	f (%)	f (%)	f (%)	f (%)
Compared to the past 10-20 years,						
1	The low yields of crops in recent past are due to changes in the temperature, rainfall, wind velocity etc.	07 (11.66)	17 (28.3)	08 (13.3)	22 (36.66)	06 (10.00)
2	I foresee more and more desertification of arable land	05 (8.33)	13 (21.66)	06 (10.00)	25 (41.66)	11 (18.33)
3	I foresee more water shortage or stress in the coming years	14 (23.3)	31 (51.66)	05 (8.33)	10 (16.66)	00 (0.0)
4	Livestock in my region will be more adversely affected in the coming years	11 (18.3)	34 (56.66)	06 (10.00)	09 (15.00)	00 (0.0)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

More than half (51.66%) of the men respondents ‘agreed’ and another 23.3 per cent of them ‘strongly agreed’ to the statement that compared to the past 10-20 years, they foresaw more water shortage in the coming years. However, 16.6 per cent of them ‘disagreed’ on this issue and another 8.33 per cent of the men were respondents ‘undecided’ with this statement. More than half (56.66%) of the men respondents ‘agreed’ and 18.3 per cent ‘strongly agreed’ that livestock in their region would be more adversely affected in the coming years. However, 15 per cent of the men respondents ‘disagreed’ on this issue. Further, 10 per cent of them were ‘undecided’ on this statement.

Table 4.2.10 Women farmers’ perceptions towards impacts of climate change on agriculture (N=60)

S.N.	Statements	SA	A	U	DA	SDA
		f	f	f	f	f
		(%)	(%)	(%)	(%)	(%)
Compared to the past 10-20 years,						
1	The low yields of crops in recent past are due to changes in the temperature, rainfall, wind velocity etc.	07 (11.66)	15 (25.00)	10 (16.66)	23 (38.33)	05 (8.33)
2	I foresee more and more desertification of arable land	08 (13.3)	14 (23.33)	05 (8.33)	23 (38.33)	10 (16.66)
3	I foresee more water shortage or stress in the coming years	17 (28.33)	37 (61.66)	02 (3.33)	04 (6.66)	00 (0.0)
4	Livestock in my region will be more adversely affected in the coming years	15 (25.00)	35 (58.3)	08 (13.3)	02 (3.33)	00 (0.0)

(SA – Strongly Agree, S – Agree, U – Undecided, D – Disagree, SD – Strongly Disagree)

f= Frequency, and % = Percentage

The data in Table 4.2.10 show that 25 per cent of the women respondents ‘agreed’ and 11.6 per cent ‘strongly agreed’ that low yields of crops in recent past were due to changes in the temperature, rainfall, wind velocity etc., whereas 16.66 per cent of them were ‘undecided’ and another 38.33 per cent women respondents ‘disagreed’ and 8.33 per cent of the women respondents ‘strongly disagreed’ with the statement. Furthermore, 38.33 per cent of the women respondents ‘disagreed’ and another 16.6 per cent of them ‘strongly disagreed’. Regarding more and more desertification of arable land in the coming years, 23.33 per cent of the women respondents ‘agreed’ and another 13.3 per cent of them ‘strongly agreed’

with this statement, While 8.33 per cent of the men respondents' were undecided on this statement. More than half (61.66%) of the women respondents 'agreed' and another 28.3 per cent of them 'strongly agreed' to the statement that compared to the past 10-20 years, they foresaw more water shortage in the coming years. Whereas only 6.66 per cent of them 'disagreed' on this issue a minority (3.33%) of them were 'undecided' on this issue. More than half (58.3%) of the women respondents 'agreed' and 25 per cent 'strongly agreed' that livestock in their region would be more adversely affected in the coming years. Only 3.33 per cent of them 'disagreed' on this issue. Further, 13.33 per cent of the women respondents were 'undecided'.

4.2.5 Discussion:

The present investigation was aimed at assessment of men and women farmers' awareness about climate change, awareness about different causes, reasons and different impacts of climate change on agriculture. The present investigation was also aimed at assessment of men and women farmers' perception about different dimensions of climate change like concerns, certainty, causes, changes in climatic parameter and impact on agriculture. During the investigation it was observed that though majority of the respondents were aware about climate change and its impacts on agriculture, many respondents also had misperceptions regarding various aspects of climate change and its impacts on agriculture.

When asked about causes of climate change, most of the respondents, perceived that human activities like deforestation, air pollution and intensified industrialisation were mainly responsible for climate change. On the issue of observed changes in climate, it was observed that majority of the respondents had perceptions that the nature and intensity of regional rainfall had become more unusual in their region. These perceptions are consistent with the national level projections for climate change (INCCA, 2010). However, a majority of men and women respondents also perceived that low yields of crops in recent past are not due to climate change and also foresaw that more and more desertification of arable land would not takes place in the future, which is not the case in reality.

Similarly, majority of the respondents perceived that agriculture in their local area is being affected by climate change, and near future climatic changes would affect it more. These

perceptions of men and women respondents match with the national level observations and projections (INCCA, 2010).

Furthermore important perceptions of women farmers regarding water shortage and affects the livestock has strong implications for increase in drudgery of especially women farmers in the coming years due to climate change.

4.2.6 Conclusion

During the investigation it was observed that overall perceptions of the men and women respondents were consistent with the climate change. Perceptions of the respondents were consistent with the climate change science but some of them had misperceptions about certain issues. Awareness campaign and short term training programme on climate change and gender in agriculture would help to bridge the gap between established science of climate change and the perceptions of the respondents. Climate change communication is very important for farmers.

RESEARCH PAPER - III

Relative assessment of women and men farmers' vulnerability to climate change in arid ecosystem**4.3.1 Abstract**

Vulnerability is the inability of individuals or social groups to cope up with or adapt to climate change induced stresses placed on their livelihood and well-being. The study was conducted in the Bikaner district of Rajasthan. This investigation was aimed at assessing vulnerability of men and women farmers to climate change in the arid region of Rajasthan. Two stage stratified random sampling procedure was followed in selection of respondents. Total sample size was 60 men and 60 women farmers. Considering various individual and social dimensions an index was developed to measure the vulnerability of sample respondents. Results showed that are 3.33 per cent men and 25 per cent women were highly vulnerable, 68.33 per cent men respondents and 60 per cent women respondents were moderately vulnerable, 17 per cent men respondents and 15 per cent women respondents were less vulnerable to climate change. As majority of women respondents were vulnerable, long term measures, capacity building and training of women farmers should be emphasized for better preparedness and adaptation to climate change.

Key words: Vulnerability, Climate change and Gender

4.3.2 Introduction

Climate change will have wide ranging effects on the environment and on socio-economic and related sectors, including water resources, agriculture and food security, human health and biodiversity of arid and semi-arid ecosystems. Changes in the rainfall pattern are likely to lead to severe water shortage in the arid region of Rajasthan. In developing countries like India, climate change could represent an additional stress on ecological and socioeconomic systems that are already facing tremendous pressures due to rapid urbanization, industrialization and economic

development. With its huge and growing population, and an economy that is closely tied to its natural resource base, India is considerably vulnerable to the impacts of climate change.

The ordinary use of the word ‘vulnerability’ refers to the capacity to be wounded, that is, the degree to which a system is likely to experience harm due to exposure to a hazard (Turner II et al. 2003). The term vulnerability has its origin in the natural hazards and food security literature. It is derived from a Latin word *vulnerable* (to be wounded) and describes the potential to be wounded physically or psychologically. Vulnerability is conceptualized in very different ways by scholars from different knowledge domains and even within the same domain. For instance, natural scientists and engineers tend to apply the term in a descriptive manner whereas social scientists tend to use it in the context of a specific explanatory model (O’Brien *et al.* 2004).

Blaikie (1994) describes vulnerability as the characteristics of a person or a group to anticipate, cope, resist and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone’s life and livelihood is put at risk by a discrete or identifiable event in nature or in society. While for Chambers (1989), vulnerability represents the ability or not to modify the impacts of disaster and the means to cushion risks. On a national level, vulnerability manifests itself in poorer countries due to a lack of resources and capacity to respond. At the community level, class, caste, gender, ethnicity, age, level of education and access to resources all determine vulnerability (Blaike1994, IPCC 2001). The Inter Governmental Panel on Climate Change (IPCC) Second Report mentioned that the vulnerability of a system increases as the adaptive capacity decreases, highlighting an inverse relationship with each other. Drawing from above relationship vulnerability assessment needs to include the indicators of adaptive capacity like technology, knowledge, wealth, and socio-economic attributes. The IPCC Working Group II, Third Assessment report defines adaptive capacity as a function of factors related to wealth, technology, education, information, skills, infrastructure, access to resources, and stability and management capabilities (IPCC, 2001). Many studies have considered the determinants of adaptive capacity as indicators for vulnerability assessment. Combining all these variables, the study aimed to examine the men and women farmers’ vulnerability to climate change.

4.3.3 Methodology

The study was conducted in Bikaner district of Rajasthan with an objective to examine the vulnerability of men and women farmers' to climate change. Two *tehsils* were selected randomly and two villages from each *tehsil* were randomly selected. Fifteen men and fifteen women farmers were chosen at random from each village thus constituting a total sample of one hundred and twenty respondents. Data were collected through interview method with the help of a structured schedule.

For the purpose of the study, vulnerability was operationally defined as the inability of individuals or social groups to cope up with or adapt to climate change induced stresses placed on their livelihood and well-being.

Considering the various individual and social dimensions, level of dependency on resources and other livelihood support systems, an attempt was made to develop an index to measure vulnerability of men and women respondents. Drawing from the approaches of UNDP (2007), a composite vulnerability index was worked out and respondents were grouped under the categories of highly vulnerable, moderately vulnerable and less vulnerable. For each component of vulnerability (awareness about climate change, perception towards climate change, level of dependency, and value orientation like fatalism and egalitarianism) sub-indices were worked out. The values of each indicator were normalized to the range of values in the data set by applying the following formula:

Index value = (Actual value – Minimum value) / (Maximum value - Minimum value)

For the indicator with negative connotation, index value was reversed (1- index value). The overall index was formed from weighted average of the sub-indices, with weights derived from theoretical understanding. The aggregated figure ranged from 0 to 1, where 0 signified highest level of vulnerability. The respective weights for sub-indices were drawn from literature and experts' opinion. The overall equation for the model employed for the study was:

$$VI = \sum_{i=1}^n (I_i * W_i)$$

I_i = Sub-index and W_i = Weights of the sub-index

$$VI = I_1 * 32.5 + I_2 * 18.2 + I_3 * 14.3 + I_4 * 11.7 + I_5 * 23.4$$

I_1 : Awareness

- I₂: Perception
- I₃: Fatalism
- I₄: Egalitarianism
- I₅: Level of dependency

4.3.4 Results and Discussion

Fatalism

Fatalism was operationalized as “a philosophical doctrine holding that all events are predetermined in advance for all time and men and women are powerless to change them”. Fatalism refers to belief in fate. Generally due to lack of education people believe in fatalism, there by attributing the process and outcome of any event to fate. Fatalism was measured on a five-point continuum and subjects were asked to express their agreement and disagreement with a set of five statements drawn from the modified scale of (Leiserowitz, 2006). For 55 per cent of the men respondents ‘the future was too uncertain for a person to make serious plans’ and about 60 per cent men believed that ‘there was no use worrying about public affairs and they could not do anything about them anyway’ (Table 4.3.1.).

For 59 per cent of the men respondents it did not make much difference if people elect one or another political candidate, for nothing would change. About 49 per cent of them agreed that they had very little control over their life. Furthermore, 45 per cent men felt that life was like a lottery and 32 per cent men respondents felt that they are better off if they do not trust anyone. Affirmation with these statements by a majority of men farmers reveals prevalence of value of fatalism. Such values only retard the development process. Hence, it is essential to bring about change in value orientation of men farmers in order to pave the way for progressiveness. Farmers should be motivated and trained to take initiatives and have control over the processes and outcomes. Exposure to climate resilient technologies is helping the farmers to enhance their knowledge, skills and attitude.

**Table 4.3.1 Distribution of men farmers respondents according to value of fatalism
(N=60)**

Statement	SA f (%)	A f (%)	UD f (%)	D f (%)	SD f (%)	Mean
The future is too uncertain for a person to make serious plans.	12 (20.00)	21 (35.00)	4 (6.67)	17 (28.33)	6 (10)	3.26
It doesn't make much difference if people elect one or another political candidate, for nothing will change.	11 (18.33)	24 (40.00)	0	19 (31.66)	6 (10)	3.25
I feel that life is like a lottery.	10 (16.67)	17 (28.33)	3 (5)	23 (38.33)	7 (11.67)	2.78
A person is better off if he or she does not trust anyone.	3 (5)	16 (26.67)	0 (0)	18 (30.00)	23 (38.33)	2.30
I have very little control over my life.	2 (3.33)	25 (45.00)	2 (3.33)	19 (31.67)	12 (20.00)	2.76
It is no use worrying about public affairs; I cannot do anything about them anyway.	15 (25)	21 (35)	1 (1.66)	16 (26.6)	7 (11.6)	3.35
I feel women's life will become more difficult/hazardous	13 (18.33)	29 (48.33)	0 (0)	17 (28.33)	1 (1.66)	3.6
I feel farmer's lives are going to become tougher	17 (28.33)	28 (46.66)	3 (5)	11 (18.33)	1 (1.66)	3.82

SA: Strongly Agree, A: Agree, UD: Undecided, D: Disagree and SD: Strongly Disagree

*Figures in parenthesis indicate percentages

About 59 per cent of the women respondents felt that the future was too uncertain to make serious plans and about 59 per cent believed that there was no use worrying about public affairs and they could not do anything about them anyway (table 4.3.2).

For 54 per cent of the women respondents it did not make much difference if people elect one or another political candidate, for nothing would change. About 45 per cent of them 'agreed' that they had very little control over their life. Furthermore, 44 per cent women respondents felt that life was like a lottery and 35 per cent of the women respondents felt that they are better off if they do not trust anyone. Affirmation with these statements by a majority of women farmers reveals prevalence of value of fatalism. Such values only retard the development process. Hence, it is essential to bring about change in value orientation of women farmers in order to pave the way for progressiveness. Women should be motivated and trained to take initiatives and have

control over the processes and outcomes. Access to modern technologies will help in enhancing the motivation level of the farmers.

Table 4.3.2 Distribution of women farmers according to value of fatalism (N=60)

Statement	SA f (%)	A f (%)	UD f (%)	D f (%)	SD f (%)	Mean
The future is too uncertain for a person to make serious plans.	13 (21.66)	22 (36.66)	3 (5)	14 (23.33)	8 (13.33)	3.33
It doesn't make much difference if people elect one or another political candidate, for nothing will change.	8 (13.33)	23 (40)	0	21 (35)	8 (13.33)	3.36
I feel that life is like a lottery.	11 (18.33)	15 (25)	3 (5)	22 (36.66)	9 (15)	2.95
A person is better off if he or she does not trust anyone.	5 (8.33)	16 (26.67)	4 (6.66)	14 (23.33)	21 (35)	2.5
I have very little control over my life.	2 (3.33)	25 (41.67)	0 (0)	23 (38.33)	10 (16.6)	2.76
It is no use worrying about public affairs; I cannot do anything about them anyway.	13 (21.66)	22 (36.67)	2 (3.33)	18 (30)	5 (8.33)	3.33
I feel women's life will become more difficult/hazardous	15 (25)	31 (51.66)	2 (3.33)	6 (10)	6 (10)	3.72
I feel farmer's lives are going to become tougher	19 (31.67)	25 (41.67)	3 (5)	13 (21.67)	0 (0)	3.83

SA: Strongly Agree, A: Agree, UD: Undecided, D: Disagree and SD: Strongly Disagree

Egalitarianism

Egalitarianism refers to value orientation to equality.

Measured on five-point continuum with modified scale of (Leiserowitz, 2006) the obtained mean values of more than 4 for most of the statements amply indicate the affirmation of the majority of the men respondents about egalitarianism. Similarly the statement with negative connotation with respect to egalitarianism- "We have gone too far in pushing equal rights" the mean score was 2.6 indicating that a majority showed disagreement with it. Hence, a large majority of the respondents held value of equality. Such positive value in a society is highly appreciating as it facilitates equal accessibility and distribution of common goods among people. In times of crisis such value orientation will embolden the efforts and approach of people in making adaptation and mitigation of adversities related to climate change.

Table 4.3.3: Distribution of men respondents according to their value of egalitarianism (N=60)

Statement	SA f (%)	A f (%)	UD f (%)	D f (%)	SD f (%)	Mean
What this world needs is a more equal distribution of wealth.	15 (25.00)	42 (70.00)	0	3 (5.00)	0	4.15
I support Government effort to get rid of poverty.	14 (23.33)	32 (53.33)	2 (3.33)	11 (18.33)	1 (1.67)	3.78
I support affirmative action.	21 (35)	35 (58.33)	4 (6.67)	0	0	4.3
Firms and Institutions should be so organized that everybody can influence important decisions.	14 (23.33)	42 (70.00)	1 (1.67)	3 (5.00)	0	4.12
If people were treated more equally we would have fewer problems.	15 (25)	43 (71.66)	0 (0)	2 (3.33)	0	4.18
The world would be a more peaceful place if its wealth were divided more equally among nations.	21 (35)	36 (60)	0	3 (5)	0	4.25
We have gone too far in pushing equal rights.	0	19 (31.67)	0	39 (65)	2 (3.33)	2.6
If men and women were treated more equally we would have fewer problems.	18 (30)	28 (46.67)	2 (3.33)	12 (20)	0	3.86
If wealth and other productive resources were equally distributed among men and women there would be more prosperity	17 (28.33)	26 (43.33)	0	15 (25)	2 (3.33)	3.68

SA: Strongly Agree, A: Agree, UD: Undecided, D: Disagree and SD: Strongly Disagree

Measured on five-point continuum with modified scale of (Leiserowitz, 2006) the obtained mean values of more than 4 for most of the statements amply indicate the affirmation of the majority of the women respondents about egalitarianism. Similarly the statement with negative connotation with respect to egalitarianism- “We have gone too far in pushing equal rights” the mean score was 2.5 indicating that a majority showed disagreement with it. Hence, it is deduced that a large majority of the respondents held value of equality. Such positive value in a society is highly appreciating as it facilitates equal accessibility and distribution of common goods

among men and women farmers. In times of crisis such value orientation will embolden the efforts and approach of people in making adaptation and mitigation of adversities related to climate change.

Table 4.3.4 Distribution of women farmer respondents according to their value of egalitarianism (N=60)

Statement	SA f (%)	A f (%)	UD f (%)	D f (%)	SD f (%)	Mean
What this world needs is a more equal distribution of wealth.	17 (28.33)	36 (60)	3 (5.00)	4 (6.66)	0	4.1
I support Government effort to get rid of poverty.	18 (30)	27 (45)	6 (10)	9 (15)	0	3.9
I support affirmative action.	22 (36.66)	31 (51.66)	7 (11.67)	0	0	4.25
Firms and Institutions should be so organized that everybody can influence important decisions.	19 (31.66)	37 (61.66)	1 (1.67)	3 (5.00)	0	4.2
If people were treated more equally we would have fewer problems.	15 (25)	41 (68.33)	2 (3.33)	2 (3.33)	0	4.15
The world would be a more peaceful place if its wealth were divided more equally among nations.	16 (26.6)	37 (61.66)	4 (6.67)	3 (5)	0	4.1
We have gone too far in pushing equal rights.	0	19 (31.67)	0	33 (55)	8 (13.33)	2.5
If men and women were treated more equally we would have fewer problems.	23 (38.33)	27 (45)	2 (3.33)	8 (13.33)	0	4.08
If wealth and other productive resources were equally distributed among men and women there would be more prosperity	26 (43.33)	21 (35)	4 (6.66)	9 (15)	0	4.06

SA: Strongly Agree, A: Agree, UD: Undecided, D: Disagree and SD: Strongly Disagree

Level of dependence

The nature and extent of dependence of the men respondents on natural and social capital was studied. It was observed that generally there was dependence to a greater extent on the resources for livelihood as drawn from the mean scores above 2.

Table 4.3.5: Distribution of men farmer respondents on the basis of level of dependence (N=60)

Resources	Level of dependence				Mean
	Fully dependent Frequency (%)	To a greater extent Frequency (%)	To a lesser extent Frequency (%)	Not dependent Frequency (%)	
Cultivable land	28 (46.6)	19 (31.66)	13 (21.66)	0	3.25
Community land	0	9 (15)	17 (28.33)	34 (56.66)	1.58
Forest	0	0	0	0	0
Common Property Resources	14 (23.33)	28 (46.66)	18 (30.00)	0	2.93
Neighbourhood	0	22 (36.66)	38 (63.33)	0	2.36
Village institutions	0	22 (36.66)	38 (63.33)	0	2.36

A majority of respondents (46.6 per cent) were fully dependent and 31.6 per cent were dependent to a larger extent upon land for livelihood. About 24 per cent of the respondents were fully dependent and about 46 per cent were dependent to a greater extent on Common Property Resources. All respondents had dependence upon neighborhood and village institutions. Hence, people need to be educated towards judicious use of natural resources for sustainability. Also they need to be sensitized for building up social capital with networking, reciprocity and linkage for better cohesiveness and collective action for collective preparedness and adaptation to crises emerging from climate change.

A majority of women respondents (55 per cent) were fully dependent and 25 per cent were dependent on a larger extent upon land for livelihood. About 24 per cent of the women respondents were fully dependent and about 44 per cent were dependent to a greater extent on common property resources management. All women respondents had dependence upon neighborhood and village institutions. Hence, people need to be educated towards judicious use of natural resources for sustainability. Also they need to be sensitized for building up social capital with networking, reciprocity and linkage for better cohesiveness and collective action for collective preparedness and adaptation to crises emerging from climate change.

Table 4.3.6: Distribution of women farmer respondents on the basis of level of dependence (N=60)

Resources	Level of dependence				Mean
	Fully dependent Frequency (%)	To a greater extent Frequency (%)	To a lesser extent Frequency (%)	Not dependent Frequency (%)	
Cultivable land	33 (55)	15 (25)	12 (20)	0	3.35
Community land	0	9 (15)	21 (35)	30 (50)	1.65
Forest	0	0	0	0	0
Common Property Resources	17 (23.33)	26 (43.33)	17 (23.33)	0	3.0
Neighbourhood	0	23 (38.33)	35 (58.33)	2	2.35
Village institutions	0	18 (30)	33 (55)	9 (15)	2.15

Table 4.3.7: Distribution of the men farmers according to their level of vulnerability (N=60)

Vulnerability Index Intervals	Frequency	Percentage
Highly Vulnerable (<0.387)	2	3.33
Moderately Vulnerable (0.387- 0.7228)	41	68.33
Less Vulnerable (>0.7228)	17	28.3

It is evident from the Table 4.3.7 that a majority of the men respondents (68.33 %) were in moderately vulnerable group followed by about 28.3 per cent men in less vulnerable group, while about 3.33 per cent men were in highly vulnerable group. The men farmers in the area largely had low level awareness, knowledge and skill about climate change and adaptation. Adequate training programmes in areas of preparedness and adaptation need to be organized besides launch of social protection measures to empower them for better preparedness and adaptation to climate change.

Table 4.3.8: Distribution of the women farmers according to their level of vulnerability (N=60)

Vulnerability Index Intervals	Frequency	Percentage
Highly Vulnerable (<0.3401)	15	25
Moderately Vulnerable (0.3401- 0.6813)	36	60
Less Vulnerable (>0.6813)	9	15

It is evident from the Table 4.3.8 that a majority of the women respondents (60%) were in moderately vulnerable group followed by about 15 per cent women in less vulnerable group, while about 25 per cent women were in highly vulnerable group. Compared to the men farmers' results, women were more vulnerable to climate change. The women farmers in the area had having low level of awareness about the climate change, knowledge about different impacts of climate change and skill about adaptation measures could be the factors for their vulnerability. Adequate training programmes in areas of preparedness and adaptation need to be organized besides launch of social protection measures to empower them for better preparedness and adaptation to of climate change.

4.3.5 Conclusion

Majority of the women farmers in the area were more vulnerable to climate change compared to men farmers. Vulnerability may be due to lack of awareness about climate change, knowledge about climate change, skill in coping mechanisms and attitudinal. Hence for developing adaptation strategies the emphasis must be laid upon socio-psychological empowerment of farmers, with emphasis on women farmers through motivational, attitudinal and infrastructural support in order to develop their capabilities for better and community-centric adaptive mechanisms besides developing competencies in skills related to adaptation practices. Their adaptive capacities need to be strengthened in a holistic manner.

CHAPTER 4**RESEARCH PAPER - IV**

Adaptive strategies of women and men farmers towards climate change in the arid ecosystem**4.1.1 Abstract**

Poor farming households are the most vulnerable and in times of drought, those who are unable to change their farming practices may face starvation, loss of health and loss of life (World Bank, 2006). To ensure the food security as well as overall well being under the difficult conditions of farming in the drought-prone areas, farmers diversify their livelihoods. Unless appropriate mitigation and adaptation measures are taken, climate change will frustrate farmers' efforts to achieve sustainable agricultural production and food security. However, developing such strategies will require information from the farmers since the ability to adapt and cope with climate change depends on their knowledge, skills, experiences and other socio economic factors (Maharjan et al, 2011). The study was conducted in the Bikaner district of Rajasthan. Two stages stratified random sampling procedure was followed in selection of respondents. Total sample size was 60 male and 60 women farmers. This investigation was aimed at documentation of the men and women farmers' adaptive strategies and indigenous technical knowledge towards climate change in the arid region of Rajasthan. Locally available proverbs were also documented. These proverbs are used by the farmer's for the prediction of the weather.

Key words: Adaptive strategies, wClimate change and Gender

4.1.2 Introduction

Adaptation to climate change is necessary, in addition to mitigation of climate change, to avoid unacceptable impacts of anthropogenic climate change (IPCC, 2007). Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices and structures to moderate potential changes or to benefit from opportunities associated with climate change (Smit and Pilifosova, 2001). Arid and semi-arid regions are characterized by a climate with no or insufficient

rainfall to sustain agricultural production. With in India almost 53.4 per cent land area comprises arid and semi-arid regions (First NATCOM, GoI, 2004). Diversified livelihood systems with a livestock component are flexible and have a higher capacity to deal with multiple stresses in general, and with a dry and drought-prone climate in particular (Morton 2007). Common property resources, including pastures, constitute an important component of livelihood assets of communities in semi-arid areas of India and offer vital income and sustenance opportunities in the harsh agro-climatic conditions (Jodha, 1995). Adaptive strategies as “Longer term (beyond a single season) strategies are needed for people to respond to a new set of evolving conditions (biophysical, social and economic) that they have not previously experienced. Adaptation is a process through which societies make themselves better able to cope with an uncertain future. In order to ensure the food security as well as overall well being under the difficult conditions of farming in the drought-prone areas, smallholder farmers diversify their livelihoods (Deb *et al.*, 2002). Adapting to climate change entails taking the right measures to reduce the negative effects of climate change by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These range from technological options such as development of drought resistant crop varieties, to behaviour change at the individual level, such as reducing water use in times of drought. Other strategies include agricultural diversification, development of rainwater harvesting structures, reforestation etc. The study was under taken with the objective to document the adaptive strategies of women and men farmers towards climate change in the arid ecosystem

4.1.3 Methodology

The adaptive strategies can be operationalized as “Longer term (beyond a single season) strategies that are needed for men and women farmer’s to respond to a new set of evolving conditions (biophysical, social and economic) that they have not previously experienced. The study was undertaken in the Bikaner district of Rajasthan state, and among the two groups of respondents: 60 men and 60 women farmers. Total sample size was 120. Men and women respondents were selected through two stages stratified random sampling. The selected respondents were interviewed personally with the help of a well structured interview schedule and focussed group discussions were organised for men and women and their responses were recorded. The data thus collected were tabulated and analyzed to characterize respondents’ responses.

4.1.4 Results

Table: 4.4.1 Summary of Indigenous and Recommended Practices used by men and women farmers

S. N.	Subject	Sub-subject	Indigenous practices
1.	Storage structure	i. Water storage structures	<i>Tankas, Johad, Khadin, Bawadi etc.</i>
		ii. Fuel storage structures	<i>Pirawanda, Kuncha (firewood storage) etc.</i>
		iii. Fodder storage structure	<i>Karai, Pachasa</i>
		iv. Seed storage structure	Earthen pots
		v. Grain storage structure	<i>Kothi</i>
2.	Conservation Practices	i. Soil conservation	<i>Kanna Bandhi</i>
		ii. Soil moisture conservation practices	Mulching
		iii. Water harvesting structures	Tanks, <i>Kundi</i> etc.
		iv. Drip and sprinkler irrigation structures	Earthen pots as a drip irrigation
3.	Agricultural practices	i. Use of drought tolerant varieties	Bajara, Gram, <i>Moth</i> , Wheat, Mustard, Datepalm, Aonla
		ii. Use of organic farming practices	Use of domesticated animal dung's, urines, fodder wastes etc.
		iii. Farm diversification	Raising of crop and livestock
		iv. Mixed cropping	Sowing of mixed crop's seeds without maintaining definite row pattern
		v. Use of Bio-pesticides	<i>Neem</i> seed kernel and leaves etc.
		vi. Changes in sowing and harvesting time	
		vii. Use of indigenous driers	Net structures
4.	Livestock	i. Making cow shed using mud (mud houses + <i>Khimp</i> + <i>Shania</i>)	
		ii. Feeding ' <i>Tumba</i> ' to livestock	
		iii. Using ash massage and gunny bags to protect animals from cold waves	

Rajasthan falls in the semi arid and arid ecosystem. The area under study is characterised by arid type of ecosystem. The climate of arid ecosystem is characterised

by late set and early cessation of monsoon. The average rainfall of the area under study is less than 40 cm per annum. Most of the rainfall occurs in July and August months. The farming practices of this region are suffering from various weather vagaries such as low rainfall, frequent drought, heat waves, lack of moisture conservation practices etc. In most of the area under study, farmers use their indigenous techniques along with certain recommended techniques to cope with the above mentioned weather vagaries. Focussed group discussion with the men and women farmers revealed the practices discussed in table 4.4.1.

I. Storage structures

Storage structures are the most innovative techniques of ancient India to conserve water, grains etc for future consumption and these structures are still used by farmers which are constructed using locally available resources. These storage structures can be used for drinking water purposes, irrigation etc. Storage structures identified in the study area are of various types:

A) Water storage structures:

'*Tankas*', '*Johad*', '*Khadin*', '*Bawadi*' etc. are the examples of water storage structures. Pictures of these structures are as follows:



Photo I: *Kundi*



Photo II: *Johad*

Kundi:

Kundi is known as the small tank in the study area. They are underground tanks which are built in the main house or in the courtyard. They are circular or rectangular holes made in the ground, constructed using lime and polished cement. These are used to collect rain water and sometimes collected using transported water. This is an underground storage

structure which helps to keep the water cool and reduce or minimize evaporation losses.

Johad:

A '*Johad*', also called as a '*talaab*', is a traditional or artificially constructed storage structure to harvest surface runoff water for drinking, irrigation in agriculture and for bathing of buffaloes in the low lying areas where soil has higher content of lime. Percolation and evaporation of water are the major drawbacks of this type of structures.

B) Fodder storage structures

Fodder storage structures are made of locally available material such as '*Sarkanda*', '*Khimp*', '*Arna*' etc. used to control the entry of rain water into the stored fodder. *Karai* (small fodder cuttings), *Pachasa* (fodder used as it is) etc. are the fodder storage structures.



Photo 4. *Karai*

C) Grain and Seed storage structure:

Farmers use previous crops output as seeds for the coming season's crop. For the purpose of seed material and food material, these need to be stored safely without losing quality of the material from pest etc.; farmers use *neem* (*Azadirachta indica*) leaves and ash to protect them. Earthen pots for storing seeds and *kothi* for storing grains are the main storage structures.



Photo 5 : *Kothi* – the grain storage structure

I) Conservation Practices:

A) Soil conservation practices: *Kanna Bandhi*

Farmers use *Kanna bandi* technique to conserve soil from transporting from one place to another, also it helps to stabilize sand dunes. The *Kanna bandi* can be made using various locally available materials such as *Khimp* (*Leptadenia pyrotechnica*), *Sania* (*Crotalaria burhia*), *pala* (*Ziziphus nummularia*) etc. In this technique one or more rows are constructed across the wind direction at a certain distance.



B) Use of Earthen pots as a drip irrigation practice:

Under this technique, earthen pot (s) with a small hole used as a water storage device in which rope is used to supply water in droplets directly to the root zone of the plants which minimizes the loss of water. It is similar to the drip irrigation system of modern time.



II) Agricultural practices

A) Farm diversification

It is also known as general farming. Here farming is diversified i.e., a number of enterprises are taken up on the farm at the same time. It also connotes production and sale of the farm product at different time during a year. There is much significance for single enterprises under this situation. No single enterprises contribution is as high as 50 per cent of the total income derived in farming. Example raising crop and livestock

B) Mixed farming

It is a type of farming in which crop production and livestock production are combined to sustain and satisfy as many needs of farmers as possible. There are limit specified regarding contribution of livestock production, poultry, fisheries, and bee keeping, etc. to the gross income on the farm. These enterprises are supposed to contribute at least 10 per cent of gross income. However this contribution should not exceed 49 per cent.

C) Mulching

Mulching is the soil moisture conservation practice in the region. Mulching is the process of applying mulch material to the soil. Mulch is a layer of material applied to the surface of an area of soil. Its main purpose is to conserve moisture, to improve the fertility and health of the soil and to reduce weed growth

D) Use of drought and salinity tolerant varieties

Farmers are using the different drought and salinity tolerant varieties to combat the adverse climatic situations. In the study area following varieties are used: Pearl millet (Raj 171, HHB 60), *Guar* (RGC 197), Mustard (RH189), Wheat (LOK1), Gram (RSG 896) etc.

III) Livestock

A) Making cow shed using dung and locally available materials:

Cow sheds are made of various locally available resources such as *Khimp* (*Leptadenia pyrotechnica*), *Sania* (*Crotalaria burhia*) and overlapped by cow and buffalo dung. This provides all round protection to animals during summer, winter and also during heavy rains.



Photo 7. Traditional Cow shed

B) Feeding '*Tumba*' to livestock

Tumba, botanically known as *Citrullus colocynthis*, is used as a seed cake, or boiled cake which is a good source of protein (contains 16-22%). It is a well known indigenous (non-conventional) healthy feed for livestock especially for goat and heifer. *Tumba* has some anti-bacterial and anti-viral properties which help to fight against virus and bacteria. Initially this was lying waste, however, now the farmers have started using this due to shortage of fodder.



Photo 8. Preparation of *Tumba* feed

C) Using ash and gunny bags to protect animals from cold waves

Due to climate change the extreme weather phenomenon will also increase, the intensity and frequency of weather extremes such as cold waves, heat waves, frost, heavy downpour etc will also increase. Gunny bags are used by the farmers in the winter season to protect the cattle's from the cold waves. This is a cheaper and indigenous way to protect livestock from cold waves. Before tying the gunny bags, ash is rubbed on the body of the buffaloes.



Photo 9: A buffalo protected from cold waves by using ash and gunny bags

Famous proverb's related to weather forecast and climate change in Bikaner district:

The study had documented some of the proverbs specially used for the weather prediction, crop production, drought etc. Proverbs are based on the experience and wisdom of the farmers. These are very helpful for farmers to take decision regarding the selection of crop, production of crop, rainfall pattern etc.

1) *“Kalo chidio jito uppar ghoslo banay, Fasal uti hi uppar jay”:*

This proverb states the direct relationship between the black sparrow nest's height and the growth (height or production) of crop plant.

2) *“Tijo kurio, aathavo kaal”:*

Rajasthan state (especially Desert Region) is adversely affected due to drought. The above said proverb *“Tijo kurio, aathavo kaal”* states that after every third year there is a problem of minor drought in which mainly water problem is faced and after every eighth

year there is a problem of food, fodder and water due to major drought. This is somewhat in the line with the *Elnino* and *Lalino* effects after every three and eight years.

3) “*Saawan surangi khejri, to kati biranga khet*”:

The above said proverb states that the greenness of *Khejri* Plant (*Prosopis cineraria*) in the month of June–July (Hindi month *Shrawan*) has a signal of adverse climatic condition in the region. The farmers said that this has always turned out to be as such repeatedly over the years.

4) “*Holi ke din aathuni baje, to jamano aacho hove*”:

South eastern winds on the occasion of Holi Festival (Month of ‘Phalgun’-March) are the signal of good climatic condition in the region.

5) “*Chahe aagat ho ya pachat, kati me sab sathi*”:

In the situation of early set or late set of monsoon, the production will remain same in the month of October (Hindi month *Kartik*). For this kind of situation it is rightly said in the north western Rajasthan that *Chahe aagat ho ya pachat, kati me sab sathi*.

4.1.5 Result and Discussion:

Science based forecasting generally based on the statistical and simulation technique that are used for long term forecasting of future water supply projections, drought related projections, give the prediction of flood and rainfall and for modelling of climatic variability. Climate change presents a clear challenge to this type of forecasting technique. Since many forecasting techniques depend on the previous year’s data, changes to baseline of the data can reduce the prediction value of the technique. The study was made to document the different adaptation strategies to climate change that farmers have learnt over time and experience. The farmers adapted to climate change in three ways:

1. Recommended practices by the different Government Institutions
2. Use of traditional wisdom for weather forecasting
3. Use of indigenous technical knowledge

The level of awareness of men and women farmers was low to the climate change in the Bikaner district. Farmers adopted their local knowledge to combat with the adverse effects of climate change. The following recommendations are given for effective adaptation to climate change:

Extension agents should be trained on climate change and its impact on farming so that they can educate farmers on appropriate adaptation measures or strategies. Extension should focus on effective climate change communication. Dr. M. S. Swaminathan has suggested 'Village level climate managers' for effective climate change communication. Farmers should be encouraged to adopt dry farming and Resources conservation technologies. Government should make gender based policies which suit climate variability and climate change by including women farmers as change agents. Government should promote planting of windbreaks and shelterbelts as study area is severely affected by wind erosion. Integration of mitigation and adaptation frameworks into sustainable development planning is important. ITK's is needed to be documented and validated for use in these areas. Gender Climate Smart Agricultural practices need to be popularised by involving men and women farmers.

RESEARCH PAPER - V

Delineation of the different institutional interventions for climate change awareness and adaptation**4.1.1 Abstract**

Climate change is widely considered to be one of the greatest challenges to modern human civilization that has profound socio-economic and environmental impacts. This study aimed to understand gender differences in access to climate smart agricultural interventions and opportunities and also aimed at delineation of the different institutional interventions for climate change awareness and adaptation in the study area. The study was conducted in the Bikaner district of Rajasthan. Two stages Stratified random sampling procedure was followed in selection of respondents. Total sample size was 60 men and 60 women farmers. The study observed that different interventions operationalized by institutions in the study area are helpful during the adverse climatic conditions. Advantage can be taken of existing traditional harvesting structures along with renovation, extending and building tanks and ponds in order to enlarge storage capacity for water. A community intervention like “familial forestry technique” was identified which was developed at local level in the study area. Increasing focus on the livestock sector, because they contribute about one third in the agricultural GDP of Rajasthan, was suggested by the farmers. Policies should be made by using gender lens to explore the needs of grass root level functionaries. Several interventions have in the past facilitated the formation of local groups. Extension should use these local groups as the entry point for future climate smart agricultural initiatives.

Key words: *Climate smart agriculture, Adaptation, Climate change and Institutions*

4.1.2 Introduction

Climate change is an emerging issue and in developing countries, which are more concerned with poverty alleviation, job creation etc., there is very little awareness on this subject. Climate change constitutes a very serious threat to sustainable agricultural

production and food security in many parts of the world. Climate change impacts on agriculture include biological effect on crop yield, the resulting impact on prices, consumption and the impact on per capita calorie and nutrition consumption. Research findings have shown that agriculture in developing countries is currently being affected by climate change (FAO, 2007; IFPRI, 2009). Projections for this century show a continued rise in temperature accompanied by changes in precipitation patterns. More frequent, severe and prolonged climate-related events such as floods and droughts are also projected. This has broad implications for many sectors, but particularly for food security, disaster preparedness, health, and water management. They will place an increasing burden on the disadvantaged group of the society. Climate change challenges the path of sustainability in the agriculture sector. Through its direct and indirect impacts on crop yields, pests and diseases, land and water resources, climate change is expected to affect agriculture through multiple pathways, thereby having an effect on livelihoods and the overall food security situation in the State. Irregular or no rainfall forces several farmers to abandon their fields or migrate temporarily to pursue alternative sources of income (Akermann *et al.*, 2009). Community and individual interventions, existing local groups mainly comprising women groups are more strongly engaged in the climate smart agriculture. The study was undertaken with the objective to delineation of the different institutional interventions for climate change awareness and adaptation

4.1.3 Methodology

This study aimed to understand gender differences in access to climate smart agricultural interventions and opportunities and also aimed at delineation of the different institutional interventions for climate change awareness and adaptation in the study area. The study was conducted in the Bikaner district of Rajasthan. Two stages stratified random sampling procedure was followed in selection of respondents. Total sample size was 60 men and 60 women farmers. The selected respondents were interviewed personally with the help of a well structured interview schedule and their responses were recorded. The data thus collected were tabulated and statistically analysed to interpret the results. Secondary sources were also used for the purpose.

4.1.4 Result and Discussion

Rajasthan falls in the semi arid and arid ecosystem. The area under study is characterised by arid type of ecosystem. The climate of arid ecosystem is characterised by late set and early cessation of monsoon. The average rainfall of the area under study is less than 40 cm per annum. Most of the rainfall occurs in July and August months. The farming practices of this region are suffering from various weather vagaries such as low rainfall, frequent drought, heat waves, lack of moisture conservation practices etc. In most of the area under study, farmers use their indigenous techniques along with certain recommended techniques to cope with the above mentioned weather vagaries. Following institutional interventions which were present in Bikaner are listed below:

Table 4.5.1: List of different institutional interventions in Bikaner district of Rajasthan

S.N	Programmes	Strategy/Objectives/Components
1.	Forest Protection programme	Strengthening of institutional framework along with supporting infrastructure, providing incentive to informers leading to detection of forest offences, institutional participatory forest protection and management systems, modernization of protection machinery by providing mobility and communicating network, undertaking forest fire control measures.
2.	Forest Development & JFM (Joint forest management)	Promotion of Agro-farm forestry on private lands which constitute approximately 61 percent of the area of the State, Panchayati Raj institutions (PRIs) involved in plant raising and their distribution. Promoting urban forestry in the major urban centres JFM consolidation through entry point activities and skill development for income generation and development of eco-tourism sites.
3.	Training Research Extension & Education	Outsourcing of research work in existing institution, modernization of training facilities at forestry training institutes, adopting E-governance, increased emphasis on communication, extension, and training by

		organizing trainings, <i>van mela</i> , <i>van mahotsav</i> , activating <i>van chetna kendras</i> , exchange visits, creating smriti van Eco-club, etc.
4.	Farm Forestry programme	Distribution of seedlings to farmers, schools, panchayats, urban areas and Government institutions for planting.
5.	Convergence of NREGS (National rural employment guarantee scheme) and NAP; National afforestation plan)	Raising of seedlings on a large scale in departmental nurseries so that tall plants will be available from next year. Plantation of trees along the road side and on the waste land, construction of water harvesting structures.
6.	Drought Prone Area Programme	Undertaking watershed projects. To provide capacity for resilience to droughts.
7.	Desert Development Programme	Drought proofing, Development of watersheds etc. Improves resilience to droughts.
8.	Integrated Wasteland Development Programme (IWDP)	Development of wastelands. Restoration of wastelands so that can become more suitable for agricultural/horticultural purposes.
9.	Rajasthan State Climate Change Agenda (RCCA) for 2010-2014	the RCCA identified a list of strategies under the following seven state level Task Forces: <ul style="list-style-type: none"> a. Water Resources b. Agriculture and Animal Husbandry c. Forestry and Biodiversity d. Human Health e. Enhanced Energy Efficiency and Solar Energy f. Urban Governance and Sustainable Habitats g. Strategic Knowledge for Climate Change
10.	Rajasthan Action Plan on Climate Change	The Rajasthan Action Plan on Climate Change will put forth a strategic plan of action for 2020; to enhance resilience in the State for addressing current and likely impacts of climate change on key sectors, enhance adaptive capacities of the vulnerable communities

		while tapping potential opportunities for mitigation.
11.	JalChetana Abhiyaan	To successfully create awareness towards water scarcity and to educate people for water conservation Roof top rain water harvesting structure for all urban buildings constructed on 300 sq. meters or bigger plot has already been made mandatory.
12.	IFFCO Kisan Sanchar Limited (IKSL) initiative	IKSL giving five messages a day to the farmers through Airtel green SIM, in which one message is related to weather information.
13.	TERI (The Energy & Resource institute) initiative	TERI is engaged in implementing ICT-based projects where information related to climate variability, weather, soil, crops, etc., is being provided to farmers with the help of ICT.
14.	Krishi Vigyan Kendra (KVK), Bikaner	Giving vocational training on the different crop and livestock issues.
15.	Agricultural Research Station(ARS) Bikaner	Conducting "farmers awareness programme" on weather and its components relevant to farming occupation.
16.	Central Institute of arid Horticulture, Bikaner	Promoting arid fruit crops like <i>ber</i> , pomegranate, <i>aonla</i> , <i>kinnow</i> , <i>malta</i> , <i>bael</i> , <i>lasoda</i> , <i>ker</i> , <i>Gonda</i> , <i>Karonda</i> , and datepalm.
17.	Regional station, Central Arid Zone Research Institute, Bikaner	Developed technologies like sand dune stabilization, soil and water conservation, improved agroforestry systems, management of cropland, pasture and range areas, management of saline-sodic soils etc.
18.	NICRA interventions	Developed drought and salinity tolerant varieties.
19.	Community based intervention: Jyani "Familial Forestry" technique	A unique forestry technique involving school children and their families is proving effective in tree plantation Community Plantation programme during NSS camp.

Harit Rajasthan (Green Rajasthan) - *Harit* Rajasthan also called as '*Hariyalo* Rajasthan' is a noble campaign of Government of Rajasthan which has the potential to

transform the state from an arid state to a green state. The campaign was launched to provide a green cover to areas where the absence of trees has led to ecological imbalances. Scheme envisages planting of over 30 lakh saplings on vacant land in schools, colleges, hospitals and Government offices as well as in public parks and along the roadside and highways. The area under forests in the State had expanded by 185 sq. Km because of this campaign. The new phase of the project will be implemented in the ten desert districts of Barmer, Jaisalmer, Bikaner, Churu, Jhunjhunu, Sikar, Pali, Jodhpur, Jalore and Nagaur and five other districts of Bhilwara, Sirohi, Banswara, Dungarpur and Jaipur.

From September 10 to October 5, 2012, 293000 saplings were planted in 100291 households of 2,086 villages of Bikaner district under National Rural Employment Guarantee Programme (NREGP). Under the green project, one teacher from each of the 2241 government schools was made task leader and was given necessary training. These leaders visited the households of the students (the village houses normally have good open spaces) and selected the site and asked about the preferred plant variety from the family. These task leaders then kept a close track on the growth of the trees for next two years. Interestingly, 175000 of these saplings are fruit yielding like *kinnu*, pomegranate, *anola* and *jamun*.

Crop and livestock insurance- Drought is a recurring phenomenon in the study area which impacted crop and livestock adversely. Therefore the schemes of National Agricultural Insurance Scheme (NAIS); Weather Based Crop Insurance Scheme (WBCIS) and livestock insurance schemes are being run to protect farmers against crop and livestock losses, due to failure of monsoon or other natural calamities. The National Agriculture insurance scheme (NAIS) has been implemented in the State since Kharif, 2003. This scheme is compulsory for loanee farmers and optional for non-loanee farmers. In the State twelve crops are covered in the *Kharif* season like sorghum, Bajra, Maize, *Moong*, *Moth*, *Urad*, Cowpea, Groundnut, *Til*, *Guar*, Arhar and Soybean. In the *Rabi* season ten crops are covered under NAIS like Wheat, Barley, Gram, Mustard, *Taramera*, *Masoor*, Coriander, Cumin, *Isabgol*, *Methi*.

The Weather Based Crop Insurance Scheme (WBCIS) is also implemented since Rabi 2007-08 in 10 districts which are Ajmer, Bikaner, Barmer, Churu, Jaipur, Jaisalmer, Jodhpur, Ganganagar, Kota and Udaipur for eight crops which are Wheat, Barley, Gram, Mustard, Coriander, Cumin, *Isabgol*, *Methi*. In NAIS, claims beyond

premium are shared equally by Government of India and Government of Rajasthan on 50:50 basis. In weather based crop insurance scheme, premium subsidy is shared equally by Government of India and Government of Rajasthan on 50:50 basis and all claims are borne by implementing agency.

Fodder Banks- The Department of Animal husbandry and livestock started a project for establishment of fodder bank to feed the livestock during the time of drought on sustainable basis. These banks are set up in areas of recurring drought NGOs and Community based organisations (CBOs) were being involved in formation of Self Help Groups (SHGs) and these SHGs were made responsible for operation and management of the fodder banks.

Rural Development Initiatives- Since Independence, a large number of Rural Development Programmes, such as infrastructure development (roads, communication, and electrification), market network, new crop technology based on seed-fertilizer-irrigation inputs, and watershed development, were initiated with different objectives of poverty reduction, drought mitigation and relief. These have significantly helped the population in drought prone areas. These programmes include the following-

- National Watershed Development Programme for Rain fed Areas (NWDPA);
- Integrated Watershed Development Programme (IWDP);
- Drought Prone Area Development Programme (DPAP);
- Desert Development Programme (DDP);
- Employment Generation Programme (EGP);
- Rural Poverty Alleviation Programmes, including Individual Beneficiary Programmes, Rural Infrastructure Development, Tribal Area Development, and Drinking Water Supply programs etc.

Under NREGP many water harvesting and storage structures like *Johad*, *medbandhi*, etc. were undertaken along with other soil and water conservation works. These works helps in harvesting rainwater thus reducing runoff and soil erosion while providing water for life saving supplemental irrigation for crops and for livestock drinking, therefore helping in adapting to climate change.

Most initiatives, while undoubtedly useful, could have been more efficient if they recognized the resource specifics in drought prone areas and related them to the age-old

adaptations and coping strategies of the people. Similarly, generalized institutional programmes-like land reforms, community development, projects, *panchayat* systems etc. were extended to these areas, without assessing their potential impacts on sub-marginal lands, common property resources and climatic uncertainty. Public relief strategies to help drought-affected people were designed and pushed to such a level that they have more or less displaced the people's own adjustment mechanism and generated strong dependence on public relief. Irrigation facilities were developed in a few pockets, but used on crops requiring a lot of high water and in the areas well endowed with water. Market integration took place, but it had serious adverse impacts on the strategic self-provisioning system and fragile resource base. Some initiatives (like the Drought Prone Area Program) followed a development process suitable for better endowed areas. All this indicates the need for understanding and explicit consideration of specifics of drought prone areas in both development strategies and drought management.

The other shortcoming of the State response is that it is relatively less sensitive to livestock issues. The State is neither supportive of people's traditional strategy of animal migration nor of building buffer stocks of fodder. To build fodder banks in the State, special steps should be taken during a good agriculture year within Rajasthan, and by neighbouring States together to provide fodder at lower cost and stock it in areas where it is most needed.

The present policy of supplying water during drought needs drastic change, as it is neither economically feasible nor sustainable. The root of the problem lies in the depletion of groundwater, meeting more than 90 per cent of rural drinking water needs. It requires serious review of the Water Policy of the State (Rathore, 2005).

Weather forecasting and early warning- The India Meteorological Department (IMD), with the help of the Ministerial Crop Weather Watch Group (CWWG), carries out a drought forecasting function at the national level. At the State level, Rajasthan has set up a Weather Watch Group (WWG) under the Chairmanship of the Relief Secretary having Director Agriculture, Director IMD, Hydrologist Irrigation Department and representative of PHED and Ground Water Department as members. This Group meets every Monday during the Monsoon season to monitor agro climatic parameters and help to provide early warning of drought onset.

In the existing structure of State Government, there is a Drought Relief Department and other allied departments with relevant programmes and policies. The activities of the Department are largely governed by the “*Famine Code*” guidelines and the national and State government agreements regarding sharing of funds for the purpose. There is a well-laid organisational structure from state to village level for management of drought in the State. The constituted committees, taskforces and specifically nominated officers to deal with drought, are fully supported by the existing government structure at all levels.

National Initiative on Climate Resilient Agriculture (NICRA) interventions of ICAR- Giving agro advisory based on IMD weather forecast and village weather observatory. Developed drought and salinity tolerant varieties like Mustard (RH 819), Wheat (LOK 1), Gram (RSG 896), Bajra (Raj 171, HHB 60), and Guar (RGC 197), Developed frost tolerant varieties of Mustard (Bio 902).

Central Institute of Arid Horticulture (CIAH) interventions- Central Institute of Arid Horticulture (CIAH), Bikaner has optimally tapped the potential of Arid areas by promoting arid fruit crops like *ber* (varieties: *Gola*, *Seb*, *Mundia*), pomegranate (*Jalore Seedless*), *aonla*, *kinnow*, *malta*, *bael*, *lasoda* (*Cordia myxa*), *ker* (*Capparis decidua*), *Gonda*, *Karonda*, custard apple and datepalm etc. as the study area has comparative advantage for arid horticulture.

TERI ICT hub: Seeding knowledge in the desert

In remote rural areas, access to information and services is a major barrier in socio-economic development. People in the district of Bikaner are forced to travel long distances for any work or even information. Remoteness of the population from the mainstream has made them vulnerable. Farmers are found lacking in knowledge of practices in agriculture, animal husbandry, etc. In order to implement a robust information mechanism of utilizing information and communication technologies, a local network of entrepreneurs and NGOs has been developed. Stakeholders of the projects play a pivotal role in collection and dissemination of information.

Hence an ICT (information and communication technology) based initiative in the desert by TERI is serving the rural population of about 90 villages, catering to their need for quality information and services. Information is provided to people, who are largely known as 'information have-nots'; the project has undertaken a small step to

bridge the 'digital divide'. More importantly, initiative in the form of the project also captures valuable information from villagers in the form of a repository of local knowledge, tradition, and culture. Information and services are provided by a chain of five access points, all linked to a hub located in Bikaner. These workers have been working on the project as knowledge torch bearers by reaching out to people to disseminate knowledge and services.

The project has adopted a two-pronged approach for the flow of communication top-down and bottom-up and aims at developing knowledge and service-delivery systems utilizing ICT as a tool. The mechanism encourages participation of the local community in forming a knowledge base and further disseminating distilled information to a larger audience, making use of modern and feasible technologies. This is done through a network of entrepreneurs and NGOs, who own the access points, collect and send information to the hub based in Bikaner, which acts as a filtering mechanism, refining and validating information and sending it back to the access points. The project has set up a panel comprising experts from different sectors - such as agriculture, animal husbandry, health, etc. who are responsible for validation of the contents. The project has developed a hub-and-spoke model in the field for effectively collecting and disseminating information in Hindi language. The youths trained under the *TERI-Uttam Urja* initiative are acting as 'knowledge workers' as part of an entrepreneurial set-up led by a local entrepreneur, supported by the project in the pilot phase. TERI is engaged in implementing ICT-based projects where information related to climate variability, weather, soil, crops, etc., is being provided to farmers with the help of ICT.

Regional station, Central Arid Zone Research Institute, Bikaner- In order to combat drought and desertification, and for sustainable development of arid areas, Central Arid Zone Research Institute (CAZRI) has developed several technologies like sand dune stabilization, shelterbelt plantation, soil and water conservation, improved agro-forestry systems, management of cropland, pasture and range areas, management of saline-sodic soils, and rehabilitation of mine spoils, and disseminating the developed technologies to the stakeholders.

Grassland Improvement and Management- The grasses are ideally suited for the desert ecosystem. CAZRI has screened a number of promising strains of desert grasses, viz., *Cenchrus ciliaris* (*Anjan*), *Lasiurus indicus* (*Sewan*), *Cenchrus setigerus*

(Dhaman), *Dichanthium annulatum* and *Panicum antidotale*, and has developed improved varieties/strains of grasses, like *Marwar Anjan* (CAZRI-75), CAZRI-357 and CAZRI-358 of *Cenchrus ciliaris*, *Marwar Dhaman* (CAZRI-76), CAZRI-1 and CAZRI-296 of *C. setigerus*, CAZRI-318, 319; 30-5 of *Lasiurus indicus*, and CAZRI-347 of *Panicum antidotale*, as well as pasture legumes like CAZRI-144, CAZRI-1462 and 1258 of *Lablab purpureus*, and CAZRI-453, 466 and 468 of *Clitoria ternatea*. All these have higher protein content and are easily digestible by the livestock.

To increase forage production from overgrazed and denuded pastures, reseeded with high-yielding varieties of perennial forage grasses like *Cenchrus ciliaris*, *Cenchrus setigerus*, *Lasiurus indicus*, *Dichanthium annulatum*, *Panicum antidotale* and *Sehima nervosum* have been found most suitable. *Dichanthium annulatum* gives high yields on heavy soils with >380 mm annual rainfall, while *Cenchrus ciliaris* and *Cenchrus setigerus* produce high forage on sandy soils under medium to low rainfall. *Lasiurus indicus* gives high yield on sandy soils under <200 mm rainfall. *Panicum antidotale* performs well under protected conditions and on medium textured soils in >250 mm rainfall, while *Sehima nervosum* yields good forage on hilly terrain.

Rainfed Crop Varieties- Suitable dryland crop varieties, which match with the rainfall pattern of the region and efficiently utilize the rainfall and stored soil moisture, have been developed by CAZRI include-

- Pearl millet: CZP-9802; CZP-IC-923 (Composite variety)
- Moth bean: *Maru Moth*, CAZRI-Moth-1, CAZRI-Moth-2, CAZRI-Moth-3
- Clusterbean: *Maru-Guar*
- Horse gram: Maru-Kulthi-1

Improved varieties of *Ber* (*Gola*, *Seb* and *Mundia*), identified by CAZRI, have made a big impact in arid and semi-arid regions. It provides reasonable income to farmers even during drought years. Propagation technique of *ber* through budding, control of *ber* fruit fly, water harvesting through micro-catchments, optimum spacing, fertiliser requirement, post-harvest technology, etc., have been standardised. Optimum spacing for planting *ber* in the region has been found to be 6 x 6 m. Inoculation of nursery soil with *Azotobacter/Azospirillum* and AM fungi has been found to provide sturdy seedlings and facilitate early budding of *ber* seedlings. The

ber technology has been widely popularised and has earned immense goodwill for CAZRI, with products sold in the market in the name of “CAZRI *ber*”.

Pomegranate (*Punica granatum*): Cultivar Jalore seedless of pomegranate was identified, propagation technique standardized, and recommended for commercial cultivation in arid and semi-arid regions. Agro-techniques for its cultivation have been standardised. Optimum spacing for planting pomegranate in the region has been found to be 5 x 5 m. Irrigation through drip system during flowering and fruiting considerably increased yield and reduced fruit cracking.

Community based interventions of Familial Forestry-

A unique forestry technique involving school children and their families is proving effective in tree plantation in Bikaner and Ganganagar districts. The technique was conceived and developed by a young college lecturer Shyam Sunder Jyani of Bikaner. Jyani calls his technique ‘Familial Forestry’ in which the saplings are planted by students inside the house boundaries and the survival and growth of the plants are monitored by their school teachers. The concept started in 2006 through National Service Scheme (NSS) volunteers. He had planted saplings in 120 houses of Himtasar village located about 15 kms from the district headquarters of Bikaner. The village households were divided into two part; 60 households were told about the benefits of trees and were included in the after plantation care of village teachers.

The survival rate of saplings in the inspired families was an astonishing 90 percent while the other 60 households had only 20-30 percent. In 2007, a mass plantation drive was taken up in *Gajsukhdesar* village about 100 kms from Bikaner. A team of 1,500 volunteers, school children and villagers planted 105000 saplings in and around the village. Limca book of records has also documented this intervention. All the funds for saplings come from National Service Scheme (NSS).

Participation of men and women farmers in different training programmes organised by Agro-met field unit and KVK, Bikaner was assessed through the available secondary data; result shows that women farmers’ have very less participation in the training programmes but it was observed that women farmers have high participation in the animal husbandry practices and daily household activities. Thus, institutions should be focus on the women farmers as they are the key agents of change in gender smart agriculture.

Table 4.5.2: Participation of men and women farmers in different training programmes organised by Agro-met field unit and KVK, Bikaner

Sr. No.	Name of interventions	Men farmers <i>f (%)</i>	Women farmers <i>f (%)</i>
1	Agro met field unit, Bikaner:- "Farmers Awareness Programme" was organized on 11/3/2011 on weather and its components relevant to farming occupation	97 (100%)	0 (0.00%)
2	KVK, Bikaner: ON and OFF Campus: Training on Cropping Systems (Improved agronomical practices in rabi & Kharif crops)	154 (100%)	0 (0.00%)
3	KVK, Bikaner: Livestock Production and Management (including dairy management, green feed management, <i>Pasu jankar</i> etc.)	89 (85.5%)	15 (14.4%)
4	KVK, Bikaner:- Horticulture (Fruits and Vegetables)	43 (84.13%)	08 (15.68%)

Women should be motivated to participate in the training programmes organised by different institutions. Women's role in maintaining biodiversity and preserving traditional knowledge should be recognised and encouraged. Even though these institutional interventions are there in Bikaner District the respondents men and women farmers in the study area were not aware of these. This calls for an urgent need to spread interventions to the villagers.

Table 4.5.3: Men and Women farmers' awareness about different institutional interventions (N= 120)

Sr. No.	Different institutional interventions	Awareness among farmers			
		Men (n=60)		Women (n=60)	
		Yes	No	Yes	No
		f(%)	f(%)	f(%)	f(%)
1.	Forest Protection programme	17	43	3	57
2.	Farm Forestry programme	17	43	3	57
3.	Convergence of MNREGS (Mahatma Gandhi National rural employment guarantee scheme) and NAP (National afforestation plan) initiative	49	11	45	15
4.	Drought Prone Area Programme	21	39	11	49
5.	Desert Development Programme	21	39	11	49
6.	Rajasthan State Climate Change Agenda (RCCA) for 2010-2014	7	53	3	57
7.	Rajasthan Action Plan on Climate Change	7	53	3	57
8.	IFFCO Kisan Sanchar limited (IKSL) initiative	0	60	0	60
9.	TERI (The Energy Research institute) initiative	3	57	0	60
10.	Krishi Vigyan Kendra (KVK), Bikaner initiative	4	56	0	60
11.	Agricultural research station (ARS), Bikaner initiative	0	60	0	60
12.	NICRA interventions	0	60	0	60
13.	Community based intervention: Jyani's "Familial Forestry" technique	36	24	31	29

The result of the table 4.5.3 revealed that women farmers were very low awareness about different institutional interventions as compared to men farmers. Women farmers were mainly aware about the MNREGA (Mahatma Gandhi National rural employment guarantee scheme) interventions.

Discussion and conclusion:

The main impact of climate change in the arid region is occurrence of frequent drought or condition of water shortage. Women are mainly affected by the drought as they are responsible for the collection of water. The significant issue in drought mitigation and relief policy is identification of vulnerable areas and population. There is a need for transparent and non-political criterion for identification of vulnerable areas and population. This will help target development programmes and drought relief to most deserving population and areas.

The impact of drought is both direct and indirect on most of the economic and social parameters. Direct impacts are easy to identify and quantify, hence there is a need for consistent collection of data on livestock mortality, human migration, coping strategies, depletion of groundwater table, etc. Drought impact on food production in the State is negative. The number of vulnerable households is increasing and more people migrate. The impact of drought on livestock is also significant.

Water is the key to all kinds of vegetative growth. To cope with drought, people have over exploited groundwater mainly for food production and the situation is aggravating further, as rainfall across the state is insufficient to recharge the falling groundwater levels. The impact of drought is ultimately on the livelihoods of people in terms of reduced food availability, forced migration, depletion of fixed and movable assets, health and nutrition and social marginalization. Vulnerability will depend on the economic status of the household. The poorer section of farmers and women will be the most vulnerable.

Drought monitoring and management require more use of technology in advance prediction, monthly status of crop condition, health of water bodies, etc. The information so generated should also be made public for people's education, and accordingly devising coping strategies.

Initiation of rural development and poverty reduction programmes as a strategy to mitigate drought or reduce the impact of drought did work partially, but needs to be revised in the context of depleting natural resources. Poverty is multidimensional; therefore poverty reduction efforts have to be multi-targeted. Creating long term employment opportunities for the rural poor in such a drought prone state as Rajasthan should be the future strategy.

Farmers' suggestions for interventions in the study area:

For identifying the farmer's suggestions on institutional interventions, a focussed group discussion was organised in the village and the salient result of the discussion are listed below:

1. Improve rainwater-harvesting capacities through direct benefit to the farmers: Take advantage of existing traditional harvesting structures. Renovate, extend and build new tanks and ponds in order to enlarge storage capacity for water.
2. People's participation in Watershed management projects (WMP's): In order to efficiently use available resources, specialists need to analyze watersheds of the villages and design adequate harvesting plans. Support local Non Governmental organisation (NGO), active in the area is probably an efficient solution to achieve this goal.
3. Assured sustainability by building up local management bodies: Help villagers build up committees, which take care of management task as well as maintain existing infrastructure.
4. Capacity building in the area of water saving agricultural techniques, as biodiversity based organic farming practices.
5. Cattle conservation programs: Many farmers complained about declining cattle populations. As livestock is an essential part of agriculture in the study area, programs designed to maintain or increase cattle population are desirable.
 - a. Abolish subsidies for foreign breeds and support local breeds.
 - b. Fodder banks or subsidized fodder should be available in drought periods.
 - c. Possibility to bring cattle to *gaushalas* (cattle camps) in case of drought.
 - d. Veterinary services are needed in the villages.
6. Increase grain and fodder storage capacities: Improve food security through construction of larger grain storage facilities, coupled with encouragement to stock larger quantities of food for calamity times.
7. Extension services: Extension services for agriculture related activities are needed. To diversify production into agro-forestry and adopt more sustainable land use practices requires adequate training. This is absent in most of the villages and is very much desired by the farming communities.
8. Assure access to weather forecast: According to government officials, weather forecast exists for most of the visited areas. However, farmers seldom have

access to such information or are simply not aware of these services. Assure adequate distribution of information to remote villages through awareness raising campaigns is a possibility.

9. Affordable crop insurance: Farmers mentioned several times that affordable crop insurance would make a huge difference for them. Designing and implementing pilot projects in the study area is desirable.
10. More research focused on indigenous crops and varieties tolerant to stresses caused or exacerbated by climate change, and more studies looking at the role of specific practices, knowledge, methods and techniques in adaptation to climate change such as the role of agro forestry and rainwater harvesting systems, would contribute to the further development of biodiversity-based adaptation strategies.
11. Capacity building of the women farmer groups for the processing and value addition of locally available fruits and vegetables. For example, training in food preservation.
12. Promotion of local crops through the creation of public private partnership for improved marketing and employment opportunities.
13. Conservation of forests through awareness raising activities and introduction of participatory forest management schemes.
14. Restoration and increase of the number of traditional water collecting structures through Government schemes: Increasing the numbers of traditional water structures would make a difference. Every village has a number of these traditional water-harvesting structures. Most of the time, they are in a very bad condition however and are in need of repair. Increasing the number of the structures could resolve some of the problems related to insufficient water.
15. Facilitate the shift to diversified organic farming: Providing incentives for farmers to shift production to organic farming could relieve some of the pressure on natural resources and at the same time benefit farmers financially. There is a need to finance the training and the transition period from conventional to organic farming, as this period is characterized by substantial yield losses. Facilitation for creation of fair-trade organic markets suitable for the goods produced by small-scale farmer
16. Awareness program to educate about conservation of precious ground water resources and training on rainwater harvesting will be beneficial to check decline in water level and justified use.

17. Ground water legislation should be implemented for regulation and control of ground water in over-exploited areas with immediate effect.
18. Use of water saving devices like sprinklers, close field distribution channels etc. should be promoted as sprinklers are also suitable for the undulating land.

Hence institutional interventions are important for the mass awareness of the people to climate change. Both men and women farmers expressed the desire to undertake the climate smart agricultural activities. Even though the above mentioned interventions were there in Rajasthan but majority of the farmers were unaware about these. They had not reached the study area. The great Indian agricultural scientist Dr. M. S. Swaminathan said that we have the 'grass root climate managers' for creating the awareness about the climate change. Hence, extension with climate change communication intervention is required to enhance the awareness of the grass root level workers. Several interventions have in the past facilitated the formation of local groups. Extension should use these local groups as the entry point for future climate smart agricultural initiatives.

CHAPTER 5

General Discussion

Climate is the long-term average of a region's weather events, thus the phrase 'climate change' represents a change in these long-term weather patterns. Over the last decade the consensus on the science of climate change has firmed up quite considerably. This has been made broadly known by the publication of the initial documents of the Fourth Assessment Report on global warming by the Intergovernmental Panel on Climate Change (IPCC): "Warming of the climate system is unequivocal". By 2100, the mean annual temperature is projected to increase by 1°C to 5°C depending on the scenarios and location. Land masses are projected to warm more rapidly than oceans. There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.

The increase in the availability of scientific proofs on climate change and corresponding national and international concerns over the topic has changed the scenario of climate change debate quite significantly. Time has come for some solid actions and policy formulations to save our planet from this looming threat. Climate change can only be effectively tackled through broad participation in the global reduction effort by all present and future major emitters. Strong political will and well planned actions can help in reducing greenhouse gas emissions across the world. Under the auspice of UNFCCC, dialogue among the key international partners to explore global climate strategies is already being conducted in various international forums. While the importance of climate change and its impacts are increasingly being recognized at the global forums the actions at local level is needed to be taken very seriously. Climate change is a global problem but its solutions lie at local level. Climate change thus directly affects the eradicating poverty mission of many developing countries.

The Intergovernmental Panel on Climate Change (IPCC) in its synthesis report published in 2007 has concluded that the global average temperature has increased by 0.74°C and eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature since 1850. This clearly

indicates the pace of recent climate change. The sensitive issues should be addressed by integrating comprehensive climate risk management into development planning, programs, and projects. The impacts result not only from gradual changes in temperature and sea level but also from increased climate variability and extremes, including more intense floods, droughts, and storms. Under changing climate few places are expected to get more rain while some may remain dry. Rajasthan in the north western part of India faced a decrease on an average 20 per cent in all India summer monsoon rainfall.

Now it is a well established fact that global climate change is unequivocal and is mostly due to human activities. The other climatic changes, like the amount, intensity and distribution of rainfall, drought, and sea level rise etc., influence agriculture in many ways such as water use, soil health, pests and disease occurrence and spread, food security, and stress on natural resources. This emphasizes the need for planned adaptations in agriculture.

Women play a vital role as agricultural producers and as agents of food and nutritional security. Based on the latest international data, women comprise an average of 43 per cent of the total agricultural labour force of developing countries. Yet relative to men, they have less access to productive assets such as land and services such as finance and extension. A variety of constraints impinge upon their ability to participate in collective action as members of agricultural cooperative or water user associations. In both centralized and decentralized governance systems, women tend to lack political voice. Gender inequalities result in less food being grown, less income being earned, and higher levels of poverty and food insecurity. Agriculture in low-income developing countries is a sector with exceptionally high impact in terms of its potential to reduce poverty. WEDO (Women's Environment and Development Organisation) and UN studies show that climate is not a gender neutral issue.

Past research studies indicate that there is considerable lack of climate change awareness and knowledge among the key stakeholders of agriculture. Though people are aware about climate change, they lack in detail information (Sarkar and Padaria, 2010). Hence a study was proposed entitled "*Vulnerabilities and Adaptation strategies to climate change in Rajasthan: A Gender Perspective*" was an attempt. The results of the study are discussed under the following sub headings:

1. Gender roles and resources analysis in crop husbandry activities, animal husbandry activities and routine household activities
2. Men and women farmers awareness and perception about climate change
3. Men and women farmers vulnerability to climate change
4. Adaptation strategies to climate change
5. Institutional interventions to climate change awareness and adaptation

Gender roles and resources analysis in crop husbandry activities, animal husbandry and routine household activities

IPCC said that climate change is not a gender neutral issue. Gender in agriculture and climate change is an emerging issue in the present era of globalization. Changing climatic conditions can have differential impacts on the different sections of the society according to the resources.

It was observed that men and women have different participation level in the crop husbandry, animal husbandry and routine family activities. According to FAO (2007), rural men and women play different roles in forests and natural resource management, and these differences apply between and with cultures, communities, and households.

An empirical model of climate and gender smart agriculture was developed which is based on the four dimensions (background situation, cognitive processes, institutional mechanisms and policy implications).

Despite the diversity in the roles and status of women in agriculture, the findings in the study confirm that women face a surprisingly consistent gender gap in access to productive assets, inputs and financial services.

Men and women farmers' awareness and perception about climate change

On the issue of observed changes in climate, it was observed that majority of the men and women respondents had perceptions that the nature and intensity of regional

rainfall has become more unusual in their region. These perceptions are consistent with the national level projections for climate change (INCCA, 2010).

The World Bank has adopted a climate-risk-management approach which focuses on the resilience of development efforts to both present-day weather variability as well as projected climate change. To help countries manage their risks, water-related investment projects will help determine the impacts of climate change on hydrology and water use, identify appropriate options, guidelines, and methodologies for adaptation.

It was observed that women have low awareness about climate change as compared to men. Furthermore most of the men and women farmer perceived shortage of water in the upcoming years. This has implications for more drudgery for women in coming years.

Women and men farmers also perceived that large scale deforestation, industrialisation and heavy use of fossil fuels are the reasons for the present climate change; but about 30.0 per cent of the men and women farmers were unable to perceive that heavy use of fossil fuels causes rapid global climate change. It appears that though deforestation is a secondary cause for climate change, farmers consider it to be the main cause for climate change and consider the use of fossil fuels as a secondary cause for present climate change. These findings are consistent with the observations of Benedicta *et al.* (2010).

Men and women farmers' vulnerability to climate change

Most fundamentally, the vulnerability of women in natural resource economies is affected by their relative insecurity of access and rights over resources and source of wealth such as forest land. It is well established that women are disadvantaged in terms of property rights and security of tenure, though the mechanisms and exact form of insecurity are contested. This insecurity can have implications both for their vulnerability in a changing climate, and their capacity to adapt to productive livelihoods to a changing climate (IPCC, 2007).

It was observed that women farmers were more vulnerable than men farmers in the study area. The reasons for high vulnerability in women are their low awareness about climate change, perception about climate change; believe in fatalism and

egalitarianism, high dependency on common property resources and others leads to increasing their susceptibility to climate change. These findings are consistent with Dercon *et al.* (2005). WEDO, CCAFS (climate change, agriculture and food security studies) also shows that women are more vulnerable to climate change as compared to men.

Adaptation strategies to climate change

Entitlements to elements of adaptive capacity are socially differentiated along the lines of age, class, religion and gender. Climate change therefore has gender specific implications in terms of both vulnerability and adaptive capacity. There are structural differences between men and women through, for example, gender-specific roles in society, work and domestic life. These differences affect the vulnerability and capacity of women and men to adapt to climate change. In the developing world in particular, women are disproportionately involved in natural resource dependent activities.

The study found that use of adaptation practices enabled the men and women farmers to live in harmony with their environment. Adaptation practices like use of soil conservation techniques, rain water harvesting, use of drought tolerant varieties, intercropping, change in time of farm operations, crop rotations; use of water conservation techniques, *kanna bandhi*, etc. were mainly used by the men and women farmers in the study areas.

Institutional interventions for climate change awareness and adaptation

Institutions play a critical role in supporting climate change awareness and adaptation. Support for partnership between local farmers and civil society institutions are very necessary to the effective adaptation to climate change.

Government institutions, non-governmental organisations (NGO) interventions, community and individual based interventions were found in Rajasthan. Although institutions play a critical role in supporting adaptation, the intensity of adverse future climate impacts is likely to increase, thereby also increasing the vulnerability and reducing existing capacity of the people.

It was observed that following programmes are going in the study area like “*Harit Rajasthan*” or “*Hariyalo Rajasthan*”, National Agricultural Insurance Scheme (NAIS), Weather Based Crop Insurance Scheme (WBCIS), livestock insurance

schemes, fodder bank, Desert Development Programme (DDP), MNREGS (Mahatma Gandhi national rural employment guarantee scheme), support through NICRA (National initiative on climate resilient Agriculture), CIAH (Central institute of arid horticulture), KVK, Bikaner, Regional research station of CAZRI (Central arid zone research institute) etc. but men and women farmers had low awareness about these programmes in the study area.

The study revealed that women were neglected by the institutions as in training on farming, livestock management and environmental awareness campaign. Climate change is not a gender neutral issue, so, women farmers need to be involved. The men and women farmers have come to rely largely on support from government employment and food distribution schemes as well as on loans and migration in order to earn additional income.

It was observed that the women farmers had less access to institutional interventions as compared to men farmers. These findings are consistent with findings of Lambrou and Nelson (2010). In addition, there appears to be a gap between the advice provided and its uptake by men and women farmers. Informal institutions, including traditional knowledge and neighbours, continue to be important sources of information for the farmers. The research has shown that farmers are getting some institutional support, but they are not thriving.

So, we need to act now and have sufficient information to do so. We will need to both do more of the things that we do today and do many different things to adapt to a changing climate. We will need to pursue activities that are both development and eco-friendly. Building the evidence base for sustained action now and in the long-term is necessary in the present era. Climate change communication can be a critical factor for effective adaptation and mitigation. Climate policies should focus on Climate and Gender smart agriculture.

CHAPTER 6**SUMMARY AND CONCLUSION**

“In order to awaken the people it is the women who have to be awakened. Once she is on move, the family moves, the village moves, the nation moves.”

Pt. Jawahar Lal Nehru

Climate change will be pivotal in redefining development in the twenty-first century. In the present context nations, societies, communities, and households response to the impacts of climate changes and variability to which the world has already been committed will in many instances determine their prospects for growth, equity, and sustainability. Given the potential magnitude of impending changes in institutional and social relationships, the gaps in current knowledge about the role of institutions in adapting to climate change are remarkably large. Historically climate policy has not addressed the differing ways in which climate change affects men and women. However in the present agricultural scenario context it is felt that there is strong need of gender informed climate policy. Review of literature points to a lack of sufficient gender disaggregated data in agriculture, especially in context of climate change.

The role of gender in agriculture has gained growing attention among researchers, aid donors, and policy makers. As new knowledge on the role of gender in agricultural productivity emerges, agricultural programs can use this knowledge to improve outcomes. But more knowledge and better outcomes will depend on a stronger evidence base on gender in agriculture, programs that do more to address the particular needs of women as well as men, and more vigorous engagement with women’s groups as full partners in agricultural development. Two recent flagship reports vis. the Food and Agriculture Organization’s (FAO’s) State of Food and Agriculture Report 2010–2011 and the World Bank’s World Development Report 2012 turn their attention to gender issues in agriculture. Emphasizing women’s contributions to agriculture in developing countries, the State of Food and Agriculture 2010–2011 highlights the need to close the gender gap in access to agricultural resources, education, extension, financial services, and labour markets, to invest in labour-saving and productivity enhancing technologies and infrastructure to free women’s time for more productive

activities, and to facilitate women's participation in flexible, efficient, and fair rural labour.

The World Development Report 2012 stresses that gender equality can lead to productivity gains, that women's increased control of household resources can improve outcomes for the next generation, and that empowering women as economic, social, and political actors can result in more representative decision making. Studies also point to the important links between agriculture, climate change, gender, and food and nutritional security. This study also identifies areas where policy can help to close the gender gap. On the basis of this background following specific objectives were made:

Specific Objectives

1. To undertake gender analysis of roles and resources in crop and animal husbandry practices with respect to changing climate scenario
2. To study the perception and awareness of women and men farmers about climate change
3. To assess the relative vulnerabilities of women and men farmers to climate change
4. To document the adaptive strategies of women and men farmers towards climate change
5. To delineate the institutional interventions for climate change awareness and adaptation

Research Methodology

An ex-post facto and survey research design was adopted for the study. The study was undertaken in the Bikaner district of Rajasthan state as the state is vulnerable to the effects of climate change with respect to gender. Total sample size was 60 men farmers and 60 women farmers, thus 120 respondents comprised the total sample size. Men and women respondents were selected through two stage stratified random sampling. The respondents' perceptions were assessed through interview schedule covering different dimensions of their work in crop husbandry, animal husbandry and in routine family activities. The selected respondents were interviewed personally with the help of a well structured interview schedule and their responses were recorded. The data

thus collected were tabulated and statistically analysed to interpret the results. Non-parametric test like Mann Whitney U Test and Wilcoxon Signed Ranks Test were used to test the statistical significance. The data collected were analyzed with the help of SPSS package. The salient findings of the research are as follows:

- It was observed that men and women had different participation level in the crop husbandry practices. Women were involved mainly in the activities like intercultural operations, harvesting and storing grains while men had high participation in the activities like land preparation, sowing, marketing of crop produce and irrigation.
- Study revealed that in animal husbandry practices, women had very high participation in the activities like fodder cutting and its transportation, offering fodder and water to the animals and cleaning of sheds while men had high participation in the marketing of livestock produce.
- Findings show that women had high participation in the routine household activities like collection of fuel and firewood, preparation of food, collection of water for domestic use, caring for elders etc. but both were equally caring for their children.
- It was observed that in livelihood security assets analysis, men farmers had significant difference among human, social and natural assets except physical and financial assets over the last decade. In the case of while for women; human, social, physical and financial assets had significant difference and natural assets had non-significant difference over a decade. So, more needs to be done to build the evidence base on gender in agriculture, strengthen women's assets, and engage with women's groups as real partners in development. Reducing the gender gap in assets is key to improving agricultural productivity. Policies and programs that strengthen women's assets are likely to have long-term effects because they not only increase women's ability to adopt improved technologies or engage in more remunerative livelihood strategies, but also contribute to women's empowerment in the household and the community.
- An empirical model of climate and gender smart agriculture was developed which is based on the four dimensions (background situation, cognitive processes, adaptation strategies, institutional mechanisms and policy implications).

- Study revealed that level of awareness about climate change was low in women farmers as compared to men farmers. Furthermore most of the men and women farmer perceived shortage of water in the upcoming years.
- Women and men farmers also perceived that large scale deforestation, industrialisation and heavy use of fossil fuels were the reasons for the present climate change; but about 30.0 per cent of the men and women farmers were unable to perceive that heavy use of fossil fuels caused rapid global climate change. It appears that though deforestation is a secondary cause for climate change, farmers consider it to be the main cause for climate change and consider the use of fossil fuels as a secondary cause for present climate change.
- It was observed that women farmers were more vulnerable than men farmers in the study area. The reasons for high vulnerability in women may be then low awareness about climate change, perception about climate change; believe in fatalism and egalitarianism, high dependency on the common property resources and others leading to increasing their susceptibility to climate change.
- The study found that use of adaptations practices enabled the men and women farmers to live in the harmony with their environment. Adaptation practices like use of soil conservation techniques, rain water harvesting, use of drought tolerant varieties, intercropping, change in time of farm operations, crop rotations; use of water conservation techniques, *kanna bandhi*, etc. were the mainly used by the men and women farmers.
- It was observed that following programmes related to climate change are going in the study area like “*Harit Rajasthan*” or “*Hariyalo Rajasthan*”, National Agricultural Insurance Scheme (NAIS), Weather Based Crop Insurance Scheme (WBCIS), livestock insurance schemes, fodder bank, Desert Development Programme (DDP), MNREGS (Mahatma Gandhi national rural employment guarantee scheme), support through NICRA (National initiative on climate resilient Agriculture), CIAH (Central institute of arid horticulture), KVK, Bikaner, Regional research station of CAZRI (Central arid zone research institute) etc. but men and women farmers had low awareness about these programmes in the study area.

- The study revealed that women were neglected by the institutions as in training on farming, livestock management and environmental awareness campaign. Climate change is not a gender neutral issue, so, women need also includes in the programmes. The men and women farmers have come to rely largely on support from government employment and food distribution schemes as well as on loans and migration in order to earn additional income.
- It was found out that local community intervention like “familial forestry technique” was helpful in increasing awareness about climate change. This study focuses on the role of local institutions in adaptation to climate change. It does so under the belief that climate impacts will affect disadvantaged social groups more disproportionately, and that local institutions centrally influence how different social groups gain access to and are able to use assets and resources.
- It was observed that the women farmers have less access to institutional interventions as compared to men farmers. In addition, there appears to be a gap between the advice provided and its uptake by men and women farmers. Informal institutions, including traditional knowledge and neighbours, continue to be important sources of information for the farmers. The research has shown that farmers are getting some institutional support, but they are not thriving.

Implications and Recommendations of the study

There is a high level of need among the men farmers and women farmers regarding awareness about climate change. A gender lens needs to be used for policy formulations and programme implementation. Drudgery reducing tools need to be developed and disseminated. Women respondents were more vulnerable to climate change. Hence, knowledge and skills related to adaptation practices should be developed besides socio-psychological empowerment of women farmers through motivational, attitudinal and infrastructural support. Training programmes should be conducted for developing and improving the competencies of men and women farmers as well as the extension worker for facilitating better preparedness and adaptation. Enhancing awareness level of women and men farmers on institutional interventions and policy initiatives on climate change is important. Climate change has profound impact on social, economic and natural resources, hence, their holistic management with emphasis

on adaptation measures such as vulnerability mapping, early warning, use of remote sensing etc. has to be given importance. The consequences of climate change were reported by the farmers and they had high vulnerability. It calls for adequate measures for their preparedness and adaptation. Value-orientation (fatalism, egalitarianism), attitude and resource conservation need to be emphasized in extension programmes related to climate change awareness and adaptation. Validation of ITK's should be done for future used. We should work towards closing gender gap and engendering climate smart agriculture.

ABSTRACT

Climate change has wide ranging effects on the environment and on socio-economic and related sectors, including water resources, agriculture and food security, human health and biodiversity of arid and semi-arid ecosystems. Developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt socially, technologically and financially. Hence it is important to conduct socio-economic studies related to climate change in order to devise appropriate strategy for preparedness and adaptation. The present study was conducted with specific objectives of assessing gender role and resource analysis in crop, animal and routine household activities, awareness of men and women farmers about climate change in arid ecosystem, studying the men and women farmers' perception about climate change, analyzing men and women farmers' vulnerability to climate change and their adaptation strategy, and documenting the institutional interventions for climate change awareness and adaptation to climate change.

The study was conducted in the Bikaner district of Rajasthan. The district Bikaner was selected purposively, while the two blocks and four villages and a total of 60 men and 60 women farmers were selected randomly. It was observed that in crop husbandry activities, women were doing mainly field work like harvesting; intercultural operations and these activities are affected by climate change. Hence, their work load and drudgery needs to be addressed. Majority of the work in the animal husbandry activities and routine household activities were done by the women farmers as compared to men farmers. Awareness about climate change was low in the women farmers as compared to men farmers. Men and women farmers perceived climate change in the same way. Majority of the men and women respondents 'agreed' that large-scale deforestation was the reason for the present climate change. Women farmers were more vulnerable (85%) than men farmers (71%) to climate change. Adaptation practices were documented from men and women farmers like farm diversification, mixed cropping, use of ash to protect crop from frost, use of drought tolerant varieties, use of biopesticide, '*kanna bandhi*', etc. A number of institutional interventions for awareness and adaptation were documented but farmer's awareness about these was very low. Furthermore these interventions have not reached these remote areas. Participation of women farmers was very low as compared to men farmers in the training organized by different institutions. Study underlines the importance of climate change communication. The study also revealed the increasing drudgery for women farmers in the changing climatic scenario.

राजस्थान में जलवायु परिवर्तन संबंधी सुभेदता एवं अनुकूलन कार्यनीति: एक लिंग परिप्रेक्ष्य

सारांश

जलवायु परिवर्तन से शुष्क और अर्ध-शुष्क परिस्थितिकि प्रणाली पर व्यापक सामाजिक, आर्थिक और संबंधित क्षेत्रों जैसे जल संसाधन, कृषि, खाद्य सुरक्षा, जैव विविधता, मानव स्वास्थ्य और पर्यावरण पर बुरा प्रभाव पड़ा है। विकासशील देशों की सुभेदता जलवायु परिवर्तन के कारण ज्यादा होती है क्योंकि उनके पास अनुकूलन के लिए कम संसाधन हैं। अतः अनुकूलन हेतु उपयुक्त कार्यनीति, विद्या व उपाय के विकास के लिए सामाजिक व आर्थिक दृष्टिकोण से जलवायु परिवर्तन पर शोध आवश्यक है। इस आशय से इस शोध की परिकल्पना तथा सम्पादन किया गया है। इस शोध के मुख्य उद्देश्य यथा महिला और पुरुष कृषकों के जलवायु परिवर्तन से कृषि व पशुपालन में भूमिका व संसाधन विश्लेषण महिला व पुरुष कृषकों के जलवायु परिवर्तन संबंधी बोध का आंकलन, उनके अवबोधन का अध्ययन, सुभेदता तथा अनुकूलन योजनाओं का प्रलेखन तथा जलवायु परिवर्तन की जानकारी व अनुकूलन के लिए संस्थागत प्रयासों को लेखाबद्ध करना है।

यह शोध राजस्थान के बीकानेर जिले में यादृच्छिक रूप से चयनित 60 महिलाओं तथा 60 पुरुष कृषकों के मौखिक साक्षात्कार द्वारा सम्पादित किया गया है। शोध द्वारा पाया गया कि कृषि की गतिविधियाँ जैसे कटाई, प्रचालन आदि कार्य जलवायु परिवर्तन से प्रभावित हुए थे अतः महिला कृषकों का कार्य भार बढ़ा है। पशुपालन व सामान्य गतिविधियाँ मुख्यतः महिला कृषकों द्वारा ही की जाती हैं। जलवायु परिवर्तन के बारे में महिला कृषकों को पुरुष कृषकों के अपेक्षा कम जानकारी है जबकि महिला व पुरुष कृषकों का जलवायु परिवर्तन पर अवबोधन समान है। अधिकांश महिला व पुरुष कृषकों ने वनों की कटाई को जलवायु परिवर्तन का मुख्य कारण बताया। शोध में पाया गया कि महिला कृषकों की सुभेदता पुरुष कृषकों से ज्यादा है। जलवायु परिवर्तन से अनुकूलन के लिए महिला व पुरुष कृषकों से निम्नलिखित प्रद्वतियाँ प्रलेखित की गईं जैसे मिश्रित कृषि, कृषि विविधीकरण, कृषि में पाले से बचाव के लिए राख का उपयोग, जैवकीटनाशी का प्रयोग, सुखा सहनशील किस्मों का प्रयोग, मिट्टी का कटाव रोकने के लिए 'कणा बंधी' इत्यादि जलवायु परिवर्तन की जानकारी व अनुकूलन के लिए जारी संस्थागत प्रयासों को भी प्रलेखित किया गया है। संस्थागत प्रशिक्षण में महिला कृषकों की भागीदारी पुरुषों के अपेक्षा बहुत कम पाई गई।

अतः यह शोध जलवायु परिवर्तन संचार के महत्व को बढ़ावा तथा जलवायु परिवर्तन का महिलाओं पर प्रभाव की तरफ ध्यान आकर्षित करता है।

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Appendix-I

**VULNERABILITIES AND ADAPTATION STRATEGIES TO CLIMATE
CHANGE IN RAJASTHAN: A GENDER PERSPECTIVE**

Interview Schedule

Sl. No.....

Date.....

1. Name of the respondent:
2. Village Block.....
3. Sex :M/F
4. Age:Years
5. Socio-Economic status:

Sl. No.	Parameter	Response				
		Illiterate	Primary school	High school	College	Any other (specify)
1.	Level of education	Illiterate	Primary school	High school	College	Any other (specify)
2.	Size of land holding (acre)	Owned		Leased		
		Operating	Barren	Operating	Barren	
3.	Family type	Nuclear		Joint		
4.	Details of family members	Men adult	Female Adult	Men children	Female children	Any Other (specify)
5.	Occupation	Agril. Labour	Non-agril. labour	Self-employment	Government service	Any Other (specify)

Gender analysis:**Crop cultivation:**

Sl no	Activities	Men	Women
1.	Land preparation		
2.	Sowing		
3.	Manure and fertilizer application		
4.	Inter-cultural operations a) Weeding b) Thinning c) Gap-filling		
5.	Irrigation		
6.	Plant protection measures		
7.	Harvesting		
8.	Threshing		
9.	Winnowing		
10.	Keeping part of grains for consumption		
11.	Marketing of produce		

Animal husbandry:

Sl no	Activities	Men	Women
1.	Fodder cutting		
2.	Transportation of fodder		
3.	Offering fodder to the animals		
4.	Cleaning of sheds		
5.	Offering water to the animals		
6.	Milking		
7.	Livestock product selling		
8.	Raising of goats and sheep		
9.	Animal health care		
10.	Artificial insemination		

Participation in routine family activities:

Sl no	Routine family activities	Men/boy	Women/ girl
1.	Collecting fire wood and Fuel		
2.	Food preparation		
3.	Child care		
4.	Health services		
5.	Cleaning and repair		
6.	Collecting water		
7.	Collecting wild fruits and vegetables		

Livelihood security:**1. Natural assets:**

Average production per unit area of land:

No. of animals per unit area of land Yield from main crops:

Production of vegetables and fruits from women gardens:

2. Financial assets:

Income generating activities:

Savings:

Accessibility of vulnerable groups to credit (women):

3. Physical assets:

Management of water wells and maintenance of water pumps:

Grain stores (capacity and accessibility):

Energy conservation techniques (improved stoves):

Effectiveness of management systems applied to pasture, water, livestock etc.

4. Human assets:

Ownership of assets:

Skilled labors:

Housing type:

Access of marginal groups to education, training and extension services:

5. Social assets:

Organizational set-up (local village committees):

Role of village men/women in the decision making process:

Membership to organizations sharing of responsibility:

Awareness

Sl no	Statements	Response	
		Yes	No
1.	Have you ever heard the term climate change?		
2.	Do you feel that climate change is a very serious issue		
3.	Are you aware about the different impacts of changes in the temperature, rainfall, wind velocity etc.		
4.	According to you what are the reasons for the consequences of these changes? a. Natural b. Religiously committed c. Deforestation d. Intensified industrialized e. Air pollution f. No response		
5.	Are you aware about the global warming		

What do you perceive about climate change? Please express your level of agreement or disagreement to the statements mentioned below by ticking in the appropriate cell.

Sl.No.	Statement	Response Category				
		(5)	(4)	(3)	(2)	(1)
1.	I am certain that changes in temperature, wind velocity and rainfall are real over a period of time					
2.	I am concerned because these changes are a serious problem					
3.	I am concerned because changes in temperature, rainfall, wind velocity etc. are affecting agriculture in my region					
4.	Industrialisation is not responsible for changes in temperature, wind velocity, rainfall and other parameters					

5.	Heavy use of fossil fuels has led to rapid changes in temperature, wind velocity, rainfall and other parameters					
6.	Large-scale deforestation is a reason for the present changes in temperature, wind velocity rainfall and other weather parameters					
7.	I think compared to the past, the monsoon rainfall now occurs earlier					
8.	To me, the nature and intensity of rainfall have become more unusual in me region					
9.	To my mind, the present changes are due to God's curse on humanity					
10.	Compared to the past, we have more droughts now than before					
11.	In the last 10-20 years, there is increase in heat waves					
12.	I personally feel that, in the next 10-20 or so years, livestock in my region will be more adversely affected					
13.	To my mind, the low yields of crops in recent past are due to these changes					
14.	In the coming 10-20 years, I foresee more increased water shortages or stress					
15.	In the coming years, I foresee more and more desertification of arable land					

Social participation: Are you a member/Office bearer of any Organization?

Yes / No

If yes, please give the following particulars:

Sl. No.	Social institution	Member		Office bearer	
		Men	Women	Men	Women
1.	Gram Panchayat				
2.	Credit Cooperative Society				

3.	Village society				
4.	Milk-cooperative society				
5.	Rural Youth Club				
6.	Religious Committee				
7.	Political Organisation				
8.	Anganwari				
9.	Self Help Group				

Communication variables: From where do you seek information about climate change related information and technology?

Category	Source	Frequency of use			
		Most often	Often	Sometimes	Never
Personal Localite	1. Neighbors				
	2. Friends/Relatives				
	3. Opinion Leaders				
Extension Personnel	1. V.L.W.				
	2. A.D.O.				
	3. B.D.O.				
	4. Bank Personnel				
	5. Cooperative official				
	6. Expert from research				
	7. Stockman/Input dealers				
	8. KVK				
Mass media Exposure	1. Newspaper				
	2. Radio				
	3. T.V.				
	4. Pamphlet/Bulletin				
	5. Krishi Mela/ Exhibition				

	6. Group meeting				
	7. Film (ICT)				

Fatalism: Please express your level of agreement or disagreement to the statements mentioned below by ticking in the appropriate cell.

Sl.No	Statement	SA (5)	A (4)	UD (3)	D (2)	SD (1)
1.	The future is too uncertain for a person to make serious plans					
2.	It doesn't make much difference if people elect one or another political candidate, for nothing will change					
3.	I feel that life is like a lottery.					
4.	A person is better off if he or she doesnot trust anyone.					
5.	I have very little control over my life.					
6.	It is no use worrying about public affairs; I cannot do anything about them anyway.					
7.	I feel women's life will become more difficult/ hazardous					
8.	I feel farmer's lives are going to become tougher					

*SA: Strongly Agree, A: Agree; UD: undecided; D: Disagree; SD: Strongly Disagree

Egalitarianism: Please express your level of agreement or disagreement to the statements mentioned below by ticking in the appropriate cell.

Sl.No	Statement	SA (5)	A (4)	UD (3)	D (2)	SD (1)
1.	What this world needs is a more equal distribution of wealth.					
2.	I support Government's effort to get rid of poverty.					

3.	I support affirmative action.					
4.	Firms and Institutions should be so organized that everybody can influence important decisions.					
5.	If people were treated more equally we would have fewer problems.					
6.	The world would be a more peaceful place if its wealth were divided more equally among nations.					
7.	We have gone too far in pushing equal rights.					
8.	If men and women were treated more equally we would have fewer problems.					
9.	If wealth and other productive resources were equally distributed among men and women there would be more prosperity					

Level of Dependence of the respondents upon natural, physical and social resources. Please give your response by giving tick mark in the appropriate cell.

Sl. No	Resources	Level of dependence				
		Fully depended	To a greater extent	Some what dependent	To a lesser extent	Not dependent at all
1.	Cultivable land					
2.	Community land					
3.	Forest					
4.	Neighbourhood					
5.	Village institutions					
6.	Common property resources management					

Please indicate the adaptive strategies followed in the region

Sl. No.	Particulars	Men	Women
1.	Agriculture		
2.	Horticulture		
3.	Forestry		
4.	Animal husbandry		
5.	Water management		
6.	Soil management		
7.	Others		

Institutional interventions:

1. What are the programmes running by different organizations in your area related to climate change awareness?
2. What is the support you get from these departments in farming activities to mitigate climate change?
3. What are the different activities done by these organization in your area related to climate change?

4. What do you expect from these departments in farming activities related to climate change?

5. Your village or community doing something for the climate change awareness: Yes/No

If yes, than mention the interventions:

6. Attended any training or awareness campaign related to climate change?

Yes/No

If yes, mention the name of the campaign, name of the organization by which it was conducted and how did you benefitted?

Sr. No	Name of programme	Name of organization	How did you benefitted
1.			
2.			
3.			

7. Suggestions