Chapter 3

Review of Literature

The review of literature is one of the most important aspects in the research process, which help the researchers to get acquainted with subject matter under study and further channelize efforts in a desirable direction. It provides necessary guidelines and motivate researcher to proceed in research.

In any scientific investigation a comprehensive review of relevant literature is essential. At direct reference on all items are not is abundance certain specific references along with some indirect references have been incorporated in this chapter for purpose of meaningful use. Its main function, apart from determining the work done before concerning the problem area, is to provide an insight into the methods and procedures and create a basis for interpretation of findings. This chapter deals with review of literature adopted from different authors and researchers who conducted more or less similar studies in this field. Following are the Review of studies on 'Impact of Climate Change on Sustainable Livelihood Generation through Rice Production Management.'

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The review of literature has been presented under the following headlines-

A) Climate change:

- Scientific consensus on climate change
- Causes of climate change
- Climate change knowledge
- Perception on climate change
- Impact of climate change
- Impact of climate change on agriculture particularly on rice production
- Impact of climate change on livelihood
- Climate change adaptation

B) Sustainable livelihood generation:

- Sustainable development
- Sustainable livelihood
- Sustainable livelihood management

C) Rice production management & constraints:

- Rice production management
- Constraints

A) Climate change:

Scientific consensus on climate change

IPCC (2001) illustrated some conclusion on climate change and global warming (climate change 2001). Working Group I: The Scientific Basis –IPCC).

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These are summarized below:

1. The global average surface temperature has raised 0.6 ± 0.2 °C since the late 19th century, and 0.17 °C per decade in the last 30 years.
2. There is new and stronger evidence that most of the warming observed over the last 50 year is attributable to human activities, in particular emission of the greenhouse gases carbon dioxide and methane.
3. If greenhouse gas emission continues the warming will also continue, with temperatures projected to increase by 1.4 °C to 5.8 °C between 1990 and 2100. Accompanying this temperature increase will be increases in some types of extreme weather and a projected sea level rise.

Sen Roy and Balling (2004) assembled & studied the daily precipitation records, initially for 3838 station, throughout India and ultimately identified 129 stations with reasonably complete records over the period 1910 to 2000. Of the 903 different time series (seven variables for 129 station), 114 had a significant upward trend and 61 had a significant downward trend; overall, 61% of the time series showed an upward trend. They generally showed increasing values in a contiguous region extending from the north-western Himalayas in Kashmir through most of the Deccan Plateau in the south and decreasing values in the eastern part of the Gangetic Plain and parts of Uttaranchal.

Guhathakurata & Rajeevan (2006) studied the monthly, seasonal and annual rainfall time series of 36 meteorological sub-

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divisions of India which were constructed using a fixed but a large network of about 1476 rain-gauge stations. Trend analysis was carried out to examine the long-term trends in rainfall over different sub divisions. It has been found that the contribution of June, July and September rainfall to annual rainfall is decreasing for few sub-divisions while contribution of August rainfall is increasing in few other subdivisions.

Bouabid and Elalaoui (2010) studied the long term past trends of stream flow in relation to climatic data in four sub-basins of the Sebou basin in northern Morocco. A hydrologic simulation was performed on one of the sub-basins using the IHACRES and HEC-HMS models. Over the last five decades, stream flow and precipitation data showed a cyclic trends as well as general decline with variables amplitude from one sub-basin to another. Recorded stream flows are significantly correlated with the corresponding precipitation. The average curve fit for precipitations showed slopes ranging from -5.5 to -3.7, indicating rainfall decline over the past 50 years. Stream flow modeling with both IHACRES and HES-HMS gave very reasonable simulations and were comparable over the studied series. Differences among years with contrasting climatic events were well depicted with HEC-HMS and gave total annual discharges ranging from 0.93 billion m3/year for a dry year to 5.3 billion m3/year for a wet year. The used models can be adopted as good tools for precipitations of stream flow in response to climatic variability for better water resources management.

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Zhao *et al.* (2010) analyzed the fossil pollen data from Tianchi Lake on the Liupan Mountains in the Loess Plateau in China to investigate the interplay of climate change, vegetation history and human activities. The gradual increase in both poaceae pollen and microscopic charcoal since about 2000 cal yr BP and sharp increase in Poaceae but a decrease in charcoal at 1000 cal yr BP indicate two phases of human impacts on vegetation. The results from pollen and charcoal analysis, together with archaeological and historical evidence, suggest that human activities over the last 2000 years have significantly accelerated deforestation that was initiated by a drying climate since the mid-Holocene.

Beaumont *et al.* (2011) indicated that by 2070 up to 80% of the world's most exceptional terrestrial and aquatic eco regions will routinely experience monthly temperatures considered extreme compared to the 1961-1990 period. Twentieth century warming has been linked to changes in biological systems worldwide and these projected changes may therefore place increasing stress on these iconic eco regions.

Csank *et al.* (2011) reported that the early Pliocene (3.5-4 million years ago) was the last sustained period of time when the earth was warmer than present and is therefore considered a good analog for 21st century climate change. New paleo-temperature records indicate that over this period, prolonged atmospheric carbon dioxide concentration of between 365-415

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ppm resulted in Arctic temperatures 11-16°C warmer than present.

Li *et al.* (2011) studied the long-term record of El-Nino/southern Oscillation (ENSO) variability and identified that cycles of 50-90 years in ENSO intensity that appeared to be linked with long-term changes in sea surface temperatures in the eastern- central tropical pacific. As ENSO events of greater intensity are observed during warm periods, this suggests that increased sea surface temperatures in these regions in the future may lead to more intense ENSO events.

Tian *et al.* (2011) revealed that climate warming presents significantly asymmetric trends with greatly seasonal and diurnal differences, greater temperature elevations existing in the winter-spring season than in the summer-autumn season and at the nighttime than at the daytime.

Causes of climate change

Schneider (1989) reported that water vapour and other “greenhouse gases” such as carbon dioxide, methane, and CFCs cause the greenhouse effect by trapping radiant heat emitted at infrared (ling) wavelengths (as opposed to shorter, solar wavelengths which can pass through the atmospheric gases) from the earth’s surface and reradiating it back to the earth’s surface.

Botkin and Keller (2000) reported that human causes of global warming include deforestation and emission of other greenhouse

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gases (methane, CFSs, ozone, nitrous oxides) that contribute to the greenhouse effect.

Ramanathan and Inamdar (2006) reported that long-lived heat- trapping gases released by human activities, mainly CO_2, are driving global warming, and water vapour is responding and amplifying the initial warming by about twofold. These understanding date back more than a century and have been confirmed through many theoretical advancements and modern atmospheric observations.

According to the summary of the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (IPCC, 2007), human actions are very likely the cause of global warming; meaning a 90% or greater probability is attributable to human action. A comprehensive assessment by the IPCC of the scientific evidence suggests that human activities are contributing to climate change, and that there has been a discernible human influence on global climate. Climate changes caused by human activities, most importantly the burning of fossil fuels (coal, oil, and natural gas) and deforestation, are superimposed on, and to some extent masked by natural climate fluctuations.

Doran and Zimmerman (2009) conducted a poll of more than 3000 earth scientists and found that 82 percent of them, regardless of their specialties, agree that human activity is a significant contributor to changing average global temperatures.

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Climate change knowledge

Chakeredza (2009) explored some methods of mainstreaming climate change knowledge into agricultural education; and identify recommendations on effective policies, institutions and capacity and presented the key issues in climate change: 'who is affected and what direction we are taking if the negative effects presented by climate change are not checked.'

Lahsen (2010) focused on the conditions of climate change knowledge in social environments and enterprises, the sociopolitical dynamics shaping climate knowledge production, and precipitation and uses of climate knowledge in different socio-cultural and political arenas. This includes the level of credibility, honor, or prestige, such knowledge enjoys or lacks in social, scientific, and political decision-making bearing on policy and remedial action.

Lemelin *et al.* (2010) conducted an analysis of 22 interviews with members of the Weenusk First Nations at Peawanuck for understanding emerging knowledge regarding climate change. Findings indicate that residents are concerned with a variety of changes in the environment and their ability to use the land. They also noted the disappearance of particular insects and bird's species, and variations in the distribution of particular fauna and flora. Possible impacts of these changes on the community's wellbeing and resiliency are examined. Another major theme that arose from the analysis was the impact of traditional models of communication (e.g. traditional knowledge, radio and newspaper) and newer forms (e.g. satellite television and the internet) on indigenous peoples undertaking of climate change.

Mastrandrea *et al.* (2010) highlighted the need for bottom-up/ top-down vulnerability assessment, bringing together bottom-up knowledge of existing vulnerabilities with top-down climate-impact projections, as a transparent basis for informing decisions intended to reduce vulnerability. This approach can be used to evaluate the likelihood of crossing identified thresholds of exposure, and to evaluate alternative adaptation strategies based on their ability to reduce sensitivity to projected changes in exposure and their robustness across uncertainty in future outcomes.

Mc.Cright (2010) studied the theoretical arguments about gender differences in scientific knowledge and environmental concern using 8 years of Gallup data on climate change knowledge and concern in the US general public. Contrary to expectations from scientific literacy research, women convey greater assessed scientific knowledge of climate change than do men. Consistent with much existing sociology of science research, women underestimate their climate change knowledge more than do men.

Orlove *et al.* (2010) indicted that farmers in southern Uganda seek information to anticipate the inter-annual variability in the timing and amount of precipitation, a matter of great importance to them since they rely on rain-fed agriculture for food supplies and income. The four major components of their knowledge

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system are: (1) longstanding familiarity with the seasonal pattern of precipitation and temperature, (2) a set of local traditional climate indicators, (3) observations of meteorological events and (4) information on the progress of the season elsewhere in the region. They discussed the social contexts in which this information is perceived, evaluated, discussed and applied and considered the cultural frameworks that support the use of this information. This system of indigenous knowledge lends farmers to participate as agents as well as consumers in programs that use modern climate science to plan for and adapt to climate variability and climate change.

Perception on climate change

Bray and Storch (1996) undertook a survey of climate scientists on attitudes towards global warming and related matters. Most of the scientist believed that global warming was occurring and appropriate policy action should be taken, but there was wide disagreement about the likely effects on society and almost all agreed that the predictive ability of currently existing models was limited.

Hageback *et al*. (2005) analyzed the change and variability in climate, land use and farmers' perception and response to change in Danaugou watershed in the Chinese Loess Plateau. The first focus was to look at how climate data recorded at meteorological station recently have evolved, and how farmers perceived these changes. Study shows that the climate is getting warmer and

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drier, the latter despite larger inter annual variability. Farmer’s perception of climatic variability corresponds well with the data record. During the last 20 years, the farmers have become less dependent on agriculture by adopting a more diversified livelihood.

Jennings and Magrath (2009) assessed the perceptions of farmers from several regions (East Asia, South Asia, Sothern and East Africa, and Latin America) of how seasons are changing and in some cases, how one distinct season appear to be disappearing altogether, and the impacts that these changes are having. Firstly, do meteorological observations support farmer’s perception of changing seasonality? Secondly, to what extent are these changes consistent with prediction from climate models? Finally it was conducted that changing seasonality may be one of the major impacts of climate change faced by smallholder farmers in developing countries over the next few decades.

Mary & Majule (2009) studied in two villages of kamenyanga and kintinku of Manyoni District, central Tanzania and showed that local people perceived changes in rainfall and temperature. The changes have affected crops can livestock in a number a ways resulting in reduced productivity. Empirical analyses of rainfall suggest decreasing rainfall trend between 1922 and 2007 whereas mean maximum and minimum temperature increased by 1.9°C and 0.2°C respectively. The average annual temperature increase of 0.7°C between 1984 and 2004 was realized.

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Wyborn (2009) conducted a qualitative case study of perceptions of climate change in Kosciuszko National Park(KNP), suggested that the human use versus conservation dichotomy must be overcome illustrated how perceptions of and attachments to, 'place shape human interactions with a national park, discussed the role of myths and paradoxes as barriers to the acceptance of management decisions in KNP and suggested that, given the growing number of social and ecological challenges faced by park agencies, it is no longer useful to consider the biophysical and social aspects of national park separately; rather they should be reconsidered as complex social-ecological system and managed as an integrated whole.

Anderegg *et al.* (2010) reviewed publication and citation data for 1,372 climate researchers and drew the following two conclusion: (I) 97-98% of the climate researchers most actively publishing in the field support the tenets of ACC (Anthropogenic Climate Change) outlined by the Intergovernmental Panel on Climate change and (II) the relative climate expertise and scientific prominence of the researchers unconvinced of ACC are substantially below that of the convinced researchers.

Jacob (2010) conducted a survey regarding traditional fishing at a historic site on the Fraser River, in 2005. The results show that the impacts of climate change are apparent to those conducting traditional fishing practices, in terms of changed timing and abundance of salmon runs. These perceptions fit closely with the information available from scientists and

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management agencies. These changes are highly problematic for the traditional fishing, in that the preservation method (drying) is tied to seasonal weather patterns. The whole cultural setting and the relevance of salmon for subsistence would be highly altered by climate change that lends to changes in the timing and abundance of sockeye salmon.

Mertz *et al.* (2010) conducted a study based on the perceptions of 1249 households in five countries across an annual rainfall gradient of 400-900 mm, and provided an estimate of the relative weight of climate factors as drivers of changes in rural households during the past 20 years. Climate factors, mainly inadequate rainfall, are perceived by 30-50% of households to be a cause of decreasing rainfed crop production; whereas a wide range of other factors explains the remaining 50-70% climate factors are much less important for decreasing livestock production and pasture areas. Increases in pasture are also observed and caused by improved tenure in the driest zone. Finally it was concluded that although rainfed crop production is mainly constrained by climate factors, livestock and pasture are less climate sensitive in all rainfall zones.

Nilsson and Kjellstrom (2010) explored the perceptions of, and reaction to, environmental heat; heat stress related perceptions in different industrial sectors in Southern India; non-heat related impacts of climate change on working populations; regional maps of occupational heat exposure; methods of

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assessing occupational heat stress; and gender perspective in climate change and global health were also discussed.

Ringler (2010) studied the perception of climate change among smallholder farmers in Ethiopia, Kenya and south Africa found that a lack of access to credit, markets, information, risk-sharing tools, and properly rights has limited the ability of many farm households to adapt to the negative effects of climate changes. It was conducted that adaption to rising temperatures and changing weather patterns is crucial to the food security of millions of people. Without significant investment in agricultural technology and rural development, however, many farmers in Sub-Saharan Africa will be unable to meet the challenges of the coming decades.

Deressa *et al.* (2011) employed the Heckman sample selection model to analyze the two-step process of adaptation of climate change, which initially requires farmer's perception that climate is changing prior to responding to changes through adaptation. Farmer's perception of climate change was significantly related to the age of the head of the household, wealth, knowledge of climate change, social capital and agro-ecological setting. Factors significantly affecting adaptation to climate change were education of the head of the household, household size, whether the head of the household was male, whether livestock were owned, the use of extension services on crop and livestock production, the availability of credit and the environmental temperature.

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Frank *et al.* (2011) conducted in-depth interviews with a sample of farmers who had participated in broader surveys the previous year to explore their perceptions of their social identity, climate related information and its sources, and climate risk. These interviews elicited compelling evidence that social identity mediates between risk perception and adaptation through its influence on motivation. Interviews revealed significant links between social identity and perception of information, risks perception and adaptation, of which the most silent were the relative credibility and legitimacy of information sources (related to us vs. the social group differentiation); the role of coffee organizations; and ethnicity and geographic marginalization. Strong in-group identity and perceptions of potentially influential out-groups such as the scientific community appear to particularly influence perception and use of information.

Raymond and brown (2011) examined spatially referenced perceived landscape values and climate change risks collected through public participation geographic information system for potential use in climate change planning. Two spatial data models – vector and raster and two analytical methods- Jaccard coefficients and spatial cross- correlation were used to describe the spatial associations. Results indicate that perception of climate change risk is driven, in part, by the values people assign or hold for places on the landscape. Biodiversity loss risk while reaction values have strong spatial association with riparian flooding, sea-level rise and wave action risks. Other landscape

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values show weak to no spatial association with perceived climate change risks.

Impact of climate change

Epstein (2002) revealed that climate change can lead to dramatic increases in prevalence of a variety of infectious diseases. Beginning in the mid- 70_s, there has been an “emergence, resurgence and redistribution of infectious diseases.” Reasons for this are likely multi causal, dependent on a variety of social, environmental and climatic factors, whoever, many argue that the “volatility of infectious disease may be one of the earliest biological expressions of climate instability”. Though many infectious diseases are affected by change in climate, vector-borne diseases, such as malaria, dengue fever and leishmaniasis, present the strongest causal relationship. Malaria in particular, which kills approximately 300,000 children annually, poses the most imminent threat.

Rosenzweig *et al.* (2002) indicated that climate change is expected to result in long term water and other resource shortages, worsening soil conditions, drought and desertification, disease and pest outbreaks on crops and livestock, sea-level rise, and so on. Vulnerable areas are expected to experience losses in agricultural productivity, primarily due to reduction in crop yields.

Patz *et al.* (2005) reported that people living in developing countries, risk of malaria will increase 5-15% by 2010 due to climate change. In Africa alone, according to MARA project

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(Mapping Malaria Risk in Africa). There is a projected increase of 16-28% in person-month exposures to malaria by 2100.

McMichael *et al.* (2006) indicated that climate change poses a wide range of risks to population health-risks that will increase in future decades, often to critical levels, if the global climate change continues on its current trajectory. The three main categories of health risks include: (i) direct- acting effects (e.g. due to heat waves, amplified air pollution, and physical weather disasters), (ii) impacts mediated via climate-related changes in ecological system and relationships (e.g. crop yields, mosquito ecology, marine productivity), and (iii) the more diffuse (indirect) consequences relating to impoverishment, displacement, resource conflicts (e.g. water), and post-disaster mental health problems.

Vannier (2007) discussed legal and animal movement, changes in human behavior and food consumption, wild animals, climatic change and the evolution of farming structure and herd management as factor for the increased risk of epizootic diseases in livestock in the European Union, followed by measures (control of animal movement, bio security and vaccination) and early warning systems (detection and prophylaxis) for disease prevention.

Lee (2009) conducted a study on the impact of climate change on global food production, prices, and land use of crop yield change as projected under the IPCC SRES scenario A2,using a multi-region, multi-sector computable general equilibrium (CGE) model. Findings showed that developing countries are more

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adversely affected by climate change than developed countries. Developed countries are mostly located in higher latitudes, and climate change benefits the crop yield of these areas. In contrast, developing countries of the lower latitudes suffer from the reduction in crop yield being induced by climate change.

Giger (2010) discussed the climate change impacts on agriculture and food security in developing and transition countries, the factor that might affect production, and the implication for agricultural extension system of climate change. The main projected future climate change are a continued rise in temperature, increase incidence of heat waves and heavy precipitation events, decrease of rainfall in sub-tropical areas, rising sea levels and the increased likelihood that these aspects will develop in a non-linear and non-predictable manner. These changes have the potential to cause heavy damage to crops and reduce harvests in many developing countries.

Redek (2010) analyzed the economic perspectives of dealing with climate change. Recent data shows that concentration of greenhouse gasses significantly increased since industrial revolution, which is causing temperature increases and consequently many unfavorable developments. There are three options to dealing with climate change :(1) do nothing, (2) try to adapt and (3) fight against climate change. Each option is related to some economic cost related with each option.

Reynolds *et al.* (2010) highlighted that in the developing world, livestock is crucial to generating livelihoods and food

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security for some one billion of the world's poorest people. Climate change impacts on livestock production systems and in turn livestock farming impacts of climate change. This paper reviews the complex interaction between livestock production and climate change and proposes strategies that could be used to help sustain livestock as a key feature of rural livelihood in the developing world.

Seguin (2010) reported that climate change will impact and has already impacted a large range of physical/biological systems and sectors of the human activity, among them agriculture (including livestock) and its main output as food production. They result from the combination of large set of elementary components of the plant eco-physiology, including the stimulation of photosynthesis by the carbon dioxide. These diverse effect may vary from positive (by some 20%) in some temperate condition to highly negative (down to 50% reductions) in warm conditions.

Ng & Zhao (2011) revealed that the contemporaneous relationship between temperature and income is important because it enables economists to estimate the economic impact of global warning without assuming a structural model. Until recently, empirical evidence generally suggests that there is a negative relationship between temperature and income, and therefore, global warming has an adverse impact on economic activity.

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Sarode (2011) indicated that India has a low- lying densely populated coastline extending about 6500 km. Most of the coastal regions are agriculturally fertile, with paddy fields that are highly vulnerable to inundation and salinity. The impacts of any increase in the frequency and intensity of extreme events, such as storm surges, could be disproportionately large, not just in heavily developed coastal areas, but also in terms of the paralyzing devastation in low income rural areas.

Impact of climate change on agriculture particular on rice production

Tsujii H. (1991) stated that the effects of climate change on the supply and demand for rice in Japan were discussed in relation to the system of food supply. A model was prepared to simulate the changes in the rice supply related to air temperatures and to supply and demand factors and was used to give predictions of rice production up to the year 2030. The predictions showed increases in yields/ha in some areas but the total yields of rice for the whole of Japan showed a decrease.

Horie T. *et al.* (1995) noticed that likely effects of doubled carbon dioxide concentration on rice production in Japan were assessed and it was concluded that rice yields and yield stability would increase in N. and N.-central Japan but that S.-central and SW Japan would have decreased yields and yield stability. Average rice production would be unchanged over the whole country but yield variability would be likely to increase.

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Jin Z. *et al*. (1995) found that Yields of rainfed rice were reduced by 7-78% depending on the scenario, largely as a result of decreased precipitation. Irrigation did not fully compensate for the effects of increased temperature on crop yields. CO2 enrichment partially compensated for the yield decrease caused by increased temperature.

Moya T.B. *et al.* (1995) observed that A new open-top chamber (OTC) system, designed to maintain increased CO_2 concentration and temperature, was verified to generate an a biotic microenvironment closely approximating that in the natural environment of flooded rice under field conditions in the tropics. Although field tests demonstrated that the system could set and control temperature and CO_2 to +or-10% precision for >90% of the time, changes in chamber microenvironment conditions that could influence crop growth and development did occur. The primary changes in microclimate between chamber and open field were in light transmission (9%) and higher night temperature within the chambers. These differences contributed to 12% reduction in vegetative and reproductive yields inside the chamber compared with that under field conditions. Data from the microclimate assessment suggest that the plant response should be corrected accordingly to approximate the climate change response of rice.

Matthews R.B.*et al.* (1995) revealed that at all sites of selected countries an increasing CO_2 alone increased simulated

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yields but temperature increase of 1, 2 and 4 degrees C decreased yields by 6.7, 14.1 and 29.4 percent respectively.

Ranganathan R. *et al.* (1995) observed that reduction in application of N fertilizers and organic fertilizers would reduce methane emission but would also reduce yields unless the area under rice production is increased.

Singh U. and Padilla J.L. (1995) noticed that the beneficial effects of CO_2 enrichment as increased grain yields, reduced transpiration, increased water use efficiency, improved use of intercepted radiation, reduced N losses, and higher N use efficiency and also observed that some of the negative effects of temperature increase in warmer regions of the world could be offset by the use of rice varieties that are tolerant to high temperature-induced spikelet sterility, and have longer growth duration, particularly longer grain filling duration and also stated that with improved varieties and good management, climate change could have positive effects on rice production.

Wu H.Y. (1996) Found that average rice yield per ha; the data sources (drawn from a variety of different bodies, covering the period 1952-92) and empirical results; evaluates the impacts of climate change upon rice yield according to four scenarios (case 1: a temperature increase of 2.5 degrees C, precipitation constant; case 2: a temperature increase of 5 degrees C, precipitation constant; case 3: a temperature increase of 2.5 degrees C, precipitation increases 8%; case 4: a temperature increase of 5 degrees C, precipitation increases 8%) and also

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stated that Global warming is found to adversely affect the rice yield under current technology.

Matthews R.B.*et al.* (1997) found that an increase in the CO_2 level to increase yields while increases in temperature reduced yields.

Mathauda S.S. *et al.* (2000) noticed that global warming would have adverse effects on rice production through advancement of maturity, reduction of source size, and poor sink strength.

Wassmann R. *et al.* (2000) determined that Rice production will be affected through excessive flooding in the tidally inundated areas and longer flooding periods in the central part of the VMD. These adverse impacts could affect all three cropping seasons, Mua (main rainfed crop), Dong Xuan (Winter-Spring) and He Thu (Summer-Autumn) in the VMD unless preventive measures are taken.

Sheehy J.E. (2001) found that yield trends for irrigated rice, then examines if the current rate of increase in the average yield can be sustained given the issues of upper biophysical limits to yield (radiation use efficiency; canopy photosynthesis; and N reservoirs and sink size). The effect of global climate change on yield is briefly described. A yield equation incorporating the important features of a high-yielding rice production system is also presented..

Lin E. *et al.* (2003) resulted that rice yield would tend to decrease in the main rice growing areas of China during 2030 and

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2056. Carbon dioxide abatement by 0.5% would not change the trend. In some high altitude regions, i.e. South Western China, suitable for rice production, the yield would increase.

Matthews R.and Wassmann R. (2003) determined that Rice agriculture is not only affected by climate change, but also contributes to global warming through the release of methane into the atmosphere.

Nakagawa H. *et al.* (2003) found that Season-long doubling of CO_2 increased rice biomass by 25% averaged over the reported data obtained under field conditions, while high temperatures may cause decreased rice yield mainly because of high-temperature-induced spikelet sterility, which would be worsened by elevated CO_2 and also predicted that a 1.5 degrees C increase in T50 (the daily maximum temperature at which spikelet fertility becomes 50% because of high-temperature damage) would remarkably mitigate the negative effects of climate change in many prefectures in central and southern Japan, and increase total rice production by 5%.

Das L. *et al.* (2007) found that drastic reduction in yield (by 10.1, 45.8 and 72.1%) when the temperature increased by 1, 2 and 3 degrees C, respectively. It was also predicted that even with a warmer climate up to 1 degrees C, production may increase by approximately 10% in an atmosphere with a 2-fold higher CO< sub>2</ sub> concentration.

Manneh B. *et al.* (2007) found that , rice production in Africa is affected by abiotic stresses such as heat stress, flooding,

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drought and salinity, all of which are expected to worsen with climate change and also stated that Climate change is already impacting negatively on Africa through extreme temperatures, frequent flooding and droughts and increased salinity of water supplies used for irrigation.

Neue H.U. *et al.* (2007) observed that the Increased CO_2 and temperature have a clear effect on growth and production of rice as they are key factors in photosynthesis and also stated that that a doubling of CO_2 increases yield, whereas an increase in temperature decreases yield. Enhanced UV-B radiation resulting for stratographic ozone depletion has been demonstrated to reduce plant height, leaf area and dry weight of two rice cultivars under glasshouse conditions.

Wassmann R. And Dobermann A. (2007) revealed that the production levels in South Asia and Sub-Saharan Africa will be more affected by climate variability and change than in most other parts of the world.

Geethalaksmi V. *et al.* (2008) found that , rice production in Tamil Nadu was projected to decline in 2020, 2050 and 2080 by 8.7, 23.6 and 42.2%, respectively, relative to the production level in 2000.

Adamson P. and Bird J. (2010) reported that a weak monsoon results in deficient flows and water levels that can have severe impacts upon agricultural production across the Cambodian flood plain and the delta in Viet Nam, where natural and controlled inundation is the basis of padi rice production. Lower flows also cause an increase in saline intrusion in the delta, which further reduces agricultural output.

Hadi P. and Amien I. (2010) stated that Climate change is likely to affect rice production due to rise in increased temperature that fasten crop maturity, extreme climate events that may lead to crop failure and the possibility for significant rise in pest attacks and diseases. Three specific areas that need particular emphasis in policies to ensure food security are anticipation, adaptation and mitigation.

Impact of climate change on livelihood

Selvaraju R. *et al.* (2006) found that the impacts of climate variability and change are global concerns, but in Bangladesh, where large numbers of the population are chronically exposed and vulnerable to a range of natural hazards, they are particularly critical. In fact, between 1991 and 2000, 93 major disasters were recorded, resulting in nearly 200 000 deaths and causing US$5.9 billion in damage with high losses in agriculture.

Morton J.F. (2007) resulted that some of the most important impacts of global climate change will be felt among the populations, predominantly in developing countries, referred to as "subsistence" or "smallholder" farmers. Their vulnerability to climate change comes both from being predominantly located in the tropics, and from various socioeconomic, demographic, and policy trends limiting their capacity to adapt to change. However, these impacts will be difficult to model or predict because of (i)

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the lack of standardised definitions of these sorts of farming system, and therefore of standard data above the national level, (ii) intrinsic characteristics of these systems, particularly their complexity, their location-specificity, and their integration of agricultural and nonagricultural livelihood strategies, and (iii) their vulnerability to a range of climate-related and other stressors.

Amit Garg *et al.* (2008) observed that Over 650 million people depend on climate-sensitive sectors, such as rain-fed agriculture and forestry, for livelihood and over 973 million people are exposed to vector borne malarial parasites. Projection of climatic factors indicates a wider exposure to malaria for the Indian population in the future due to climate change.

Osbahr H.(2008) found that Natural resource-dependent societies in developing countries are facing increased pressures linked to global climate change. While social-ecological systems evolve to accommodate variability, there is growing evidence that changes in drought, storm and flood extremes are increasing exposure of currently vulnerable populations. In many countries in Africa, these pressures are compounded by disruption to institutions and variability in livelihoods and income.

Rosegrant M.W. *et al.* (2008) determined that the impact of climate change on production and opportunities for emissions reductions is reviewed with a focus on developing countries, including the implications for food security and livelihoods for the poor.

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Rabia K. *et al.* (2008) showed that land degradation and desertification are threatening the livelihood of more than a billion dry land inhabitants.

United States Agency for International Development (USAID) (January 25, 2008) stated that the Change in rainfall has had an impact on water sources and availability, as well as agricultural production. This has led overall to increased vulnerability in food and water security, with direct impacts to health (mainly nutrition and water-borne illness) and poverty. In the South, where communities have always been vulnerable to water scarcity, decreased rainfall has created a dire situation for access to water and production of rain-fed crops (particularly manioc).

What is becoming quite clear in all regions is that climate change will exacerbate existing rural development challenges including income generation, food and water security, and health. Without the resources available to fall back on, rural populations are extremely vulnerable to small upsets in their livelihood production, making climatic unpredictability extremely dangerous for their continued subsistence. In addition, the increase in natural disasters and their effects (mainly cyclones and flooding) will require more emphasis to be placed on disaster management measures as well as disaster warning systems.

According to FAO and United Nations Development Programme (UNPD), the food consumption crossed population growth rate in the period of 1995-2003 in the South Asian context. For example, in Pakistan, the population growth rate was

2.4 % and its agricultural sector recorded growth rate was 1.9%. FAO data (2002-2004) suggests that the 30% proportional to the total population remained undernourished. Bangladesh is in the poorest state of affairs and followed by Pakistan (24%), Sri Lanka (22%) and India (20%). Maldives is comparatively on a better pitch with just 10% of its population recorded as undernourished. Along with them, climate changes in recent decades in the forms of natural calamities like drought, flood, fluctuation in the rainfall pattern, cyclone and sea level rise, also pose serious threat to ensure food security.

Zomer R.J. *et al.* (2008) observed that Within the Kyoto Protocol, the clean development mechanism (CDM) is an instrument intended to reduce greenhouse gas emissions, while assisting developing countries in achieving sustainable development, with the multiple goals of poverty reduction, environmental benefits and cost-effective emission reductions. The CDM allows for a small percentage of emission reduction credits to come from a forestation and reforestation (CDM-AR) projects. We conducted a global analysis of land suitability for CDM-AR carbon 'sink' projects and identified large amounts of land (749 Mha) as biophysically suitable and meeting the CDM-AR eligibility criteria. Forty-six percent of all the suitable areas globally were found in South America and 27% in Sub-Saharan Africa. In Asia, despite the larger land mass, relatively less land was available. In South America and Sub-Saharan Africa the majority of the suitable land was shrub land/grassland or

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savanna. In Asia the majority of the land was low-intensity agriculture. The sociologic and ecological analyses showed that large amounts of suitable land exhibited relatively low population densities. Many of the most marginal areas were eliminated due to high aridity, which resulted in a generally Gaussian distribution of land productivity classes. If the cap on CDM-AR were raised to compensate for a substantially greater offset of carbon emission through sink projects, this study suggests that it will be increasingly important to consider implications on local to regional food security and local community livelihoods.

CCAFS (Climate Change, Agriculture and Food Security) (2009) reported that Climate change represents an immediate and unprecedented threat to the food security of hundreds of millions of people who depend on small-scale agriculture for their livelihoods. At the same time, agriculture and related activities also contribute to climate change, by intensifying greenhouse gas (GHG) emission and altering the land surface. Responses aimed at adapting to climate change may have negative consequences for food security, just as measures taken to increase food security may exacerbate climate change. This complex and dynamic relationship between climate change, agriculture and food security is also influenced by wider factors. Agricultural and food systems are heavily influenced by socioeconomic conditions, which are affected by multiple processes, such as macro-level economic policies, political conflict, the spread of infectious disease, etc. A recent report by the World Economic Forum warns

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that "food security will become an increasingly complex political and economic problem over the next few years" (WEF, 2008).

Minaxi R.P. & Acharya K.O. (2009) stated that the impact of climate change will be particularly significant on smallholder and subsistence agriculture. Livelihood systems predominantly in low latitudes will be affected by major changes due to climate change. The farming system will be directly affected by changing weather patterns, sea level rise, and the increase in frequency and intensity of extreme events. The productivity of livestock and fisheries systems will also be affected, as well as potential income from collecting activities in forests (Christoph Bals et al, 2008)

Saldana Zorrilla S.O. & Sandberg K. (2009) observed that Mexico is still dominated in many regions by agriculture, and during the last 25 years, weather-related disasters have accounted for about 80% of economic losses. This is dramatic, especially considering that this sector produces only ca. 4% of GDP while providing a livelihood to one-quarter of the country's population. Based on a spatial model, the contribution of natural disasters to catalyzing the emigration process in vulnerable regions throughout Mexico. Besides coping and adaptive capacity assessd the effect of economic losses from disasters in combination with adverse production and trade conditions during the 1990s in triggering out-migration.

Chevallier P. *et al.* (2011) found that almost all of the world's glaciers in the tropical latitudes are located in the Central Andes (Peru, Bolivia, Ecuador and Colombia). Due to their high altitude,

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to the high level of radiation and to the tropical climate dynamics, they all are particularly threatened by climate change, as a result of not only warming, but also of changing variability of precipitation. Many glaciers are of crucial importance for the livelihood of the local populations and even for three capitals, Lima (Peru), La Paz (Bolivia) and Quito (Ecuador), which depends on them for water and energy supplies. After a period of increased flow due to the glacier melt disequilibrium, the available water resource will decrease along with the rapid shrinking of the glaciers considered as water reservoirs. The case of the Cordillera Blanca (Peru) is analyzed more in detail with the mid-term (20 years) and long-term (1-2 centuries) impact of the glacier shrinking on the local water resources. Associated risks for the population and consequences for the human activities (tourism, hydropower, agriculture and stock-breeding, large-scale irrigation) are described at each stage of the mountain range.

Dejene A. & Malo M. (2011) resulted that the impact of climate change threatens the progress made over recent years in reaching the Millennium Development Goals in many parts of Africa. The Intergovernmental Panel on Climate Change (IPCC) reiterated that Africa will be hard hit by climate change with serious effects on the agricultural and natural resources sector where the majority of the population derives their livelihood. Without immediate steps to adapt to climate change, there will be grave implications for agriculture and food security.

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Devkota R.P. *et al.* (2011) resulted through primary data by household survey, focus group discussion, key informant interview, and field observation that the Tharu people of Nepal have a longstanding knowledge of their locality and its patterns of weather and agriculture. The impact of climate change severely affects their livelihoods.

Dinar.A & Mendelsohn.R (2011) observed that Agriculture is essential to the livelihood of people and nations, especially in the developing world; therefore, any impact on it will have significant economic, social, and political ramifications. Scholars from around the world and from various fields have been brought together to explore this important topic. The contributions found here analyze direct agronomic effects, the economic impacts on agriculture, and agricultural impacts on the economy, agricultural mitigation, and farmer adaptation.

Muhammad Anowar Saadat and A.K.M. Saiful Islam (2011) resulted that Impact of climate change was assessed on the five major livelihood capitals: natural, financial, social, physical and human as defined in the Sustainable Livelihood Framework of the DFID. Farmer, fisherman, labour and women were the four major livelihoods groups of this study. It has been found that due to the climate change overall access to the natural capital for the farmer group will be reduced from 75% to 54%. On the other hand, access to the physical capital and financial capital will be reduced to 63% and 30% from the present condition respectively. Access to the financial capital for the labour group will be reduced from

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58% to 44%. Annual work days of farm laborers will be 40% less than their present situation

Minaxi R. P. *et al.* (2011) resulted that the impact of climate change will be particularly significant on smallholder and subsistence agriculture. Livelihood systems predominantly in low latitudes will be affected by major changes due to climate change. It is found that of the four main elements of food security, i.e., availability, stability, utilization, and access. Agriculture must provide all people with sufficient food to prevent extensive hunger and starvation. However, food security is aggravating day by day, resulting increase in hunger in the world. The impact of climate change on food security will be huge and substantive

Rashed Al Mahmud Titumir & Jayanta Kumar Basa (2011) found that a rise in temperature will negatively impact the crop production in the tropical parts of South Asia where these crops are already being grown close to their temperature tolerance threshold. Crop yields could decrease by up to 30% in South Asia by the mid-21st century. The Human Development Report (HDR, 2006) has pointed out that in South Asia alone; 2.5 billion people will be affected by water stress and scarcity by the year 2050. This could hamper the achievement of many of the Millennium Development Goals (MDGs), including that of poverty eradication.

Sissoko K. *et al.* (2011) found that agriculture is the main source of livelihood of the majority of the people living in the West African Sahel area. Increases in temperature and/or

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modifications in rainfall quantities and distribution will substantially impact on the natural resource on which agriculture depends. The vulnerability of livelihoods based on agriculture is increased and most likely exacerbate and accelerate the current 'downward spiral' of underdevelopment, poverty and environmental degradation.

Sharma V.P *et al.* (2011) observed that the Climate change responsible to higher the average temperature near the earth surface, changed rainfall pattern, increased severity and frequency of floods, droughts, cyclones, retreating of glaciers, coastal erosions etc. These factors highly impacted availability of fresh water, oceanic acidification, food production, increased burden of vector borne and water borne diseases associated with livelihood and health of poor rural population of developing countries like India.

Anya M.I. *et al.* (2012) stated that Climate change will impact significantly on food security. It will affect food production and availability, the stability of food supplies, access to food and food utilization. However, the poorest farmers are the most vulnerable and the most challenged to the impacts of climate change. Africa is the region with greatest risk of increased hunger and threatened livelihoods due to climate change. This study briefly reviews the potential impact of climate change on food security in reducing by half the proportion of people suffering from hunger by 2015.

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Bagamba F. *et al.* (2012) resulted that 70-97% of households will be adversely affected by climate change in Uganda. The southwest will be most affected due to smaller farm sizes and limited livelihood alternatives. There will be no positive gains from encroaching on swamps, which is one of the reported adaptation strategies to climate related stresses.

Climate change adaptation

Smith (1997) reported that adaptation is necessary to avoid impacts that can otherwise occur gradually and may be irreversible. That is, increasing the robustness of infrastructure design and investments can reap immediate benefits through improved resilience to climate variability and extreme atmospheric events.

Chen (2009) identified that mitigation and adaptation are two principle strategies for managing human induced climate change. This paper first identified the mitigative and adaptive options and potential in agriculture, then addressed the integrated analysis of mitigation and adaptation and its benefits for agriculture. Finally, it discussed the implications to Chinese agriculture in dealing with the global climate change.

Khanal (2009) revealed that climate change and agriculture are closely linked and interdependent. Compared to conventional agriculture, organic agriculture is reported to be more efficient and effective both in reducing GHG_S (CO_2, CH_4 and N_2O) emission mainly due to the less use of chemical fertilizers and fossil fuel.

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Organic agriculture also reported to be climate change resilience farming systems as it promotes the proper management of soil, water, biodiversity and local knowledge there by acting as a good options for adaption to climate change.

Whitmarsh (2009) concluded that “responsibility for tackling climate change is most commonly placed with international organizations”, the public “disassociate themselves from the causes, impacts and responsibility from tackling climate change” and there is “widespread skepticism about the reality of or human causes of climate change.”

Senaratne and wickramasinghe (2010) reported that farmers are in a continuous process of, individually and as community groups, adjusting to the observed variability in climate parameters. The findings revealed that there are two major forms of voluntary adaptation responses by farmers against climate shocks: (1) aligning of farming activities with the recognized seasonal pattern of rainfall; and (2) management of rain water harvested in commonly owned village tanks. Farmer’s adaptation responses have been facilitated by local institution that helped to adapt joint adaptation responses.

Spence & pidgeon (2010) studied how the way in which climate change communications are framed impacts on their effectiveness. Results indicate that discussion of the gains to be made from behaving to mitigate climate change are more likely to have a positive influence on perceptions. Similarly, focusing

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communications on distant impacts of climate change is more likely to endanger a belief that its impacts will be more severe.

Stuczyinski (2010) demonstrated the ability of polish agriculture to adapt to predicted climate change according to GISS and GFDL scenarios. Both climate change scenarios will significantly affect farming condition in Poland through water, deficit, shifts in planting and harvesting seasons, changes in crop yields and crop structure. Neither scenario seems to endanger the self-sufficiency of Poland as long as preventive measures are taken. Moreover, the realization of GISS creates the possibility of a surplus in production. It must be emphasized that regardless of the scenario, the adaption of agriculture to an expected climate change cannot be handled by the farming community itself.

Arora *et al.* (2011) conducted the climate situations based on the next generation of emission scenarios developed for climate change research (Repetitive Concentration pathways or RCPs). The result indicate that to limit the global temperature increases by 2100 to 2°C, rapid reduction of greenhouse gas emission must begin immediately and negative emission (i.e. carbon sequestration greater than emission) must occur from 2060 onwards.

Olesen *et al.*(2011) studied on anthropogenic climate change performed in the last decade over Europe show consistent projections of increases in temperature and different patterns of precipitation with widespread increases in northern Europe and decreases over parts of southern and eastern Europe. A set of

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qualitative and quantitative questionnaires on perceived risks and foreseen impacts of climate and climate change on agriculture in Europe was distributed to agro climatic and agronomy experts in 26 countries. Results showed that farmers across Europe are currently adapting to climate change, in particular in terms of changing timing of cultivation and selecting other crop species and cultivars.

B) Sustainable livelihood generation:

Sustainable development

Sola P. (2005) stated that sustainable resource use should be based on socially responsible economic development while promoting the resource base and the status of the ecosystem. The efforts to attain social responsibility make indigenous knowledge system (IKS) a crucial component of any development and conservation intervention.

Dong S.K. *et.al.* (2007) suggested that traditional resource management practices have been ignored in the past, which has resulted in conflicts and resource degradation. In this context, a survey was conducted in the Rasuwa District of northern Nepal to identify existing indigenous ranglend management systems, examine the challenges facing the development of sustainable practices and suggest possible strategies for promoting their development.

Malley Z.J. *et.al.* (2007) studied to assess linkage of environmental change to emerging water scarcity, livelihoods

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insecurity and decline in wildlife biodiversity and hydropower generation in the Great Ruaha ecosystem, and to discuss policy lesson for sustainable development.

Nanya T. (2008) concluded that small-scale reclamation area has an advantage in sustainability over large scale development area, which is managed by the government. In order to improve the livelihood of rural society, it is important to put more focus on farmer empowerment: the major challenge would be revisiting how to manage the society to make the best use of both human and social resources.

Sustainable livelihood

Chambers S.R. (1995) stated that a sustainable livelihood-intensive strategy stresses natural resources management, redistribution of livelihood resources, prices and payments, health, abolishing restriction and inconvenience, and safety nets for poor people at bad times. Policy and practical means to promote and sustain well-being livelihoods and equity include two complementary agendas, one conventional and one new.

Sharda V.N. *et al.* (2005) participatory watershed management following new guidelines is the right approach to maximize productivity on sustained basis through efficient use of natural resources and to achieve economic, livelihood and environmental security.

Herberg L. (2007) observed that sustainable livelihood framework to identify the links between certification schemes and

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organic farmer's livelihoods. It was found that all certification systems that were part of this study contributed to the success of their farmers, when success is defined as the achievement of the farmer's livelihood goals.

Mishra A.K. *et.al.* (2007) stated that livestock play an important role in the sustainable livelihood of poor people of rain fed agro-ecosystems, because of inherent risks involved in crop farming due to uncertainty of rainfall and occurrence of recurrent droughts. The objectives of the present investigation were to characterize the traditional livestock production systems, identify major constraints and suggest livestock production strategies based on participatory action research.

Sati V.P. (2008) examined that various farming system including cereal farming, fruit cultivation and the practice of out of season vegetables in the different altitudinal zones of the state of Eritrea and suggests strategies for sustainable livelihood of the populace. The study reveals that potential of cultivating out-of-season vegetables, fruits and cash generating products is considerably higher than traditionally cultivating subsistence cereal crops.

Sustainable livelihood management

Krishna S (2004) examined that the complex process of mainstreaming gender in natural resource management in India. The contributors build a 'genders cape' of community resource rights in varied contexts; unravel the gender barriers in

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traditional practices, community institutions and modern systems of governance; document diverse approaches to livelihood ; and present a strong case for gender equality in sustainable resource management.

Asis Mazumdar (2007) stated that livelihood of approximately 68% of the Indian population depends on agriculture directly or indirectly. More than 70% of its population lives in rural areas although there is an increasing trend of urbanization in the last two decades. Irrigation water accounts for approximately 90% of the total utilization of water resources. India stands at a crossroads in institutional options for natural resources management at the local and the village levels.

Jager A. De. (2007) showed that once smallholders are equipped with knowledge and the capacity to learn, are empowered in organizations and connected to markets and the private sectors, they can substantially improve their rural livelihoods. Therefore a focus on participatory experiential learning approaches and farmer organizations that result in new arrangements in innovation systems needs to be mainstreamed in rural development projects.

C) Rice production management& constraints

Rice production management

Vijayraghavan and Subramaniam (1981) noted that in case of dry land farmers the Gramsevak emerged as the most credible source scoring maximum scale value (1.57). The dry land farmers

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in generals have placed the maximum trust on Gramsevak whom they found more homophiles.

Gwalbanshi (1982) reported that education had shown significant relationship with adoption behavior of high yielding varieties of paddy.

Bhoite and Nikhade (1983) reported the age of the farmers had no significant relationship with adoption of improved agriculture practices.

Kulkarni and Patil (1984) reveal that there is a significant association between education and adoption of improved paddy cultivation practices.

Kulkarni and Patil (1984) reported a significant and positive relationship between socio-economic status of farmers and adoption of improved paddy cultivation practices.

Ramteke (1984) revealed that socio economic status and significant relation with adoption behaviour of high yielding varieties of paddy.

Malyadari (1986) found that 60 percent of the respondents were laborers, 20 percent were cultivators and remaining was engaged in petty business.

Mohiddin (1987) found that among the members of IRDP one fourth of them were engaged as agricultural labourers.

Reddy and Reddy (1988) stated that age of the respondents significant with adoption improved paddy cultivation practices.

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Reddy and Reddy (1988) have observed that farm size is significantly relationship between land holding and adoption of paddy crop.

Jaiswal and Sharma (1989) reported a significant relation of education with adoption of high yielding varieties of paddy.

Sakharkar *et al*. (1992) have revealed that socio –economic status was positively and significant related with knowledge level of farmers.

Ghosh (1993) found that majority of of respondents under IRDP (35.42 percent) were agricultural labourers.

Swarankar and Chauhan (1993) reported significant relationship between education and adoption of paddy crop among small and marginal farmers.

Chauhan *et al*. (1994) have observed that annual income was significantly associated with knowledge of tribal farmers.

Meshram (1995) revealed that majority of paddy cultivator (54.33%) procured their inputs from Krishi Seva Kendra.

Bhople *et al*. (1996) found that sources of information were positively related to knowledge of farmers.

Dhanorkar (1998) revealed that maximum tribal farmers low or extremely low level of adoption of improved farm practices of rice cultivation.

Kakade (1998) reported that relatively higher proportion of the farmers had moderate level of adoption.

Shinde et al. (1998) have observed that 65% of the farmers had between 31-45 years age.

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Shinde *et al.* (1998) have observed that 26.57% of the have land holding about 2 ha

Mohinder Kumar (1999) observed that 44.44 % of large and 14.29 % of small farmers did not adopt 30 to 40 and 40 to 50 percent of recommended package of practices respectively.

Masram (1999) reported that important input requirements of paddy growers were seeds, fertilizer, equipments money and labours.

Masram (1999) found that majority of paddy growers (39.66%) had full use FYM followed by 34% of respondents had partially use of irrigation.

Bhoite and Barve (2000) noticed that most of the tribal's did not adopt the practice of seed treatment at all. The adoption in case of chemical fertilizers and use of plant protection measures against pest and diseases was only 28.46 & 2.96 percent respectively.

Shinde et al. (2000) have observed that 42% of the farmers were about 50 years of age.

Maleka Shaheen (2001) observed that tribal women were using gunny bags, bamboo bins and pots for storage cereals and pulses. Neem leaves, Salts, Ash and Oil were the preservatives used by majority of tribal women for preserving cereals, pulses and legumes.

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Ramashetwad (2001) observed that majority of the respondents (62.51%) had an access to the various sources of information of medium level.

Dudhe (2002) reported that over half of the farmers (54.67%) found to be in middle age category.

Dhudhe (2002) found that majority of paddy growers (63.67%) belong to medium category of input requirement.

Sawant and Patil (2002) found that the majority of the farmers were not aware of the significant contribution of practices like collecting and burning the crop residue.

Dudhe (2002) reported that 85.33% farmers were illiterate followed by only 12.67% of them having educate up to primary school.

Dudhe (2002) reported that over half of paddies cultivating farmers 52.66% were found to small farmers followed by 18% of there being marginal farmers.

Dudhe (2002) reported that the sources of input procurements are Krishi Kendra, progressive farmers and Pachayat Samiti.

Reddy (2003) revealed that seed treatment was a common production practices which was not applied by both irrigated and rainfed rice respondents.

Sharma & Nair (2003) stated that education had no significant relationship with adoption.

Supe *et al*. (2003) had reported that age had no relationship with the adoption behaviour of farmers

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Zate (2003) stated that annual incomes were positively correlated with the input management of farmers in progressive and non progressive villages.

Bajaj and Kambale (2004) observed while studying adoption of improved agricultural practices by tribal farmers that the adoption of improved agricultural practices was low among tribal farmers.

Bajaj and Kamble (2004) observed that more the value placed by tribal farmers on education more was their use of farm practices.

Ghodichor (2004) concluded that socio-economic status was significantly related with the adoption level IPM technology by rice growers.

Mogal (2004) observed that 54% of the respondents were in middle age group between 31-50 year

Rajput (2004) observed that relatively higher proportion of the 36.00% belong to small land holding.

Rajput (2004) observed that majority of the farmers (50.66%) had middle socio-economic status.

Bajaj and Nayak (2005) stated that there is a significant relationship between socio-economic status and adoption of high yielding varieties of paddy.

Kore (2005) noted that most of the respondents had labour as occupation.

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Pawar and Patil (2005) observed that majority of tribal farmers were not adopting improved agricultural technology. Most of them were adopting age old practices of cultivation.

Rathod (2005) found non-significant relationship between age and information seeking behaviour of farmer.

Rathod (2005) stated a highly significant relationship between land holding and information seeking behaviour of farmers.

Rathod (2005) found a significant relationship annual income and information seeking behaviour of farmers.

Rathod (2005) stated a significant relationship between socio-economic status and information seeking behaviour of farmers.

Haque (2006) stated that a small percentage of farmers adopted seed treatment, plant protection and weed control measures.

Kapgate and Ingale (2006) observed that 40.78 percent tribal respondents hold below 4 acers of land.

Mahanor (2008) stated that traditionally cropping pattern is more, now use new technique for cultivation of crops.

Raut (2008) stated that tribals getting a farm land which are residing at most deep area and cultivation of their farm in his own hand.

Gawande (2009) reported that 'Shree' method is identified as most important method for increasing yield under rice cultivation.

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Constraints

Pandhare (1971) found that credit offered by co-operative is too inadequate even to manage the normal cultivation expenses.

Tiwari (1987) found that the official harassment (86.54%), loan not available on time and easily (78.75) and commission for verification of works were the main problems faced by the farmers.

Shrivastav and Singh (1990) express that the major constraints were lack of technical knowledge high cost of pesticides and fertilizers and non availability of credits for paddy growers.

Mahajan and Hanava (1991) showed that non-availability of good quality seeds, lack of funds for purchase of inputs, scarcity of transport and poverty were some of the constraints identified in adoption of new technology.

Pawane (1992) found that age and cast having positive and significant relation with the constraints while land holding and source of information having non-significant relationship.

Bhujbal (1995) observed the age group and socio-economic status having the positive and significant relationship with overall constraints.

Anonymous (1996) reported that non availability of certified seed, fertilizer, scarcity of labour and complicated technique of IPM and lack of information were major constraints faced by paddy growers in adoption IPM practices.

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Kharat (1996) showed the factors like education, size of land holding and socio-economic status having positive and significant relationship overall constraints.

Anonymous (2000) reported that major and uncertain income, unpredictable rainfall and low input use were the major problem. Therefore policy issues related to low productivity access to technology and input supplies and investment in the research and development were needed to be examined.

Gupta *et al*.(2001) observed that 98% paddy growers expressed high cost of inputs and lack of finance as constraints in the use of plant protection.

Chahal *et al*. (2003) observed that lack of irrigation facility was the major constraint in adoption new improved cultivation technologies of rice; tack of technical knowledge was also major problem face by 27.5% farmers in adoption of pheromone traps.

Mogal (2004) revealed that non-availability of recommended seed, non-availability of labour in time, lack of knowledge about the seed treatment, high cost of manures and fertilizers were the major constraints.

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