

CHAPTER 2

REVIEW OF LITERATURE

Review of literature provides a detailed account about the stock of knowledge existing in the research area. It is just a revision about what has already been researched time to time in any specified area. Thus literature review is an informative process which helps us to understand the level of research work done previously in any area. It also helps us to know and understand the different types of methods and methodologies which are incorporated in different studies so as to get the required results.

In the present study review of literature is broadly divided into three parts:

(1) Global level literature review (2) National/ All India level literature review and (3) State specific review of literature (J&K state). All the three categories provide a detailed account about the amount of work done in the research area, methods and methodologies incorporated, results found and policy suggestions put forth by the studies.

2.1 Review of Literature: Foreign Studies

Ali et. al. (2017) conducted a study in which they evaluated the climate change effects on major crops of Pakistan viz. wheat, rice, maize and sugarcane taking temperature, rainfall, relative humidity and sunshine as climate variables. Secondary source time series data from 1989 – 2017 is used in the study. Feasible generalized least square (FGLS), heteroskedasticity and auto correlation (HAC) consistent standard error methods were executed in the study in order to attain the objectives concerned. It was found that some climatic variables negatively and significantly affect the crop yield while others are

insignificant. In the wheat crop production the most influential climatic variables observed were maximum temperature, rainfall and relative humidity. The results revealed that maximum temperature is significant and negatively affects the wheat yield, while rainfall and relative humidity are both insignificant and negatively influenced the wheat yield. Maximum temperature was found significant for the rice yield. Regarding maize yield it was found that maximum temperature and minimum temperature are positive and non-significant, while relative humidity depicts significant contribution towards maize yield. Both temperature and relative humidity exhibited positive relation with sugarcane yield. The overall results show that climate change has adversely impacted the yield of major food crops in Pakistan. The policy suggestions of the study towards the government stressed upon to tackle, combat and mitigate the adverse impacts of climate change. Also it is implied that heat and drought resistant high-yielding varieties of seeds need to be used in order to ensure food security in the country.

Zhang et.al. (2016) studied the climate change impacts on agriculture using different climate variables other than temperature and precipitation. Agriculture data of rice, wheat and corn from 1980-2010 of China was employed in the study with respect to humidity, wind speed, sunshine duration and evaporation. The study highlights the contributions made by the variables relative humidity, wind speed, sunshine duration and evaporation. Regression model was incorporated in the study in order to assess the impacts of climate change on crop yields. The future predictions were established using other climate models like PCM, ECHAM, CGCM and CCSM.

The results revealed that the additional climate variables have economically as well as statistically significant effects on crop yields. Humidity is beneficial for all crops. The

study revealed that a 1% increase in average humidity during the growing season enhances rice, wheat and corn yields by 0.75%, 0.96% and 0.61% respectively. Also it was found that wind speed has a significant impact on crop growth, especially for rice and wheat. The results exhibited that if average wind speed increases by 1 meter/second, rice and wheat yields diminish by 14.51% and 13.91% respectively. Positive effects of sunshine duration were found on rice and corn crops. As per point estimates rice and corn yields increased by 6.10% and 3.84% respectively, when average sunshine duration extends by one hour during the growing season. No significant effects for evaporation were found in general.

Amin et.al. (2015) investigated the climate change impacts such as maximum temperature, minimum temperature, rainfall, humidity and sun shine on the yield and cropping area of major four crops (aus rice, aman rice, boro rice and wheat) in Bangladesh using country level time series data from 1972-2010. The methodology incorporated in the given study was heteroskedasticity and auto correlation consistent standard error (HAC) and feasible generalized least squares (FGLS). Major findings of the study show that the climate variables contributed significantly both to the yield and cropping area with differential impacts. Maximum temperature except for aus rice had significant impacts upon the yields of all food crops. It also insignificantly impacted area under cropping of all the crops concerned. In the domain of minimum temperature the results revealed that aman rice was impacted insignificantly but had a positive impact on the other three crop yields and cropping area. With respect to rainfall aus rice cropping area gets positive boost but had a significant impact on both the yield and cropping area of aman rice. Humidity gives positive contribution to the yield of aman and aus rice but

negatively impacted the cropping area of aus rice. Sunshine proved itself beneficial only for the yield of boro rice. The overall results show that the maximum temperature had detrimental effects upon the yield and cropping area of the crops concerned and rainfall seriously impacted aman rice only. The policy implications highlight the concerns of climate change to food security and hence impressed upon the concerned authorities for generation and development of drought and flood resistant varieties of crops particularly aman rice.

Sarker et.al. (2012) carried out time series analysis in order to assess the impacts of climate change for three major rice crops, aus, aman and boro with respect to three major climate variables, maximum temperature, minimum temperature and rainfall in Bangladesh at an aggregate level using the country level data from 1972 – 2009. Ordinary least squares (OLS) and Median quantile (MQ) regression methods were incorporated in the study for climate change assessment. The findings of the study revealed that there exists a significant relationship between climate change variables and agricultural productivity, but this significant relationship varies between the three rice crops. Maximum temperature depicts significant results for all the three kinds of rice with positive effects on aus and aman yield but a negative effect on boro rice yield. Minimum temperature shows significant results in case of aman and boro rice with negative effects on aman and positive effects on the boro rice respectively. Rainfall depicts significant results only for aus and aman rice varieties with positive effects on both kinds of rice yields respectively. The policy suggestions address the policy makers to fund for the research and development of temperature tolerant varieties of rice with a special focus on aman and boro rice varieties respectively.

Braun and Muller (2012) studied the impact of climate change on production and productivity among apple trees, in the state of Hesse, Germany. They reported that due to climate change there are numerous possible threats to production and productivity of fruits. The threats involve spring frost, diseases and pests, hailstorm, water scarcity and variable precipitation with longer drought periods. The results of the study revealed that climate variables are critical to fruit crops than any other variable. They argued that the initial flowering and full flowering stages are the two crucial stages of crop growth with reference to mentioned climate variables such as precipitation and drought.

Iqbal and Siddique (2010) worked on the paper impact of climate change on agricultural productivity in Bangladesh with reference to time period 1975 – 2008 for 23 regions. The study explores descriptive statistics with maps in order to know the long term changes both at country as well as local level in climate variables like temperature, rainfall, humidity and sunshine. In addition, the study utilizes regression models OLS and FE to estimate the climate change impacts on the productivity of agriculture viz., Aus, Aman and Boro rice. The study is different from previous works as it uses regional fixed effect (in order to neutralize the regional differences) to estimate the effect of long term changes in climate variables on agricultural productivity. The results revealed that long term changes in means as well as in standard deviations of climate variables have different impacts on the rice productivity. More over the results vary significantly with the option of weather variables employed. The policy suggestions of the study impressed upon concerned policy framers and researchers for the robust estimates of the climate change impacts on productivity of agriculture under different climatic prognoses.

Haim et.al. (2007) conducted a study in which they estimate the climate change impacts on wheat and cotton in Israel. Production function approach was incorporated in the study in order to explore the economic aspects of agricultural production under projected climate change scenarios. In this study projections were generated for 2070-2100 temperatures and precipitations for two scenarios of climate change utilizing global climate model (Hadley's Centre global circulate model, HadCM₃).As per the results wheat revealed variation between the two climate scenarios .Net revenues turn negative under severe scenarios (varies from -145 to -273%) but they might increase under the moderate scenarios (-43 to +35%) depending upon the nitrogen application to the crop. Rain distribution plays a key role in yields .In contrast to it cotton depicts a decrease in output with significant losses (-240 and -173%) both in A2 and B2 scenarios respectively. The policy implications as per results suggest the researchers to include technological developments on one side and on the other side impresses upon the government and private corporations to provide insurance for the research projects which will boost the research in the concerned area.

Ching and Chang (2002) studied the impacts of climate change on the agriculture of Taiwan using the country level data from 1977 – 1996 with respect to average yields of 60 crops from 15 sub regions. Multiple regression model was adopted for crop yields that merge the physical and social determinants of yield. In order to simulate the welfare impacts regarding output changes under different scenarios of climate change, a price endogenous spatial equilibrium model (TASM) was used. The empirical results revealed that the two variables of climate (temperature and precipitation) had a significant impact on crop yields. The results regarding welfare impacts of different scenarios of climate

change depict that the impacts of climate change on welfare are mostly positive. The results further revealed that the temperature rise is not bad for the farmers and might be even fruitful when adaptive measures are taken, however the right ward shift in precipitation could wipe out the farmers welfare.

2.2 Review of Literature: Indian Studies

Japneet Kaur (2017) studied the impact of climate change on agricultural productivity and food security resulting in poverty in India .The researcher incorporated state level data of 4 major crops viz, rice, wheat, cotton, sugarcane and climate variables annual rainfall, maximum temperature, minimum temperature, gross irrigated area, fertilizer consumption, agriculture workers, number of tractors, total forest area, farm harvest price over the time span 2004 – 2013 in the study. Seven agricultural states with different climates belonging to tropical and subtropical zones were taken into consideration. The methodology of the present study relies upon Cobb Douglas production function. The climate change and agricultural productivity relation is assessed by an econometric model utilizing panel regression. The results of the study revealed that agriculture in India is sensitive to climate changes and varying precipitation levels. Rice and sugarcane are most impacted by climate variations. Results further revealed that the detrimental impacts on agriculture productivity due to climate change have led to food shortage in India. Regarding policy suggestions the study stressed upon adaptations and mitigation strategies in order to combat the detrimental impacts of climate change on agricultural productivity and food security.

Farook and Kannan (2015) studied the impact of climate change on rice yield in India by evaluating the relation between the output of two rice crops namely kharif and rabi and main three climate variables maximum temperature, minimum temperature and rainfall with reference to the time period 1974 – 2011. The study is based on secondary sources of data and the required data is taken from IMD Pune, Directorate of rice development, Patna etc. Comprehensive methodology was incorporated in the study based on Vector Auto regression (VAR) model with the application of Granger causality test, Impulse response function and Variance decomposition technique. The results of the study revealed that the average temperature both (maximum, minimum) significantly affect the kharif yields while rainfall depicts negative effects on kharif rice. Detrimental effects were shown on rabi rice in relation to average maximum temperature and rainfall but positive impacts were found on rabi yield due to average minimum temperature. The policy implications of the study stressed for appropriate adaptive techniques in order to overcome this alarming issue of climate change on rice production.

Sharma et.al. (2013) studied the climate change effects on apple production in Shimla district of Himachal Pradesh. The study stretches over the time period 2001 – 2009. The climate variables considered for depicting the effect were temperature, rainfall and Snowfall and the required data sets for climate variables were taken from Kotkhai horticulture research station. The data related to the apple production was taken from Directorate of horticulture, Himachal Pradesh. Data revealed that annual minimum temperature slowly increased from 8.65°C – 12.70°C from 2001 – 2009. Correlation analysis was incorporated in the methodology in order to study the effects of climate change on apple production. Also coefficient of Variation was computed in the study to

know the year to year variability in climate variables. Coefficient of Variation was also used to check out the stage to stage variation in different weather variables.

The various results of the study are listed below;

- 1) Minimum temperature shows positive and significant impact on apple production. Yearly minimum temperature also shows significant and positive connection with the apple produce were, $r = 0.685$.
- 2) Maximum temperature revealed significant but negative impact on apple produce. Also yearly maximum and mean temperatures were significant and negative corresponding to the r – values - 0.813 and – 0.733.
- 3) No relationship was found between rainfall and apple produce. However between annual rainfall and annual apple produce non-significant positive correlation was found.
- 4) Annual snowfall shows non-significant and negative relation with annual apple produce.

The policy suggestions address the issue of poor apple production by tackling seasonal shift and combating the variability in climate conditions in order to boost the sustainability in the apple produce.

Banday and Aneja (2014) studied the impact of climate change on the agricultural productivity in Haryana over the time period 2000 – 2012 .The impact was studied on wheat with respect to two climate variables annual rainfall and average temperature. The study is based on secondary sources of data. The analysis of data was done through descriptive and inferential statistics. In descriptive statistics analysis was depicted

through maps, tables, flow charts and figures while inferential statistical analysis was made through percentages, averages, correlation etc. Multiple regression tests were carried to know the impact of climate change on wheat production. The results revealed that the agriculture sector is highly impacted by climate change than any other sector. The model further reveals that the decrease in rainfall negatively impacted the agricultural production in Haryana. If there occurs 1% decrease in rainfall it leads to 1.25% decrease in production. The model doesn't depict any significant impact of temperature on the production of wheat in Haryana, because wheat is cultivated in winters and during that time period temperature remains below 10°C which was found favorable for the wheat production. Regarding policy implications the study suggests a two way approach based on adaptation and mitigation. For climate variability crop insurance is necessary to overcome the losses and hence gets full stress. Stress was also given for the production and use of new varieties of certified seeds that would be least affected by rainfall variability. Crop diversification should be adopted to combat the negative impacts of climate change.

Sharma (2011) analyzed the impact of climate change on different crops in Himachal Pradesh. The results of the study revealed that there occurred slow but predictable variation in climate conditions which are fatal for the production of high value crops (HVC). The results further revealed that there occurred a shift in apple cultivation since last 20 years due to the variability in precipitation periods, affecting the required chilling period for the crops. These creeping fluctuations in weather variables turn wild with the passage of time and take a huge toll on apple output and thereby incurring the growers in huge financial losses.

Aggarwal et.al. (2010) carried out the simulation analysis in selective 11 districts of Uttar Pradesh and Uttarakhand by incorporating infocrop-rice and infocrop-wheat models in their study. The results of the study revealed that the Rice and Wheat yields are likely to be impacted by climate change.

Singh et.al. (2008) studied the structural changes in horticulture sector of India for the 11th five year plan, 2007 – 2012. As per the study decline was witnessed in agricultural sector from 3.7% to 2.5% during ninth and tenth five year plans per year in comparison to earlier periods 1991 – 97, while GDP growth rate got enhanced to 6.6% from earlier 5.7% per year during the specified time periods. In methodology Markov chain model was incorporated in order to reveal the land holding structural changes, land use, farm structure and market structure. The results pertaining to the study revealed that high value crops (HVC) contributed significantly to total agriculture exports. The results further revealed that substantial growth took place in the respects of area, production and output of major horticulture sub sectors between the time period 1991 – 2006. The policy implications of the study stressed upon the specific policy measures based on area constraints.

Birthal (2008) analyzed the trends of production and productivity in horticulture crops with respect to agriculture growth and diversification. The study was carried over the time period 1995 – 2005. The study revealed that the gross value of vegetables and fruits grew at 5.6% per annum during 1995 – 96 to 2004 – 05. Growth rate of agriculture decreased significantly from 3.2 to 1.9% during the above mentioned periods and would have diminished further if robust growth in vegetables and fruits wouldn't have taken place. Vegetable and fruit contribution to overall agriculture production was 64% during

the specified time period, three times more share than the earlier periods. The methodology of the study is primarily based upon Cobb Douglas production function approach. Cost benefit analysis was also incorporated in the study in order to compare the crop diversification costs. The main finding of the study revealed that the agriculture diversification towards horticulture crops enhances and accelerates agriculture growth. Also this diversification gives a chance to small farmers to boost their incomes.

Guiteras (2007) carried out a study titled, the impact of climate change on Indian agriculture. Panel data approach was applied in the study by using the panels of more than 200 districts covering the time period 1960 – 1999. Yearly district level major agricultural yields were regressed with respect to yearly climate variables (temperature and precipitation) and district fixed effects. The results of the study revealed that the projected climate change over the time period 2010 – 2039 decreases crop yields between 4.5 – 9%. The long term effect (2070 – 2099) decreases the yields by 25% and more if not tackled by proper adaptation. The policy implications of the study revealed that suitable and proper policy measures and strategies need to be incorporated quickly in order to overcome the imperative imposition of significant costs on the Indian economy.

Prashar et.al. (2006) evaluated the supply function of apples in Himachal Pradesh. Data pertaining to various variables viz. area, production, subsidies, climate variables etc. of secondary sources was incorporated in the study under the time period 1969 – 2000. Various equations for the yield and new planting responses were introduced in the model. The results exhibited that there occurs an increment in apple production from 50524 tons in 1969 to 376720 tonnes in 2000 with respect to 6.02% compound annual growth rate. The selected model results revealed that chilling hours are crucial factors

impacting the apple yield. The study reveals that due to the extension of certain facilities particularly road infrastructure, the acreage under apples increases in the long run.

Krishna et.al. (2004) identified the climate crop relations in India. They incorporated correlational analysis in their study in order to examine this relationship. Time series data with respect to both climate variables and yields was used by regression modeling. The results of the study revealed that there exists a significant relationship between Rainfall and crops with respect to their production.

2.3 Review of Literature: Studies at Jammu and Kashmir

Wani and Bhatt (2017) attempted to study the effects of climate change on horticulture sector of Jammu and Kashmir State. It is a descriptive study and gives the detailed overview of the various fluctuations that occurred in the respective sector with respect to production and productivity since 1990s to 2016. The study revealed that climate change shows its impact in wide range of natural calamities like floods of 2014, dry weather of 2016, unpredicted hailstorm and untimely rain and snowfall. The various findings (with respect to climate impacts on horticulture crops) of the study are listed below:-

- 1) The 2014 floods account for the loss of 14.25 billion rupees.
- 2) Hailstorm that occurred in 2012, 13, 15 and 2016 causes the loss of 2 billion rupees.
- 3) Saffron production starts diminishing below average from last few years.
- 4) Fruit diseases like scab, red mite etc. are the outcomes of less or erratic precipitation and high temperatures.

- 5) High temperature and humidity favors the growth of bacteria, fungus and algae which are responsible for fruit falling. The number of sprays increased from 3 per year in 1980s to 12-15 per year today.
- 6) Low rainfall hinders growth and color which ultimately lowers the taste and price of the fruits.
- 7) Rainfall decreased from 1000 – 1200mm in 1999- 2000 to 600-800 mm in 2016, which is responsible for delayed sprouting.

The policy suggestions of the study stressed upon the government to inform the farmers via news bulletins regarding various precautions and procedures needed to be followed in respective crop cultivations. Government should supply the farmers with chemicals and fertilizers on subsidies in order to combat the pathogens, pests and diseases and to enhance the quality crop yields.

Lone and Guroo (2017) carried out a research work entitled effects of climate change on Agri-Horti sector in district Baramulla of J&K. The study relies on primary as well as on secondary sources of the data. The methodology employed in the study is based upon exploratory research design. Ten villages were selected randomly from Baramulla district and interview method was employed to collect the required data. The results of the study revealed that there is a general perception among the respondents that climate change effects agri-horti production and productivity to a great extent. The results further revealed that shift in cropping pattern is the outcome of climate change and this shift at present is the only available solution to combat the ill effects of climate change. The policy suggestions of the study insisted government intervention as the prime

requirement in order to tackle and combat the severeness of climate change which takes a huge toll on the backbone of the states economy.

Wani et.al. (2015) studied the changing scenario of Kashmir climate and its impact on different pros and cones of agriculture like production, productivity, area under cultivation, crop diversification, cropping intensity, gross farm income, women involvement, mitigation measures etc. The study is based upon primary as well as on secondary data. The required Primary data was collected from farmers perception and the secondary data related to climate variables (temp., rainfall) since 1980–2011 was collected from meteorological section of SKUAST-K, Shalimar. 270 respondents belonging to different age groups were interviewed over the time period 2013–14 and 2014–15 stretching over North, Central and South Kashmir. The survey was based on group discussions carried with the concerned persons like farmers, scientists and agricultural experts over the period 2013-14 and 2014-15. In order to analyze the data averages and percentages were calculated. The results of the study revealed that temperature rise helped the temperate mountain farming favoring increased cropping intensity. The average annual rainfall per day decreased to -19.44% and annual average number of rainy days per month also diminishes to -24.10% during the specified time period. The various climate changes perceived by the farmers are increased temperatures, long summers, short winters, less snowfall and highly uncertain weather conditions which got revealed in late 1990s. The results further depicted a negative change in net cultivated area over the specified time period. Cropping pattern shift was the major change occurred over the time period 1980-2011. Positive changes occurred in the cropping intensity as witnessed by the farmers. Increment in growing period length was

also experienced by the concerned farmers. Livestock sector also becomes the victim of climate change as due to inefficient snowfall pasture lands lose moisture which leads to poor growth of the grass and there by lessens the feeding options for the said sector. The policy suggestions put forward by the study implied and insisted upon researchers to conduct empirical research work which is lacking in the area in order to know the actual impact condition. It also stressed upon adaptive measures so as to combat the negative impacts of climate change through a proper policy framework. Stress was also given on technological development which can predict various climate uncertainties. Setting up financial institutions was the need of hour for the farmers as they have no financial source which supports them at the time of calamity.

Muslim (2012) predicted and assessed the climate change and its impact on paddy crop in Kashmir valley over the time period 1980-2010. The study utilizes a general approach combining data base of crop, soil, farm management and climate for baseline and future climate, utilizing GEPIC agro climate model. Base line climate data for the year 1980-2010 were taken from IMD, Pune. The various results of the study are listed below:

- 1) Maximum and Minimum temperature increased by 1.43% over the specified time period.
- 2) Annual precipitation increased from 909.23mm to 1225.58mm over the said time period.
- 3) The future results revealed that the Maximum and Minimum temperature is predicted to increase by 5.39°C over the years 2011-2090.

- 4) Precipitation is likely to vary between 3094.72mm to 2578.53mm over the time period 2011-2090. Predicted precipitation is expected to decrease by about 16.67% in the year 2090.
- 5) Other than climate results the impact results revealed that rice production for the base line would decrease by 6.6% by the 2040 and 29% by the year 2090.

The present study addresses an important alarming issue about the severe climate changes and their deteriorating impacts on agriculture sector. So the policy implications as per the study stressed upon integrated mitigation and adaptive measures in order to combat the imperative negative impacts of climate change on agriculture.

Masoodi (2003) studied the apple production and productivity in J&K state. The study revealed that area covered under apples in J&K was 90.08 thousand hectares in (2002) with annual production of about 9.09 lakh tonnes at an average yield 10.09 tonnes per hectare. Although the area increased from 86.65 thousand hectares to 90.08 thousand hectares but both production and productivity got decreased. The justification for this decrease is the prevailing drought like situations over the entire state.

Farooqi (2003) carried a study related to the future market of apples produced in the J&K state. The study revealed apple as the main principal fruit which constitutes 60 – 65% of the total area covered by all fruits in general. Approximately 9,00,000 MT was the yearly apple production in the state. As per present production status of apples, only one apple meets per person yearly which states that there is 1:1 equation between total apples produced and total population of the country. The results hence revealed prospect future market for apples in the country.

2.4 Research Gap

The study undertaken is a research deficit area and because of this deficiency and dormancy it becomes a serious issue as Jammu and Kashmir is becoming rapidly warmer than rest of the country which takes a huge toll on the states pearl resources. From the empirical point of view nothing noteworthy is done in the said area. Meager portion of work has been done like climate change and its impacts on fish fauna, horticulture, saffron sustainability of Jammu and Kashmir, while the impacts of climate change on agriculture and its allied sectors is not addressed properly and hence becomes a big and demanding research gap for the research.