CHAPTER 1

INTRODUCTION

Background of Study

A country needs to utilize its agricultural area efficiently to improve food safety, the value of life and indorse enhance economic growth. The indication from the least developed countries (LDCs) specifies that the agricultural output contributes to a large proportion of their gross domestic product (GDP). Thus, the growth of such economies cannot is attained without better utilization of the agricultural area. According to the Economic Survey of Pakistan (2017-18), its key natural resource is arable land, and the agricultural sector's contribution to GDP is 25.6 %. Agriculture absorbs 45% of the workforce and has an export share of 18%. Given the contribution of the agricultural sector in economic growth, it is significant to study the effect of climate variation on major yields in Pakistan but this study is focused on rice production due to its exports and value addition potential.

Climate is traditionally defined as the mean and predictability of relevant variables in the atmosphere, such as rainfall and temperature. Temperature and rainfall can be described in several ways. One way to describe the climate variable as an average of temperature and rainfall such as maximum and minimum. On the other hand to make different stages of both. Like the first stage, the second stage and third stage mean that the time era of rice productivity is in May to October and this month divided into different stages.

There are two seasons of cultivation in Pakistan, Rabi, and Kharif. Rabi yields are normally grown from November and April and Kharif yield are grown from May to October. The performance of the agriculture sector is contingent on the climate throughout the year and temperature variation and precipitation generally affected the agriculture output.

In Pakistan, the agriculture sector employs more than 47% of the population and their incomes face the risk of climate variation. Temperatures are forecast to rise by 3°C by 2040 by 5°C to 6°C by the end of this century. Because of this situation, Asia can lose fifty percent of its wheat productivity (MOE, 2009). Moreover, Pakistan's agricultural area is extra susceptible to weather variation due to its geographical location (Janjua *et al*, 2011).

1.1. Significance of the Study

The agricultural productivity in Pakistan can be increased either by improved agricultural technology or improvement in efficiency or both. The pace of development and adoption of improved agricultural technology is slow in Pakistan. Therefore, improvement in efficiency is the most suitable option to enhance agricultural productivity in Pakistan. This study will offer the viewpoint of current condition prevail in Pakistan regarding climate change and its impact on rice production. And also analyze the current scenario temperature and rainfall and its effect on rice production in Punjab. The combination of the variables which are used in this study with climate change to find out its effect on rice production is not used after four years in case of Pakistan according to the best of my knowledge winch I have gained by reviewing the literature of different studies which had been conducted on Pakistan economy Also the time is different from previous studies.

1.2. Limitation of the Study

- This investigation will be conducted in Punjab, Pakistan.
- Weather change (temperature and precipitation) are not the only features that can influence the productivity of rice, other factors influence the productivity of rice e.g. fertilizer takeoff, etc.
- In the case of a natural disaster like floods etc. rice productivity can be disturbed and natural are beyond the control of the study.

1.3. Research Objectives

The revision will examine the ensuing objective:

- ❑ To highlight the importance of climate change in the agriculture sector.
- ❑ To find out the impact of climate change on rice production in Punjab.

- To investigate the impact of different stages of temperature and rainfall on rice production.
- To empirically examine the effect of non-linear variables on rice production in Punjab

1.4. Hypothesis

H_{Y11} = The impact of different stages of temperature and precipitation on rice production in Punjab Province.

H_{y10}= No impact of different stages of temperature and precipitation on rice production in Punjab Province.

H_{Y21} = The impact of non-linear variables on rice production in Punjab Province.

H_{Y20} = No impact of non-linear variables on rice production in Punjab Province.

1.5. Research Questions

- Why climate change is important for rice production?
- What variations occur in the production of rice in Punjab due to variation in climate?
- What is the impact of different stages of rainfall and temperature on rice production?
- What is the impact of non-linear variables on rice production in Punjab?

1.6. Plan of Study

This study is organized in such a way that Chapter 2 narrates reviews of literature detailing theoretical and empirical studies. Chapter 3 sheds light on the profile of Pakistan's resource distribution system economy in Pakistan. Also, Chapter 4 describes the methodology and theoretical framework that streamlines the theoretical model and variables selection, and finally explains the technique and methods of estimation followed in the analysis. Finally, the data presentation and analysis of data will be reported in chapter 5. The chapter discusses the data source, variable construction, and descriptive analysis of the study variables. This chapter also reports results obtained with theoretical and reasoning after estimation analysis. Finally, Chapter 6 deals with findings and recommends policies.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

In history, many researchers operated superbly to investigate the theoretical and empirical sources of climate-production suggestions. The concept of climate-production connection was essentially driven by the Ricardian approach. The outcome of weather change on rice production was carried out in later empirical studies.

Under developing countries as well as rising countries are additionally susceptible to climate variation compared to developed countries. The agriculture sector of developing countries in one of the most threatened areas because crop production is more delicate to rainfall than the temperature. The phenomena are evaluated that observed by many researchers from the world like Deressa (2006), and Madisson (2007). However, many researchers tried to research agriculture sectors.

2.2. Theory and Literature Review

The expansionary policy to enhance cumulative demand in the economy should be adopted during the recession period, thus increasing the gross domestic product. The Ricardian approach derives from the hedonic method. The Ricardian approach was based on the surveillance of David Ricardo (1772-1823). It has specified that farmers make the most of their incomes by using land in the decreasing sort of fecundity i.e. soil quality as well as climate, etc. For this determination Polsky (2004) will place the land with the mainly suitable weather for the mainly gainful agriculture movement.

However cross-sectional output data exposed that rising temperature has a harmful influence while rising precipitation has an optimistic influence on both net farm income and crop production. Climate variation has a major impact on irrigated farming. Increasing the expanse of irrigation was recognized as a durable procedure of mitigation to manage the impact of climate variation and land deprivation, climate roasting, and increased evapotranspiration. By increasing the amount of irrigation water, the plants can withstand the high temperatures. But the issue is that most of the countries in the world have Arid or Semi-Arid climate which is known for the shortage of water and warmer. The availability of water resources is also declining. Salinity is another way which is damaging the land used for production. The outcomes of studies lead in this sector showed that increased irrigation can also be useful in resisting salinity, as increased availability of water leaks deep into the soil down the additional salts (Connor *et al.*, 2012).

Rosen (1974) suggested that because of the heterogeneity in the value of the goods ' attributes, the hedonic relationship will arise. Agricultural land prices depend on a feature that decides agricultural output, i.e. whether (max, minimum, solar radiation, rainfall, etc.), slop, and soil value (hilly vs. flat). Pizer and Goulder (2006) discussed "the hedonic move toward useful to agriculture intended at embracing an inclusive variety of swap choice, using cross-sectional data to observe how geographic, climate and physical variables were associated with agricultural land prices.

Furthermore together with Asia and Brazil, Dinar and Mendelsohn (1999) considered the precise effect of weather variation on farming in growing nations around the arena. They will use three distinct policies for scrupulous studies, which had been also the specific Ricardian technique, agro-financial product, and agro-ecological zoom studies. Planting capability, assets value, or even net income has been reduced to three ecological apparatuses, ordinary assets, and paintings-associated economic recommendation, also, to assisting programs to include types-related amenities (Nordhaus and Shaw 1994). This study, unlike many research, highlighted the importance of the farmer’s model. They will verify which maqui berry farmers can familiarize themselves with a new circumstance as and a sign of climate modifications by generating output judgments in keeping with their man or woman wishes. Harvest choice is normally simply one of the examples from the farmers ' edition to make the climate of the document cozier. The grain of wheat, hammer, and grain are three vegetation while instances are decided by the particular temperature as regions upward thrust (McKinsey and Evenson, 1998; Dinar and Zilberman, 1991). Because temperature makes it less difficult for grains or wheat maqui berry farmers to move grain or wheat to hammertoe to generate sales. Subsequently, maqui berry farmers modify to more cozy weather and therefore pass to grain via the hammertoe in case temperature turns into more comfy once more enough to shed sales. Ricardian technique outcomes, agro-monetary product in addition to agro-ecological quarter outcomes.

However, the South African zone, Gbetibouo, and Hassan (2004) used the Ricardian technique on sugarcane, maize, groundnut, wheat, soybean, and sunflower. The results revealed that the rise in temperature would have an optimistic cause on sugarcane, maize, soybean, and sunflower invention while it would harm the productivity of sugar cane and wheat (Kiker 2002 and Kiker *et al*, 2002). They said this area already has high temperatures and any further temperature rises in the potential due to climate variation would disaster the yield of wheat. They recommended replacing wheat with sorghum and maize or another heat-modified yield to evade possible yield loss due to higher temperatures.

(Deressa *et al.,* 2005; Hassan and Gbetibouo, 2005) claimed the contradiction of this idea. Deressa *et al.,* (2005) suggested that the effect of climate variation on sugar cane production in South Africa by using the Ricardian method revealed that increasing the supply of irrigation does not help combat against the changing climate but by adopting new innovative technologies, the harmful impact of climate variation could be mitigated. Throughout the study, the behavior of farmers in the country was acquired by experiencing their adaptive technologies in the changing climate scenario. Eleven districts were used to apply the model for twenty-two years' time-series data. They were with the view that weather variation has a nonlinear effect on disposable income per hectare in South African sugarcane farm fields. These new technologies will increase the tolerance of the sugarcane crop to withstand in the warmer winter and especially the winter season in the country's farms.

Hassan and Gbetibouo, (2005) suggested that Using the same approach, vulnerability due to climate change was analyzed on the African cropland. Regression of farm net revenues against soil, climate, and other socio-economic was carried out to capture a glimpse of climate variation and its impact on farmer adaptive strategies. The studies were conducted in300 districts of South Africa and the outcome showed that the production of field yield is more perceptive to change in temperature levels than the variation in precipitation level.

Furthermore, the season and location matter in the agricultural sector. African crops are more sensitive to marginal changes in temperature than changes in precipitation. Temperature rise has positive effects on African crops, while rainfall reduction harms net income. These explanations depended on seven field yields (maize, wheat, sorghum, sugarcane, groundnut, soybean, and sunflower) from 300 areas in South Africa (Gbetibouo 2005). The revision also advised that a crop's growing season may change depending on the temperature, but there is a likelihood that this type of exploit could lead to the complete rejection of certain yields in certain sections.

The effect of climate variation on net farm revenues the studies conducted in Sri Lanka highlighted that the developing countries which lie at low latitude have more vulnerability to climate change impact. The reason came out; these countries are less adaptive to climate change and unawareness of farmers toward coping with the present changes (Adams, 1989; Alexandrov and Hoogenboom, 2000; Southworth *et al.*, 2000). The result of Sri Lanka showed that the dry and less infertile regions of the country in eastern and northern provinces are more vulnerable to change and hence can lose a greater portion of their agriculture produce while the productive and cooler regions in the essential highlands are anticipated to endure the same or may have elevated levels of yield (Seo *et al*., 2005).

Studying the Economic influence of weather variation on Ethiopian agriculture by expending Ricardian technique, it was analyzed that the marginal impact disclosing that the unit rise in temperature in winter and summer would reduce US $177.62 and US$ 464.70 respectively in the net farm revenues (Molua, E 2002; Maddison, D 2000). On the other hand, the marginal effect of rising rainfall during spring would raise the net farm revenues by the US $ 225.09. The overall study showed that the cumulative temperature and declining precipitation in destructive for Ethiopian agriculture (Deressa, 2006).

The researcher's work done by using this approach confirmed that the agriculture sector in Africa is under great threat due to climate variation (Deschenes, O and M. Greenstone 2007). The results revealed that the production losses in Burkina Faso and Niger would be around 19.9 percent and 30.5 percent respectively by 2050. But countries like Ethiopia and South Africa are not under such stress of climate variation where losses in production are estimated to be just 1.3% and 3% respectively for the same 2050. Similarly, in sub-Saharan Africa (SSA) agriculture region is also susceptible to climate variation like in Niger where production losses are approaching 30.9 percent (Madison *et al.,* 2007). In Latin American countries; the Ricardian analysis to estimate both land values and net revenues showed an overall negative impact of climate variation. Both the land values and net revenue are sensitive to climate variation. A hill shaped connection is obtained for both small and large farms for temperatures. The rained areas are more receptive to temperature while on other hand irrigated areas are susceptible to precipitation. The study also showed that the countries in Latin American, that have cooler places will get benefit from the warming but the places which are already hot will be damaged by the warming (Seo and Mendelson, 2007)

The Ricardian approach and cross-sectional data to estimate climate change impact on African cropland were used; Results showed large income variations within the continent of Africa due to climate variation. The continent is already susceptible due to the high heating phase during the year and low level of precipitation. These situations are a serious risk, not only to the food safety of the continent but also to the net farm revenues to the farmers. For instance, in 2100, the income variation will range from -34 to 66 percent depending on the GCM in Nigeria (Kurukulasuriya and Mendelson, 2007).

Furthermore to estimate the climate variation impact on different agro-ecological zones of Africa Ricardian model analysis revealed that farms in Africa are springy to the impact of climate variation both in production and net revenues obtained. This is because many of the farmers in hotter zones are switching to livestock keeping which is more heat tolerant than the crops and hence farm revenues are generating at a good pace without being affected by the climatic vulnerability [Seo *et al.,*2008). To find the said evidence, cross-sectional analysis was done. Firstly, the production of yield is susceptible to change in temperature and precipitation as well. Predictions are that arise in the temperature will be harmful for the production of yield while rainfall in both the season i.e. winter and summer will be valuable (Quiggin, J. and Horowitz, J. K 1999). Furthermore, in the study, a new point is raised that was not highlighted earlier. The warming in the agro-ecological regions of Africa is beneficial. This is due to the reason that both crop income and livestock income was taken into account while studying the region. Warming has a positive impact on livestock production and hence beneficial for this sector and it can offset the losses in the crop sector due to the warming (Reilly, J 1995).

An economic valuation impact of weather variation in Zambia, a neighboring country of Zimbabwe was done. Zambia has only one cropping season in the country that twitches in November and ends in April (Hassan *et al.,*2005). As the country is small and processes only one season for crop production, the result in this regard showed that the socio-economic variables have no significant for estimating net farm revenues. Using multi-linear regression; model with net revenues per hectare was regressed with the soil, weather hydrological, and socioeconomic variables. On the other hand, climate variables are very much significant for estimating net farm revenues (Kumar, K, and Parikh, J 2001). The month from November through February is very critical for crop production in the country. A rise in the mean temperature during November-December and reduction in the precipitation from January to February harm the yield production and eventually on the net farm revenues (Rao DG & Sinha SK 1994). The finding has an interesting side that arises in the mean temperature and the mean runoff from January to February has a beneficial impact on the net farm revenues (Jain, 2007).

Using 40-year data the Ricardian approach was used to find the sensitiveness if agriculture to the climate change impacts in India (Parikh, J 2001). The finding was interesting with the view that the sensitiveness of the Indian agriculture sector is increasing. It was found that the only way to cope with the change is by adopting proper mitigating strategies. The large masses of farmers in the country should adjust their farming practices (Kumar, 2009).

Climate change has great importance for China from an agricultural point of view and net farm revenue generated. Ricardian analysis for tracking climate change impact on China shows the elevated levels of annual temperature lowers down the farm revenue slightly. The interesting observance from the analysis is that spring temperature and precipitation both, are critical and harmful for the agriculture sector in China. However, a warmer summer and winter are helpful for the production and revenue generation. On the other hand, higher annual precipitation is good for this sector. Soil shows a very significant part in the production of crops. Analysis of soil in the study revealed that earthen and residue soils rise the net revenue per hectare in China. Also, the farms on the plains having access to the main roads are more revenue capturer than the farms with larger sizes and on the higher elevation (Wang *et al.* 2008).

Shakur *et al.,* (2011) applied the Ricardian approach on the wheat yield of Barani areas of Punjab in Pakistan. The approach finds that climate variation has serious impacts on the agrarian economy of Pakistan which is posing threat to yield production in the country. Cross-sectional data on farm input and output uncovered that rising temperatures have a negative effect while rising precipitation has an optimistic outcome on both disposable farm income and crop invention. But the overall beneficial effect of rising precipitation levels cannot manage with rising temperature levels (Kaiser and T. Drennen 1993). By all these climatic concerns, which might also rise in the latest future, mitigation methods are optional including, changes in the harvesting pattern, new and inventive irrigating operation, and new approaches of crop farming.

Odjugo (2010) found that climate variation had a major impact on Nigeria's agricultural production. They preferred twelve Nigeria stations and collect data from the Meteorological Agency between 1938 and 2007. They also use primary data, filled in 9 rural areas 900 questionnaires from the former. The independent variable was air temperature and precipitation, and the dependent variable was agricultural production (Rahimzadeh F 2006 and Brown RA, Rosenberg NJ 1997). The percentages and LSR techniques used to analyze the data. The result showed a rise in temperature and a fall in precipitation and rainy days also indicated that farmers shifted to guinea maize production requiring more rainfall to millet requiring less rainfall.

The climate variant look at on agricultural yield in Norway changed into performed by way of Torvenger *et al.,* (2004). For the decade, they used barley, potatoes, wheat, and eats as reliant on variables, while climate and yearly rainfall are unbiased variables. They accumulated statistics for total variables from 1958 to 2001. They recycled the biophysics ' statistical exemplary. They determined that during 18 percent cases there may be a helpful courting among yield and temperature, whereas in 20 percent there's a bad correlation among precipitation and yield (Wolfe D *et al.,* (2011)].

Thomas and Twyman (2005) concluded that it was important to peer the predictable impact of weather alternate on agriculture at the conditions of other developments that formed the rural environment (Duffy PB *et al.,* 2007). Such traits had been growing populations, continual farm earnings dependence, and unbalanced off-farm profits due to political and socio-economic factors. Other full-size extra traits that engage with the impact of climate exchange manufacturing covered land desertification, decreasing range efficiency, and land devoted to livestock manufacturing or food manufacturing (Costa-Roberts J *et al.,* 2011). This adversely impacts farm animal manufacturing, which in turn adversely impacts the livelihoods of households.

Wolf *et al.,* (2005) linked five wheat models of different agronomic conditions designed for Europe. They concluded that the same results were predicted by nearly all models. The results showed that higher temperatures would lead to lower yields, while higher rainfall and CO2 impregnation would have an optimistic effect on Europe's wheat production.

Mudasser and Hussain (2006) envisioned the effect of weather exchange on areas of Pakistan, Chitral plus Swat 960 m, and 1500 m above sea degree. The examine's principal motive turned into to govern whether or not temperature rises as much as 30 C might decrease the developing seasonal duration (GSL) of the wheat crop of this country (Michael Green *et al* 2007). The evaluation became based on the methodology of the Ordinary Least Square (OLS). Owing to its area on excessive elevation and poor effect on Swat attributable to its low loftiness role, the result indicated that temperature rises could have a wonderful impact on the Chitral district. Rising the temperature to at least one, 50 C would have an optimistic effect on Chitral and rise the crop via 14% and the poor effect on Swat via 7%. An extra temperature upward pushes off as much as 30 C would bring about a 24 percentage discount in Swat's wheat yield and a 23 percentage upward thrust in Chitral. Due to the predictable future temperature upward push, coverage references had been given to adopting policies for calming great crop diversities for heater parts in northern Pakistan, (Nelson Roger *et al.,* 2007)

Anwar *et al.,* (2007) used the Global Atmospheric Model of the Australian commonwealth scientific and industrial research organization (CSIRO) under three low, mid and excessive climate exchange scenarios for the South-East Australian area (2000-2070). The results confirmed that the medium wheat yield decreased with the aid of about 29% for all 3 scenarios, but this decline in manufacturing turned into decreased from 29% to twenty-five% in the presence of expanded CO2 (Martin L. Parry 1994). A very minor degree of small rainfall and an advanced temperature is offset through CO2 fertilization. They gave pointers that thru higher agronomic techniques and wheat breeds better yield productivity can be completed (Cline, William R.2007).

Cerri *et al.,* (2007) used Brazil's Central South simulation version for estimation as much as 2050. They uncovered that temperature increases of 30 C to 50 C and rainfall increases of 11% would purpose wheat productiveness to decrease with the aid of weight to the extent of 1,000,000 lots. It became additionally discovered that what had already been grown at the edge temperature level in Brazil, and in addition to this temperature level could bring about a decline in agricultural manufacture, mainly wheat (Schlenker W and Roberts MJ 2009). They brought that maximum developing nation on the steamy girdle and counting on agriculture could be faced with agricultural yield losses.

Molua (2008) carried out proceeds a look at the effect of weather trade on agriculture in Cameroon. Results showed that a boom of 3.5 percent in temperature and 4.5 percent in rainfall because of loss of irrigation centers would be dangerous to Cameroon's agriculture, resulting in a loss of 46.7 percent in output fee. This loss became expected to harm the financial system as a whole as nearly 30% of an's countrywide GDP came from farming (Ewert F *et al.,* 2012).

Hassan and Deressa (2009) used the Ricardian technique to take a look at the unique financial result related to climate alternate at harvest output in Ethiopia. Country-degree survey records are broadly used for this opinion, and web harvest income has also been decreased by way of climate (precipitation and also temperature), residence, and soil particulars (Darwin, R 1999 and Reilly, J 1995). They will examine the specific weather specifics associated with temperature and additionally precipitation at the harvest internet earnings in seasonal limited consequences. The research encouraged which restricted temperature enhancement has a noteworthy negative impact on net harvest profits in keeping with hectare all through the summer and iciness in addition to confined precipitation enhancement through spring has a sizable impact on internet harvest income in step with hectare.

Basak (2009) functions weather variant impacts studied using simulation invention on grain output in Bangladesh. The product is typically devoted to Boro once production, which normally debts for 58 percent of Bangladesh's complete-grain output through 2008 to calculate the effects of expectable destiny climate adjustments (Ogunwande, S *et al* 2010). Patch soil and too hydrological features on the web sites, normal crop control strategies, normal increasing time, and also climate statistics in 2008 had been valuable for precise investigation in addition to hotness and also CO2 stages are achieved within the imitation invention known as Decision Assist System for Agrotechnology transmission. The very last results of the simulation showed which grain output may additionally vary for one-of-a-kind weather conditions in lots of locations and additionally hydrological traits related to soil, even though equal Boro grain turned into used in each place (Prasada, V *et al.,* 2000). Also, the product suggests which grain output to twenty-eight decreases drastically by using 3.6 percentage to 30.5 percent, and also by 0.11 percent of the 7%extreme temperature became expanded through 2°C and also using four°C. While the simulation invention suggests that additionally, the drop within the least temperature reduces the particular grain yield, the object indicates that extra destruction inside the output increases in the utmost temperature motives. Additionally, the product detected a few wonderful

CO_2-associated results on the specific ounce crop, though the result became small in contrast to the temperature-related alternate.

Molua (2009) examined a study on the effects of weather variation on Cameroon's smallholder farming. The estimation was based on the Ricardian method. Results showed that the 2.5C temperature increase would decrease net revenue by USS$ 0.79 billion and US$ 1.94 billion would decrease 5 C. The study showed that climate variation was not good for Cameroon's economy.

Siwar *et al.,* (2009) explored Malaysia's effect on agricultural sustainability and poverty as a result of climate variation. Climate variation effect on agricultural sustainability differs in different regions over different periods, according to them Agricultural yield is affected by disappearance due to weather variation, growth rate and structures of generative existence and physiological process timing due to a rise in annual evaporation temperature of approximately 5 percent (D E Schimmelpfenning, (2001). In the long run, climate variation generates water and other resource scarcities that increase attacks on crops and livestock from soil pests and diseases and increase sea level, etc. In susceptible areas, this leads to concentrated agricultural productivity that ultimately affects the poor A (Woodward *et al.,* 2007). This is the main threat to sustainable farming yield in Malaysia

Bockel and Smit (2009) recognized influences of weather change that were a shift in agro-climatic zones and modifications in land suitability for various pasture sorts. They predicted that a boom in sea degree might flood agricultural areas and/or direct intrusions into seawater, for this reason stopping the use of certain areas for the production of livestock (Dawe D, *et al.,* 2010). They additionally forecast a rise in temperature in maximum places which, in line with them, would lessen rainfall, exchange desertion techniques, affect water resources, alter intense seasonality in addition to a drop in crop yield (and a few rise), lessen production and earnings, and strain on livestock, compounded through illnesses and lower productiveness of livestock (Wall GW, *et al.,*2011). The rise in hotness joined by way of a drop in rainfall becomes predict to drastically lessen output and limit the invention of livestock. The high-quality feature expected approximately weather trade was that increases in rainfall might bring about crop profits with associated manufacturing and income blessings. On the other hand, it becomes predicted that decreases in rainfall could lead to crop losses, decreased manufacturing and lower incomes, restricted cattle production, and deficits in humidity (Diaz-Soltero H, *et al.,*2011). At the identical time, it turned into expected that the increase in floods and droughts would cause animal losses, disease outbreaks, and harm to infrastructure, starvation, and that displacement.

Zhao *et al.*, (2009) examined China's agricultural sector's effect on climate variation in 2080. The estimation was based on the comparable general equilibrium (CGE) model. Results illustrate a decline in the agricultural share of GDP of 1.3 percent (Cline, W. 1996). The results of the CGE simulation revealed that agricultural output would slow in 2080, initially resulting in productivity losses excluding for wheat, which visible development in output due to a rise in the worldwide wheat petition (A. Raneses. *et al.,*1995 and Velthuizen. *et al.,* 2005). The simulated consequences also exposed that, related to the world's normal agricultural production, agricultural yield in China would fall less.

Anderson and Bausch (2006) had been investigating scientific proof on connections in Europe among intense climate tragedy and climate variation. An instance of climate-associated tragedy given that 1900 has been growing average temperatures. The value of the imply temperature upward push and severe excessive existence had been contradictory with usual cycles. With effect on human-prompted GHGs, that is dependable. Strong rainfall and accelerated deficiencies and hurricanes were extra examples.

A study on the impact of weather variation on Indian agriculture turned into investigated by using Guiteras (2007). Estimated an in-depth 40-year panel statistics on agricultural outcomes from 1960-1999 masking two hundred Indian districts. The facts have been accumulated from the Agriculture Ministry of India and other professional assets (Chaudhari HS *et al.,* 2007). Except for Kerala and Assam, these statistics usually refuges the principal agricultural situations. The idea procedures used in these statistics usual were fertilizer inputs, agriculture wages and the degree of double cropping, every of that is restrained annually on the district level so that it will estimate the range of modifications to negative weather shocks within the year. The outcomes confirmed that the quick-to-medium-time period effect of weather alternate on Indian farming is in all likelihood to be negative (Hansen JW *et al.,* 2004). The impact on yields within the medium period (2010-2039) is anticipated to be terrible between 4.5 and nine percent. Since agriculture accounts for approximately 20% of India's GDP, over the medium term, this means a value of whether the exchange of one to at least one.8% of GDP in line with 12 months. Policy guidelines have been given that, first of all, what are the elements that explain the distinction between these terrible results on a growing country and, secondly, how quickly growing international locations might be capable of adapt their Agri-business performs to the varying weather and what regulations or machinery will permit for the quick model (Ramesh KV, Goswami P 2007).

In Sub-Saharan Africa, Calzadilla *et al*. (2009) conducted a look at the economic impacts of weather change on agriculture. The observation's motive is to analyze techniques for variation in Sub-Saharan Africa's climate trade (Tol RSJ *et al.*,2011). The technique consisted of two types of models that were a version of the worldwide partial agricultural sector equilibrium and a worldwide version of the CGE (GTAP-W). Under the SRES B2 situation, two possible versions of climate trade options for Sub-Saharan Africa had been evaluated. The first scenario doubles Sub-Saharan Africa's irrigated vicinity by 2050, compared to the baseline, but retains a powerful overall crop area. The 2d scenario will improve the returns of both rained and irrigated crops by 25 percent for all global places in sub-Saharan Africa (Raneses A *et al.,* 1995). The results showed that a rise in the irrigated area and agricultural productivity leads to a decrease in the production costs of agricultural products, resulting in a decrease in market place fees. Nevertheless, despite the reality that sub-Saharan Africa has no longer become the main business for worldwide food production or irrigated meal production, both eventualities assist to reduce the cost of meals. Under the state of politics simulating higher crop productivity, both GTAP-W and impact showed greater specific cuts in home and world market expenses (Lobell D, Field C 2007).

Pant (2009) premeditated the consequences of agriculture on whether trade: pass-united states have a look at of carbon-related factors. The take a look it's important cause changed into to empirically check the factors affecting carbon dioxide emissions to the surroundings (Alam, M. and B. R. Regmi (2004); and Chang C. C. 2002). The facts become taken from the 120-country Green Data Book of World Bank on national variables associated with carbon emissions, electricity intake, and agriculture. The dependent variable changed into consistent with capita carbon dioxide releases and sovereign variables had been agriculture land, fertilizer use, irrigation, and populace strain on agricultural acreage, woodland location, and biomass strength, range-deflated vigor use in step with capita, and strength performance use. The estimation turned into primarily based on the linear multiple regression method [Kane, S., J. Reilly, and J. Tobey

(1992)]. The effects confirmed that agriculture land, irrigation wooded area, biomass strength, and power performance have a poor effect on carbon dioxide emissions, but it has a tremendous impact on fertilizer use and consistent with capita power use. The analysis confirmed that human beings are extra chargeable for carbon emissions in wealthy countries than human beings in poor international locations.

Bezalih, *et al.*, (2010) carried out a have observed on weather alternate, fashionable productivity problem, and the Tanzanian economic system. The reason for the has a look at changed into to have a look at the overall equilibrium implications of climate trade for Tanzania, a low-earnings America of the USA in Africa. The CGE (Computable General Equilibrium) model method has been used to take a look at the outcomes of whether alternate with the overall economic growth as the consciousness of shocks is probably to rely upon the macroeconomic structure of the monetary device [Long, S. P. (1991)] and [D. Shaw.*et al.*, (1994)]. The consequences confirmed that even though the predicted decrease in agricultural productivity, the poor effects may want to probably be fantastically constrained. This is since the time balance concerned and the economic system's low beginning factors depart sufficient time for element replaceability and elevated normal productivity.

They have a look at the economic effect of climate trade at the Punjab agricultural region turned into conducted by Hanif *et al.* (2010). The reason for the takes a look at turned into to identify climate exchange in both nearby and U. S level agricultural region development. The records had been taken from eleven Punjab districts from 1970-2009. They used the method of regression of the Feasible Universal Least Fair panel to discover their consequences [Amiraslany, A.(2010)]. The outcomes confirmed that within the Kharif season the rain-associated undoubtedly to the expenses of the land and had a sizable impact. The imply Kharif minimum temperature additionally has a positive and enormous relationship with the costs of the land [Goodman, A. C. (1978)]. With land prices, the imply Kharif most temperature is not full-size. Rabbi season rain and minimal temperature have a considerable bad relation to land fees and suggest most rabbi temperature has an extensive high-quality courting to land prices. There is a high-quality relationship among population density and according to capita earnings and land fees.

Mubaya *et al.,* (2010) determined the terrible socio-financial influences of Zimbabwe and Zambia's deficiency, which was a shortage of livestock farming profits. They were, consequently, not able to find the money to send youngsters to high school. Farmers additionally had farm animal theft, which decreased inventory numbers. The decline in inventory range ended in families promoting inventory to satisfy each day's household obligations requiring coins [Cline, William R. (2007)]. The excessive rains in Zimbabwe and Zambia had poor in addition to effective effects. The health of livestock deteriorated and died as maximum farmers had been not able to find the money for veterinary fees. Also, useless rains brought on bridge breakdown and road harm. To get to metropolis transportation, farmers had to flow long distances. Other setbacks, which include destroyed homes, colleges, infrastructure, and those being swept away by using rivers, have additionally been pronounced [L Parry *et al.,* (1994)]. The high-quality results of excessive rains in both nations were enough pastures for cattle. Farmers established precise crop for cowpeas and sweet potatoes within the Monze District of Zambia since they exist on the excessive ground. The returns, in a twist, improved the income of the family.

Janjua *et al.,* (2010) investigated the impact of climate exchange on Pakistan's wheat manufacturing. From 1960 to 2009, they recycled the time collection facts on whether exchange and worldwide heating. They used the vector autoregressive version to estimate the consequences. They found that there is no tremendous negative effect of weather trade on Pakistan's wheat manufacturing. They recommended that there's no want to undertake new techniques such as higher irrigation and timely cultivation.

The courting between weather trade and Pakistan's agriculture was investigated utilizing Ahmad and Schmitz (2011). The studies paper showed how climate change influences agricultural production in 4 provinces. From 1971 to 2004, they used panel information. Average meals plants are the based variable, and the unbiased variable on this have a look at is temperature and rainfall. They used a fixed-effect model and initiated that reduces productiveness in infertile areas with climate variation and additionally has a bad effect on meals safety

Ashfaq *et al.,* (2011) performed examined the have an effect on climate trade on wheat efficiency in Punjab's numerous crop machines. The cause of the takes a look at turned into to assess this wheat productivity property within the Punjab province's mixed region. The statistics were time series from 1980-eighty one to 2008-09. The based variable modified into the productiveness of wheat in kg ha-1. The independent variables had been climate variables and economic variables to limit the effect of climate change. The method used to become the Ordinary Least Square (OLS) technique for estimating the effects of weather alternate. Results confirmed that growth in suggesting a minimal temperature of 1-diploma centigrade at the sowing degree will increase the productivity of wheat by 146.57 kg ha-1. At the undergrowth stage, the growth in propose most temperatures will lessen productivity, even though not substantially, with the aid of accelerating vegetative growth and decreasing the period of brain development. At the development level, because of a one-diploma centigrade boom in suggest maximum temperature, the productiveness gain will be 136.63 kg ha-1. A sufficient amount of precipitation increases the productivity of wheat through 275,77 kg ha-1. The productiveness response to financial variables turn out to be relatively smooth and strong, ninety 4.43 kg ha-1. Thus it turned into concluded from all of the outcomes that weather variation is the most crucial determinant of wheat productiveness at every level of wheat growth.

2.3. Review of Empirical Studies

In this section, some previous work on climate issues will be studied to get a better understanding of the issue in hand.

Severe impacts on rice crops have been imposed by the climate shift in Nigeria. Surveying 20 rice-producing states of Nigeria with irrigated and drylands, the results revealed that the rise in temperature has different impacts on dry land and irrigated farms. In drylands, it has negative impacts while in irrigated farms the impact was positive. Precipitation has also the same trend as a temperature. The farmers in the country are also adapting significant techniques for irrigation to conserve water and to increase the net farm revenue. Forecasts climate change impacts are that there is a decline of 65.35 percent in income with a 5 percent decrease in the rainfall on non-irrigated farms. On the other hand, rice at a temperature of 2°Ccauses only 11.7 percent decrease in income (Ajetomobi *et al.*, 2010). To cope with these changing climatic trends, the challenges in adapting different strategies to have a bearable agriculture development in Nigeria have been studied. The varying climate is posing a serious threat to the population of the world with greater concern on deprivation and malnourishment. The African region is on the verge of damage owing to o climate variation. The fatal disease like HIV/AIDS is present in Nigeria which is also a problem in adopting mitigating strategies against climate change. Agriculture technology infrastructure is demanding the need of the nation to face the challenge of the weather change (Aselm and Amusa, 2010).

However, estimation of the weather change effect on Nepalese agriculture shows that it has unstable effects. Six fifty-six farms were cross-sectional analyzed using the Ricardian approach. The result reveals that the change in the levels of precipitation and temperature mainly depends upon which season is prevailing in the country [Storchmann, K. *et al*., (2010)]& [SR Voleti *et al*., (2009)]. For instance, low rainfall during the winter and spring season coupled with high temperatures is beneficial to gain better farm revenues because these are the harvesting seasons in the country. Low temperatures and high precipitation help generate healthy farm revenues for the period of the summer era. Other socioeconomic variables have a different effect on net farm profits. Farmer's readily available credit and irrigation facilities have good incomes (Thapa and Joshi, 2010).

A research project carried out in Kenya showed most of the crop damages occurred due to elevated levels of temperature. Global Circulation Model (GCM) for Kenyan agriculture, expected that change in temperature of around 3.5°C to 4°C, and in precipitation, 20%t by 2100, will significantly affect the net farm incomes. The study used primary statistics for thorough investigations, the secondary data for climatic variables were also collected which constituted time series in nature [Gbetibouo *et al*., (2005)]& [Kurukulasuriya *et al*., (2007)]. These two types of datum were studied combine to analyze the climate change impact. Results revealed that upper summer temperature has a negative result on the net farm income while great winter temperature has an optimistic effect on the net farm incomes. However, the farmer in the country is conscious of both a long period and short period, changes in the climate. In this scenario, they have adopted several techniques to cope with this situation. One of the techniques used in the high probable zones i.e. varying the crop mix, while in drier regions/zones, water protection, irrigation, and shading/sheltering of crops are commonly in use (Marinara and Karana,2007).

Almost similar research that was conducted in Kenya was passed out to study the environmental change impact on West African crop yield in the future. The crop in this region is mostly rain-fed. Climate models predicted that the increase in temperature in this region is more severe than the change in the amount of precipitation thus posing threat to the production sector of crops [Knox *et al*., (2012)] & [Schlenker *et al*., (2010)]. Thus warming in the region is disturbing the crop growth cycle and causing an increase in the rate of vapor-transpiration which eventually causes water stressing in the crops. Projections are that increase in the rainfall pattern may offset the negative impacts of warming on the crops (Roudier e*t al.*2011).

(Willenbockel *et al*.,2011; and Di Falco *et al*., 2014) claimed the contradiction of this idea. Ethiopian agriculture has been affected by the economic and distributional effects of weather change impact. The weather change would distress the economic development of the country in many ways. It would slow down the crop production and cause losses in the yield which further slows down the economy of the country and hurt GDP. The decrease in production and output is likely to reduce Ethiopian GDP by 10 percent from its benchmark level. Similarly, the further impact of this would be seen on the scarcity and rough income distribution of prosperity among the citizens. Food poverty and fuel poverty is also a serious threat to the country after the effects of climate change (Mideksa, 2010).

Furthermore, development from an economic perspective to sustain in the changing weather change effects in Sub-Saharan Africa then other socioeconomic factors are also related to sustainable economic growth to pace with the international demand. Dryland farming mostly prevails in the Sub-Saharan Africa region is mostly which is at a greater risk owing to weather change Onoja (2014). The warming of the climate is also enhancing the carbon content in the atmosphere. The income popular in the region is highly needy on the agriculture produced. 14 percent in the GDP was contributed by the agriculture sector in the 2008 fiscal year for the SSA region. The farmer is facing difficulties in adapting mitigation techniques against climate variation [Adedeji *et al*., (2017)]. One of the core causes of this is the scarcity in the SSA region which causes less finance availability. Hence the productivity in the region is too low. Any deviation from the mean by climate variables can bring severe damage to the economies of this region (Hassan, 2010).

As stated earlier, the economies of developing countries have been devastatingly precious by the weather change. For Cameroon to have vision into the effects of weather change, the connection between climate and net income from the crops studied. Studies were conducted in more than eight hundred farms all over the country [Ajwad *et al*., (2007)], [Sanghi *et al*., 2008].

The revealed that climate is one of the dominant factors influencing the agriculture and allied practices in Cameroon. The result was alarming for the economy of the country with the focal point that reduces precipitation and a rise in temperature is depriving the farm owners of the net farm revenues. The trend was the same in all the eight hundred surveyed farms. They also found that the income variation in 2100 will range from -50 percent to +37 percent (Molua and Lambi, 2011).

Also the economic effect of weather change on the Zimbabwean agriculture area, a revision was done using the Ricardian approach to judge the said changes in the sector. The study revealed that weather variables, especially temperature and rainfall, have important in crop production. [Jain *et al*., (2007)] studied the effect of weather change on the dry property as well as on the irrigated land in the country. The result found that higher precipitation, the beneficial impact will on crop production. While an elevated level of temperature can regress crop production and also the net farm revenues. Small farm holders are more sensitive to the climate change scenario. Similarly, the irrigated land is more resistant to climate change than the dry land [Charles *et al*., 2014]. The farmers are using the adaptive techniques to cope with climate change impact including dry and early planting of crops, growing the verities with drought-tolerant ability, changing the planting dates of the crops, and using irrigation. These are methods of fighting are very much effective in having safe methods of agriculture production (Mano and Nhemachena, 2009).

Working on the effect of a climatic variable on Egyptian crop growing by using the Ricardian approach, a conclusion has been derived that the high temperatures will restrain the agriculture production in Egypt [Ouedraogo *et al*., (2006)], [Nhemachena *et al*., (2007)]. Warming will affect the water resources of the country as well. Thus it will pose a threat to crop production in another way too. The only way to have a sustainable yield production in the nation with elevated temperature in coming future in the efficient management of water resources and irrigation (Eid *et al*., 2007)

European agriculture and allied systems are also on the verge of climatic variability. The anthropogenic climate change studies carried on the climate of Europe during the past decade showed that the temperature of the continent is increasing with variety in the pattern of rainfall. Furthermore, the countries in the Pannonia zone of the continent, including Hungry, Serbia, Bulgaria, and Romania will undergo augmented heat surfs and lacks [Reidsma *et al*., (2010)], [Trnka *et al*., (2011)]. Overall climate change impacts across Europe are not positive. The cropping sector may face a delay in crop production especially in the case of cereal yields, which already showed decay in the scrap in recent years (Olesen *et al.,* 2011).

However, the effect of environmental change on the Australian agronomy sector is very much diversified due to the large of the country where several areas could get benefit while several like south-west zones are projected to be under the adverse impact of these changes. [Tyagi *et al*., (1984)] also concluded that the rural Australian farmer will have to face opposing climate variation effects in the coming two eras. In this changing scenario, the farmers are extra likely to spend more on the version strategies [Toan *et al*., (2010)]. So, weather variation will make it tough in deciding for investment in this sector for the farmer as well as for the large investors (Kingwell, *et al*., 2011).

Effect on rice production in Malaysia, due to the Difference in temperature and carbon dioxide it was investigated by the researcher. Pooled data were used for the analysis of crop production [Deressa *et al*., (2005)]. Climate and non-climate variables were used to examine the effect on rice by changes in temperature and carbon dioxide. [Benhin *et al*., (2008)] concluded that changes in temperature harmed rice production and economy face losses by the reduction in the rice yield. They recommended that the economy adopted mitigated policies to overcome the adverse effect of weather variations on rice production.

The agriculture sector was extremely dependent on natural resources such as water, land, rainfall, and weather, and agricultural production was disturbed as the variation in climate and which affected almost all the regions in the world's human. [Piyasiri *et al*., (2012)] used pooled cross-sectional data from major rice-producing areas in Sri Lanka. The responsiveness of rice production to average temperature and rainfall variation was analyzed by Monte Carlo simulations [Rathnayake *et al*., (2016)]. The result showed that the average temperature and rainfall both were the non-monotonic and concave effect on the rice production and variations increased in climate was a harmful effect on the production of rice. (Walisinghe *et al.,* 2017).

Climate change had the main impact on Nepal's agriculture area. Higher temperatures and rainfall scenario change directly affected yield production. The impact of weather variation on major crop production such as wheat, rice, and maize, barley, and potatoes was observed by

[Mehmood *et al*., (2013)] and [Ashenfelter *et al*., (2010)]. Depending on their sowing period, these yields were separated into two clusters, winter and summer season. In the summer season, the climatic variables were on the rise, while in the rainfall, minimum temperature and winter decreased. Increased summer precipitation and an optimistic impact on rice production was the extreme temperature (Joshi *et al*., 2011).

K. Bakhsh *et al.*, (2012) was designed to use aggregate time-series data to define the impact of change in temperature and precipitation on rice yields. To estimate impacts, the OLS method was used. The revision findings specify that variables of temperature and precipitation have a major impact on the crop of rice. Statistically significant is the average extreme temperature in September-October and July-August and the normal minimum temperature in July-August [Janjua *et al*., (2010)], [Poudel *et al*., (2014)]. Also, precipitation for the duration of September-October is associated with rice crop significantly and negatively.

Ostendorf *et al* (2017) had been intended to sympathetic the spatial variables impact of weather exchange on rice yields throughout Bangladesh for three ecotypes. The whole results revealed that the effect of weather variables on rice vegetation is ecotype-precise primarily based on past crop observation facts. (Rahman *et al*., 2015) confirmed that Amancrop may be the wickedest affected ecotype, as compared to the yields of Aus and Boro, through a destiny temperature boom. Among the 23 large districts, there is a vast spatial unpredictability of rice crop compassion to a 1 ° C rise in temperature. In most districts, the temperature has unfavorably affected outputs from Aus and Aman evaluate to universal fantastic temperature response from Borocrop. Certain this sympathy to local versions within the yield of rice, precise ecotype edition strategies in exceptional districts needs to be adopted urgently to combat destiny weather trade (Ghadikolaei *et al.,* 2011). Priority may be given to deprived districts where the yield of rice may be considerably decreased. Adaptation strategies include improved dissemination of weather records as well as the improvement and creation in those districts of new temperature-tolerant types (Talukder, 2011). However, there has been a need for non-stop tracking of the sizable use of recent varieties in distinctive districts. For this motive, adequate funding and involvement of the public-non-public quarter may be required over an enormous time frame. The spatially aggregated data from the time series used on this look at targeted in particular on weather variables alone. Because of a lack of information, the study did no longer bear in mind other sizable variables, which in the course of the look at length contributed to higher yields in many districts. Future research has to consequently recognition on climate exchange in addition to other variables on the way to imprison a far better depiction of local rice crops for Bangladesh-wide ecotypes.

The impact of climate change in Tegal Regency, Indonesia, on paddy field renovation vicinity and rice production. The studies changed into performed through the translation and classification of dependency image records as well as the evaluation of property location adjustments and rice invention. Support Vector Machine (SVM) has been used because the oversee technique of type observed through correlation trying out. The effects showed that the paddy subject place dropped from 39,365.3 to 36,629 ha in 2009-2015. While weather situations fluctuated in 2009-2015, rice manufacturing extended from 350,116 lots to 382,161 lots between 2009 and 2015. Changes in rice pasture region and weather limitation did not have an effect on the production of rice (Rainfall: r= zero.32, P>zero.05; Temperature: r=-0.05, P>zero.05; Humidity: r= 0.09, P>0.05, n= 7). To optimize and maintain rice invention in Tegal Regency, however, paddy area conversion and climate alternate need to be addressed. (NR Sutopo *et al.*, 2018).

Nigerian rice production turned into predominantly rain-fed and naturally liable to rainfall variability vagaries. The aim of this has a look at changed into to decide the possible outcome of precipitation unpredictability on Nigeria's common rice crop over a 22-yr (1992-2013) period. Using descriptive statistics and regression fashions, suggest annual precipitation facts from primary rice generate states and countrywide normal rice yields have been analyzed. [Ara *et al*., (2017)] analysis revealed an enormous deviation in mean annual precipitation across flowers grouping from the swamp forest to the Sudan savanna in descending order. Mean rainfall in all flower businesses was good enough for rice production besides Sudan savanna where rainfall became much less than the minimum rice production amount prescribed. Rainfall becomes associated with rice yield in all plant groupings besides Sudan savanna but dating at five percentage becomes no longer statistically significant. It was concluded that there was a statistically negligible impact of annual rainfall variability on the countrywide common yield of rice. Rice cultivation became recommended in conjunction with farming practices geared toward mitigating the adverse effects of rainfall variability on rice yield, in particular in the Sudanese savanna (Oladele Bakare *et al.*, 2015).

Understanding the character and volume of weather effects on agricultural productiveness below a selection of eventualities is extremely critical for growing nations, wherein a full-size part of the population depends on farming for existence and residing. This paper consequently presents proof of climatic impact heterogeneity on crop yield in Assam, India. Specifically, making use of the non-parametric quantile regression approach to district-stage facts from 1978 to 2005, this study tested heterogeneity in temperature and rainfall impacts across seasonal rice types (autumn, wintry weather, and summertime), agro-climatic (AC) zones, and rice yield distribution. [Goyari *et al*., (2017)] results counseled that the outcomes of temperature on the yield on any of the 3 seasonal rice sorts had been not statistically huge in trendy. However, the magnitudes, signs, and symptoms and statistical significance of those consequences across AC zones and the distribution of yields for each price range had been no longer uniform. Similarly, the outcomes of general precipitation throughout seasonal sorts, AC zones, and distribution of yields have numerous extensively. The consequences also advised that an increase in variability in temperature is useful and that variability in rainfall is dangerous to the yield of autumn and wintry weather rice [Bezbaruah *et al*., (2013)]. For summertime rice, there were advantageous but statistically insignificant results of these two weather variables. Given the significance of rice yield in Assam for food safety and poverty comfort, those results could inform the design of appropriate version strategies and public regulations to counter the adverse outcomes of whether exchange on Assam agriculture. Moreover, as most rural humans are engaged in agriculture, these results are important for the rural economy's sustainability (RajuMandal 2010).

The effect of temperature and precipitation on Zimbabwean farms ' farm net income, small-scale farming community, has been greatly affected. Net revenue decreased as temperature rises and started to rise as precipitation rises. Defining non-linear effects on net revenues was observed as a significant result [Jain *et al*., (2007)], [Ouedraogo *et al*., (2006)]. Irrigation is the most effective adaptation strategy to the severe temperature and rainfall shocks that provide the farming community with a pad in the summer season as well as dry spells (Reneth *et al.,* 2007).

Furthermore, the climate sensitivities were observed from Israel's relative warner climate. Instead of net income per hectare, net income was used. For temperature, a curved farm revenue function was detected but a curved in rainfall revenue function was observed by [Mendelsohn (2001)] and [Liu (2004)]. The whole result revealed that net income rises in the casual and dry region, but as temperature and precipitation rise to a convinced level, net income decreases (Fleischer, 2007).

American and Canadian farmers ' climate effects using the standard Ricardian model. The result was found to be significantly different for both countries due to different agricultural conditions prevailing. The dry land farms ' response was not the same as irrigated farms ' response by [Reinsborough *et al*., (2003)], [Lippert *et al*., (2009)]. Marginal studies have shown that when temperature increases, farms showed a decreasing trend. As the temperature rises, Canadian farms will be harmed more (Mendelsohn and Reinsbourgh, 2004).

Small SriLanka farmers ' landholdings are greatly affected by changing climatic conditions. Climate variables explained fourteen percent of the variation in net revenues, while variation reached thirty-four percent when adding some other communities and social characteristics [Mendelsohn *et al*., (2017)]. Benefits were estimated more when the temperature rises slightly and rainfall rises sharply [Seo *et al*., (2008)]. Losses were observed when medium temperature but a very slight increase in rainfall. In a few key moths, rainfall reduction occurred in production (Kulukulasuriya *et al*., 2016).

The Cameron economy's agriculture sector and it depends on climate factors. Global warming has been seen as the most important factor in declining productivity and vulnerability in agriculture. Agriculture was found to be limited in the availability of humidity in Cameron. Reduction in future rainfall and temperature rise was found to be both harmful and damaging, harming farms ' net income. Increased rainfall was found to be beneficial. Climate fluctuations are declining instruments of net productivity that ultimately result in loss of national income (Ernest *et al*., 2007).

Jeff Gow *et al.,* (2012 examined the relationship among the yield of three main rice plants(e.GBoro, Aus and Aman)and three most important climate variables(e.g., most temperature, minimum temperature, and rainfall) for Bangladesh. Time collection data at an aggregate stage for the duration 1972–2009 to evaluate the relationship among weather variables and rice yield using each the ordinary minimal squares and the techniques of median (quintile) regression.[Basak *et al*., (2010)] discovered that climate variable has had massive effects on rice yields, however, that those results differ between 3 rice plants. For all rice yields with high-quality effects on Aman and Aus rice and negative outcomes on boro rice, the maximum temperature is statistically huge. Least temperature has a statistically considerable bad impact on rice from Aman and an appreciably tremendous effect on rice from Boro. Finally, the impact of rainfall on Aman and Aus rice statistically great by [Amin *et al.*, (2015)]. However, the most temperature and minimal temperature impacts are extra said than rainfall impacts. Because of those temperature consequences on rice vegetation and increasing vulnerabilities to climate exchange, policymakers ought to fund research and development of temperature- tolerant rice varieties, in particular for Boro and Aman rice.

However, Glulam Hussain *et al.*, (2011) had been too tested the latest weather trade trend and expect future climate trade eventualities with Global Climate Models (GCMs) and, most importantly, to investigate the influences of weather alternate on rice production. The district of Satkhira changed into taken as the observed location representing Bangladesh's coastal quarter. There has been a statistically non-extensive developing trend of most and minimum annual temperatures and overall annual rainfall via the 1950-2006 length. The trend analysis of the 1981-2006 seasonal rainfall may want to reveal that the everyday seasonal rainfall pattern has modified because of the closing a long time. Rainfall had a lowering fashion inside the pre-monsoon and iciness seasons, whereas at some stage in the monsoon and post-monsoon seasons it had an increasing trend. Variations in temperature had a determining impact on crop yield. Summer crop notably reduced output. Boro rice manufacturing, a winter crop with the boom of the bottom minimal temperature, is growing appreciably by [Kumar, S. *et al.*, (2017)]. There changed into little inter-annual variation in the quantity of rainfall within the wintry weather season. Therefore, this variable had an insignificant effect on boro manufacturing. However, there was no statistically sizeable correlation between production and climate variables. On the occasion of the destiny prediction of whether exchange.

Agricultural production performed a critical function in weather alternate. A variety of factors that affect agricultural productiveness, with rainfall, temperature. This broadsheet tested that the connection among the yield of predominant rice plants (e.g., Kharif and Rabi) and three primary weather variables (e.g., maximum temperature, minimum temperature, and rainfall). Based at the Vector Auto Regression (VAR) model, the dynamic relations among the variables careful to examine the effect of climate change on rice yields are examined the use of Granger connection test, impulse reply functions, and information variance decay by [Khuda, B *et al.*,2006]. Maximum and minimal temperature have considerable effects, while rainfall has bad consequences on the yield of Kharif rice. Maximum temperature and rainfall are located to have damaging consequences on the yield of Rabi rice, whereas minimal temperature has a high-quality effect on yield (FarooqJawahar and K. SenthamaraiKannan 2015).

Govinda Bhandari (2014) studied the impact of rainfall and temperature deviation on main cereal yields (e.g. maize, wheat, rice, and barley millet) in Nepal's Dadeldhura district. They used yield and seasonal meteorological data (e.g., precipitation and temperature) time-series information to evaluate the effect of using exponential growth regression techniques. The results of this study definite that rice and maize yields were adversely affected by extreme temperature and least precipitation. The temperature was statistically significant for the yield of all cereals whereas for the yield of maize and barley precipitation is statistically significant. Finally, the influence of precipitation and temperature on rice and maize crop is statistically significant by [Kundu, D. K *et al*., (2018)]. The influence of maximum temperature and minimum precipitation, however, played an important role in Nepal's growth of major cereals. During crop growing seasons, low precipitation and high temperature severely precious the yield of major cereals in the district of Dadeldhura. 1979, 1980, 1982, and 1987 were the main years of drought in agriculture in the Dadeldhura district of the far-western region of Nepal.

Khaled Ali Ahmed Ben Youssef *et al.*, (2004) were estimated possessions of temperature and rainfall changes on the yield of paddy rice in Peninsular Malaysia's three granary areas. Higher maximum and minimum temperature above the optimum temperature level for the production of paddy rice resulted in lower yield. However, the comparative rise in minimum temperature has a serious adverse effect on the yields of MR219 compared to the fluctuations in extreme temperature. Changes in rainfall also have different implications for grain yield, but not as Assessing Temperature and Rainfall Sensitivity to Paddy Rice Yield... deeply as the effect of temperature changes. The decrease in rainfall in MADA during the main season showed a marginal effect as opposed to rainfall increase, which has a more devastating effect. Rainfall changed in IADA rice-growing areas generally have a deeper influence on the grain.

[Dhakal *et al*., (2016)] and [Haque *et al*., (2014)] claimed the contradiction of this idea. The impact of weather exchange on rice vegetation in rice developing areas dedication relies upon real configurations of climate trade elements. Owing to spikelet infertility and better breathing losses, collectively better intense and least temperature can decrease rice vegetation. At the equal time, rice invention may be threatened in a few mainly susceptible regions, along with those tormented by sea-degree upward push, drought, cyclone, and many others. Now not considered in this study. Whole, there was nevertheless a top-notch deal of uncertainty about the proper course of carbon dioxide and temperature effects on rice crops. In this study, the DSSAT model became carried out to assess the capacity results of weather alternate on Boro rice crop in Bangladesh as Boro rice became one of the principal meal grains contributing over fifty-eight percent of general rice invention in 2008. Crop growth and yield are at once linked to photosynthesis and phenology quotes and their reaction to temperature, solar radiation, and rainfall. Under Bangladesh's climate situations, top-quality temperatures for extreme photosynthesis range from 250 C to 300 C for rice. Results of the simulations advised that most and minimum temperatures may have an effect on rice crop extensively, and this impact can also emerge as greater mentioned if temperatures upward push at forty C. Analysis of sensitivity suggests that the crop version is CO_2 touchy and has a superb impact on the yield of rice. While higher ranges of CO_2 within the future could to some extent balance the detrimental outcomes of higher temperatures, the scenario would no longer be able to compensate them. The version imitations also cautioned that adjustments inside the sample of rainfall can also adversely affect rice production (Jayanta Kumar Basak 2012).

Panomsak Promburom *et al.,* (2015) had been conducted to evaluate the impact of seasonal climate variability on rice invention in Nam Dong District, Vietnam's Central Highland. Trendy two changed developing seasons, the Ordinary Least Square method turned into used to inaugurate the relationships among climatic factors and rice yield. [Pokhrel *et al*., (2011)] concluded that climatic factors were the most average temperature, minimal common temperature (average minimum temperature), and average rainfall (common). The seasons of rice growth are referred to as Winter spring (WS) and Summer-Autumn (SA). During these two developing seasons, records on climate factors and rice yield were gathered over 27 years from the District Meteorological Location and District Statistical Office. The statistics used ranged from 1986 to 2012 (Pant *et al*., (2012). Local rice farmers additionally had a focus group discussion. During this dialogue, the facts collected became treated the usage of the timeline fashion, which is a device for the participatory rural method (PRA).

The consequences of weather change on yield manufacturing and food refuge have been direct and oblique. Agriculture and crop manufacturing became one of the factors that depended on climate conditions and in many respects, it provided the human necessities. This look at aims to assess the impact of destiny climate alternate on irrigated rice yield the usage of the CERES-Rice model inside the Caspian Sea's Southern Coast under three Mrs1b, Sra2 and Srb1 weather alternate situations. Soil, meteorological, and crop management statistics compulsory for these studies are included. Meteorological data covered daily solar radiation, most temperature, minimum temperature, and precipitation facts from 1981-2010 in addition to worldwide climate models (INCM3, HADCM3, IPCM4, NCCCSM, ECHAM5, and GFCCM2) from 1971-2000 [Lamsal *et al*., (2013)]. Data from the sphere experiment on soil and product management were confirmed at the Rice Research Institute in Rasht from 2008 to 2009. Validating Global Climate Models showed that the ECHAM5 climate model has the highest correlation to simulate future precipitation and temperature with the bottom blunders. [Siavash *et al*.,1999] to simulate the effects of weather trade on rice protection used the ECHAM5 climate model coupled with a crop growth model. The consequences of climate trade prediction situations confirmed that the least and severe temperatures might be upward push and rainfall within the Rasht station can be decreased. Results of simulated rice crop yield and biomass primarily based on Mrs1b, Srb1 and Sra2 eventualities showed that rice crop yield and biomass are reducing as suggest temperature increases and precipitation decreases (F. Rabbani *et al.,* 2015)

Also, rice is Bangladesh's main food for about 158 million people, but growing vulnerabilities to weather change and worldwide warming were strictly reducing the yields of various rice yields and may threaten the country's food security. This revision was therefore assumed to investigate the probable effect of weather change on the crop of three altered rice yields in Bangladesh (i.e., Boro, Aus, and Aman). Based on country-level period sequence data for the era 1972-2014, a multiple regression analysis using the OLS technique is used to estimate the climate yield interrelations. Outcomes found that over the period under study, all-weather variables have had a major impact on rice yield, but these impacts vary between three different rice yields. Also found reveal that the extreme temperature is statistically significant and the crop of all three rice crops is negatively affected. Minimum temperature, on the other hand, was highly significant and only has a positive impact on Boro rice yield. Also, for all rice crops with optimistic effected on Aus and Aman rice and adversely affected on Boro, rainfall is found to be significant. However, humidity affected the yield of all three rice crops statistically significantly Wei, H *et al.,* (2012). However, the influence of extreme rainfall and temperature on rice yield in

Bangladesh was more prominent than that of minimum temperature and humidity. Also found highlight the importance of temperature-tolerant rice varieties adaptation and suggested that sustainable agricultural development may play a vital role in mitigating adverse effects of climate change (IftikharUddin Ahmed Chowdhury and Mohammad AbulEarshad Khan 2015).

Hassan *et al*., (2011) described the Ricardian method to test the relative importance of normal climatic conditions (precipitation and average long-term temperature) to explain Nigerian rice farming net income under irrigation and dry soil conditions. A survey of twelve hundred rice farmers from twenty rice-producing states in Nigeria was conducted. The conditions enclosed the country's six geopolitical zones. Maddison *et al*., (2007) results indicated that temperature increases will lower net income for parched land rice farms while gross income increases with temperature increases for watered rice farms. Rainfall had a similar impact on net income from rice. Increased precipitation will lead to a decrease in income for dry land rice farms, while it will lead to increased income for watered ranches. [Nhemachena *et al*., (2008)] outcomes clearly show irrigation as a major technique recycled by farmers to familiarize themselves to weather variation. Other options for adaptation include animal husbandry, off-farm work, and the use of various market channels.

Furthermore, weather is unique among the key reasons for causal agriculture yield in the area in its spatial and temporal inconsistency. Climate effects should be reserved in mind as longstanding agricultural strategies are developed. This study determined to investigate the 1989-2009 variation in rice invention in Pakistan using GIS methods then the effects of weather variation on rice invention. Pakistan is very gorgeous in rice invention and exporting rice earns a lot of foreign exchange. The results indicated that rice invention in all four provinces of Pakistan increased in Pakistan. The maximum ratio rise in Punjab has been observed. Though, when the nation tackled a scarcity later in 2000, KPK and Sindh's invention decreased, which in the following years again reached its increasing level. The association of weather variables with variables of rice productivity indicated an important relationship and the investigation of regression exposed that the high smooth of alteration in rice productivity could be clarified by the climate parameters being studied by [Nwambuonwo *et al*.,2008]. This feature might be related to some other conceivable best decisions to raise the productivity of rice to a higher smooth to ensure sustainable productivity of rice (Naveen Fatima and RabiaShabbir 2013).

The rise in temperature is unique to the climate variation issues that has the impact of rice productivity in Indonesia, particularly on plant improvement and growth. [Agho *et al*., (2007)] study used the Sherry Rice technique with Geographic Info System to evaluate the decline in rice invention in each Indonesian province built on some temperature rise situations. The technique used Sherry Rice to estimate the productivity of rice and the Sherry climate to predict the climate on the location built on the normal climate situation. Research results showed that rising temperatures would shorten the age of rice and reduce rice crops. This study piercing out that irrigated farming has less effect from the increase in temperature compared to rain-fed farming, which has decreased rice yield sequentially by 11.1%/OC and 14.4%/OC (TaufiqYuliawana and I. Handoko., 2016).

However the effect of climate variation on China's rice production remains very uncertain owing to climate change scenarios worries, biophysical process parameterizations, and exciting temperature worry in yield models. The model for capturing the crop-weather correlation over a large area (MCWLA)-Rice crop technique has been developed here by parameterizing the process-based general crop model for rice yield MCWLA. To examine reservations in parameter estimates and elevate parameters, Bayesian probability inversion and Markov chain Monte Carlo method were then applied to MCWLA-Rice. Collaborative hindcasts presented that MCWLA-Rice was able to imprisonment fairly well, especially over a large zone the internal variability of the detruded historical yield series [Lee *et al*., (2013)]. A super-ensemble-base probabilistic projection system (SuperEPPS) coupled with MCWLA-Rice was developed and applied in the context of future climate change scenarios to project the probabilistic changes in rice productivity and water use in eastern China. Results showed that rice yield in most cells in the study region would change by an average of 7.5 percent –17.5 percent (from 210.4 percent to 3.0 percent), 0.0 percent-25.0 percent (from 226.7 percent to 2.1 percent), and 210.0 percent to 25.0 percent (from 239.2 percent to 26.4 percent) over the 2020s, 2050s, and 2080s, respectively. The rate, biomass, and yield of rice photosynthesis would increase as a result of an increase in mean temperature, solar radiation, and CO2 concentration, although the rate of rice development could accelerate especially after the heading stage. Mean there would also be a significant increase in the risk of high-temperature stress on rice productivity with climate change. The effects of extreme temperature stress on rice productivity were parameterized explicitly and address in the study(Zhang., 2012).

(Michael Raphael Baha *et al.*,2018) used a Ricardian exemplary to estimate the effect on gross rice income per hectare of weather, biophysical, and socioeconomic variables. The effects of weather variation have been estimated with and/or without adaptations. Multiple direct and log-linear regression models were used to evaluate the Ricardian model used in this study. Hotness was found to have more negative effects on rice net income compared to precipitation among climate variables. Annual temperature and precipitation were found to have U-shaped and hill-shaped response functions with rice net income per hectare respectively for the climate change impacts without adaptation. But temperature and precipitation during the dry season were found to have hill-shaped response functions with net rice revenue per hectare, while temperature and precipitation during the wet season had U-shaped response functions. Even when the adaptations were taken into account, the temperature remained more effective in reducing rice net income per hectare. In this case, annual and wet-season temperatures had U-shaped relationships with net income of rice per hectare, while dry period temperature, dry season precipitation, and wet season precipitation had hill-shaped response functions with net income of rice per hectare [Olaniran *et al*., (2010)]. Annual and wet season hotness has been found to have negative marginal effects on rice net income, while dry season temperature and precipitation, annual precipitation, and wet seasonal precipitation have had positive marginal impacts. Ogbeibu *et al.*, (2007) expected effects of climate variation on net revenue from rice showed that annual and wet seasonal temperatures will have negative effects, while annual, dry seasonal and wet seasonal precipitations and dry seasonal temperatures will have positive effects by 2050. It was recommended that access to irrigation be increased to alleviate the impact of climate variation on rice net income.

Mahmood Laghar *et al.*, (2016) was showed to observe the impact on rice crop cultivation in Nanjing of different weather parameters. The rice crop was also grown at two different timings during this study, i.e. June 22nd and July 10th during 2010 and 2011 at Nanjing's Jampoo farm, respectively. Seven different treatments were tested during these experiments with the only variation in water quantity application, while all other parameters of input were kept constant. In the end, yields were compared with the same type of treatments to observe the impact of timing of cultivation [Jogi *et al*.,2002]. At the same time, climate data from 1987-2007 were also analyzed to observe the impact of hrs. Of temperature, humidity, rainfall, wind velocity, and sunshine. It was observed that the crop is grown on June 22, 2010, resulted in an increase in production of 25.28 percent compared to July 10, 2011. At the same time, the temperature variation also shows that the 2nd week of May is suitable for nursery growth or targeted rice sowing, so the 2nd week of June is best for transplantation.

Furthermore, Scientific evidence on predictability in precipitation and temperature with significant impacts on rice crop is stronger than ever formerly. In most parts of Nigeria, rice, a cereal crop that can be upland or low land type, serves as a staple food. This revision evaluated the effect of weather variability on rice crops in Nigeria's southwestern states. The Federal Ministry of Agriculture, Abuja, collected data on rainfall, temperature, and rice yield (1991–2007) in the six states of southwestern Nigeria and analyzed it using ArcGIS 9.2 version. Geospatial deviation maps showing precipitation, temperature, and rice crops in the study were generated to assess the precipitation and temperature correlation on rice crops in the southwestern part of Nigeria by [Ilunga (2019)]. The interpolation of Kriging and other techniques of the geospatial investigation were used to evaluate and map spatiotemporal e values. The time series of rice yields were interrelated with the time series of precipitation and temperature for each state. To reduce the prediction of rice yields on temperature and rainfall variability, linear regression analysis was conducted Ayanlade *et al*., (2007). Rice yield correlation with rising seasonal precipitation resulted in a maximum of 0.403 (Ogun, Lagos, Ekiti, and Ondo) and the lowest of-0.215 (Oyo). Meanwhile, rice yield correlation with growing seasonal temperature gave 0.453 (Ogun and Oyo) peak and-0.012 (Ondo and Ekiti) peak. Rice yield and rainfall ratio range from y= 0.007*x + 0.13 to y= 0.018*x -0.8714, while rice yield and temperature ratio range from y= 0.5*x to 12.52 and y= 0.7*x -18.6. Rice farmers can make better rice farming plans despite varying weather. The database of Geographic Information Systems (GIS) formed and maps prevented in the revision region can be used by policymakers and mitigation of weather variation (OlumuyiwaIdowuOjo *et al.*, 2016).

2.4. Review of Studies: Case of Pakistan

Uzma, *et al.* (2010) in this paper it was found that the minimum temperature of Kharif is a significant positive relationship with the price of land. With the prices of land, the mean extreme temperature of Kharif is not substantial. As regards precipitation, it was found that in the Kharif season, a rise of one mm in rainfall will raise the land value on average through Pak Rs

166,577 per acre. (Peng *et al.*, 2004).1 percent increase in the minimum rice production temperature by about 10 percent.

Temperature rise and rainfall adversely affected Pakistan's crops. By applying cross-sectional data and time-series data, Shakoor and their fellows investigated the effect of weather variations on the agricultural area in the arid region. The Ricardianmethod was used to check the association between gross form income and weather through the arid area. High temperatures harmed crops, as income increases in rainfall. In the arid region, an insignificant temperature exceeded the significant effect of rainfall. New farming techniques in which new methods of irrigation and new yield farming methods and revised crop patterns would be the appropriate results of the paradigm shift required in Pakistan's arid agricultural sector (Shakoor *et al.,* 2011)

The researchers suggested that temperature had an important effect on the production of Basmati and as well as coarse rice. The effect of change in climate differs in greatness and way across the growing phases of production. The huge rainfall normally played an important role in the increase in the production of rice. The high temperature and rainfall during the second stage reduce in the production of Basmati rice but the other two stages these significant effects on the production of Basmati. (Munir, *et.al.* (2011)

Initially, Rehana, *et.al.(*2012) found a temperature rise to be helpful for rice manufacture. Though, a further increase in high temperature becomes dangerous for rice invention outside a certain optimal temperature. Interestingly, precipitation increases do not harm the productivity of rice.

The impact on major agriculture crops by changes in the climate were studied by using panel data for the period 1980 to 2008 of districts of Punjab. The four major crops were sugarcane, Wheat, rice, and cotton. Researchers examine first, the effect of technical info ‘son the segments of growth of all yield in instruction to estimate the effect of weather variations on every stage of the yields. This info was gained from Pakistan Agriculture Research Council, Rice Research Institute, and Cotton Research Institute. Found that increase in temperature affected wheat production in the short run but in the long run, the high temperature had an optimistic effect on the invention of wheat. For rice productivity, the high temperature had a positive effect on early-stage but the more risen temperature was dangerous for rice invention and cotton and sugarcane were also affected by changes in temperature in long run (Siddiqui *et al.,* 2012).

By more frequent and intense droughts and rising temperatures in Bangladesh, weather variation was predictable to rise food demands. Researchers investigated the outcome of variability in climate variation on the future production of rice. They checked the combined effects on rice production of major climatic parameters. They used the model of biophysical simulation to inspect the belongings of weather variation on popular winter rice cultivation in Bangladesh. The situation was found that the average rice yields for 2046–2065 and 2081–2100 were reduced by 33 percent. Projected rainfall patterns and distribution will harm invention in the future, and the model will also show that less damage will result from the projected climate transplantation. (Muhammad R., 2012)

Climate change was caused by different economic externalities and it was a great impact on agriculture production. Pakistan was producing a huge quantity of rice and exports it to foreigners. The researcher investigated rice productivity and climate variation impact on yield in Pakistan by using GIS approaches. To examine the temporal analysis of rice invention and climatic trends from the period 1998 to 2009 was selected. Results found that production was increased in all provinces but Punjab had more production of rice than others. However, in 2000 Khyber Pakhtunkhwa and Sindh, production of rice was decreased due to drought and foreign earnings were also decreased. To found a correlation between climatic data and rice yield, the correlations well as regression analyses were both used to examine the data and also revealed that the contribution of a percentage of the variables in crop yield. Results of the studies showed the relationship of variables with rice invention had important relation and high level of variance explained by climatic parameters of rice production by regression analysis. (Fatima and Shabbir. 2012)

The researcher found that an increase in extreme temperature during the ripening stage will lead to a rise in rice crop, this will awake to a serious verge of 29.9°C. Rice yield declines if maximum hotness was beyond this inception. Thus, it was expected that rice invention was already being negatively precious by increases in the daily maximum temperature. (Karn2014)..

For analysis, Hassan and Sofia (2015) used secondary rice crop production data from seven Punjab districts. These districts were Lahore, Sialkot, Jhelum, Faisalabad, Multan, and Sargodha, selected based on high rice invention and found that hotness has an optimistic outcome on rice invention but later the optimal fat it is dangerous. At any stage of production, rainfall does not affect rice production.

This study revealed that using panel data of seven districts, researchers analyze the effect on rice production when the climate was changed in Punjab, Pakistan. For the analysis, the Fixed Effect Model was used. Their findings showed that temperature had significant for the production of rice but at their optimum levels it was harmful to the production and rainfall was not affected any phase of rice invention in Punjab. (Raza and Anwer., 2015)

Change in climate had affected the agriculture crops almost all over the world and due to that decreased production in major crops of Pakistan. Researchers applied a vector autoregression technique to examine the effect of weather variation on the production of rice. Results showed that high temperature was harmful for the production of rice and the least temperature leads to the best for the production. Mean temperature and increase in rainfall, in the long run, will affect negatively on future production of rice. (Shakoor *et al.*,2015)

Climate change was a worldwide environmental issue especially an impact on the agriculture area. Pakistan had handled risky weather threats like heavy rainfall and floods affected major crops. This study revealed the effect of high and low temperature, humidity, heavy rainfall on crops rice, wheat, sugarcane and maize of Pakistan. Researchers used possible generalized least square, heteroclites, an autocorrelation method. The time-series data used from the period of 1989 to2015. The outcome of this revision was that extreme hotness was important for wheat production while rainfall and humidity were insignificant. Least temperature was positive and significant for rice, maize, and sugarcane production. Overall, changes in climate harmed the crops (Ali., *et al* 2017).

Climate Change Affecting Other Sectors

The opposing consequences of climate variation on the various sectors of economy, environment, and society have been studied by researchers around the globe. A report of Bank of Asian Development (2009) highlighted the fact that the climate variation in treating crop production, eventually the food and other livelihoods of the masses in habituating the Asian and Pacific regions. 2.2 billion Population in the region is straight o circuitously dependent on the agriculture sector. The portion of agriculture to GDP decreasing throughout the countries of the region. So the countries in the region which are already combating poverty are additionally vulnerable to climate variation as their population is highly dependent on this area.

In Germany, the increase in temperature and lower the spring precipitation increase the land rents, thereby showing a negative relationship between the land rent and spring precipitation. When studied the relationship between land rent and climatic variables. However, for East Germany, there is a positive relation between spring precipitation and land rents. Projection of the country in climate change scenario will be a moderate change in climatic variables with 1.44°C and a 44 mm rise in temperature and precipitation respectively will rise the land rents about 600 million Euros (Lippert *et al.,* 2009).

The developed and developing countries must undergo substantial changes in their production process/procedure by 2050 to cope with the decreasing land and water resources. The climate variation impact on trade-in agriculture. Besides these two resources, the phenomenon of climate change is also manipulating its impact on yield growth. It has been proposed that developing countries of the world that import food items will face malnutrition as trade will not help them to get more food due to a shortage of food for the food-exporting countries themselves (Huang *et al.,* 2011).

Climate variation will have a more adverse effect than on any other country if the exports and international trade are considered. According to the researchers, climate variation in profitable to posture thoughtful threat to worldwide agriculture possessions like sugarcane, beef, dairy, and wheat. The projected decrease in these possessions is estimated to be 2-6 percent by 2030 and 5-11 percent by 2050. Same in the case for Australian agriculture where the threat to have decreased in these possessions are likely to be 9-10 percent by 2030 and 13-19 percent by 2050. To sustain the competition in the international market, the government should direct its policies on adaptation strategies, and investment of more on research to maintain steady growth in this sector is required (Gunasekera *et al.,* 2007).

Mitigating Climate Variation

Studying the outcome of climate variation impacts on the North American farms in the coming future, the researcher examined several ways for the mitigation from the effect of climate variation. Increasing the production scale of crops is one of the ways to handle the change. Growing the production scale of the crops is one of the ways to cope with change. Furthermore, it is an important duty of government institutions to design an easily understandable policy framework. This way people can adapt themselves with the changing climate scenarios (Easterling, 2005).

The adaptive techniques to alleviate the impact of climate variation on the maize crop in north China plains revealed that the adaptation techniques could vary in different regions differently. One of the suggestions by the authors in the study was provided that, to grow heat resistive changes and also the varieties which have great thermal requirements so warming and increase in the level of temperature which is expected to occur in the recent future, could be mitigated. The adaptive measures can contribute significantly to coping through the harmful impact of climate variation. Similarly, the late planting of the crop is also an effective measure of adaptation (Tao and Zhang, 2013).

Conclusion of Literature

Earlier studies on the impact of climate change on agriculture emphasized developed countries' agriculture which indicated they are not affected adversely. Very few studies of developing countries' agriculture have increased recently. The results, however, are not homogeneous because of different agricultural systems, geographical characteristics, and technological states. Moreover, most of these early studies have assumed little or no adaptation and focused merely on the likely impact of climate change on agriculture. Previous studies using time series data have not focused on rice. Moreover. the results from those studies were not robust because of insufficient statistical and diagnostic tests. Previous studies using cross-sectional time series are very limited and have not been done for different rice crops. In the case of Pakistan. there are some simulation studies but this study is using only one crop.

CHAPTER 3

An Overview of the Economy of Pakistan and the effect of climate Variation on Agriculture

3.1. Pakistan Economy

Agriculture has unique of the world's oldest economic activities. It is the spine of supplying food granule to the workforce and providing the industries with raw material. Pakistan is a country of agriculture. The agricultural zone of Pakistan shows a central part in the economy as it contributes eighteen point nine percent to Gross Domestic Product and absorbs 42.3 percent of the labor force (Economics Survey of Pakistan 2017-2018). Pakistan ranks 28th along with those countries that are detrimental to climate variation. Agriculture is highly dependent on the conditions of climate. Many climate variables include temperature variation, variation in precipitation patterns, and changes in sowing and harvesting dates, affect agricultural productivity.

Pakistan's economy is largely dependent on the farming and farm animals sector. Approximately sixty percent export of Pakistan depends on this area and approximately forty-three percent of its agricultural zone employees. Pakistan's population is steadily rising, thus providing them with adequate food without damaging the fragile ecosystem is a major problem. Climate change has affected crop productivity and also harms livestock health that creates the country's food safety issue. Cyclones, draught, and Floods, etc. also reduced yield productivity and created a scarcity of goods related to agriculture. (Climate Change Task Force, 2010).

In Pakistan, there is two yield period the Rabi and Kharif. Bajra, Rice, Jowar, cotton, and sugarcane are the yield of Kharif while Barley, tobacco, Gram, Mustard, and Wheat are the yield of Rabi.

The agricultural zone shows an important part of the economy of Pakistan. Its influence on GDP is twenty-one percent and Pakistan's second-largest economy zone. Approximately 62 percent of rural populations live in rural areas. For their livelihood, they are directly or indirectly related to agriculture. On the one side, it arranges for the industry with raw material, on the other side it provides agriculture sector is a huge market for industrial products

Table 3.1.1: Agriculture Growth Performance

Years	Percent
1960	5.1
1970	2.4
1980	5.4
1990	4.4
2000	3.2

Source: Federal Bureau of Statistics 3.1.1

Despite its precarious important, the growth of this area decrease the last few periods which shows in Table 3.1.1

The table shows a better picture of Pakistan's agricultural growth. Growth was 5.1 percent in the 1960s. That was high in the 1980s but then it started to decrease and in the 2000s it was 3.2 percent. The table displays that agricultural growth has declined over the last three decades.

Table 3.1.2: Area, Production, and Crop of Rice

Year	Area		Production		Yield	
	(Hec.)	Percentage	(Tones)	Percentage	(Kgs/Hec)	Percentage
2012-13	2309	-	5536	-	2398	-
2013-14	2789	20.8	6798	22.8	2437	1.6
2014-15	2891	3.7	7003	3.0	2422	-0.6
2015-16	2739	-5.3	6801	-2.9	2483	2.5
2016-17	2724	-0.6	6849	0.7	2514	1.2

Source: Federal Bureau of Statistics 3.1.2

In agriculture, rice represents three percent of the value-added and 0.6 percent of Gross Domestic Product. Rice yield was spread over a part of 2724 thousand hectares during 2016-

17, viewing a reduction of 0.6 percent over the past few years of 2793 thousand hectares. Rice productivity situate at 6849 thousand tons reaching its embattled productivity of 6838 thousand tons and viewing a rise of 0.7 percent over the corresponding period of 6801 thousand tons production of last year. Due to the refuse in domestic rice prices which decrease the part under the yield, the rice area reduces and growers shifted to sugarcane and maize.

Various socio-economic and biophysical situations are uncontrolled in the rural area of the province of Punjab, where agricultural goods were produced. Punjab is Pakistan's second-largest province with a land area of 20.63 million hectares. Approximately 12.51 million hectares are 67% of that area on refined land.

Climate variation has to raise severe concerns for rising countries. The position of Pakistan as a rising country depends on the area of agriculture. 65% of native exchanges are received from exports of goods produced from agricultural raw materials. The two-thirds population of Pakistan lives in a rural area and is reliant on agriculture (Pakistan Economic Survey, 2015-16).

There has been an increase in warming in the entire continent of Asia. According to the forecast, in this region, the temperature increase is predicted to be higher compared to the rest of the world. In the wet seasons, heavy rainfall was expected to result in deep floods. These climate variations have reduced the production of agriculture and thus compact economic growth (ADB 2009).

Variation in climate become a serious risk to the crop industry. The temperature and precipitation change affects the crop directly. (Usman *et al.*, 2011)found the temperature to have a negative and important impact on agricultural productivity. They found that the temperature rise of 1 percent caused by Rs.4180 reduces annually by net income. Increasing GHGs will vary farming in low developing countries in comparison with rising countries (Kurukulasuriya *et al.*,2006; (Mendelsohn and Seo, 2008). Weather variation could not have a huge impact, but there is a broader regional impact. Some region will benefit from weather variation while some area is going to be strictly affected. Weather variation will only affect agricultural commodities productivity. (Drennen and Kaiser, 1993).

3.2. Effect of Climate Variation on Agriculture

Weather alternate is probable to adversely have an effect on the productive sources of the country and in the long run the rural productivity of us of a. The fundamental climatic stresses to positioned pressure on farming are growing temperatures in arable areas; adjustments in rainfall styles (turning into irregular and excessive); elevated monsoon variability; adjustments in water availability; intense water-burdened conditions in arid and semi-arid regions; excessive occasions including droughts, floods, warmth waves, cyclones, cold waves, and so forth. Small landowners representing more than 80% of the whole farming network are the most inclined communities in Pakistan to climate change. Farmers in arid and hyper-arid areas in addition to those in mountain and coastal regions are more vulnerable to climate exchange and intense activities. The effects of weather change on agriculture encompass: shortening Growing Season Length (GSL), warmness stress at crucial reproductive degrees, and growing call for crop water. These factors lessen yields using round 6-18% in arid and semi-arid areas.

3.2.1. Climate Variation and Agricultural Challenges in Pakistan

Pakistan has been one of those few developing countries who always suffered from problems brought by the developed nations. For instance, the current issue of climate variation is the main reason by the world's highly industrialized nations due to massive emission of greenhouse gasses (GHG) and Pakistan despite having a trivial count (0.72%) in greenhouse gasses emission is ranked among the highly susceptible countries under the threat of climate variation. According to the 2018 Global Climate threat Index report by Germanwatch, Pakistan fall between the 10 most-affected countries due to climate variation. During the last few decades, the planet has experienced a series of changes in the environments such as alterations in temperature, increasing frequency of droughts, floods, and changes in rain patterns. These variations in the climate are owing to the enhance of greenhouse gases (GHG) in the environment produced by human activities. Currently, more than 500 climate-induced disastrous events are happening each year around the globe which was reported to be only 125 in 1980. Climate modeling reported a rise in temperature between 0.5 to 2 degrees Celsius and between 1 to 7 degrees Celsius by 2030 and 2070 respectively which harms a different division of the economy including agriculture. Agriculture is one of the most climate-sensitive areas because extreme events and changes in weather pervasively affect crop production. During the past few years, variations in the environment have negatively affected the agriculture sector as the yield of major cereal crops has been significantly reduced by the sudden rise in temperature, irregular precipitation, and extreme droughts. It is detailed that a rise of 1 degree Centigrade in the hotness reduced the wheat production by way of 5-7%. This is an alarming situation for food security in the current scenario of a high growing population and countries in South Asia are likely to be more affected because of their high population and agro-based economies. Affording to the intergovernmental panel on weather variation and World Bank, South Asian countries particularly Pakistan, Bangladesh, and India are predicted to be highly affected due to the increase in temperature which will reduce the cereals production 4-10% by 2100. These challenges are much severe for developing countries like Pakistan which is already struggling to ensure food security and is fighting against poverty. Pakistan having an arid climate and being an agro-based economy fall amongst those vulnerable countries which are at high risk of climate variation. In the last two decades, there has been a significant rise in the incidence and strength of catastrophic climate incidents in the country which placed the people at high risk of calamities such as storms, extreme floods, droughts, changes in precipitation and disastrous nature of rainfall.

In Pakistan, all sectors of agriculture particularly crop production has been significantly affected due to the persistent incidence of these severe climate events and variations in the environmental pattern. Recently, Pakistan has experienced several severe climate events such as disastrous floods of 2010, 2011, 2012, and 2014 and a period of extreme droughts between 1990 and 2003. If considering the economic loss, damage of two million hectares of un-harvest yields in the flood of 2010 caused a loss of more than 10 billion USD to the poor economy of the country. These calamities are predictable to more rise in the prospect as according to IPCC, Pakistan is to experience a further reduction in the yield of the cereal crop. These effects are very critical for Pakistan where agriculture is the back of the economy as it contributes regarding 2 percent in the national GDP and offers employment to 43 percent of the country's workforce. Other than 60 percent of the population live in a rural area which majorly relies on agriculture. In this scenario, agriculture must be placed as the priority to make the sector resilient against climate change through certain adjustments or adaptation strategies in the farming systems. Version to climate variation is the way to reduce or avoid the negative effects of environmental changes at the farm stage in the form of changing yield variety, altering irrigation and changes in soil management practices. Although climate-induced losses in production are a threat to agriculture through the suitable adaptation policy these impacts could be reduced and even avoided. But the dilemma is that in Pakistan the adaptation capacity of the agricultural system is very poor due to the absence of basic policy and infrastructure. Pakistan has no agricultural adaptation policy against the changing climate.

CHAPTER 4

RESEARCH METHODOLOGY

4.1. Theoretical Model

This study is based on the Ricardian method to assess the economic impacts of climatic changes. The method was named after David Ricardo (1772 – 1823) because of his original observation that land value would reflect its net productivity. The Ricardian method is a cross-sectional model apply to agricultural production. It explains how variations in climate change affect net revenue or productivity (Hassan *et al 2010*). Greenhouse gas emissions from human activities are responsible for climate change (IPCC 2007; Li *et al.* 2011). Climate change leads to increased temperatures, changing rainfall patterns and amounts, and a higher frequency and intensity of extreme climate events such as floods, cyclones, droughts, and heatwaves (IPCC 2007; Tirado *et al.* 2010; Roudier *et al.* 2011). Temperature increases and erratic rainfall patterns affect crop agriculture most directly and adversely (Lansigan et al. 2000; Rosenzweig &Tubiello 2007; Almaraz *et al.* 2008). Changing climate over time affects rice crop production adversely (Behnassi 2011). Changes in a climate generally involve changes in two major climate variables: temperature and rainfall. The increase in temperature shortens the phenological phases of crops (such as planting, flowering, and harvesting) (Liu *et al.* 2010; Roudier *et al.* 2010; Teixeira *et al.* 2011) and affects plant growth and development. The fluctuations and occurrence of extreme climate events reduce rice yields significantly, particularly at critical crop growth stages (Lansigan *et al.* 2000; Teixeira *et al.* 2011). Rainfall extremes, through droughts and floods, are very detrimental to rice productivity. Higher and/or heavy rainfall results in higher yield losses through flooding (Rosenzweig *et al.* 2002; Reid *et al.* 2007; Roudier *et al.* 2011). In contrast, insufficient rainfall leads to greater drought frequency and intensity, while increased evaporation leads to complete crop failure (Reid *et al.* 2007; Liu *et al.* 2010). Overall, temperature and rainfall changes reduce the cropped area, production level, and yield. This reduction or fluctuation in rice yield warrant farmers' adaptability to minimize these adverse effects. However, adaptation strategies at the farm level vary from area to area and from farm to farm. Farmers' adaptive capacity is determined by their socio-demographic characteristics, farm characteristics, and accessibility to institutional factors.

$Crop_{iR}$ = f (FST,FSTS,SST,SSTS,TST,TSTS,FSR,FSRS,SSR,SSRS,TSR,TSRS)

$$Crop_{iR}=\alpha_i+\beta_1(FST)_{it}+\beta_2(FSTS)_{it}+\beta_3(SST)_{it}+\beta_4(SSTS)_{it}+\beta_5(TST)_{it}+\beta_6(TSTS)_{it}+$$
$$\beta_7(FSR)_{it}+\beta_8(FSRS)_{it}+\beta_9(SSR)_{it}+\beta_{10}(SSRS)_{it}+\beta_{11}(TSR)_{it}+\beta_{12}(TSRS)_{it}+v_{it}$$

4.2. Description of Variables

The dependent variable is rice productivity. Production of rice is divided into seven districts such as Faisalabad, Lahore Sialkot, Jhelum, Multan, Sargodha, and Bahawalpur. The data source for rice production is the Pakistan Bureau of Statistics.

4.2.1. Impact of Temperature on Rice

Rice is cultivated in the tropics and is the critical temperature determinant for growth. Rice is a tropical and subtropical plant requiring a fairly high temperature between 20o and 40oC. The harvest is unfavorably affected by rising temperatures in the worse tropical altitude and lower temperatures in temperate areas. This serious temperature varies depending on variety, critical temperature duration, diurnal changes, and plant physiological changes.

Vegetative Stage

- **Germination**

  Low-slung temperature depresses the level of propagation and extends it beyond the desired span of 6 days. Rise temperature of thirty-five ºC or extra halted the sprouting because of the rising respiration rate (Sreenivasan, 1985). Yoshida (1981) affirmed that temperature has a huge effect on germination, particularly in the first week of post propagation development. It also added that a common symptom is a poor and delayed germination.

- **Seedling Emergence**

  Bardhan and Biswas (1983) reported that before panicle initiation, the foliage emerges around every 4-5 days, later around 7-8 days. Temperature affects the rate of leaf emergence. Once the rice plant is grownup at twenty ºC, leaves arise every five days. Once it is grownup at twenty-five ºC, they emerge every four days before panicle commencement. Low temperature adversely affects the seedling dry matter since low temperatures decreased the photosynthetic activity. The optimum temperature for leaf emergence and elongation is 25 ºC and 30 ºC, respectively.

- **Tillering**

Rise temperature arranges for more tiller buds and thereby increases tiller computation. Higher extreme and least temperature during tillering decrease the crop. The optimum temperature for the tillering is 25 -31 ºC. The rate of tillering in rice tends to increase as the temperature increases. Temperature only marginally distresses the tillering level and the virtual growth level, excepting at the lowermost temperature 22 ºC from 3 to 4 weeks after sowing. The impact of temperature on tillering is precious by the close of sunlight (Mahbubul *et al*., 1985). In low light situations, some of the tiller buds may not grow into tillers for the reason that of a shortage of carbohydrates which is essential for growth. In these circumstances, the low-slung temperature may harvest more tillers. When light is tolerable, however, a rise in temperature increases tiller number.

Sreenivasan (1985) perceived that the tillering rate is reserved by low temperatures, but the era of tillering is extended, resulting in more tillers and more panicles than at high temperatures. The mean temperature exceeded 26 ºC, the tiller production stopped abruptly by 5th week after planting, and whenever it fell below 26 ºC the duration of tillering increased to 7-8 weeks after planting (Lalitha *et al*., 2000). It indicated that temperature influences the duration of the tillering. Temperature exceeding twenty-eight ºC during the vegetative stage reduces the days to caption and reduces the life cycle.

Reproductive Stage

Higher maximum and minimum temperature during ear initiation depress the yield. In general, high temperature accelerates the floral initiation (Vergara *et al*., 1972).

- **Low-Temperature Induced Spikelet Sterility**

The booting phase is measured as the most complex phase to low temperature. The second greatest complex stage is caption or flowering. Once the rice bush is exposed to low temperature for three days, it is more complex at the booting phase than the caption, as designated by the greater percentage of spikelet infertility. Once the low temperature is continual for six to nine days, though, the heading is as complex as, or level more complex than booting. Spikelet infertility seems to be precious by mutually night and day temperatures (Yoshida, 1981). Cool-weather causes panicle infertility by interfering with pollen grain formation. The serious temperature for inducing spikelet sterility varied from ten to fifteen ºC (Tinarelli, 1989). Alvarado (2002) found that the average temperature under 20 ºC for 5 days during flowering increased the probability of obtaining spikelet sterility is greater than 10 to 12 percent. Ghosh *et al*. (1983) observed that the temperature and sterility had a negative correlation which indicated lower temperature-induced high sterility.

- **Rise Temperature Induced Spikelet Infertility**

Rice is most complex to high temperatures at the caption and next most complex at about nine days before caption. One or two hours of rising temperature at a thesis has a conclusive effect on the incidence of infertility. High temperature before or after has much less effect on infertility. High infertility may be attributable to misuse of fertilization instigated by the faulty splitting of another or wilting to stigma induced by rising temperature and low humidity. High-temperature desiccated pollens (Osada *et al*., 1973). Sterility was increased at a high temperature of 35 ºC (day) and 30ºC (night) as a result of smaller pollens and no dehiscence of others. Mackill *et al*. (1982) stated that the abridged crop as a result of lowly pollen shedding as well as insufficient pollen evolution in temperature above about thirty-four ºC. The day time temperature of 32º to 38 ºC caused sterility, depending on the cultivars.

- **Flowering Duration**

Higher temperatures (both extreme and lowest) and worse diurnal changes in temperature are more favorable for initial flowering in rice varieties. Delayed floral initiation at low temperature had been reported and the critical minimum was around 15 ºC and the optimum was 25-30 ºC. India cultivars were better adapted to high temperatures (Ghosh *et al* ., 1983). Yoshida (1981) observed that a 13-day delay in flowering for each degree drop in temperature between 24º and 21 ºC in IR 26 rice cultivars. Even if plant growth is vigorous, a temperature that remains at 14-16 ºC for more than 3 days during the period from reduction division to heading will cause serious damage because of grain sterility (Toriyama and Heu, 2000).

Ripening Stage

The yield of grain was generally higher when the temperature was relatively low during the ripening stage, an influence ascribed to a more fortunate balance among photosynthesis and respiration. Temperature influenced rice maturation in two methods, first, low temperature preferred grain weight rise, and second, the low daily mean temperature rises the length of the maturation stage. Higher grain yields could generally have been attributed to lower temperatures during ripening in temperate countries than in tropics, which extended the ripening period, thus providing more time for grain filling. The translocation of photosynthesis to grain took place at a lower temperature at a slower rate and thus delayed the maturity period. During grain filling, the temperature below 28 C increased its period and size of the germ (Tashiro and Wardlaw, 1989).

Worse night temperature for the duration of the growing phase had an optimistic relationship with the crop. A high diurnal change leads to more proficient adaptation and the use of solar energy during photosynthesis leading to higher net photosynthesis. High day temperature combined with low diurnal variation is not a favorable ripening temperature environment. High temperatures during this stage caused an impaired reduction of grain filling and a 5-15 percent reduction in test weight at 27 ºC in some cultivars. The incidence of chalky grains was associated with the spread between optimum and maximum temperature. Low grain filling at high temperature was mainly due to a lack of ability of the spikelet to serve as a sink. Ear photosynthesis to grain yield ranged from 8-23 percent and the contribution of panicles (sink) ranged from 13-20 percent. Rice exhibits photorespiration which is stimulated by high temperature and light (Abrol and Gadgil, 1999).

The optimum temperature for ripening is 20-25 ºC. Super-optimal temperature for the period of grain filling can decrease seed mass since of a lower level of starch accretion. High temperature during this stage increases the thickness of the bran. Low temperature during this stage leads to an excessive shattering of grain during harvest and transportation resulting in high losses. Higher maximum and minimum temperature during maturity depress the yield. Grain thickness in rice was most reduced by great temperature beginning 12 days after heading, but grain length and width were most complex to the great temperature at the early stages of development (Tashiro and Wardlaw, 1991).

Low temperature reduced the grain dry matter increasing rate, extends the grain filling, delays grain maturation although moderate cool temperatures sometimes benefit grain yield (Egli, 1998). High temperature decreased the grain yield significantly due to the reduction of the percentage of ripened grains. It shows that test weight is less affected by high temperatures rather than a percentage of ripened grains. Consequently, the percentage of ripened grain was the major contributor to differences in grain yield. Grain crop declined by ten percent for all 1 ºC in the rising period at least temperature in the dry time of year, whereas the impact of extreme temperature on crop yield was immaterial. It delivers a through the indication of reduced rice crops from better night temperature (Kobata and Uemuki, 2004).

4.2.2. Impact of Rainfall on Rice

Rainfall amount and distribution is the most critical weather component in rainfed rice ecologies (Upland, lowland, and flood-prone). Its effect on irrigated ecology is indirect through the availability of water in irrigation sources (tank, canal, well, etc.,) and its effect on the evapotranspiration of the crop through changes in solar radiation, temperature and wind speed. Daily precipitation is more serious than monthly or yearly rainfall. Precipitation of 100 mm/month dispersed calmly during the growing period was preferable than 200 mm/month, which fell in two or three days. Availability of about two hundred to three hundred millimeters of water per month is considered the minimum to produce a worthy crop of rainfed rice.

Vegetative Phase

In the rainy season, tillering is continued up to 42-45 days, whereas it is up to 50-55 days in the dry season. According to Kamalam *et al*. (1988), the accumulated rainfall during the tillering phase of the crop growth over and above the normal requirement had an adverse effect (significant negative correlation) on the straw yield. High rainfall during the active growth period resulted in higher plants and them cottage and decay in vertical water. High rainfall may outcome in the reduced accessibility of sunlight. Variability in rainfall affects the stand establishment and growth duration of the crop.

Narayanan (2004) reported that total rainfall during the nursery stage was negatively correlated with grain yield in a non -significant manner but with straw yield, it was significant and positively correlated. During the vegetative stage, it was non-significant with grain yield, whereas it showed an important negative association with the straw crop. Water shortage throughout the vegetative period decreases the plant height, tiller number, and leaf part but the crop can recover without much loss in yield if the water is available before flowering.

Reproductive Stage

Variability in precipitation is associated with premature cessation at this stage, the yield reduction is severe. Wind damage to the crop at this phase was triggered by temporary water stress in the panicle spikelet and the injury was less when the wind was accompanied by rain. Rice flowering was affected when rain occurred continuously for three days during flowering (Vijayakumar, 1996). Low yield was obtained due to continuous rain coupled with a strong wind at flowering in the wet season (Pradhan and Dixit, 1989). Due to heavy rainfall, panicles have a large number of blank florets and nitrogenous fertilizers are less effective. The response of paddy to rainfall during the sharp critical phase of panicle initiation is significantly favorable. This beneficial influence persisted even when this factor was taken jointly with other climatic elements namely mean temperature and sunshine (Sreenivasan, 1985)

Narayanan (2004) observed the optimistic non-significant relationship between grain crop and total rainfall; whereas total rainfall was negatively correlated with straw yield in a non-significant manner. Girish and Hittalmani (2004) found that moisture stress after 10 days of 50 percent flowering significantly reduced particular panicle weight, test weight, abundant spikelet per panicle, total spikelet each panicle, and spikelet density then significantly increased sterile spikelet per panicle. It indicates 10 days after 50 percent flowering to be the most critical stage for grain filling. Among the rice growth stages, the panicle initiation stage is more sensitive to moisture stress. Jeyaraman and Balasubramanian (2004) reported that panicle initiation and flowering stages are more sensitive to submergence. They also found that muddy or turbid water inflicts greater damage to plants than clear water because sediments in turbid water block the pores in the plant body and hamper the respiration and photosynthesis process.

Ripening Stage

Viswanathan *et al*. (1989) reported a negative correlation between yield and number of rainy days during the maturity phase. Wet incantations are harmful to rice yield from peak ripeness. Narayanan (2004) stated that total rainfall during this stage was negatively correlated with grain and straw yield in a non-significant manner.

Gupta *et al*. (2000) explained the yield variations in rain served rice by the quantum of precipitation for the period of the critical vegetative as well as reproductive phases. Deficit soil moisture during the grain filling stage drastically reduces the grain yield even if there was normal rainfall during the preceding phases. On the contrary, however, in 1995 more than the normal and normal yield of rice was obtained despite deficit rainfall during the season, because respectively 86 mm of rain was received during grain filling stage. It suggests yield variations are largely due to rainfall received during the ounce filling period of the yield.

4.3. Definition of Variables

Table 4.3.1: Definition of Variables

Y	Rice Production
FST	First stage temperature consisting of August. Used secondary data by the meteorological department of Pakistan
FSTS	Square of first stage temperature.
SST	The temperature of the second stage consisting of September to October. Data were taken from the department of the meteorological of Pakistan.
SSTS	Temperature Square of the second stage.
TST	The temperature of the third stage consisting of November. Secondary data used by the meteorological department of Pakistan
TSTS	Temperature square in the third stage.
FSR	The first stage of the Rainfall
FSRS	First stage square of the rainfall
SSR	The second stage is the Rainfall. Used the secondary data by the department of meteorological of Pakistan
SSRS	Second stage square of the rainfall
TSR	The third stage is the rainfall. Used the secondary data by the department of meteorological of Pakistan
TSRS	Third stage square of rainfall.
DUF	Dummy area of Faislabad
DUJ	Dummy area of Jhelum
DUM	Dummy area of Multan

DUS	Dummy area of Sialkot
DUS	Dummy area of Sargodha
DUL	Dummy area of Lahore

4.3.1. First and Second Stage Temperature and Rice Production

Initially, in the first stage, an increase in temperature is beneficial for rice production. However, for the first stage, beyond a certain optimal temperature of 27 ° C, further temperature increase becomes harmful to rice production. Temperature rise is harmful to production, but the effect becomes positive beyond a certain temperature limit (which is 26.75 ° C). Because rice production is harmful to both low and high temperatures (Syed Hassan Raza,2015)

4.3.2. Third Stage Temperature and Rice Production

Production is not affected by temperature increases. It means that for Punjab, the third stage temperature remains in the optimum limits for this stage's entire period. The average temperature for included Punjab districts is 22 degrees centigrade, while the optimum temperature required for this stage is 20 °C-25 ° C. (Syed Hassan Raza,2015)

4.3.3. Rainfall

Another variable of climate is. rainfall. It's measured in a thousand meters (mm).

4.3.4. The First and Second Stage of Precipitation and Rice Production

Pakistan's annual precipitation is less than[only 20 mm] than the optimal precipitation required for rice production[which is 40 mm at the bottom]. The artificial arrangements of irrigation water through canals and tube wells have met this deficiency, thereby reducing the rainfall dependence. The rice fields should have 6 mm of slow-moving water for 75 days[which is nearly the first two stages]. However, during the crop maturity period, the water requirement gradually decreases.

4.3.5. Third Stage Precipitation and Rice Production

The third production stage, in our case, in November. This month's average rainfall is only 5 mm and can therefore not be harmful to the crop. In a nutshell, we can say this climate variable is irrelevant to rice cultivation in the sense that both the lower and upper precipitation levels are harmful. The lower precipitation is covered by irrigation methods and does not reach the upper level at all.

4.4. Empirical Model

$$Crop_{iR} = \alpha_i + \beta_1(FST)_{it} + \beta_2(FST)_{it}^{\ 2} \quad +\beta_3(SST)_{it} + \beta_4(SST)_{it}^{\ 2} + \beta_5(TST)_{it} + \beta_6(TST)_{it}^{\ 2}$$

$$+\beta_7(FSR)_{it} + \beta_8(FSR)_{it}^{\ 2} + \beta_9(SSR)_{it} + \beta_{10}(SSR)_{it}^{\ 2} +\beta_{11}(TSR)_{it} + \beta_{12}(TSR)_{it}^{\ 2} + v_{it}$$

The empirical model is divided into the equation such as linear and non-linear. Linear functions are polynomials with the highest exponent equal to 1 or where c is constant in the form y= c. All other functions are nonlinear functions. A non-linear function example is y= x^2. This is nonlinear because despite being a polynomial, its highest exponent is 2, not 1 (Sofia and Hassan 2015).

Linear Equation:

$$Crop_{iR}=\alpha_i+\beta_1(FST)_{it}++\beta_2(SST)_{it}+\beta_3(TST)_{it} + \beta_4(FSR)_{it}+\beta_5(SSR)_{it}+\beta_6(TSR)_{it}+ v_{it}$$

Non-Linear Equation:

$$Crop_{iR} = \alpha_i + \beta_1(FST)_{it}^{\ 2} + \beta_2(SST)_{it}^{\ 2} + \beta_3(TST)_{it}^{\ 2} + \beta_4(FSR)_{it}^{\ 2} + \beta_5(SSR)_{it}^{\ 2} + \beta_6(TSR)_{it}^{\ 2} + v_{it}$$

4.4.1. Pooled Model

The pooled model is no different from the common equation of regression. Each observation is regarded as unrelated to the other, ignoring panels and time. No information on the panel is used. You can express a pooled model:

$$Y_{it} = \beta_0 + \beta_1 X_{1.it} + \beta_2 X_{2.it} + \beta_3 X_{3.it} + \ldots + \beta_k X_{k.it} + \varepsilon_{it}$$

A pooled version is used under the assumption that the separable behave inside the same way, where there are homoscedasticity and no autocorrelation.

1) The model is correct: (ε_{it}) = 0.

2) There is no perfect collinearity: $rank$X = $rank$X 'X = K, where X is the cause with$k$columns and N=nt rows.

3) Exogenity: $E(\varepsilon_{it}/X = 0;\ Cor\ (\ \varepsilon_{it}, X) = 0$

Exogenity assumption is always decreased if it contains a lagged dependent variable, but it can be deposited in another case where xit+1 is correlated with uit.

4) Homoscedasticity::$Var(\varepsilon_{it}/x) =:\ E(\varepsilon_{it}2/x) = \sigma^2$

The variance of the error term is constant in all x and over time: the error variance is a measure of model uncertainty. Homoscedasticity implies that the model uncertainty is identical across the observation.

5) Normal distribution of the disturbances

These traditions also apply to data models for the panel. The estimates of parameters are unbiased and consistent under the assumptions. However, the autocorrelation of the disturbances within individuals is likely to occur in panel data studies in which case the fifth assumption is not met. This would clue to the standard error estimation being biased. They will be underestimated which will lead to overestimated t-statistics. The error has to be adjusted and using clustered standard errors is one way to do so. Because the pooled model is not so altered from the simple linear regression model, it does not cover all of the advantages and benefits of the panel data stated in the previous unit. Compared with fixed-effects or random-effects models, this model is more restrictive. However, if the fixed effect is not suitable, it should be used. If it is used when it should have been the fixed effects.

4.4.2. Fixed Effect Model

A fixed-effect regression is an estimation technique used in the data set of a panel that enables one to control unattended individual characteristics that can be correlated with the independent variables observed the following regression equation with the single regressor as,

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Z_i + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where i=1,2,3….,n and t=1,2,3….., T and $Z_i$is omitted time-invariant variable (Z_{it}=Z_i)

The overhead equation can be written as

Y_{it}= (β_o +$\beta_2 Z_i$)+$\beta_1 X_{it}$ +μ $_{it}$

$$Y_{it} = (\beta_0 + \beta_2 Z_i) + \beta_1 X_{it} + \mu_{it}$$

Let $\alpha_i = \beta_0 + \beta_2 Z_i$

The thought behind the FE (fixed effect) estimation method show is that a few parameters are cross-segment particular the FE (fixed effect) model technique in both of the parameters (Hayashi, 2000). The condition for the FE model in cross-area is expressed underneath:

$$Y_{it} = \alpha_i + \beta_1 X_{it} + \mu_{it} \quad \ldots\ldots\ldots\ldots(2)$$

- ✓ Y_{it} is the outcome variable for unit i at time t
- ✓ α_i is a fixed but unknown intercept for unit i
- ✓ X_{it} is the binary treatment assignment for unit i at time t
- ✓ β is the effect to be estimated
- ✓ μ_{it} is a disturbance term for unit i at time t

The term μi is used to capture or measure effects specific to every factor that impacts yit in the cross-section estimation however these effects don't change over time (Brooks, 2014). Model have evaluated by using dummy factors, as the accompanying condition appears:

i = 1, 2, 3, 4, 5,………., n

One of the advantages of the use of panel data as point out in section is that models just like the fixed effect model can deal with the unobserved heterogeneity. The fixed-effects model for k factors can be expressed within the following way

$$Y_{it} = \alpha_0 + \beta_1 X_{1.it} + \beta_2 X_{2.it} + \beta_3 X_{3.it} + \ldots + \beta_k X_{k.it} + \varepsilon_{it} \ldots.. (3)$$

Where t=1,2,3,….T and i=1,2,3,……n

Where $X_{1.it}$,$X_{2.it}$,$X_{3.it}$,$X_{k.it}$are first, second, third and k^{th}regressor for an entity I in a period t respectively, $\alpha_1 \ldots \alpha_n$ are entity fixed effects.

The traditions that are legal for the fixed effects model are as follows:

1) The model is correct: (ε_{it}) = 0.

2) Full rank: $rank$X = $rank$X ′X = K;

3) Exogeneity: = 0, but there is no assumption that (αixi = $E\alpha i$ = 0;

ε_{it} can be thought of as a time-varying shock that is independent of the unobserved individual characteristic c_i and the observed characteristics x_{it}.

4) Homoscedasticity: (εit2 , = σu 2 ;

5) No cross section or time series correlation: (,εjsX = E($\varepsilon it\varepsilon js$X = 0 $i \neq j$; $t \neq s$

6) Normal distribution of the disturbances.

Two strategies for computing the estimates of the fixed effect model are offered in the Appendix; inside-group method and least squares dummy variable approach (LSDV)

4.4.3. Random Effect Model

In the random effect model, the individual-unique element α is not handled as a parameter and it isn't being predicted. Instead, it's miles considered as a random variable with imply $\mu$and variance α2 . The random effect version can, for this reason, be written as:

$$Y_{it} = \alpha + \beta_1 x_{1\,it} + \beta_2 x_{2\,it} + \beta_3 x_{3\,it} + \ldots + \beta_k x_{kit} + (\alpha_i - \mu) + \varepsilon_{it}$$

Where$\mu$is the average individual effect. Let it = (αi–μ) + $\varepsilon it$and (4) can be rewritten as:

$$Y_{it} = \alpha + \beta_1 x_{1\,it} + \beta_2 x_{2\,it} + \beta_3 x_{3\,it} + \ldots + \beta_k x_{kit} + \mu_{it}$$

$$y_{it} = \alpha + \beta x_{it} + u_{it}$$

$$u_{it} = \mu_i + v_{it}$$

The (α) intercept is evaluated the same for entirely elements in the cross-sectional estimation above the time. The variable can change in the cross-sectional estimation and the significance variable check the abnormality of each substance's cut off term around (α) intercept (Brooks, 2014).

The assumption for the random effect model are as follows:

1) The model is correct: $(\mu_{it}) = E\alpha i - \mu + \varepsilon it = E\alpha i - \mu + E\varepsilon it = 0 + E\varepsilon it = 0$

The individual-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, current and future time periods of the same individual.

2) Full rank: $rank$X = $rank$X 'X = K;

The regressors including a constant are not perfectly collinear, that all regressors (but the constant) have non-zero variance and not too many extreme values.

3) Exogeneity: E(uit/xi, αi) = 0; $E(\alpha i – \mu/$xi = $E(\alpha i – \mu)$ = 0

4) Homoscedasticity: $E(\mu_{it}^2/x_i, a_i) = \sigma_\mu^2; E(\alpha_i^2/x_i) = \sigma_i^2$

the constant variance of the individual specific effect.

5) Normal distribution of the disturbancesuit.

Because of the more specific error term, special attention must be paid to some of the conditions. The estimates of the random effects model are consistent only if assumptions 1) and 3) are satisfied. However, the individual-specific component α might be correlated with the independent variables, which means that the compliance of the exogeneity condition must be verified. If it turns out that there is a correlation between the error term uit and the factors used in the model, then either pooled or fixed-effects models must be used.

4.5.Estimation Technique & Methods

This study is based on panel data. Under this situation, the Hausman test is applied to check the correct estimation model. The panel data is also called longitudinal data for different entities observed at different periods. One of the advantages of panel data is that it allows control of the unobserved variable's influence and that for this purpose the fixed effect regression method is used. The model of fixed-effect regression is applicable when data are observed over two periods of time. But the Siddiqui (2012)used the common estimation technique of the Least Square (OLS) to capture the effects of climate change on rice production productivity.

4.5.1. Descriptive Statistics

In the first step of the analysis, descriptive statistics are reported. Descriptive measurements are the restraint that describes quantitatively the main sorts of an information assortment. The purpose of descriptive measurements is to encapsulate a sample instead of expending the data to learn about the population that the data sample is thought to represent. Procedures of central tendency that are usually used to describe a data set include mean, mean, and mode.

4.5.2. Hausman Specification Test

In a regression model, the Hausman test (also identified as the Hausman Specification Test) perceives endogenous regressors (interpreter variables). Endogenous variables have values determined in the system by other variables. One of OLS's assumptions that there is no relationship between an interpreter variable and the error term, having endogenous regressors a model will reason ordinary least square estimators to be unsuccessful. The Hausman test is sometimes described as a faulty model test. The Hausman test can assist to choose between a random effect model or fixed-effect model in panel data analysis (data analysis over time). The null hypothesis is that random effects are the favored model; another hypothesis is that fixed effects are the model. It is fairly straightforward to interpret the result of a Hausman test: if the value of p is minor (less than 0.05), the null hypothesis is excluded.

Summary

Chapter 4 substantiates the study's theoretical framework. The theoretical model followed in the study is to apply the Hausman Specification Test for the best model of choice.

CHAPTER 5

DATA PRESENTATION& ANALYSIS

5.1. Data Source

The experiential analysis of this revision is depended on the panel data start from 1970 to 2017. The data of rice production of seven districts are engaged from the Pakistan Bureau of Statistics and several annual reports issued by the State Bank of Pakistan. Data of other economic variables are composed of the Metrological Department of Pakistan Islamabad.

5.2. Descriptive Analysis

The statistical analysis starts with descriptive analysis. This is the first step before conducting any analysis or following any estimation Technique.

5.2.1. Descriptive Statistics

Table 5.2.1: Description of Statistics

Variables	Obs.	Mean	Std.Deviation	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bara
Y	1813	58.67	77.11	0.3	353	2.06	6.57	320.9
FSR	1813	172.44	204.62	0	1109.7	2.12	7.93	457.2
SSR	1813	50.57	60.10	0	551.2	3.20	21.62	4187.3
FST	1813	31.66	1.73	22.15	34.7	-1.17	7.13	244
SST	1813	25.77	1.78	22.05	31.835	0.78	3.88	34.94
TSR	1813	15.00	21.07	0	152.1	2.50	12.38	1221.8
TST	1813	29.41	1.73	23.47	33.71	-0.78	3.5	29.35
FSRS	1813	716.87	1721.30	0	1231434	4.14	22.34	4780.3
SSRS	1813	617.49	2112.21	0	303821.4	11.14	152.8	247750
FSTS	1813	1005.52	106.30	491.0156	1204.09	-0.79	5.12	76.07
SSTS	1813	667.48	94.17	486.2025	1013.467	1.01	4.4	65.81
TSRS	1813	668.85	2012.13	0	21134.41	7.21	69.03	49305.6
TSTS	1813	867.98	99.31	550.8878	1136.566	-0.61	3.17	16.81

This study is based on data consuming 1813 observations of each variable recycled in the exploration. Descriptive statistics show that the production of rice consumes a mean value of 58.672 with the least value of 0.3 and an extreme value of 353. The less significant worth of standard deviation indicates that data is not highly discrete and data points are close to the mean normal value. Economically it may be reasoned here that the production of rice has been stagnant throughout production in Pakistan and several economic, social, and political factors are responsible for this.

The descriptive statistics display that the usual first stage rainfall is 172.44 with the array of 0 to 1109.7 in all districts. In elevation value of the standard deviation for the first stage designates the upper level of change found in the data points from the mean worth and portrays the poor condition of rain and another factor.

Similarly, the first stage temperature indicates the mean value of 31.66264 with the range of 22.15887 to 34.7 in all districts. There is the variation found in the stage but not of a higher level. Economically, these variations are due to the level of technology.

5.3. Correlation Matrix

Table 5.3.1: Correlation Matrix

	FST	**SST**	**TST**	**FSR**	**SSR**	**TSR**
FST	1	0.42* (0.000)	-0.08 (0.2622)	-0.57* (0.000)	-0.34* (0.000)	-0.28* (0.000)
SST	0.42* (0.000)	1.00	-0.35* (0.000)	-0.48* (0.000)	-0.25* (0.000)	-0.17* (0.000)
TST	-0.08 (0.2622)	-0.35* (0.000)	1.00	0.24* (0.000)	0.08* (0.000)	-0.03* (0.000)
FSR	-0.57* (0.000)	-0.48* (0.000)	0.24* (0.000)	1.00	0.34* (0.000)	0.24* (0.000)
SSR	-0.34* (0.000)	-0.25* (0.000)	0.08 (0.2260)	0.34* (0.000)	1.00	0.09* (0.000)
TSR	-0.28* (0.000)	-0.17* (0.002)	-0.03 (0.6714)	0.24* (0.000)	0.09 (0.129)	1.00

Table 5.3.1 is of correlation matrix that represents association and strength among independent variables. Correlation coefficients demonstrate the degree of the linear relationship between variables whereas sign describes the direction of the correlation coefficient of association among variables. The upper table indicates a feasible connection among all variables. The value of correlation coefficients in the diagonal of the correlation matrix describes the relation of a variable with itself. The upper correlation matrix illustrates that there exists absolute as well as unfavorable, and weak & powerful association among the independent variables.

Association between SST and TST is negative and weak as represented by a coefficient value that is -0.35. The association among SST with FST is positive but weak which also depicted the coefficient value. Its value is 0.42. SSR and FSR are positive but weakly connected. It is exposed to a coefficient value which is 0.34. SSR with TSR has a positive and weak relationship with each other with the coefficient value 0.09. The results discussed above indicate that there is no problem of multicollinearity in the model.

5.4. Estimation Analysis & Discussion

5.4.1. Result of the Linear Model

Result of FEM estimation: Dependent Variables: Rice's Production (Thousands of Tones)

Table 5.4.1: Result of the Linear Model

Variables	Co-efficient	t-statistic	Probability.
Intercept	-15.6484	-4.603070	0.0000
First stage temperature	-1.097**	-1.963929	0.0497
Second stages temperature	4.886	10.79131	0.0000
Third stage temperature	1.230***	2.598121	0.0095
First stages rainfall	-3.320*	-0.005667	0.9955
Second stage rainfall	0.026***	2.440816	0.0148
Third stage rainfall	0.166	5.032589	0.0000

DUF	22.640	8.1829	0.0000
DUJ	-11.703*	-3.927	0.1956
DUM	-0.869*	-0.359828	0.7190
DUS	215.715	19.47	0.0000
DUS	42.86160	15.54	0.0000
DUL	32.98358	11.82	0.0000
R^2	0.84	-	-
DW. Statistic	0.581284	-	-
F-statistic	845.8294	-	0.0000

Reminder: ***,**,* displays the level of significance of limitations at 1 percent,5 percent, and 10 percent correspondingly.

Description

This sector explores the impact of weather variation on rice invention of seven areas of Punjab, Pakistan. The rice yield contains four-month technology July, August, September, and October. It consists of three most important phases of manufacturing this is flowering, germination, and ripening. Rice crop distributed into three stages in this study. The first stage consists of only July and August month, the second stage having September and the third level consisting of October. The outcomes of rice production are given by way of the above table.

Two models assessed to estimate the impact of weather adjustments on rice manufacturing. The above desk indicates the degrees of temperature and precipitation used as the independent variable. The consequences show the second and third levels of temperature impact the yield manufacturing positively because the second level is flowering and the third phase is ripening at this stage crop required great temperature. The coefficient of the second phase is 4.886034 which shows that $1C^0$rise in temperature 4.886034 tones in thousand rise the rice manufacturing of 7 areas. The second phase temperature co-efficient also suggests that $1C^0$rise in temperature in the third period which reason using 1.230582 tones in thousand rises in rice productivity. First level temperature suggests a large impact but a negative effect on productivity.

An exciting outcome is the inconsequentiality of rainfall for the productivity of rice in the first section. This outcome is, although, justified considering that the yearly rainfall in Pakistan is much less [only 20 mm] than the top of the line required rainfall [which is 40mm on the worse bound] for rice invention. This scarcity has been met by the simulated arrangement of irrigation water over and finished with tube wells and canals, thereby falling the dependency on precipitation. The rice field needs to have six mm of sluggish stirring water for 75 days which is almost the first two phases. However, the water responsibility step by step declines throughout the maturity era of yield. This maturity era is the third phase of the invention which is in November. The data demonstrates that the normal precipitation for this month is five mm and, as a result, might not be destructive for the crop. In a casing, weather variable is unrelated for rice yield inside feel that mutually neither the more severe nor the higher ranges of rainfall are dangerous. The lesser rainfall is blanketed via irrigation techniques and the better stage does not reach in any respect. The second and third phase of precipitation is importance the outcome in second segment precipitation co-efficient additionally specify that one mm increase in rainfall 0.026625 thousand tones increase the rice manufacturing and in third phase which reason by 0166791 tones in thousand rice in rice productivity. The higher t statistic value shows the strong relationship between variables.

Finally, the significance of area dummies confirms the detail the manufacturing of rice yield does react to district particular traits. A Dummy variable or IndicatorVariable is an artificial variable created to represent an attribute with two or more distinct. The intercept duration in the model indicates the mean rice invention of those seven areas, whereas the coefficient of area dummies indication the eccentricity from this normal manufacturing. It is obvious from the consequences that except for Faisalabad, Sialkot, Sargodha, Lahore, all different regions such as Jhelum and Multan produce less rice than the usual manufacturing due to the climatic scenario. The R square and F-statistic certify the significance of the complete model. The value of R square is almost 89% which suggests that 89% variation is showed by independent variables (district dummies) in the dependent variable.

5.4.2. Result of Non-Linear Model.

Result of FEM estimation: Dependent Variable: Rice's Production (Thousands of tons)

Table 5.4.2: Result of the Non-Linear Model

Variable	Co-efficient	t-statistic	Prob.
Intercept	-42.613	-3.235	0.0012
First stage temperature square	-0.01**	-1.88	0.0601
Second stages temperature square	0.08	9.74	0.0000
Third stage temperature square	0.02***	2.41	0.0157
First stages rainfall square	0.003*	0.74	0.4590
Second stage rainfall square	0.005**	1.86	0.0621
Third stage rainfall square	0.009*	3.032433	0.1125

DUF	23.21	8.29921	0.0000
DUJ	-9.72*	-3.353929	0.8254
DUM	-0.207139*	-0.085465	0.9319
DUS	216.4462	56.40608	0.0000
DUS	44.14801	16.86057	0.0000
DUL	37.09863	13.87732	0.0000
R^2	0.892920	-	-
DW. Statistic	0.568930	-	-
F-statistic	831.0975	-	0.0000

Reminder: ***,**,* displays the level of significance of limitations at 1 percent,5 percent, and 10 percent correspondingly.

Description

The above table displays that precipitation and temperature cycled with their square period to the invention of the non-linear relation effect on the variable. The result ratifies that in the third and second stage temperature nonlinear related to the productivity of rice so the result shows that temperature is beneficial for second phase rice productivity but the square time of the second phase shows that if temperature more increases so that temperature dangerous for rice productivity. The assured frontier of the second phase is 26.75C^{o}before this assumed perimeter temperature has an optimistic impact at the second stage and if the temperature is more then one percent by the certain limit the temperature result harmfully. The phase of third temperature square similarly displays that temperature has an optimistic impact on production and it also displays substantial effect its co-efficient displays 1C^o rise in temperature caused by 0.2023 tones in thousands rise in productivity of rice. The first phase outcome shows that at this phase temperature has an inconsequential effect and no indication found the non-linear relationship. It means that temperature in all the phases remains in the optimal for the whole era.

An interesting outcome found in this revision that precipitation expressions significant result in the second and third phases. The validation of the first stage outcome is that the optimal 40 mm precipitation compulsory then the real precipitation of this era is 20mm the shortage is 20mm. This shortage eradicates by simulated based that are tube well and assemble irrigation over the canal. The second phase result shows that 1 mm increase the rainfall so 0.00054 increases the thousand tones production of rice. Second phase rainfall co-efficient to designate that 1mm rise in precipitation in the third phase which effect by 0.000942 tones in thousand rises in rice productivity. The result of the first phase also designates that square term of the first phase to have a positive and insignificant impact that displays after the optimal rainfall.

Finally, the impact of area dummies ratifies the detail the productivity of rice yield does retort to are exact characteristics. The intercept term in the model represents the mean rice productivity of these seven areas. Whereas the coefficient of area dummies displays the deviation from the usual productivity. It is evident from the result that except for Sialkot, Faisalabad, Sargodha, Lahore, all other areas produce less rice than the average production due to climate situation. The R square and F-Stats authenticate the significance of the overall model. The value of R square is almost 89% which displays that 89% deviation is showed by the independent variables (district dummies) in the dependent variable

CHAPTER 6

CONCLUSION AND POLICY RECOMMENDATION

6.1. Conclusion

Climate chooses the right crop for a particular environment, while the prevailing weather condition of that environment decides the potentiality of that crop. Rice is a sensitive crop that depends highly on weather conditions. Among the abiotic stresses, weather plays a dominant role in influencing the growth and yield of rice. The most important weather elements that influence growth, development, and yield of rice are temperature and rainfall. Rice cultivation continues to be a risky enterprise, despite advances made in modern technologies. The deviation in the weather can be exploited by resorting to the optimum time of sowing or planting.

This study's main purpose existed to observe the effect of the climate variable on Pakistan's agricultural productivity. Panel data used various Punjab stations. For the data analysis, the fixed-effect model is used because if the probability value is less than this model is used. The first model displayed the variables' linear effect and the second showed the non-linear relationship between the variables. The rice production outcomes display that temperature has a positive impact on rice productivity, but after the optimum point, it is harmful. The result of precipitation displays that it does not affect rice production at any stage of production and no indication found the prevailing the non-linear relation. The impacts of climate change, such as increased floods and droughts, temperature rise, and uncertainty of rainfall patterns, have been occurring in the selected study area. In the past decades, extreme events such as floods and drought significantly affected the livelihood of farmers, especially rice production. Human lives, rice crops, cattle, houses, home gardens, farming ecosystems, and other socio-economic opportunities were reportedly lost due to droughts and floods. Although heavy droughts and floods have not occurred recently, its past and current negative impacts on poor farmer victims, for instance, food insecurity, continue to hurt farmers. To improve their livelihoods, farmers have autonomously changed their rice production practices and techniques. These changes have enabled them to better adapt to climate change. Rice-cropping calendars in all study areas were changed while many farmers have chosen more seasonal rice varieties to increase their rice productivity. By using these strategies, farmers have successfully been able to improve their household sufficiency levels and to sell their rice surplus. Other strategies farmers have adopted include applying more chemical fertilizers and pesticides on their rice field and increasing the usage of agriculture machines to replace cattle labor in their rice production cycle.

6.2. Policy Recommendation

In response to the findings, this study would like to make several recommendations to policymakers, practitioners, and farmers so that they can better mitigate and adapt to climate change in Cambodia:

- The government, including relevant provincial departments, and development partners should prepare responsive strategies and be ready to provide appropriate materials, such as pumping machines and rice seeds, to help farmers respond to disasters. Doing so would minimize the risk of a crisis.
- Continue to raise the awareness of climate change effects and knowledge of how to mitigate and adapt to changes in a local context. This can be jointly done by line departments and NGOs.
- There should be a development of a better early warning system for extreme climate events.
- A Weather information sharing system, especially on rainfall, temperature, and extreme events, should be nationally and provincially established to immediately inform farmers of upcoming weather-related risks so that they are well prepared for them.
- The government should continue to help farmers diversifying their livelihood options by teaching how to maximize production in limited areas, to increase the planting index in suitable areas, to develop or rehabilitate existing and new irrigation facilities. The government should also explore new opportunities for off-farm investments from the private sector which would generate new employment.
- A gender perspective should be integrated into all disaster risk management policies, plans, and decision-making processes, including those related to risk assessment, early warning, information management, and education.
- It is important to ensure equal access to appropriate training and educational opportunities for women and vulnerable constituencies and to promote gender and

cultural sensitivity as integral components of education and training courses on disaster risk reduction

- The national and local government should develop strategies to (1) improve natural resources management and to ensure that women have access to and have control of them; (2) to create educational and training opportunities in areas related to climate change; (3) to encourage the development of technologies taking women into account; and (4) to foster the transfer of technology to women.

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