Impact of Fiscal Measures on Agriculture Sector Productivity; Evaluating the Empirical Evidence from Pakistan

BY

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ABSTRACT

Fiscal interventions can play a vital role in transforming agriculture productivity in Pakistan. The key objective of the present study is to dynamically measure the influence of fiscal instruments on the agriculture sector productivity in Pakistan in both the long and short periods along with the cause-and-effect relationship for the period 1981 to 2020. To explore outcomes agriculture productivity is used as a dependent variable agriculture loan, agriculture subsidy, agriculture research, and agriculture infrastructure is taken as regressors of the model. Initially, the estimated empirical outcomes of the bound test extensively validate the presence of a strong long-run association between the variables taken under contemplation for the present study. Secondly, the estimates of the ARDL model displays that individually all the regressors in longer and shorter period positively influence the agriculture sector productivity in Pakistan. Meaning that a substantial boost in agriculture productivity can take place if fiscal measures of agriculture loan, agriculture subsidy, agriculture research, and agriculture infrastructure have been employed. Firstly, promote the farming sector by giving each farming family easy access to interest-free agriculture loans. Also, provide maximum subsidy to these farming families on basic agriculture products. Secondly, enhanced agriculture research and also develop agriculture infrastructure in such a way that the agriculture products loss can be minimized. Adoption of this policy straightens a strong path toward enhancing agricultural productivity in the developing economy of Pakistan.

Keywords: Agriculture Productivity, Agriculture Loan, ARDL Model, and Agriculture Infrastructure

JEL Classification: Q1, H8, C32, 010

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AEZ	Agro-Ecological Zones
AI	Agriculture Infrastructure
AL	Agriculture Loan
AP	Agricultural Productivity
AR	Agricultural Research
ARDL	Autoregressive Distributed Lag
AS	Agriculture Subsidy
BLS	Basic Link System
CSA	Community Supported Agriculture
CSIRO	Conformal-Cubic Atmospheric Model
ECM	Error Correlation Model
FAO	Food And Agricultural Organization
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
IPCC	Inter-Governmental Panel On Climate Change
IPCC	Intergovernmental Panel On Climate Change
LDA	Loss Distribution Approach
MAF	Million Acre-Foot
NARDL	Non-Linear Autoregressive Distributed Lag
NFDC	National Fertilizer Development Center
NGOs	Non-Governmental Organizations,
NHI	Net Homestead Income
OECD	Organization For Economic Co-Operation and Development
PP	Potential Productivity
TAR	Third Assessment Report
TE	Technical Efficiency
TFP	Total Factor Productivity

UNFCFM	United Nations Framework Convention on Fiscal Measures
WA	Water Availability
WBDI	World Bank Development Indicators
ZTBL	Zarai Taraqiati Bank Limited

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Thank you all

DEDICATION

This thesis is dedicated to my family specially my parents for their love, endless support, and encouragement. Dad, you are in my every breath.

Also Dedicated to

My Teachers

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Today, the effectiveness of fiscal measures toward agriculture production is a familiar concept to both academic and scientific communities around the world. With consequences for agricultural production, natural habitats, fresh water supply, and health, climate change is most significant global environmental concern confronting civilization. Extreme weather events like storms, floods, and droughts are increasing in frequency and intensity around the world due to less adoption of key fiscal measures, which is ultimately having negative effects on agricultural productivity.

The key factor of agriculture production is heavily reliant on quite crucial fiscal measures (Eakin and Pat, 2011). It is possible that a higher level of the adoption of key fiscal measures like agriculture research, investment income, and water availability can play a vital role to boost agriculture production. However, benefits from these fiscal measures regarding agriculture productivity enhancement can only be obtained when a large number of farming populations of both developing and developed states are provided easy access to these key fiscal measures. Increases or decreases in the frequency or severity of climate change which can cause serious problems for farmers and ultimately lead to a decline in food. Traditionally, the farming community had grown food, raised animals, worked on the poultry and fishery without fiscal support leading to a substantial loss in productivity of these products. While in the modern age, with the adoption of fiscal measures in these sectors plays a vital role to minimize loss and boost the productivity of different sectors.

Three distinct ideas might be referred to as adaptation of the basic fiscal measures. According to Salvador (2001), while autonomous adaptations are deliberate policy decisions made by public authorities, natural adaptations are actions taken by private players without the involvement of authorities (IPCC, 2013). Bryant et al. (2000) found that fiscal adaptation in agriculture played a key role in fighting against drastic climate change challenges and enhanced the agriculture productivity.

In the developing state of Pakistan, as per the views of Malik et al. (2018), climate change is the most threatening challenge for the coming generations because it not only brutely destroyed agricultural productivity but also impacts every aspect of human life. Further, they also stated that to protect each aspect of human life, especially the agriculture sector, there is a desire need to develop an agriculture industry that boost the level of employment by providing job opportunities to the available labor force. This is only possible when major fiscal measures are adopted at an extensive level so that loss due to dramatic changes like temperature uplifts, unpredicted rainfall, and the frequency and severity of floods and droughts can be declined (IUCN, 2009 and Rao et al., 2005).

As per views of different scholars, it has been detected that fiscal measures and agriculture production are interlinked concepts and their importance cannot be ignored especially for agricultural countries. Adu et al. (2014) stated that dramatic climate change drastically influenced the agricultural sector of agrarian economies in the last couple of decades therefore keen attention is essentially needed under appropriate fiscal measures to protect agriculture sectors from the severe harm of changing climate. Chandio et al. (2017) signified that the agricultural sector of any economy widely needed a protective fiscal policy so that loss of the crops can be curtailed due to the harsh effect of climate change. Keith et al. (2008), concluded that the adoption of comprehensive fiscal measures plays a vital role to reduce the harsh and complicated impact of changing climate on agriculture production, especially in least-developed economies (Warren, 2011). IPCC (2013) defined that due to the increasing use of technology, chlorofluorocarbon emission had increased that uplifting the world temperature and causing unpredicted rainfall, if the crucial fiscal measures for agriculture production are not adopted on an emergency basis, then there is greater agriculture productivity loss till the end of 2050.

It is generally agreed that the agricultural industry is one vulnerable and sensitive to the deficient use of key fiscal measures (Smit & Skinner, 2002). In addition, they reported that the adoption of fiscal measures is a significant policy response that should be taken in the agriculture sector to deal with different key issues that have been strongly linked with fiscal measures. According to the study conducted by Ullah (2019), agriculture is considered the primary sector for all fiscal policies and action plans in Pakistan. Agriculture is also referred to as the foundation of Pakistan's economy. Pakistan is a country that relies heavily on agriculture; almost 45 percent of the country's workforce is connected to this industry (Rehmen et al., 2022).

1.2 Need of the study

Pakistan is one of the countries with the lowest adaptive capacity especially in the context of fiscal measures because the country suffers from extreme poverty and a lack of the resources necessarily needed to adapt for enhancing production (Abid et al, 2016). Therefore, to overcome the deficiency the government of Pakistan has launched several initiatives to strengthen the capacity of farmers to implement appropriate adaptation measures in the agriculture sector so that agriculture productivity can be boosted (Nishtar, 2010). One of the most important goals of the fiscal measure's adaptation is to make societies more resilient so that they can better deal with dramatic climatic effects in one side while on the other side, it enhanced the agriculture production (Mumtaz et al., 2019).

There is an urgent requirement to provide integrated solutions that consider the environment, society, and technology (Potter and Skinner, 2000). Bazzaz et al. (1991) had the view that fiscal measures have direct and indirect effects on crops in the agricultural sector. In a contest of direct effect, the adoption of fiscal measures leads to boosting crop yield, crop quality, and also create an opportunity to explore various crop varsities. However, in the case of indirect effect, the adoption of fiscal measures leads to boosts in nutrients level, decline in various insects, diseases and also pollution of water (O'Connor,2015).

The basic fiscal measures have caused significant concerns for Pakistan. However, Pakistan is not the only country that is experiencing significant social, environmental, and economic impacts (Akram, 2015). In the past few decades, according to Warsame et al. (2021), the adoption of basic fiscal measures attains keep attention because of the negative effects of rising temperatures on the agriculture sector in Pakistan. The agricultural productivity, the fiscal measure and the level of poverty had a direct relationship that affects the vast majority of the country's population. According to Awan (2015), Pakistan's status as a developing country is defined by the fact that its economic success is primarily dependent on the agricultural sector, which makes the country extremely susceptible to the effects of climate change due to poor adoption of various fiscal measures (Warr,1989). According to the findings of the analysis, 65 percent of a country's foreign currency comes from the export of goods that were manufactured using raw materials obtained from the agricultural sector. More than two-thirds of Pakistan's population call rural areas home,

and the majority of those people depend on agriculture and other agro-based industries for their livelihood (GoP,2008).

Key fiscal measure, agriculture research, water availability, and investment income has a significant impact on the agricultural sector (Mishra and Sahu, 2014). Lobell et al. (2011) described those basic fiscal measures has a greater impact on agriculture productivity, because due to changing climate droughts, floods, and temperature increases that cause severe agriculture losses these fiscal measures are key to a decline in agriculture loss at a wider level. Yu *et al.* (2006) & Schiermeier, (2015) defined that fiscal tool adoption is favorable in curtailing losses of agriculture production from the changing climate.

The process of adaptation is intricate, multifaceted, and multiscale. Nhemachena et al. (2007) claim that changing agricultural management practices to consider changing fiscal circumstances is one way to adopt the necessary fiscal measures. It is described as the process of changing economic structures or behaviors to lessen society's vulnerability to resource scarcity or possibly hazardous environmental change (Bryan et al., 2013). According to the Bognor (2008) report, the Inter-Governmental Panel on Climate Change (IPCC) survey findings indicated that Pakistan's agriculture sector is anticipated to be most affected by contradictory effects of climate change. An increase in the frequency of droughts, an increase in the frequency of strong rainstorms, and an increase in temperature are likely to have these impacts, thus to decline them must focus on various key fiscal measures (Shrestha et al., 2018). Atlin (2017) defines adaptation as an ongoing process in which we adjust to the ever-changing climate by creating and implementing superior breeds and efficient crop management strategies. Agriculture has historically relied heavily on continuous adaptation to environmental conditions, particularly in areas like breeding and crop management (Postma et al., 1988).

Adaptation of fiscal measures, according to Waha et al. (2013), boosts agriculture production and also lessens the severity of the effects of climate change. Stouten Borough and Vedlitz (2013) emphasized how critical it is to have access to relevant information as a key enabler. In a similar vein, the limitations imposed by physical environments also have significant implications for human adaptation. Afshari et al. (2009) looked at the factors that influence how educators utilize information and communication technology. Information and communication

tools have the potential to play a highly effective role in the process of fostering an environment and increasing productivity.

It is generally acknowledged that the single most crucial element of strategic responses to the problems posed by various fiscal measures is an adaptation to it (Moser and Lures, 2008). Insufficient resources (such as farm input availability, water, and water access routes, land constraints, etc.), inadequate income, loan restrictions, and a complex banking system are all important problems (Antwi et al.,2014 and Bryan (2009). Lack of labor, insufficient government assistance or other agricultural extension services, and an insufficient supply of farm inputs are additional contributing issues (Khanal, 2009).

Because of fiscal measures, adaptation has taken on a new level of importance and likely a different meaning (Alley et al., 2010). According to Salvato (2009), the most significant difference between the ordinary adaptation process that has been commonly known and conducted by human beings over centuries and the adaptation process that is related to the impacts of fiscal measures is primarily the level and scale of involvement. The current impacts of fiscal measures have the potential to have an effect on almost every aspect of human life, including but not limited to agriculture, human settlements, physical infrastructures, water resources, environments, and biodiversity, and the economy in general (Pittock and Jones, 2000; Adger et al., 2003; Schlenker and Lobell, 2010; Ahmad et al., 2013).

Fiscal measure adaptation is defined as the process of improving agriculture production and defending the agriculture sector from harsh ecological threats which mostly took place due to greenhouse gas emissions (Boucher,2014). Farmers face production risks as a result of climatic and pest conditions, market risks as a result of fluctuations in input and productivity prices, and institutional risks as a result of agricultural, environmental, and strength laws. These risks can all have a negative impact on their businesses, therefore to minimize the losses from these risks farmers must focus on the appropriate utilization of the basic fiscal tools (Hardaker, 2004).

1.3 Problem of the Statement

Alternations in the fiscal measures on both the demand and supply side have keen effectiveness on agriculture productivity. A large number of developing countries have low agriculture productivity due to a lack of access to interest-free agriculture loans. In Pakistan, farmers lack research-based agricultural inputs. Farmers are facing multiple problems in their agricultural

business like the availability of water, cheap subsidized seeds, fertilizer, pesticide, etc. Habibullah et al. (2019) studied that there are 7.2 million farm families out of which 90 % of farmers have less than 12.5 acres of land. These farmers do not have the capital and financial resources to combat climate change.

Now there exists a need for government support to farmers to increase agricultural productivity. A country with a poor fiscal structure also has low agricultural productivity because of the severe deprivation of basic facilities required to boost agricultural production. Shevchuk and Kopych (2017) highlighted the strong linkages between fiscal measures and agriculture productivity and found that without appropriate fiscal measures, the appropriate level of agriculture productivity can't be achieved. Gaiha et al. (2010) stated that fiscal measures had quite a crucial role in growth and agriculture productivity acceleration for both developed and developing countries. Okoh (2015) described that most of the fiscal measures lead to a boost in agricultural productivity, however, some fiscal measures like increasing customs duties and various other heavy taxes on the production sector declined agriculture productivity. The under-discussion developing economy of Pakistan is also facing serious challenges of low agriculture productivity because of a couple of major reasons like poor fiscal policy regarding the agriculture sector and also increasing demand for agricultural goods due to population pressure. Thus, as per the sensitivity of the problem of low agriculture productivity, the research in hand made a distinct effort to find the key causes of low agriculture productivity under various fiscal measures and also recommend an effective solution under these fiscal measures which helps to enhance this agriculture production for discuss developing state of Pakistan.

1.4 Significance of the Study

The production of agricultural goods is heavily reliant not only on environmental factors like variations in the weather and climate but also on factors that are not related to the environment, such as various fiscal measures and the pace of technological advancement. This study can serve as a foundation for future research on agriculture and the retrieval of information regarding the impacts that agriculture has had on the overall production of Pakistan's agricultural sector. The gaps that exist in the implementation of climate adaptation policies for the agriculture sector at the national level are investigated to establish this framework.

This study makes a significant contribution to a more comprehensive understanding of how authorities in Pakistan support the farmers in their efforts to adapt to the various climatic and environmental changes that affect and/or threaten the livelihoods of resource-deficient farmers. This study wants to measure the impact of adaptation measures taken by officials of Pakistan to cope with climate change in the agriculture sector.

The findings of this study provide decision-makers with a useful blueprint for developing and enacting an effective strategy to protect the agricultural industry from the impacts of climate change. Because of various kinds of adaptation strategies that are made available by private and public institutions, unequal distribution of benefits and inadequate provision is fairly commonplace. This research also demonstrates why it is essential to have a solid understanding of the local adaptation strategies and problems, as well as the character of adaptation efforts led by businesses and governments. Our framework is useful because it offers an efficient mechanism for incorporating concerns about climate change into development policy and plans at the subnational level.

1.5 Motivation of the Study

The study in hand is based on exploring the impact of fiscal measures on agriculture sector productivity; evaluating the empirical evidence from Pakistan. Given study will motivate the reader into following key aspects; initially, it is the key idea that described different key variables of agriculture loan, agriculture research, agriculture infrastructure, and agriculture investment impact on agriculture productivity and provides in-depth knowledge about the utilization of these factor in the production process to enhance productivity. Secondly, the estimation method adopted to explore outcomes provides an inclusive stream of knowledge about the analytical package of the autoregressive distributed lag model. Thirdly, on the bases of estimated outcomes, the policy has drawn in such an easy context, that motivates the readers to adopt these elements in the production process quickly for the uplifting of agriculture productivity. Lastly, this study also has motivational views, because it is based on a wide stream of easily understandable knowledge that not only creates an ease for the readers but also straightens a pathway for more comprehensive research in the future.

1.6 Research Gap

After the detailed introduction regarding the current problem, it has been broadly noted that an extensive array of literature has been found nationally and globally that studied fiscal measures and agriculture productivity linkages for different states like Okoh (2019) described the effectiveness of the fiscal policy on agriculture production in Nigeria. Okoh (2015) studied the influence of various tax measures on growth and agriculture production in the developing economy of Nigeria. Zakaria et al. (2019) defined the impact of financial development on agriculture production in five countries in the South Asia region. Llanto (2012) explored the influence of infrastructure development on agricultural productivity in the Philippian economy. Similarly, Iqbal et al (2003) analyzed the institutional credit effectiveness on agriculture production in Pakistan. However, as per knowledge, no single study could find the impact of whole fiscal measures on agriculture productivity Hence, the research gap of how all fiscal measures as a whole affect agriculture productivity in Pakistan is still needed to be addressed. The originality of the existing study is that it made a comprehensive effort to explore the influence of all relevant fiscal measures on agriculture productivity in Pakistan through well-organized statistical methods of ARDL bound testing co-integration tests.

1.7 Research Question

Reserves in people's homes are crucially important for local adaptation since they allow people to either save for or invest in such measures. Financial assistance can aid the affected populations in recovering fast and returning to regular life after a disaster. The families may be able to take adaptation steps if they have the financial resources. Secondly, in Pakistan mostly there is a shortage of fertilizers and pesticides which are imported, and farmers cannot afford to buy such expensive imported inputs. Thirdly, individuals and small communities cannot build dams for the provision of in-time water supply to irrigate. Fourthly, individual farmers cannot initiate research institutions for research-based highly productive inputs. Last but not least, infrastructures like evacuation shelters, boats, life-saving buoys, etc. are also crucial forms of human-made capital in dealing with flood risk. Acknowledging this, the authorities and NGOs have started to provide farmers with basic financial and infrastructure resources. Agriculture is the primary industry that contributes to Pakistan's economy, and the government’s support to cope with the seasonal temperature, precipitation, and water availability system that exists in the Indus Plain is essential to the success of this primary activity. So, this research poses the question that how far the

government of Pakistan has succeeded in supporting the farmers in coping with changing climate through fiscal measures?

1.8 Objectives of the Study

- To estimate the effect of agriculture subsidy on agricultural productivity in the long run.
- To estimate the effect of government expenditure on infrastructure over a longer span of time.
- To suggest the policy on the basis of results to enhance the agricultural productivity of Pakistan.

1.9 Organization of the Study

Chapter 2: This section discusses the general impact that fiscal measures are having on agriculture. Additionally, it provides a concise description of several other studies. The second section begins with a quick overview of some of the responses to fiscal measures before focusing on the function of international organizations. The third section explains the approaches that were used to measure the effects of fiscal measures and briefly discusses the advantages and disadvantages of each methodology. The fourth portion identifies the research gap.

Chapter 3: It is broadly accepted that the selection of appropriate methodology is quite a crucial step of any research. For the measurement of well-accepted outcomes, while examining qualitative or quantitative data, a balanced methodology is necessary for every research dilemma.

Chapter 4: This chapter presents the methodology-based estimations and results of research variables in depth. A dependent variable is agricultural productivity. Agriculture loan, Agriculture subsidy, Agricultural research, availability of water and Agriculture infrastructure are all independent variables in this study. However, due to issue of multicollinearity availability of water has been removed by statistical package itself to avoid spurious regression. The current study is secondary in nature, and it examines a few key factors during the sample period 1981-2020.

Chapter 5: As per importance of the fiscal measures for the agriculture production, the study in hand explores the dynamical impact of fiscal measures on agriculture productivity in Pakistan by utilizing globally organized ARDL (Autoregressive Distributed Lag) bound testing method, and time series data since 1981 to 2020. The ARDL model use to dynamically measure the influence of fiscal measures on the agriculture sector productivity in Pakistan in both the long and short span of time.

CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

The agriculture sector in Pakistan is probably going to be significantly impacted by the consequences of various climate changes. This chapter provides an overview of earlier research that has been done as well as the current body of literature that is available on various facets of the research issue. The literature study has been divided into four major categories to account for the effects of fiscal measures. This research makes an effort to acknowledge the concept of fiscal measures in the opening section. Additionally, it provides some insight into how Pakistan's agriculture industry will be boosted by the adoption of key fiscal measures.

This section discusses the general impact that fiscal measures are having on agriculture. Additionally, it provides a concise description of several other studies. The second section begins with a quick overview of some of the responses to fiscal measures before focusing on the function of international organizations. The third section explains the approaches that were used to measure the effects of fiscal measures and briefly discusses the advantages and disadvantages of each methodology. The fourth portion identifies the research gap.

The agricultural industry in Pakistan has also been positively influenced by the utilization of numerous fiscal measures. According to the findings of several studies, under ARDL analytical method, with dramatic climate change an increase in agriculture subsidy and loans has the potential to boost rice and wheat yields for a longer period. The United Nations Framework Convention (UNFCCC) defines the "adoption of fiscal measures has the direct or indirect impact on human activities, that caused leading role to influence the agricultural production. Fiscal measures are the long-term alteration that was easily observable from the per hector agriculture production (Zeb et al., 2013). The research that was carried out also estimated the effect that many other factors have on the productivity of agricultural land. This research also suggested significant policy measures that could be implemented to enhance the beneficial effect that various fiscal measures are having on land productivity in the province of Punjab in Pakistan.

To evaluate the effects of fiscal measures on agricultural operations in Southern Africa for both irrigated and dry land settings. Desersa et al., (2005) used a Ricardian model that takes into account grower adaptations. This model was used to evaluate the situation. For the purpose of the study, data were collected from 11 different districts over a period of 11 years, from 1977 to 1998. Data from time series were utilized for this study. According to the findings, scholar stated that fiscal measures and climate change has significant effects on the net productivity per hectare of sugarcane in South Africa meaning that drastic climate change adversely affects the productivity in the agriculture sector while adopting few fiscal measures played a significant role to decline the harsh impact of changing climate in the area under study.

An agricultural model was used by Gouveia et al. (2009) to forecast agricultural yield in the tropical southern region of Brazil. Agricultural productivity was forecasted for the years 2020, 2050, and 2080, taking into account the potential effects of changing temperature, precipitation, and other fiscal factors. The Auto Regressive Distributed Lag Model was utilized in this study to highlight the impact of fiscal and climatic variables on agricultural productivity in Brazil. The estimated results revealed both fiscal and climatic variables are positively affecting the agriculture productivity in Brazil. Further, the experimental findings suggest that the potential productivity (PP) will increase significantly with an increase in temperature especially in the winter season, and also with adoption of the key fiscal measures like agriculture subsidies, loans and agriculture research, etc.

The effects of climate variability and water availability for various yield production in Swaziland are analyzed by Knox et al., (2012) using a crop growth model and the time series data that was collected from 1980 to 1997. According to the findings, an increase in the expected climate variability in the future played a vital role in adversely influencing the agricultural productivity of sugarcane, however with a boost in unpredicted temperature can be controlled at a wider extent with appropriate availability of water and various other fiscal measures like subsidized agriculture products and loan, etc.

Mali et al. (2014) investigated the role of fiscal as well as climatic measures on agricultural productivity and found that variations in both measures had a significant impact on the production of various agricultural products like sugarcane, rice, and wheat crops, etc. The results of the study

showed that sugarcane, rice, and wheat crops without the adoption of key fiscal measures especially the time of drastic climatic changes, such as monsoons had significantly declined.

Van Passel et al. (2017) used regression to analyze the effect of fiscal measures and climatic hazards on European agriculture through the globally accepted multiple regression analysis and time series data of 19 years from 1992 to 2010 and found that European agriculture had achieved significant benefits from the adoption of fiscal measures against serious climatic hazards like continuous temperature rise and unpredicted rainfall due to savior environmental contamination. According to the results of the study, it was found that Europe would achieve significantly higher benefits from the adoption of fiscal measures than the United States and Asia. In addition, the amount of land lost by the twenty-first century could range anywhere from five percent to thirty-two percent, depending on the available fiscal scenario. The effects of fiscal measures vary from farm to farm depending on their location, with irrigated farms experiencing a different range of effects than desert farms.

Shakoor et al. (2011) statistically explored the dynamic impact of various fiscal adaptations and changing climate on the agriculture production of the arid zone of Pakistan. For the calculation of outcomes, primary as well as time series data and the Ricardian statistical approach were used. Results of the study widely highlighted that without adoption, increasing temperature has quite harsh effectiveness over agriculture productivity in arid zones of Pakistan. However, it has been significantly noted that by adopting various fiscal measures agriculture production got improved. It simply means that the harsh influence of changing climate can be minimized to a wider extent and agriculture production can be enhanced by adopting different fiscal measures.

Schlender and Lobell (2010) studied fiscal measures' impact in financial terms on Kenyan agriculture production. The goal of the study was to determine the extent to which Kenya's agricultural output is being impacted by fiscal measures in financial terms. A sample of 816 households' climatic, soil hydrology, and household data was taken from the Cross Nairobi et al. (2006) sectional data. The study examined the link between financial terms and net crop revenue per acre over the years 1970 through 2016, using a seasonal Ricardian model. It was found that the amount of agricultural production is influenced by various fiscal financial terms like agriculture subsidies and agriculture loans.

Huong et al. (2018) examined the effectiveness of various fiscal measures in the form of adaptation and climate change on agriculture production in Vietnam. Vietnam survey data of 1055 households and a Ricardian statistical approach were employed to calculate the empirical outcomes. Analytical results evaluated that without fiscal adaptation increase in temperature and rainfall declined agriculture production to a greater extent, especially in the dry season. However, adopting fiscal measures significantly evaluated that increasing temperature and rainfall has quite minimum adverse impact on agriculture production in the study area of Vietnam.

Khan et al. (2022) studied the impact of climate changes and fiscal adaptation on the monetary value of agriculture production (Net Farm Revenue) of five major crops grown in two distinct seasons 'Kharif and Rabbi' in Pakistan by using a survey data set of HIES, 2015-16 and time series data since 1981 to 2016 along with globally accepted Ricardian approach. An empirical measurement of the study widely concluded that upsurges in winter (summer) temperature and average summer (winter) rainfall significantly favorably (adversely) impact crop productivity in Pakistan in both summer (winter) seasons. However, it has also been observed that continuous increase in temperature is quite harmful to crop productivity but at the same time, this harmful impact of temperature can be significantly reduced by adopting various fiscal adoption.

Kayani et al. (2018) examined the effectiveness of climate change and a couple of fiscal measures like credit dispersal fertilizers used on agriculture productivity of the province of Punjab Pakistan. To explore outcomes, time series data from 1985 to 2015 and the globally accepted analytical method of the ARDL (autoregressive Distributed lag) model have been used. Results of the study widely highlighted that agriculture productivity and all the regressors, temperature, rainfall credit disperse and fertilizers are co-integrated with each other's. Nevertheless, the individual impact of each variable revealed that except for temperature increase, all other variables are playing a significant role to boost agriculture productivity in both longer and shorter spans of time in the province of Punjab, Pakistan.

Farooq and Kannan (2016) investigated the association between two major crops; kharif and rabbi yield and three key variables maximum, minimum temperature, and average rainfall. To explore the outcomes, time series data from 1974 to 2011 and the vector autoregressive (VAR) model have been used. Results of the study widely stated that on the kharif rice crop maximum and minimum

temperature had favorable while rainfall had an adverse impact. Contrarily, on the rabbi rice crop maximum and minimum temperatures had adverse while rainfall had a favorable impact. Thus, overall measurement widely recommends that in both rice cropping seasons, the burning challenge of changing climate can be mitigated by implementing appropriate different fiscal adaptations.

Janjua et al. (2014) investigated the influence of changing climate and various fiscal adaptations on agricultural production, especially wheat crops in the developing state of the Pakistan by employing time series data from 1960 to 2009 and ARDL (autoregressive distributed lag) analytical approach. Measurements widely demarcated that all the study variables are significantly correlated with each other in the long run because there is strong evidence of co-integration between a dependent variable and all the regressors. Further individual impact on both shorter and longer periods of time demonstrated that climatic indicators had no significant impact on wheat productivity in Pakistan. However, various fiscal adaptations had revealed a significant positive impact on wheat productivity which means wheat productivity in the developing state of Pakistan can be uplifted to a greater extent by adopting various fiscal adoption like using subsidize fertilizers, advanced technology, and agriculture credit, etc.

Thappa et al. (2010) measured the impact of changing climate and various adaptations like farm credit and education on agriculture production of the agrarian economy of Nepal. To calculate empirical outcomes Ricardian land valuation methodology and a couple of data sets like cross-sectional data of Nepal Living Standard 2003/04 and time series data from 1977 to 2006 of climatic indicators had taken under consideration. Empirical outcomes widely demarcated that both climatic and non-climatic (fiscal adaptation) had a significant impact on the agricultural productivity of Nepal. Further, per unit analysis highlighted that farmer agriculture production in monetary terms had been uplifted with summer rainfall but declined with temperature hikes. Moreover, fiscal adoption of farm credit and education widely demarcated that by adopting more fiscal measures one side play's role to adopt precautionary measures against adverse climatic effects while on the other side, it also plays a role to enhance agriculture productivity in the study area.

Siddiqui et al. (2012) studied the impact of climate change fiscal adaptation on four major crops (wheat, rice, cotton, and sugarcane) at the district level in the province of Punjab, Pakistan by using

time series data from 1980 to 2008 and well- reputed basic panel fixed effect model. The results widely highlighted that except for the wheat crop, drastic changing climate adversely influenced the all-other crops namely rice, cotton, and sugarcane. However, various fiscal adaptation reveals a positive impact on all the crop's productivity which means in every season to minimize drastic climatic effects it is necessary to adopt different fiscal measures like fertilizers subsidy, agriculture credit subsidies, and agriculture loan, etc.

Kabubo-Mariara and Karanja (2007) examined the climatic and non-climatic (fiscal adaptation) impact on crop production in Kenya by using survey and time series data as well as Ricardian Model. Estimated results revealed that climatic variable initially has a significant impact on crop productivity in Kenya. However, non-climatic variables highlighted that by employing fiscal adaptations like farm credit, education and subsidize irrigation one side crop production can be enhanced while on the other side, drastic climatic impact on crop productivity can also be curtailed.

Dumrul and Kilicaslan (2017) inspected the economic influence of changing climate on agriculture production in the developing state of Turkey by employing time series data from 1961 to 2013 and an ARDL (autoregressive distributed lag) analytical approach. Measurements widely demarcated that all the study variables are significantly correlated with each other in the long run because there is strong evidence of co-integration between a dependent variable and all the regressors. Further individual impact on both shorter and longer periods of time demonstrated that climatic indicators like rainfall (temperature) had a significantly positive (negative) impact on agriculture production in the developing state of Turkey. To minimize the adverse impact of drastic change in climate on agriculture production Turkey must focus to utilize different fiscal adaptations like subsidized fertilizers, advanced technology, and agriculture credit, etc.

Mishra et al. (2016) studied the key influence of climate sensitivity on agriculture production in Odisha, a state in eastern India. To measure outcomes a couple of climatic variables temperature, rainfall, and panel Ricardian model is taken under consideration. Estimated outcomes widely demarcated that both climatic variables had a significantly harsh impact on agriculture production in the study area of Odisha, a state in east India. Therefore, to minimize this adverse effectiveness in the future, there is desired need on urgent bases to adopt some quite crucial fiscal measures during the production process.

Shakoor et al. (2015) described the vulnerable impact of the drastic changing climate on rice crop production in Pakistan by using time series data from 1980 to 2013 and VAR (Vector autoregressive) statistical model. Empirical measurements widely highlighted that increasing temperature had an adverse impact on rice crop productivity in Pakistan. However, rainfall had a beneficial impact on rice crop productivity. Further, the simulation situation till 2030 highlighted that both increasing temperature and rainfall both had a drastic impact on rice crop productivity in Pakistan. Therefore, to minimize these adverse influences, Pakistan must need to focus on various fiscal adoption like increasing farm size, create the possibility of the provision of subsidized fertilizers as well as irrigation.

Ali et al. (2017) inspected the vulnerable impact of changing climate on four major crops (wheat, maize, rice, and sugarcane) of Pakistan by using time series data from 1989 to 2015 and an FGLS (feasible generalized least square) analytical model. An estimated outcome of the study deliberately highlighted that maximum temperature harshly affected the wheat crop only while minimum temperature and average rainfall has a positive influence on all the selected four crops. Thus, by summing up the discussion, it has been noted that in the developing state of Pakistan changing climate had a drastic impact on different crop productivity. Therefore, to mitigate the challenge, it is necessary to adopt various fiscal measures appropriately during the production process.

2.2 Climate Change, Fiscal Measures and Agricultural Sector

Agriculture, which is highly susceptible to the effects of climate change, is the backbone of the economies of most nations. Consequently, agriculture is the cornerstone of economic development, which can play a role in the alleviation of poverty. It is essential to place a strong emphasis on the agricultural sector, particularly on the effects of climate change, to eradicate poverty and hunger. Agriculture is a sector that is highly dependent on natural resources and is subject to a variety of climatic stresses. As a result, it is essential to devise effective strategies for adaptation and mitigation that are tailored specifically to this industry. According to the findings of Stokes and Howden (2010), the climate change and various fiscal measures on agriculture can be broken down into two categories: direct and indirect. This study explains that climatic patterns such as temperature and precipitation and fiscal measures like agriculture subsidies and loans directly influence growth development. Climate and fiscal measures also influence production

aspects indirectly such as the availability of water, soil fertility, agriculture research and agriculture infrastructure etc.

The impacts of climate change and fiscal adaptation are felt negatively and positively in both economically developed and less developed nations. Emerging economies, on the other hand, are particularly vulnerable because they have not yet focused on adaptation to their environments. The economies of Pakistan are especially susceptible to the effects of climate change due to poor fiscal adoption strategies and also direct reliance on agricultural productivity. Even more so when one considers that developing nations only make up a minuscule portion of the world economy, it is inevitable that these nations are contributors to the factors that result in climate change because of their location. They are subjected to more severe consequences, and the fact that they are not equipped with modern technology or sufficient financial and fiscal resources makes the problem even worse (Weitzman, 2007).

Numerous factors have an impact on the strategies that can be utilized in response to alterations in the climate. Farming and the socioeconomic characteristics of farmers are among them. In addition, these characteristics vary from farm to farm and from farm household to farm household. It is therefore of the utmost importance to comprehend how small landholders understand climate conditions, the effects of those conditions on agricultural productivity, and the ongoing adaptation measures taken by farmers. It is difficult for the government of Pakistan to assist farmers due to a lack of resources as well as the breadth of the problems that exist in the country (Sadie, 2018). The governments of emerging nations have a strong urban bias in public investment to provide for the ever-increasing population in urban areas as well as the operations of industrial businesses.

Brien and Leichenko (2000) researched to investigate the effects of globalization on the economy and the climate. These long-term occurrences were going to change the world in the long run, and their repercussions were extremely varied, multifaceted, and interconnected with one another. According to this study, those who would benefit economically from these changes would be considered economic gainers, while those who would be adversely affected would be considered economic losers. Poor people all over the world, regardless of where they live, are the ones to bear the brunt of the effects of climate change. The wealthy, on the other hand, might also be impacted by an increase in extreme weather occurrences like floods, storms, and droughts;

however, because of their better capacity for adaptation, they can reduce their financial losses by taking the necessary preparations, such as buying insurance.

Production, consumption, technology, trade, worldwide investment, and pay patterns would all be affected by globalization, but the total worth of the global economy wouldn't alter. According to the regional impacts, Africa would be the region that would suffer the most severe negative effects, both in terms of the effects of globalization on the economy and the effects of climate change. The agriculture sector is also threatened by these, and small farming communities and those practicing subsistence farming would suffer economic losses as a result. Industrialists, corporate farmers, and mechanized peasants, on the other hand, would enjoy economic benefits. In terms of social class, the negative effects would be felt most strongly by those living in small cities located in developing regions. On the other hand, those living in large cities would also be subject to adverse effects.

According to Smit and Skinner (2002), climate adaptation for Canadian agriculture was evaluated, and potential adjustments were suggested for farmers, policymakers, and industry. It differentiated the adaptations in terms of the time frame, agriculture subsidy, and agriculture research, as well as the current responses of stakeholders to climate change and the amount of time it takes for modifications to take effect. The most significant changes were brought about by advances in technology and agriculture subsidy. These changes improved agricultural management as well as government spending, investment, and insurance. They concluded that farmers would be in a better position to protect the environment and improve their capacity to adapt to changes in the climate if they were provided with comprehensive information. The majority of actions that can be taken to prepare for the effects of climate change involve modifying existing agricultural management practices and changing official government policy.

Researchers Jones and Thornton (2003) found that global agricultural productivity concerns are exacerbated by climate change. They studied the impacts of climate change on maize output in Africa and Latin America. Producing weather data for more complicated maize crop simulations with the help of methods that have a high resolution. In general, the research showed that crop yields would decrease by ten percent by the middle of this century and that the losses would be significant. In the United States alone, approximately two billion dollars are spent annually on agricultural productivity.

Researchers in the United States, led by Reilly et al. (2003), examined the impact of climate change and fiscal adoption on agricultural output in the 2030s and 2090s. The impacts of future climate change on growing crops and agricultural land, livestock, chemical use, demand and supply, and demand for food were all factored into the simulations for water availability, international trade, and prices. In addition, the demand for food was also taken into consideration. The findings of the study indicated that climate change and fiscal measures have on the whole, a positive influence on agricultural productivity in the United States; however, there were regional differences, and climatic variations in the southern United States might have a negative impact. As a result of temperatures rising, crop production enjoyed several benefits in 2090 that were not present in 2030. These benefits were directly related to the higher average temperatures and appropriate fiscal adoption.

According to Padgham (2009), the assumption that agricultural productivity receives a large portion of agricultural investment due to the high expected productivity is at the root of the problem. The agricultural practice of storm farming is fraught with significant difficulties, including water management, heat conservation, and nutritional management, all of which place greater reliance on the actions of natural forces. According to a report by Maddison (2006), it is essential to keep in mind that these areas may be subject to adverse effects of climate change, such as alterations in the patterns of rainfall and the stress caused by heat.

Gbetibouo (2009) suggested that farmers' ability to adapt to new circumstances is just as crucial in mitigating the effects of climate change on agriculture. Plant diversity is crucial for adaptation to climate change. In addition, they explain that the difficulties associated with agricultural adaptation are caused by a lack of technical understanding, a lack of financial resources, and small farm size.

According to a study conducted by the OECD (2011), efforts to adapt to climate change are concentrated on a very small scale at the national and provincial levels. It is of the utmost importance to provide integrated support on the technological, socioeconomic, institutional, and policy levels to the agricultural community to combat the changing climate. To avoid the negative impacts of climate change, fiscal adaptation is necessary; in its absence, these effects will gradually take place. Climate models have predicted that there is an increase in the number of instances of high rainfall events, heat waves, and floods that are destructive. Consequently, in light of the

aforementioned climate change scenario, the implementation of adaptation strategies is required. It is widely believed that adaptation is a promising step toward strengthening local capacity to deal with both expected and unforeseen climatic conditions.

According to Truelove and Parks (2012), the measured frequencies of the responses are reported to comprehend the behavior of the respondent. For the purpose of comparative analysis, these frequencies are displayed as figures. There is no evidence of climate change, particularly increases in temperature, in this region. Effects of climate change are especially clear in the northern regions of Pakistan, as evidenced by the explosion of Lake Explosion, the sliding of land, the melting of mountains, and the flow of rivers.

According to Jarawura (2014), the combination of local perception and scientific ideas provides the foundations for effective adaptation. If farmers believe that climate change poses a risk to their livelihood, they will adjust their practices accordingly. Because the majority of those who participated in the survey held the opinion that climate change is not an ongoing process and that variations in the weather have become increasingly common over the past two decades. For this research, information was gathered from the household head regarding the socioeconomic characteristics of the household, as well as the household's perceptions of adaptation strategies to climate change, as well as obstacles to adaptations.

The study by Amadou and colleagues (2015) investigates the effects of climate change on Ghana's agricultural sector. They concluded that farmers in Ghana are aware of rising temperatures, changing patterns of rainfall, and an increase in the frequency of floods. On the other hand, farmers have a unique point of view regarding hailstorms as well as the early, late, and inconsistent arrival and departure of winter and summer. There were approximately 55 people who claimed to not know whatsoever about climate change. The question was posed to the farmers asking them to report on what they knew about the changing climatic pattern, and this is what they came up with. They were given background information on what climate change is as well as the indicators that represent climatic variance, specifically increases in temperature.

Howden et al. (2007) investigated the fiscal adaptations against climate change with a clear stance that changing climate had significant effects on agricultural productivity. Their findings were published in Nature. In terms of climate adaptations that have been proposed, the change in the management of climate risk is already in place. The suggested adaptation in management

operations at the farm would only work for moderate climate change; however, to adapt to severe changes, extensive work on adaptation, such as diversification in crops and livelihoods, is required.

2.3 Climate Change Adaptation in the Agricultural Sector of Pakistan

Stocker et al. (2013) argue that Pakistan's poor infrastructure and inadequate ability to adjust to changing conditions are to blame for the harmful effects of climate change on agriculture in the country. Changing crop patterns and the types of crops grown are highlighted as two key adaptation methods documented in the Pakistani agriculture sector, as the authors of this study explain further.

Abid et al. (2015) highlighted the importance of adapting fiscal agricultural practices to climate change to lessen the impact of climate change on crop yields. On the other hand, there has been insufficient adaptation in Pakistan because there is a lack of information about climate change. Rice and wheat, both of which are important staple crops, are expected to have significant adverse effects due to their widespread cultivation. These effects on agricultural commodities pose a threat to agricultural productivity in Pakistan because a significant portion of the population relies on wheat and rice for their economic well-being.

Ali and Ernestine (2017) found that there are several aspects to consider while adapting to climate change. Increased agricultural adaptation might mitigate agricultural risk if policies addressing these concerns were implemented. The impact of this is related to Pakistan's agricultural productivity. However, the results of this study indicate that the literature already in existence offers the most information regarding the variables that affect the adoption of technology or practices as climate adaptation strategies in the Pakistani agricultural sector.

Nasir et al. (2018) did a study to determine how farmers view climate change, and their findings indicated that most farmers are aware of the shifts taking place as a result of this phenomenon. They have the ability to forecast and anticipate weather based on the information they have internally. At least two different aspects of the research are improved as a result of this study. First, the sample size of this study is at least three times larger than the one we used in ours. When compared to a sample that is too small, a sample that is sufficiently large is much more likely to produce accurate results. Second, the area chosen for the study is situated in a region that is predicted to be particularly hard hit by the effects of climate change in the form of water scarcity and drought.

CHAPTER 3

MATERIAL AND METHODS

3.1 Introduction

It is broadly accepted that the selection of appropriate methodology is quite a crucial step of any research. For the measurement of well-accepted outcomes, while examining qualitative or quantitative data, a balanced methodology is necessary for every research dilemma. Therefore, the given study used well acknowledge methodology with four different parts; initial part entails a unit root test which is used to check, whether the mean and variance of the data over the period of time comprehend variations or not, in simple words it discusses that over time data is stationary or it needs unit root for the stationarity. However, in the second part, a comprehensive econometrics procedure is used which designate the impact of independent variables over dependent variable. It simply means how much change in dependent variables takes place due to unit change in the independent variable. The third part consists of a diagnostic test that guaranteed the accuracy, relatability, and consistency of the outcomes. In the end, the fourth part consists of Granger Causality measurements which described the cause-and-effect relationship among variables. Given methodology has the authentic theoretical and statistical background for the estimation of time series data.

3.2 Theory of Production

This section’s goal is to review the theoretical methods used to measure fiscal policy and agricultural productivity in the larger body of literature. The section begins by defining key concepts including technical advancement growth in productivity and efficiency. This is required for supplying a clear understanding of how these phrases are used in the examination of agricultural output. It is crucial to highlight that research on agricultural productivity can be divided into two groups: theoretical and empirical, before identifying essential ideas in productivity analysis. More clearly describe productivity and its factors and establish estimation relationships they also offer potential theories that are empirically evaluated. Rising unemployment will result if the rise of the economy's productive capacity is not matched by an

increase in the overall demand for goods and services. Although many experts have emphasized that the execution of macroeconomic policy is a crucial issue, the ideal policy mix is a combination of fiscal policies that help macroeconomic policymakers to achieve their goals. According to them, the issue of the appropriate mix of fiscal policies emerges because the two policies are interconnected and reinforce one another, indicating that they are complementary. Additionally, each is dependent on the other for effectiveness (Ekanem, 1999). Monetary policy, which affects money supply and credit availability, and fiscal policy, which impacts the overall flow of purchasing power, are the two main tools for regulating demand. According to Wise Geek (2013), a variety of factors that are difficult to consistently foresee or fully comprehend beforehand affect how effective fiscal policy will be.

According to Wise Greek's analysis, the amount of time that passes between the introduction of a new policy and the realization of its effects, the influence that changes in policy have on interest rates and other aspects of the economy, as well as the quality of the policy change itself, are all additional factors that contribute to the success of the fiscal policy. The purpose of macroeconomic policy is to bring the rate of inflation, unemployment, and economic growth to levels that are considered to be objective. According to Dornbusch (1990), fiscal policy is what outlines the scope and structure of services that the government will fund; it also modifies the distribution of income through taxes and maintains economic stability so that these objectives can be met if aggregate demand increases at a rate that keeps up with productive capacity. If overall demand does not expand at a higher rate than resources become accessible, then inflationary pressures will increase.

Kelly et al. (1995), on the other hand, present empirical facts, analyze patterns over time, and quantify the contributions of particular inputs, regulations, technologies, and other factors that enhance productivity. The comprehensive categorization used in the research provides the organizational structure for this review. The next section covers empirical micro, whereas this section looks at the theoretical foundations of productivity and fiscal implementation on agriculture production.

It is crucial to be able to gauge how changes in production methods affect the finished product as they occur. It is better to include these impacts in the production function's purview. Having a

simple production connection where the output is dependent, and the production function can be expressed as inputs for labor and capital (K, L).

$Q = \int(K, L)$---------- (1)

Where the amount of K and L used determines Q (the output). It is anticipated that Q will rise or fall in proportion to changes in the values of K and L. By using the same level of K and L, Q can likewise rise. However, in addition to the increase in the generally specified inputs, other factors can also be responsible for output growth. Whenever this occurs, technical advancement. In terms of the relationships between the production change can be described as a change in the production possibilities.

It has been found that the productivity theory is extensively based on the Cobb-Douglas production function. Particular function widely represents the technological relationship between two or more inputs like capital and labor and the amount of output that is produced by these factors (Khorolskyi, 2023 & Giang and Huong, 2023). Generally, Cobb-Douglas production function is expressed as.

$Y\ (K, L) = AK^{\alpha}L^{\beta}$----------(2)

In Equation 13 Y demonstrates the total production during a year, and K and L are the capital & labor inputs that are utilized during a year for the production of an amount of various goods and services. 'A' is total factor productivity and finally 'α and β' are the elasticities of capital and labor that attain different values during the production process. If $\alpha + \beta = 1$ then the production function is revealing a constant return to scale. $\alpha + \beta > 1$ the production function is revealing an increasing return to scale. $\alpha + \beta < 1$ the production function is revealing decreasing return to scale.

Table 3.1: Productivity Studies on Agriculture, by Approaches: 1986-2017

Authors	Year	Time	Productivity	Methodology
Evenson and Sardido	1986	1950-1984	0.0190	Growth Accounting Method
Fulginiti and Perrin	1998	1961-1985	-0.0250	Growth Accounting Method
Martin and Mitra	1999	1967-1992	0.0207	Growth Accounting
Cororaton and Cuenca Index Number Approach	2001	1980-1998	-0.0056	Growth Accounting Method
Teruel and Kuroda	2005	1974-2000	0.0162	Index Number Approach (Törnqvist Index Procedure)
Coelli and Rao Econometric Approach	2003	1980-2000	0.0130	Index Number Approach (Törnqvist Index Procedure)
Fulginiti and Perrin	1998	1961-1985	0.0010	Production Function (Variable Coefficient)
			0.0180	Production Function (Fixed Coefficient)
Martin and Mitra	1999	1967-1992	0.0164	Translog Production Function
			0.0157	Cobb-Douglas Production Function
Mundlak, Larson and Butzer	2004	1961-1998	0.0025	Production Function (With State Variables)
Teruel and Kuroda	2004	1974-2000	0.0051	Translog Variable Cost Function
Teruel and Kuroda	2005	1974-2000	0.0091	Cobb-Douglas Production Function
Teruel and Kuroda	2005	1974-2000	0.0142	Translog Cost Function
Malmqvist Approach				
Trueblood and Coggins	1997	1961-1991	0.0119	Malmqvist Index
Arnade	1997	1961-1993	-0.0040	Malmqvist Index
Fulginiti and Perrin	1998	1961-1985	-0.0030	Malmqvist Index
Coelli and Rao	2003	1980-2000	0.0080	Malmqvist Index
Adiqa Kiani	2008	1969-2004	0.2863	Divisia Index
Sajjad Ali,Ying Liu, Muhammad Ishaq	2017	1989-2015	0.2501	Feasible Generalized Least Square

Source: Author's Citation

3.3 Methodological Framework

In this modernized era, fiscal measures have quite an important role in increasing agriculture production. In the past few decades' drastic environmental changes adversely influence the agricultural production of the overall world, however, the least developed economy is severely victimized by this menace of environmental change due to poor focus on the adoption of key fiscal measures like attainment of agriculture subsidy and agriculture loan in time, weak access toward the policies of agriculture research institute and poor utilization of agriculture infrastructure. In the recent era literature, it has been widely noted that various fiscal measures have played a vital role to minimize the harmful environmental threats on agriculture production on one side while on the other side, it also plays a role to boost agriculture productivity by encouraging farming community in different monetary and non-monetary aspects. This study does not distinguish between rule-based fiscal measures and discretionary policy measures because previous research on the impact of fiscal policy on agricultural output did not consider it. However, fiscal policy extensively defines as the policy under which government uses different tools like public spending, public borrowing and taxation to achieve different goals that help to make the country on way of progress and also play vital role in running the country's economy smoothly. Fiscal policy is a key tool used by governments to manage the economy through changes in government spending and taxation. The two main types of fiscal policy are discretionary fiscal policy and rules-based fiscal policy. Discretionary fiscal policy involves deliberate changes in government spending and taxation that are initiated by policymakers in response to economic conditions. This type of policy is flexible and can be tailored to address specific economic challenges. During times of economic downturn, governments might increase spending and lower taxes to stimulate demand and boost economic activity. Conversely, during periods of high inflation or economic overheating, governments might reduce spending and raise taxes to cool down the economy. Discretionary fiscal policy requires active decision-making by government officials and can be influenced by political considerations. Its effectiveness depends on the timing, magnitude, and direction of the policy changes.

Rules-based fiscal policy involves setting predetermined guidelines or rules for government spending and taxation based on certain economic indicators or conditions. These rules are often designed to promote fiscal discipline and stability. Common examples include: i) **Balanced Budget Rule:** This rule requires that the government's annual budget be balanced, meaning that

government revenue equals government spending, ii) **Debt-to-GDP Ratio Rule:** This rule limits government debt as a percentage of the country's Gross Domestic Product (GDP) and iii) **Cyclically Adjusted Budget Rule:** This rule allows deficits during economic downturns but requires surpluses during economic expansions to offset the deficits. Rules-based fiscal policy aims to provide a clear framework for fiscal decision-making and reduce the potential for short-term political influences. It can help prevent excessive deficits and debt accumulation, promoting long-term fiscal sustainability.

Both discretionary and rules-based fiscal policies have their advantages and limitations. Discretionary policy offers flexibility in responding to specific economic conditions but can be subject to political considerations and timing challenges. Rules-based policy provides a stable framework for fiscal management but might lack the flexibility needed to address unique economic circumstances. Governments often use a combination of these two approaches, adjusting fiscal policy as needed within the confines of predetermined rules. The choice between these approaches depends on a country's economic goals, political context, and the state of the economy.

Okoh et al., (2019) analytically examined the role of key fiscal measures on agriculture productivity in Nigeria's economy and highlighted those various fiscal measures like dam construction, government investment in infrastructure and irrigation played vital roles to boost agriculture productivity. In developing economy like Pakistan taxation has great important because Pakistan is an agrarian economy but due to high level deprivation in farming community still agriculture tax has not been introduced. The government must focus on farming community and decline their all-basic issues in production process so that they earn heavy amount of revenue and do not feel any difficulty while paying agriculture tax when it is introduced. Introduction of this tax with improvement of farming community livelihood not only promote agriculture sector but also played vital role in country’s overall financial development. Lawal et al. (2018) analyzed the key fiscal measure of government capital expenditure toward agriculture output in Nigeria and found that the fiscal measure of government capital expenditure has a positive role in the boost in agriculture output in Nigeria. Chandio et al. (2023) described the role of financial development on agricultural value added of cereal production in selected Asian economies including Pakistan and found that fiscal measure of financial development has a significant role in boosting the agricultural value added of cereal production in the selected study area. Raza et al. (2023)

described the role of fiscal measures of financial literacy and credit availability on the rice production in Pakistan and stated that both the regressors played positive role toward the boost of rice production in developing state of Pakistan. Chaiya et al. (2023) highlighted the dynamical influence of the formal agriculture credit on the farm production in KPK (Khyber Pakhtunkhwa), Pakistan and found that famer utilization of the credit in agriculture sector especially land preparation and modern technology use played vital role to boost farm production in study area of KPK, Pakistan.

3.3.1 Model's General Specification & Variable Description

The effect of fiscal policy implementation on the agricultural sector has not been as positive as has been expected in recent time. Both fiscal policy implementation and agricultural production are considered to be incredibly significant in nation (Oyeleke and Ajilore, 2014), but studies about their contribution have research as little attention have been given to the contributions of fiscal policy implementation on the agricultural sector, using agricultural sector and manufacturing

$$AP_{\mathrm{t}} = \alpha_o + \alpha_1 AR_{\mathrm{t}} + \alpha_2 WA_{\mathrm{t}} + \alpha_3 AI_{\mathrm{t}} + \alpha_4 AS_{\mathrm{t}} + \alpha_5 AL_{\mathrm{t}} + \in_t$$

The current research studies the long and short-run influence of agriculture indicators and fiscal measures on agriculture productivity of Pakistan by employing time series yearly data from 1981 to 2020. The precise data series of all the key variables are taken from numerous sources like agriculture productivity, Agriculture Research & Agriculture Infrastructure (Pakistan Bureau of Statistics), Agriculture Loan (ZTBL Limited), Agriculture Subsidy (National Fertilizer Development Center, Islamabad) & water availability (Global Waters). Generally, the variables are described as

3.3.2 Agricultural Productivity (AP)

It measures as crop yields kg per hectare. Due to climate change, agricultural productivity around the globe diminished so this study took agricultural productivity of Pakistan as a dependent variable to know the effect of adaptation strategies on agricultural productivity. Total agricultural productivity of Pakistan is taken among 1981-2020, from Pakistan Bureau of Statistics. This variable has been used in previous research by Adu et al. (2014) Submitter et al. (2021).

3.3.3 Agriculture loan (AL)

It determines what percentage of the overall agricultural assets are funded by the owner's equity capital and measures that proportion. Loan disbursement to the agriculture sector is a coping mechanism against climate change. By agriculture loan we mean the amount of loan given to the farmers to buy Agri machinery, seeds, fertilizers, and pesticides. Das et al., (2009) & Hussain and Taqi (2014). The source of agriculture loan is Zarai Taraqiati Bank Limited (ZTBL).

3.3.4 Agriculture Subsidy (AS)

A subsidy for agriculture is an incentive offered by the government to encourage agricultural production. One definition of a subsidy is "a payment provided by the government to people or businesses, either directly or indirectly, generally in the form of money or a targeted tax relief." Subsidies can be given for a variety of reasons. Consequently, agricultural organizations and farms regulate the supply of agricultural goods in order to supplement their existing incomes Garonne et al., (2019) & Kumbhakar and Lien (2010). The information regarding agricultural subsidies comes from the National Fertilizer Development Center in Islamabad.

3.3.5 Agricultural Research (AR)

The goal of the activity was to increase crop yield and quality. It means that advanced and technical material is introduced into the agricultural industry. Agriculture research grew to incorporate disease and pest management, superior cultivars, and productive areas as the industry progressed Evenson (2001) & Alene and Coulibaly (2009). Pakistan Bureau of Statistics is the main source of data on agricultural research.

3.3.6 Agriculture Infrastructure (AI)

Agricultural infrastructure is measured as the ratio of agricultural productivity to inputs. Agricultural infrastructure largely consists of a diverse set of public services that help in the production, procurement, processing, preservation, and trading of agricultural products Llano (2012) & Knox et al. (2013). The data source is the Pakistan bureau of statistics.

3.3.7 Availability of Water (AW)

The provision of water can be accomplished by public utilities, commercial organizations, community endeavors, or even by private individuals, and it is typically accomplished through a network of pumps and pipes. In order for societies to operate effectively, it is necessary to have

public water supply systems. These systems are what provide people living in different parts of the world with water. It measures in MAF (Million acre-foot). Elliott et al. (2014) & Rock Strom et al. (2009). The data source is global waters.

Table 3.2 Summary of the Variables with Unit of Measure and Possible Sign

Variable	Description	Units	Possible Sign
AP	Agriculture productivity is defined as the ratio of agriculture output to input	Yield/hector	
AL	The amount of money loan to finance agriculture production	Million Rupees	+
AS	Amount of money given by the government to farmers either directly or indirectly, generally in the form of money or a targeted tax relief.	Million Rupees	+
AR	An activity that is used to increase crop yield and quality is regarded as agriculture research	Percentage	+
AI	Agricultural infrastructure is measured as the ratio of agricultural productivity to inputs	Percentage	+

3.4 Empirical Specification of the Model with Detail Description

To designate the results at wider extent, the present study used globally recognized literary supported Auto Regressive Distributed Lag (ARDL) Model. Given model is mostly used to predict the long and short run linkage among the variables of the study. It is also a suitable method to evaluate results of the study when variables taken for research are following distinct pattern of stationary condition like few are integrated at level and few are integrated at first difference but none of the variable is integrated at 2nd (Shita et al., 2018 & Koondhar et al., 2020). Stepwise description of the overall model with each necessary test required for current model is given below.

3.4.1 Estimation of Stationarity: Dickey and Fuller Test

After the descriptive measures of the variables. In the first step of the study stationarity of the variable has been checked. Basically, Dickey and Fuller (1979) recommended methodology has been used to explored it. Precise estimation method has numerous features while quite imperative is that it pronounces both, the presence of unit root and stationarity by treating them equally. The precise method is defined on the basis of simple autoregressive AR (1) procedure.

$Z_t = \rho Z_{t-1} + \epsilon_t$ ---------- (3)

In eq. (13) if '' is equal to 1 it purely means that series under consideration is not stationary & comprises of the issue of unit-root which states that data has oscillation in mean and variance over the period of time (Gujarathi,2022). Moreover, to present the picture precisely, the series under debate is further expressed broadly in the following way.

$Z_t - Z_{t-1} = (\rho - 1)Z_{t-1} + \epsilon_t$---------- (4)

$\Delta Z_t = (\rho - 1)Z_{t-1} + \epsilon_t$---------- (5)

$\Delta Z_t = \omega Z_{t-1+}\epsilon_t$---------- (6)

Above describe series of equations (14, 15 & 16) explores the overall statistical phases which are used to present the Dickey Fuller unit root test. In an eq. (14) which reveals that if then Z_t follow a pure random walk situation simple meaning that precise series of present study is stationary at level and it does not need any unit root procedure. Similarly, while if value of it means that the existing data series is non-stationary and it substantially needs unit root. At the end, if value of it means series is detonated and it essentially prerequisite unit root to make them stationary first before any statistical application (Asteriou and Hall, 2021). The disadvantage of using series without making stationary is that, it provides spurious estimates that does not favor the theory and ultimately misguide the researcher during policy making process. However, as per requirement in the first equation (13) of unit root test a constant term is also included. Generally, it is written as

$\Delta Z_t = \alpha_o + \rho Z_{t-1} + \epsilon_t$ ---------- (7)

While in the second equation for the stationarity as per needs a time variant trend is also included a series to confirm stationarity. It is widely discussed for macroeconomics variables. In such case, the constant term is also part of the equation. Generally, the equation is written as

$\Delta Z_t = \alpha_0 + \tau_1 t + \rho Z_{t-1} + \epsilon_t$ ----------(8)

The empirical test statistics of the Dickey Fuller follows 'T' distribution which displays that a series is stationary and it does not need unit root estimation, if calculated value of given test is greater than '2' or probability statistics of such test are less than equal to '0.05' under significance level of 5%. (Gujrati *et al*.,2022).

3.4.2 Estimation of Stationary: Augmented Dickey and Fuller Test

Due to non-ignorable shortcomings of preceding outdated stationarity calculation method, current study also discussed and used latest stationarity measure to predict the apt stationary situation of the variable under consideration. No doubt the previous measure of stationarity has keen importance in empirical research but these non-ignorable shortcoming makes the estimation of the stationarity doubtful and left serious question marks on it. First given series does not include the lag dependent variables and second the estimated residual term of such series is not purely white noise meaning that it does not remove the problem of serial correlation. Therefore, we move toward Augmented Dickey Fuller Test (ADF). Given measure has advantage that it completely removes the disadvantages of previous measure; ADF measure initially includes extra lag term of dependent variable and secondly it makes the residual term pure white noise by removing the problem of autocorrelation. Moreover, lags are selected on the basis of most widely used criteria's i.e., AIC (Akaike Information Criteria) and SBC (Schwartz Bayesian Criteria) (Asteriou and Hall,2021). Generally, the equation of ADF statistics is materialized as;

$$\Delta Z_t = \vartheta Z_{t-1} + \sum_{p=1}^{t} \theta_i \, \Delta Z_{t-1} + \epsilon_t \text{----------(9)}$$

$$\Delta Z_t = \vartheta_0 + \sigma Z_{t-1} + \sum_{p=1}^{t} \theta_i \, \Delta Z_{t-1} + \epsilon_t \text{----------(10)}$$

$$\Delta Z_t = \vartheta_0 + \theta y_{t-1} + \tau_1 t + \sum_{i=1}^{p} \varphi_i \, \Delta Z_{t-1} + \epsilon_t \text{----------(11)}$$

Above discuss eq. (19), (20) & (21) are same like earlier one, however the difference is the extra lag of dependent variable while given equation of both models differ from each other because of the inclusion of constant term and time variant whereas lag selection criteria and criteria for the acceptance or rejection of null hypothesis are same.

3.4.3 Auto Regressive Distributed Lag Model (ARDL) to Explore Fiscal Measure and Agriculture Productivity Relationship

The underpinning dilemma used yearly time series data of different indicators from 1981 to 2020 to find the longer and shorter span influence of agriculture loan, agriculture subsidy, availability of water, agriculture infrastructure and agriculture research on agriculture productivity through ARDL bound testing approach. The basic reason behind the selection of given estimation

technique is different integration level like few variables are integrated at level *I(0)* and few at 1st difference *I(1)* but no variable is integrated at second order *I(2)*. According to earlier ideas of various scholars Shah et al., (2021) Liu et al., (2021) & Saboor et al., (2016) if any variable integrated at order *I(2)* ARDL fails to provided apt outcomes and if results are presented in any study these are not literature supported measures and declared as superior's outcomes. Further Pesaran *et al*. (2001) validated that if any one variable is *I(2)* computed F-statistics is not vialed because basic assumption of bound test approach *I(0)* and *I(1)* is violated. For the current study general form of the model is as follow.

$$LnAP_{\mathrm{t}} = \alpha_o + \alpha_1 LnAR_{\mathrm{t}} + \alpha_2 LnWA_{\mathrm{t}} + \alpha_3 LnAI_{\mathrm{t}} + \alpha_4 LnAS_{\mathrm{t}} + \alpha_5 LnAL_{\mathrm{t}} + \in_t \text{----------(12)}$$

In a given model number of variables are selected to explain the current problem in a broader way given short term name of the variables in a model are the representative of the following variables.

Ln AP=Log of Agriculture Productivity

Ln AR= Log of Agriculture Research

Ln AW= Log of Availability of Water

Ln AI= Log of Agriculture Infrastructure

Ln AS=Log of Agriculture Subsidy

Ln AL= Log of Agriculture Loan

ε_t= Represents the White Noise Residual term of the model

In case of long run, general specification of the model is as follow.

$$Ln\ AP = \pi_0 + \pi_1 \sum_{i=1}^{p} Ln\ AP_{t-i} + \pi_2 \sum_{i=1}^{p} Ln\ AR_{t-i} + \pi_3 \sum_{i=1}^{p} LnAW_{t-i} + \pi_4 \sum_{i=1}^{p} Ln\ AI_{t-i} + \pi_5 \sum_{i=1}^{p} Ln\ AS_{t-i} + \pi_6 \sum_{i=1}^{p} Ln\ AL_{t-i} + \epsilon_t \text{----------(13)}$$

By following the study of Pesaran *et al*. (2001), ARDL bound testing approach is used to measure the long run relationship among the variables under assessment. However, in a current study

variable of Water Availability, land, Disease Pest Management has been removed due to their insignificant results which are available in appendix. Given estimation method is based on F-statistics which is used to check the presence of co-integration. For the given estimates hypothesis structure is as follow.

H_0= All the variables of interest have no co-integration with each other

H_1= All the variables of interest have co-integration with each other

In case of short run general specification of the model is

$$\Delta LnAP = \emptyset_0 + \sum_{i=1}^{n} \emptyset_1 \Delta LnAP_{t-i} + \sum_{i=1}^{n} \emptyset_2 \Delta LnAR_{t-i} + \sum_{i=1}^{n} \emptyset_3 \Delta LnAW_{t-i} + \sum_{i=1}^{n} \emptyset_4 \Delta LnAI_{t-i} + \sum_{i=1}^{n} \emptyset_5 \Delta LnAS_{t-i} + \sum_{i=1}^{n} \emptyset_6 \Delta LnAL_{t-i} + \emptyset_7 ECM_{t-1} + \varepsilon_i \text{----------(14)}$$

In the eq. (24) ECM (Error Correction Mechanism) represents the results of short run which discuss variables of the model have short run relation or not it also describes adjustment toward equilibrium which shows that due to shock effected equilibrium show improvement in a year.

3.4.4 Optimum Lag Selection Criteria for the current Study

To check the pervious years effect on current year number lag are included in the model. Current study uses VAR lag length criteria to estimate appropriate lags. For current model's variable such method uses number of criteria but current study follows two basic AIC (Akaike Information Criteria) and SBC (Schwartz Bayesian Criteria) criteria. Estimation of current method is not easy manually therefore E-views 9 statistical package is involved to make the estimations (Shahid et al.,2022)

3.4.5 Estimation of Diagnostic Test for Given Study

After successful calculation of coefficients, validity of these coefficients is checked by employing number of diagnostic tests like autocorrelation test, residual normality test, Heteroskedasticity test. However structural stability of data is judge by applying CUSUM and CUSUM square test.

3.4.6 Normality of Residual

Gujrati *et al*. (2022) explained that error term is normally distributed if mean is zero and variance is constant over the period of time. However most appropriate statistics J-B test is used to check the problem which has null hypothesis error term is normally distributed and alternative hypothesis error term is not normally distributed. If probability value of J-B statistics is greater than 0.05 null hypotheses accepted which shows that error term is normally distributed.

3.4.7 Heteroscedasticity Detection

The problems under study a coefficient is spurious and remain no longer BLUE if problem of Heteroskedasticity exist in the data. Under such problem variance of error term remain no longer constant over the period of time. In many times such problem does not exist in time series data except financial data because of little fluctuation in data. However, given problem have close relation with cross sectional data which contains larger fluctuations over the period of time. Number of tests like White, Park, Glesjer, Harvey-Goldfeld and Goldfeld- Quant LM are used for the detection of current problem (Gujrati *et al*.,2022).

3.4.8 Serial Correlation Estimates

Representative time series data shows that coefficient of study under assessment are BLUE (Best Linear Unbiased Estimates) when all assumption of CLRM (Classical Linear Regression Model) are satisfied. But some time all the assumptions are not satisfied which cause spurious estimates for time series e.g., in case of serial correlation 6^{th} assumption of classical linear regression model is not satisfied i.e. "Two error term are uncorrelated with each other's". Nevertheless, for the dictation of current problem Durbin Watson test is used which consist of number of assumptions like; estimated model must have an intercept; estimated model must have distributed lag model and third one show autocorrelation must have degree 1. If all the given assumption successfully satisfied that such method can easily be applied for the detection of current problem (Asteriou and Hall,2021). Generally given model is written as

$$DW = \frac{\sum_{t=2}^{n}(\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=1}^{n}\mu_t^2} \text{----------(15)}$$

Thus, in many regressions model one of the Durbin Watson assumptions are not satisfied therefore two more measure Durbin h-test and Godfrey LM test are used for serial correlation detection

$$H = \left(1 - \frac{d}{2}\right)\sqrt{\frac{n}{1-n\sigma_{\gamma}^{2}}} \quad \text{----------(16)}$$

Here ‘d’ is the Durbin Watson stat ‘n’ is the number of observation and ‘’ is the variance estimates of the lag term.

CHAPTER 4

EMPIRICAL FINDINGS

4.1 Introduction

This chapter presents the methodology-based estimations and results of research variables in depth. A dependent variable is agricultural productivity. Agriculture loan, Agriculture subsidy, Agricultural research, availability of water and Agriculture infrastructure are all independent variables in this study. However, due to issue of multicollinearity availability of water has been removed by statistical package itself to avoid spurious regression. The current study is secondary in nature, and it examines a few key factors during the sample period 1981-2020. The findings and discussion of a selected variable are detailed discussed in this section.

Agricultural productivity is controlled by a number of factors, including productivity, subsidies, infrastructure, water availability, agriculture research, and site suitability. Wheat productivity is expected to decrease by 6-9% as temperatures rise. Pakistan lies in a high-risk agricultural region, with an annual drought rate of 40% and serious drought in some parts. There is a problem with regular severe weather 60 percent of the time. Because inadequacies affect a vast area of the country's agricultural landscape and can result in considerable losses for agricultural product makers.

The amount of a loan given to farmers to purchase machinery (truck, harvester, etc.), seeds, insecticides, and fertilizers is referred to as an agriculture loan. Agriculture loan data comes from Zarai Taraqiati Bank Limited (ZTBL). Agricultural incentive is another name for it. A government subsidy is a direct or indirect payment made to individuals or enterprises by the government, usually in the form of cash or targeted tax relief. The National Fertilizer Development Center (NFDC) in Islamabad will provide information on agricultural subsidies. Agricultural data has several relationships with agricultural productivity. Reliable and relevant knowledge can arguably boost agricultural productivity. The Pakistan Bureau of Statistics provided the data.

The goal of this endeavor was to boost crop yield and quality. The agricultural industry has been introduced to sophisticated materials. As the sector progressed, agriculture research expanded to include disease and pest management, as well as productive areas. The Pakistan Bureau of Statistics is the primary research source. The production, procurement, processing, preservation,

and trade of agricultural products are all dependent on a variety of public services. Seed, fertilizer, and other input-based infrastructure, such as water availability, are all examples of input-based infrastructure. Pakistan Bureau of Statistics is the data source. This study uses time series data, which requires a series of stepwise calculation to explore outcomes at wider extent. Initially estimates of descriptive statistics has been presented in table 4.1 which includes a complete series of statistical measures like mean, median, maximum, minimum, standard deviation, Jarque Bera normality test, Kurtosis and Skewness test. Under all above mention statistics calculates of the variables taken under deliberation are found quite logical and consistence. In the estimation, during pre-checking time variable of availability of water has been removed by software due to problem of multicollinearity that's why precise variable is not taken under consideration for further discussion. Moreover, all the variables are also found normally distributed because the calculated probabilities of Jarque Bera statistics are greater than 5% level of significance which accept the null hypothesis of series is normally distributed in favor of alternative hypothesis series is not normally distributed. These calculates are also validated with couples of literary supported measures Kurtosis (close to 3) and Skewness (close to 0) (Shah et al.,2021 & Ahad,2016; Uz Zaman et al.,2023; Liu et al.,2020; Amin et al.,2020 and Amin et al.,2022).

Table 4.1 Descriptive Statistics

Measures	AP	AL	AI	AR	AS
Mean	0.837	3.483	1.537	1.220	2.085
Std. Deva.	0.298	0.081	0.281	0.015	0.109
Minimum	0.225	3.334	1.110	1.180	1.984
Maximum	1.425	3.615	2.021	1.255	2.375
Skewness	-0.272	-0.209	0.318	-0.016	0.431
Kurtosis	2.037	1.876	1.813	2.880	2.958
Jarque- Bera	2.038	2.395	3.019	0.025	2.227
Prob.	0.361	0.301	0.220	0.987	0.441
Observations	40	40	40	40	40

AP: Agriculture Productivity; AL: Agriculture Loan; AI: Agriculture Investment; AR: Agriculture Research & AS: Agriculture Subsidy

Source: Author's Calculation using E-view 12

In first phase detail explaining the descriptive statistics and confirming the normality of variables, secondly correlation matrix has been drawn which present the definite association among variables as well as strength of relationship. In table 2 it has been noted that all the variables are strongly

interrelated with each other, however particular interrelation is not much stronger to cause damaging issue of multicollinearity because all the values in table 2 are smaller than 0.80.

In the second step, stationary condition of the variables has been calculated under couples of well-known tests for time series estimations, ADF and PP. Estimated results of table 4.2 explore the stationary condition of the variables. Calculated measures evaluate mixed stationary condition meaning that few variables like AP and AS are stationary at level while maximum variables like AL AI and AR are stationary at first difference. These estimates also reveal that no variable of the existing study is stationary at second difference. So according to Pan et al. (2022) when variables of any research study reveal mixed stationarity outcomes without 2nd order integration than ARDL bound test is most suitable procedure to estimated long and short run linkages among variables of the study. In case of 2nd difference integration of any variable the outcomes of ARDL are not authentic because ARDL fails to provide an apt F-statistic measure for co-integration judgment.

After the descriptive analysis and correlation matrix the trend of each variable has also been discussed in the current study by using the line graphs. The measurements of the line graph for each variables reveals that all the variables are positively sloped with fluctuating trend. These graphs are expressed as;

Table 4.2 Empirical Presentation of Stationarity Measures Under ADF and PP tests

Variables	Exogenous			Decision	
		PP	ADF	PP	ADF
AP	Constant	-3.33**	-3.86*	Level	Level
AL	Constant &Trend	-2.67***	-2.83***	First Diff.	First Diff.
AI	Constant &Trend	-5.58*	-5.64*	First Diff.	First Diff.
AR	Constant	-4.43*	-4.09*	First Diff.	First Diff.
AS	Constant	-3.75*	-3.46**	Level	Level

*Represents the significance level at 1,5 and 10%

Source: Author's Calculation using E-view 12

After the confirmation of stationary condition of the variables, for any long run model adoption of suitable lag length has keen importance which can't be ignored. Therefore, for the present study as stated by Shah et al. (2021) and Pan et al. (2022) VAR lag length selection criteria has been employed to calculate apt lag length. On the basis of estimate results given in table 4.3 the suitable

lag length is '1' for study under contemplation. However, existing problem also used lag length '1' to calculate the empirical measures by following well-organized AIC and SBC criteria.

Table 4.3 Order of the Lag Selection under VAR Method

Lag	LR	FPE	AIC	SC	HQ
0	NA	7.44e-12	-11.43	-11.22	-11.35
1	412.61*	7.06e-17*	-23.01*	-21.72*	-22.55*
2	25.98	1.08e-16	-22.66	-20.28	-21.81

*Represent the order of the lag selected for existing study

Source: Author's Calculation using E-view 12

On the basis of above discussion and strong theoretical support, study underpinning utilized ARDL procedure to martialize long and short run linkage among the variables of study. To explore the presence of co-integration relationship among variables initially, Pesaran et al. (1999) F-Statistics & Banerjee et al. (1998) T-statistics are used. In table 4.4, calculations of both tests authenticate that variables of the present study are co-integrated with each other because null hypothesis of not co-integration among variable is reject at 5% level of significance because both estimated measures 4.51 & 4.21 are greater than lower and upper bound given at 5% level of significance.

Table 4.4 Bound Test ARDL Co-integration Confirmation Estimates

Bound	Measures at 5%	Measures at 10%
Bound F-Test	**K=4**	
Lower Bound	2.86	2.45
Upper Bound	4.01	3.52
Bound T-Test		
Lower Bound	-2.86	-2.57
Upper Bound	-3.99	-3.66
Co-Integration	**F-Test = 4.51**	**T-Test = -4.21**

Source: Author's Calculation Using E-Views 12

After the confirmation of co-integration association among AP, AL, AI, AR and AS, the upcoming step is to highlight the impact of each individual variable on AP in Pakistan in both span of time. Stepwise calculation highlights that ARDL (1,0,0,0,0) has been selected following AIC criteria to explore outcomes. Further selection of the model also validated with figure 3. Long run per unit calculation of table 4.5 reveals that 1 percent increase in agriculture loan increase the agriculture productivity by 6.75%. These estimates are in line with pervious ideas of Shah et al. (2008); Udoka

et al. (2016) and Iqbal et al. (2003). The reason behind this direct relationship is that increase in fiscal measure of agriculture loan increase the financial strength of the farmer and they used modernized seeds and advance tools in production process that reduces the labor and time cost by doing significant more and fast work that ultimately leads to increase productivity and revenue of the farmers.

Secondly, improvement in agriculture infrastructure increase the agriculture productivity in agrarian economy of Pakistan. Empirical outcomes reveal that 1% improvement in agriculture infrastructure increase the 0.94% agriculture productivity. The estimated outcomes are consistence with early studies of Goswami and Chatterjee (2009) & Sharma and Sehgal (2010). The reason behind this increase is that, improvement in infrastructure reduce the transportation cost for farmer, improve their access toward local area market and other districts markets in one side while on the other side appropriate infrastructure straighten the pathway for farmer to earn maximum revenue because maximum level of population gets easy access to their products.

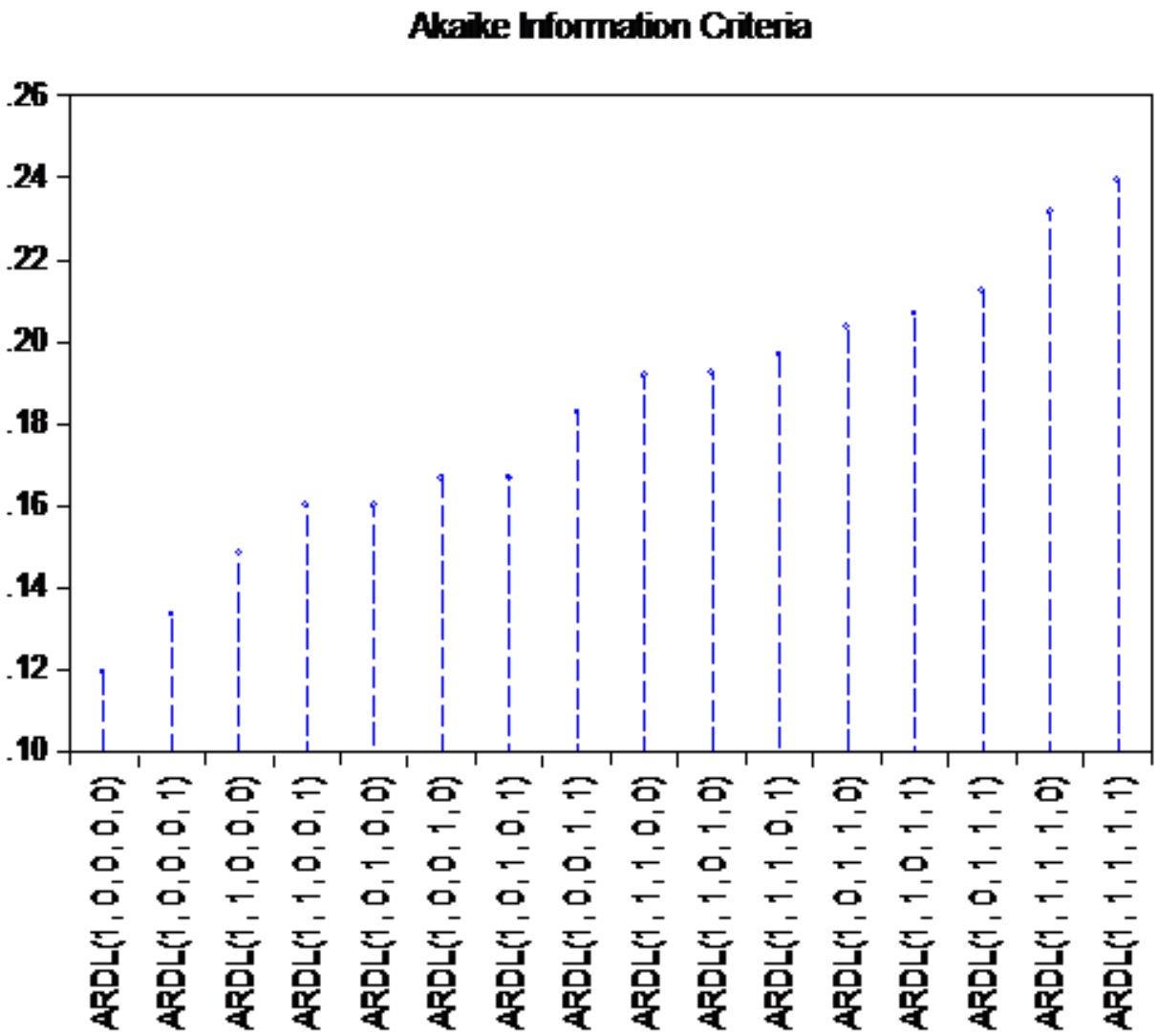

Figure 2: Selection of the Model Under AIC Criteria

Like above, outcome of agriculture research also has positive impact on agriculture productivity of Pakistan. Numerical measures reveal that 1% increase agriculture research in Pakistan increase agriculture research by 5.75%. The calculations are in line with previous views of Alene and Coulibaly (2009) & Thistle (2003). However, in context of developing economy of Pakistan the impact of agriculture research remains insignificant on agriculture production. The sound reason behind this inconsequential measure is that, since independence to present era Pakistan is facing various social and political problems, due to political instability and lack of interest toward agriculture production, the agriculture research has not gotten keen consideration and remains under developed that's why its fail to contribute toward boost in agriculture production.

At the end, calculated measure of agriculture subsidy reveals that 1% increase in agriculture subsidy increase the agriculture productivity by 3.31% in developing economy of Pakistan. The calculations are consistence with Kumbhakar and Lien (2010) & Zhang et al. (2021). The reason behind this positive association is that increase in subsidy on different agriculture product encourage farmer community to enhance productivity by utilizing more agriculture land. Because with appropriate prices of their final product and availability of raw agriculture material at subsidies rate make farmer financially stronger and provide more monetary assets for agriculture purpose that ultimately boost the farmer's agriculture production.

Table 4.5 Long and Short Run Measurements of ARDL Estimation

ARDL Long Run Outcomes				
Variables	**Coefficients**	**Std. Error**	**T-Statistics**	**Prob.**
Ln AL	0.751	2.180	3.095	0.004
Ln AI	0.941	0.364	2.584	0.014
Ln AR	5.75	4.570	1.258	0.216
Ln AS	3.31	1.217	2.723	0.010
Constant	22.78	8.666	2.629	0.012
R-Squared	**0.650**	**F-Statistics**	**8.50**	**0.000**
Durbin Watson	**2.333**	**AIC Measure**	**0.1194**	
ARDL Short Run Outcomes				
Ln ΔAL	4.314	1.544	2.793	0.008
Ln Δ AI	0.601	0.261	2.298	0.028
Ln ΔAR	3.676	3.133	1.173	0.249
Ln ΔAS	2.118	0.778	2.720	0.010
ECM_{t-1}	-0.639	0.151	-4.218	0.000
Residual & Stability Diagnostic				
ARCH (1)	0.119 (0.7301)			
Serial Correlation	4.099 (0.1288)			
Residual Normality	3.558 (0.1687)			
Ramsey RESET	0.0002 (0.9879)			

Source: Author's Calculation Using Statistical Package E-Views 12

Like long run, estimations of short run are also revealed similar trend. Initial calculation of agriculture loan demarcated positive association with agriculture productivity in short run, meaning that 1% increase in agriculture loan boost the agriculture productivity by 4.31%. Similarly, empirical measure of agriculture infrastructure, agriculture research and agriculture

subsidy are also in line with earlier long run measures. Empirics of agriculture infrastructure demarcate that 1% improvement in agriculture infrastructure increase the agriculture productivity by 0.601%. Outcomes of agriculture research are positive but insignificant like long run outcomes. Per unit calculation highlights that 1% boost in agriculture research positively influence the agriculture productivity by 3.67%. At the end, agriculture subsidy empirically demarcates that 1% increase in agriculture product subsidy uplift the farmer agriculture productivity by 2.11%. In every measure, it has been further noted that estimated coefficients of long run are greater than shorter span of time meaning that if farming community of Pakistan is promoted in above mentioned sectors than agriculture production can be enhanced at greater extent however, this production is significant more beneficial in longer span of time than short run. Therefore, developing long run polices for the farming community of Pakistan is quite helpful gadgets to reduce their production related deprivation and boost their living standard.

After the detail discussion of estimated outcomes, these measures are also statistically and theoretically authenticated by goodness of fit, overall significance and various diagnostic measures. Empirical measure of R-Squared highlights that given model is theory supported and good fitted because 65% variation in dependent variable is due to independent variables while remaining 35% are due to other factors which are not the part of model but effecting it from outside. Higher R-squared measure with maximum individual significance value confirm that overall model is good fitted. Similarly, estimation of F-Statistics 8.50 (0.000) reveals that overall model is highly significant and has great importance for the economy under consideration because null hypothesis of all explanatory variable has no impact on dependent variable is reject at 1% level of significance in favor of alternative hypothesis of at least one of the explanatory variables is significant impact on agriculture productivity.

Stepwise diagnostics measure favor above discussion and confirming that variable of interest is appropriate and according to theory because data under consideration has not shown any statistical issue like serial correlation, heteroskedasticity, multicollinearity and non-normality of the residual. Estimated measure of Ramsey RESET, serial correlation, heteroskedasticity and non-normality collectively accept the null hypothesis of no serial correlation, no heteroskedasticity and residual is normally distributed. However, CUSUM & CUSUM square test states that the empirical data is structurally stable because blue lines of both tests exist within 5% bound. At the end, ECM

calculate reveals that around 64% disequilibrium recovered toward equilibrium every year in study area.

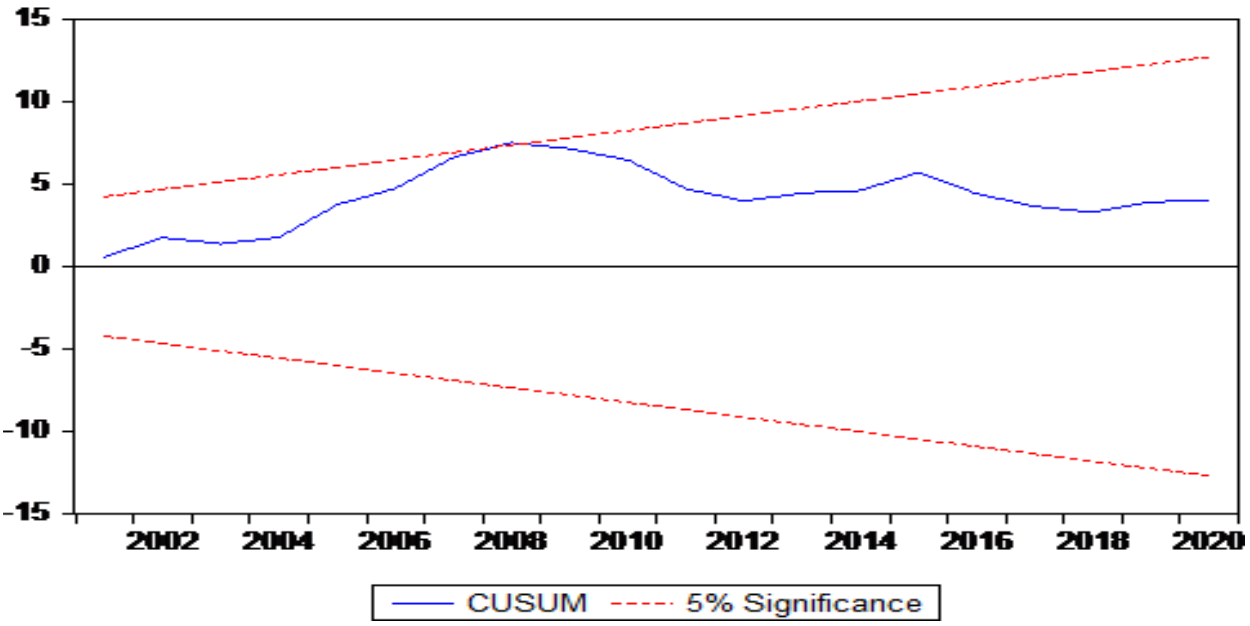

Figure 3: CUSUM Test

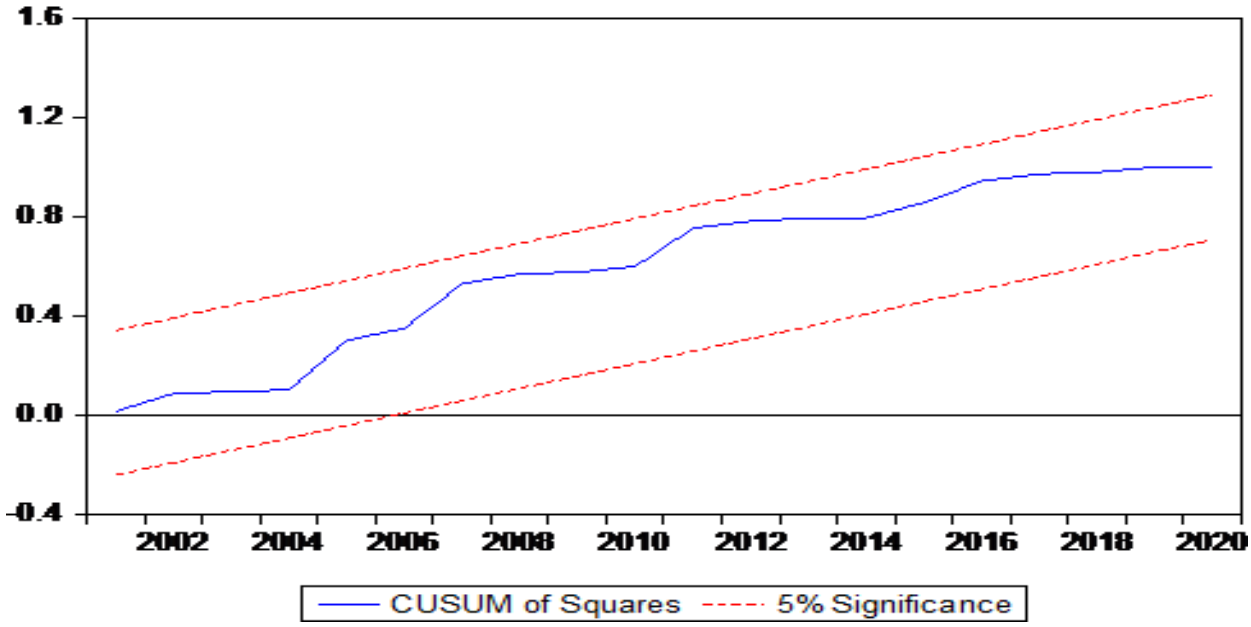

Figure 4: CUSUM Square Test

4.2 Discussion

It is anticipated that climate change would have a negative influence on agricultural output, which will lead to losses in productivity that will disproportionately affect nations that are still in the process of developing. In every region, adaptation, such as the choice of crop and when it should be planted, has the potential to partially compensate for declines in agricultural productivity. Even if quite a few models have predicted this pattern, there are still quite a few regional considerations that need to be considered. In addition, not enough attention has been paid to a great deal of pressures, such as harsh weather occurrences, pests, and infections. Furthermore, there have only been a handful of studies that have investigated how important crops like root crops and millet are to people who live in rural areas and how the consequences of climate change and carbon fertilization have manifested in those crops.

As a consequence of the shifts in output that will be brought about by climate change, agricultural productivity will be affected. In conclusion, it is imperative that climate change adaptation and mitigation take place simultaneously. Because attempting to adapt to the effects of climate change becomes increasingly difficult and costly as the size of those effects grows, it is imperative that climate change be mitigated. The lighter the load that must be carried by adaptation, the higher the level of climate change mitigation that can be accomplished at an affordable price. Policies that aim to reduce emissions can be of assistance in the construction of a new development strategy if they are carefully structured. This new development strategy would support the creation of new value in initiatives aimed at helping the poor by increasing the profitability of environmentally sustainable practices.

To be successful in this endeavor, investors will need to make the measurement and enforcement of offsets, cash flows, and carbon credits more straightforward. It is absolutely necessary to strengthen global financial facilities and to reform their governance in order, in particular, to lessen the number of steps involved in the mitigation process and to increase money flows. The process of adapting to a changing environment has a propensity to be viewed as an independent activity, despite the fact that it has to be incorporated into development initiatives, plans, programs, and strategies. In the meanwhile, the community working on climate change and development policy must work together to solve questions of development policy.

A combined perspective is necessary in order to enable the formulation and execution of integrated approaches and procedures that reflect how pervasive poverty and environmental demands exacerbate the negative effects of climate change. Because of climate change, the nature and geographic locations of acceptable investments and policies will shift over the course of human history. Because of this, efficient adaptation requires not only the deliberate selection of solutions within the context of a policy framework and a strategic development framework, but also the overt mitigation of the negative consequences of climate change, particularly on the less fortunate. It is predicted that farmers who have already adapted their practices in response to climate change have made a profit in the form of increases in agricultural produce.

The findings imply that there have been beneficial adaptation improvements made by farmers; however, these changes are not statistically significant. This highlights the need of taking into consideration variances in how different crops respond to changing conditions. It's possible that the improvements aren't having the desired impact of raising average yields, but that's just one possibility. One key strategy of adaptation that is discussed in Abid et al (2015) research is delaying the planting dates for wheat till later in the year. Due to the fact that this practice essentially shortens the growing season, farmers may be giving up the potential benefits of a longer growing season in exchange for the security of producing wheat during months with more moderate temperatures.

Amadou et al. (2015) investigate how wheat is adapting to climate change in Europe. They find that while using faster maturing varieties is a positive adaptation for avoiding the hottest months, it is also associated with reduced yields due to shorter growing periods. This is because the shorter growing periods mean that there is less time for the plant to grow. As a consequence of this, minimizing yield losses due to risk aversion or loss aversion on the downside may end up being a significant factor in the decisions that farmers make on adaptation.

CHAPTER 5

CONCLUSION, AND RECOMMENDATION

5.1 Conclusion

In this modernized era, increasing agriculture productivity has been keen concern of the both developing and developed nations of the globe. In the past few decades' especially in developing states of the globe due to dramatically drastic change in climatic situation agriculture production has been severely. In the recent era literature, it has been widely noted that various fiscal measures have played vital role to minimize the harmful environmental threats on agriculture production in one side while on the other side it also plays role to boost agriculture productivity by encouraging farming community in different monetary and non-monetary aspects. Thus, as per importance of the fiscal measures for the agriculture production, the study in hand explores the dynamical impact of fiscal measures on agriculture productivity in Pakistan by utilizing globally organized ARDL (Autoregressive Distributed Lag) bound testing method, and time series data since 1981 to 2020. The ARDL model use to dynamically measure the influence of fiscal measures on the agriculture sector productivity in Pakistan in both the long and short span of time. Initially the bound test results evaluate the long run relationship between all the regressors and the dependent variables because null hypothesis of no co-integration is rejected at 1% significance level. Further, individual impact of each fiscal variable, agriculture subsidy, agriculture loan and agriculture infrastructure except agriculture research in the long and short run reveals significance positive impact on agriculture productivity in Pakistan.

The reason behind this direct relationship between agriculture loan and agriculture productivity is that increase in fiscal measure of agriculture loan increase the financial strength of the farmer and they used modernized seeds and advance tools in production process that reduces the labor and time cost by doing significant more and fast work that ultimately leads to increase productivity and revenue of the farmers in both long and short run period of time. Similarly, the impact of agriculture subsidy on the agriculture productivity is also positive. The reason behind this positive association is that increase in subsidy on different agriculture product encourage farmer community to enhance productivity by utilizing more agriculture land. Because with appropriate prices of their final product and availability of raw agriculture material at subsidies rate make

farmer financially stronger and provide more monetary assets for agriculture purpose that ultimately boost the farmer's agriculture production in both long and short run period of time.

Likewise, above, the impact of agriculture research on the agriculture productivity is also positive with insignificant response and the reason behind this insignificant relationship is that since independence to present era Pakistan is facing various social and political problems, due to political instability and lack of interest toward agriculture production, the agriculture research has not gotten keen consideration and remains under developed that's why its fail to contribute toward boost in agriculture production in both discussed periods. Lastly, the agriculture infrastructure also revealed a positive impact on the agriculture productivity in developing economy of Pakistan in both span of time, and the sound reason behind this positive association is that improvement in infrastructure reduce the transportation cost for farmer, improve their access toward local area market and other districts markets in one side while on the other side appropriate infrastructure straighten the pathway for farmer to earn maximum revenue because maximum level of population gets easy access to their products. Further by summing up the overall discussion it has been extensively concluded that dramatic change in climate adversely effected the Pakistan agriculture sector in last few decades that leads to severe decline in agriculture production. However, by adopting appropriate fiscal measures at greater extent by the farming community of agrarian economy of Pakistan plays vital role to reduce harsh impact of dramatic change in climate on the agriculture productivity in one side and on the other side it leads to boost the agriculture production.

5.2 Recommendations

- As per concern of the policy, it is widely needed that the government of the Pakistan must provide subsidy to the farmer in different most important agriculture products like different pesticides medicine, good quality seeds and various fertilizers etc. These measures encourage farmer to grow maximum agriculture products that leads to increase the agriculture productivity because agriculture productivity and subsidy on agriculture products are directly related enhancement in the subsidy on agriculture products marginally decline farmers loss that ultimately means uplifts in production because financially farmers get better off.

- The government must develop farmer friendly loan policies with zero or quite low margin interest rate in one side while on the other side government must facilitate farmers for the easy attainment of loan. These measures also play vital role to enhance agriculture productivity in Pakistan. Provision of easy access to the low markup agriculture loan helps farmers to start agriculture production activity in time by using advance technology along with good quality seeds that leads to uplift agriculture production.
- It has been noted that agriculture research also leads to increase the agriculture production, because agriculture research develops a pathway toward new innovations in agriculture sectors that is helpful in uplifting per acer production. Thus, government of the Pakistan must focus on this sector and improve agriculture research at international level. So that all the basic problem related to the production of various crops can be handled before time. Precise measure also plays vital role to minimize the loss and uplift the agriculture productivity in agrarian economy of Pakistan.
- Agriculture infrastructure in Pakistan is quite poor that leads to significant loss in agriculture sector. Thus, the government of Pakistan must develop agriculture infrastructure on emergency basis by adopting advance technology so that farmer utilize it and get maximum benefits by minimizing the loss at greater extent especially in case of daily useable products like vegetables and fruit. Precise measure also leads to boost the agriculture production of Pakistan and create an opportunity to earn maximum revenue.

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Appendix
Annexure-I

ARDL Cointegrating And Long Run Form
Dependent Variable: D(OUTPUT)

Selected Model: ARDL (2, 2, 2, 2, 2, 2, 2, 2, 2)

Date: 06/15/22 Time: 11:34

Sample: 1990 2020

Included observations: 29

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OUTPUT(-1))	0.064597	0.027140	2.380148	0.1403
D(LOAN)	-15.09839	0.815424	-18.51601	0.0029
D(LOAN(-1))	-44.06688	1.510822	-29.16748	0.0012
D(SUBSIDY)	0.028436	0.268463	0.105920	0.9253
D(SUBSIDY(-1))	2.939218	0.254509	11.54858	0.0074
D(LAND)	-175.8418	6.881696	-25.55210	0.0015
D(LAND(-1))	197.4119	6.489510	30.42016	0.0011
D(LABOR)	49.48865	3.665992	13.49939	0.0054
D(LABOR(-1))	-63.23727	5.229017	-12.09353	0.0068
D(F___P)	0.185032	0.006627	27.92184	0.0013
D(F___P(-1))	0.082272	0.007637	10.77263	0.0085
D(DPM)	-6.411805	0.281669	-22.76361	0.0019
D(DPM(-1))	7.715991	0.270789	28.49446	0.0012
D(SEED)	-0.708936	0.068286	-10.38183	0.0092
D(SEED(-1))	-1.938044	0.105147	-18.43176	0.0029
D(WATER)	1.914679	0.760003	2.519305	0.1280
D(WATER(-1))	3.966087	0.680947	5.824370	0.0282
CointEq(-1)*	-1.366738	0.034279	-39.87109	0.0006

Cointeq = OUTPUT - (11.9337*LOAN -10.4251*SUBSIDY -138.5381*LAND +
62.8604*LABOR + 0.1989*F_P -11.6767*DPM + 2.5929*SEED –
6.0095*WATER + 7246.4758)

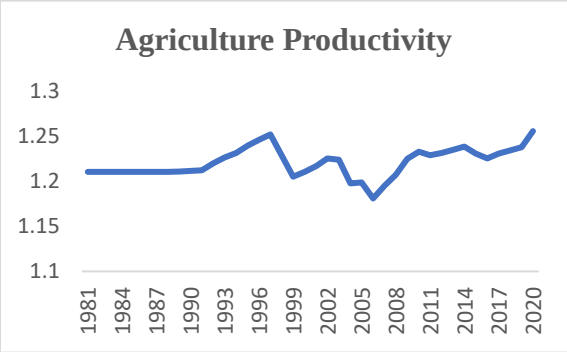
* p-value incompatible with t-Bounds distribution.

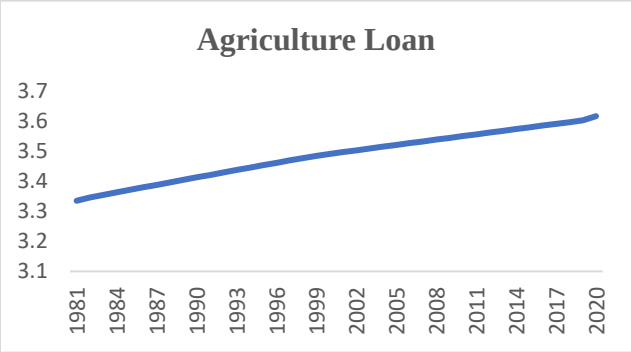
ARDL Long Run Coefficient

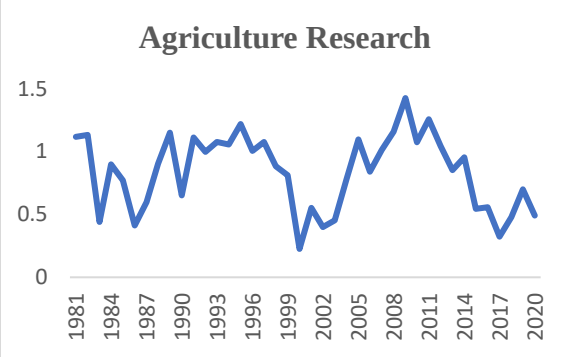
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOAN	11.93366	1.311094	9.102063	0.0119
SUBSIDY	-10.42507	2.352336	-4.431797	0.0473
LAND	-138.5381	52.26235	-2.650820	0.1177
LABOR	62.86036	12.44890	5.049470	0.0371
F___P	0.198903	0.032229	6.171508	0.0253
DPM	-11.67672	4.747621	-2.459490	0.1331
SEED	2.592861	0.472846	5.483519	0.0317
WATER	-6.009468	7.325243	-0.820378	0.4982
C	7246.476	4154.772	1.744133	0.2233

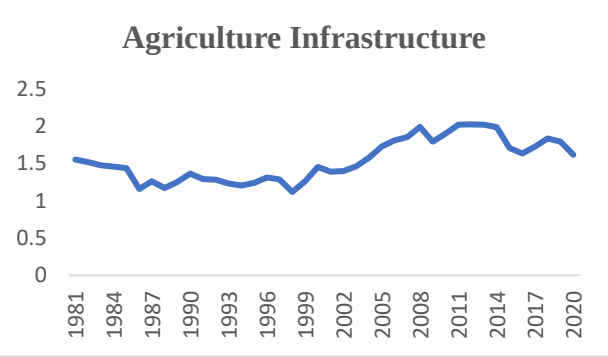
Annexure-II

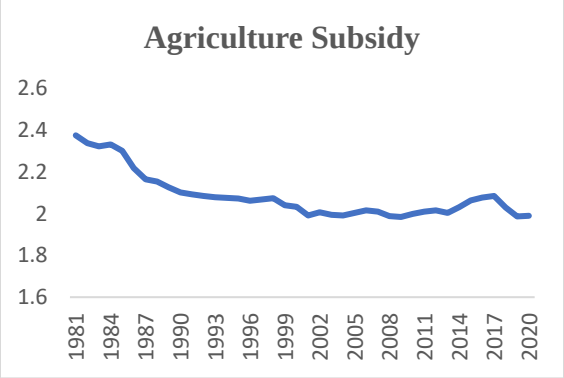
Figure 1: Trend Analysis of the Variables Taken under Consideration











Annexure-III

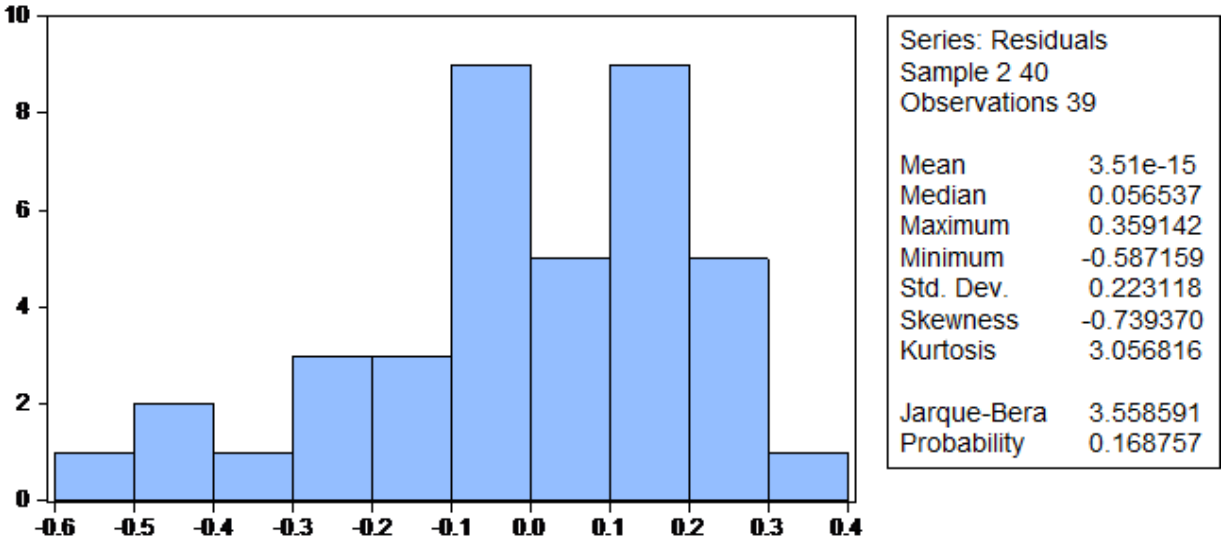
Table 4.6 Calculates of VIF and Tolerance

Variables	VIF	Tolerance
Ln AL	8.25	0.121
Ln AI	2.79	0.358
Ln AR	1.44	0.694
Ln AS	4.21	0.237
Mean VIF	4.17	

Source: Author's Calculation

Annexure IV

Figure 5: Residual Normality Graph



Source: Author's Calculations

Figure 6: Residual, Actual and Fitted plot