

**IDENTIFYING KEY CHALLENGES TO AGRICULTURAL PRODUCTIVITY IN
PAKISTAN**



**Thesis Submitted to
The Superior College Lahore
In Partial Fulfillment of the
Requirement for the Degree of
Doctor of Philosophy in Commerce**

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DEDICATION

I dedicate this work to my late parents, Shehzadan Bibi and Iqrar Hussain Shah, whose affection I missed in every step of my life. Also, to my elder sister Anwar Shaheen, my wife Saira Ijaz who made me dream it, and my friend Dr. Syed Anees Haider Zaidi, who made me achieve it.

ACKNOWLEDGMENTS

I am very thankful to Dr. Salman Masood Sheikh for his continuous support, kindness, and hard work in completing this thesis. I am also thankful to my sisters, my wife, my brothers, Shahbaz Hussain Shah and Fiaz Hussain Shah, my mentor Jalal-ud-Din Shah, and all other friends who helped me a lot in the whole degree program, especially in thesis preparation. Here, I am also thankful to all my research group fellows help in research, academic issues, and other matters. I must thank the administrative staff of Superior University Lahore for their supporting behavior during my whole study period.

ABSTRACT

Pakistan is a developing country that mainly relies on agriculture. The country's growth is directly related to this sector. This sector in Pakistan is a primary food provider and a pillar for the growth of other related sectors like textile, shows, fiber, biogas, and contraction. So, the development of this sector is most important within Pakistan for its growth. Nevertheless, unfortunately, the agricultural sector's performance in Pakistan degrades over time. Since late 1947 there has been a significant decline in the performance of this sector. The share of agriculture in GDP in Pakistan was at 60% in 1947 but only limited to 18.5% in 2018-2019. It is evidence of the low performance of this sector. The population growth challenge and, in contrast, the continued decline of the agriculture sector is a real problem right now that Pakistan is facing. If agricultural sector performance within Pakistan is not increased, it will cause an immense food crisis and negatively affect its GDP. The increase in the demand for food will ultimately increase food prices, which will cause a big circle of poverty. The performance of the agriculture sector depends upon its productivity. So, the dire need is to increase the agriculture productivity within Pakistan on the most urgent basis. Agricultural development theories have been proposed to describe the forces in society and the economy that place the agricultural sector on the road to growth and change. One of them, along with three other agricultural theories as a theoretical lens of the research, is the conservation model of farming growth applicable in this Study.

The conservation model has shown success in producing crops and livestock in developing economies, such as the English Agricultural Revolution, among other agricultural growth models. This Study presents the case of Pakistan by Identifying Key Challenges to Agricultural Productivity in Pakistan. Data from 1975 to 2017 is used for the case of Pakistan. The Autoregressive Distributive Lag (ARDL) bounding technique and the Johansen co-integration approaches are used to check the long-term co-integration between study variables. Similarly, the short-term and long-term dynamics of the ARDL model are studied. The findings of ARDL confirm a long-term co-integrating relationship. Besides, the Granger Causality test is used to examine causality between study variables. The findings indicate a bi-directional causality between environmental degradation-agricultural Productivity, financial development-agricultural Productivity, human capital, and agricultural Productivity. Further, it assessed the

real challenges facing crop production and created new models to resolve farmers' crop production challenges. Models may decide the relationship between infrastructure growth, environmental factors, agricultural technology, financial development, and crop production. This Study also contributed new insights into the growth of agriculture and pastoral economics.

Theoretically, this research work adds value to the literature concerned by testing the effect of environmental degradation, financial growth, and human capital on agricultural Productivity: Pakistan insights. Via the conservation model of agricultural production and three other agricultural theories as to the research's theoretical lens. The troubling situation is that Pakistan's agricultural land is being decloyed and transformed into residential societies. This persistent decline in agricultural output in Pakistan does not attract the young generation to adopt this sector as a profession. Attraction can be improved in this sector if the government gives the sector due concentration. The Government of Pakistan should provide subsidies in the form of cheap loans, fertilizers, pesticides, seeds, and agricultural technology to young graduates to attract them to the agricultural sector as a profession. Finally, it may be concluded, the Government of Pakistan must devise policies to improve the financial sector and make the canal branches' best use by rising fruit plants. For that, the PEF and PEIMA models should be followed for this reason. As well, these models are operating effectively in the education sector in Pakistan.

Keywords: Agricultural Productivity, Environmental Degradation, Financial Development, Human Capital

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LIST OF ACRONYMS

AIC	Akaike Information Criteria
AP	Agricultural Productivity
ARDL	Autoregressive Distributive Lag
CC	Climate Change
CDF	Cobb-Douglas Production Function
CPI	Consumer Price Index
CRP	Community Researcher Participation
CS	Climate Services
DCV	Dynamic Capability View
EA	The Yellow Area
ED	Degree of Yellow
EKC	Environmental Kuznets Curve
EO	Earth Observations
EPB	Export Promotion Bureau
FD	Financial Development
GATT	General Agreement on Tariff and Trade
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GR	Green Revolution
HC	Human Capital
HYV	High-Yielding Varieties
ICC	International Climate Change
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
KPK	Khaybar Pakhtunkhwa
LAC	Latin America and Caribbean
MBT	Malt Barley Technology

MHA	Mega Hectare
NAADS	National Agricultural Advisory Services
OWC	Operation Wealth Creation
PK	Pakistan
R&D	Research and Development
RBV	Resource-Based View
SBC	Schwarz Bayesian Criterion
SSA	Sub-Saharan Africa
TCs	Total Costs
TDAP	Trade Development Authority of Pakistan
TFP	Total Factor Productivity
UNFCCC	The United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VAR	Vector Autoregression
VECM	Error Correction Model
WDI	World Development Indicators
WFP	World Food Program
WFS	World Food Summit
ZTBL	Zarai Taraqiati Bank Limited
PEIMA	Punjab Education Initiative Management Authority
PEF	Punjab Education Foundation

1 CHAPTER ONE: THE INTRODUCTION

1.1 Background and Context

“Productivity is not everything, but in the long run, it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker” (Krugman, 1994, p. 1).

Agriculture is the leading food providing sector worldwide. Agricultural economists emphasize the importance of this sector for economic development. This sector in developing countries plays a vital role in employment, poverty reduction, food security, inflation control, and business development (Yumei Zhang & Diao, 2020). The world's agenda is to increase agricultural production to provide the growing population's food supply (Duro, Lauk, Kastner, Erb, & Haberl, 2020).

Agricultural land covers 36.7% globally (FAO, 2019). It was 42% of the total land in 2011 (Foley et al., 2011). The decrease in agricultural land is putting pressure to increase agricultural production to meet food needs. Furthermore, it will be presumed that in 2050 the world population will increase by more than 10 billion, requiring 70 to 100% more food at the world level (Godfray et al., 2010). This perception identifies that it is necessary to take immediate measures to increase food for humans and animals because the shortage of food for humans decreases the livestock ratio worldwide. The increasing population of the world will demand more food. Besides food, other bio-based products like fiber, plastic products, gardening equipment, and lubricants will ultimately pressure the agriculture sector to increase productivity. Simultaneously, there is a continuous decrease in the land, causing to decrease the crop productivity (Farrukh, Bashir, & Rola-Rubzen, 2020).

At present, the agriculture sector globally is facing many challenges. The most and dangerous factor at present that is affecting agriculture productivity is COVID-19 (S. Zhang, Wang, Yuan, Liu, & Gong, 2020). Other factors include environmental degradation, urbanization, financial development, human capital, infrastructure expansion, consumer price index, technology, financial management practices, and underground water, pollinator health, farmer's ability to perform, and resource extraction are common factors affecting agriculture

productivity throughout entire the world, especially to the developing countries (Inwood, 2017; Islam, 2017; Professor Richard Harris, 2003; Rattalino Edreira et al., 2017; Svanbäck et al., 2019; W. Yin, Kirkulak-Uludag, & Zhang, 2019; Zaidi, Zafar, Shahbaz, & Hou, 2019).

The Islamic Republic of Pakistan (hereafter, "Pakistan") relies mainly on the agricultural sector, the economy's primary income, and the employment-generating sector. The agricultural sector is the backbone of Pakistan's economy and is considered the primary contributor to GDP; afterward, the service sector. From 1947 to the present, this sector is working as an essential pillar for the country. Unfortunately, at present, the performance of this sector is decreasing. Multiple factors are affecting the performance of this sector. Climate change, financial degradation, political and economic conditions, lack of advanced technology, low input quality, human capital, consumer price index, farmers' financial management practices, and water shortage are the common factors. Its contribution to GDP is 18.9%. 38.5% of the total labor force is earning from the agriculture sector (Economic Survey of Pakistan 2017-18). Approximately 63% of the population is involved in this sector by earning directly or indirectly from agricultural products. Agricultural base exports are sources of earning foreign exchange and economic growth of the country. The sixth housing and population census of Pakistan 2017 indicates a 2.4% rise in its population. As the community is overgrowing, the need to increase agricultural Productivity also arises. Moreover, the agro-based industry is mainly dependent on the agricultural sector to get the raw material for their production. Some of the other industries are directly earning from the agricultural sector by selling pesticides, agricultural machinery, fertilizers, and tractors to this sector (H. et al., 2019).

The share of the livestock industry is 58.92% in agriculture and 11.11 % of GDP in Pakistan. It indicates a growth rate of 3.76% while comparing with 2.99% in the prior period. According to recent observations, dairy is referred to as a large sector of the Pakistani economy. It stands in the 4th position in supplying milk worldwide. Thirty-five billion liters in gross production in 2018-19 is 59,759 (000 tons), and human consumption is 48185,682 (000 tons) in its recent production. Meat production is 4,262 (000 tons), beef is 2,155(000 tons), while Poultry is 1,391(000 tons). According to the estimates, the US \$ 105.541 million foreign exchange was earned by exporting 30.450 (000) tones of red meat from 2018 to 2019. Eight million farming households possess fifty million animals. In the country, the total milk supply helps in earning 177 billion rupees. In coastal areas, most of the people are connected

with the profession of fisheries. These fisheries consist of maritime fishery and inland fisheries. The contribution of the business of fisheries is about 0.4% of the GDP. Moreover, its share in earning foreign exchange by exporting is also valuable. In Pakistan, the coastal belt is spread over an area of 1050 kilometers. It is a precious and well-known fisheries area for the value addition in the country's GDP. The fisheries sector provides the best seafood that Pakistan exports to the United Arab Emirates, China, the Kingdom of Thailand, and some other Arab countries. Sixty-nine percent share is occupied by fresh, chilled, and frozen fish in the exports of the economy, while twenty-one percent share is occupied by the export of shrimps (M. M. Khan, Cheema, Arshad, & Khaliq, 2020; Odhiambo, Nyangito, & Nzuma, 2004).

Pakistan is situated in South Asia and is known as a dry to semi-dry country. Annually average rain in Pakistan is 150 mm (Abbas, Hussain, Sherazi, Khurshid, & Wahla, 2020). Approximately sixty-seven percent of rains take place in the summer season. Out of 80 million hectares, 22 million hectares are used for agricultural production (Chandio, Magsi, & Ozturk, 2020). Approximately 17 and 5 Mha of this agriculturally cultivated area, 22 Mha is irrigated and get water from rains (Kahlowan & Majeed, 2004; A. S. Qureshi, McCornick, Sarwar, & Sharma, 2010). Approximately ninety percent of agricultural Productivity consists of the irrigated area (Kahlowan & Majeed, 2004; A. S. Qureshi et al., 2010). The water is gained from the Indus basin system for the crops that need water irrigation. However, sixty percent of water is gained from groundwater for the crops' irrigation purposes (Anjum & Zia, 2020). Rain-fed agriculture provides approximately 10% of its total agricultural production (Mahmood, Arshad, Kächele, Ullah, & Müller, 2020). Agriculture is referred to as the country's backbone, and most of the food needs are fulfilled by this sector.

The diffusion approach considers the significant dissimilarities in land and labor productivity among various regions and farmers. According to this model, agricultural development may be attained through the optimum utilization of technical knowledge and getting to know the dissimilarities in Productivity by different farmers and regions. Productivity growth may be enhanced by the insertion of farming practices in today's agricultural patterns. By considering modern farming methods, it is necessary to explore the crops and their rapid growth. The testing and refinement of farmers' innovation are necessary; even highly developed economies prefer to test farmers' innovations and adapt exotic crop varieties and animal species. This model was developed by putting stress on the diffusion

rates and the personality, characteristics, and educational accomplishments of farm operators. The primary intellectual basis is provided with the diffusion model's help regarding research and extension efforts in managing the farms and increasing Productivity. The diffusion model's confines as a groundwork for agricultural development policies' strategy became progressively seeming as technical support and community development programs, based explicitly or implicitly on the diffusion model (Udemezue, J.C.; Osegbue, 2018).

The conservation model of agricultural growth is used in this analysis, along with three other agricultural theories, as a theoretical lens. The conservation model has created crops and livestock in developing economies, such as in the English agricultural revolution, among other agricultural growth models. It also contains concepts that are already being explored by soil scientists and German chemists about soil exhaustion. The conservation model is all about using sustainable manures and producing them. The cropping method involves intensive labor and individuals' involvement when conducting tasks related to land and water resources during cropping. It is also shown that this model has been accepted internationally, and by considering this model, almost all farmers have carried out farming. Nevertheless, by taking this model into account, farming has been carried out for several years and has achieved efficiency to meet the population's food requirements. Farmers have been increasing agricultural products for a longer time by implementing conversation models and yielding approximately 1.0 percent productivity annually. As the population increases, however, agricultural production is not consistent with modern times. There is a need for 3 to 5 percent annual agricultural production, as in developing economies, to meet people's food requirements.

1.2 Agriculture: An Overview of Commencement

At the dawn of civilization, the man nearly survived by either wild hunting animals or by identifying and consequently, consuming edible plants. Herds of men flocked from one part of the world to the other, searching for food once they had depleted the mentioned resources in their former habitations. However, through all these wanderings, as man consistently devised new ways of survival, as he expanded his knowledge of nature's edible bounty- both flora and fauna alike. Nevertheless, he/she struggled to make ends meet, and he finally began considering it worthy of having his quintessential flora and fauna always at his disposal. It was thus on a quest of a convenient survival that the nomadic lifestyles gave way

to a system that led to settlement: on the first hand, he began gathering and cultivating food extensively; on the other hand, he/she also perfected the domestication of animals, in an epoch in which dogs were the only hunters and cattle was not reared but consumed (Quirós-Castillo, Tereso, & Seabra, 2020).

This influx of harvest not only led to an increase in population, flourishing thus the first civilizations known to man, but it also resulted in the change of habitation of the first homo sapiens. Rather than living in primitive caves like animals, the man began to constructively move to permanent and semi-permanent establishments near its harvesting site. One of the first examples of such villages can be traced back to Jericho, a village birthed near 9000 B.C that is presently a habitation site. Another early record of a settlement stemming from agriculture is Catal Huyak on the Konya Plain in Turkey, whose earliest traces date back to 6500 BC, similar to the Jericho mentioned above the town. Be it then in the Euphrates Valley or ancient paranoiac Egypt, inhabitations went on a rise under the flagship of agriculture. The man started developing the first cultivation techniques; he gained a more profound knowledge of nature's workings and began intensively taking advantage of it. The above evident in the case of the people of Egypt, who apprehended the river Nile's predictable flooding cycle that used to leave the land fertile upon inundation, giving way to a boom in agriculture.

Moreover, this agriculture leading to a proportionate increase in settlements equally resulted in establishing practices and crafts other than cultivation and harvesting. These settlements became the initiation of all crafts such as copper smiting, rope making, with the assurance of a regular and consistent food supply, Hence, thanks to their new-found agricultural practices, rather than the nomadic wanderings. That resulted in sporadic periods of hunger, these settlements eventually gave way to civilizations, and the world, as is depicted upon the canvas of our history, began to take shape (Quirós-Castillo et al., 2020).

1.3 Global Trends in Agricultural Productivity

The previous researchers present a method to compare countries' Productivity. They stated that the comparison of production starts by Gasques, Bastos, Valdes, and Bacchi (2012) comparing agriculture productivity in land and labor. The country that will use agricultural land and labor effectively and efficiently will gain a significant result. Land labor

productivity depends on fertilizers, environmental changes, advanced agriculture technology, irrigation system, energy, financial development, and skilled human capital. So, the countries controlling the factors are gaining significant agricultural Productivity, like the developed countries of the world are producing high agricultural Productivity rather than the developing countries. Agriculture productivity means the total factor productivity (Lombardozi et al., 2020). TFP is calculated by dividing total outputs units of livestock and crops by total inputs by aggregating all the four-factor of productivity labor, capital, material, and land (Gasques et al., 2012).

The growing population is demanding more food; it is necessary to increase agricultural Productivity (Fuglie and Wang, 2012). As the increasing population needs more food to get energized and live a healthy life, it is necessary to develop the agricultural yield required to feed the people without difficulty. Schutz (1956) said that most people are connected with agriculture to earn their livelihood while accepting his Nobel prize. Even nowadays, the situation is the same as Cervantes-godoy and Dewbre (2010) stated that most people are engaged in getting their livelihood by the agricultural sector. Shepherd (2008) explained that the world food crisis of 2007/2008 reinforced the conditions of inequality in the region and exacerbated poverty. Further, the number of malnourished people in the region has diminished very slowly. In particular, in the last ten years in LAC, the number of poor and the rate of inequality has increased. She shard pointed out that despite rising agricultural production and trade, the region still has severe inequality, with small rural and urban farmers struggling to eke out a living. She uses the case of Brazil to illustrate this discrepancy.

Pakistan stands at 4th number in the world of cultivation by providing rice, cotton, and wheat. Rice is the leading exporting crop of Pakistan. While the performance of important crops during 2018-2019 reams negative. Rice (-3.3%), wheat (-0.5%), sugarcane (-19.4%), and cotton is measured (-19.5). Further, the cultivated area under crops is reduced by 12.1%. The wheat crop area was reduced by 2.6%, cotton 12.1%, Rice 3.1%, wheat 0.6%, and other crops reduced by 8.9% (Pakistan Economic Survey, 2018).

Brazil is the highest global beef exporter and one of the biggest food producers in the region; however, this does not stop 14 million out of 188 million from going hungry and another 72 million from not eating regularly. The entire region has a similar problem. Therefore, the issue of food security in the region is not measured by agricultural production

for export and trade but rather an agricultural production in terms of the output of poor farmers and their income generated from agriculture (Schierhorn et al., 2016). From An International Assessment of Agricultural Knowledge, Science, and Technology for Development report, the researchers Beverly, Herren, Wakhungu, and Watson (2009) explains that Latin America and the Caribbean have 569 million people. The 209 million are low, and 81 million suffer extreme poverty, most of whom live in rural areas.

However, these growth rates are not up to the mark as it is seen that total resources employed in agriculture in the developed countries are getting low since 1980. It is also seen that total factor productivity levels are vigorous in countries like Australia and the UK. Moreover, labor productivity is increasing, and Productivity from cultivated land and farm size increases. Nevertheless, total factor productivity growth is getting double from 1960 to 2009 in developing economies. It is getting double from less than 1% to 2% annually. However, input growth is not as fast as needed. Few developed economies like Brazil and China have succeeded in sustaining higher total factor productivity levels in the last two decades. Some of the other developing economies like Southeast Asia, North Africa, and Latin America have also developed considerable total factor productivity growth during the 1990s to 2000s (Egal, 2019).

One of the major concerns is food security that the world is facing nowadays. It is necessary to increase the agricultural productivity levels so that secured foods' levels may be provided to the people globally regardless of where they live; they need food to get energy and live a healthy life. Estimates indicate that to feed 9.1 billion of the population in 2050, there is a dire need to raise food production by seventy percent between 2020 to 2050. Particularly in developing countries, there is a need to double the productivity levels of agricultural items. It is needed to increase each item's production, like meat production, by over 200 million tons to a total of 470 million tons in 2050, 72 percent of which are up from the 58 percent today (FAO, 2015).

Africans are majorly connected with the agriculture sector to earn their livelihood. It is estimated that two-thirds of Africa consists of rural areas and are directly or indirectly linked with the agriculture sector to get their livelihood. In other countries like Uganda, Burkina, Rwanda, and Burundi, 85 to 90 % population lives in rural areas. Moreover, 45% to 50% of the rural population is engaged in the agricultural sector. Even in their urban areas

like South Africa, one third is engaged in this sector. Moreover, it is seen that 80% of poor Africans live in rural areas and are earning their livelihood from the agricultural sector (FAO, 2015).

The Study of Fuglie and Wang (2012) states that over the past 50 years, the Northeast Asia countries Japan, Taiwan, and South Korea produce the world highest crops and livestock in terms of per hectare of land. In terms of worker productivity, North America and Oceania countries US, Canada, New Zealand, and Australia produce the highest. The data is evident that developing countries are far behind in agriculture productivity. The Asian countries, especially Pakistan, have the best irrigation system, weather and land availability, and fertility, but unfortunately still do not produce significant agricultural results. Hence, the large productivity gap is still there in agrarian countries, especially in developing ones (Somasundaram et al., 2020).

The world population is increasing daily, but global agriculture productivity is relatively constant over the 60 years. In the 1960s, the total factor productivity was 2.7%, and from the 1960s to onward 2010, it is still between 2.1% to 2.5% globally, while in the present decade, the TFP is 2.1% that is evident low Productivity in the world. In high-income countries, the total resources employed are failing science 1980: the agriculture labor ratio is falling faster than the agricultural land into the world. The per-year TFP growth measured between 1960-2009 in developing countries doubled from 1% to 2%. The growth of the input among these countries in the agriculture sector is slowing annually but still producing positive Productivity by producing a 3% annual growth rate from the last three decades. The fast-developing countries like Brazil and china focus on agriculture productivity and produce sustainable growth in TFP. Nevertheless, many other developing countries, including Pakistan, are well behind in significant agriculture growth. Hence, it is necessary to take serious action to increase agricultural Productivity to meet the country's international and national food needs and economic growth; nevertheless, in 2050, these countries will face serious problems (Sheng, Tian, Qiao, & Peng, 2020).

R&D investment is considered very important to get the desired level of agricultural Productivity by best-utilizing knowledge gained and innovation (Alene, 2010; Alston, Libecap, & Mueller, 1999; Hall, Julia; Scobie, 2006; Rahman & Salim, 2013b; Sadras et al., 2020). This idea is found faithful in the Sub-Saharan African (SSA) context Beintema and

Stads (2011), Maredia, Byerlee, and Pee (2000), Masters, Bedingar, and Oehmke (1998) as most of the households are dependent on agricultural Productivity to earn their livelihood. It also makes a valuable addition to the GDP of the country. However, it is also clear that it is no longer useful to get the desired agricultural productivity levels (Fan & Zhang, 2004; Schutz, 1956; Timmer, 2005). It is needed to get a clear explanation of the linkage between R&D investments and agricultural output. It is also seen through the detailed discussion of this phenomena in the literature that total factor productivity (TFP) is mainly dependent on the domestic and foreign R&D investments (Gutierrez & Gutierrez, 2003; Johnson & Evenson, 1999; Luh, Chang, & Huang, 2008). It is also argued by Luh et al.(2008), who focused on eight East Asian economies, Gutierrez and Gutierrez (2003) and, Johnson and Evenson (1999) used 6 SSA countries (Kenya, Malawi, South Africa, Tanzania, Zambia, and Zimbabwe) as a sample to analyze the data. Additionally, the studies adopted a two-stage approach where TFP is considered exogenous and estimated considering the first stage's traditional growth-accounting procedure.

Agriculture remains critical to the Ugandan economy. Agriculture in Uganda accounts for 22 percent of gross domestic product (GDP), 53 percent of all merchandise export earnings, and the sector employs 80 percent of the labor force. Despite the importance of the sector, overall agricultural growth has been consistently lower than growth in the non-agricultural sectors in the last 20 years; the minimal agricultural growth recorded has been linked to favorable climatic conditions rather than policy interventions. It suggests that the liberalization and privatization of marketing of agricultural commodities pursued by Uganda since the early 1990s have not yielded the expected outcomes to spur the desirable growth target of 6 percent per annum in the sector. Likewise, outcomes from recent interventions such as the provision of extension through the National Agricultural Advisory Services (NAADS) and input distribution through Operation Wealth Creation (OWC) are yet to transform production structure from subsistence to a commercial orientation. Specifically, no actual gains in measured agricultural Productivity have been observed, and food insecurity for the rising population worsens in most countries (Seymour, Malapit, & Quisumbing, 2020).

1.4 History of Agriculture in Pakistan

The agriculture in the subcontinent starts in two stages; at the first stage, from 9500 to 7500, BP Mehrgarh starts growing Barely. After that, four types of wheat (Einkorn, emmer, durum, and bread wheat) were grown to meet human and animals' needs. While in the second stage, cotton was the crop that was started in 7000 BP. Pakistan and India came into existence in 1947, so the history of agriculture in Pakistan starts with the separation. In 2019 Pakistan had 217 Billion populations that are equal to 2.81% of the world population. Pakistan's total area is 881, 931 SQ KM; only 26% is cultivable. Pakistan is ranked 33rd position in the world according to the area. The agriculture sector of Pakistan is irrigated with the Canal system. It is about 56073 KM long and is known as one of the world's best water systems (A. S. Qureshi et al., 2010).

Agriculture is the largest sector of Pakistan. The strengthening of the agricultural sector is significant as other economic development strategies' success depends mainly on this sector's success (GOP, 2008-09). Allah gifts Pakistan with a favorable climate, best available irrigation infrastructure, and agricultural research system. It is the farmers' core duty to take advantage of this blessing, as, with advanced techniques and effort, farmers may get higher levels of agricultural Productivity and get a place in an internationally competitive market (M. Khan, Akram, Husnain, Haq Padda, & Qureshi, 2011). While at present, the Pakistan agriculture sector's productivity levels are still lower than the productivity levels in developed economies.

In Pakistan, livestock share in the entire agriculture sector is 60.54%, and it contributes 11.22% in Economic Growth. This sector gains significant growth of 4.0% despite a 3.8% target. The fishing sector of Pakistan contributes 0.39% in economic growth and have a share of 2.1% in the entire agriculture sector. During 2018-2019 forests contribute 26.7% of aggregate by an increase of 6.47% due to a government of KPK initiative to increase the timber production. There are two cropping seasons in Pakistan "Kharif" and "Rabi." The period of "Kharif" starts in April and ends in December, while the "Rabi" season starts in October and ends in April. The crops rice, moong, cotton, bajra, maize, mash, and sugarcane are grown in the "Kharif" season. While potato, wheat, barley, tobacco, gram, masoor, and mustard are the crops grown in the "Rabi" season. In this way, water plays a

significant role in the agriculture sector's Productivity, while in Pakistan, underground water is decreasing (Ali Chandio, Magsi, Rehman, & Ghulam Murtaza Sahito, 2017).

The growth of the agriculture sector during 2018-2019 remains deep slow, as this sector's growth performance is 0.8% growth during 2018-2019 against the target of 3.8%. This sector's low performance is due to environmental degradation, shortage of advanced technology, shortage of water availability, shortage of fertilizers off-take, financial management practices, financial development, financial constraints, low-quality seed & pesticides, human capital, and consumer price index. The low performance (-6.55) of significant crops effects incredibly on the overall sector growth. Major crop cotton, rice, and sugarcane production remain negative, cotton -17.5% 9.861 million bales, cotton ginning 12.74%, rice -3.3% to 7.202 million tones sugarcane's performance was 19.4% to 67.174 million tons. In contrast, the crops of maize and wheat growth were noted positive 6.9% and 0.5%, respectively. Other than significant crops, other crops pulses and oilseeds contribute 2.08% in economic growth and show positive growth of 1.95% (Pakistan Economic Survey, 2018).

The past agricultural contribution in GDP from 1995 to 1996 was 24.8%. In 1996, its workforce was 16.2 million individuals that were 47.5% of the total workforce. 70% of individuals live in rural areas. This sector is a crucial source of earning foreign exchange by exporting agro-based products and agricultural items. Still, more foreign exchange is required to import commodities. It is essential to take crucial and severe steps to increase agricultural Productivity. In this way, Pakistan may get enough foreign exchange through the export of agricultural items to meet the required foreign exchange level to import necessary commodities. From 1991 to 1992, raw cotton exports added 7.5% value to the total exports. Nevertheless, this share fell one percent from 1993 to 1994 and 1994 to 1995 as the cotton crop was affected by the leaf curl virus and inclement weather conditions (Azam & Shafique, 2017). The second major export was rice export as its share was 3.6% and 6.7% in 1988 to 1989 to 1994 to 1995. Next to it was the export of fish, fruit, and spices. In terms of the total export, the higher levels were 31% from 1998 to 1999 and a low of nine percent from 1993 to 1994. Raw agricultural items manufacture things like cotton yarn, clothes, carpets, and leather things. The total export of these things was 33 and 38% in 1988 to 1989 to 1993 to 1994 (Pakistan, 1996). While considering the total worth of exports, it was 45 to 55% in earning foreign exchange in the 1990s (Mughal, 2019).

In Pakistan, increased agricultural output has been created by reforming land and water usage accompanied by increased research investment. The significant improvements will come through the enhancement of education, training, education, and technology. The agricultural inputs and product price, and trade policy can affect productivity growth and productivity levels. By going over the historical production and productivity data, one can read the signs of things to come. The share of the agriculture sector in the gross domestic product of Pakistan increased from 5 percent in 1959-60 to 6.4 percent in 1993-94 (Birdsall, 1992)

1.5 Agriculture Contribution in Pakistan

The agriculture sector is the spine of the Pakistani economy. This sector is the leading producer of raw materials, food, and employment in Pakistan. However, unfortunately, the contribution of this sector to GDP is decreasing every year. The contribution of agriculture to GDP in 1947 was 60%, contributing only 18.5% in 2019. The huge gape of contribution is evident in the low performance of the agriculture sector. So, it is necessary to focus on this sector, because it is still considered the primary sector although there is a massive decrease. This sector contributes around 38.5% of the direct and indirect labor force in-country (Pakistan Economic Survey, 2018). Experts are in the view that without the development of the agriculture sector, it is hard to get economic growth and to reduce the poverty level in Pakistan (Peerzado, Magsi, & Sheikh, 2018; Zulfiqar & Thapa, 2017; Saqib, Kuwornu, Ahmad, & Panezai, 2018; Chandio, Jiang, Gessesse, & Dunya, 2019). So, there is still a large gap to find the factors creating hurdles in agriculture productivity.

1.6 Agriculture Mechanism in Pakistan

The economic growth of Pakistan largely depends on agricultural Productivity (Kahlown & Majeed, 2004). It is observed that several inputs may impact the Productivity of agricultural items like biological, chemical, mechanical, and hydrological inputs. Mechanical inputs consist of farm mechanization (Legesse, Ayele, & Bewket, 2012). It is the most critical input as utilization of other inputs is dependent mainly on the farm mechanization. People started using private tube wells to get the groundwater for irrigating their lands by utilizing mechanical power in the early fifties (I. Ahmad, Chaudhary, Ashraf, Uzair, & Janbaz, 2012). Most farmers were reluctant to use farm machinery as they were illiterate and rigid in

utilizing conventional farming methods. However, as time passes on, farmers started using these mechanisms to save time, water, and other agricultural resources due to farm mechanisms' advantages. Due to the use of farm mechanisms, agricultural Productivity also increases. While comparing the agricultural Productivity with other countries globally, it is seen that Pakistan's agricultural Productivity is not up to the mark. Technology is one of the most important reasons for that, as the farm mechanisms' non-availability and non-awareness (Tahir et al., 2003a). When farmers cannot buy costly machinery, they intend to make an inefficient selection of agricultural machines. Due to these reasons, they cannot produce high standardized products (Muhammad Iqbal, Ahmad, & Abbas, 2003). Finally, Pakistani farmers use old agricultural productivity mechanisms comparatively to advance countries (M. A. Iqbal, Iqbal, Afzal, & Akbar, 2015).

Furthermore, it is agreed that advanced appropriate mechanization helps save 15%-20% seeds, 15%-20% fertilizers, 20%-30% working time, and 20%-30% labor at the farms. Additionally, it may also help enhance crop intensity by 5%-20% and 10%-15% crop productivity (Singh, 2009). In developing countries like Pakistan, these mechanizations are only limited to tractors and small machinery. Pakistan is facing challenges in filling the yield gap due to the significantly less utilization of innovative technology (FAO, 2012). Furthermore, the rapidly increasing population is adding challenges to meet the food requirements with this lowered agricultural Productivity. Thus, it is essential to get agricultural Productivity increased as soon as possible by taking precautionary steps to save the people from the starving situation shortly. This serious challenge may be overcome by using the latest technology in farming to increase agricultural Productivity.

1.7 Productivity Gap in Crop Sector in Pakistan

In the settled agriculture epoch during the hunter-gatherers, the production measure was created based on the amount of energy collected per unit of energy consumed. From settled agriculture to modern agriculture, the definition of yield had changed into the number of planted species sown and harvested plant. With the increasing populace, the demand for food will also increase. The world food program identifies that the demand for food will increase in the future. Agriculture productivity improved significantly because of LUCC (Arndt et al., 2020).

Pests and diseases continue to hinder our production because of their continuous increase. Yield can be calculated using many methods. UDA is still under debate (FAO, 2015). Productivity gaps can be broken down into research, extension, technology gaps (F. Ahmad, Ahmad, & Khan, 2005). Which requirements do these measures follow, and how are they related? There will always be a compromise between yield gaps that can be calculated from data availability and analysis of yield gaps. Small farmers' economic problems are partly due to farmers' reluctance to invest and adopt technology. It means that above 60% of the cultivated land is underperforming. The need for renovation is also a common reason why stagnation occurs in economies. Weed and pest control are potential areas of improvement in agriculture by enhancing Productivity and bridging the yield gaps. The conventional procedures usually will not work, and the research is now moving to develop herbicide-resistant crop cultivars. A study of sugar beet yield in three US states showed that the introduction of Roundup Ready sugar beet cultivars affected the yield significantly. The cane lines resistant to herbicides and pests have been developed by the Centre of Agricultural Biochemistry and Biotechnology (CABB).

The productivity growth ratios of major crops, sugarcane, wheat, maize, rice, and cotton, stand at 61.6%, 43.5%, 58.55%, 45.6%, and 30.85%, respectively (Pakistan Economic Survey, 2018). Pakistan's agriculture is no match for developed countries. The nations are considered to produce more efficiently than Pakistan. Since Pakistanis farmers do not have modern management techniques, advanced technologies, quality seeds, financial regulation practices, financial development, human capital, and similar supports, they work in unfavorable conditions.

1.8 Productivity Gap in Livestock

The livestock sector of Pakistan produces a lot of meat and beasts of burden. Nevertheless, it also is lacking in terms of Productivity. While the farm has produced quite accomplished livestock, much of the potential of the breed lies unused. New and modern cattle breeds are high processors of energy. There must be a balance between the native genetic stock and good new breeds (P. Shahbaz, Boz, & ul Haq, 2020). According to the data, 51 percent of farming households in Pakistan owned 1-4 cows, 28 percent owned 5-10 cows, 14 percent of the households owned 11-50 cows, and 7 percent of the farms in Pakistan had more than 50 cows (Pakistan Economic Survey, 2018). Since most dairy farms are small, the

scope for technology transfer to increase productivity decreases. Only large dairying households with more than 50 animals can afford to adopt advanced technologies, improving Productivity (Mehmood, 2020). In Pakistan, most of the large acreage sheep flocks are held by the pastoral and nomadic owners in Cholistan and other rangelands that are not likely to be converted into high-yield animals (Jamil et al., 2020).

As a result, the small farmers often do very little with their livestock and do not make any money at all. Because of the inferior breeds, the farmers get insufficient livestock, even though it gives them no profit. Furthermore, it is also challenging for the farmer to profit from the milk, as it is not sold well at all in season (Zia, 2009). A challenge in the agriculture industry is the side of feeding livestock well. The clear case for a scientific management process for rangelands, the improvement of fodder (silage and hey), and animal feed industries' development are there. Traditionally, for the past decade, there has been a problem of stagnancy, in that the unachieved gap has remained large while breakthroughs or limits have yet to be reached. Narrowing the gap among certain groups could be achieved by enabling and offering market incentives and proper management of this sector.

1.9 Regional Efforts to Address Agriculture Issues

Several commitments have been made at the regional and global levels for low agriculture performance issues and Pakistan's challenges. In 1996 WFS (world food summit) was introduced and reinstated in 2009. This reinstatement aimed to remind the international community to ensure food security for humans and animals globally by taking severe measures to increase agriculture productivity. WFS set the target to achieve the object "food for all the poor" at a global level by 2025. For the agenda to achieve the goals on agriculture productivity, the Paris Declaration re-confirmed by Accra Agenda to use the US\$20 billion Aid on agriculture effectiveness to G8 countries for three years to ensure agriculture food security. In Pakistan, the government is on a severe node to promote the agriculture sector by providing subsidies on agriculture tools and making policies to maintain crops' prices at a reasonable level. The objective to provide food to all is only possible by increasing agriculture productivity, and it is possible by increasing per acre productivity. In Pakistan the agriculture and its sub-sectors, livestock, and fisheries influence the most significant economic growth role, so the government must focus on this sector. Pakistan is enriched in weather and an environment suitable for agriculture, but there is still a productivity gap. The

agriculture sector is not growing, according to the target. Hence, Pakistan's core responsibility is to promote this sector by providing advanced technology, new methods, skilled human capital, proper financial development, and controlling environmental degradation. In 2019 the Prime minister of Pakistan was serious about developing this sector; he has made many recommendations to find the real issues relating to the agriculture sector (Pakistan Economic Survey, 2018). In this way, the present study aims to provide a comprehensive model that will help theoretically and practically for Pakistan's agriculture sector's growth.

1.10 Prime Minister's Agriculture Emergency Program

To enhance agriculture productivity government has developed a program focusing on the Productivity of major crops, sugarcane, wheat, and rice, as they are the main contributors to economic growth. The government wants to promote oilseed crops to fulfill the needs of food. Pakistan is facing diverse water conditions, so in this regard, the government has developed a watercourse program to conserve the water. To overcome the shortage of water, the government is taking serious action by enhancing its small dams in barani areas. Along with the agriculture sector, the government is keen to enhance the fishing sector, shrimp farming, and trout forming in Northern and poultry programs. The current government of Pakistan has introduced a five-year program, "Prime Minister's Agriculture Emergency Programme," to enhance the agriculture sector. The government's keen focus is to increase agricultural Productivity and add value by reducing agricultural-based products' imports. The agenda is to secure food security to overcome food crises. These efforts will help the farmers for hard-earned income. The government is assuring that the related sector with agriculture will also grow with this sector's development. The COVID-19 effects are still there, so it is necessary to enhance this sector (Pakistan Economic Survey, 2018).

1.11 Determinants of Agriculture Productivity

The followings are the primary determinates related to the agriculture sector in Pakistan.

1.11.1 Financial Development

Literature urges that financial development contributes a significant role in agriculture productivity by acquiring financial reserves, credit disbursement to farmers, easing business deals between stakeholders of the agriculture sector, and supervising this sector's financial resources. The properly developed financial sector leads to economic development in the country. The developed financial sector leads to an increase in agriculture productivity that helps for economic growth, impacting positively on environmental degradation (Seetanah et al., 2019).

The most crucial factor in the agricultural sector is the timely availability of finance to farmers. Credit is required to buy agricultural inputs, commercialize, and modernize farming in rural areas. In the agricultural sector, one of the most crucial credits is institutional credit. It is necessary to use modern ways of farming and recent innovative technology to enhance agricultural productivity. However, farmers do not have much purchasing power, which is overcome by the timely availability of credit to the farmers to utilize innovative technology to get the optimum agricultural yield levels (Schultz, 1980; Zuberi, 1989). The developed economies also recognize that the utilization of innovation and technology in the agricultural sector increases agricultural productivity levels. Increasing agricultural productivity is by providing farmers with sufficient credit limits to get modernized machinery (Ullah, Mahmood, Zeb, & Kächele, 2020). Through the easy, accessible, and timely credit availability, farmers may utilize the modern mechanisms to get their work done efficiently and effectively.

Moreover, governments in Pakistan must ensure credit availability to farmers in their respective areas on a timely basis. In developing countries like Pakistan, institutional credit positively impacts agricultural productivity (Muhammad Iqbal et al., 2003; A. Rehman, Jingdong, & Hussain, 2015). Farmers may hesitate to utilize institutional credit due to the documentation hurdle and lack of knowledge (Abedullah, Khalid, & Kouser, 2009).

Business is only possible to run when sufficient investment is invested in the business. Businesses manage to get this capital on their own or through loans. Likewise, farmers invest their money in the form of inputs. The farmers cannot invest on their own, so they need money in the form of a credit to purchase high-quality inputs for cropping purposes.

Agricultural credit is a financial support for the farmers. For the growth of the agricultural sector, credit is essential. Credit bridges the gap between income and expenditure in the agricultural sector. Farmers need money to buy high-quality seeds, required fertilizers, and modern mechanisms for farming. They may meet all these expenses after gaining timely credit to increase agricultural Productivity (Mohammad Iqbal & Okada, 2003).

The dearth of access to credit is often identified as one constraint on the adoption of agricultural technology, upsurge input costs, and to surge Productivity (Boucher, Carter, & Guirking, 2008; Croppenstedt, Demeke, & Meschi, 2003; Feder & Burggren, 1985; Henry & Crawford, 2005; Judd et al., 1998; Morris III, 2007; Moser & Barrett, 2006). Low-income families without adequate collateral tend to be omitted from recognized financial services due to high transaction costs and flawed data, making official banks unwilling to offer services to them (Delavande, Giné, & McKenzie, 2011; Ghatak, 1999; Joseph E Stiglitz & Weiss, 1981). Resultantly, poor farmers may be incapable of financing new technology or profitable income-producing activities (Conning & Udry, 2007). In Pakistan's case, the credit disbursement data shows that from 1947 to the present, there is a continued increase in credit issuing to farmers, but unfortunately, the agriculture productivity is decreasing. It means that there are some other factors due to that finance is not producing significant results. So, the aim of selecting the financial development variable is to investigate the other factors due to that agriculture productivity is decreasing.

1.11.2 Environment Degradation

Over the past 50 years, the environment's degradation has become a global issue, and every sector faces the dangers of environmental degradation, especially in the agriculture sector. Environmental degradation primarily caused by greenhouse gases (GHGs) has increased significantly over the years (Gmidene, Zaidi, & Zouari Ghorbel, 2016). So, in the current era, the threat of global environmental degradation change is getting significant attention from scientists and environmentalists as environmental changes affect crop production growth on local and global levels. The effect of environmental degradation on agriculture production varies from region to region, i.e., different in developing than the developed countries. The environmental risk includes flooding in flat areas, low rainfalls in semiarid areas, continuous increase in temperature, and water shortage. All these issues negatively affect agriculture production and limit crop yield all around the world. The official

data identify that small farmers, especially in developing countries, are most victims of the environmental changes because of their low income, greater dependency on agriculture, low capacity to adopt advanced agriculture technology and alternative livelihoods, limited geographic exposure, and last but not the least the education (Kimball, 2008). About 370 million poor worldwide belong to rural poor and live in less resource, high risk, and high heterogeneous areas. The arid, semiarid, and hilly areas of the world having a high poverty ratio (Gebreyes & Theodory, 2018). The minor change in environmental degradation impacts these poor's lives significantly as these changes will reduce agriculture production (Altieri & Nicholls, 2017).

Environmental degradation may not always negatively affect agriculture, particularly in high latitude and high-income economies. The agricultural sector is accompanied by innovative technological apparatuses and resources, putting way towards enhanced land productivity. This climate change is a crucial hinder to developing countries, such as India, where agriculture share is 55% of its total employed population and accounts for about 14.1% of its GDP (Bansal, Saini, & Khatod, 2013). In this Study, environmental degradation is selected in the model due to the reasons mentioned above. The environment's implications are necessary to increase agriculture production and reduce poverty in less developed countries, especially Pakistan

1.11.3 Agriculture Technology

In the modern era, advanced technology in the agricultural sector is essential to gain higher crop productivity (Foster & Rosenzweig 2004; Hornbeck & Keskin 2015). Agricultural technology reduces the cost of crops by reducing the fuel consumption in tractors, harvesters, and other agricultural tools; and reducing labor cost. Modern agricultural technology helps increase land fertility, crop turnover, quality of crops, and, most importantly, reduce climate risks on crops. For better agriculture productivity, sustainability and profitability, it is necessary to develop the agricultural techniques and tools with innovation and extension with the help of research (Ebrahimi Sarcheshmeh, Bijani, & Sadighi, 2018). Pakistan is the leading grower of agricultural products globally, but unfortunately, Pakistani farmers are still using Stone-age farming techniques in the modern technology era. These traditional techniques are the hurdles in better agriculture productivity

and increase the CO₂ emissions in Pakistan. Based on these elements, I have to select technology as a variable in our Study.

1.11.4 Human Capital

Human capital (HC) also plays a vital role in agriculture growth. Good health and education reveal the quality of human resources in a country. The sound human capital works like intellectual capital for farmers. Building healthy HC and its proper leverage can increase agricultural Productivity, food security, and livelihoods for farmers, mostly small-scale farmers worldwide. As human capital in agriculture occupies the center of production, distribution, and consumption; therefore, it is considered a vital element for agriculture productivity. In developing countries like Pakistan, agriculture production relies on farmers' education, knowledge, experience, and skilled labor availability. The improved human capital enables the farmers to effectively utilize the inputs, use advanced technology, financial management practices, use fertilizers, pesticides, and crops management effectively. Knowledge of farmers is only a way to efficiently and effectively use all these elements (Rustamovich & Musaevich, 2020).

1.11.5 Economic Growth

The importance of exports may not be denied when talking about any country's economic growth and development. Moreover, a country that mainly depends on agriculture may not achieve the desired export goal without enhancing its core sector. So, it is argued that any country's economic development and growth are mostly dependent on its international trade (Burke, Lobell, & Guarino, 2009). It is the reflector of the economic development of the country. Nurkse (1959) argues that trade is like a train, and the strong is the engine; the train will run fast if the trade is smooth. Ali et al. (2020) suggested that economic growth and the development of international trade are interconnected. Economic growth causes effective and efficient management, enhanced production techniques, and technical expertise. When combined effectively, the factors lead to muscular and sustained economic growth for both a short and long period. Likewise, exports of agricultural items are the backbone at both national and international levels, particularly for agrarian economies like Pakistan. The export of agricultural items also assists in generating jobs and manufacturing high-quality upgraded products to compete at both national and international

levels. Along with while exporting new products may add value and significantly contribute to earning foreign exchange for the country's economic stability. It may also assist in the progress and betterment of the rural areas and their better living standards. When country exports diversified products and earn foreign exchange, it is also better for the favorable balance of trade (Aydođan & Vardar, 2020).

The agricultural sector may promise the fulfillment of food necessities by increasing its Productivity at a rapid pace. In this way, it may help lower the poverty levels, increase the number of employments, and a certain amount of food necessary to live off the human beings and develop the economy. There are many challenges faced by the country's economy, but if precautionary steps are taken, this problem may be overcome and may enhance agricultural Productivity shortly. Several strategies are necessary for the development and progress of the agricultural sector. Agriculture may promise food security, strengthen economic growth, increase livelihood, and poverty alleviation through enhanced Productivity. However, there are several challenges that the agricultural sector is facing to increase its Productivity. Some of those challenges are discussed in this Study, and implications are provided to deal with these challenges. Pakistan's agriculture sector faces irrigation water, cultivable land, institutional quality, socio-economic, environmental, and agro-economic challenges. There is a dire need to develop comprehensive strategies and actions to manage the factors that may cause lowered agricultural productivity levels.

1.11.6 Consumer Price Index

Overall, the theory of the reason for considering commodity prices as an estimate of inflation is based on the assumption that prices have been well-determined globally and thus rapidly evolved to reflect demand and provide risks to the economy (Ciner, 2011). The recommendation to review farm prices and house price inflation is two types, as mentioned in (Sasmal, 2015). There is a discrepancy between agricultural production and demand for change, i.e., commodity prices show a more robust trend over time than non-agricultural prices. Second, the demand for agricultural products is so low that there is little change in the exchange rate. There is strong evidence in this regard. For example, Adams and Ichino (1995) predict that, before the panic attack, global inflation will have an impact. The Ciner (2011) study confirms the long-run relationship between inflation and agricultural product prices. Furthermore, Durevall, Loening, and Ayalew Birru (2013) show that global food

prices reflect the household income, reflecting a long-term change in household prices. The aggregate world commodity prices are responsible for inflation (Y. C. Chen, Turnovsky, & Zivot, 2014). Concluding, inflation as other sectors affect badly to agriculture products. Based on the above, I select this variable in the Study.

1.12 Problem Statement

The rapid increase of the world's population is a global problem. The developing and underdeveloped countries are concerned about the consequences of it. The increased population is increasing the demand of basic necessities of life and putting pressure globally for its increase. In the way, the entire world is worried about how to deal with this phenomenon. As the developed nations have more resources in the form of country income and healthy GDP ratio, they are better positioned to control this phenomenon versus the underdeveloped. The underdeveloped countries cannot overcome the challenge until they do not focus on their countries' core sectors. Pakistan is a developing country that mainly relies on agriculture. The country's growth is directly related to this sector. This sector in Pakistan is a primary food provider and a pillar for the growth of other related sectors like textile, shows, fiber, bio gas, and contraction. So, the development of this sector is most important within Pakistan for its growth. Nevertheless, unfortunately, the agricultural sector's performance in Pakistan degrades over time. Since late 1947 there has been a significant decline in the performance of this sector. The share of agriculture in GDP in Pakistan was at 60% in 1947 but only limited to 18.5% in 2018-2019. It is evidence of the low performance of this sector. The population growth challenge and, in contrast, the continued decline of the agriculture sector is a real problem right now that Pakistan is facing. If agricultural sector performance within Pakistan is not increased, it will cause an immense food crisis and negatively affect its GDP. The increase in the demand for food will ultimately increase food prices, that will cause a big circle of poverty. The performance of the agriculture sector depends upon its productivity. So, the dire need of the time is to increase the agriculture productivity within Pakistan on the most urgent basis. In the way, the problem statement of my thesis is To Identifying Key Challenges to Agricultural Productivity in Pakistan.

1.13 The Research Gap

The connection between agriculture and human survival can be traced to the very development of agriculture. Humanity's need for food has always propelled his quest to secure its production or procurement against all odds. Over the years, many researchers, politicians, economists, and development practitioners alike have presented information indicating that this concept has prevailed through the years and remains very valid in the context of today's world food discourse. The link between agriculture, human survival, and development lies in the fact that humankind cannot survive without food. Many researchers set the basis for Cancalon's conclusion. However, the most notable is Robert Thomas Malthus, an economist who set the economic world on fire with his population growth model in the late 18th century. Malthus claimed that human population growth would occur faster than food production resulting in the inevitable constraining of human population growth (Duflocq, Le Bras, Bullier, Couraud, & Davenne, 2008). Furthermore, Rittenberg and Tregarthen (2009) claim on the assumption that food production would occur at diminishing returns: as more labor is invested in a given quantity of land; there would be increased food produced but at lower and smaller rates. The result would be small increases of food production unable to support a growing population.

De Schutter and Vanloqueren (2011) explained that some crises remain very real for some people despite the time. One such crisis is global food insecurity. FAO (2012) emphasized that global food prices in December 2010 were higher than those of 2008, which created the food riots in Africa, Asia, and Latin America. Norton, Alwang, and Masters (2010) highlighted that the 2007 food prices stopped the decline of global malnutrition and left the figure of global malnourishment at 860 million people. This stop in global malnutrition declined because the increased food prices created a situation where the poor could barely have afforded food before the crisis could no longer afford it when the food prices started to climb. Erokhin and Gao (2020) have argued that the world food problem, specifically related to developing countries in the current phenomena of COVID-19, is one of the most urgent needs to be addressed today. They also posit that there would be a reduction in the severely malnourished by half of its current figure at best over the next thirty years. However, many developing countries will see their struggle against poverty and lack of access to food end in hunger, malnutrition, and famine. De Schutter and Vanloqueren (2011) puts it quite succinctly, "the food crisis is here to stay." FAO (2009) report explained that this

food crisis is a technology challenge that can be solved by pushing the technology frontier outwards. How this can occur will vary from country to country, and region to region, depending on farmer's needs and resource allocations however developing countries must take the lead.

Hence, the above discussion proves a dire need to investigate the key challenges to agricultural Productivity (J. Liu et al., 2020; Misra, 2013; Raina, Danish, Khan, & Sheikh, 2020; Zhai, Martinez, Beltran, & Martinez, 2020; N. Akram, Akram, & Hongshu, 2020; Aldosari, Al Shunaifi, Ullah, Muddassir, & Noor, 2019; Aslam, 2016; Jabbar et al., 2020). No research has been carried to investigate the above-mentioned agricultural productivity model, particularly in developing countries, especially in the Pakistani context. So, this Study will fill this gap by providing a useful model.

1.14 The Objective of the Study

This Study was undertaken with two main foci; so, the following are the objectives of the Study,

- To identify the key challenges of agriculture productivity in Pakistan.
- To investigate the impact of environmental degradation, financial development, and human capital on agricultural Productivity in the presence of economic growth, technology, and consumer price index.

1.15 Research Questions

This Study presents Pakistan's case by identifying the key challenges of agriculture productivity in Pakistan. Following research questions are considered to achieve the purpose of the Study.

RQ1: What is the effect of financial development on agriculture productivity?

RQ2: What is the effect of economic growth on agriculture productivity?

RQ3: What is the effect of environmental degradation on agriculture productivity?

RQ4: What is the effect of human capital on agriculture productivity?

RQ5: What is the effect of technology on agriculture productivity?

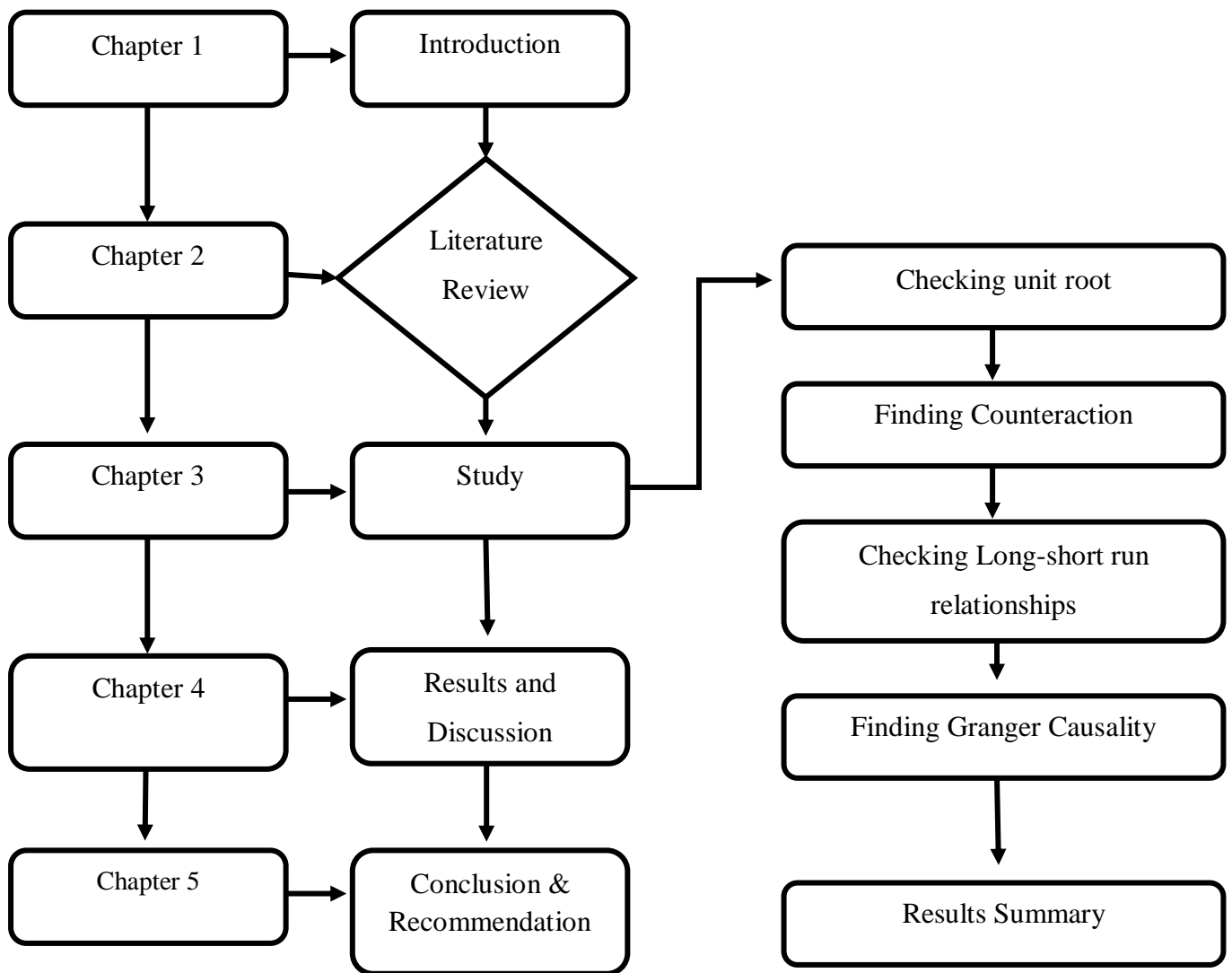
RQ6: What is the effect of the consumer price index on agriculture productivity?

1.16 Conceptual Framework

Agriculture productivity means the total output ratio against the total input in farm production (Chambers & Pieralli, 2020). Every society of the world always effort to attain the optimal living standard. Any effort to increase farm production helps to achieve these objects globally by increasing the living standard. The increased Productivity of agricultural products increases society's living standard and increases its economic condition. Hence, the economists' ultimate objectives remain to find the ways, tools, and techniques to increase agriculture productivity within inter-firm, intra-firm, and inter-sector. Thereby, according to Olayide, S. O and Heady (1982), to find the solution to these four major problems; a) the proper distribution of income, b) the proper allocation of the available resources, c) the stock and flow relationship, and d) the productivity efficiency measurement, is an essential tool in agriculture productivity. The precise definition of Productivity always helps to assess the movement of input and output relationships.

Meanwhile, finding the consistency of input and output in a particular condition of Productivity in a specific question is also most important. In many conditions, the output may face particular problems against input while measuring the factors of productions like labor, land, and capital. In this Study, finding the critical challenges related to agriculture productivity within Pakistan will help increase agricultural Productivity, ultimately increasing economic development and will cause to reduce poverty. This situation makes the concept of agriculture productivity a central issue in the agriculture sector. So, it is essential to mention the noted theoretical frameworks on agriculture productivity.

1.16.1 The Flow of Thesis Chapters



1.17 Significance of the Study

There are several challenges that Pakistan's economy is facing, and one of them is the lowered levels of agricultural Productivity (A. Rehman, Chandio, Hussain, & Jingdong, 2019). There are several reasons for this lowered agricultural Productivity; therefore, this Study intends to explore these reasons and put forward the solutions to these challenges for policymakers and practitioners to achieve enhanced agriculture productivity. This Study has highlighted the evaluation regarding underlying issues related to agricultural Productivity. It has also come up with new models for the betterment and increased production of crops for the farmers. The Study's conceptual model may examine the association between infrastructural development, environmental factors, agricultural technology, and crop production. So, this research work also adds value to the literature regarding agriculture and better economic development. Further, the findings of this research work are novel for the

concerned stakeholders. This research work's findings are beneficial for the Pakistani community as a foundation for ensuring agriculture sector development, especially. Recommendations of this research work provide a basis for improved and sustained agriculture productivity to fulfill its food requirements and economic development.

1.18 The Rationale of the Study

This study explores the factors which hamper agriculture productivity in Pakistan. I included the critical factors, namely environmental degradation (CO₂), GDP, agriculture technology, consumer price index, financial development, and human capital, to check their impact on Agri productivity. Previous researchers have not checked the impact of human capital and consumer price index ever on agriculture productivity in economic growth and technology in Pakistan's case. This Study fills this literature gap. Further, this study measures environmental degradation through carbon (CO₂) emissions. I have to use the financial development as the proxy for agriculture credit disbursement, and agriculture technology represents the proxy of tractors and tube-well for agriculture sectors. With the ARDL approach, I can compare the impact of environmental degradation, CPI, GDP, human capital, agriculture technology, and financial developments on agriculture productivity. This study results provide valuable information and help the policymakers develop an optimal combination to increase agriculture productivity and meet the national food demand in Pakistan.

Chapter Summary

The introductory summary of the thesis is concluded in this chapter. Pakistan's agricultural sector is the main contributor to economic growth. There is, however, a continuous downturn in this sector over time. In 1947, agriculture accounted for 60% of GDP, 57% in the 1960s, 31% in 1978-79, 20.8% in 2013-2014, and 18.5% in 2018-2019. However, agriculture is the backbone of all major sectors and economic growth in Pakistan, which still accounts for 38.5 percent of the workforce. The main aim of this study is to identify key challenges to agricultural productivity in Pakistan. The study further investigates the impact of environmental degradation, financial development, and human capital on agricultural productivity in the presence of economic growth, technology, and the consumer price index.

The study highlighted the evaluation of the underlying issues related to agricultural productivity and new models for improving and increasing crop production for farmers. The study's conceptual model may examine the association between infrastructure development, environmental degradation, agricultural technology, and crop production. This research work also adds value to the literature on agriculture and better economic development. Furthermore, the findings of this research work are novel to the stakeholders concerned.

2 CHAPTER TWO: LITERATURE REVIEW

Numerous factors that influence agricultural productivity have been established in the existing literature. However, because of variations in different economies, econometric methods, and the variables covered, existing studies are still not definitive. I summarize the current factors in the following paragraphs to equate their results with those of this study.

2.1 Agricultural Productivity

Initially, agricultural functions followed annual patterns governed by the crops' structure as the crop productivity is dependent on physical land, climatic parameters, and agricultural activities. Each thing varies in time and space. FAO (2019) outlined a requirement for the correct agricultural economic data linked with a correct structuring in the observing centers. Information is worthless if it becomes accessible too slowly or after the event. Remote sensing is a powerful means for the acquisition of helpful information. It is convenient to filter the data above important regions by using high accuracy.

Adopting the latest seeds and fertilizer technologies has boosted agricultural income and revenues due to higher profits and higher sales (Mortimore & Tiffen, 1994). Economic dividends linked with the population compactness led farmers to save more land for long-term agricultural investment. The Briggs et al. (1995) study clarifies that sustainable amplification should always boost population actual size. The green revolution (GR) was an era of adequate food security worldwide. The era was characterized by an impressive enlargement in food production and exchange, particularly in grains like wheat, rice, and maize due to rural agriculture's progression. Crops are augmented through a mixture of high ones. Land, agriculture, the level of investment, usage of pesticides, fertilizers, and genetically modified foods (P. L. Pingali, 2012). The cereal production had tripled in only a 25 percent rise in farmland (Wik, Pingali, & Broca, 2008). Although the general public benefited from lower-priced food due to shortage, numerous agrarian and less-developed nations perceived unfavorable side results of environmental degradation and declining biodiversity failure (Armanda, Guinée, & Tukker, 2019).

The agricultural investments of the public and private sectors improved international agricultural production. Agriculture is an essential part of financial development because it

leads to higher crop yields. Profitable growth of crops reveals the yield, quality, resource use, and benefits generated from agricultural productivity. Due to such devastation, agriculture has been altered dramatically in developed countries. Automation will be facilitated for the productivity of society and the country (Binswanger, 1986). This situation changed when productivity increased, and the environmental impacts were more significant. For instance, Carson and Neill (1962) reveal that uncontrolled pesticides can kill thousands of agricultural worker youngsters.

Research has been continuous to demonstrate the challenges of agricultural amplification, mainly in biodiversity preservation and the stipulation of other environmental services, like that, is healthy earth and pollination (Kremen & Miles, 2012; Pimentel, 2006). Since research and agricultural societies became conscious of the want to equilibrium productivity with environmental and social results, the perception of sustainable agriculture was progressively more encouraged. Busato et al. (2017) explain agricultural sustainability as an idea that judges the agricultural economic, environmental, and social facet. In contrast, it also supported the resilience and determination of creative agricultural land. Sustainable agriculture has not been performed in a regulatory way, with several ideas and agricultural forms expected to raise more food (for profit) and given environmental and social benefits (Plumecocq et al., 2018; Pretty & Bharucha, 2014). Furthermore, today's agriculture has become a significantly extensive component that shows the circumstances of its achievement while selling goods lying on the eventual markets and the nature and measurement of agriculture production organizations in definite areas. In this way, a capitalist environment substantially impacts agricultural manufacturers' decision-making procedures relating to the construction and factors of their productivity. It regularly collides with the vital restrictions, regulations, and confines of the previously visualize agricultural policies.

In Pakistan, the population's livelihood depends mainly on agriculture. Key crops are wheat, rice, vegetables, sugarcane, cotton, and fruits. It is crucial to improve agricultural productivity by effectively and efficiently using agricultural resources. In developing countries, landowners control the irrigation system, whose land is 40% more than others. Exportable crops comprise wheat, cotton, sugarcane, and rice as these exports help earn foreign exchange. Cotton is referred to as a cash crop as it adds the value of 6.9%, and its contribution to GDP is 1.4%. Pakistan is at 4rth number in cotton production, and its share in 2011 to 2012 was 9.8% in the international market. Its share in the form of yarn was 26%,

and in apparel form 14% in the international market. Out of total exports, the cotton share is 46% at the national level and possesses 35% of the total labor (Government of Pakistan, 2011–12; A. Rehman et al., 2016).

Moreover, when agribusinesses carry out their functions, the country's load on agriculture should reduce, and it can be possible for the country to perform the agricultural strategies expertly. For this basis, the central policy after the understanding of the current potential of agribusiness must be in the direction (Demirba, 2007). Predictably, the effect of climate change marked extra in "agriculture, health, water, among other areas (Naab, Abubakari, & Ahmed, 2019). Despite the demonstration of climate change in diverse sectors, the agricultural segment is the most involved in the worldwide South mostly because the area is rain-fed with the smallest technical keys (Abubakari et al., 2016; Conway, 2011). To acclimatize towards climate change, the expected choice has extensive occupy the sustainable applying of the traditional knowledge. Thus, the growing evaporation of traditional knowledge joined with the changeability in the group of climate information, have been impelled they require for inclusive execution of climate services (CS) for the creation of information regarding climate and climate change (Buizer, Jacobs & Cash, 2016; Hansen et al., 2011; Ranger et al., 2011).

Though prolonged droughts and substantial warming have been expected in Scandinavia, the fact that these situations have occurred simultaneously is statistically significant. Strandberg et al. (2014) expected that the number of rainy days would rise in the months ahead (ibid). The reasons behind the changes are expected to affect changed conditions for Nordic crop creation, which might face considerable constraints to creating farms shortly. In environments, warmer and wetter situations may be linked with an improved risk of pest and weed infestations. Changes in weather extremes (improved rainfall, deficiency, and storms) and growing susceptibility toward warmth influence and weighty rainfall are expected to have a noticeable consequence on agriculture (Olesen & Bindi, 2002). If we do not act now, we will come to face-plant into a future of climate change. For example, if the growing season is, it offers senior yields, other crops, and the start of a new crop. In this context, it is necessary to adapt the procedures to detain this possibility to increase rather than drop from climate change (Neset, Wiréhn, Klein, Käyhkö, & Juhola, 2019).

Climate change intimidates crop yields, both honestly by changes in plant growth and creation and circuitously throughout collision on crop diseases. It has been expected that climate changes have previously been dropping worldwide agricultural productivity by 1–5% per decade above the last 30 years (Porter et al., 2015). The most significant yield declines have been examined in hot cereals, for example, maize and rice. The tendency of condensed production is anticipated to carry on in the future (Newbery, Qi, & Fitt, 2016). Thus, the world requires staple crop products to enhance by 60% to nourish the population in 2050 (T. Fischer, Byerlee, & Edmeades, 2014).

Arable crop diseases become for decrease the crop yield, which is expected at 16% internationally for insecure crops (Oerke, 2006). Thus, the management of crop diseases has a critical role in facilitating high yield from crops and guarantees food security in the upcoming era. Since risks of decline in crop yields enhance climate change and further changeable climate models, crop disease losses must be reduced. Agriculture is frequently explained as a region that is utilized toward constant revision to changing conditions; the effects of farmers' adaptive proceedings are rarely examined (Hildén et al., 2005; Kongsager, Locatelli and Chazarin, 2016 and Ncube-Phiri, Mudavanhu & Mucherera, 2015).

The theory of Information and Communication Technology (ICT) has been first started during the 1940s. Currently, there is no standardized description of ICT in the world. Typically, ICT should frequently be concerned like a synonym in favor of information technology (IT) or the expansion of information technology theory. Evaluation through IT, the Information and Communication Technology (ICT) model, including the “Communication Technology, Computer Technology & Assistive Technology” linked to both. In the established view, CT lying on the transfer and getting technologies used for message broadcast, whereas Information Technology stands on “encoding, decoding, and besides processing the information.” Since technology develops, these two technologies have been gradually flattering associated and are slowly fusion into one type; that is, the theory of Information and Communication Technology (ICT). The ICT theory is frequently employed on the IT model base to symbolize the things congregated through “telecom networks, Computer Networks, and audio/video networks. Because these networks' intersection should decrease the network structure expenditure, the population is dynamically looking for technological solutions to understand the information and communication technology (ICT) network. In an extensive view, ICT comprises of every part of the media that could record

information (for example, compact disk, CDs), those technologies which transmit information, and those technologies which facilitate people to converse by “Audio/ Video” (like that video camera, cellular phones). The progress in the theory of ICT has generated the whole thing, such as of “small home electronic datasheet to oversized enterprise software packages, online software services, and the hardware and software utilized to distribute information above the Internet (Yang et al., 2019).

The information and communication technology (ICT) area is presently rising, and it is emergent rapidly. In the previous two decades, there is a broad extension of ICT worldwide, determined through the advantages that are accomplished, and adjust via organizing information and communication technology (ICT) in the private area (Jaeger, 2003). Several countries worldwide are observed enormous opportunities by applying the initiatives to enhance the ICT implementation in various disciplines. Information and communication technology (ICT) is a technology that comprises different components such as “computers, software, peripherals, and internet connections communications” necessary to maintain the information processing in a way to perform functions and provide services (Raji, Ayoade, & Usoro, 2006). According to Sesan (2001), information and communication technology (ICT) like the microelectronics convention, work out, and telecommunications. This has been developing into an international trend with great importance regarding every field of human attempt, as “straddling about education, authority, business, market share, labor, productivity, culture, trade, commerce and” (Mofleh & Wanous, 2008).

Castells (2000) describes that a country maintains an expansion position while “it ascertains like its rule of authenticity, the capability to support and continue development. Perceptive with developing the grouping for stable high rates of economic expansion and structural transform within the financial method nationally and in its affiliation toward the global financial system”. Despite an international explosion in governments spending on ICT initiatives and assuring toward the accomplishment of social & economic development, the chances intended for the accomplishment of these initiatives in less developed nations are mostly unemployed (Avgerou, 2000; Corea, 2007; Ndou, 2004; Sein & Harindranath, 2004). It is widely granted that ICT should be playing a significant task in conduit the expansion gap among countries (POST, 2006). Introducing information and communication (ICT) in less developed countries should support the quick rise in the capital with development in social and individual wellbeing (Kodakanchi, Kuofie, Abuelyaman, & Qaddour, 2006). It can be

lead while an issue of a hurry, as interruption lies by less-developed nations at risk of being more marginalized (Busa, 2004).

The effect of ICTs on the output in industrialized and service region organizations is widely studied in developed economies (Cardoso et al., 2014). The role of information and communication technologies (ICTs) in the agriculture area is less study worldwide. These technologies should help in communications and facilitate the processing and conduction of information by electronic means. Information and communication technologies can “gather, process, store, recover and distribute statistics and information through microelectronics, optics, telecommunications, and computers” (Richardson, 2006; FAO, 1993). it consists of the modern social set of connections features, read and write edges on the network, and file distribution structures online, strategies and rules that administer the extensive employ of media and tools (Yakubu et al., 2013). Agriculture plays a vital role in socio-economic development in less developed countries during employment formation, revenue creation, and GDP (Barakabitze, Fue, & Sanga, 2017).

Success in agriculture depends upon elegant and appropriate decision-making. Smart decisions involve consistent information essential for everyone level of agricultural season (Misaki, Apiola, & Gaiani, 2016). Production planning, implementation of the useful agricultural methods post-harvest management, marketing, purchasing means, and selling yield required the information. At present various means for information have been existing for cultivators. These consist of the following elements: “home organizations; key provider, rural societies, expansion officers, NGOs, radio, and television transmit” (C. S. Rao, 2007). Furthermore, farmers acquire ICTs are changing economic actions every one sector, as well as agriculture. The fast growth of ICTs and the simultaneous propagation of the latest communication tactics and applications open ways for rising production in agriculture. Information and Communication Technologies (ICTs), for example, cellular phones and telecasters, perform a leading role in distributing data about farming sources for further admittance and exercise of the essential agricultural information. Telecentres have been systems in several less developed countries like that “India, Tanzania, Uganda, Zambia, and Mali” (Kaddu, 2011; Kameswari, Kishore, & Gupta, 2011; Souter, 2010) to distribute critical agricultural information to cultivators.

Additionally, Mobile applications are employed to distribute critical agricultural information to farmers. We can mention some mobile applications name in different countries such as “Senekela and MyAgro in Mali; Nokia Life in India, Indonesia, Nigeria, and China; Indian Farmers Fertilizer Cooperative Limited (IFFCO) Airtel Initiative and E-choupal in India; TigoKilimo in Tanzania; Ukisaan and Kissan in Pakistan” (GSMA, 2015; Pshenichnaya & Clause, 2013; Siraj, 2010). Thus, information and communication technologies services on critical farming information have been accessible in less developed nations. In simple words,) cultivators are viewing these technologies.

Information through home groups, relations, and personal experience affect positively (Lwoga, 2014). The rapid development and employment of digital technologies are slected because of the ‘fourth industrial revolution,’ which is typified through a “combination of technologies that are shaping the lines among the “physical, digital, and biological fields” (Schwab, 2016). Several consider that such modifies supported big assure designed for less developed nation farming (Blattman, Green, Jamison, Lehmann, & Annan, 2016; Gates Jr, 2016; Warshauer, 2017). According to the World Bank report, the African Development Bank and the African Union note, ‘The planned purpose of ICT in the agricultural business is the significant financial area in most African countries.

On one side is "e-science" (or e-Research), described through global cooperation and the next invention of infrastructure that would allow it. On the other side, the "m-Agriculture" exercises mobile digital devices such as phones, laptops, and sensors that set ICTs, connectivity, and function into rural societies' hands. Among these boundaries, ICTs are transforming agricultural expansion (in the United States and the Philippines). It makes easy the delivery of education and knowledge in universities via open distance and empowering the rural poor in less developed nations. Further, it is powering a broad range of agricultural funding, credit, market, weather, and other services. It provides computers, radio, television, internet, CD-ROMs, and telecommunication networks for public and private organizations (Shetto, 2008). In rural and partially urban regions, telecentres are increasing availability and practice for it. Telecentres are recognized as appropriate for communication and information sharing since they could give numerous services: "internet, telephony, radio and print resources.

Like in other less developed economies globally, agriculture is the foundation of the South Asian nations. Agriculture and the agricultural industry are fueling an increase in the spaces where they "provide food due to the substantial population on the rise and coordinated economic development. No matter how farmers and other people support the infrastructure, any economic development infrastructure project will significantly contribute to the GDP within the area. To retiree in rural areas, it takes up 55% of their jobs. Since Thailand has a large agricultural sector, its currency plays a vital role in fulfilling its basic food requirements. This area also gives materials that are not processed to the industries. It shows that if we can make agriculture economically competitive, it can show that nations can live on a higher standard of living. Counting on hand, South Asian agriculture (agriculture in South Asia) is less than five percent of the US's agriculture. In the agriculture area, the unbalanced growth in large-scale agriculture and increase in small scale farming has done more to cause food shortages and economic suffering in South Asia. It needs an understanding of everything that has to do with agriculture growth and productivity (Hedlund, Longo, & York, 2020).

The theory has been recognized in numerous aspects that can influence agriculture development and productivity, for example. "Environment, skilled human capital, capital utilize, agricultural chemicals, gross domestic product, trade openness, agricultural terms of trade, and industrialization." One powerful dynamic is financial development. Financial development permits farmers to put in and accept the latest innovation in the agriculture area, which facilitates to increase agricultural production. It gives poor farmers money to purchase sources such as "seeds, fertilizers, and agrochemicals, which should enhance agricultural production. Hence, affordable and available economic services are compulsory to get better productivity in the agriculture region. Agriculture sectors in developing nations as Pakistan are broadly measured to perform an essential function in abolishing poverty. Regardless of the importance in the area, the productivity perspective in agriculture in several of the less developed economies is frequently unrealized remained mostly, the less investment in "research and progress, irrigation, rural infrastructure, rural education, and health." Thus, the agriculture region's production levels in these countries are extreme under the perspective that the developed nations attained numerous decades before. The multi-dimensional nature of the association between agriculture and poverty should be recognized more extensively. Top agricultural productivity influences the family income and food to carry the labor productivity and outputs to improve people's health and welfare (Devkota & Upadhyay,

2013). Poor health of employees any outcome in the defeat of working days or decreases their working capability, leading toward lesser productivity (Croppenstedt & Muller, 2000).

Pakistan's agricultural region openly sustains its population and makes approximately 26 percent of gross domestic products' contributions. Main crops which are mostly cultivated in Pakistan comprise "Sugarcane, Rice, Wheat, Cotton, Vegetables, and Fruits. Hence, there is a severe and urgent need to recover agricultural productivity from formulating the further employ of capital, for instance, "water & land more successful. However, in Pakistan, the irrigation method is frequently proscribed through landlords, who have approximately 40 percent of the arable land, make it complicated to carry it regarding improvement. Principal crops, including Cotton, Wheat, Sugarcane, and Rice, involve Pakistan's vital merchandise due to their top export value into the worldwide trade market. Cotton, known as a primary cash crop, reports approximately 6.9 percent of the agricultural more value and adds 1.4% toward its gross domestic products (GDP). Pakistan is the 4th biggest cotton creator by 9.8% of the international market share in 2011–12. Throughout the identical era, the export of thread and related attire reported approximately 26%, and it was 14 percent of the international market. The export of cotton reports 46% of the overall exports on the national level and use 35 percent of the whole industrial labor force (Rehman, Jingdong, et al., 2019)

The agriculture area in Pakistan performs a vital role because it takes up 42.3% of the workforce. It motivates development in different nation sectors and a critical means for foreign exchange income (Abedullah et al., 2009). The government is dedicated to sustaining little-level modern technologies and marginalized and undersized farmers to improve agricultural development. According to the 6th population survey of Pakistan, the population expansion is increasing at 2.4% each year. This increasing population is increasing the demand for agricultural goods in the economy. The current government pays attention to this sector's enlargement through support financially and through fertilizers, development in agriculture credit, encouraging high-value crops, crop diversification, and little mark upon credits for tube wells. The performance of this segment above the previous 13 years has been improved multiple. The agricultural sector demonstrates massive growth for 2017-18. It was 3.8 % throughout the similar time, which is comparatively enhanced compared to the growth rate in 2016-17 (Pakistan Economic Survey, 2017).

In numerous facets, the agricultural sector of Pakistan is in front of the rarer constraints in provisos of credit, for example, the scarcity of water, enlarged prices of primary agricultural sources, such as “ seeds, fertilizers, pesticides and lack of electricity/power (Chandio, Yuansheng, & Magsi, 2016). However, as a result of agricultural credit services, the undersized level farmers are counting the additional complexities in accepting old technologies to swell their agricultural efficiency (Faridi, Chaudhry, & Tahir, 2015). However, this sector has a different growth prospective(A. Rehman et al., 2016). Credit plays a significant job in humanizing agricultural output; thus, suitable accessibility of credit services lets farmers buy main agricultural sources and contemporary agricultural technology for working farm functions (Saleem & Ali Jan, 2009). Lack of credit and money is one of the major reasons for reduced agricultural production in our agricultural zone. The problem of growing agricultural production, so, mainly reliant upon the accessibility of credit services for the small and marginalized farmers in their relevant regions (Jehan & Muhammad, 2008). Agricultural credit is given to the undersized farmers since the great expansion and financial development attempts are deepened. It resulted via credit and concentrated fertilizers use, suitable accessibility of the approved seeds, elegant cooperative and production prices and superior yields”. The crops segment observer an expansion rate of 3.83 %in 2017-18 measure up to 0.91 % in 2016-17 (Pakistan Economic Survey, 2017).

Credit is a significant contributor to virtually every company, and it can significantly improve the agriculture sector in Pakistan. Agricultural credit is an essential aspect of farm innovation and farm commercialization. Unproblematic and affordable credit is the best way to improve agricultural production. Thus, it was the primary goal of all the consecutive governments to help Pakistan's agricultural society. Since agriculture is dependent on credit more than any other sector, seasonal fluctuations in the farmers' income are to blame. Credit gives them a chance to earn more money and change their lives (Manafi, 2011). Under the Agriculture Loan Act of 1958 (ALA), credit is available to purchase animals, fertilizer, seed, and machinery (Salman, Khattak, Yar, & Khan, 2016). The value of credit accessibility should be noticed because each hectare farmer faces a higher level of expenses through credit. Higher variable costs are associated with further output expansion. The influence of institutional credit on agricultural production in Pakistan is positive and considerable (Muhammad Iqbal, Ahmad, & Abbas, 2003b).

Agricultural credit is measured as one of the strategic assets for increasing crop productivity toward the high sphere increases the living standards of our rural deprived agricultural society. Thus, it performs a fundamental role in the development of the country. It has mostly two means; Informal and Formal. Informal ways usually comprise commission negotiators, key suppliers, rural community supermarket keepers, friends, and family. Beyond these resources, credit through commission negotiators, shopkeepers, and source providers have a more baneful consequence on the rural community low. Facts recommend that loans contribute more to rural poverty because the effectual rate of interest lying on informal credits is mostly high (M K Bashir, Yasir, & Sarfraz, 2010). Adequate admittance toward the credit helps by farmers recovers source utilize on the farm and thus has an import consequence on agricultural production. Therefore, admittance toward the credit services allows farmers to gratify their cash needs promoted through the agricultural production cycle and consumption necessities.

However, despite substantial attempts to restructure, improve, broaden and institutionalize the agricultural credit structure, little has been accomplished by announcements, policies, and programmers. However, agricultural credit is methodically institutionalized for small scale farmers; there is no evidence of agricultural development. Due to limited assets, low crop yields, and low incomes, savings are minimal among the bulk of Pakistan's farmers. Therefore, credit organizations must emerge to promote the introduction of better farm activities. The livestock sector's role in growing agricultural production is well known, and its participation in reducing poverty in rural areas is enormous. It significantly contributes to the maximum supply of nutrients in food and increases the productivity of the workforce.

Furthermore, a study was carried out by Abedullah, Khalid, and Kouser (2009) demonstrated that trouble-free admittance and changeable agriculture credit had an important influence on agricultural productivity. Bashir, Yasir, and Sarfraz (2010) examined the nexus between institutional credit and wheat output in Lahore, Pakistan. Study results showed that credit had a noticeable influence on wheat productivity in the district of Pakistan. They more illustrated that farmers' socioeconomic circumstances were enhanced in the region. It occurred consequently of employing computerized inputs and good fertilizers requisite, which become achievable through institutional credit.

According to a growing body of scientific evidence, in the same way, Bashir et al. (2007) observed the case study of 114 loan and non-loan farmers to investigate the consequence of the formal credit on the productivity of sugarcane crop in Faisalabad, Pakistan. Study findings suggest that the increase in institutional credit has had a considerable impact on the sugarcane output. The new study in Jhang, Pakistan, was the same as the previously conducted study in Lahore, Pakistan, only in a different field location (Ahmad et al., 2015).

The agricultural industry is essential to maintain the nation's financial health. It is realistic to install efficient green farming technology when farmers are afforded financial services to purchase agricultural inputs (Ali Chandio et al., 2017). Institutional credit sharing through commercial banks has had a significant impact on the Pakistani's economy. Conversely, Obilor (2013) banks positively affect agricultural development because they assist in industrial development. In Pakistan, LUCC has been giving tremendous critical and positive influence on agricultural production and marketing (Chandio and Rehman, 2016; Akram et al., 2008). Hence, it shows that credit unions can significantly impact food production and farmers' income (Jan & Manig 2008).

Both Abedullah et al. (2009) and Regla et al. (2012) declare that easy, simple, and fast access to capital is needed to increase agricultural productivity. Meanwhile, Bashir, Yasir, and Sarfraz (2010) investigated the effect of institutional credit on wheat output in the Lahore region by employing the Cobb-Douglas Production Function (CDF) and observe that credit had a significant positive impact on wheat productivity. The research study provides the right to think that credits develop the socioeconomic situation of the rural domestic. This survey exposed that, as a result of every other farming practice, it would be beneficial to solidify seed, land preparation further, and fertilizer utilization when wheat is farmed, and the farmers are forthcoming.

2.2 Risks in Agriculture

Agriculture growth desires sufficient and appropriate supplies of vital farm inputs. The farmers are at a deprived level, and they cannot put in the suggested dosage of fertilizers, enhanced the seeds, and farm proceeds machinery. Thus, the small availability of financial assets is one of the main problems that lead to little production yield in Pakistan judge against

the developed countries worldwide (Inam, 2018). Different studies were carried out to demonstrate that farmer's yields of diverse crops were very much high in borrowers from different means compared to non-borrowers (Hayat, Shah, Bacha, & Muhammad, 2019). Farmers continuously deal with and supervise the various kinds of agricultural risks (Huirne, 2002). Risk innately entails undesirable results, which consist of lesser yields and earnings and can also entail disastrous actions, for instance, financial insolvency, food insecurity, and individual health troubles, even though superior estimated returns are usually one of the positive incentives for taking a risk. Farmers thus handle concurrently by and supervise numerous risks that could have compounding results (Frankwin et al., 2000; Wauters et al., 2014).

The complex outcomes are compounded up to a level before farmers are making decisions and reaching results. It greatly influenced the idea of the global food price crisis. In a few countries, governments issued restrictions on food exports for neighboring countries to ensure their citizens' right ingredients (Headey, 2010). During this crisis, farmers may experience production risk, price jump (can have an immediate or a delayed influence), market impact risk (unexpected changes in government policy), and institutional risk (change in policy or a big turnaround such as a government bailout). Due to the nature of the supply and demand relationship of goods, when one supplies an excellent direction to another, and in this case, it is a risk, the positive result from that goodwill, in turn, result in additional risks. Take, for instance, extreme rainfall events during crop production and financial crises resulting from being unable to refund parking money (Pelka, Weber, & Musshoff, 2015). Farmers have faced continuously various risks; for illustration, in pre-modern Iceland main worry intended for farmers incorporated climate changeability and personal sickness (Eggertsson, 1998). In response to the Wollenberg et al. (2016) study that argues that climate changeability does not affect the harvest yields, various other studies have claimed that the harvest yields are both impacted or maybe not impacted by climate changeability. Being so specific is merely like looking at a single type of risk. It gives us an uninformed idea of everything that risks are.

Many other things can worsen the situation, so increasing numbers of people emphasize that the risks related to climate change, economic volatility, globalization, and political instability are also especially severe (Hansen et al., 2019; Darnhofer et al., 2016). As can be seen, there is no definitive answer as to whether farmers have more contact with risks,

in general, or not. With that said, specific risks and some crops have increased over time (Wildemeersch, Garba, Sabiou, Fatondji, & Cornelis, 2015). Even though we knew the ailing companies and operations were present, the authorities remained not open to risk and took the steps on behalf of the farmers. The challenges of the animal-based food segment from increasing the world population, from varying diets through the demand of advanced animal world foods, and climate change will create constraints numerous risks more significant than ever (Anderson, 2004). There are general kinds of risks in agriculture that can be viewed as the following (1) the production process, (2) the market, (3) the institutional, (4) the personal, & (5) the financial. The four initial risks associated with farming are the ones that have not been thoroughly explained to the public in regards to farming. The unknown risks with farming are the ones that are financially dependent on the farm whether or not it is financed (Komarek, De Pinto, & Smith, 2020).

The five common forms of risk in agriculture are described as (1) Production risks trunk from the tentative natural development procedures for the crops and livestock, along with usual resources of these risks allied to weather conditions and climate (temperature and rainfall) and pests and illness. As we move forward to the future, we must be cautious of how much yield comes from too many weighty metals in soils or earth salinity. Market risk is all about the uncertain expenses, prices, and access to the market. The prices of agricultural products may be volatile due to the sudden weather changes that may adversely impact agricultural production output, changes in energy prices, and asymmetric access to the required information. Some of the more things included in the market risk are international trade, protectionism, and liberalization. These are included in market risk because of the increase and decrease in access to the market. The decision making of farmers depends on weather changes or increased or reduced access to the market (D. Harvey, 2014; Holden, Shiferaw, & Pender, 2004; Lazzaroni & Wagner, 2016).

Production risks such as "Prices, Costs, and Market Entry" consist of climate shocks and how they can cause erosion in yields. Recessions and other financial shocks also play a rather large factor in volatility in the market and how much production costs can rise or scale back. International trade in the market risk space is enhanced by liberalization, that is, fewer barriers, and is decreased by protectionism because it places trade barriers in the way of free trade. Instead of making riskier crop choices (such as using climate changeability as a reason to use a crop), farmers should make some decisions even when there are many competing

variables and shifts in the market (Harvey et al., 2014; Lazzaroni and Wagner, 2016). These critical risks are related to the unpredictability of the natural growth processes of crops in these fields, where the weather norms and climate circumstances can be too different from one year to the next, such as having an extremely hot or freezing day, or pollinating or not pollinating. Other factors that are fought in cultivation are yield-limiting and yield-reducing factors, including heavy metals in soils or soil salinity.

A variety of institutional change is non-random. For example, changes in formal institutions (e.g., international trade agreements, WTO) and informal institutional (such as changing ad hoc regulations created by the FDA) are not easily explained or anticipated. Being a formal institution, the Government has many risks that were absent in the farmer's operations. For example, the Government could voluntarily do something that would affect the farmer's business as the researcher Risk (1999), Nguyen, Wegener, and Russell (2011) finds that the variation of institution-based factors that originate from informal industries, including unstable changes, made by rural-based organizations (such as the non-farm related business) or changing societal values all impair the agricultural sector. There has been growing support from institutions not directly related to production and related to farming. This recognition has slowly been implemented. The three 'institutional risks' risks that arise from changes in the legislation have to do with the unpredictable changes in the policies and regulations caused by formal or informal institutions. The Government, a formal institution, may create risks for farmers through unpredictable changes in policies and regulations, factors over which farmers have limited control. Indicators of institutional risk for institutions in agriculture can derive from informal institutions that might not be predictable, such as changes in trading partners' or rural consumer organizations' actions and social norms that might affect agriculture or changes in the weather. Furthermore, Perry, Bligny, Gout, and Harwood (1999) state that the number of farmers and agribusiness interests is also growing. These farmers and companies are linked to institutions like the Farm Bureau or other agricultural associations as agribusiness becomes more market-driven.

Human risks are intimate, unique, and differ with each individual. There are a small number of health implications that come from using several agricultural chemicals. For example, using certain fungicides can become toxic to specific crops, poisoning certain people. This is why the medical community strongly recommends working closely with a licensed ag extension agent or agricultural pest control specialist (Lopes Soares & Firpo de

Souza Porto, 2009; Arana et al., 2010). The farmers most concerned with chemicals' health risks earn a high income (Dercon, Hoddinott, & Woldehanna, 2005). Farmers also have to contend with the interdependence of individual and institutional risks. For example, a spouse's divorce or death can lead to misappropriation of property or livestock due to conventional legislation's institutional risks (Huyer, 2016). In the literature, the terms "personal," "individual," and "idiosyncratic" typically refer to the same form of "personal" risk that we have calculated. (5) Financial risk refers to the risks associated with how the farm is financed and is defined as the additional changeability of the farm's operating cash flow due to the fixed financial liabilities inherent in credit usage (De Mey et al., 2016).

Furthermore, human health or personal relationships influence the household of the farm or farm. Some causes of personal risk include damage to farm equipment, death or illness of family members from diseases, adverse human health effects from pesticide use, and transmission of disease between livestock and humans (Antle & Pingali, 1994; Arana et al., 2010; Lopes Soares & Firpo de Souza Porto, 2009; Masuku & Sithole, 2009; Tukana & Gummow, 2017). Health risks are a significant source of income volatility and concern for farmers (Dercon et al., 2005). Farmers also face the interconnectedness of personal and institutional risks; for example, divorce or the death of a husband can lead to the appropriation of land or livestock due to the institutional risks generated by customary laws (Meinzen-Dick, Kovarik, & Quisumbing, 2014). In literature, the terms "personal," "human," and "idiosyncratic" typically refer to the same sort of "personal" danger that we considered.

Some financial risk types include changes in interest rates or credit accessibility or changes in credit circumstances. Credit is one of the well-known aspects, among other sources of production, of linking the production capacity gap between underdeveloped and developed countries and organizing small farmers' cash needs. In Pakistan, two types are used for credit purposes. The first is credit advance; credit advances to farmers are forked by institutional and non-institutional credit. Both loans are used for agricultural development. In the early days of Pakistan's record, agricultural credit was mostly guaranteed through committee negotiators, landowners, relatives, and family members. Informal supplies of money accounted for 84% of the total lending in the region. The interest rate for these loans was very high relative to the market rate. Besides, the situation has forced the farmers to trade their yield to the lenders. In this case, the lender has two advantages, the first was purchasing the farmer's output at a lower market price, and the second was the payment of a premium (M

K Bashir et al., 2010). Financial risk refers to the risks associated with the farm's financing. It is characterized as the additional variability of the farm's operating cash flow due to the fixed financial obligations inherent in credit use (Biggs et al., 2016; Gabriel & Baker, 1980). Some financial risk sources include fluctuations in interest rates or availability of credit, or changes in credit conditions.

The agriculture region is in front of the two essential troubles. One is the reliance on nature, which is a biological character. This consequence in variations in production yield from period to period to the area wise disparity depends on the country's natural possessions. The second issue related to it is the economic nature, which is the modification of farmers in agriculture growth succession. In contrast, still, the output is increasing at a retreating rate. Since the economy develops, the GDP and employment share out of the agriculture area regularly diminish. Indubitably, the size of the labor force in the agricultural area reduces in the present phases of the expansion in these countries (Mellor, 1986). Thus, environmental degradation affects mostly the farmers of less developed countries like Pakistan, as in Pakistan environment change if effecting farmers products badly, the phenomena is discussed by different researchers, e.g. (Esham and Garforth 2013; Lotze-Campen & Schellnhuber 2009; Altieri & Nicholls 2017). Therefore, now a day's environmental degradation is getting full recognition and a hot topic (Wilbanks et al. 2007; Smit & Skinner 2002; Thornton & Comberti 2017). Hence, developing countries have a low adaptation capacity and have not modern technology for handling the sophisticated CC (Lotze-Campen & Schellnhuber, 2009).

2.3 Theoretical Literature and Empirical Studies

This section discuss in detail the theoretical literature and empirical studies on the determinants of the agriculture productivity

2.3.1 Environmental Degradation

The most critical determinants of living and survival for the human class are the climatic character. The presented literature shows the reality of climate change, which are no longer conceptual because its effects have been understood all around the world along with the divergence in its amount and degree of its effects, which is dependent upon the existing resources (Munang et al., 2013; Girma, Tino, & Wayessa, 2016). Climate is an essential part

of life and livelihoods for all human beings and in growth like an entire (Barros et al., 2014). In the last two decades, Climate change is an entire environmental issue in each continent and every region worldwide. It happens due to an increment in the environment's temperature through a flaming of fossil fuels and the discharging of Greenhouse Gases, most particularly CO₂. Climate change is a well-studied subject in the latest years. The research literature has been developed significantly as the start of this century, reflecting increasing temperatures, growing the sea acidification, changing rainfall patterns, and growing the rate of recurrence and harshness of extremes climate actions (Füssel & Klein, 2006; Chapman et al., 2017; de Los Ríos, Watson & Butt, 2018).

Experts in the sector have evaluated the fact that climate change effects have been experiencing earlier days in the alteration in the average temperature, rainfall, humidity in the air, plants, and formation of deficiencies (Neelin et al., 2017; Mehta et al., 2019; Roberts & Pelling, 2018). With the exemption of central factor of Africa wherever the knowledge is inadequate to depict the inference, it is likely that above the vast districts of this continent, the mean annual temperature has been enhanced at the end of the previous century and mostly due to anthropogenic behavior (Jones and Stott, 2011; Stotand Jones, 2012). It has also been highlighted that countries like Ethiopia, South Sudan, Uganda, and Kenya have experienced increasing styles in the seasonal average temperature end of the past years (Funk et al., 2018). Ethiopia was becoming warmer at a rate of 1.7 C per decade in the 1970s (Bandakoti, 2003). Additionally, the "Scientific Assessment of the Status of the Greenhouse Effect: 2014, IPCC", notes that Earth will warm between 1.5 C and 5.8 C over the next 100+ years (B. Legesse et al., 2012).

Conversely, disparate the apparent temperature style, it is not very easy to place the clear style for the rainfall (IPCC, 2014b) as there are differences in diverse areas. Environment and climate intensity can create constraints in the environment and human health. Changes in the earth's face are drivers for changeability in rate and intense climate at local and regional levels. These climate structure changes also make changes to the physical and natural structure (and human systems). In the same way, Spatial and geopolitical prejudice is a recurring study topic in biological writing. An exceptional level of concentration has been given to the terrestrial environments compared to the water ones, covering 71% of the ground surface (Lawler et al., 2009). Terrestrial environment studies are typically stand in temperate sectors, biodiversity hotspots, and depopulated regions (Tittley,

Snaddon, & Turner, 2017; Martin, Blossey, & Ellis, 2012). On a considerable level, locations like North America, Europe, and Australia are excessively represented, although studies in Africa and Asia are absent: from 0 in a few countries to approximately zero in others (Pacifiçi et al., 2015 & 2017; Di Marco et al., 2018). This information gap is essential since underdeveloped countries frequently have more notable endangered species and high biodiversity levels. Geographical bias is chiefly harmful because it will result in poor biodiversity and preservation results (Onen, Farooq, & Gunal, 2017; Stein et al., 2013).

Geographically Pakistan is a diverse country. The effect of environmental degradation is different throughout all of Pakistan. Like in northern areas environment is different from the plain, hilly, and desert areas. Pakistan is a semi-industrialized economy with one of the best agriculture sectors and the world's best irrigation system. Only 26% (21.2 Million hectares) area is cultivable. Among the total, 79.6 million hectares crops area is 23.8 Million, and forests are on 1.21 million hectares. Canal irrigation system irrigates 80% of the cultivated area. Pakistan is famous and the world's best producer of cotton, rice, dates, wheat, mango, orange, and sugarcane. Rice, wheat, sugarcane, cotton, and wheat are the key crops of Pakistan, and these crops contribute 6.5% of economic growth, while dates, mango, potato, and orange are the minor crops that contribute 2.3% in GDP. The share of fishers and forest sectors is very nominal, and these sectors add 0.4% and 0.2% only in economic growth. Even though the agriculture sector is the producer of the significant and best important crop globally, it is still striving for a high level of food insecurity. The WFP (World Food Program) reports indicate that more than 48% of Pakistan's people struggle for food.

An ancient phenomenon may be influenced by the increasing population, innovation, high living standards, technological progress, industrialization, increasing infrastructure, lessening several trees, and cultivable land. According to the IPCC results (2013), Greenhouse Gases' level has exceeded the maximum heights of concentrations on earth over the last 800,000 years. Consequently, this greenhouse effect is causing increased rainfall, frequent hot extremes, floods, droughts, cyclones, and the gradual recession of glaciers. The rise in precipitation levels has been observed in Northern Europe, eastern parts of North America, South America, Northern Asia, and Central Asia. Tropics and Subtropics have been facing severe and long-lasting droughts since the 1970s, whereas areas like Sahel, Southern Africa, and Central Asia have parched lands (Aggarwal et al., 2008). Bestowing to the IPCC Fourth Assessment Report, strengthening of actions done by individuals since 1750 has

caused atmospheric absorptions of Carbon-dioxide, Methane, and Nitrous Oxide globally. The level of greenhouse gases has now surpassed the preindustrial standards that existed thousands of years ago.

Climate change may not always negatively affect agriculture, particularly in high latitude and high-income economies. The agricultural sector is accompanied by innovative technological apparatuses and resources, putting way towards enhanced land productivity. This climate change is a key under to developing countries, such as India, where agriculture share is 55% of its total employed population and accounts for about 14.1% of its GDP (Aydin Gol, Lazar, & Belta, 2014). In this study, environmental degradation is selected in the model due to the reasons mentioned above. The environment's implications are necessary to increase agriculture production and reduce poverty in less developed countries, especially from Pakistan.

While human beings are acclimatizing with their environments all over the times past, Climate change creates new and distinctive constraints that intimidate the lives and livelihoods. To know the rising risks and threatening uncertainty, awareness of climate change adjustment has increased in the last two decades. Although the word was the earliest use in the 1990s, it obtained the impetus infraction due to the Inter-government Panel on Climate (Nformation, Ools, & Ollaboration, 2012). Most lately in its fourth estimation like “modification in natural or human being structures in reaction to the definite or predictable climatic stimulus or their consequences, which moderate damage or exploit helpful chances” (IPCC, 2007). Furthermore, according to Doherty, Klima, and Hellmann (2016), several “The United Nations Framework Convention on Climate Change” (UNFCCC), Conference of the Parties (COP) have been including in this increasing body of apply, concluding in the COP21’s accent the desire to build the worldwide aim on the adjustment by increasing the adaptive capability, intensification of the flexibility and dropping the susceptibility to the climate change (UNFCCC, 2016). The literature demonstrates that the transform in climate and weather conditions consequences in natural actions and environment turbulence throughout lesser seasons of rainfalls, floods, drought, and small crop output (Awojobi, 2017; Schaeffer, Szklo & Lucena, 2009). Climate change also influences “Agricultural, Industry, the Health area, Political and social-economic area, among others, are everyone expected to be impacted considerably through climate change in future (M. Doherty et al., 2016).

Since then, lesser rainfall might significantly affect farming, fishing, and the labor system people are built upon it. These incidents destabilize political and social structures in all human societies (Galaz, Biermann, Folke, Nilsson, & Olsson, 2012). Climate change is specifying through tremendous weather, volatile temperature, and changeable rainfall. Research Studies are demonstrated that climate change might decrease a nation's overall agro-economy performance (Günther Fischer, Shah, Tubiello, & Van Velhuizen, 2005). Thus, could intimidate food protection (Krishnamurthy et al., 2009, 2014; Richardson et al., 2018). In southeast Asia, climate susceptibility should reduce grains and maize productivity by about 10% (IPCC-TGICA, 2007). According to one study, climate change in Indonesia becomes the reason for the water scarcity, lesser soil humidity, reduced soil fruitfulness, and enhanced vanishing and rainfall (Measey, 2010). Overall, this keeps a risk toward food security. Research explains that Indonesian paddy production was declined by approximately 25% because of climate change in 2014 (Fadhliani, 2016). Climate change might be raising the oceans levels and flood rice and shrimp fields (Measey, 2010). Climate change both directly and indirectly influences the social and economic sustainability of the agricultural region. Crop collapse, short productivity, and high production costs ensue as climate change directs toward farmers' earnings loss and enhancement of seasonal redundancy rates (Alam, bin Toriman, Siwar, & Talib, 2011). Unluckily, farmers' awareness about climate change is restricted because they do not have the institutional ability and information on adjustment and environmental engagement (R. M. Adams, Hurd, Lenhart, & Leary, 1999).

Greenhouse gas (GHG) emissions characterize an international hazard due to their unfavorable consequence on climate and present and future generations' welfare. For numerous years now, these issues have been pointed out by the parties' conferences to the United Nations Framework Convention on Climate Change (UNFCCC). The recent consent at the international level is reproduced in the Paris Agreement outlined in December 2015 to contain GHG emissions. Not surprisingly, the fulfillment of this goal requires considerable and steady resources eventually. Incidentally, developed nations have planned to finance up to \$100 billion for each year in 2020. Governments are decided that a significant component of these resources should be directed to the Green Climate finance that is liable for applying the Paris Agreement. Nevertheless, nowadays, this objective is yet far from what should be accomplished. In its previous document, the Fund reports donations equal to only \$10.2 billion. Thus, one accumulated resource to battle climate change has become urgent worldwide (UNFCCC, 2016).

There are various associations between a country's economic development and the environment. The environment supplies assets for the economy and performs a drop in emissions. Aye and Edoja (2017a) examined the consequence of economic growth and CO₂ emissions, and their study results showed that in the small growth system, economic growth has a negative influence on CO₂ emissions. However, in the high growth system, a positive influence through the marginal effect being superior exists. Researchers have planned that economic rule and regulations, institutional structure, industry directness, and global relationships considerably influence business enterprises and their economic productivity. Geopolitical institutions, government authority, and regional trade markets have become fundamental driving forces of the New World Business (New Normal). As the outbreak of the 2007-2009 international financial crisis, these outside forces greatly influence the sustainable and complete expansion of the economy (J. E. Stiglitz, 2016).

One of the most critical problems for environmental destruction is global warming. When looking at the details below, it is easy to understand that the Earth's climate system is warming in a manner with no known human development record. The continued incremental heating breaks the equilibrium of human being Earth that has been spread recognized at a minor temperature. The most recent IPCC study predicts an increase of the universal level surface temperature from 1990 to 2100 between the 1.8°C and 4°C, although it is probable that it will be as high as 6.4°C (Gyrning, Gaarder, & Lohne, 2017). Due to melting glacial ice caps and brine expansion (due to a warmer climate), the deep level has risen between 1993 and 2003 at a rate of 3.1 millimeters for each year; rainfall patterns are changing with increased droughts in a few regions and heavier rain in others; glaciers and snowstorm melting are increasing the water level in oceans over a definite period; winds have strengthened in power Over the past few decades, climate-related natural hazards have caused 90 percent of natural disasters, and there is scientific evidence that most of them are rooted in global warming. If agriculture was necessitated to warm and dry crops on an incline, it could destabilize fields without a proper drainage system, thus minimising fresh water sources and destroying the soil. Since cigarettes contain carbon monoxide and ultrafine particles, global warming's environmental effect also harms vast populations' livelihoods (Tyagi, Garg, & Paudel, 2014).

Climate change does not merely generate enhanced rainfall, but it also triggered the rising temperature is recognized the same as global warming. The alteration in temperature

itself might happen one time in a decade. Irwansyah (2016) distinguished that in 2000 & 2009, the temperature rose to 0.013 C. The bearable doorsill of rising temperature is less than two C (Gao, Gao, & Zhang, 2017). The world's countries determined to bind the rise of global mean temperature to well less than 2°C and make struggles to bound temperature enhance 1.5°C above the pre-industrial level. This ambition to structure a country level discharge security identified the same as Nationally Determined Contributions (NDCs)

The formation of environmental degradation is known as the deterioration of the environment by deteriorating and damaging the natural assets of air, water, soil, the destruction of the ecosystems, and the extinction of flora and fauna. If anyone wishes to be cynical about the climate, they might claim that it acts as a change that is negatively influencing or destroying the environment. Environmental degradation is one of the ten "Ten Threats formally concerned with " has formally defined as a danger to global security. According to the United Nation's International Strategy for Disaster Reduction, environmental degradation is defined as reducing the environment's capacity to fulfill the social and ecological goals and needs. The fundamental explanation for environmental degradation is human disturbance. Environmental pollution is based upon factors such as the location and the plant life species, and the animal species that live in it. The toxic use of humans and their actions are the key sources of environmental pollution (Tyagi, Garg, & Paudel, 2014).

Many kinds of environmental degradation are occurring in the world, such as. Whenever natural environments are damaged or natural assets are exhausted, the environment is degraded. Environmental consequence or degradation is produced by consolidating a successfully considerable and growing human population, continuously increasing the financial growth or per capita affluence and the resource-draining function, and contaminating the technology. Environmental degradation happens as the soil's natural assets are exhausted. The environment has cooperated in the type of destruction of species, contamination in air, water, and soil, and speedy enlargement in population. It sees the degeneration of the soil or decline of the environment through the utilization of resources, the devastation of the environment, and the natural world's obliteration. It is typified as whichever varies or irritates nature's grass to be destructive or unattractive (Aye & Edoja, 2017). Environmental degradation is known as every change or interruption in the environment that is supposed to be harmful or unwanted (Johnson et al., 1997).

Various types of human being behavior are the major causes of environmental degradation. These are leading to climate changes, which have become destructive for all living organisms. The smoke released through automobiles and factories enhances the number of toxic gases in the atmosphere. Generally, we can observe the pollution in city regions where the population is overgrowing (Tyagi et al., 2014). Reasons consist of “overpopulation, air & water pollution, Deforestation, global warming, indefensible agricultural & fishing activities, overconsumption (influenza), mal-distribution of wealth, the increase of the business, the Third World debt disaster, and militarization and wars” Mining is as well an unhelpful expansion action where environment go through the altar of the economy. Scientific mining functions escorted through the environmental re-establishment and restoration of the mined wastelands and careful employ of the environmental resources. Seek out eco-friendly alternates, and options should be given magnificent exposure to Mining's effects on the human being environment (Singh, 2009).

Gas emissions have been one reason for Climate Change, through the emissions from automobiles & industry causal more than 380 parts per million (ppm) (Irwansyah, 2016). According to the International climate change (ICC), the bearable level for gas emission is from 330 to 350 ppm, although most of the emissions have been beyond the traditional standard (Pathak et al., 2018; Sukarno, Matsumoto, & Susanti, 2016). Thus, these emissions can reason for the holes in the ozone layer. The Ozone-Indonesia.org (2010), the ozone defends the soil from sunlight through the sun's fascinating ultraviolet radiation. A significant COP gathering in 1997, which was attended in 160 countries, formed by the Kyoto Protocol (UNFCCC. Int, 2011). The single of its results was a contract to create a considerable growth towards dropping the climate change in 2012. The protocol is an agreement involving developed countries like the United States, Japan, Germany, and Canada to decrease the gas emissions that influence climate change. Unluckily, the United States do not sign the contract since of inequity between developed and under-developing countries; additionally, the agreement regulations that every country should pursue the protocol to decrease the greenhouse consequence in expectation of more climate change (Patz, Frumkin, Holloway, Vimont, & Haines, 2014). Increasing urbanization is the motivating urban policy creator to accept the sustainable practices that are meant to bind the buildings' environmental effect, which is accountable for an expected 36% of climate-changing gas emissions in the European cities. Hence, to achieve the EU's emission diminution standards, it is necessary to build up the strategy for CO₂ emission saving.

The conference of the parties detained in Paris (COP21). The Member States put out an international plan to set the world on the path with two chief goals: to avoid hazardous climate change by keeping the less than two centigrade over the pre-industrial levels and practice an attempt to bound the temperature increase to 1.5°C. These aims are a long-term goal that will need the start of "zero GHG emission" from an era between 2020 & 2030. The latest Intergovernmental Panel report on climate change (IPCC), in print in 2014, approximate that due to technical procedures, around about 29% of emissions would be avoided in housing and commercial building area in 2020 and 40% in 2030. Governments are dominant in order to produce and organize buildings areas reactions and should be able to recognize and promote the synergies between building's adjustment to climate change and greenhouse gas emissions mitigation (Lisitano et al., 2018; Masson-Delmotte et al., 2018).

Climate changeability and change put considerable pressure on the agriculture region. Extremely changeable seasonal rainfall, rising temperature, and high climate measure simultaneously with increasing demand for food places further stress on the food structures and the natural assets. Innovative climate services, adjustment policies, and sustained strategy support are essential to deal with sustainable agriculture and food security (FAO, 2019). More than 84% of worldwide energy creation results from fossil fuels and natural gas, petroleum, and coal (Höök & Tang, 2013). Energy manufacture from these non-renewable resources discharges the 35 billion Mg of the CO₂ each year; if the trends cannot change, yearly emissions will go beyond the 43 billion Mg in 2050 (Administration, 2007). Fossil fuel dependent on CO₂ emissions is the main reason for climate change, which is anticipated to increase the average global temperature between 1.5 and 4°C by 2050. The Intergovernmental Panel on Climate Change (IPCC) advises that the lowest calculated rises can generate destructive consequences, counting ocean level increase, mass population disarticulation, enlarged the rate of extreme climate, and mass species extinctions (Jarraud & Steiner, 2012).

To enhance the understanding and deal with climate hazards in climate-responsive areas like agriculture, it is essential to contact reliable and consistent facts and information about the products. The standard agricultural adjustment policies in which include “irrigation, setting up, Shifting crop choices, Pesticides & Fertilizer management, transform in the tillage practices, and alteration in the timing of main field activities which are previously employed by numerous farmers to deal with changeable climate situations” (Hatfield et al., 2011).

Thus, the lengthy period adaptation should be requisite to containing the additional transformative procedures centered toward redesigning agricultural structures for environmental flexibility and sustainability. Those events would be consist of the policies like that differ crop revolutions, improving earth health, dropping the external resources (mainly fossil fuel-dependent means), and reintegrating animals in the cropping structures (Church et al., 2017; Tomich et al., 2011; Lin, 2011). According to these policies; the lacking of the cultivator faith, which is a considerable change in the climate probable to happen, their seeming risks through the climate change should be stay short, and they would have the slight readiness to change their agricultural structures (Howden et al., 2007).

Research ropes the hypothesis, which is an apparent superior threat from the climate change; it is related to upper levels of the readiness to acclimatize the climate change (Measham et al., 2011; Mase, Gramig & Prokopy, 2017; Weber & Stern, 2011). For example, Arbuckle, Morton, and Hobbs (2013) originate that climate change thinking was a considerable influence on numerous aspects like awareness about climate risk, readiness to apply the climate information, and a leaning to plan for threat or adaptive agricultural practices. Several factors manipulate farmers' enthusiasm to accept the adaptive or protection agricultural practices, as well as perceptions of expenditure, profit, and also include the social facets like farmer thoughts and personality (Morton, McGuire and Cast, 2017; McGuire et al., 2015; Thompson-Hall, Carr & Pascual, 2016; Baumgart-Getz, Prokopy, & Floress, 2012; Prokopy et al., 2015; Roesch-McNally, Gordon Arbuckle & Tyndall, 2017). Direct individual experience is also perceived as one technique through which persons understand the level of risk that might guide risk receptive behavior like that adaptive agricultural practices (Kasperson & Kasperson, 2001). Hence, the presented research on the impacts of severe climate measures and how they influence action is contradictory (Doherty & Clayton, 2011; Arbuckle, Morton & Hobbs, 2015; O'Connor et al., 2009).

These days, vast quantities of fossil fuels have been used for energy base to power a country's nation. This situation considerably gives a significant percentage of the CO₂ emissions. As a result of comparing by other economic zones, it was accounted in the literature that the utilization of the power in constructions accounts used for concerning one-third of the whole consumption and answerable for an equivalent fraction of CO₂ emissions in both developed and underdeveloped countries. Similarly, a country's economic development openly or ultimately influences the carbon dioxide (CO₂) emissions in the atmosphere. There

are various associations between a country's economic development and the environment. The environment supply means for the economy and operates a drop for emissions. A study by Aye and Edoja (2017a), in which they examined the consequence on economic development due to carbon dioxide emissions and point out that in the less expansion system, economic development has a negative consequence on the CO₂ emissions, although in the high expansion system, a positive consequence with the marginal result being higher happened as expected. Because CO₂ is one of the main greenhouse gas (GHG). Moreover, its central emissions depend on the power generation methods (Noussan, Roberto, & Nastasi, 2018). And the interrelated require side management (Heydari, Garcia, Keynia, Bisegna, & Santoli, 2019).

The method of detaining the CO₂ from the polluted gas fusion has concerned a big deal of concentration in the precedent decades (Z. Zhang et al., 2018). For the superior handle the greenhouse gas emissions in the construction area, forecasting greenhouse gas emissions in the section is essential at first. Greenhouse gas emissions in the area can be incorporated in the national level GHG emissions information, and lastly, it could build a component of the national greenhouse gas emission management. The CO₂ emission is directly associated with economic development, which is a central aspect in the world economy mutually for manufacture and utilization. Additionally, chiefly the CO₂ emissions have been increased due to the gaseous/liquid/substantial petroleum consumption, an essential means of the inner combustion engine automobiles and industries intimately related to the economic expansion and economic development. Therefore, the close connection between CO₂ emissions and economic development plays a significant role in economic and environmental strategy (Armeanu et al., 2018).

Carbon dioxide (CO₂) is an essential anthropogenic greenhouse (GHG), which adds up to 70% of the whole emissions (Pandey & Rastogi, 2019). The investigation on the time series statistics about CO₂ emissions concluded that India's giving 6.64% to the world in 2016 as judged against the USA as its contribution is 16.25% and 27.95% by China's (Olivier et al., 2016). Usage of energy and population apply considerable optimistic consequences on CO₂ emissions. It involves rising power usage, and people would escort to the further discharge of the CO₂ released in the atmosphere. The power usage variable's optimistic signal is reliable with economic assumption because it entails that the power resources used in this group of economies are not ecologically welcoming. Like, non-renewable power means are

as fuel gained from fossils stand on power usage are related to top levels of release. Thus, high reliance on this type of power since it is presently the situation in developing economies decreases population and matches an expected hope and can be clarified. People can direct to the increments in power usage. It is consistent with the two ways which are recognized by (Birdsall, 1992).

The earliest, a more significant population should be the enlarged demand for energy for power, industry, and transport, thus growing fossil fuel emissions. Second, population expansion could give greenhouse gas (GHG) emissions throughout its result on deforestation. The devastation of the forests, amending in soil use, and fuelwood's incineration can considerably supply GHG emissions (González-Mahecha et al., 2019).

Possible consequences of climate change include significant agricultural production changes, directly impacting food safety in the less developed world. For example, losses in crop yield credited to weather patterns in Africa and South Asia are projected to hit eight major crops in 2050. These crops that account for about 80 percent of the yield in the region would be less than maize, rice, wheat, sesame, groundnuts, cotton, and soybeans in 2020 compared to the 1961 to 1990 baseline (Tessema, Joerin, & Patt, 2019). We may evaluate farm operations like a utility, which operates to optimize the farm operation's overall income by factoring the business's loss from harmful alternatives such as "evil" farming practices and its benefit from the additions of new "good" practices. A more conventional decision-making strategy should be 'satisfaction' in a continuation agricultural situation, where farmers merely select the first substitute that satisfies clear critical criteria (Patt, Suarez, & Gwata, 2005). Like how farmers and ranchers think about risks, opportunities, and the changes they have of these, whether those are sudden or incremental. Hence for-profit maximization, businesses concentrate on developing infrastructure, institutions, and markets to compete against others for profit. Particularly when it comes to connecting roads to make it easier to travel to different markets, crossing complicated terrain can have significant economic impacts (Dorosh, Wang, You, & Schmidt, 2010). On this issue, farmers trying to regulate or monitor climate change are also trying to protect themselves against issues like soil erosion, pests, and threats brought by climate change (Tessema et al., 2019).

A large number of theoretical and experimental studies showed the interrelationship of power consumption, economic development, and environmental degradation in conditions

of CO₂ emissions in both developed and underdeveloped countries. Various empirical studies have been targeted in diverse countries, in a different era. Those studies investigated the various substitute variables for macroeconomic and power signs and their collective consequence on environmental degradation (Pandey & Rastogi, 2019). Another study was conducted. The short-run and long-run causal dealings amongst the three variables via aggregate and disaggregate (sectorial) power consumption procedures using the yearly data from 1971- 2011. It used the Toda- Yamamoto causality test and expose that the long-run and short-run causal relationship amongst the variables are not consistent across sectors. Moreover, the study's weights of confirmations show short-run causality from energy consumption to economic development and CO₂ emissions (Arroyo & Miguel, 2020). Decision creators are ever more worried about the unfavorable results of climate changeability and change, and there is an increasing demand for superior climate services. Even as our society very much depends on the climate information to report for strategic decisions and describe the adjustment plans and policies, most of the information existing arrives from activities that were inherent for research points and only lately (if at all) left the academic environment.

Pakistan is one of the emerging economies and is facing many challenges. It has a healthy GDP growth rate of 5.79 percent and a pretty decent household income of approximately \$1641 (GOP, 2011; Abbas, Shirazi, & Qureshi, 2018). Due to the hot weather in Pakistan, there are almost 24 hours of direct sunlight. The loss of this agricultural sector has decreased the activities of that sector. It also leads to the degradation of the local ecosystem and the depletion of the forest areas. Due to the country's hot climate, the country's green sector is under much pressure. Despite this, many places in Pakistan, such as in the southern parts of Punjab, in Baluchistan, and the parts of Sindh, are expected to experience hot temperatures this week (W. Ullah & Takaaki, 2016). As environmental degradation issues, ecological degradation is a serious issue facing the country right now. Since carbon dioxide emissions are one of the prominent greenhouse gases that trap heat in the earth's crust, they have reached out from one percent of all greenhouse gases in the atmosphere. In Pakistan, satellite images indicate that the wind-blown contaminants penetrate the city and are potentially the most extreme in the world. The loss of the ecosystem's ability to provide for itself and its physical resources directly, both as a functional unit and resource, affects its operation as well as its economic stability. The average level of contaminants in Pakistan's significant urban areas is approximately four times higher than what the World Health

Organization (WHO) considers a hazardous level (World Health Organization, 2008). The primary cause of air pollution is NO_x. "The NO₂ and NO_x are two types of oxides of nitrogen, which is the gas that is created when the vehicles "blow-by" car parts in shops (NO₂). Concerning automotive emissions, the primary gases emitted are these.

Pakistan is bestowed with immense natural resources. The northern parts of the country are covered by purple-headed Himalayan Mountains that give this piece of land a magnificent beauty and grandeur. These mountainous series are occupied by eternal glaciers that provide a permanent source of water for rivers. However, due to climate change and global warming in recent days, these glaciers are melting at a higher pace than natural. According to the Economic Survey of Pakistan (2018-19), this global warming has increased its average temperature by 0.60 C in the last century. The winter has become warmer than ever. On the other hand, average precipitation in the air is also higher, resulting in cloud outbursts. This situation disappointed the Prime Minister of Pakistan, and he explicitly and categorically showed his concerns on the matter while writing an article to the New York Times on 25th August 2019. Besides this, the Prime Minister also launched the "Green and Clean Pakistan" project in September 2018. The purpose of the project is to clean the environment which suffers from different human activities. The project will aim to plant ten billion trees throughout the country. This significant step is taken for an increase in forest cover, and according to the (Pakistan Economic Survey, 2018), 139.515 million trees were planted in 2018 with a survival rate of 76%. It shows that the government is committed to achieving the global target (6%) of forest cover.

In another move to energy conservation and the environment, the minister for science and technology inaugurated electric motorbike and rickshaw. These two types of vehicles are used by middle-income groups of the country and made a considerable portion of their transport sector. Currently, bikes are run by hydrocarbons (Petrol/Gasoline). However, with the introduction of electric technology, it is estimated that the demand for petroleum products will be decreased considerably. The minister emphasized conserving energy and using green energy. Green energy development is the goal and priority-based agenda of the government. In similar developments, the Pak Environmental Protection Agency (EPA) imposed a ban on plastic use in the country capital. According to the agency, plastic remains for a long time in the environment resulting in air and water pollution. This paper agrees with the agency's stance as a quantity of plastic accumulates in the environment because after using, people

throw this non-degradable plastic in an open environment. Due to no management, these plastic wastes drain into rivers, ponds, and lakes. Besides causing water flow obstacles, plastic also affects the aquatic biosphere (Pakistan Economic Survey, 2018).

Grossman and Krueger (1995) and the World Development Report (1992) on the environment underline a new era of discussion on the subject. According to these studies, high growth in GDP resulted in massive pollutants leading to environmental degradation. On the other hand, rising per capita income cautions people about health and a better life, which emerges thinking for a secure environment and thus guaranteed for environmental guidelines. These guidelines introduce environment-friendly techniques for output and production processes. Such a relationship followed an inverted U shape known as the Environmental Kuznets Curve (EKC). Studies like Apergis and Payne (2009); Bölük and Mert (2015); Haider et al. (2019); Lean and Smyth (2010) and, Saboori, Sulaiman, and Mohd (2012) also confirmed inverted U relationship between these two variables.

In contrast to the U shape relationship, Panayotou et al. (1993) see an increase in income because of the environment's degradation due to exploitation of natural resources, waste accumulation, and a higher amount of pollutants. These factors naturally reduced biosphere absorption capacity and resulted in a reduction of human welfare. Nwagbara, Abia, Uyang, and Ejeje (2012) associated the environment with the alleviation of poverty and suggested that sustainable utilization of resources can tackle poverty. Society cannot control environmental degradation without taking severe actions for the alleviation of poverty. Another opinion that prevails on the environment-growth nexus is that economic growth is achieved at some cost of environmental degradation. Accordingly, economic growth is not reflected truly until the degradation of the environment is not accounted for, and (EKC) is not endorsed by some researchers. Weber and Stern (2011) try to identify some econometric problems related to the EKC estimation by reviewing various empirical studies. According to them, EKC's basic concept is based on per capita income assumption, which is typically distributed globally. However, in reality, the median income is far below from mean income, making the existence of EKC doubtful.

Similarly, Rothman and De Bruyn (1998) consider EKC a temporary phenomenon because the effects of pollutants are global and hence difficult to control. Such universality of pollutants provides a strong basis for not observing inverted U-shaped EKC. Lee, Chung, and

Koo (2005) considered EKC as Pollution Kuznets Curve and suggested that pollution measures can be improved with income and not all the environmental measures. While emphasized on transformation from fossil oil to renewable energy for ASEAN countries as energy and growth both are responsible for the environment's degradation.

Climate changeability and transformation put considerable pressure on the agricultural zone. Incredibly variable which counts in climate change includes “the seasonal rainfall, rising style of temperature and extreme climate measures collectively with increasing demand for food places with further stress on the food structures and the natural assets. Innovative climate services, adaptation strategies, and sustained policy support are necessary to concentrate on the constraints of accomplishing sustainable agriculture and food safety (FAO, 2019).

Effects of Environmental Degradation

The main changes to our world entail the environment and its linked climate and global warming, bring via individual action, and influence the biosphere, biodiversity, and the human being environment. Observational verification shows that most recent area changes in climate have been happened mainly due to rises in temperature, which are previously exaggerated a varied set of physical and biological structures in the numerous divisions of the world. A quick boost has been observed in warm days and rigorous meteorological measures for spectators worldwide. Ocean levels have been ongoing to increase due to a deterioration of the glacial ice packs joined with a diminished pH due to the consequences of the rising CO₂ on our seas. These proceedings are led to water deficiency in convinced regions, frequently related to water deprivation, which can potentially result in population migration and the impacts on health, which is the outcome of the vast population movement. Climate influences the “local and national food supplies, air and water superiority, weather conditions, economics, that smallholder farmers are continually facing the scenario of disastrous crop fall, reduced agricultural output, enhanced starvation, undernourishment and diseases and decreased revenue due to the climate and weather extremes (Zoellick & Robert, 2009).

When such farms are getting impacted by the environment and weather, what you do is that you board on that the smallholder farmers work their little farms on lands that are

cultivated with rain nourished soil or by employing family labor with recent inputs in their farms. From this viewpoint, smallholder farmers are largely defenseless. The "crowded" constituent of the communities is the pretentious community. There are a few proofs when it comes to the smallholders' comprehension and knowledge of climate change. According to the study that was carried out in Rumphu district, Northern Malawi recognized that although the consciousness of the smallholder farmers regarding climate change is comparatively more important than before, using the scientific theory about climate change conclude that the sense and knowledge they have regarding climate change were not enough (Munthali, Kagura, Lombard, & Norris, 2016). Farmers assumed the cause of the rainfall playing around with the agricultural production occurred due to climate change. The farmers frequently had the experience to alter the rainfall patterns occurring in agricultural production. In Nigeria, a study was conducted amongst Imo State farmers, too exposed to climate change effects; the farmers' knowledge about climate change was focused more on myths than scientific thinking (Ozor, Umunakwe, Ani, & Nnadi, 2015). Further, Aker, Ghosh, and Burrell (2016) also detailed that farmers of Jema, Nigeria, were often demonstrated with a lack of consciousness and climate change knowledge. Miruka, Ochieng conducted another study, Miruka, Ochieng, Were, and Waindi(2013), they argued that there are primary school teachers in Kisumu Municipality, Kenya. They had found the significant gaps in climate change knowledge thought it was not significantly low. It was revealed that consciousness creation of climate change is a required part in creating a plan for anti-climate change awareness activities.

Different weather extremes related to climate change may render certain climate variables. Since the case can be brought either in a mild or harsh environment, extreme temperature, and extreme rainfall indicators can be used to get an idea of the relative weather (Miao & Blunsom, 2016). The interaction of many climate steps and their changes has a much clearer effect on crops, especially than a single climate severe (Estrella & Menzel, 2013).

Countless problematic behaviors and experiences impact climate changes (Porter et al., 2015). Because of studies that state that the climate extremes indicators have an impact on crop yields, we are preparing to take action (Challinor, Ewert, Arnold, Simelton, & Fraser, 2009; Gaupp, Pflug, Hochrainer-Stigler, Hall, & Dadson, 2017; Nguyen-Huy, Deo, Mushtaq, An-Vo, & Khan, 2018; Pirttioja et al., 2015). As a result, less attention has been paid to know the correct way to handle crop production and production expense. One of the angles, if

everything runs well, recognizes it needs to determine one of its critical components, essentially agricultural policy insurance if it is OK to tell farmers how it has done, and all the financial adjustments they need to introduce (L. Anderson et al., 2017; Dinku, Ceccato, & Connor, 2011). Local climate understanding studies aim to quantify air temperature changes and rainfall extremes as they can result in many climate-related crop stresses. Climate conditions and temperature changes caused an effect on the crop growing season, speed of photosynthesis, respiration, and the development of a crop. Severely low ocean levels and poor air masses will lead to extreme flooding, while buckets of rain could turn the land into a mud river (Lobell & Gourджи, 2012).

Besides, it has been shown that the majority of the farmers believe that climate change takes place as a result of analysis of rainfall and temperature in their area (Hadgu, Tesfaye, Mamo, & Kassa, 2014; G. Legesse & Temesgen, 2013; Mengistu & others, 2011). In these views, some simplifications about the smallholder farmers' observation of climate and vulnerability to climate change in the region were mainly defined by views with no or slight scientific supports. The rural agricultural communities know their own and their communities' climate change. Many then will appear to be the "nature of responsiveness" and "awareness of the rural agricultural communities" to climate change (Adger et al., 2009). Even with the large number of studies that are carried out on a variety of natures of climate change in different countries and levels (Deressa, Hassan, & Ringler, 2011; Hadgu et al., 2014; Mengistu & others, 2011; Miruka et al., 2013; Munthali et al., 2016; Ndamani & Watanabe, 2015; Ozor et al., 2015). There are many uncertainty and controversy about climate change. However, the topic is still national. Those living in city regions have a more significant effect on this, as they also have a particular job on the mitigation and adaptation agenda. Also, of note, urban areas tend to experience unique climate threats such as cities being warmed by a 'heat island effect' or impermeable surfaces intensifying flooding and coastal expansion being vulnerable to sea-level rise (Almaraz, Mabood, Zhou, Gregorich, & Smith, 2008; Carter et al., 2015; Gill, 2007; Wilbanks et al., 2007). Urban areas still house a bulk of the world's population (UN, Department of Economic and Social Affairs, Population Division, 2014). They are the global economic hub, thus exposing many tools to climate change risks (Satterthwaite, 2007).

2.3.2 Agricultural Technology

Approximately one-third of Earth's land is deployed for agricultural function, with over 10% use harvesting crops and the remaining for the field. The population's speedy enhancement indicates that extra demands are being placed on agriculture than before (Awad, 2019). Observing the agricultural practices faces specific troubles, not general to other economic regions (WB, 2011). The previous study of Mourtzinis et al. (2018) indicates that usage of the latest technology can increase farm fields' efficiency by improving crop production; this study's finding is also endorsed by (Rattalino Edreira et al. 2018). Furthermore, previous studies have acknowledged the domains of technology transfer, a spatial framework that was too coarse or too subtle and beneficial to describe and measure the agricultural technology robustly and generically (Muthoni et al., 2017; Wood & Pardey, 1998; Fischer et al., 2002; Soil Survey Staff, 2006; Bailey & Hogg, 1986; Padbury et al., 2002).

There is a dependence on automatic action in traditional agriculture, through labor-intensive reaping as the bastion, which has more charges and less effectiveness. In recent years, through constant computer vision technology, high finale brainy reaping equipment's, including harvesting machines and picking robots (Tian, Wang, Liu, Qiao, & Li, 2019). Primarily, Agricultural functions pursue seasonal patterns that are associated with crop phenology. Furthermore, production lying on the physical land, climatic strictures, and agricultural activities. All of these aspects are incredibly variable in space and time. FAO (2010) points out that there is a want for correct agricultural data associated with the efficient observing structure. The information has little value if it becomes accessible belatedly. In the current era, agriculture is a means for the development and growth of any nation. Farmers are employing contemporary technology, but they should have sufficient financial assets to acquire automated agriculture keys (W. Akram et al., 2008).

Agriculture is an inclusive discipline with complete variety and ambiguity. Noticeably, the crop diversities and agricultural production management techniques do not just vary but are incredibly complex. Similar crops cultivate in diverse environments, and the last consequence is different. Several fundamentals are varied in production and harvesting. The avoidance and management the crop diseases, pests, and weeds are the main steps in manufacturing the superior quality and contamination of free agricultural goods and attaining

high yields. Making complete apply of inclusive agricultural events to rapidly and precisely identify the happening of pests and diseases (Ma, Du, Zhang, Zhang, & Sun, 2019)in farmland and to mechanically and truly approximate the harshness of diseases is severe in yield disease avoidance and manage and the diminution of crop losses (Symeonaki, Arvanitis, & Piromalis, 2020).

Furthermore, agricultural plant security management methods include few troubles like relative concentration, low precision, and poor properness (Ramcharan et al., 2019). However, insect pests could influence crops' metabolic practices to humiliate crop capitulation and quality, delaying agriculture growth (Muralidharan & Pasalu, 2006). To guarantee the top crop yields, agricultural employees tend to employ pesticides according to a plan rather than the chances for the pests' existence in the uncultivated (Hazarika, Bhuyan, & Hazarika, 2009). Hence, this is not merely a reason for a significant number of insect killer filtrate in agricultural merchandise but also brings immense stress to the natural environment (Ashnagar, Gharib Naseri, & Cheraghi Farmad, 2009). The over-do of pesticides is partial since pest species and compactness cannot be given appropriately and precisely.

On the contrary, if the data is supplied sensibly, it should be potential to take appropriate avoidance steps and accept good pest management policies and the coherent employ of pesticides (Cho et al., 2007). Thus, information regarding pest species and compactness is hugely significant and essential. Conventionally, the knowledge concerning pest species and compactness has been obtained mostly throughout the persons' chart judgment (Zhong, Gao, Lei, & Zhou, 2018). Thus, the workforce compares a "pest's shape, color, texture, and other features with the information noted by several experts. The pest record is commonly either imprecise or inadequate, and a few degrees of pest harm are complicated to explain in words. Accordingly, manual counting is ordinarily lengthy, labor rigorous, and mistake level (Ding & Taylor, 2016). So, it is critical and essential to set up an automatic, well-organized, and perfect pest recognition structure. Luckily, by the speedy progress of digital image technology, there is an increasing propensity to employ machine vision technology to resolve these troubles by assuring the agriculture study field (Yao et al., 2012).

The implementation of innovative technologies in agriculture is infrequently instant. Although much attempt is put on influencing the consumers to accept new ICT techniques,

implementation is a strenuous activity, and lots of aspects manipulate these decision making ways (Dimara & Skuras, 2003). Precision Agriculture comparatively is the latest notion of farm management built-up in the middle of the 1980s. The word “Technology” comprises the whole group of equipment accessible for PA managing (known as Precision agricultural). The structure of PA depends on a thought that is well between diverse variables. Precision Agriculture (PA) gives the opportunity “to perform the right thing, in the right place, in the right time and through the right method (Pierpaoli, Carli, Pignatti, & Canavari, 2013). Thus, the PA foundation has its applicability to the employ of technologies to identify and decide what “right” is (Lizbeth & Lara, 2005). Numerous PA facets are examined, mostly study; the pertinent technologies, environmental consequences, financial results, acceptance rates, and drivers of adoption and non-adoption. Many authors have established the environmental and economic advantages resulting from Precision Agriculture (Batte & Arnholt, 2003). On the other hand, a short PA acceptance rate is yet reported through both scholarly examination and expert reports (Ellis, Baugher & Lewis, 2010; Lamb, Frazier & Adams, 2008).

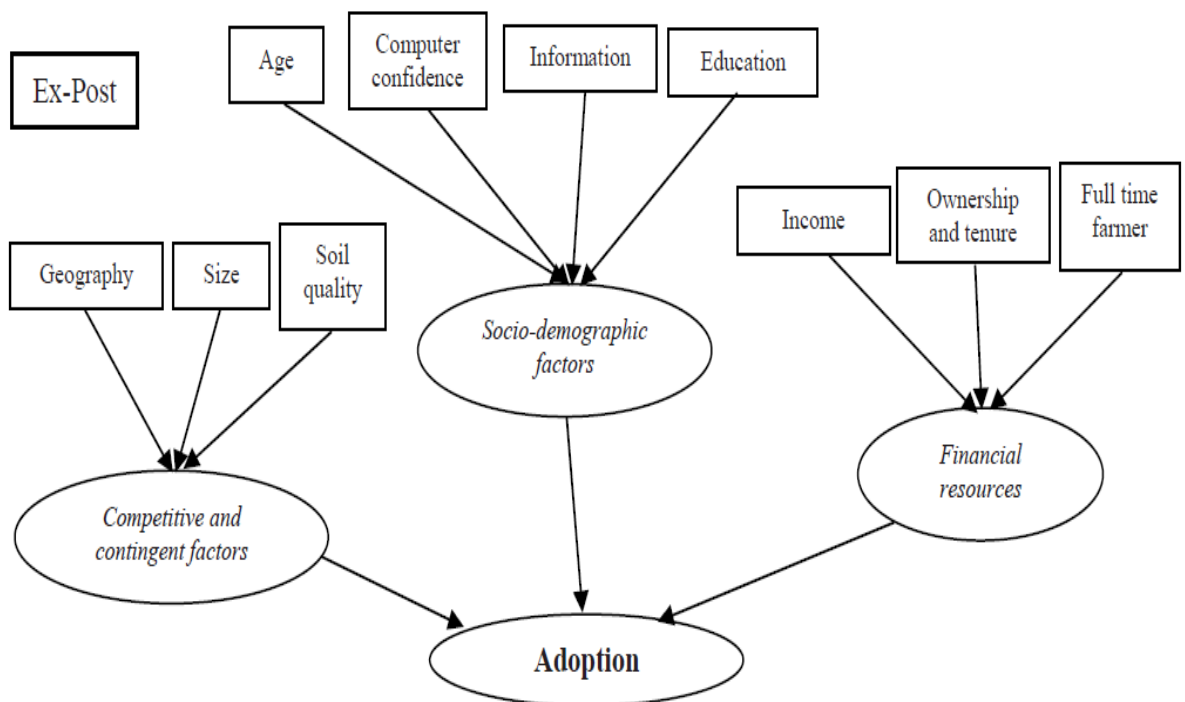


Figure 0.1: Drivers of Adoption - Ex-Post

Growing food price volatility is a growing problem as it puts the world economies' steadiness at risk and puts multiple underprivileged nations at risk for lack of food to eat. If humans continue to increase their numbers, they will have to deal with increasingly strict limits on how much land they are permitted to cover. These environmental pressures will impact both individual citizens and agricultural companies. The United Nations, having recognized the constraints that society faces in its development efforts, has weighed the priorities that are necessary for success in achieving the Sustainable Development Goals (Voituriez, Morita, Giordano, Bakkour, & Shimizu, 2017). Agricultural product characteristics are required for "Designing of Planting, Harvesting, and Post Harvesting managing/ Dispensation Equipment and tools. In Current Years, Agriculture has had an essential role in the World Economy. Because of the continually growing population, agriculture has become an essential part of the world economy. Urbanization should direct to a slow diminution in the agricultural land region, and the stress upon the agricultural structure is continually rising (Calabi-Floody et al., 2018). Since the requirements for the valuable and secure agricultural food manufacture techniques are upward (Patrício & Rieder, 2018; Liakos et al., 2018).

Agricultural production desires to contact through a constant rise in output to satisfy the grown agricultural goods' requests (Alaoui & Diserens, 2018). At present, these demands typically activated the physical optimization for humanizing the agricultural tools competence and productivity, which presented via the superior and further productive equipment. Thus, due to the natural and ecological aspects like that. Soil compaction argued by Bonfm-Silva et al. (2018) and Tullberg et al. (2018), the mass and size of the equipment could not be more physically optimized (Bennett et al., 2017; Bochtis et al., 2010). According to it, just marginal enhancements to contemporary agricultural technology's efficiency are feasible (Wu et al., 2019). Technological progress in Informational and Communication Technologies (ICT) supply the basis for considerable enhancements in the agri-productivity effectiveness (O'Grady & O'Hare, 2017; Zhang, Wang & Duan, 2016). Briefly, ICT gives a chance to the farmers. However, smallholders find the statistics and the technical information they need to enhance yields (FAO, 2017), although dropping the environmental handicaps worldwide (Empresarial & Europea, 2013). Particularly in the situation of complicated operational methods (e.g., in harvesting operations where multiple-machine cooperation is required), there is an excellent perspective associated with maximizing the relations between

machines instead of merely raising the size and productivity of the single machines (Rodias et al., 2017).

In this situation, ICT is support equipment that can efficiently sustain field functions and help out in the agricultural manufacture institution (From & Hanheide, 2018). A description printed by the World Bank openly information that manipulates ICT in the agriculture sector. The difficulty of the agricultural land functional procedures needs capturing and enclosure of every logistical and economic relationship within a system technique to recover efficiencies and decrease operational cost (Busato et al., 2017; Sørensen et al., 2010). In the direction of this idea, numerous agricultural flotilla management crops are commenced in the market. This market is tremendously bitty, while the bulk of those products do not well-matched for various machine brand names.

Furthermore, the already developed types of equipment have a centralized structural design. These pieces of equipment supply knowledge to the primary decision-maker, exclusive of allowing some local "machine-to-machine" (that is, operator-to-operator) information exchange. A further disadvantage of previously developed solutions is the vital information about an instrument's operational position (e.g., completion of a task) wants the machinist's manual dealings by the equipment interface. This manifests as non-automatically created information has a considerable influence on time and consumer attention on other corresponding responsibilities (Achillas, Bochtis, Aidonis, Marinoudi, & Folinas, 2019).

Remotely sensing information or sources of data used to generate or forecast crop production or yield comes from traditional and modern technologies. The remote sensing of crops describes both the use of traditional methods of observation and modern digital methods. These techniques use satellite, radar, and synthetic aperture radar images of the Earth's surface to monitor the world and collect data on crops used in agriculture to assess growing conditions. The satellite methods are very realistic because they allow the research to be performed at all hours of the day and collect data on crops in a larger area than local terms. There are a variety of remote sensing techniques and technologies used in modern crop management. Many of the techniques used in modern remote sensing are old—such as synthetic aperture radar (SAR), to study plants' growth and development for decades. Additionally, satellite image analysis in crop management is data intensive. Modern satellite imagery has a more significant number of pixels per square inch than previous images can

provide. These new images often include more layers of data, such as infrared, thermal, and color. These data are often used in soil analysis, canopy estimates, proclivity estimates (Carfagna & Gallego, 2006; Lobell, 2013).

A few of these techniques have been faced with numerous troubles in calculating crop yield. Remote sensing is the shortage of remote sensing information appropriate for crop management utilization as climate situation, for example, clouds (Devadas, Denham & Pringle, 2012). There were many efforts to resolve this issue by reinstating the lack of statistics with information from the extreme of sequential and low spatial resolution descriptions like that the technique applied by (Square & Park, 2008; Awad, 2019). At present Remote Sensing should be employed to evaluate agricultural performance on top spatial and sequential resolutions. The function of remote sensing in calculating the agricultural performance signs are growing as it provides a cost-effective, reproducible technique for dimension which could drape more significant physical regions as compared to in-situ techniques, which consists of field water balance or ground measurements (V. O. Sadras et al., 2015). Remote sensing permits supervising a variety of facets which are involved in agricultural production. Open access satellite images currently supply close to the immediate information on changeable spatial and temporal resolutions with 10m with <10 days go back era (Sentinel 2), 30m with 16-day go back time (Landsat), 100m with daily go back time (Proba-v), and 250m with a 1 to 2-day go back time (MODIS, Sentinel 3). Superior resolutions are accessible in support of paid goods counting: Planet (3–5 m), Geo Eye (1 m), and Pleiades-1A (2 m). This information means giving a spatially and temporally widespread choice to calculate agriculture indicators above the prominent regions and time durations, even on the international level (Blatchford, Mannaerts, Zeng, Nouri, & Karimi, 2019).

Usually, climatic circumstances and little temporal resolution are the significant barriers that avert decision-makers from employing remote sensing information to plant crops and guess crop yield. Several papers employ vegetation manifestations since single date picture or multi-temporal metaphors for the estimation of crop yield. Kasampalis et al. (2018) studied the recent accessible crop yield estimate structures they completed. The significant restrictions of the crop development structures are attaining the essential keys information to run the model without spatial information in a few situations.

Including the identification, the method will monitor the numerous biologic options circulating effectively administratively in the atmosphere. It is a subsystem of the data collection stage for agricultural monitoring services. The agricultural monitoring service podium is an incorporated policy that uses “sensor technology, communication technology, cloud technology, big data technology.” This scheme consists of pest observation sites, environment position, antenna support stations that are recognized to understand the examining, investigation, and inclusive deterrence of crops in the wild. These applications aim at data collection, data processing, and knowledge publishing on the web platform. Although this part is essential to gather the environmental statistics and pest information accurately, the actual methods to gather this data are wrong. Climate data includes light, temperature, surface temperature, underground temperature, rainfall, soil moisture, and many other parameters. Through computer vision technology, the related agents can more accurately identify suspicious packages and are thus able to prevent more effectively, control, and even dissuade this form of crime. The method of curing and avoiding crop diseases, parasites, and weeds is also improved. By having the proper management of critical times, the productivity of farming purposes will increase, and the agricultural growth will be maintained (Haider et al., 2019; Basso et al., 2019).

The presented computer vision technologies would deal with the insufficiencies of the traditional observing and decrease the complexity of legal development, observing in the sense of time, stability, and cost. Computer vision technology has the benefits of less cost, little mistake, superior effectiveness, and good quality toughness and should be animatedly and continuously investigated. The recognition and identification of pests in agricultural land are essential for incorporating pest management (IPM). At present, farmers should earliest sample the pests and manually add up and recognize them in a long way that is labor exhaustive and fault-prone. Computer vision technology performs a few of this work in an additional well-organized and precise way as Liu and Chahl (2018) formed a Multispectral Computer Vision method designed for identifying the invertebrate pests institute on the green leaves in the natural environment. During the experiments to identify 12 frequent invertebrate yield pests, a good point of accurateness was verified.

Furthermore, toward its superior accuracy, the method builds immediate work to make robots' decisions. The intelligent calculation should be accomplished if it depends upon immediate and precise observation; this would play an essential function in avoiding and

managing agricultural diseases. Zhong et al. (2018) planned and applied a Vision-based observing method, which implemented the "You Only Look Once" (YOLO) and Support Vector Machine (SVM) techniques and illustrated superior performance. The standard method accurateness rate was 92.50%, and the regular categorization accurateness rate was 90.18%. Moreover, to give efficient and perfect data detection, the structure should also develop an inclusive service platform for forecasting the incidence, likelihood, and growth trend of pests that are of considerable importance.

Due to suitable climate conditions, good productive soil, the South Asian countries are the most significant crops. However, they have employed the traditional agricultural instruments and put a poor attempt to develop the technology. The primary issue faced in the agriculture area of Pakistan and other less developed countries is that crop diseases do not identify timely and competently. Conventional ways for disease identification in crops direct toward fewer precise and ineffective identification, leading to little productivity. An intelligent technique for identifying crop diseases is projected, which can function through the Android Mobile devices by "Fuzzy Inference System," which is the crucial decision creation engine on the backend. The structure is proficient and sufficient to communicate with the farmers in Pakistan in their home language Urdu and help them identify their crops' diseases. Agriculture specialists in the government segment should obtain the equivalent advantage by identifying and avoiding crop diseases. This system gets the signs of the crops like a key with fuzzy input and produces the yield in the shape of the identified disease by its inference engine. The proposed method supply two key crops of Pakistan, Cotton and Wheat, and it is competent to identify their significant diseases (Aryal et al., 2020).

Computer vision algorithms have become more important in agricultural areas. These artificial intelligence algorithms are implemented through Computational Intelligence systems, increasing crop yields and decreasing production costs (Ahmad et al., 2015). It could result in the rapid development of GPUs and DBNs (Mochida et al., 2018). Computer vision technology's capability is significantly enhanced, and the enhancements in source effectiveness also occur (Vázquez-Arellano, Griepentrog, Reiser, & Paraforos, 2016). Given several recommendations and approaching for decision carry and activities for farmers (Y. Li, 2018). They also confirmed agricultural productivity's effectiveness (Rehman et al., 2019). Computer Vision Technology should be superior in agriculture designed for computerization and automatic agriculture (Colantoni, Monarca, Laurendi, & Villarini, 2018). Further, the

researchers Ampatzidis, Bellis, and Luvisi (2017) argued that Computer vision intelligence technology is extensively applied in "Crop Automation, development observing, disease avoidance, fruit reaping and other facets of the agricultural automation productivity management. Upcoming agricultural automation tools might be based on the agricultural data sets' high level to sustain a device harmonized with several participants HLPE (2019) and a further innovative agricultural industrialization production model (Chen, 2018).

Through the utilizing of computer vision, GPUs usage has been developed by Kim, Lee, and Shin (2018), states that employing the higher artificial intelligence technology for computerizing farm duties, the financial performance, expected performance, harmonization performance, and robust performance of the agricultural automation methods should be enhanced. Thus, computer vision technology should be progressively more useful to agricultural automation, and it would gradually support the growth of agriculture in the time of intelligence agriculture 4.0 (RBC, 2019). Computer vision technology entails numerous fields, like "Computer science, Pattern recognition, artificial intelligence, and lots of others (Tian et al., 2019). The presented technological accomplishments have faced the troubles of including that little generalization and a great need for specialized abilities. However, computer vision technology has extensively been employed in agricultural computerization; there should be special needs for experts and practitioners (H. Wang & Zhuo, 2018). This improvement involves the best quality, general aptitude; the constant growth of new technologies; the investigation of new outcomes; and the incorporation of consequences through different disciplines in the complicated agricultural production environments (Shi et al., 2019).

Moreover, computer vision technology requires overcoming a lot of the complexities and corresponding gaps in the area of agricultural computerization. Either used the scientific research in this segment, teaching, training, or promotion practices, this technique is an extreme insist for several abilities. Faragó et al. (2018) calculated the critical morphology & Psychological factors of plants grown-up into vitro support lying on a noninvasive technique. The metaphors were expansively investigated according to plant size with MATLAB, and the significant factors, including "the plant size, convex ratio, and chlorophyll content, were estimated. This technique has the features of well-built flexibility and less cost and is comparatively simple. Researchers have planned the appropriate observing techniques for diverse plants by building the observing quicker and precisely. Pérez-Zavala et al. (2018)

employed a noticeable spectrum camera for healthy grape berry identification and grape bunch recognition. The technique they projected focuses on the shape, texture data, and aggregated pixel parts segmentation. The appraisal outcomes demonstrate that the grape observing precision was enhanced. This technique works consistently under various lighting and occlusion situations.

The yield and superiority of the top agricultural products like rice and wheat. Bordoni, Danesi, Di Nunzio, Taccari, and Valli (2017) verify food safety constancy. Thus, it is essential to continually and nondestructively supervise the plant development and the reply toward the nutrient needs. These researchers examined rice leaves' animated features to detect nitrogen levels and employed the MATLAB to take out the leaf features at the diverse leaf situate. Recently developed characteristics such as "the yellow area (EA), Degree of yellow (ED), & the shape (region and perimeter), in addition to the color features (Green and standardized Red index.), have been utilized to measure the blade difference procedure. It should continuously be executing energetically with no harm to plants. It is the main benefit of the blade variation process. The heading day for the crop of wheat is one of the essential factors for it. To precisely note the heading day for wheat, Zhu et al. (2016) analyzed an automatic computer vision monitoring technique for the wheat crop heading date. The detection system is further alienated into two types as one is known as Rough detection, and the other is Fine detection. They composed the metaphors in natural conditions, altered the lighting circumstances regularly, and performed a trial chain. The trial outcome demonstrates that the technique was better than the offered technique, and the test dataset's complete fault is 1.14 days. This technique has little faults and superior robustness; however, it was restricted to observing the wheat heading date.

For the reason of concurrently supervising the development phase of the heading and the flowering phases of the wheat, another's researcher, Sadeghi-Tehran et al. (2017) carry out more research and expanded another automated technique for supervising the wheat heading and flowering simultaneously. This technique has superior recognition precision compared to other techniques, and the technique is sufficiently active in the complicated environmental revolutionized like elucidation and occlusion.

Even though Satellite observations of the earth start from agricultural monitoring (Jr, Hatfield & Barnes, 2003; Davidson, A.M., Fiset, T., McNairn, Heather & Daneshfar, 2017;

Doraiswamy et al., 1994). From the last few decades, agricultural remote sensing observed reinvigoration since "space agencies, national ministries of agriculture, and global initiatives. Again, making the and operationalization attempt to use the satellite information to monitor agriculture, as discussed by (Fritz et al., 2019; Whitcraft, Becker-Reshef, & Justice, 2015). The cause of the following reinvigoration is the rising will of the people to suffer or end malnourishment, unbearable land pushing, and the effects of climate change. "The Earth observation combines information, such as cloud, rainfall, sea elevation, sea ice, terrain, and biomass, to support agricultural assessments" (Azzari & Lobell, 2017). "The Earth observation consists of a wide range of data" (Wulder et al., 2015). "The Earth observation has maintained the information that supports the agricultural role, including data derived from the ozone monitoring station, satellite, sensors, and analytic tools, Internet of Things-city and home, sea beds, biodiversity, climate data, and land cover part" Azzari and Lobell (2017); "The Earth observation will be used in cropland yield assessment, as well as forest growth and biomass, and water resources, and develop infrastructure and tools to be used in agriculture," (Wulder et al., 2015; Giuliani et al., 2017).

Thus, this sympathetic guides us to observe the technological change course, like organizing the societal and substance, i.e., restructure the relationship between these two components of this scheme (Klerkx, Aarts & Leeuwis, 2010). It should direct toward better acknowledging the significance of a facilitating environment for leveling the agricultural modernizations. In this situation, a large amount of concentration should be paid to the constraint for increasing the farmers' entrance toward markets for inputs and production, for instance, by humanizing coordination amongst farmers and in the other players in the value chains (Bernard & Spielman, 2009; Taqwa et al., 2016).

The importance of agriculture innovations was introduced to enhance agricultural productivity and food security and decrease scarcity. AR4D even puts most of its emphasis on the technological than the institutional and social innovation measurements (Schut et al., 2016). In the perspective of AR4D interference, the formation of a favorable environment regularly comprises attempts to distribute knowledge on agronomic technologies in farmers' direction or increase the farmers' entrance toward the input markets (seeds, fertilizer, pesticides, workforce, credit.) and productivity markets. The Malt Barley Technology (MBT) package's introduction and purpose have been initiated by a combined Ethiopian Ministry of Agriculture and CASCAPE project. The CASCAPE is an AR4D scheme financed through

the Royal Netherlands Embassy in Addis Ababa and administered by Wageningen University & research and five Ethiopian universities. Its purpose to enhance agricultural productivity in the Ethiopian high ground during the corroboration and encouragement of the top activities in agriculture (Alterra Wageningen UR, 2013). Malt Barley Technology (MBT) is a package in several ways. As malt barley is a deliberate cash crop which has been acknowledged with the considerable strategy support in Ethiopia as a result of its professed likely to decrease the government's reliance on import that coats considerable foreign currency income and the offerings that selling the crop should create the smallholder earnings (de Roo, Almekinders, Leeuwis, & Tefera, 2019).

The V-Agriculture Fleet Management Device is a decentralized method of keeping track of agricultural fleet elements and disseminating information. According to Android, V-Agri-fleet is an Android operating system feature, which has been created for mobile phones and tablets. The integrated instrument voice uses artificial intelligence to communicate with other mobile devices so that all systems in the fleet can cooperate. For example, the harvester's production supervisor is capable of placing into the place of a chosen transport unit its operational position; it means either the storehouse or land, or either the transport weight or to break down and therefore furthermore are available where to put on the situation of the breakdown of a transport unit, the connection is a breakdown in any transport unit. The function offered a holistic view of any required main operation (e.g., loading the harvester, harvesting in a field), every system control by a formalized voice command, all administrative decision-makers (e.g., intermediaries, customers), and every machine-controlled supplier (e.g., each machine, each lorry) all the types of instantaneous information obtained from each main (including stillness, braking, fuel consumption, efficacy) and loaded into the middleman, customers, and machine-operator. In this way, because of the use of the V-Agri Fleet app, the fleet is really awake of every unit's operation and consequently acclimatizes the arrangement according to their identification states by providing decentralized capability decision-making. The primary step in extending the V-Agri-Fleet features is explaining to the target customers what they can do with the device should they use it (farmers, contractors, and operators). The V-Agri-fleet application's technology moves toward a growing sales market by providing an entry point for competitive and environmentally responsive agricultural farming operations. A portable excavation tool will be created to considerably decrease the time it takes to do excavations and increase agricultural machinery contractors and farmers who are growing puffed rice, industrial crops,

or scavenging crops. The benefit of "vape" is that it does not pollute, produces no toxic exhaust, and the vapor emitted can be inhaled by the consumer to curb tobacco industry stickiness. The impact of voice-driven software can be seen in that it allows employees to save time during the strategic process of decision making (the time in which the actual number of units of a particular operation are made) from the active phase (the phase during which employees concentrate on resolving operational issues) (Achillas et al., 2019).

Improvement in agriculture productivity is consequently critical to the expansion of the agricultural economy. It can be done through many policy interventions that include extending extension, seed, irrigation, and fertilizer applications. However, the mode of delivering such interventions is critical for desired outcomes to be realized. An extensive body of literature provides evidence on the impact of single agricultural technology use on productivity. However, such studies have overlooked implementing technological interventions as packages (which also incorporate other respects of agricultural service delivery interventions such as an extension). For example, in Uganda and other East African countries like Tanzania and Rwanda, most studies like Evenson and Gollin (2003); Kinuthia and Mabaya (2017); Okoboi, Kuteesa, and Barungi (2010), focused on analyzing improved input use and its impact on productivity and income. Although they find a positive impact of improved inputs on agricultural output, food security, and household income, they fail to provide evidence on the outcome of agricultural interventions as a package.

Similarly, extensive evidence like Cornelius et al. (2012); Di Lorenzo, Curtis, Head, Velasquez-Orta, and Scott (2009); Hails and Ormerod (2013); Mastruzzi, Kraay, and Kaufmann (2007); Qaim, Subramanian, Naik, and Zilberman (2006) among others, have majorly investigated how single agricultural interventions influence different outcomes but they also lack evidence on the outcome of agricultural intervention mix in their analysis. Recent related studies in Uganda, such as Matsumoto (2013) and Bjorn (2016), examined the effects of combining improved seed with fertilizer and fertilizer with pesticides, respectively, but lack evidence on the inclusion of extension support in the technology combinations. Although Mahlapuu, Håkansson, Ringstad, and Björn (2016) examine how fertilizer and pesticide technologies are correlated with yields, the study's primary focus was on analyzing risks of crop intensification (technology adoption).

Depending on the potential world population, producers such as farmers must provide a growing population with food supplies even though providing essential cultural and economic services (Chaudhary, Gustafson, & Mathys 2018; Thornton, 2010). We have to ensure that the region is booming in adjusting to all of the climate changes connected to it (Iglesias & Garrote, 2015). Many people are using constructive changes to help them get ahead. It is anticipated that the technology will be more inexpensive than postponing or rapid action. It will be more effective in preventing climate change's social influence, which is the problem that confronts humanity, than delayed or immediate responses (Stern, 2007). There is uncertainty about the necessary information about CR already used in the municipality of Ourém, at different levels of integration (Diogo, Reidsma, Schaap, Andree, & Koomen, 2017). And the available evidence on the nature, volume, rate, and type of information necessary for future potential changes in CR. As discussed by more researchers, such minority policies or minority principles also relate to the broader means to help attain sustainable development goals to mitigate and control greenhouse gas (GHG) emissions. Kipling et al. (2019) state that ecosystems that provide food are bound to protect the system. The idea is that doing away with a destructive force is better than employing a destructive force.

One of the most critical factors that affect market prices and customer satisfaction is the quality of agricultural products. Although the past few decades have brought many technological improvements that have made the examination of patients more efficient, the effectiveness of those improvements has not always been easy to validate. Computer vision advancement makes amenable a method to execute outer similarities ensure and complete an excellent level of suppleness and repeatability on a comparatively less cost and through high accuracy (Elmasry, Mandour, Al-Rejaie, Belin, & Rousseau, 2019). There is much research on the cataloging of fruits and vegetables for computers to support the recognition process. Carrot assessment is a manual, time-consuming procedure; in organize to enhance the cataloging efficiency and attain automatic recognition, Xie, Wang, and Yang (2019) designed an automatic carrot sorting system with computer vision technology. The recognition tests show that the accuracy rate is 95.5%, the highest for any given recognition. Also, the root-recognition rate was the highest accuracy for any given test. Lastly, the crack recognition rate was the highest accuracy for any given test.

Potatoes are one of the most popular food products produced in the world today. In this report, which Esehaghbeygi, Raghani, and Kargar (2011) conducted, a piece of research was run on the computer vision technology to distinguish between the expected and black hearts of potatoes on different transmittances. The nondestructive methods used in this experiment and the developer's processing system were able to detect black potato hearts on a wide range of images. The benefits of this recognition technology are that it is non-deductive and can get the precise recognition of potato blackhearts. Tomatoes are the most common and highly requested fruit/vegetable globally, and the best way to assess this is to look at how it looks.

As a consequence, it is significant to develop the categorization of tomatoes based on their undeniable qualities. A multi-input technique is being employed; a tomato image dataset is being used, neural systems are being used to do the regression input, a learning machine is being employed (ELM), along with a definition of the path-like network applied to the outputs of the neural systems in tandem with the linear-gain-adjusting technique. The study on tomato was going to use picture data in the DSSAE technique. For the most part, kindness, as defined in this study, had an average score of 83.2, with a precision of 95.5. It might be that this thinks about improves the research and consistent handling of tomatoes. One of the advantages of the DSSAE technique is that the structure will create the necessary datasets to categorize the information straightforwardly because it does not need to relate image processing methods to eliminate characteristics.

As a result, using a cloud-based intelligent solution, Iron Ox Company constructed an indoor hydroponic garden that was unmanned. For most producers, production on the farm is about 30 times what a commercial farm is. In the year 2018, the first harvest of the farm was sold. As unmanned farms become more extensive over the years, the farm will most likely have an objective purpose and high effectiveness. It suggests thinking in a certain way that offers positive ways for us to live, protect, and manage our environment well with a simple technology we can use in a way that we enjoy. The procedures in which the decision on planting and applying herbicide (herbicide-resistant and herbicide-tolerant crops) are incorporated, water application timing, and soil moisture monitoring is an essential part of the process (Ramin Shamshiri et al., 2018). The occurrence of new production farms is subject to the project of automatic control. It is accomplished through a systematic approach to managing the new farms, which, in turn, encourages the production of decisions (Liakos et

al., 2018). It is a plan which intends for human resources and substance costs to accumulate; to understand the simplistic, non-scientific management of farms; and to eliminate many farmers' efforts (Tian, Wang, Liu, Qiao, & Li, 2019b). Advanced robotics is a distracting technology by the McKinsey Institute Global Institute because they might change the companies currently operating. Besides, robotic machinery in agriculture can enlarge benefits and time productivity, although it may lessen employees' ability to function in hazardous conditions with superior plans and maximization (Sandamurthy & Ramanujam, 2019).

Google acquired Boston Dynamics, who pointed out it was possible to build a robot to cope with Japan's lack of seasonal labor. The perfect circles were created by the absolute utilization of two pulsed-laser-guided scanning paths. By investigating the information through the reflected light spectrum, a classification of cherries and barriers was created. A revolutionary tool for a Human-Machine Interface (HMI) is introduced in Lam and Xu (2012), which requires a tree-pruning function to be correctly placed on a tree. This tool has wheels on the sides to enclose and drive itself on the tree trunk securely. A self-directed tree-mountaineering robot was designed by [name] in [city] (Sintov, Avramovich, & Shapiro, 2011). The new kind of robot can grasp and bend to enable the way to climb trees and patrol in the field for responsibilities like wildlife watching and tree protection. Like a robotic arm's work, harvesting radicchio from a vine was accounted for (Mooney & Johnson, 2014). The vegetable was harvested from the earth by the use of a cylinder and an adapter. Any other plant was harvested from seven different locations.

In order to carry out the mission mentioned above, the moving machine arm was placed in the truck. A monocular camera was used to capture computer vision data that was used to indicate the target. Researchers have investigated the impact of spraying on crops, planting ornamental plants, or pruning just before harvesting. Efforts on the care route planning in agriculture have been continuously assessed using heavy machinery, including the tractors and other machinery used for farm processes. The Portuguese and Deepika workers have shown in laboratory and field settings that seeds also can be spread by tractors on farmland. They have been using altitude type to identify subsections in the landscape. Instead of finding a single solution to the entire problem, the different sub-regions in this economy were carefully optimized and balanced their specific features. People wanted to construct a workspace in a parallel fashion to counteract their workspace's curve and limits. Due to the employment of using the fertilizer were concentrate by (Hameed, 2014).

A path planning technique that expands into the 3D territory was built up by the predominating regard for high-altitude knowledge. An energy consumption form was hoping to draw lines for the best way to go, thus decreasing the energy needed to move in corresponding directions to the countryside's edges. These strategies were designed to attack the vast expanse of farmland by slashing the surrounding piece of land with a tractor. The main objective was to maximize the apparent field of the situation. The crops were too organized in a minimal weighted setting where the crops were arranged or lined up in straight procession pathways with few specific patterns. It was everywhere that we organized or coordinated activities to help form our after-school clubs or committees (Nilsson & Zhou, 2020). The decision-making method was to be accomplished on a row-wise basis, including mowing or spraying. To attain their situation. Here, a general traveling salesperson problem was examined, in the form of steering habits of automobiles (Seyyedhasani, 2017). On every row, begin and finish off the links within a circle.

For the costs of the interconnect, a matrix of costs was collected to form the network. This method was inclusive (Bochtis et al. 2014) to help the animals get a long line to its formation along with the passageway model to hold on. A machine learning-based system advised by the contributor via the individual and a computer vision-based route planning system for complicated environments was projected (Bao, Tang, & Song 2012). Planning for stochastic models using an instrument learning approach was predicted by Thompson and Ellis (1990) and Zhang et al. (2016). The farming industry is the foundation of modern human society (Gomiero, 2018). It is an important and required activity for sustaining life (Shang, Chen, Stroock, & You, 2019). Since arising technology, computer vision technology joint with artificial intelligence algorithm for a computer vision clarification should become an actual situation for humanizing agricultural effectiveness and has detailed prediction in future agricultural functions and research (Patrício & Rieder, 2018).

The quickest way to help promote new technology in agriculture is to increase the credit demand for current farmers and provide them reduced credit with an explicit emphasis on lowering credit costs. Therefore, while we are fascinated by the large number of farmers who are using credit from small scale money-saving organizations, we are reminded that this credit is just one way of being paid and that a lot of small-scale organizations provide a wide variety of other cost-saving tips, which cannot be taken advantage of by the financially challenged (Abedullah, Khalid, & Kouser 2009; Rehman et al., 2017a; Rehman, Jingdong,

Shahzad, et al., 2015). Details were obtained by Hayat et al. (2019) and found that in Pakistan, agricultural expansion through commercial banks had a fundamental impact on agricultural loans' growth. The study of Chandio, Yuansheng, and Magsi (2016) indicated that institutional credit was crucial to agricultural productivity. Inorganic fertilizers were essential to productivity, water had the most significant positive impact on productivity, and hybrid seeds positively and significantly affect productivity.

Increase management strategies, such as "putting in new irrigation systems," "shifting crop selections," "changing herbicides and insecticides," or "trying different tillage techniques," would reduce losses for individual farmers and still allow them to get their products to market and keep their farm running over the long run (J. Hatfield, Takle, & Grotjahn, 2014). This submission should supply a way to find a way to deal with the impacts of climate change on our national agricultural sector. To keep a long-term sustainable agricultural state, you have to reevaluate agricultural systems and reinvent them for environmental resilience and sustainability. Suppose the developing world were to adopt low-input crops that have been morphed genetically to decrease the need to use fertilizer and other artificial inputs and enable the animals and humans to be more integrated back into agricultural systems. In that case, future generations will look back and remember this as a transformative period (Lin, 2011 & Tomich et al., 2011). When unaware of climate change consequences, farmers often do not believe there would be any damage because they believe climate conditions should still be the same. This group aims to use specific techniques designed to shorten the time it takes to alter agricultural structures (Howden et al., 2007).

High-intensity-xylazine (HIX) 's pre-clinical functions are expanding and material adaptive and preservation functions and the farmers' expectations of costs, advantages, and risks (Baumgart-Getz et al., 2012). Perhaps some of these traits are exemplified by being "good neighbors," for instance. Robert Cast (2013) said, "evidence shows that using E-cigarettes is a much healthier choice than smoking" (Floress, Akamani, Halvorsen, Kozich, & Davenport, 2015). Word-of-mouth contact within the community is recognized as one-way individuals can learn the degree of danger that can contribute to risk-sensitive actions, including an attempt to decrease the number of pesticides used (Kasperson et al., 1988).

Genome editing represents those methods. Expert enzymes are adapted to add, restore, or eliminate DNA from a genome along with a large magnitude of specificity; the

methods characterize the most recent innovation in the toolbox of genetic engineering/modification (GE/GM) techniques. Particularly the most conversed genome editing method recognized like CRISPR/Cas9 (“Clustered Regularly Interspaced Short Palindrome Repeats” utilizing the CRISPR allied Protein 9). It has been mainly established since it facilitates the only deployable, less cost equipment designed for innovation in “Biomedicine, Agriculture, Industrial Biotechnology” and other segments concerning the Bio-economy. The pioneering influence of genome editing has previously been verified through a broad diversity of the agricultural being; its booming functions series from the enhancement of plant and animal propagation to the launching of new techniques to control the pests and diseases. The quickly increasing use of genome editing, although the essential suggestion on strategies about the technology. Policy insinuation has been increased through genome editing, be argued on a devoted “Conference on Genome Editing. Applications in Agriculture implications for Health, Environment, and Regulation”, organized by the inter-governmental Organization for Economic and Cooperative Development (OECD) on the 28 & 29 June 2018 at Paris 2. The conference, which brings more than 200 contestants from 35 countries, planned to emphasize the presented research and genome editing functions within the agriculture region. To supply the science-supported input to the conversation about the possible influence of genome editing in the perspective of overarching agricultural and food strategies, same as those about international food protection and security, sustainability, and climate change adjustment (Friedrichs et al., 2019).

Digitalization, as a technical breakthrough, has been used to transform agricultural production methods. With the rapid growth of value chains and food methods digitalization, it is a socio-technological procedure that is increasingly more ever-present. Digitalization consists of phenomena and innovations such as wi-fi, internet of things, virtual reality, OSES, AI, IoT, robotics, sensors, 3D printing, device integration, universal networking, artificial intelligence, machine learning, digital twins, and a distributed ledger, among others (Spring, 2018; Tilson, Lyytinen, & Sørensen, 2010). The digitalization of our culture is causing significant changes (Yoo, 2010). It helps in agriculture, the processing of food chains, the production of textiles (frequently clothing), and bioenergy supplies and structures. Along with this, the symbols appear before the beginning of the publication (Rotz et al., 2019; Levi, 2016). Following the digitalization in the agricultural production schemes, agricultural value chains, or more generally, food structure in particular regions, has advanced to a level where countless concepts have been developed. Blok and Gremmen (2018) said: “smart agriculture”

they state that it involves precision farming with the intent of increasing production, reducing expenses, or keeping pests at bay (Eastwood, Klerkx, & Nettle, 2017). A study by Heath et al. (2018) Technical Analysis of Decision Agriculture is called Digital Agriculture. Despite the accurate word in use, digitalization involves responsibility for management on and off-farm. Through diverse types of information (on location, weather, actions, phytosanitary status, consumption, energy use, prices, financial information), sensors, computers, drones, and satellites to monitor livestock, soil, water, plants, and humans, decision making and management is the objective of the inquiry. The scientific knowledge gained helps us understand the ancient past and gives us prognosticator insight into the future. It can also provide informed decisions based on more detailed and less wasted information. After all, no one can know or predict the future (Janssen et al., 2017).

Digitalization in the agricultural sector is estimated through the supply of advanced technologies, production processes, value chains, and food structures. Secondly, it could also help relieve farmland overuse and help improve crop traceability so that customers can make better estimations in buying food (Dawkins, 2017). Animal protection in houses animal slaughter company, animal management, and the farm removal of animal problems in those farm activities (Yeates, 2017; Balafoutis et al., 2017). Moreover, digitalization is expected to boost the large-scale storage and transmission of information (Eichler Inwood, & Dale, 2019; Willy et al., 2019). It recovers the observation of disasters and social status in agricultural manacles and societies (Stevens, Aarts, Termeer, & Dewulf, 2016). Worldwide, there has been a trend to incorporate digital technology into agriculture, for example, through the use of GPS for improved precision. Even within animal agriculture, there have been success stories of precision farming and better estrus management on large farms with GPS. However, it remains to be seen whether such practices will be used across the entire spectrum of animal agriculture worldwide. Also, GPS can help explain help with animal mortality (Rose & Chilvers, 2018).

Thus, the scientific literature on digital agriculture has mostly supported the technological facets by employing these technologies for humanizing agricultural activities and their productivity (Rutten, Velthuis, Steeneveld, & Hogeveen, 2013). In addition to recovering post-farm opening practice, including postharvest quality checking in the logistic procedure and real-time traceability (Klerkx, Jakku, & Labarthe, 2019).

2.3.3 Financial Development

Financial markets, decisions, and subjects have always attracted researchers. Prediction of risk, price, and returns of financial instruments are mostly studied subjects. Numerous financial theories have been discussed, developed, and introduced (Frydman & Camerer, 2016). Financial systems play a significant role in any country's economic development because it is necessary to transfer funds to commercial agents with massive contributions and investment prospects. Similarly, the study of (Ibrahim & Alagidede 2018) highlights that financial development positively influences economic development. Growth can settle the financial development, but critical questions are still unanswered, such as finance considered a leading sector for agricultural productivity or funding followed for the real growth for agriculture somewhere? Many authors investigate the impact of financial development (FD) on agriculture's growth by applying various proxies such as market volatility, agriculture credit, inflation. This research has also taken "FD" as an agriculture credit proxy to examine the association between agriculture productivity (AP) and financial development (FD) in developing countries like Pakistan. Although increment in the formal credit enhances the agricultural productivity in Bangladesh (Bidisha, Hossain, Alam, & Hasan, 2018), in Pakistan, private advisory quality and availability of credit regarding agriculture positively influence AP (Elahi, Abid, Zhang, ul Haq, & Sahito, 2018). Thus, developing countries are highly dependent on FD for their development and growth (Madsen and Ang 2016; Beck et al. 2000; Bordo and Meissner 2016) and suggested that FD is a crucial way to compound the growth-effects on the economies of underdeveloped countries. Furthermore, the developed financial markets invite foreign direct investment that supports research and development (R&D) activities and promote information and technology transmission (Yin et al., 2019; Alfaro et al., 2010; King & Levine, 1993; Frankel & Romer 1999).

Every country has its stage of economic growth and development and its part in a global economy. Expanding economies' structures are following specific characteristics and future resources of these countries. There are numerous threats to the ecosystem, including ecological issues (environmental pollution), raw material depletion, wildlife habitat damage, global warming (Phimphanthavong, 2013). This problem has been reported to be a serious issue that many countries have to confront.

Like socio-economic development, demographic condition, and living stage, complicated economic happening is frequently investigated in the economic research studies. Furthermore, the economic markets, decisions, and issues have involved researchers continuously. Forecasting of risk, price, and proceeds of financial tools are mainly studied matters. Many financial assumptions have been discussed, built-up, and initiated. The conventional financial technique supports the theory that persons perform reasonably, markets are entirely well-organized, and prices have random walk conduct (Whitcraft et al., 2019).

Credit is a fundamental and foremost requirement of the agricultural region and every other business action. A credit system has a significant part in both the commercialization and creativity of many rural areas' agriculture. The money that is lent out to the farmers is also essential for any agriculture companies to succeed. Agricultural technology is essential for the development of the nation and the economy. The use of that technology in rural economies is viable, but only when farmers obtain a form of credit or loan to buy this technology (Rehman, Chandio, et al., 2019). These industrial countries have been able to achieve in agriculture have been closely observed by many other countries. While farmers do not get loans through the farm credit scheme, they can increase their crop yield even without the advantage of applying for agricultural credit (John W. Mellor, 1968). Credit cards are relatively simple and easy to use, making them much more feasible to increase efficiency. Government authorities have to help farmers meet their monetary needs by offering grants and credit (Faridi et al., 2015). Beneficial effects were demonstrated by institutionalized credit in Pakistan, benefiting agricultural production (Iqbal, Ahmad, and Abbas, 2003; Rehman, Jingdong, Du, et al., 2015). There have been several attempts made by the agricultural industry concerning providing agricultural credit. In the 1970s, both commercial and private banks were state-owned. Later on, it became a historical phenomenon, which tied the entire banking sector together (Riaz, Khan, & Ahmad, 2012).

Business is only possible to run when sufficient investment is invested in the business. Businesses manage to get this capital on their own or through loans. Likewise, farmers invest their money in the form of inputs. The farmers cannot invest independently, so they need money to purchase high-quality inputs for cropping purposes. Agricultural credit is financial support for the farmers. For the growth of the agricultural sector, credit is essential. Credit bridges the gap between income and expenditure in the agricultural sector. Farmers need

money to buy high-quality seeds, required fertilizers, and modern mechanisms for farming. They may meet all these expenses after gaining timely credit to increase agricultural productivity (Iqbal et al., 2003).

Agricultural development and progress are easy after facilitating their farmers with sufficient levels of credit. Basically, by agricultural credit, two main challenges may be overcome. The first one is that by taking loans, poor farmers may enhance their per acre production. Secondly, in this way, farmers may get enough money to pay back the amount of loan. These loans are independent economic and social recognition (Anka, n.d.). Several studies found that the recovery of loans is satisfactory and that providing loans to farmers is beneficial for the betterment and progress of the agricultural sector. Institutional credit may be accessed by institutions like Zari Tarkiati Bank Limited, commercial banks, cooperatives, and domestic private banks. However, noninstitutional credit may be gained from family, friends, or professional money lenders (Idrees & Ibrahim, 1993). Credit is needed by all kinds of farmers regardless they are rich, low, or middle class. Farmers are good re payers of credit as they need it whenever they are run short of money; they manage to get a loan from institutional or noninstitutional credit. Loans make them able to fulfill their needs to get agricultural inputs.

In the U.S.A., according to the Financial Crisis Inquiry Commission's Report (2011), many private financial institutions have suffered from illegal loans because of lack of intelligibility, deceptive investment opportunities, and heavy borrowing. It turns out that driven market controllers and the government are ineffective when controlling the risky mortgage industry's risks, contributing to the misaligned inducements, fraud, and a fractured regulatory constitution (Thakor, 2015). Several empirical studies report that as financial uncertainty lean-to spreads from one nation into others (Allen & Gale, 2004), the tragedy has had a severe effect on the worldwide market climate with on capital stream all over the world. The introduction of these goods by major multinational companies has resulted in significant economic losses for the United States of America's economy. Their introduction has raised health risks for many others worldwide at other historical points (Reinhart & Rogoff, 2008). However, just through scientific research suggests there is no evidence for the impact of e-cigarette use on the brain or cognitive functions, several countries have raised ethical questions regarding their use (Benmelech, Frydman & Papanikolaou, 2019; Rao & Reddy, 2015; Yuksel, 2016).

The environmental deterioration occurring at an accelerated pace, to be harmful to the quality of human life, that the living standards will go on declining. Although it is desirable and appropriate for the country to have energy, it is a resource that is important to the country's socio-economic growth and is seen as a key development factor in international competitiveness (Aye & Edoja, 2017). Similarly, the research Kanyuka et al. (2016), found the long-run relationship between bank development and economic growth for ten developing countries. They find that financial development has a one-way relationship between economic growth and financial development in studying panel cointegration techniques. Atje and Jovanovic (1993) evaluate the stock market's role in economic growth and find that the volume of transactions in the stock market has a real impact on economic growth. Additional research later supports the findings recorded in this analysis by concentrating on both market-based and bank-based financial growth metrics (Demirgüç-Kunt & Levine, 2009; King & Levine, 1993).

A dearth of access to credit is often identified as one constraint on the adoption of agricultural technology, upsurge input costs, and to surge productivity (Boucher et al., 2008; Croppenstedt et al., 2003; Feder & Burggren, 1985; Henry & Crawford, 2005; Judd et al., 1998; Morris III, 2007; Moser & Barrett, 2006). Low-income families without adequate collateral tend to be omitted from recognized financial services due to high transaction costs and flawed data, making official banks unwilling to offer services to them (Delavande et al., 2011; Ghatak, 1999; Joseph E Stiglitz & Weiss, 1981). Resultantly, poor farmers may be incapable of financing new technology or profitable income-producing activities (Conning & Udry, 2007). In Pakistan's case, the credit disbursement data shows that from 1947 to the present, there is a continued increase in credit issuing to farmers, but unfortunately, the agriculture productivity is decreasing. It means that there are some other factors due to that finance is not producing significant results. So, the aim of selecting the study's financial development is to explore the other factors and financial development because agriculture productivity is decreasing.

2.3.4 Gross Domestic Product

The world financial system has been taken an irregular journey above the precedent years, since 2009, considering the first recession of the international Gross Domestic Product (GDP) in postwar history. Not merely higher economies bore the impact. Several developing

countries, considered initially secure from a crisis derived in a little section of the US economic system, were amongst the hardest-hit sufferers. Back to envelope computations, stand on country development rates, recommend that the crisis can have included as much as 50 million near the amount of the persons live through in US\$1.25 a date in 2009, relation to a no-crisis situation, and approximately 64 million by the end of 2010 (World Bank, 2013). Further controversially, it anticipated that the crisis could put down an additional 30,000–50,000 baby departed in Sub-Saharan Africa. Economic recovery is comparatively fast in the developing world; however, autonomous debit troubles in the US and the euro region can only like rapidly put the revival procedure.

The vast and increasing size of scholastic and strategy jobs is proof of the occurrence, and the difficulty to discuss the crisis has been spawned, as well with revere to future growth paths of non-advanced economies. Since worldwide demand drooping as of delayed utilization and investment in highly developed economies, globe trade did consequently as well ahead of suddenly collapsing in late 2008. A vital force of expansion in developing countries, trade is generally measured since the number one means of crisis conduction for lots of them (Berman & Martin, 2012). The Bank (2013) reports a calculated 11.6% reduction in global trade for 2009, incredibly inferior to the 2.1% collapse in global gross domestic product the same year. Hence, a natural resource is diverse as compared to other kinds of resources due to several causes. Some fundamentals of natural resources have serious doorsill beyond which sudden and spectacular changes should be happening; a few predetermined restrictions, for example, transforms in natural resources that have potentially irretrievable impacts and enlarge throughout various generations. So, a natural resource is employed to make financial growth. It should be utilized in a sustainable and efficient method to guarantee continuing expansion. It is mainly manifest in the framework of non-renewable assets as oil & minerals. Simultaneously, the renewable resource utilization speed, like jungles and fisheries, and services that include Biodiversity and Carbon confiscation in the environments, should also have measured relative to their charging speed and replacing the severe thresholds they show. CO₂ emissions and financial development perform the main task in the financial and environmental strategy.

Agriculture is referred to as the business, art, and science, where crops are produced or grown, the soil is cultivated, and livestock farming is carried. Like many other agrarian countries, agriculture is crucial for the betterment and strengthening of the Pakistani

economy. It is the source of income for most of the population in rural areas. People living in urban areas are running their businesses by getting raw material from the agricultural sector. Total 45% of the labor is engaged in the agricultural sector. 70% of the people are living in rural areas and getting their earnings from this sector. Agricultural related items share 80% of all the exports of the country. Other industries are also largely dependent on this sector by gaining leather, cotton related inputs from this sector. Despite these realities, the exports of agricultural products are not satisfactory to earn foreign exchange in Pakistan. So, there is a need to efficiently and effectively increase the agricultural productivity the required line of getting foreign exchange to make the balance of trade favorable and strengthen the country's economy.

Another reason is the low quality of the products. This low quality of product to meet the international standards is necessary. It can be achieved by using high-quality agricultural inputs to grow the crops. The government is taking steps for the betterment of the exports and economic growth. It established the Export Promotion Bureau (EPB), Trade Development Authority of Pakistan (TDAP) membership of General Agreement on Tariff and Trade (GATT) as an active member of WTO subject to liberalizing trade through reducing tariff and removal of other trade barriers. However, these efforts are not up to the mark. More efforts are needed to get higher levels of productivity to meet the population's needs nationally and compete in the international markets. Pakistan, situated in South Asia, is a dry to semi-dry country. Annually average rain in Pakistan is 250 mm (Kahlowan & Majeed, 2004). Approximately sixty-seven percent of rain takes place in the summer season. Out of 80 million hectares, 22 million hectares are used for agricultural production (Ahmad, 2009). Approximately 17 and 5 Mha of this agriculturally cultivated area, 22 Mha is irrigated and gets water from rains (Kahlowan & Majeed, 2004; S. Qureshi, Breuste, & Lindley, 2010). Approximately ninety percent of agricultural productivity consists of the irrigated area (Kahlowan & Majeed, 2004; S. Qureshi et al., 2010). The water is gained from the Indus basin system for the crops that need water irrigation. However, fifty percent of water is gained from groundwater for the crops' irrigation purpose (Qureshi et al., 2010). Rain-fed agriculture provides approximately 10% of its total agricultural production (Kahlowan & Majeed, 2004; S. Qureshi et al., 2010). Agriculture is referred to as the backbone of the country's economy. Moreover, most of the food needs are fulfilled by this sector. Agricultural products make a 20.9% contribution to the country's GDP (Chandio et al., 2016; GOP, n.d.; MNFSR, 2015). It

helps in earning 60% of foreign exchange. In total, 68% of the rural population earns their livelihood from this sector.

Agriculture symbolizes 3.2% of global value-added GDP. It also produces between one quarter and one-third of the international greenhouse gas emissions, on-farm actions, and land employ transform to cropland (World Bank 2013). The analysis of the causal relationships between financial growth and environmental degradation was examined into various empirical mechanisms. This causality is dependent upon the Environmental Kuznets Curve (EKC) assumption. This assumption assumes that the relationship between financial growth and environmental degradation is significant on a top and positive level. Grossman and Krueger (1991) and Aslanidis and Iranzo (2009) showed that the causality between economic growth and environmental degradation is positively considerable. Their empirical proof points out that an increment in economic growth raises environmental degradation considered in environmental degradation.

Zhang and Broadstock (2016) and Li, Chi, and Wang (2016) expand a research study to examine the collision of economic markers on pollution (CO₂ emissions) in China in the duration from 1995–2010 by applying the fixed effects model and the technique of “least square generalized linear regression.” They use the “demographic intensities, urbanization, gross domestic product, industrial production, production of services, and energy consumption like economic markers.” The primary outcome of their research illustrates that all under-study variables influence CO₂ emissions. Gmidene, Zaidi, and Zouari Ghorbel (2016) employ the different techniques for the analysis of the impact of different variables on the economic growth and pollutions, as they use the “co-integration Johansen, variance decomposition, and GC” through the model error correction vectors for China the period from 1977–2008. These researchers employ CO₂ emissions as a sign of pollution and energy consumption, labor, capital, and a gross domestic product like a marker of economic and energy activities. Their principal findings suggest that GDP and energy consumption laying a positive influence on pollution.

To observe the impact of economic action indicators lying on environmental degradation, Omri (2013) exercises the way of least squares generalized during the era 1990–2011 in nations in the MENA area. He employs CO₂ emissions the same as a marker of pollution and labor, capital, population, financial development, and gross domestic products

(GDP) since pointers of economic actions. Their study findings conclude that the existence of a positive and significant effect of the gross domestic products & negative influence of financial growth and capital on CO₂ emissions. Rafindadi, Yusof, Zaman, Kyophilavong, and Akhmat (2014) using the regression through the ordinary least square on pane data and the fixed effects model on panel data regression in the least-squares method of two ways to examine the causal connection among pollution and economic doings marker in the Asia-Pacific nations the era 1975–2012. In their work, pollution is calculated through CO₂ emissions. Economic indicators are calculated with the gross domestic product (GDP), water production, the extra value of natural resources, and energy consumption. They discover the presence of a positive and vital connection between CO₂ emissions and GDP. Besides, they find out that energy consumption influences pollution optimistically.

An additional study was carried out to examine the effect of energy consumption and CO₂ emission on gross domestic products (GDP) expansion and the financial development in thirty Sub Saharan African nations. The panel model was employed in that research study during the time from 1980- 2008. The study findings demonstrated that energy consumption significantly enhanced economic growth and the financial development in the examined nations, resulting from superior pollution (Saidi & Hammami, 2015). By utilizing the data from 1971–2013 for five chosen South Asia countries, Mariyakhan et al. (2020) investigated the association between CO₂ emission, energy consumption, income, trade openness, and population. The outcome of FMOLS demonstrates that energy consumption, trade openness, and population enhance environmental degradation negatively. Additionally, consequences show single directional causality operating from energy consumption, trade openness, and population to CO₂ emission.

Furthermore, the most important crops, wheat, and cotton demonstrated considerable expansion throughout 2017-18. It has been recorded by 3.57% for 2017-18, which was more than the supposed crops' performance for 2016-17. Sugarcane and rice, the main Kharif crops, went beyond the production targets in 2017-18 and recorded a considerable number of 8.65%. The crops having a key share in the value-adding procedure as "vegetables, fruits and fodder" rise near 3.33% throughout 2017-18 and added approximately 2% of gross domestic product (GDP). Livestock contributes to 11 % in GDP and 58% in farming (agriculture) raise near around 4% during 2017-18 judged against 3% expansion in 2016-17. Likewise, the fisheries region shares approximately 0.4% of gross domestic product (GDP) and 2% into the

agriculture area. Forestry area having 0.4% contributions in GDP and 2% give in the agriculture region have a considerable growth rate of 7% during 2017-18 as compare to - 2.4% expansion for 2016-17 as a result of massive production of wood in Khyber Pakhtunkhwa (Hayat et al., 2019).

Wheat production, Provinces of Punjab & Sindh recognized like Pakistan's irrigated provinces, has historical concerns for green revolt in wheat. For the 1960s, the Green Revolution in Pakistan should concern with public investment in irrigation channel and marketplace development. The rural people and wheat production were changed; malnourishment expectations retreated (Chandio & Rehman, 2016). Despite highly praised development, the sustainable production of wheat stays the main concern for Pakistan's people. The government of Pakistan yet requests the upgrading for the production of wheat in diverse ranges. An earlier study on wheat crops demonstrates that crop diversity's slow growth rate substituted with farmers in encouraging new wheat diversity in Pakistan (Edmeades, 1997; Iqbal, Azeem Khan & Ahmad, 2002). In 1997, a predictable million ha region was utilized for wheat fabrication, which is 51% of Pakistan's whole wheat region (Smale et al., 2002). Wheat is an essential cereal crop for many states where it should be used as a staple food. It is acknowledging the reality that nothing is more significant than the person's requirements. Sustainability and consistency in food production are essential for sustainable crop production. Thus, in support of wheat production, accessibility of irrigation and energy is of considerable significance and would persist in being an essential foundation in agriculture that can give surety for sustainability and consistency in food production (GOP, 2008-09).

Pakistan is a key player such as a rice exporter worldwide and per annum exports approximately 2 million tons that are 10% of the global trade. As one kind of rice known as Basmati rice has around about 25% of exports is Pakistan's well-known aromatic. Thus, the income generates through rice export is a second income generating source in Pakistan. In Pakistan, approximately 60% of the population's food requirements are fulfilled through the rice grains globally, since rice is a possible means of food for animals in the winter season (Ashraf, Ejaz, & Arshad, 2017). Rice is a whole food of Pakistan. The practice of pesticides grew up after the 1950s, as 250 metric tons of pesticides were brought into our country to enhance production. Its practice enlarged next to 2158.6 % from 1952-2004 (Khan, Tariq, Yuanlai, & Blackwell, 2006). Rice crop performs a vital role in the agricultural nation of

Pakistan. It is cultivated in diverse areas of Pakistan, consisting of "Central Punjab, North-Western districts of Sindh & KBK." It is known as a staple food for the people of these areas, and as well rice is especially the leading internationally traded goods (Hussain, 2012). Rice is the most important crop for several nations. Its farming expands from the damp tropics to moderate North-Eastern China and South-Eastern Australia areas, from the sea level to above 2500 m in Nepal & Bhutan. While mainly rice is grown in Asia although there are multiple regions located in Oceania & Europe. Since an effect of total geographic allocation, rice is a farm in several climates and on a great variety of soils with enormous divergence in earth characteristics. Past studies focus on swamped rice production in Asia because of the exemplifying rice soils (Ishizuka, 1980).

Maize is one more crop known as cash and food crop of Pakistan that supplies like a feed with fodder and high yielding cereal crop in the world. After wheat, rice, and cotton, maize is the 4th main cereal crop of Pakistan; mostly, it is grown in two seasons, the spring & autumn. It has been planted in spring from February to March, whereas for autumn, maize begins from July to August. Çakir (2004) demonstrated that the maize life cycle is based on water accessibility; the water inconsistency at any phenological phase, i.e., reproductive and ripeness phase, has many rejoinders and should spoil the granule yield. While Edmeades (1997) study illustrates that deficiency stress besides sources for the granule yield harm when it happens on the reproductive phase of crop's life cycle. Maize grain is a crucial food grain and makes a range of raw materials for multi goods and value additions. Its financial records 2.1% toward the value supplementary in agriculture and 0.4% to GDP. Maize was farmed on a region of 1117 (000, hec) in 2013-14, showing a rise of 5.4% prior year's region of 1060 (000, here). The expected maize production was 4,944(000, tones) throughout 2013-14, demonstrating an increment of around 7.3% compared to the previous year's production of 4220,000 tones (GOP, 2013-14).

2.3.5 Consumer Price Index

Price and price policy have been granted a special place in economic science. Quantity is an economic matter. It is a straightforward observation made by the description of the old days of Aristotle and Xenophon. The price is the amount of money that the purchaser is willing to pay to the manufacturer (seller) in return for the purchaser's products on the open market. In numerical activities, the circumstance is the comparative price of diverse fields,

which measures to contrast the price mechanisms in these regions (for example, branch, geographic area). General Price index is associated with the condition when the index is fewer definite than general, relative prices fall or rise. The price calculates something. There is a crucial question: "What measures the price?" The significant economic schools have been set various well-known clarifications for price theories. Exceptionally diverse answers should be set into three significant theories: Classical theory of price, Neoclassic price theory, and Modern theory of price combined collectively. In various papers and practical activities of economic representatives, they coexist. In the classical theory, the price has its hold at the financial value of merchandise subject dealings. The value measured through the utilization of the factors of production provides payment through their holders. The condition of the open market builds the price to be precisely on the financial value. However, in chronic conditions, it cannot rupture the supported thing for financial value through the unit cost, and insignificant was defined in (Enzweiler & Gavrilu, 2009).

The subjective theory of price determines the neoclassical school who established the economic theory wherever the price tells the utility value and marginal in frequency, which is good, or the quantity judged against the solvable appeal. Financial value and a good quality-price are yet superior like a marginal utility. Its economic value is superior and is further odd. The two factors determining the marginal economic and infrequency value and price could work in a similar direction or different directions. The disparity between the classical theory and the critical neoclassical reason observes the consequence of the price. After the classics, price articulate themselves mostly production situation of goods, how it is acquired in joining the production and utilization factors. The producer is the "conductor prices." The neoclassical price is resolute through market conditions. The means they are supposed and demonstrate its infrequency and marginal utility and its essential role in the construction and progress linking with the buyer price precise (Dolca & Nicolov, 2013).

Rising price instability in agricultural markets intimidates the firmness of the global economy and food safety also. An increasing human population by varying consumption methods and agriculture structures gives the person's critical constraints and natural methods previously worried due to climate change. Price has a significant financial role, and economic manipulate decisions and events through his union office. Due to these characteristics, price is a lever to persuade financial and economic stability of the considerable economic. Aspect price purposes are those of financial development and the distribution of resources, in the

scope in which prices are right, which reproduces the effectual infrequency, marginal costs, and marginal social utilities. A range of free financial products develops via conflict between demand and supply indirect and properly competition situations. Prices are used to measure the different elements for society's economic actions and the international trade economy. Promoted throughout their particular interests to pursue accomplishing financial and social goals, it struggles to adjust for economic action and manners (Dolca & Nicolov, 2013). Inconsistent to this point of view, credit constraints are the source of cross-country income and firm productivity gaps (Aghion, Fally, & Scarpetta, 2007; Banerjee & Duflo, 2005; Bartelsman, Haltiwanger, & Scarpetta, 2013; Buera, Kaboski, & Shin, 2011; Buera & Shin, 2013; Caselli, 2005; Demirgüç-Kunt & Levine, 2009; Hsieh & Klenow, 2009; Midrigan & Xu, 2014; Moll, 2014; Restuccia & Rogerson, 2008). These discrepancies are at the middle of a fiery conversation on the reasons and results of cross-country firm productivity and income variances. Therefore, there is rising attention in considering how financial limitations impact resource allocation, firm productivity, and cross-country income differences.

Research study lying on consumer behavior in trade perspectives has been understood particular importance in latest years like globalization and propagation of brands and goods, chiefly in the food area, are prepared the considerate for consumer preference and brands grouping which is essential toward the achievement of the organizations (Dolbec & Chebat, 2013; Waterlander et al., 2011). From the information theory's point of view, the market comprises the agents (negotiators) performing the same as producers (Sellers) and purchasers. These negotiators may keep the contradictory or the same expectations on the causal capital and sort out some private or public data (i.e., signal) via examining the market price and activate buy/sell orders if the current price level congregates their target policies (Nunes, Madureira, Oliveira, & Madureira, 2016).

The Consumer Behavior region has been developed above the years as a broad body of knowledge allied toward “cultural, social and psychological dynamics that could manipulate the consumer on the buying time. A national repute for technical supremacy, goods quality, design, and value should differ from country to country; however, consumers lean to simplify their attitudes and thoughts across a wide variety of goods from a specified country. This typecast should result from attitudes towards the country's public and awareness (Patterson & Tai 1991). Through the stable fluctuation of globalization, a perceptible raise in the movement of goods all around the national boundaries has been

examined (Makanyeza & Du Toit, 2017; Teo, Mohamad, & Ramayah, 2011). However, this incident has not just been offered opportunities to marketers, although it has also produced some disputes (Renko, Crnjak Karanović, & Matić, 2012). Directness on foreign markets initiates the consumers that the goods and services are accessible worldwide, know that they are progressively more showing towards products bring from various nations (Yim Wong, Polonsky, & Garma, 2008). For this cause, marketers search to recognize which dynamics could influence the consumer's behavior toward the consumption of foreign goods (C. L. Wang & Chen, 2004). Mass media, personal experiences, and the observation of the national opinion leaders could as well form the repute of a nation like a producer. Numerous research studies have been established this picture, or typecast, a consequence of the nation of basis, recommending that nations also have metaphors, maybe not until now detached from the marketers' thought of 'brand image.' Hence, like the quantity of world trade persists in rising and the global marketplace becomes extra competitive in the 1990s, marketing managers must recognize the consumers' attitudes and opinions toward the sign, "country of origin" (Karoui & Khemakhem, 2019). Indeed, Bhakar, Bhakar, and Bhakar (2013) originate that attitudes for a particular product or brand should be significantly misused, both positively and adversely, while the country of its foundation or brand was exposed to the consumer.

People in less developed nations are becoming extra anxious by consuming goods, which has direct toward their marketplaces as "inundated" through a vast number of abroad products. This increase questions above the consumers' actions in these components of the world; how ethnocentrism influences their purchasing behavior and how they grade overseas goods above the nationwide produced ones (Othman, 2002). It is approved ahead that the nationwide goods are a basis, and it is one of the most significant markers for the product quality (Han, 1989). Wang and Chen (2004) conclude that consumers in developed nations usually distinguish that local goods have superior quality than the imported goods. Kalicharan (2014) confirms the results of Wang and Chen study. As the reverse concerns for consumers in less developed nations (Khare, 2011; Batra et al., 2000). As a subject of reality, prior research performed in numerous less developed economies shows a general faith amongst consumers in a foreign country made products higher than those manufactured via domestic manufacturers. It broadly shared thought between the consumers of less developed countries goes backside toward an evenly enveloping colonial attitude in which consumers approve the inferiority of their local goods judge against the out of country products stand on the financial stratum of the developed nations (S. Yin, Han, Wang, Hu, & Lv, 2019). As

Topçu and Kaplan (2015) propose, the alike. Specified that consumers' appraisal of the quality of goods affects their buy inclinations, ethnocentrism's influence on the readiness to purchase domestic or foreign products could be diverse in underdeveloped & developed nations. This guides to assessing the goods coming from developed economies more confidently than domestic goods within the market place. However, Kragulj, Parezanin, and Miladinovic (2017) clarify that the comprehensive inclination for goods initiated through different developed countries is not complete. Still, in less developed countries, a few consumers liked to choose domestic goods.

A study was conducted in which a positive relationship between the assessment of local goods and the nation's stage of financial development has been analyzed. However, in less developed nations, consumers should be high worried about their economy since it is commonly susceptible to foreign competition. Thus, local consumption would be highly optimistic in developing rather than in developed nations (Karoui & Khemakhem, 2019). Nagyova, Krocanova, and Madarova (2007) assert that the bulk of the large dealers pay their vigilant concentration to get the data regarding their consumers' actions as "where, when, how, how much, and why" they execute their shopping. The recognition of the main factors affecting the demand lying on the consumers' stage of the goods vertical line is identical to the demand examination. It stands on the theory of optimizing the consumer's usefulness, whose demand achieves the primary place. As declared by Stavkova, Stejskal, and Toufarova (2008), consumer decisions are made merely based on some conditions. Rather than comparing superior features, a consumer takes decisions according to price measure (he/she issues from the conjecture that an upper price means higher quality). Worldwide studies of demand structures are extra abundant, even though nothing has remarkably appeared at the factors of the consumption ways in a change situation. Employ an entropy standard of diversity; they discover that superior-income countries have fewer expert consumption baskets. Effectively, diversity has positive income elasticity. Their findings oppose the notion that tastes are equal worldwide and evaluate consumption in commodity groups over the 18 OECD countries through a static demand model (Benda-Prokeinová & Hanová, 2016).

2.3.6 Human Capital

Human capital (HC) is the key driver of economic growth. The study of Ono and Uchida (2018) demonstrated that fiscal policy is dependent on having a degree of altruism by

parents for their children. Similarly, a handful of studies found that HC has become the direct source of economic progress (Dunning & Lundan 2008; Barro 2001), but it is also beneficial indirectly through collaboration with other elements (Gennaioli, La Porta, Lopez-de-Silanes, & Shleifer, 2013). Additionally, it acknowledged that HC is the main FDI element (Villaverde & Maza 2015; Iwai & Thompson 2012).

Human capital (HC) also plays a vital role in agriculture growth. Good health and education reveal the quality of human resources in a country. The sound human capital works like intellectual capital for farmers. Building healthy HC and its proper leverage can increase agricultural productivity, food security, and livelihoods for farmers, mostly small-scale farmers worldwide. As human capital in agriculture occupies the center of production, distribution, and consumption; therefore, it is considered a vital element for agriculture productivity. In developing countries like Pakistan, agriculture production relies on farmers' education, knowledge, experience, and skilled labor availability. The improved human capital enables the farmers to utilize the inputs best, use advanced technology, financial management practices, use fertilizers and pesticides, and crops management effectively. Knowledge of farmers is only a way to efficiently and effectively use all these elements (Huffman, 2020).

Since the countries or districts have been moving from agricultural towards industrial and information civilizations, competitiveness forms and notion also progress as of classical aspects of productivity, like labor, land, and assets to the knowledge aspects (as formation, acquirement, and use of knowledge). From previous decades, the national or district values (for example, person and social capitals, culture, history, financial, official, and governmental institutions) have involved important consideration as both pieces of knowledge supported. Productivity aspects have been enormously exaggerated; they cannot articulate, through domestic practices. Nowadays, yet in the intense, powerful storms of globalization experienced in the everyday lives of ordinary people, competitive gain and core capabilities of countries, districts or firms are certainly recognized should be produced, formed, developed, and sustained through local practices, institutes, and values (Sherrard & Alvarado, 2017). Briefly, countries or districts could not achieve and sustain competitiveness through various, good or better goods, technologies, and services. However, they require constantly humanizing quality knowledge, ability, and value-based structures to support knowledge formation and use it.

"Human Capital" was first projected by the American economist Walsh, J. R., before being formally formulated in the late 1950s and early 1960s. Education has been classified as a supply of information, knowledge, experience, and competence. The human capital theory is about the significance of human capital in clearing up demographic conversions and financial developments. Over the past few decades, the well-known quantity–quality (QQ) exchange between economic development and the education of children has been the topic of a few researchers (Harbison, Hanushek, & others, 1992; Guinnane, 2008; Bleakley & Lange, 2009; Diebolt, 2015; de la Croix, Perrin, & others, 2016)

Human capital is classifying as, the training, information, knowledge, and abilities of its experts that should be employed to make specialized products and services (Pennings, Lee, & Witteloostuijn, 1998; Khan, Akram, Husnain, Haq Padda, & Qureshi, 2011; Vidotto et al., 2014) carried this explanation by describing that it is "a group of knowledge, information, competencies, skills, and abilities which exist in the person and that are utilized via him/her." (Ployhart and Moliterno (2011) define human capital as a unit-level source and competence formed through a person's information, capacities, abilities, knowledge, or characteristics. Human capital (HC) is the key driver of economic growth. The study of Ono and Uchida (2018) demonstrated that fiscal policy is dependent on having a degree of altruism by parents for their children. Similarly, a handful of studies found that HC has become the direct source of economic progress (Dunning and Lundan 2008; Barro 2001), but it is also beneficial indirectly through collaboration with other elements (Gennaioli et al., 2013). Additionally, it acknowledged that HC is the main FDI element (Villaverde & Maza 2015; Iwai & Thompson 2012). Folloni and Vittadini (2010) argued that human capital is a complicated, versatile incident by several intangible measurements that are complicated to examine and calculate with accuracy through one variable, a place of objects, or their compound total lying persons or domestics.

Additionally, they examined that human capital is a multidimensional variable allied to explicit knowledge and training and toward values and norms, family framework, social perspective, and, to a significant level, inherent and non-cognitive capabilities skills. Vidotto et al. (2017) indicated that knowledge is a crucial element for human capital and should be existing in two types: explicit or tacit. Tacit knowledge is represented on the way to like "know-how," of the ten noncodified part toward activity (Karoui & Khemakhem, 2019). Cabrera-Suarez, DeSaa, Perez, and García Almeida (2001) pointed out that those industries'

know-how could be created through learning by performing research studies. Earlier studies demonstrated that tacit knowledge is the substitute dimension of the financial result.

Natural capital is differently defined like the collection of physical resources into the environment (as water, trees, minerals, and species), however as well the practices (e.g., water sanitization, climate rule & regulation) through which we should get advantages (NCC, 2013). More comprehensive explanations by (Daily et al., 2000) are provided that the entire environment, reason complexities when struggling to recognize how the natural constituents join with others. Human resulting keys to creating environment services, and fail to identify how capital should influence the environment services formed.

Human resultant capital is an umbrella expression that summarizes the following types of capital: Produced capital, moreover called construct, human-made or reproducible capital, comprise human-made resources, for example, roads, vehicles, houses, machinery. Social capital deals with the collection of relations, trust, reciprocity, and joint considerate linked with the social arrangement. It contains both 'bonding' social capital, which includes built up social relations and links of trusts in the tightknit, banded social group, and 'bridging' social capital that is comprised of the associations of trust in varied, undoes groups and between groups (Fritz et al., 2019). Cultural capital, which deals with the broader factors that permit us to contact through each other and the environment, as well as values and attitude, in a social context detained knowledge in addition to the socio-political institutes (Bourdieu, 1986; Holling, Berkes, & Folke, 1998; Malhi et al., 2006).

An additional is the determining unique worker's measurement in particular segments. Holland examiner (Boxman et al., 1998) hence three factors (education, working experience, and working performance) considered the human capital of 1359 higher managers in the Dutch Company. In Keeton (1996), the findings are as follows: government and middle (female) commission members' human capital depends on their high education, competitiveness, intelligence, skills, career plans, and years in the company. Things are being done today is drastically different from how things have always been done, and they are changing all around us, which is causing so many conflicts. Because of the changes in our "capitalistic society," the means of economic values and prosperity are no longer embodied in material goods production. Instead, they are embodied in the formation and management of information, thoughts, and knowledge. In these cases, they attempted to be birthed as firm-

level constructs and allow firms to change revenue. Human resources are critical for gathering resources and abilities. This study shows that final organizational competencies, polished abilities, and focus are primarily due to human capital. In other words, it shows that human capital determines an organization's competencies and abilities (Prokopy et al., 2015). Therefore, the dynamic measurements required for human capital to competitive performance have not been developed. Some academics argue that resources and capabilities should be put into human capital that produces good results (Coff, 1997). Policies are constructed through different approaches like classical, neoclassical, and modern on various problem-solving issues.

There is wide concord that climate change characterizes a main challenge toward the international food structure. The IPCC (2014) recommends that from 1960 to 2013, climate change put more negative than positive influences on food production schemes. Geologically, climate influences agriculture (IPCC, 2014 and Cortignani et al., 2016). Simultaneously, agriculture is under stress from the increasing demand for agricultural goods caused by worldwide population enlargement (Ziervogel & Ericksen, 2010). However, in present circumstances, agricultural structures should be unsuccessful in dealing with the undernourishment of over 2 billion people who experience micro-nutrient insufficiencies (International Panel of Experts on Sustainable Food Systems (IPES-Food, 2016). Since climate change grows, farmers tend to shift away from crops with ever more new situations (Seo and Mendelsohn, 2008 and b. Climate change should also influence crop productivity ultimately via inspiring migration and off-farm functions, which can in order to involve the accessibility of labor and resources for crop production and, ultimately, farmers' crop options. Over this, there are additional policy demands, chiefly on the quality of food, which describes an improved center on more healthy crops, ahead of the full yield of the primary energy supplies crops (P. Pingali, 2015). By growing population worldwide and alteration towards the customer, demands could besides have to be accounted for via future agricultural structures (Manners & van Etten, 2018).

Based on these studies, I know that HC has a prominent role in the economics literature (Carkovic & Levine, 2005; J. Roaf, R. Atoyian, B. Joshi, K. Krogulski, 2014). The host country has a rare discussion of HC as an agricultural productivity element that improves its growth productivity. Hence, when HC is deliberate in AP, but it is unnoticed in the theoretical framework.

2.4 Theoretical Framework

Current research in agricultural management is making significant contributions in the development of agricultural theories, which emphasizes the fundamental motive for the subsistence of the organization as being the generation, amalgamation, and use of agricultural products. Following are the theories which are considered as a theoretical lens in this study. Development theories have been provided different perceptions about the structural change, mostly by the role of agriculture. Lewis (1954) reflects on modern economic development can be known through industrialization. These authors think that agriculture is a way of employment and a collection of labor used for the modern industrial region, which has higher production and rising returns to scales. This modern area, which has a more significant development prospective, slowly takes in agricultural employees. Wang and Piesse (2009) observe that the agricultural region while an excess labor area through a significantly less suggested salary.

Furthermore, Wharton (2019) pressurized the significance of agriculture via food provide. According to that researcher, in developing nations, the route of financial development could merely start when these economies should generate the main ingredient of their food requirements since imports are costly and these nations have little capital. Furthermore, large food prices could worsen the cost of living, particularly for fewer proceeds households. They want to meet the requirements because agricultural expansion should correspond with the population expansion to prevent the "Malthusian trap." Thus, agricultural excess is an actual situation for beginning the growth procedure. Hence, due to these opinions, structural transform leading to an industrial economy's appearance is escorted through a decrease in agriculture share in the gross domestic product (GDP) and the workforce employed (Von Witzke, 2007). The ending consequence of the structural change is an economy in which productions of assets and work in agriculture are balanced with those of the other areas (Naseem & Oehmke, 2017).

2.4.1 Theories of Agricultural Development

Theories regarding agricultural development have been presented to explain the forces in society and the economy that puts the agriculture sector on development and change. One of them is the conservation model of agriculture development used in this study, along with

three other agricultural theories as a theoretical lens. Among other agricultural development models, the conservation model came up with the progress in the production of crops and livestock in developed economies such as in the English agricultural revolution. It also includes concepts regarding soil exhaustion that is already discussed by soil scientists and German chemist. The conservation model is all about utilizing and producing organic manures. The cropping system needs intense labor and individuals' engagement while carrying tasks related to using the land and water resources while cropping. It is also seen that this model was globally recognized, and almost all of the farmers conducted farming by considering this model. Although, by considering this model, farming has been conducted for many years and obtained productivity to meet the population's food requirements. For a more extended period, farmers have grown agricultural products by adopting the conversation model and yielded approximately 1.0% productivity annually. However, as the population is increasing, agricultural productivity is not compatible with modern times. As in developing economies, there is a need for 3 to 5 % annual agricultural productivity to meet the people's food requirements (Udemezue, J.C.; Osegbue, 2018).

The fundamental goal behind agricultural growth and development is the enhancement of people's social and material well-being. Therefore, as an adopter of this theory, it is also seen as an integrated approach to improving the community's inhabitants' environment and well-being (Nwagbara et al., 2012). To understand agriculture production, it is first essential to abandon the concept of agriculture as a fixed and static term. However, agricultural development should not transform a stagnant agricultural sector into a new dynamic sector but accelerate the growth rate of agricultural production and productivity consistent with the growth of other sectors of a modernizing economy. The postwar period's socio-economic and political paradigm produced a fast-paced growth in production activities, leading to a diversified agricultural product market. To survive in this competitive market, the farmers need to up their production and marketing activities to innovate new techniques and innovations. Because of this theory, an analysis of agricultural development should look into the dynamics of complex agricultural growth, either at the level of the evolving sources of growth, in economies ranging from those in which production is increasing at a rate of 1. to 2. percent, to those in which output is growing at an annual rate of 4 to 5 percent (Ruttan, 1977). These five models have been developed by agricultural development theorists, though several other theories are on the subject.

- a) The frontier model
- b) The conservation model
- c) The urban-industrial impact model
- d) The diffusion model
- e) The high-payoff input model

The Frontier Model

Agricultural production is increased through expanding the cultivated area in western economies. Moreover, due to the discovery of new continents (North and south America and Australia), the area for cultivation enhanced during the 18th and 19th centuries (Ruttan, 1977). The addition of these continents added great value in food production and the attainment of other agricultural products. More products can be produced through the process in western Europe's metropolitan countries. Anciently, farming was carried similarly regardless of any country of the world like in Europe, Asia, and Africa. The area of cultivation increased as where people found the most favorable land; they started cultivation there. Such as river basins are the best soil for cultivation.

Moreover, the plains' soil is very favorable for agricultural productivity, so people started cultivating those areas. People started intensifying the cultivation in their areas to gain more agricultural productivity. However, in the areas like hills or upland places, people started discovering places and shifting cultivation from unfavorable soils to more favorable soils for cultivation or nomadic grazing. However, due to the increasing population levels, this model is no longer working to produce higher agricultural productivity levels. Due to increased population, limitations of the frontier model start getting highlighted. As per the seed sowed for productivity, the per seed output was not up to the mark.

The Conservation Model

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conservation model is all about utilizing and producing organic manures. The cropping system needs intense labor and individuals' engagement while carrying tasks related to using the land and water resources while cropping. It is also seen that this model was globally recognized, and almost all of the farmers conducted farming by considering this model. Although, by considering this model, farming has been conducted for many years and obtained productivity to meet the population's food requirements. For a more extended period, farmers have grown agricultural products by adopting conversation models and yielded approximately 1.0% productivity annually. However, as the population is increasing, agricultural productivity is not compatible with modern times. As in developing economies, there is a need for 3 to 5 % annual agricultural productivity to meet the people's food requirements.

The agricultural sector is the backbone of Pakistan's economy and the major contributor to GDP afterward, the service sector. At the independence time, agriculture was the principal sector. Due to climate change, financial degradation, political and economic conditions, lack of advanced technology, low input quality, the farmer's financial management practices, and water shortage. Cause decreased production and yield. This sector has shown a different growth rate with 3.8% that was more than the set target of 3.5%. Its contribution to GDP is 18.9%. 42.3% of the total labor force is earning from the agriculture sector (Economic Survey of Pakistan 2017-18). Approximately 63% of the population is involved in this sector by earning directly or indirectly from agricultural products as they live in rural areas. Agricultural exports are a source of earning foreign exchange and helpful in the growth of other countries' growth. Small scale farmers bring innovative technologies at a smaller level, which foster agricultural growth. The sixth Housing and Population Census of Pakistan 2017 indicates a 2.4% rise in its population. As the community is overgrowing, the need to increase agricultural productivity also arises. Moreover, the agro-based industry is mainly dependent on the agricultural sector to get the raw material for their production that helps enhance the country's exports. Some of the other industries are directly earning from the agricultural sector by selling pesticides, agricultural machinery, fertilizers, and tractors.

The Urban-Industrial Impact Model

The conversation model was extended to understand the more successful output of both the factor and product markets between the agricultural and nonagricultural sectors in regions characterized by rapid urban-industrial developments. The model has been tested

extensively in Pakistan but has gained minimal attention in developing countries. The sustainable agriculture model uses agricultural waste materials as organic manure and various modern agricultural techniques such as crop rotation and hedges planting. This model was internationally adopted, and most farmers are now doing their farming based on this model.

The Diffusion Model

Diffusion of innovations theory is concerned with and seeks to explain how innovations are taken up in a population. Nilakanta and Scamell (1990) explain that a general definition of diffusion that applies to a wide variety of innovations, product, and process alike is developing and implementing new ideas by people who engage in transactions with others over time various contexts. The diffusion process of innovation refers to the spread of new technology within a universe of potential adopters. The literature indicates that it is a phased process consisting of initiation, adoption, and innovation implementation. The definition of diffusion most often cited in research on the diffusion of innovations is given by Rogers (2003), which says that “diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system.”

Therefore, diffusion is seen as a particular type of communication concerned with the spread of messages that are perceived as new ideas. Roggers et al. (1988) explain that “communication is a process in which participants create and share information to reach a mutual understanding.” Diffusion is only different from communication in that it refers mainly to transferring information about innovations with the specific purpose of creating change. This change often relates to behavioral change. The nature of the diffusion process that both the necessary change and the communication process by which information about the innovation is disseminated are encapsulated. According to Martensson et al. (2009), diffusion of innovations theories forms some of the most valuable methods by which a communication planner can assess communication strategies. They further explained that diffusion theory had been formulated mainly from empirical evidence gathered from observing planned communication strategies. This communication aspect of the diffusion process makes the theory of diffusion of innovations highly relevant to any research that explores enhancing the rate of adoption of innovations.

The High Payoff Input Model

The inadequacy of policies focused on the conservation, urban-industrial effect, and diffusion paradigm led to a new viewpoint in the 1960s, where adaptation could be accommodated. The most critical step in transforming a conventional agricultural sector into an abundant economic growth source is an investment designed to make new, high payoff inputs available to farmers in developing countries. The outlook practices and resource allocation methods for peasants were "supported" by conventional agricultural systems. Most developed countries had an inadequate capacity to assist the poor because they had minimal technological and economic resources to assist the poor adequately. According to Rutten et al. (2013), inputs have a higher payoff in category 1, category 2, or category 3.

- I. It is felt that public and private research institutions' capacity to develop new technical information plays a crucial role in keeping pace with the fast-evolving technological climate.
- II. The productive potential of the industrial sector is limited. Hence the ability to generate new technological inputs is inhibited.
- III. The farmer's capacity to invest in R&D and their willingness to use inputs in this way are her strong suit.
- IV. It is primarily due to the high cost of inputs that this model has garnered public support. New types of high-yielding wheat and rice crops were developed in Mexico and the Philippines during the 1950s and 1960s, respectively, to meet global hunger. Since industrialization, these were used because of pesticides. They have a strong knowledge of healthy and sustainable agriculture and farming methods. High returns inspire farmers to work towards the improvement of farm productivity and profitability. This scientific way of growing plants has led to a new plant that no one has ever seen before. Proper licenses to cultivate these plants will never be issued under these circumstances. However, there are still some things that require further research.

Nevertheless, these two sectors are characterized as "public goods" rather than "commodities" that can be traded in a "free market." Allocating capital, including education or research, among different schooling, science, and alternate non-standard economic activities, reflects currencies' price dynamics. Since this operation is not studied in the economic model yet, this problem is not analyzed. This model seeks to benefit from the

financial returns of a business. The aspect of the analysis was condensed to make it more interesting. It does not examine how the economy and the resources it uses were made to support society. It is important to note that variables (of our analysis) and product costs did not directly impact research budgets, but they expanded the possible research topic.

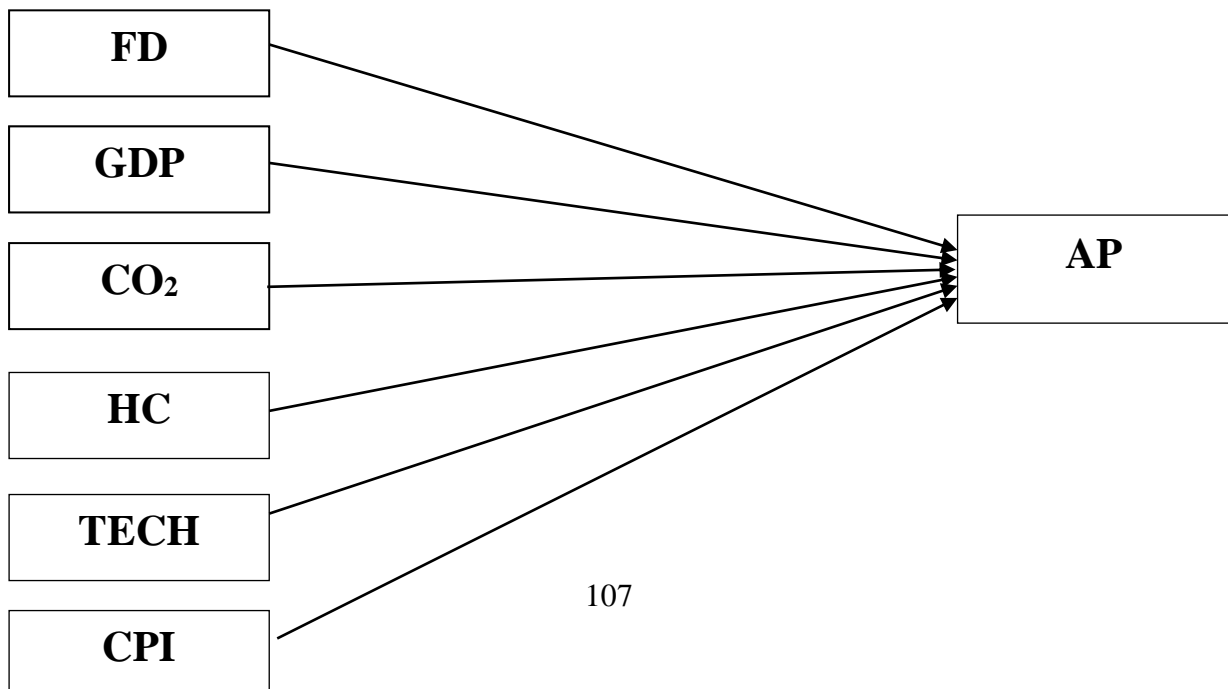
2.4.2 Development of Hypothesis

Following are the hypothesis of the study.

- H1. Financial development affects the agricultural productivity
- H2. Economic growth affects the agricultural productivity
- H3. Environmental Degradation affects the agricultural productivity
- H4. Human Capital affects the agricultural productivity
- H5. Agriculture Technology affects the agricultural productivity
- H6. The consumer price index affects the agricultural productivity

2.4.3 Conceptual Model

Model: To investigate the impact of environmental degradation, financial development and human capital on agricultural productivity in the presence of economic growth, technology, and consumer price index.



Dependent Variable: AP → Agriculture Productivity

Independent Variables: FD → Financial Development

GDP → Economic Growth

CO₂ → Environmental degradation

HC → Human capital

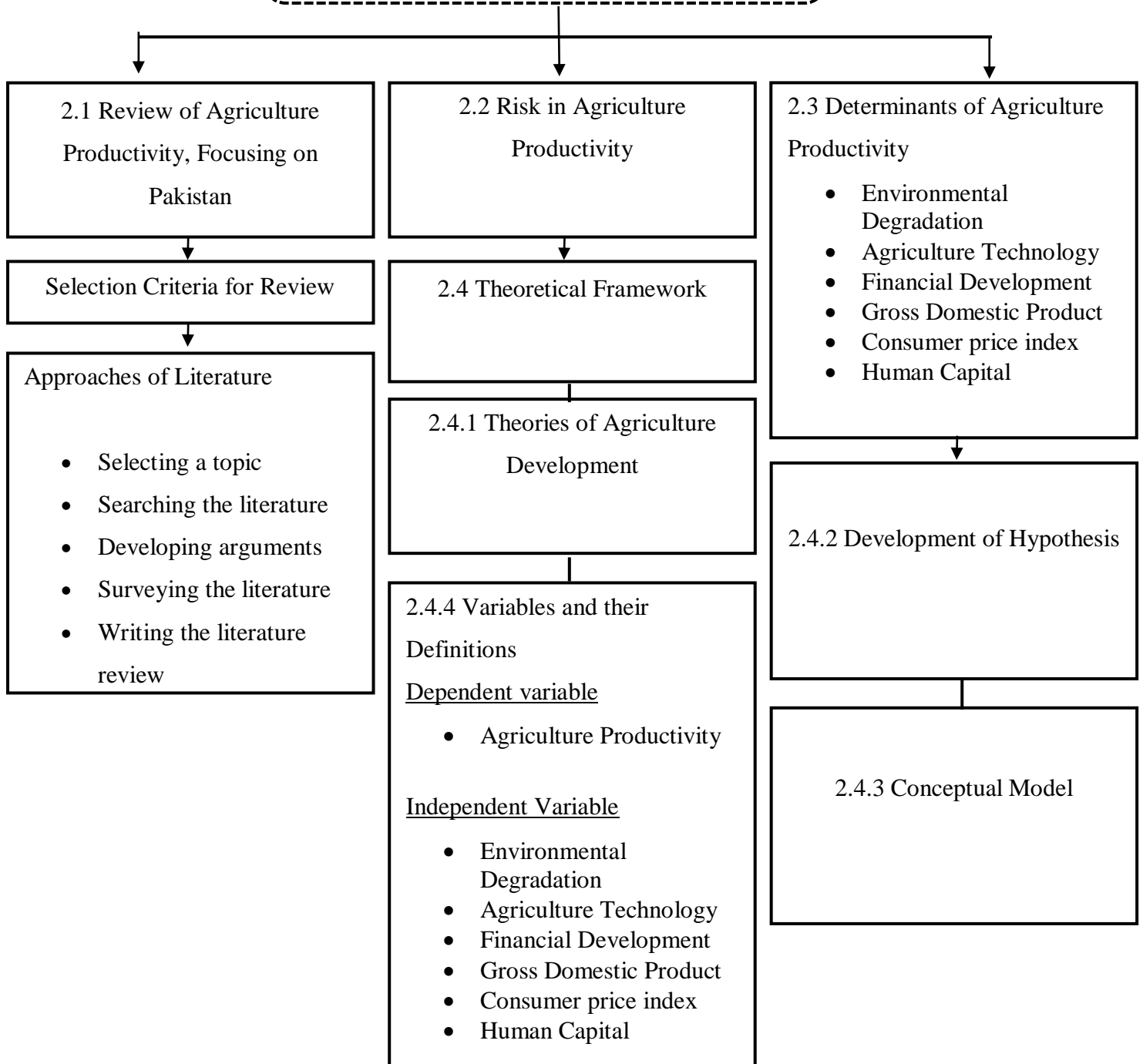
TECH → Agriculture Technology

CPI → Consumer Price Index

2.4.4 Table 4.1 Variables and Their Definitions

Variable Name	Unit of measurement	Definition
Agri. Productivity	MAF	Agriculture productivity is referred to as agriculture outputs ratio by agriculture inputs like labor and capital. Simply agriculture productivity measures the efficiency of farms.
CPI	2010=100	Consumer price means measuring the people's purchasing power with a change in the price of goods, services and a change in the currency's value. Consumer price identifies the inflation rate in the country.
GDP	Constant 2010 US Dollars	GDP identifies the country's economic growth by dividing the country's total population's domestic products to acquire per capita Gross Domestic Product.
HC	Index	Human capital refers to the people's standard of living by measuring their education, training, knowledge, health, and skills in any country.
Financial development	% of GDP	Financial development calculates the amount of credit provided by the financial and private sector (% of GDP) at a domestic level and the loan amount to the country's private sector by banks (% of GDP).
Agri. Technology	Qty in numbers	Agriculture technology means the machinery that farmers use for farming in agriculture production. The agriculture machinery refers to the different tools like a hand, power and tractors, tubewell, and other helping tools used in land preparation to crop cultivation.

Chapter Two Summary
Review of Literature



3 CHAPTER THREE: RESEARCH METHODOLOGY

The economic analysis approaches are discussed in the methodology chapter of the study. In this particular research thesis, data from secondary sources are used. This chapter address that, the data that has been obtained and broken down into three sections. This chapter is arranged as follows: Section 3.1 discusses the data collection sources. Section 3.2 discusses the methodologies applied to the time series data. Section 3.3 introduces the regression models for data estimation. Further, section 3.4 concludes this chapter. The study uses data from 1975 to 2017 for the case of Pakistan. Autoregressive Distributive Lag (ARDL) is used as the bonding technique and Johansen cointegration approach to check long-run cointegration among study variables. Similarly, the ARDL model is used to examine the short-run and long-run dynamics. The results of ARDL confirm the long-run cointegrating relationships. Further, to investigate causality between study variables, the Granger Causality test is used.

3.1 Data

This study uses time-series data concerning Pakistan. For estimation purposes, I extract data of CPI, GDP, agriculture productivity, and CO₂ from the World Bank (2017). The data on human capital from (PWT) Pen World Table 9.0 database, previous researchers Feenstra, Inklaar, and Timmer (2015) also used this table for their study. And the data of technology and financial development from the Pakistan Economic Survey (2018) report. I extrapolated the data to get the values for 2018 as the data up to 2017 is available on WDI. To check the relationship between variables, I use a standard linear log function. The following model is used for analytical purposes:

$$\ln Agri_t = c_0 + \beta_1 \ln Agri_{t-i} + \beta_2 \ln CO_{2t-i} + \beta_3 \ln GDP_{t-i} + \beta_4 \ln HC_{t-i} + \beta_5 \ln CPI_{t-i} + \beta_6 \ln Tech_{t-i} + \beta_7 \ln FD_{t-i} + \varepsilon_t,$$

(Eq. 1)

$\ln Agri$ means a natural lag of agriculture productivity, CO₂ means carbon emission, and GDP represents the gross domestic product. GDP helps to measure the country's economic growth; HC describes the Human capital, CPI denotes the consumer price index,

Tech indicates the tube's well, and tractors technology for agriculture. FD refers to the amount of credit disbursed to farmers from 1975 to 2018.

3.2 Estimation Technique

The Johansen and Engle & Granger model is widely used to check the integration between variables. The two techniques used to non-linear model correlations (single equation and difference in index inputs) showed that conflicting findings emerged from not considering cointegrated pairs of quantitative variables for the study. The Johanson cointegration test is used in the first step to calculating the long-run relationship between variables. In a given method to measure the Johanson cointegration test in the first step, the method is proven (Anindya Banerjee, Dolado, Hendry, & Smith, 1986). So, it is possible to produce a significant biasness by omitting the dynamics, which could inaccurately gauge the severity of the disease situation and make the results almost inaccurate. As well, the two-step residual base method's process produces a residual series; at the first step, it calculates a new collection of regression terms that are supposed to be noisier than the calculated base model. At the second stage of analysis, the variables' stationary levels should be tested, either series are stationary or not. As a result, the first step calculation errors have to be carried forward to the next step (Wallis & Bridge, 1972; Peugh & Enders, 2004).

Johansen's cointegration method is commonly known as the best approach to check cointegration, over the Engle and Granger cointegration method. This approach offers a solution if; there are two or more variables and multiple cointegration vectors. Furthermore, the Johansen approach overcomes the lagged value that Engle and Granger's approach creates by omitting the lagged value bias. Although this approach is more efficient than the Engle and Granger, it is also criticized. Gonzalo (1994) believes that this approach produces sensitive results, as this approach's results include lags in the test. While Ayalew (2013) criticizes that in more than one cointegrating vector, the implied economic relationship is complicated. So, the finding of an appropriate vector for the subsequent test is also tricky. Moreover, both cointegration techniques and the Johansen and Engle and Granger are further criticized based on order level. The validity of these two approaches' results requires that all variables be in the form of order 1(1). If some variables are on 1(0) and some are on 1(1), these two approaches do not produce significant results, so that in this case, both the approach may not be applied.

Hence, after the criticism of Johansen and Engle & Granger's approaches, the ARDL approach is commonly used the best approach, argued by (Zaidi et al., 2019). The ARDL approach from 2001 to date is considered the alternative approach to finding the variables' long-run relationship. Several features of this statistical approach among those that are prominent make this approach the best to find the long-run relationship. With the help of OLS, the cointegration relationship can be found easily by taking lag order. Secondly, this approach provides the facility to find the short and long-run relationship at the same time. Thirdly, against the Johansen cointegration, this approach helps find the validity of the variables in the following order form, i.e., $I(0)$, $I(1)$, and manual cointegration form. It means the ARDL approach does not depend upon the requirements of the unit root test. However, the test will not produce significant results if the variable is stationary at $I(2)$ level. Fourthly, this approach provides unbiased cointegration results with the help of valid t-test results. This approach omits lagged variable biasness. Researchers believe that this approach is efficient in long and small time-series data size based on these features.

This study has applied the ARDL technique, representing the autoregressive distributed lag model, to calculate the data's long and short-run results. However, those techniques have multiple drawbacks, like the results of the estimation of the structural break and sequence of integration for variables calculated with these approaches are not unique. ARDL approach covers numerous accepts of the data. Zaidi, Danish, Hou, and Mirza (2018) Report that the ARDL approach is useful as, with the help of this approach, we use to measure cointegration if all the variables are cointegrated at $I(0)$ level, or first level difference $I(1)$.

Further, Zafar et al. (2019) and Harris and Sollis (2003) reported that the ARDL approach is also useful for the robust finding if the sample size is not significant. The ARDL approach helps adjust the lag model and provide valid t-test results; with these tests, I measure the study's long-term model. The ARDL approach simplifies the linear transformation and helps to extract ECM. With the help of unfettered ECM, we can join the short and long-run dynamics, this joint venture of short and long-run keeps long-run data unbroken. Pesaran et al. (2001) report that if there are endogeneity and serial correlation in the equation for time series data, then the ARDL approach is appropriate. The equation for the formulation of the ARDL approach is as follow: -

$$\begin{aligned} \Delta \ln Agri = c_0 + \sum_{i=1}^p \beta_1 \Delta Agri_{t-r} + \sum_{i=0}^q \beta_2 \Delta \ln GDP_{t-r} + \sum_{i=0}^q \beta_3 \Delta \ln CO2_{t-r} + \sum_{i=0}^q \beta_4 \Delta \ln HC_{t-r} + \\ \sum_{i=0}^q \beta_5 \Delta \ln CPI_{t-r} + \sum_{i=0}^q \beta_6 \Delta \ln Tech_{t-r} + \sum_{i=0}^q \beta_7 \Delta \ln FD_{t-r} + \lambda_1 \ln Agri_{t-1} + \lambda_2 \ln GDP_{t-1} + \\ \lambda_3 \ln CO2_{t-1} + \lambda_4 \ln HC_{t-1} + \lambda_5 \ln CPI_{t-1} + \lambda_6 \ln CPI_{t-1} + \lambda_7 \ln FD_{t-1}, \end{aligned}$$

(Eq. 2)

Where Δ acts as the 1st difference operator between variables, while p represents the variables' lag length, I framed two hypotheses from this equation. These hypotheses represent the long-run relationship between the variables. Equation two represents the null hypotheses for no co-integration (H0: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$). So, we test the 1st hypothesis divergently with the 2nd alternative hypothesis (H1: $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq 0$).

It is essential to check the data before applying the ARDL approach; either the data fulfills the required assumptions or not. I used different unit root tests to check the stationary level of the data. Because the ARDL bound test requires that all the entries of data must be stable maximum at first difference 1(1), if any single entry is stationary at second difference 1(2), it will cause unreliable the F value of ARDL (Ouattara, 2004). According to Kwiatkowski et al. (1992), Dickey and Fuller (1979), Phillips and Perron (1988), if the structural break exists in data, then the unit root test results will not produce reliable results. Shahbaz et al. (2014) recommend that it is necessary to apply such a unit root test that considers the structural breaks. I applied the Zivot-Andrews unit root test, that was introduced by Zivot & Andrews (1992) to find the unit root with structural breaks in data. Next, I applied the ARDL bounding test that contains two steps. At the first step with Schwarz Bayesian selection criteria, I select the lag variables. In contrast, at the 2nd step, by calculating the F statistics value of regression, I confirm the presence of a long-run relationship between variables. The results confirm integration; this presence provides a clue to study the causality among the study variables. So, the ECM model is used in this study to find the causality between variables. The ECM results identify that there is causality among the whole series of variables.

4 CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Time Series Analysis

This section has two parts of the work. Section 4.1.1 reviews the popular tests of unit root and the integration order of data series. Section 4.1.2 discusses the co-integration technique and the ARDL approach. Section 4.2 discusses the empirical analysis and discussion.

4.1.1 Unit Root and Integration

The first step of the time series study is to define the appropriate order of integration in which the various input sets must be interpreted. This test can be instrumental before we choose methods of time series analysis. The time-series data regression is such that all data series are stationary in past patterns (Asteriou & Hall, 2007). It means that, regardless of when the series is evaluated, the series orbits about a constant mean value with a broad degree of variance. When the data is examined through correlation results, it indicates that there could be a relationship between the variables due to the close relationship between the variables, because over half of the changes in the mean for these variables are much less than five. However, these changes in variance may be caused by other variables (Granger & Newbold, 1974). A unit root test is generally used to check if a time series is stationary. To test for unit roots in a time series, we need to define the data's nature and integration order. If the results of a unit root test show the order of integration is 0 (denoted by it $\sim I(0)$), there is no unit root in the data set. It is stationary on the floor. Now suppose the data sequence is integrated of order one (denoted by $y_t \sim I(1)$). To this series corresponds a unit-root, but its first hyperparameters are not stationary. Because of the stationary component, however, this series still varies from a strictly stationary one. If the series' order is two, where the second difference is applied, the series is stationary. Since the ADF and the PP test are unique to the Dickey-Fuller distribution, you should be familiar with each of these tests to choose which is suitable for a given situation (Dickey & Fuller, 1979). For transforming the original data set, the Dickey-Fuller distribution is used to (estimate the) quantify the discrepancies between the original sample data. The estimation equation of the Dickey-Fuller distribution tests is expressed as below:

Basic form:

$$\Delta y_t = \theta y_{t-1} + \varepsilon_t, (\theta = \rho - 1);$$

Basic form with an intercept:

$$\Delta y_t = \alpha + \theta y_{t-1} + \varepsilon_t;$$

And basic form with an intercept and a trend:

$$\Delta y_t = \alpha + \theta y_{t-1} + \lambda t + \varepsilon_t.$$

Suppose the data series is in form as: $y_t = \rho y_{t-1} + \varepsilon_t$, ($t = 1, 2, \dots, n$), ε_t is a white noise process. If $\rho < 1$, the series is stationary. If $\rho > 1$, the series is exploring. When $\rho = 1$, the series is non-stationary with a unit root.

If the t statistics for H_0 is less than a critical value, it can be inferred that H_0 is less than zero, which helps us reject H_0 , which is the evidence for the unit root test's existence. A set of stationary points, $\theta < 0$, indicates that the series is a Cauchy sequence. In $\{(H_0)$ if there is no unit root in the data, then the movement of the differenced series Δy_t can be mirrored to the original test series so that the series are more likely to display a unit root (Asteriou and Hall 2007). Based on a set of randomly sampled data, assume independently and identically distributed noise. Truth can also be a little brutal to find its fulfillment. In addition to the Dickey-Fuller test and Phillips-Perron test, there are other relaxation methods for the DF test that loosen the error word's constraint. These two screening tests are used more often than others. The Augmented Dickey-Fuller (ADF) test removes higher-order auto-corollary by adding lagged variations on the equation's right side to eliminate autocorrelation. Phillips and Corne (1988) test the covariance of the error term ε_t with the parameters θ to see if this leads to a regression of their AR (1) model.

4.1.2 Cointegration Technique and ARDL Approach

A time-series regression specifies that the all-time series used in the model be stationary (Asteriou & G.Hall, 2007). Sometime sequences will always be stationary, like the time pattern of the money sequence. The data should not be expressly treated from the time series. Once we have a simple model for the data, we will use our model to forecast the observed data and assess if our model has made a fair prediction. This method has a problem because we cannot show the relationships between the study variables as they grow. After all, all variables are different-form. If the data series with a unit root is cointegrated, it can be used as long as it does not perform any sequence.

Often a linear combination of two independent variables may cause a stationary time series. In this way, the value of all the variables will decide the outcome. These problems are usually addressed with a co-integration test. Economic cycles are incorporated into macroeconomics equations. There are two approaches for estimating the co-integration: From the two-step method Engle, Granger, and Granger (1987); a system-based reduced rank method is recommended; and a simple two-step method (Johansen, 1995). The Engle-Granger method is traditionally used to test the relation between two variables. Two variables limit the use of the Engle-Granger Approach. This relationship cannot be concluded when the number of relationships is less than one.

In testing for integration in a multivariate equation, the Johansen method is sufficient. However, all the explanatory variables of order ones are strictly incorporated since if they are cointegrated, the variables should have the same nonlinear pattern. Therefore, the Johansen test is not suitable for the mixed integration order data set. Therefore, the ARDL model is an alternative solution to the long-run relationship between the data series and mixed integration orders being discussed. When the independent variables are $I(0)$ and $I(1)$, two asymptotic critical values provide a boundary test for co-integration (Pesaran, Shin, & Smith, 2001). The lower value assumes that $I(0)$ is the regressor, and the upper critical value assumes that $I(1)$ is the regressor. The null hypothesis of no long-run relationship can be denied if the F-statistic value is greater than the upper critical value. The null hypothesis cannot be dismissed regardless of the integration of individual data series if the F-statistic value is smaller than the lower critical value. The ARDL method is not restricted to strictly $I(0)$ or purely $I(1)$ sequence in this case; it is also ideal for co-integration with each other. However, this method's drawback is that if the predicted results are between the two boundaries, the calculation is inclusive, which cannot be guaranteed unless the integration test is pre-tested.

The ARDL method is a suitable fitting model for small or finite sample data compared to VAR (Vector autoregression) and VECM (Error Correction Model) by (Harbo, Johansen, Nielsen, & Rahbek, 1998). The asymmetric model of VAR and VECM demands that all endogenous variables have identical characteristics. The equation number is equal to the number of equations. In all estimations of the equation, the lag length is identical. In this case, the model can be incorrectly defined if the lag length is too short; but if the lag length is too long, then the degrees of freedom quickly erode. The ARDL approach does not need the variables with the same lag order. According to the Akaike Knowledge Criteria (AIC) or Schwarz Bayesian Criterion, the lag order can be chosen if the F-statistic indicates a long-run relationship between the variables (SBC). Besides, ARDL is more convenient to estimate than VAR and VECM since it enables OLS to estimate the co-integration relationship once the model's lag order is known. Also, pre-unit root tests are not needed, as the model allows variables with a mixture of unit roots, as long as the order of integration of the variables is less than two. The model collapses with I(2) variables in the estimate, however. An alternative solution, such as the Johansen model, has to be implemented in this situation.

The long-term dynamic relationship is discussed using the ARDL model in this chapter. For a limited sample size, as long as the integration order of variables is less than two, the ARDL model is superior. Harris (1995) argues that it is possible to use the Johansen estimation method to provide a combination of I(0), I(1), and I(2) variables. Because the multivariate model suggested, these variables should be included. As I(0) variables are stationary, creating a co-integration relationship by themselves and generating a linearly independent column in the long-run cointegrated vector. If Z_t is believed to be a composition of variables I(0) and I(1), the rank of co-integration increases by the number of variables I(0). Nevertheless, if there is a mixture of I(2) variables with I(1) variables, and there are more than two I(2) variables, this condition is more complicated. The two I(2) variables can be merged into I(1), and I(0) variables can be reintegrated into I(1) by this combination. For the Johansen method, however, it is possible to evaluate only I(1) variables I(2) variables must be combined with I(1) in this case before the Johansen model can be implemented. So, the Johansen estimation model may involve some degree of subject judgment in this case.

4.2 Empirical Analysis and Discussion of Results

At the first step, the ADF (Augmented Ducky Fuller) and Philips Pearson (PP) tests were used to check the data's unit root test. In table 4.2, the results show that agriculture productivity (AP), human capital (HC), and technology variables are stationary at level I(0). The environmental degradation (CO2), GDP, financial development, and CPI variables are stationary at the 1st difference I(1). The Zivot and Andrew results show the structural breaks in the data. Table 4.3 shows the results of the Zivot and Andrews structural break unit root tests.

4.2.1 Table 4.2: Results of Unit Root Tests

Variables	ZA test at level			Integration
	t-Statistic	Prob.*	Break Year	
lnAgri	-11.35344	0.000911	1997	I(0)
lnCO ₂	-2.629076	0.000882	2004	I(0)
lnGDP	-5.577687	0.014156	2008	I(0)
lnFD	-3.807734	0.003924	2005	I(0)
LnTech	-3.686281	0.045324	1990	I(0)
lnHC	-3.477570	0.073038	2005	I(0)
LnCPI	-6.960185	0.092456	1999	I(0)

*Note: * refer to the rejection level at 1%*

4.2.2 Table 4.3: Results of Zivot and Andrews's Structural Break Unit Root Test

The results of ADF and PP tests show the entire variables integrate at level form or first difference. These results fulfill the ARDL model's pre-condition that all the variables must cointegrate at the level form or first difference. Further, the results of the Zivot Andrews test reflect the structural breaks in the data. The presence of structural breaks in data occurs due to government policies, the evolution of economic conditions in the country, or the introduction and implementation of new regulations regarding study variables. For example, the financial crises of 2008 bring a structural change; these crises affect the economy of most countries of the world. Moreover, the crisis of 2008 become a cause to reduce agriculture productivity. So, the low production of agriculture becomes the cause of weak GDP growth in these countries. Previous studies provide a solution to overcome the structural break problem by adding an extra or dummy variable from a fundamental change in the dependent variable. For the significant results, I added a dummy variable to improve this study's long-run constancy. The unit root test results allow me to use the ARDL technique because all the

Variables	Augmented Dickey-Fuller test statistic				Philips-Pearson test statistic				Order of integration
	At level (Intercept)		1st Difference (Intercept)		At level		1st Difference		
	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	
LnAgri	-8.3222	0.0000	-7.1412	0.0000*	-8.2956	0.0000	-37.3025	0.0001	I(0)
LnCO2	-2.6046	0.1002	-3.8466	0.0053	-2.1985	0.2099	-3.8964	0.0046	I(1)
LnFD	-1.0458	0.7280	-4.0039	0.0033	-1.4023	.5723	-4.0150	0.0032	I(1)
LnHC	-2.3655	.01645	-4.6704	0.0059	-3.1985	0.2099	-3.8964	0.0182	I(0)
LnTech	-2.6519	0.0908	-1.463	0.5231	-3.516	0.7644	-3.133	0.0651	I(0)
LnGDP	-7.9626	0.0000	-6.5445	0.0000	-7.9626	0.0000	-18.447	0.000	I(1)
LnCPI	-05784	0.8562	-4.325	0.0906	0.288	0.9761	-4.791	.0439	I(1)

model variables integrate at I(0) and I(1).

After checking the unit root and structural break test of the data, the ARDL bound testing approach was used to check the variables' co-integration. Table no. 4.4 is showing the results of ARDL bound tests.

4.2.3 Table 04.4: Results of ARDL Co-Integration Results of Bounding Testing

Model	Ln Agri= $f(\text{Ln CO}_2, \text{Ln CREDIT}, \text{Ln HC}, \text{Ln TECH}, \text{Ln TEMP}, \text{Ln GDP}, \text{Ln RAIN})$
Bond test-F-statistics	6.693418***
Significance	1%
Lower 1(0) Bond	2.65
Upper 1(1) Bonds	3.91

Note, *, **, and *** indicate the significance level at 10%, 5% and 1% respectively.

ARDL bound test estimates the F-Value for the given model; I compare F-value results with upper and lower bounds' critical values. Previous researchers Zaidi et al. (2019) identify that; if the F-statistics value is higher than the upper bound's critical values, the null hypothesis of no integration will be rejected. The results of my study show that all the variables are cointegrated in the long-run. Thus, it allows checking long-and short-run results. I also checked the co-integration through Johansen co-integration technique; it confirms that all the variables cointegrated in the long-run. Table 4.5 shows the results of the Johansen co-integration method.

4.2.4 Table 4.5: Results of Johansen Cointegration Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.937980	427.8467	239.2354	0.0000
At most 1 *	0.921114	322.1955	197.3709	0.0000
At most 2 *	0.860092	225.6848	159.5297	0.0000
At most 3 *	0.654744	150.9474	125.6154	0.0006
At most 4 *	0.609303	110.5356	95.75366	0.0033
At most 5 *	0.542869	74.82226	69.81889	0.0188
At most 6	0.410446	45.07641	47.85613	0.0891
At most 7	0.284258	24.99764	29.79707	0.1615
At most 8	0.212828	12.28910	15.49471	0.1436

At most 9	0.080651	3.195391	3.841466	0.0738
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Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.937980	105.6512	64.50472	0.0000
At most 1 *	0.921114	96.51073	58.43354	0.0000
At most 2 *	0.860092	74.73736	52.36261	0.0001
At most 3	0.654744	40.41186	46.23142	0.1839
At most 4	0.609303	35.71331	40.07757	0.1431
At most 5	0.542869	29.74585	33.87687	0.1440
At most 6	0.410446	20.07877	27.58434	0.3357
At most 7	0.284258	12.70854	21.13162	0.4794
At most 8	0.212828	9.093706	14.26460	0.2784
At most 9	0.080651	3.195391	3.841466	0.0738

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level

** denotes rejection of the hypothesis at the 0.05 level*

***MacKinnon-Haug-Michelis (1999) p-values*

The Breusch-Godfrey and Arch test is used to find serial correlation and heteroscedasticity. The results of these tests provide evidence that the data may not contain an error term. After confirming error-free data, I use the Ramsey Reset test; this test helps find the model's excellent fit or okay specification. The Ramsey Reset test results show that the study model is well-specified. After confirmation of the model specification, I choose the required lag level to estimate the long-term and short dynamics. To find the best-suited lag order, I used the Schwarz knowledge criterion. For further calculations, the acceptable lag order is 1. The VAR lag order details are revealed in Table 4.6.

4.2.5 Table 4.6: Results of (VAR) Vector Autoregressive Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	146.6629	NA	4.28e-16	-7.008355	-6.581801	-6.855311

1	526.6988	545.6926	2.90e-22	-21.36917	-16.67707*	-19.68569
2	693.1847	153.6793*	2.92e-23*	-24.77870*	-15.82106	-21.56478*

4.3 Long- and Short-Term Relationships

After finding the data's co-integration ratification, I checked the long-run and short-run dynamics with the ARDL approach's help. Table 4.7 shows the results of the long-run and short-run dynamics.

4.3.1 Table 4.7: Results of Long and Short Run Estimation

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGRI(-1))	0.266843	0.150117	1.777565	0.0893
D(LNCO2)	5.819338	1.498870	3.882482	0.0008
D(LNCPI)	4.167049	1.797161	2.318685	0.0301
D(LNFD)	4.512846	1.894759	2.381752	0.0263
D(LNFD(-1))	5.029624	1.793772	2.803937	0.0103
D(LNGDP)	0.123194	0.081435	1.512792	0.0446
D(LNTECH)	1.732751	0.858949	2.017291	0.0560
D(LNTECH(-1))	1.539859	0.597103	2.578885	0.0171
D(HC)	10.453906	5.993173	1.744302	0.0951
D(DUMMY)	-0.273897	0.667280	-0.410469	0.6854
D(DUMMY(-1))	1.454314	0.590399	2.463272	0.0221
CointEq(-1)	-2.193082	0.272517	-8.047516	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCO2	-2.653498	0.642685	4.128770	0.0004
LNCPI	-1.900088	0.821728	-2.312309	0.0305
LNFD	0.738995	0.494223	-1.495267	0.0491
LNGDP	0.056174	0.038354	1.464624	0.0572
LNTECH	0.353928	0.355331	-0.996051	0.0301
HC	-1.133178	0.627747	-1.805150	0.0848
DUMMY	-1.501217	0.273671	-5.485484	0.0000

C	2.460101	2.434278	1.010608	0.3232
R-squared	0.798171			

The long-run results reveal that the relationship between CO₂ and agriculture productivity is negative (-2.653498) and highly significant (0.0004). The negative coefficient states that with the increase of CO₂, agriculture productivity decreases. So, the 1% change in CO₂ will change agriculture productivity by 2.653498%. There is a challenging situation of the environment and CO₂ emissions in Pakistan, and the efforts are sporadic to overcome these challenges (Zaidi et al., 2018). The core reason for climate change is the frequent use of fossil oil and cutting the trees from agricultural land. Farmers believe that trees in agricultural land negatively affect their productivity, while the results are different from the farmer's thinking. According to Eckstein (2017), Pakistan is considered a high-ranked affected country by CO₂ emission. So, the arguments provide evidence that climate change (CO₂) is the main reason and causes air pollution. This study's findings are similar to the previous studies of Awais et al. (2018) in Pakistan and the study of K & Boqiang (2017) in China. Furthermore, the study of Sapkota et al. (2019) also proves our results significant; according to them, climate and temperature affect India's agricultural productivity.

Furthermore, the coefficient of CPI (Consumer Price Index) is (-1.900088) this is showing a negative and significant (.00305) effect on agriculture productivity. The negative relationship between CPI and agriculture growth explains that if the consumer price index increases, agriculture productivity decreases because of weak purchasing power. A 1% change in CPI will change agriculture productivity by -1.90008%. An increase in price level discourages the farmers from investing more in agriculture farming; for example, when oil prices increase, pesticides will also become expensive. Their financial position will fall, and agriculture productivity declines. This study's results are similar to Tule et al. (2019) findings and Tule and Salisu. (2018) who find that agricultural commodity prices exhibit persistence and endogeneity conditional high volatility price effects.

Credit is the primary driver of the economic system. The results reveal that the financial development coefficient is (0.738995), showing a positive and significant (0.0491) impact on agriculture productivity. A 1% change in financial development will increase agriculture productivity by 0.738995%. In the long run, the results are similar to the study

done in Pakistan by Chandio et al. (2019). Their results show that credit poses a positive and significant effect on efficiency, suggesting that proper credit utilization can enhance rice productivity and improve the irrigated rice farmers' livelihoods.

Economic growth in Pakistan is dependent on agriculture growth, as the results of this study show positive and significant. The coefficient of the GDP is (0.056174) that is positive and significant (0.0572). The significant positive results confirm that with the increase in agriculture productivity, the GDP will also increase. A 1% change in economic growth will bring 0.056174% changes in agriculture productivity. The results are similar to the previous studies done by McArthur and McCord (2017) on 70 countries and found that with the increase in fertilizers, the agriculture productivity will increase, which will significantly impact economic growth. So, the actual need for fertilizers for agriculture productivity can overcome with the help of finance. All scale (the large, the medium, and the small) farmers want to use recommended fertilizers for better agriculture production, but they cannot do so due to financial issues. The results identify the need for finance in agriculture, as agriculture is the primary driver of Pakistan's economy. The higher agriculture growth increases farmers' savings, leading to an increase in the GDP, and ultimately reducing poverty.

Moreover, the coefficient of agriculture technology is positive at (0.353928) and significant (0.0301). The significant positive result shows that with the increase of technology the agriculture productivity increases. The results indicate that a 1% change in agriculture technology will change agriculture productivity by 0.353928%. According to Hu et al. (2019), small-scale farmers use less modern technology. So, in Pakistan, most small-scale farmers are not using advanced technology for the crops.

The results of human capital and agriculture growth are positive (1.13317) and significant (0.0848). A 1% change in human capital will change the agriculture sector productivity by 1.13317% in Pakistan. Educated farmers with the right health conditions can put their best efforts to minimize the cost, using modern technology with best practices in the agriculture sector. The results of this study contradict the findings of the study of (Inwood, 2017).

The short-run diminishing results report a positive and significant relationship between all the variables in the short run. It refers to the subject that the development of

environmental degradation, GDP, consumer price index, financial development, agriculture technology, and human capital will increase agricultural productivity in the short-run.

To check ARDL results' reliability, I used Breusch-Pagan-Godfrey and Ramsey RSET tests presented in table number 4.5. Further, I use CUSUM and CUSUM2 sum of squares (shown in Fig. 4.1). Charts of figs. 1 and 2 are evident of the good fit of the model, as the upper and lower bonds critical values are at 5% level; further, the blue line in graphs lies between the upper and lower red lines of the CUSM and CUSUM2, the blue lines between the red line and 5% level confirms the good fit of the model. The good fit of the model indicates that short-run and long-run dynamics are efficient and reliable.

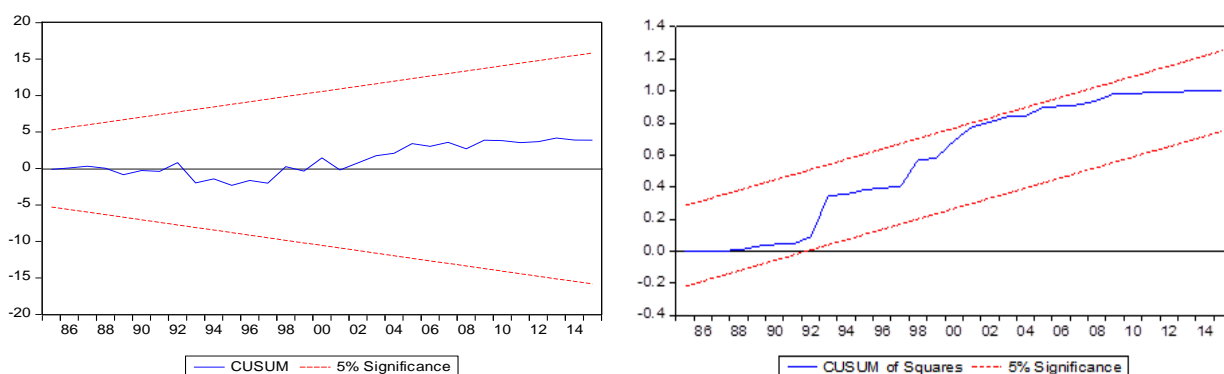


Figure 0.1: Chart of Good Fit of the Model

4.4 Granger Causality Results

The results of co-integration provide evidence of the existence of a long-run relationship between variables. After finding the testimony of a long-run relationship, I checked the direction of the causal relationship with the help of VECM. According to Phillips (1993), if there is a long-run relationship between the variables, then the error correction model is suitable for finding the variables' causal relationship. ECM also helps and allows differentiating the short-term and long-term granger causality. Wald statistic measures the VECM Granger causality of all independent variables that determine the difference and lag difference coefficients. The following equation reveals the functions of Granger causality:

$$\begin{bmatrix} \Delta \ln \text{Agi}_t \\ \Delta \ln \text{CO}_{2,t} \\ \Delta \ln \text{GDP}_t \\ \Delta \ln \text{HC}_t \\ \Delta \ln \text{CPI}_t \\ \Delta \ln \text{TECH}_t \\ \Delta \ln \text{FD}_t \end{bmatrix} = \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \\ \delta_6 \\ \delta_7 \end{bmatrix} + \sum_{p=1}^q \begin{bmatrix} \theta_{11p} & \theta_{12p} & \theta_{13p} & \theta_{14p} & \theta_{15p} & \theta_{16p} & \theta_{17p} \\ \theta_{21p} & \theta_{22p} & \theta_{23p} & \theta_{24p} & \theta_{25p} & \theta_{26p} & \theta_{27p} \\ \theta_{31p} & \theta_{32p} & \theta_{33p} & \theta_{34p} & \theta_{35p} & \theta_{36p} & \theta_{37p} \\ \theta_{41p} & \theta_{42p} & \theta_{43p} & \theta_{44p} & \theta_{45p} & \theta_{46p} & \theta_{47p} \\ \theta_{51p} & \theta_{52p} & \theta_{53p} & \theta_{54p} & \theta_{55p} & \theta_{56p} & \theta_{57p} \\ \theta_{61p} & \theta_{62p} & \theta_{63p} & \theta_{64p} & \theta_{65p} & \theta_{66p} & \theta_{67p} \\ \theta_{71p} & \theta_{72p} & \theta_{73p} & \theta_{74p} & \theta_{75p} & \theta_{76p} & \theta_{77p} \end{bmatrix} \times \begin{bmatrix} \Delta \ln \text{Agi}_{t-p} \\ \Delta \ln \text{CO}_{2,t-p} \\ \Delta \ln \text{GDP}_{t-p} \\ \Delta \ln \text{HC}_{t-p} \\ \Delta \ln \text{CPI}_{t-p} \\ \Delta \ln \text{TECH}_{t-p} \\ \Delta \ln \text{FD}_{t-p} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \\ \alpha_7 \end{bmatrix} \text{ECT}_{t-1} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \\ \mu_{6t} \\ \mu_{7t} \end{bmatrix}$$

(Eq. 3)

F-statistics results are measured with the Wald statistics that determine the short-term results, while ECT₋₁ calculates the long-run causality results. The negative sign of ECT₋₁ proves the significant result of Granger causality (Klarin et al., 2018). Table eight shows the findings of Granger causality.

4.4.1 Table 4.8: Results of Granger Causality

Variables	$\Delta \ln \text{Agi}$ (1)	$\Delta \ln \text{CO}_2$ (2)	$\Delta \ln \text{GDP}$ (3)	$\Delta \ln \text{HC}$ (5)	$\Delta \ln \text{FD}$ (4)	$\Delta \ln \text{CPI}$ (6)	$\Delta \ln \text{Tech}$ (7)	ECT ₋₁
$\Delta \ln \text{Agi}$	----	2.8327 (0.0924)*	0.0294 (0.0638)**	0.4659 (0.0949)*	0.9458 (0.0308)***	0.7681 (0.0522)	2.8180 (0.0932)*	-0.6297 [0.0332]***
$\Delta \ln \text{CO}_2$	0.8180 (0.0139)***	----	1.4870 (0.0227)***	0.0166 (0.8973)	2.0073 (0.1565)	2.1059 (0.1467)	0.1429 (0.3831)	-0.0447 [0.0505]**
$\Delta \ln \text{GDP}$	0.6126 (0.0038)***	7.6829 (0.0056)**	----	1.6150 (0.0638)	7.7220 (0.0055)**	0.9384 (0.3327)	6.0110 (0.0336)***	-1.7505 [0.0012]***
$\Delta \ln \text{HC}$	2.8680 (0.1932)	6.1199 (.0134)***	0.0397 (0.8420)	----	0.2289 (0.0223)	7.0110 (0.2381)	4.0073 (0.2565)	-0.2984 [0.0049]***
$\Delta \ln \text{FD}$	0.9132 (0.0393)***	5.1106 (0.9982)	1.7714 (0.1832)	0.7374 (0.3905)	----	0.9206 (0.6373)	1.6622 (0.3266)	-0.4625 [0.0020]***
$\Delta \ln \text{CPI}$	2.0073 (0.1565)	0.0926 (0.7608)	0.2370 (0.6263)	0.8058 (0.3693)	0.9622 (0.3266)	----	7.0110 (0.0081)***	0.0065 [0.0638]**
$\Delta \ln \text{Tech}$	0.6132 (0.3393)	0.4881 (0.4848)	4.7787 (0.0522)	3.3916 (0.0725)**	6.8180 (0.0939)*	1.9714 (0.1432)	----	-0.3407 [0.0894]**

Note: ***refers to the 1% significance level. ** depicts the 5% significance level and * refers to the 10% significance level

The results show a bidirectional relationship between agricultural productivity and environmental degradation (CO₂); environmental degradation granger causes agricultural

productivity. In response, Agriculture productivity also Granger causes environmental degradation in the short run. My study results match with Thoai et al. (2018), who studied Vietnam. The findings of Dissanayake et al. (2019) on Sri Lanka and Bangladesh found that climate affects agricultural productivity and must respond differently. Furthermore, the GDP results show that Granger's economic growth causes Agri productivity in the short-run, and in-response agriculture productivity also Granger causes economic growth. The results match the effects of Loizou et al. (2019), who found that agriculture growth is an essential driver of economic growth for the region. Financial development is the proxy of finance available and provided by the financial institutions to the agriculture sector. The FD granger causes agriculture productivity, and in-response, agriculture productivity also Granger causes FD. The results are not similar (Ibrahim & Alagidede, 2018). These authors' results show that the rapid growth of credit causes an increase in the cost of agriculture productivity. My study results are similar to the effects of Adu et al. (2013) in Ghana and suggested that credit provided to farmers by public and private banks is conducive for economic growth and agriculture growth. The granger causality results between the consumer price index and agriculture growth show that CPI granger causes agriculture productivity.

In contrast, agriculture productivity does not Granger cause the consumer price index in the short run; My study results are similar (Tule, Salisu, & Chiemeké, 2019). Furthermore, agriculture technology granger causes agriculture productivity while in return, agriculture productivity does not Granger cause agriculture technology in the short run; the results are similar (Hu et al., 2019). The results of ECT-1 Colum from table number eight shows a bidirectional causality in the long run between agriculture productivity, environmental degradation (CO₂), economic growth, human capital, financial development, consumer price index, and agricultural technology. This bidirectional causality among all variables indicates the feedback effect of agriculture productivity with other study variables.

Chapter Summary

This study found that environmental degradation in Pakistan has a direct impact on agricultural productivity. Increasing levels of environmental degradation have a serious impact on agricultural production. Pakistan is a developing country with weak infrastructure, so it is most affected by environmental pollution. Besides, rainfall forecasts indicate that Pakistan's temperature would rise 2-3 °C in 2050 due to differences in rainfall distribution,

which is incredibly damaging to crops (Gorst, Dehlavi, & Groom, 2018). Credit plays a vital role in developing all sectors; the relationship between financial development and agricultural growth is positive and significant. It shows that improved and safer credit schemes available have recently improved the efficiency of agriculture. The results of the long-term balance show positive and significant results between agricultural and GDP growth. In the short term, agricultural production is also strongly correlated with economic development and human resources, leading to large and negative CPIs and CO₂. The sensitivity analysis shows the robust performance of ARDL, while the reliability results of CUSUM and CUSUM₂ suggest a good fit for this study's model. The relationship between environmental deterioration and agricultural productivity is substantial but adverse, suggesting an increase in CO₂ will reduce agricultural productivity. The results of human capital and agricultural growth are both positive and significant. The results show that a 1% change in human capital will change Pakistan's agricultural sector's productivity. Educated farmers with the right health conditions can do their best to minimize costs by using modern, best-practice technology in the agriculture sector. The results of this study contradict the findings of the study (Inwood, 2017).

5 CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Pakistan is an agrarian country where the agriculture sector is the primary driver of Pakistan's economy that contributes 18.5 percent of economic growth. The agriculture sector is the backbone of all the industries of Pakistan. With time, the share of the agriculture sector in GDP decreases. This study identifies the main challenges to agricultural production in Pakistan, seeking to recognize the real challenges. I have analyzed the degree of data series integration through various unit root methods. Further, I used the ARDL bonding test and the Johansen Co-integration test to verify the long-run co-integration relationship. Finally, I study the short-run and long-run elasticity between variables by using the ARDL approach.

In this study, it was reported that credit plays a vital role in developing every field; the relationship between financial development and agricultural growth is positive and significant. It indicates that better and safer credit schemes available have recently improved the efficiency of agriculture. The long-term balance results indicate positive and significant results between growth in agriculture and GDP. Furthermore, the environmental degradation in Pakistan directly impacts agricultural productivity. In the 21st century, the increasing pattern of environmental degradation is seriously hurting agricultural production. Pakistan is a developing country with weak infrastructure, which is why environmental pollution most affects it. Besides, rainfall forecasts indicate that Pakistan's temperature would rise 2-3 ° in 2050 due to differences in rainfall distribution, incredibly damaging crops (Gorst, Dehlavi, & Groom, 2018). In the short term, agricultural production is also strongly correlated with economic development and human resources, resulting in large and negative CPIs and CO₂. The sensitivity analysis proves ARDL's robust performance, whereas the reliability results of CUSUM and CUSUM₂ suggest a good fit for the model of this study. The relationship between the deterioration of the environment and agriculture's productivity is substantial but adverse, suggesting that a rise in CO₂ will decrease agricultural productivity.

The effects of financial innovations have a significant and positive impact on agricultural growth in the long term; the results of this study suggest that better development of farmers' financial sectors would increase Pakistan's agricultural growth. In the meantime, literature also shows the appositive relationship between agricultural credit and productivity.

However, Pakistan's issue is that the ratio of agricultural credit increases over time while production does not increase. It means that there is an issue with the overall financial system. The study concludes that without government support for the development of the financial system, Pakistan's agricultural production is unlikely to increase. Concludingly, this is the credit that helps to buy high-quality agricultural inputs for farmers in the region.

All activities of agriculture want money and fund, and without funds, these activities are impossible. The farmers of the Pakistan majority are poor and cannot afford the inputs' cost, so the per acre production is less than those wealthy farmers. Large-scale farmers have a great experience and a better financial position in agriculture, due to that their production cost is less than the small-scale and middle-scale farmers. The government of Pakistan tries to help the farmer in the country. However, due to less and deficit budget, the amount for agriculture programs is significantly less. Thus, they do not arrange the country's programs that play a significant role in agriculture development. For agriculture development, farmer development is required when farmers will be developed. Then, agriculture development is possible because they will purchase the input, advanced technology, and climate measures in time for their agriculture activities, enhancing their farms' production.

The study, therefore, points out that the development of a farmer in the country is because, in the Rostow model, the first phase is agriculture. Then the other stages have begun in the development of a country. Every agrarian country in the world started developing from agriculture. When Pakistan came into being; its share was 60 percent, while it now reduced up to only 18.5 percent. The share of industries and services at that time was abysmal. In contrast, the share of other industries improved. The industry's share is now 17 percent, compared to 9 percent at the beginning of Pakistan. Similarly, the service share is at the top of 64 percent, compared to 38 percent in Pakistan. As a result, the development process is on the verge of Pakistan, compared with other developing countries globally, mainly behind them due to lack of funds. In Pakistan, various problems are facing the farming community in securing loans in Pakistan. The loan process is complicated, and, in time, the loan is not available to farmers for the purchase of their inputs. Some farmers get an informal loan whose interest rate is very high, and the return of the loan is also tricky, and often they sell their land to repay the loan. The workers of the bank misbehaved the farmer to get the loan. Similarly, the amount of the loan is considerably less than the requirement. Simultaneously,

in some places, religious people have not granted the bank's loan and have said that it is an interest that is forbidden in Islam.

Based on problems, the study recommends that to provide colossal amount loan to a farmer in Pakistan for enhancing agriculture production; Support price should be imposed on agriculture output in the country; Subsidies price should be put on the inputs in the country; Free based education should be provided to farmer children in the country; Free based hospital should be constructed for health services to farmers in the country; Market facilities should be developed to farmer in the country; High quality varieties of all crop should be provided to farmers in the country; Agriculture products should be exempted from the tax in the country; Bank number and agriculture schemes should be increased for provision of a loan to farmer in the country; Diesel price should be provided on the low rate to a farmer in the country; Electricity facilities should be provided on the low rate to farmers in the country for enhancing agriculture production. At present, small farmers dislike availing traditional loans from Pakistan's financial institutions because of the documentation burden and credit providing criteria; that is why farmers to avail of in-formal loans. The government ought to develop such a mechanism that must increase financial development: the arrangement, i.e., one window operation on both public and private sector banks. The schemes like loans on personal guarantees must also promote compared with old methods, i.e., mortgages and pledges. The data analyzed that only developed farmers developed the country very well. Therefore, it is requested agriculture development in Pakistan.

The CPI results are negative signs that show that with the decrease of farmer's expenditure, agriculture productivity will increase. As discussed previously, in-formal loans increase the production cost and decrease the profit margin of the farmers. The government of Pakistan must develop such policies that focus on formal and informal loans and farmers' other production expenditures. It is worth mentioning here that government must facilitate farmers by providing less costly inputs by taking a severe note of inflation and must take some remedial actions like subsidy on agricultural inputs, seeds and fertilizers, pesticides, and agriculture machinery.

In conclusion, an alarming situation is that Pakistan's agricultural land is decaying and converting into residential societies. This continuous decline of the industry in Pakistan does not attract the young generation to adopt this sector as a profession. The attraction can be

increased in this sector if the government gives due concentration to this sector. The government of Pakistan should provide subsidies in the form of cheap loans, fertilizers, pesticides, seeds, and agriculture technologies to young pass out graduates to attract them to adopt the agriculture sector as a profession. Furthermore, Pakistan's higher education commission should instruct institutions to conduct seminars in universities and colleges on agriculture importance. The young generation takes an interest in this sector. In this way, they will be familiar with the benefits of adopting agriculture as their future career.

I studied agriculture in Pakistan in the 1950s. This business sector has not been adequately established so far. In this regard, I believe that the destructive natural forces are comparatively minor. The good news is that we have more control over public decisions than the moods of nature. Following effects are extracted from the results of this study and literature regarding environmental degradation, technologies, financial development, human capital, and inflation;

- Issue regarding production, water supplies and land efficiency are damaging agriculture performance in Pakistan.
- Development of advance crop seed's and issues related to livestock breeds.
- Environmental degradation has an increase in temperature in Pakistan by 2-3 centigrade.
- The increased temperature causes a shortage of underground and rivers waters.
- The increasing trend of vehicles in Pakistan increases CO₂ emissions.
- As there is a water shortage in Pakistan, the Pakistani farmers make frequent use of diesel in tractors to water their crops. The excess use of diesel creates CO₂ emission and also increases the production cost of the farmers.
- Most Pakistani farmers use old age technologies for the agriculture sector; they give less performance while using more diesel and running costs.
- Pakistani farmers are currently using the following climate adaption techniques against environmental degradation;

- Change in crop varieties.
 - Increase in fertilizers.
 - Adjustment in planting dates.
 - Only a few farmers implement advanced measures like planting shades, soil conservation, and crop diversification, while most farmers use old techniques.
- In Pakistan, there is a gap in human capital investment, especially related to the agriculture sector. The government's focus on special training and technical education regarding agriculture is deep slow.
 - Financial development is lacking in Pakistan. Over time, the ratio of agriculture credit increases, while the agriculture sector performance is decreasing.
 - The inflation rate in Pakistan has an increasing trend that is directly affecting this sector.
 - Enable to meet the changing consumer tastes and dietary habits caused by income growth and urbanization in developing countries.
 - To maintain essential environmental resources, particularly in the face of uncertain but potentially severe climate change.
 - Enable small farmers and livestock holders to participate in commercial agriculture.
 - Develop sustainable rural non-farm development through joint efforts between the private and public sectors.
 - Integrate into the global markets for food and industrial raw materials.

On the one side, these difficulties may pose problems, but at the same time, it may bring new opportunities to make agriculture an even more vibrant part of the nation's economy. There are numerous and conflicting classes with various goals, concerns, and desires due to many causes.

5.2 Recommendations

I have present key points that are close to other policies and procedures related to agriculture.

First, rather than guiding farmers to drive production, we should establish a situation where farmers continue to agitate for change in a positive direction but are regulated and assisted by the government without direct state interference.

The **second** thing to remember is the small farmers and landowners, the leading players in this process, small-scale agriculture is a vital part of the transition away from reliance on agriculture and hence famine and famine-dependent agriculture, and the expansion of large commercialized farms (like beef, poultry, and some cereals) is an integral part of the transformation process. The problem is that modern farming has been more competitive than conventional farming because of innovations in farm machinery and laborers' availability.

Third, it is recommended that the state's business agencies should be in the realm of securing well-defined property rights.

Investing in public goods (like keeping the roads in good shape, employ enough staff to maintain the public baths and parks, and provide scholarships for students).

To allow the marketplace to control both the quality and safety of producers and consumers.

There must be a practical and equitable regime of taxation.

Assimilation of the idea that the poor and disabled people be provided with protection because many lack access to financial or health-care services.

The state's business is not to throttle private initiative and creativity in the economy, by thousands of regulations, and to distort the signals for effective production and delivery of

goods and services. Due to the low degrees of productivity that crops and livestock products obtain in Pakistan, the average yield levels are far below what would achieve in the region. In addition to producing and selling the milk, dairy farmers often engage in an agricultural marketing scheme that appears to be punitive to both producers and consumers.

It is fair to establish a comprehensive and sustainable agricultural growth process in Pakistan, considering at least five conditions.

(1) It has become more or less necessary than the national and provincial research system can up-to-date, concentrate on, evaluate, produce, and adapt the best scientific knowledge that exists throughout the country and internationally.

(2) the essential key to this long-term research is transferring the stock of tested information and technology from big-city universities and companies to farmers and cattle-holders in packages that lift the criteria of the viability of new technology as the ultimate measure of how well farmers embrace it. Since farmers are already at the mercy of natural resources, it is not difficult to imagine how they can leap into technological advances, no matter how great a sacrifice they will undergo.

(3) Farmers should have the right to private property (their land) and resources; farms must have access to free (or low-cost) inputs and services in a competitive market; farmers should receive government support in exchange for maintaining the conditions of the land and farms. Furthermore, the farmers must feel safe with crime deterrence (law enforcement and judicial system) and fair access to markets (free trade), and the government must provide appropriate public goods (roads, schools, water, health, and safety programs) and properly implemented regulations that offset over-regulation.

(4) Rural folk and livestock farmers should be included in a similar and cooperative setting in the marketplace. With their integration into the rapidly-growing commercial marketplace, there are good participatory models available for this purpose. That will contribute to those in this group's well-being and other economic and social objectives at the local, regional and national level.

(5) To secure the natural world to protect it against pollution of energy and water, flood protection, and health requirements worldwide around us to respond to environmental concerns and allow a competitive international market.

- (i) Teach the farmers to become independent of technology and more responsible for managing their land.
- (ii) Give a proper structure for the private sector to prosper by reducing the spaces landlords can exploit and ensure that market actors who participate in anticompetitive behavior are inhibited or disciplined (pollution and free-riding).

Countries are not doing any unjust or irrational things that are compounding ethanol subsidies' costs, nor are they doing anything that would be unfair or unreasonable when it comes to how global cotton subsidies are allocated. The government's policies must be changed from providing subsidies on farm inputs to expenditure and funding for research and extension services, consumer infrastructure and infrastructure, electrification, and value-addition in crop and livestock products.

The author recommends three things to bear in mind here.

First, there is some doubt regarding many of the current studies, but generally, it can be said the preliminary knowledge is very high to very strong. Any evidence or propositions would have to be checked and confirmed to conclude the climate's present and potential state. Almost all of the reports on economic and social indicators come from one or another government entity; government-collected data are usually accessible in the expectation that it will be useful and provide information on statistical trends. Knowledge and data kept by agencies such as the FDA, CDC, and USDA have been virtually unchallenged by their opposition. Knowledge of the data archive data is de-centralized so that the monopolist can openly take measures. It is the secrecy that utterly empowers those who hold the knowledge. A third explanation is that the experts in this field do not possess sufficient expert knowledge and do not perform adequate and standard research on the results.

Second, it is not acceptable to make drastic or large-scale changes in which the effects are not well known or well tested on a small scale. As in: "do not throw the baby with the bathwater!" Do not make drastic or large-scale changes of which the consequences are not

well known or well tested on a small scale:" However, there is justification for making an effort to act because the cost of having nothing done or procrastinating can be high if not catastrophic. Suffice to say, a strong and longstanding social structure such as this one should not be underestimated. This insiders' community is fixed in the belief that the status quo works for and delivers to them the needed income.

In light of the findings mentioned above, the present study proposes the following policy implications for the development of agriculture sector and its financial development, the economic growth and for the environmental degradation control:

Agriculture Land

Good farmland around the outskirts of a city should be maintained for passive recreation, including walking, biking, and other recreational patterns, dining, and drinking. Simultaneously, density limits must be enforced to better direct urban development and preserve the housing stock's aesthetics in those active areas of town.

Furthermore, legislating the private right to own or hold agricultural land, recording the rightful owner's title, and then entering the Republic's official records title. As a prerequisite, it is essential to include all stakeholders in the land survey (using the GIS) required to address the conflicting claims on land in the current land record.

Education related to land record computerization needs to be enhanced. To this end, it should be made clear how land records are being computerized and determine the pilot projects' impact. What errors have we already made? If the digitized records are finally done, we will need to do away with the "patwari" system.

An assumption on land quality security should sadly be high on the policy agenda. Adjust the skewed price signals or similar policies that enable farmers to use input-intensive technologies.

We can realize that the zero tillage, green manuring, composting, and crop rotation will increase the soil's structure and fertility that will ultimately increase the productivity.

Irrigation Water

Analyze the use and legislation of groundwater to ensure that the resources are adequately managed, and that water reserves are not overconsumed. As a group, why not grant an individual access to groundwater and follow a more collaborative approach to resource management?

Due to the farmers having control over the canal irrigation system, they have been able and fast to institute the irrigation system to be more rapid and efficient. Compared to the state and federal-run centrally operated pen-irrigated canal system.

Implement a volume-based irrigation water supply on a pilot basis at the tail-end of watercourses.

How to treat water efficiently at the farm level must be improved by testing and disseminating technologies that consider the economic and technological constraints of farmers and the small farmers in particular. Is the small farmers' progress in applying pesticide as fast as it is with the large farmers? The people who are affected are: What else would they do to support themselves?

The government needs to assist farmers in building small dams to store water for fall and winter use. Integration of agronomic approaches to sustainable grain production for crop biotechnologies could be feasible. There will be the reinforcement of multiple cropping to promote economic opportunities in the agro-ecological region of Pakistan.

Crops and animals and their different varieties.

From a public health perspective, alternative breeding systems should be promoted at various levels. Such items, such as plant seeds, need to be accessible at all levels of the quality continuum and have to be controlled based on the health risk they present to the consumers and persons who contact it. Too many controls would create plenty of space for rent-seeking among the industries. Offer incentives to the private sector to invest in breeding, feeding, and veterinary services for livestock. Given the success of genetically modified organisms in many countries, should we not concentrate the knowledge of biotechnology on

crop varieties that are better suited to climate change, lower in resource dependence, and more resistant to pests and weeds.

If this technology is used to improve livestock breeds, this concept will improve milk and meat production.

Agriculture and Food Research and Extension Facilities.

The government should invest in agricultural research and extension services to expand the agricultural sector. To determine whether these programs are worth any taxpayer's money and to make sure they are getting value for their money, it would be prudent to predict how many people are likely to re-enroll in some form of training once they have gone through the training.

The universities and provincial research and extension institutions, and the private sector need to strengthen their partnerships in utilizing genetic resources, especially by 2030.

The proposal to make provincial research institutions more autonomous must be treated carefully. In addition to the outstanding issues about the transfer of assets and liabilities, contests with the selection of research staff must be expected.

People who communicate with agriculture are divided into their separate physical locations to deliver their technological messages to people seems like a good thing. Likewise, the government's infrastructure that helps promote this kind of expanded method seems like a good thing. Do you think the extension scheme should be a specialized service form, which both the public and private sectors support hiring? Can we concentrate too much on the technical aspects of the systems without considering how the system should be applied, what exactly it should feed to be effective and at the same time maintain efficiency, and learn more and more about the subject? The internet and information technology research labs are currently working on a digital infrastructure that helps more farmers and information technologists.

The marketplace of agricultural goods.

At this time, the monopoly ended, that the government had to avoid maintaining mandis for agricultural produce (e.g., fruit and vegetables). These markets are private, but to minimize the number of intermediaries and their margins, the private sector can operate with the government. The government should concentrate its attention on ensuring that the producers have a level playing field to have the freedom to work to ensure that the buyer and the seller are safe and purchase their product in perfect condition.

This bill emphasizes the importance of having similar effects on buying and selling live animals and the successful slaughter of animals. Though they would like to control the mandis for live animals and abattoirs themselves, it is not beneficial for the government to control so tightly (let the private sector do its business). To provide significant monetary incentives and facilities to livestock holders, the government should create livestock pockets in the rural areas where the livestock owners keep their animals by a large number of people.

The government does not compromise on the limits on the price of milk and meat. Both of these laws will increase the cost of living. Moreover, both of them, in the end, can be considered a breach of the freedom to freely provide to one's family without first having to pass an inspection.

The Advance agricultural technologies.

The study suggests that farmers should use more advanced farming techniques to cope with climate change and variability. Other proper adaptation techniques such as applying heat-resistant crops, water, and soil conservation, using better-adapted crop varieties, and altering planting dates must also be utilized to guarantee ambitious yield. This aim could not be achieved without the greater involvement of multiple stakeholders such as policymakers, extension agents, researchers, and farmers to effectively minimize climate change impacts on agriculture in the region and strengthen local adaptation capacities.

The Special Education for Farmers.

Because climate change is predominantly viewed and tackled by farmers with more education and more extensive land holdings, policies should concentrate on smallholders. It is

suggested that Supporting better education and better access to resources, information, and institutional services such as ITUs could enhance small farmers' adaptive capacity to climate change positively affect their productivity and livelihoods. As with 3D knowledge and training on advanced levels, enhanced access to advanced information about agricultural crop management could further reduce Pakistan's climate change damages and will help to increase agriculture productivity.

The Environmental Degradation.

People can use solar or wind-generated energy to lower the cost of electricity and diesel to irrigate crops. The government must be allowed to subsidize instruments generating solar and wind power. Encouraging commercial banks to offer loans directly to farmers to purchase solar and wind energy instruments are the best way to provide subsidies. The move would help reduce farmers' CO₂ emissions and production costs, increase farmers' productivity, and increase the profit margin. As banks introduce solar/wind loan items, they will assist farmers and the general public with job opportunities, eventually reducing poverty and helping the country's economic growth.

Forests in Pakistan should have to be increased by the government. Recently, the billion-tree program launched in Khyber Pakhtunkhwa by the KPK government has helped reduce CO₂ emissions in KPK. Like KPK, it is essential to start this program throughout Pakistan, particularly in Punjab, because Punjab is Pakistan's agricultural sector hub. One of the best water irrigation systems in Pakistan operates in the form of canals. On both sides of the canal, colossal land is accessible in all of Pakistan. The government may engage young educated people by providing them with the contract to grow fruit trees on canal branches. Not only would the strategy decrease CO₂, but it will also improve fruit production and quality. This fruit production will enhance Pakistan's exports and will contribute to economic development. It will lead to a rise in the number of jobs that will reduce poverty in Pakistan. For that, the PEF and PEIMA models should be followed for this reason. As well, these models are operating effectively in the education sector in Pakistan.

5.3 Limitations and Future Research Areas

5.3.1 Limitations

- Current research has considered agriculture productivity into consideration.
- Only single dependent variable.
- In this study the agriculture productivity is examined with FD, GDP, CO₂, HC and TECH.
- The focus of this study was only on agriculture productivity of Pakistan. Due to time constraints, I could not include other countries in consideration.

5.3.2 Future Research

- Researcher can consider agriculture productivity, livestock productivity and forest factors.
- Researcher can consider more than one dependent variables for model development.
- Future researcher should add more components like, fertilizer consumption, water availability, financial management practices etc.
- This study may be replicated in various industries like fiber, plastic or livestock, where increased levels of productivity may be needed to carry assigned tasks. In this way, results may also be generalized to other industries

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