



***IMPACT OF INFRASTRUCTURE ON AGRICULTURAL PRODUCTIVITY,  
EXPORT AND FOOD SECURITY IN PAKISTAN***

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**IMPACT OF INFRASTRUCTURE ON AGRICULTURAL PRODUCTIVITY,  
EXPORT AND FOOD SECURITY IN PAKISTAN**

By

**NAZIA TABASAM**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in  
Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

**January 2019**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

## **IMPACT OF INFRASTRUCTURE ON AGRICULTURAL PRODUCTIVITY, EXPORT AND FOOD SECURITY IN PAKISTAN**

By

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**January 2019**

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This macro level study uses a multi-faceted view of infrastructure and examines the impact of various defined categories of infrastructure on agricultural productivity, exports and food security in Pakistan. Pakistan - an agrarian country- lacks infrastructure facilities that may influence agricultural productivity, trade and food security which are crucial elements for developing the agriculture sector. This study therefore examines the effect of capital intensive, capital extensive and institutional infrastructure on agricultural productivity in Pakistan. Autoregressive Distributed Lag (ARDL) method is used to analyse time series data from 1980 to 2015. Long run positive relationship between capital intensive, capital extensive and institutional infrastructure and agricultural productivity is observed. In capital extensive infrastructure, however, credit has an opposing effect on agricultural productivity. The policy implications suggest developing, connecting roads, irrigation, research and extension, health care services and electricity supply to the agriculture sector. Secondly, this study investigates the role of transport, ICT and energy infrastructure on agricultural exports. To achieve this objective, panel data analysis for 20 countries based on gravity model, uses Fixed Effect or Random Effect model chosen by Hausman Test. Findings indicate that the road, air and port related transportation infrastructures positively affect agricultural exports. Foreign ports in trading countries also have a positive effect. This finding suggests more investment in transportation facilities, specifically ports. Likewise, ICT and energy infrastructure is significant in boosting agricultural exports in Pakistan. Finally, this study identifies the effect of infrastructure for food access and food utilization, on food security. Safe drinking water is found to be significantly positive in enhancing food security, whereas sanitation and health is negatively significant. Results for food access as a variable indicate building road and rail networks reduce food insecurity. This finding suggests policy action should prioritize the supply of safe drinking water to markedly address the issue of food insecurity. In addition to the practical implications identified above, this research reduces the scarcity of literature focusing on the components of infrastructure that are crucial for agriculture-sector development.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

## **KESAN INFRASTRUKTUR KE ATAS PRODUKTIVITI PERTANIAN, EKSPORT DAN SEKURITI MAKANAN DI PAKISTAN**

Oleh

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Kajian berperingkat makro ini mengambil pandangan menyeluruh berkaitan dengan infrastruktur dan sekaligus mengenalpasti kesan infrastruktur ke atas produktiviti pertanian, eksport dan sekuriti makanan di Pakistan. Namun, Pakistan yang merupakan sebuah negara pertanian, masih kekurangan kemudahan infrastruktur yang dapat mempengaruhi produktiviti pertanian, perdagangan dan keselamatan makanan yang merupakan unsur-unsur penting untuk membangunkan sektor pertanian. Oleh itu kajian ini menyelidiki kesan modal intensif, modal meluas dan infrastruktur institusi terhadap produktiviti pertanian di Pakistan. Kaedah autoregresi susulan teragih (ARDL) telah digunakan untuk data siri masa untuk jangka masa dari 1980 hingga 2015. Hubungan positif jangka panjang antara modal intensif, modal meluas, infrastruktur institusi, dan produktiviti pertanian turut dikenalpasti. Walau bagaimanapun, pembayaran kredit di dalam infrastruktur modal meluas menunjukkan kesan bertentangan ke atas produktiviti pertanian. Implikasi dasar memerlukan sumber langsung untuk pembangunan jalanraya, pengairan, penyelidikan dan pengembangan, perkhidmatan penjagaan kesihatan dan bekalan elektrik kepada sektor pertanian. Kedua, kajian ini menilai peranan pengangkutan, ICT dan infrastruktur tenaga terhadap eksport pertanian di Pakistan. Oleh yang demikian, analisis data panel telah dijalankan bagi 20 negara termasuk Pakistan, dari tahun 2005 hingga 2015 menggunakan model graviti. Pengganggu kesan rawak atau kesan tetap dipilih untuk model yang digunakan berdasarkan ujian Hausman. Infrastruktur pengangkutan seperti darat, udara dan pelabuhan di Pakistan menyumbang secara positif dalam meningkatkan eksport pertanian di Pakistan. Dapatan kajian mencadangkan agar lebih banyak pelaburan dijalankan ke atas kemudahan pengangkutan, khususnya infrastruktur pelabuhan. ICT dan tenaga perlu dikaji sebagai salah satu cara untuk meningkatkan eksport pertanian Pakistan secara menyeluruh. Akhirnya, kesan infrastruktur ke atas sekuriti makanan di Pakistan dikenalpasti dengan menilai infrastruktur untuk akses kepada makanan dan penggunaannya. Kaedah ARDL telah digunakan bagi jangka masa 1986 hingga 2016. Tahap kebersihan air minuman menunjukkan hubungan positif dalam meningkatkan

sekuriti makanan, sementara sistem sanitasi serta kesihatan mempunyai hubungan yang negatif. Tindakan dasar perlu fokus kepada bekalan air minuman yang selamat sebagai asas utama menangani sebahagian besar isu ketidakeselamatan makanan. Publisiti serta peruntukan untuk kemudahan sanitasi serta kesihatan yang mencukupi untuk penggunaan makanan akan memberi faedah kepada keselamatan makanan. Hasil kajian ke atas pemboleh ubah akses makanan mendapati pembinaan jalan raya dan rangkaian kereta api mengurangkan insekuriti makanan. Penemuan ini mencadangkan tindakan dasar harus memberi keutamaan kepada bekalan air minuman yang selamat untuk mengatasi isu insekuriti makanan. Di samping itu, implikasi praktikal yang dikenal pasti di atas, kajian ini meningkatkan sumber *literature* yang memberi tumpuan kepada komponen-komponen infrastruktur yang penting untuk pembangunan sektor pertanian di Pakistan.



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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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## LIST OF ABBREVIATIONS

IT	Information Technology
FAO	Food and Agriculture Organization
WEF	World Economic Forum
GDP	Gross Domestic Product
GNP	Gross National Product
GoP	Government of Pakistan
UNDP	United Nations Development Program
HDI	Human Development Index
PCP	Planning Commission of Pakistan
ILO	International Labor Organization
PKR	Pakistani Rupee
PIA	Pakistan International Airlines
ICT	Information and Communication Technology
WDI	World Development Indicators
MAF	Million Acre Feet
PNSC	Pakistan National Shipping Corporation
CPEC	China-Pakistan Economic Corridor
IFC	International Finance Corporation
FSA	Food Security Analysis
OECD	Organization for Economic Cooperation and Development
GCI	Global Competitive Index
NTC	National Tariff Commission
HFA	Health Facility Assessment

IFPRI	International Food Policy Research Institute
R&D	Research and Development
ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
UNESCAP	United Nation Economic and Social Commission for Asia and Pacific
GHI	Global Hunger Index
OLS	Ordinary Least Squares
WAEMU	West African Economic and Monetary Union
USAID	United States Agency for International Development
HFIAS/HFIAP	Household Food Insecure Access Scale/Prevalence
MAHFP	Months of Adequate Household Food Provisioning
NFNSP	National Food and Nutrition Security Policy
PCP	Planning Commission of Pakistan
LPI	Lived Poverty Index
CNPP	Cropland net primary productivity
UNWFP	United Nation World Food Program
ADF	Augmented Dicky Fuller
ARDL	Autoregressive distributed lag
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMQ	Cumulative Sum of Square of Recursive Residuals
PP	Phillips-Perron
SBC	Schwartz Bayesian information criterion
AIC	Akaike information criterion

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of the Study

Infrastructure is considered a major productivity driver of any country's economic growth. It contributes to overall wellbeing by enhancing productivity, integrating different regions and ensuring food security by making food transportation accessible and cost-efficient. Infrastructure works as a foundation that is also called a "public overhead capital" (Nurkse, 1953). Whether economies adopt export-oriented growth strategies or import-expanding growth strategies, rapid and effective infrastructure development is imperative. It links various regions of the world by making transport and distribution a more efficient process. During the last two decades, world spending on economic infrastructure was \$2.4 trillion, which is 3.8% of the world's Gross Domestic Product (GDP) (Inderst, 2016). Globally, an estimated \$80 trillion is required for infrastructure needs over the next ten years (Organisation for Economic Corporation and Development, (OECD), 2012). Based on these statistics, global estimation by World Economic Forum (WEF, 2012) shows infrastructure investment needs to be 1.25% of world GDP per year, which is almost \$1 trillion per annum. Table 1.1 shows that the investment needs in global infrastructure until 2030 is over 4% of GDP. The energy sector requirement is the highest followed by water and transportation.

**Table 1.1 : Worldwide Infrastructure Investment Requirements till 2030 (% of GDP)**

Infrastructure	Investment	
Water		1.3
Telecom		0.5
Transportation		0.9
a) Road	0.3	
b) Rail	0.3	
c) Airports	0.2	
d) Ports	0.1	
Energy		1.5
a) Electricity operation and Supply	0.2	
b) Electricity generation	0.7	
c) Other energy	0.4	
d) Oil and gas, diffusion and Supply	0.2	
<b>Total</b>		<b>4.1</b>

(Source: OECD 2006, 2007, 2012, WEF 2012)

Due to underinvestment and improper maintenance of infrastructure, developing countries are lagging behind global infrastructure rates of investment. The progress in least developing and low-income countries such as Pakistan remains sluggish due to insufficient infrastructure investment and the lack of resources. These kinds of countries ignore the fact that the opportunity cost of not having appropriate infrastructure surpasses the cost of building it (Samli, 2011). To keep pace with the demands of rapid urbanisation and economic growth, developing economies will need to increase spending from the current \$800 billion–\$900 billion to about \$1.8 trillion–\$2.3 trillion per year by 2020, or from 3% to 6%–8% of GDP. A spending gap of approximately \$1 trillion per annum is projected for developing economies (World Bank, 2016). For the South Asian region, infrastructure investment needs through 2020 are larger than all other regions (Bhattacharya, Romania and Stern, 2012) as indicated in Table 1.2. In fact, Transport Infrastructure has the highest investment requirement with 5.6% of GDP, followed by energy and telecom. As infrastructure is lacking in the South Asian region, so each sector of related economies suffer, including the agriculture sector.

**Table 1.2 : Infrastructure Investment Needs, 2010–2020 (% of GDP)**

	Energy	Transport	Telecom	Water and Sanitation	All Sectors
East and South Asia	3.2	1.6	0.5	0.2	5.5
South Asia	3.0	5.6	2.0	0.4	11.0
Central Asia	3.0	1.9	1.4	0.4	6.6
Pacific	0.0	2.6	0.7	0.3	3.6
All Developing Asia	3.2	2.3	0.8	0.2	6.5

(Source: ADBI, 2016)

Addressing infrastructure needs for the agricultural sector of the economy is essential for progress, national strengthening, policy making and sustainability in the long run--especially for low income countries that are agro-based. Infrastructure makes it easier to transport agricultural output from farms to potential markets nationwide. As transaction and distribution costs fall, profitability of the farmers increases and ultimately increases further output in the sector. Higher output not only has the potential to increase agricultural exports but also to ensure food security internally. Therefore, this study focuses on infrastructure and its impact on agricultural productivity, export and food security using Pakistan as a case example of how the relationships function in lower middle income countries.

## 1.2 Infrastructure

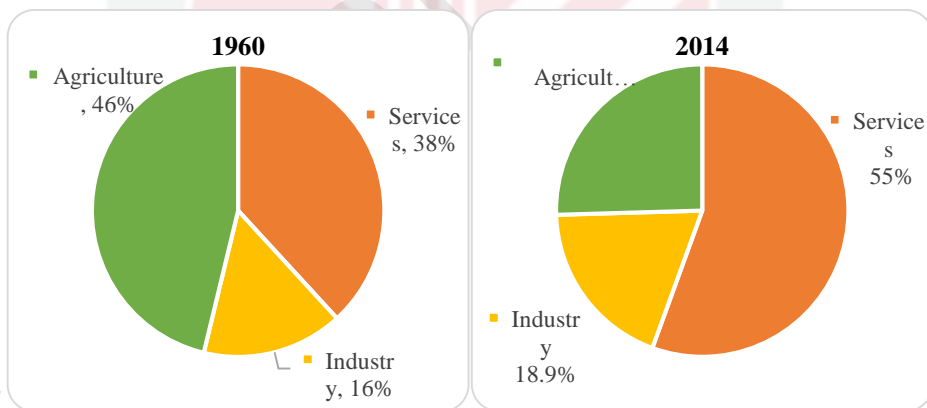
Clarifying the meaning of the term infrastructure is important before proceeding further. The expression 'infrastructure' alludes to fundamental structures. Infrastructure can be categorised as economic infrastructure that consist of utilities essential for development of an economy. It can also be categorised as social infrastructure that ensures the well-being of the community like housing, health and education. The term can also be categorised as commercial infrastructure that is predominately developed for commercial reasons. Thus, infrastructure provides essential services to the community. It generally involves long term stable cash inflows and it gets regulated by competent authorities or by economic regulators (WEF, 2012). Infrastructure includes the development of ports, roads, water sources, energy, institutions, communication, schools, hospitals, markets, and information technology (IT) which are prerequisite for economic development and quality of life. Infrastructure can be defined in terms of its characteristics or by compiling a list of infrastructure services and goods such as transport, communications, education, energy and water supply (Fourie, 2006). In terms of goods, Fourie followed Hirschman (1958), who defined infrastructure as a capital good that provides public services. Infrastructure is also taken as a public good that is non-excludable and releases positive externalities (Fedderke and Garlick, 2008).

Infrastructure's importance in economic development is identified as pertaining to agricultural research, financial institutions, extension services and irrigation (Ahmed and Donovan, 1992). A list of eleven components of agricultural infrastructure includes: irrigation and water, transportation, storage facilities, market infrastructure, infrastructure for processing, public services, research and extension, communication, land conservation, financial institutions and health and education facilities (Fosu, Heerink, Jhodo, Kuiper and Kuyvenhoven, 1995). Infrastructure is also classified as economic or "hard" infrastructure (e.g. electrification, roads, railways and bridges), social or "soft" infrastructure (e.g. education and health) or institutional infrastructure (e.g. farmers' cooperatives and agricultural institutions) (Stilwell and Atkinson, 1998).

According to Wharton (1967), there are three classifications in infrastructure: capital intensive, capital extensive and institutional infrastructure. Capital intensive infrastructure includes of transport infrastructure, water for irrigation, electricity, telecommunication and information. In capital extensive infrastructure, there comes research and extension infrastructure such as extension workers and agricultural research expenditures or researchers. Financial infrastructure also comes under the same category and includes access to credit for farmers through financial intermediaries. Institutional infrastructure consists of formal and informal institutions such as government stability, and law and order.

### 1.3 Overview of Pakistan Economy

Pakistan resource endowments are in abundance, thereby raising potential for development. Location of the country is such that the regional markets of South Asia, Central Asia, China and Middle East are accessible. With a population of more than 190 million and diverse endowments, Pakistan has strong potential for growth. But Pakistan has not succeeded in bridging the gap between actual and potential growth and has also lost considerable economic ground to the competitive economies of East Asia such as China, Malaysia, Thailand, South Korea, and Indonesia (World Bank, 2016). South Korea's per capita income was only slightly higher than Pakistan in 1960. With a time elapse of one generation, Korea achieved five times higher income levels than that of Pakistan. Pakistan's growth pattern has been severely flawed because it does not ensure either sustainability or a rationally fair distribution of growth benefits. This pattern can be seen in Figure 1.1 and shows the agriculture sector has fallen at the expense of the services sector even though the agriculture sector absorbs the highest labor force and a majority of the population resides in rural regions. Factors that have led to slow growth rate in Pakistan include higher dependency on external resources, poor development of human capital, insufficient long-term infrastructure investment and serious structural weaknesses in the agricultural, manufacturing and exports sector. Between 1985 and 1995, the per capita Gross National Product (GNP) growth rate was only 1.2% per annum and was significantly lower than 3.2% for India, 2.1% for Bangladesh and 2.6% for Sri Lanka (Hassan, 1997).

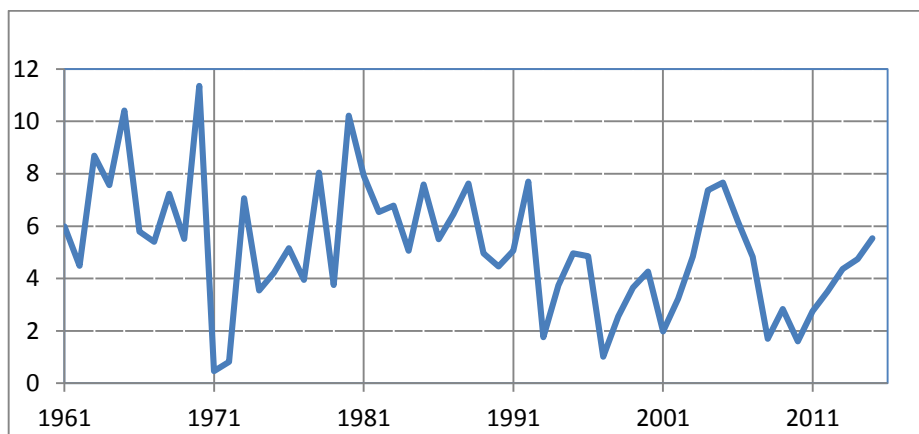


**Figure 1.1 : Structure of Pakistan Economy (Percentage of GDP)**  
(Source: World Development Indicators, 2016)

During the so-called golden era of economic history of Pakistan from 1958-1969, the highest priority was given to industrial development at the expense of the agricultural sector. Despite that, in the 1960's with the introduction of the Green Revolution, technology in agriculture expanded to the respectable rate of 4%. Pakistan's manufactured exports were more than the combined exports of Thailand, Malaysia and Indonesia by 1969 and Pakistan would have attained a higher degree of development in



a short time period if the economic policies and programs practiced in this regime were continued for next two decades (Zaidi, 2015).



**Figure 1.2 : Pakistan GDP Annual Growth Rate (%)**

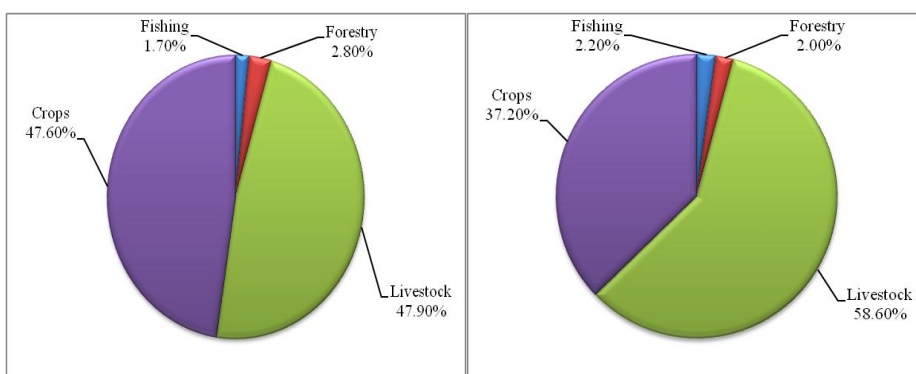
(Source: World Development Indicators, 2016)

Figure 1.2 shows that economic growth has remained volatile, falling from almost 8% to 3% in the period from 2005 to 2009 and recovering gradually to 4% in 2014. During 2010 to 2014, the average rate of growth was 3.5% when there were more intense energy shortages that led to decrease in domestic output (Planning Commission of Pakistan (PCP), 2015). Moreover, political instability and security issues led the economy to more severe disorder and the allocation of expenditures for the social sector were squeezed to pay debt service and accommodate defense expenditures. Pakistan lost its world trade market share. The poverty level doubled from 18% to 34% and the rate of unemployment increased significantly. United Nations Development Program (UNDP) ranked Pakistan in its lowest development category in its Human Development Index (HDI), placing it at 147 out of 188 countries (UNDP, 2015). Pakistan's economic crises were created by domestic factors and worsened by external conditions as foreign private inflows were affected by global financial turmoil and demand for exports from Pakistan were reduced largely due to a recession in OECD countries (PCP, 2015).

### 1.3.1 Agriculture Sector in Pakistan

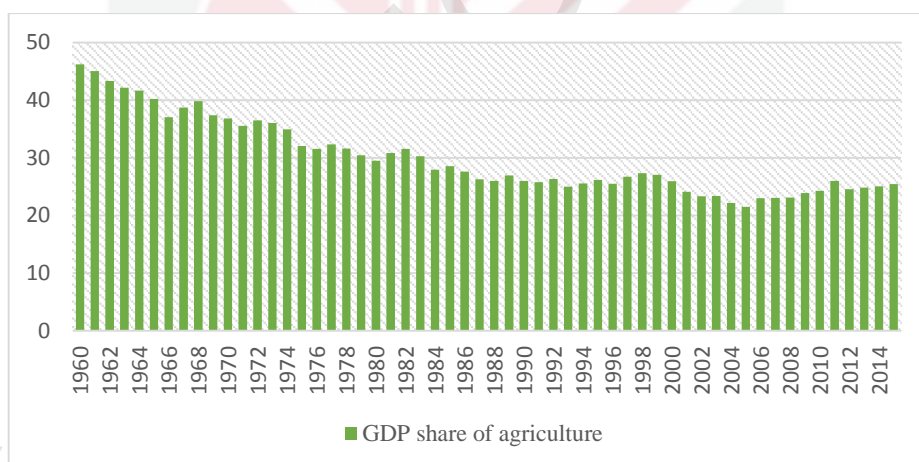
Agriculture has been a significant sector contributing 21% to Pakistan's GDP. It sustains 62% of the population and employs 44% of the total workforce (GOP, 2016). The sector retains vital importance due to provision of basic necessities of life, such as food clothing and livestock. Figure 1.3 shows that over the period of 15 years, the proportion of livestock has increased at the expense of crops production in the agricultural sector.





**Figure 1.3 : Composition of Agriculture Sector for 2000-01 and 2015-16**  
(Source: Economic Survey of Pakistan, 2015-16)

Figure 1.4 shows the decline in growth rate of the agriculture sector over time, which may be due to mismanagement of resources or absence of required infrastructure facilities to cope with uncertain weather conditions, to minimize post-harvest or pre harvest losses and to lessen the damage from natural calamities.



**Figure 1.4 : GDP Share of Agriculture (%)**  
(Source: World Bank, 2016)

Out of total 79.6 million hectares, 27% of the country is under cultivation. Hence, there is substantial potential for development in production as well as in the processing of primary output in the agricultural sector. The World Bank, in collaboration with United Nation's Food and Agriculture Organisation (FAO), identified key areas to address Pakistan's rural and national challenges. These include the categories of agricultural research and extension, rural finance, water resources and the seed industry. Pakistan's

agricultural research system is not strong. Extension services related to agricultural field are outdated and unlike other research and extension institutions, agricultural universities operate in relatively isolated areas. Water levels and irrigated areas have decreased to a large extent (FAO, 2011). The agriculture sector has significant impact on the economy due to its backward and forward links with industrial sector. The current need is to increase agricultural productivity by strengthening basic infrastructure along with other necessary measures to enhance efficiency, trade and ensure food security.

## **1.4 Issues and Challenges**

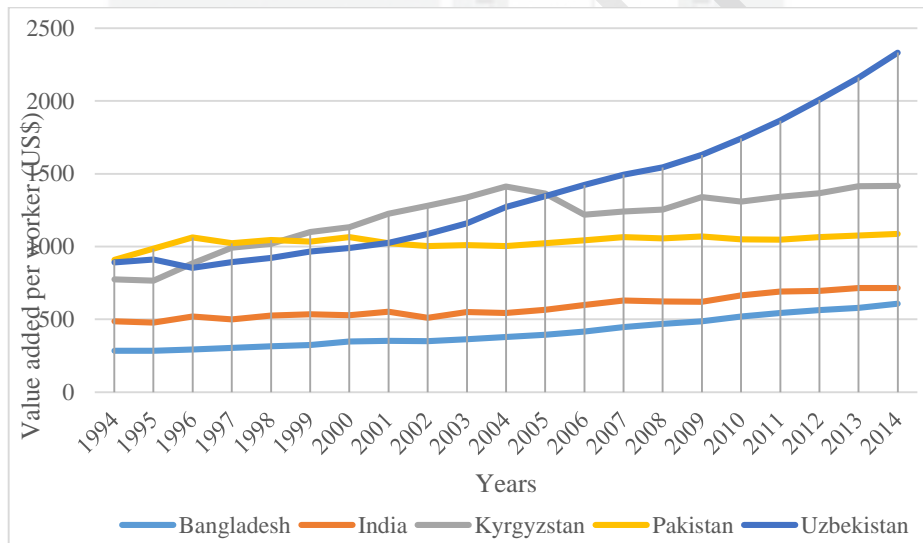
### **1.4.1 Infrastructure and Productivity**

Infrastructure influences productivity by lessening transaction costs, reducing distance and time to transport goods, encouraging the stream of information and encouraging integrative strategies about businesses under worldwide esteem chains. Physical and digital infrastructures give access to basic services including safe drinking water, health, sanitation and education. In this way, infrastructure helps to improve the health and skills of the workforce, which contributes to higher productivity. Provision of information through ICT has profound impact on productivity because communication can be done in a more cost effective manner (Franklin, Stam and Clayton, 2009; Brynjolfsson, Hitt and Kim., 2011).

Agriculture infrastructure has three branches (Wharton, 1967 and Lipton, 1987): capital intensive, capital extensive and institutional. Capital intensive infrastructure includes irrigation systems, road networks, agricultural machinery and utilities such as electricity, power and potable water. Capital extensive infrastructure has a minimum physical capital component and includes services like extension education, agriculture research, credit and financial institutions, health and education facilities (Wharton, 1967). Institutional infrastructure consists of institutions that are responsible for political stability, protection of property rights, contracts and safety such as judiciary and land record divisions.

Agricultural productivity can improve with better infrastructure (Pritchett, 2000; Canning and Pedroni, 2008; Manalili and Gonzales, 2009; Khandker and Koolwal, 2010). Basically, infrastructure acts as an essential input that can contribute positively to productivity (Aschour, 1989). Better access to roads in villages reduces fertiliser costs by 14%, and wages and output increased by 12% and 32% respectively in Asia (World Bank, 2008) Agricultural research and extension is the primary factor increasing agricultural productivity and ensuring food security among all types of agricultural infrastructure expenditures (Rosegrant and Evenson, 1992; Byerlee, 1994; Thorat and Fan, 2007). In addition, social interaction through ICT and transport infrastructure helps creativity, innovation and results in enhanced productivity.

In developing countries, there is resource deterioration and when combined with an increasing trend in population growth, limited opportunities are available for the extension of cultivated land (Murgai, Ali and Byerlee, 2000). Pakistan has very low agricultural productivity and is ranked at 103<sup>rd</sup> out of 144 countries (WDI, 2016). Moreover, with the rising gap among potential and national average yield (GoP, 2012), productivity enhancement is imperative to face the future challenge of food insecurity. Pakistan's agricultural productivity is shown in Figure 1.5. It can be observed that productivity has remained stagnant over the past 20 years signifying lack of improvements in infrastructure and productivity of other inputs such as machinery, labor, and land. Although the agricultural productivity is higher than South Asian countries such as Bangladesh and India, it is lower than other agro based Central Asian economies of Kyrgyzstan and Uzbekistan. Since agriculture sector is the major sector contributing to employment and food provision, it is imperative to seek ways to enhance the stagnant level of productivity so that population growth and the associated rising demand for food can be addressed.

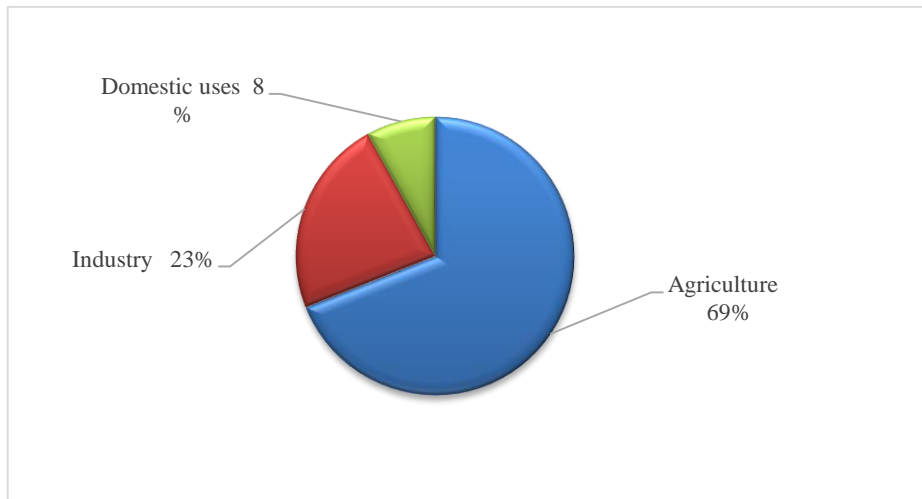


**Figure 1.5 : Agricultural Productivity of Pakistan and other Selected Agro-Based Economies**

(Source: World Development Indicators, 2016)

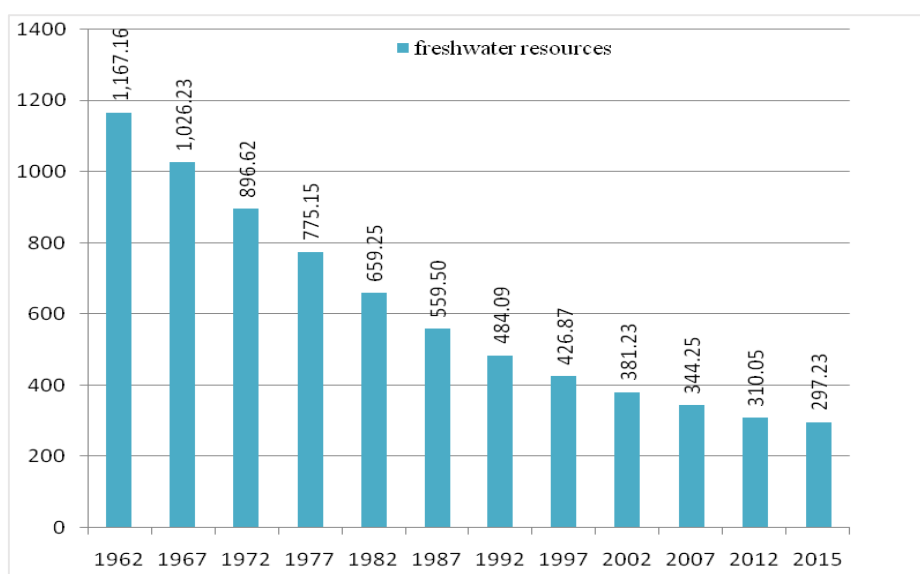
A prominent issue relating to lack of capital intensive infrastructure in Pakistan is water availability. It is decreasing over time due to a continuous increase in its demand from a rising population. Pakistan has the world's largest bordering irrigation system named the Indus Basin covering approximately 35 million acres. It consists of three large dams named Tarbela, Mangla and Chashma, 23 barrages, 12 inter rivers links and 45 canals extending to 60,800 km serving 140,000 farmer-driving waterways. Ground water pumped about 42 MAF through more than 921,229 tube wells to supplement channel

supplies. The consumption pattern of water in domestic, industrial and agriculture sector is shown in Figure 1.6.



**Figure 1.6 : Uses of Water (percentage of total use)**  
(Source: World Development Indicators, 2016)

Due to high withdrawal, underground water stores are exhausting quickly and surface water is subjected to contamination and metropolitan releases. In urban areas, there is progressively scarce and low quality water supply. Spillages in water passage systems cause 35% to 40% of water supplies to be lost. Sewage is gathered through open depletes in many urban communities, and is allowed to be released untreated into streams, lakes, waterways, and channels. Uncollected trash gathers in the avenue and in empty spaces among houses, from where foragers collect the recyclable and reusable materials and leave the rest to rot. As indicated in Figure 1.7, renewable internal freshwater resources per capita are decreasing rapidly over time.

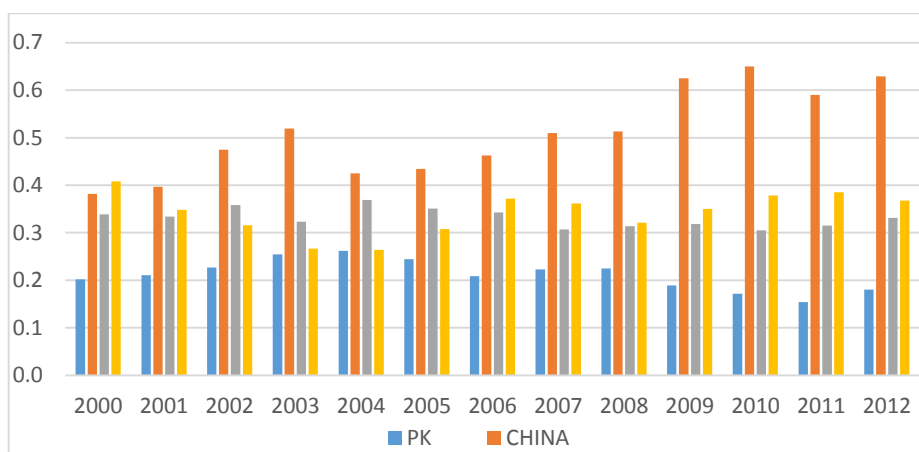


**Figure 1.7 : Pakistan's Renewable internal freshwater resources per capita (cubic meters)**

(Source: World Development Indicators, 2016)

Investment of the public sector in water resource management is as low as 0.25% of GDP. Physical infrastructure quality is declining with highly inequitable distribution which is why poor pay and high costs to water merchants leaves them feeling denied and burdened. Water and sanitation facilities are 85% and 65% in urban areas, respectively, whereas in rural areas, water access is much lower. Pakistan will begin in the near future the China Pakistan Economic Corridor (CPEC), which is a route that will be used for transporting goods from China to Pakistan and vice versa. Although CPEC has financial and economic benefits, the problem is that the path is not connected well to the rural areas and districts adjoining the CPEC route. The road infrastructure along the local districts of the route is highly inadequate, restricting the potential benefits of CPEC (Nawaz and Iqbal, 2016). Since the human capital and business environment is generally low in Pakistan and specifically dismal in these adjoining districts, the foreign direct investment for this route will be low, leading to further dip in profitability.

Within capital extensive infrastructure, science and technology enhance productivity, international integration and contribute to food security as proven in Asia through the Green Revolution in agriculture since the 1970s. Agricultural research and development (R&D) during 2000–2012 shows sluggish growth in Pakistan as indicated in Figure 1.8 as compared to other neighboring countries, such as China, India and Bangladesh. The expenditure in agricultural research and development is significantly lower in Pakistan, which is a cause of concern where almost half of the labor force occupies this sector. This indicates a weak capital extensive infrastructure in Pakistan



**Figure 1.8 : Total Agricultural Research and Development Expenditures (as % of agriculture GDP)**

(Source: International Food Policy Research Institute (IFPRI), 2016)

Institutional infrastructure of a country provides the basis to carry on different activities and motivations for financial managers. If institutional infrastructure is adequate, productive struggles are rewarded to initiators and thus evade deviation. Political stability, quality of government and social infrastructure are the most important factors defining institutional infrastructure and significantly influence productivity (Cherchye and Moesen, 2004). If institutions are strong and working properly, then appropriate amounts of offices controlling law and order have been built across the country. It also reflects presence of optimal amount of police stations, courts, and local government bodies with necessary infrastructure such as phones and security cameras enabling them to work effectively. Pakistan is facing internal political unrest and a deteriorating law and order situation for a long time now. Due to political and economic instability, currency has depreciated by 40% since 2007 (UNDP, 2011) leading to inflation. Such political unrest also signifies that institutional infrastructure comprising of local government offices, courts, and police stations are not working at optimal levels or is in need of strengthening. Thus, government needs to introduce policies and institutional reforms conducive to establishing an enabling environment and boosting investment in cotton and textile, livestock, poultry, fisheries, and the related value added production services such as skill development.

Pakistan has obtained an average annual growth of 4% in agriculture sector from 1970 to 2010. Although this growth was due to progress in technology along with agricultural-based investment in physical infrastructure, extension and agricultural research (Ali, 2005), higher investment needs to be done in the capital intensive, capital extensive and institutional infrastructures. Investment in research and development for agricultural and extension have high rates of returns specifically in Asian and Pacific regions (Wesley and Faminow, 2014). There is need for persistent innovation achievements. Because a



significant time lag is involved between the period of investing in research activities and reaping their benefits, long term commitment and funding are needed (Stads, 2013).

#### **1.4.2 Infrastructure and Agricultural Export**

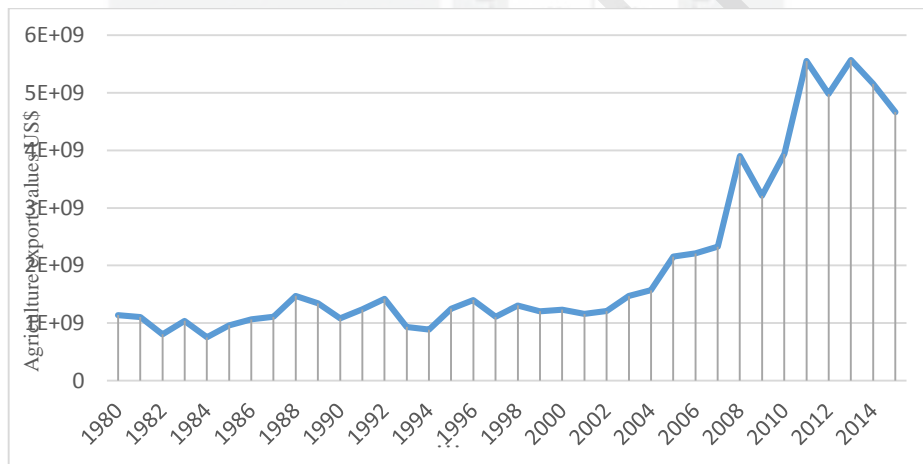
Trade makes use of various types of infrastructure such as transportation network, vehicles, ports and warehouses, storage and handling services, and information and communication technology (United Nation Economic and Social Commission for Asia and Pacific, (UNESCAP), 2011). According to Ismail and Mahyideen (2015), a 10% increase in paved roads, 10% increase in the number of fixed phone subscribers (for both exporters and importers), and a 10% increase in internet facilities raise economic growth by 5%, 2.6% and 2.2%, respectively. An inefficient logistics sector and insufficient transportation infrastructure can severely impede competitiveness of developing countries (Asian Development Bank (ADB, 2009). Anderson and van Wincoop (2004) evaluated that distribution costs of the products within the country can be twice as much as the international transportation costs due to poor domestic infrastructure. In order to access international markets, the most important impediment is poor domestic transportation infrastructure in developing countries (Cosar and Demir, 2014). Therefore, for sustainable growth, a favourable investment environment is an important element and is heavily dependent upon efficient and affordable infrastructure. In developing countries, due to higher trade costs, both hard and soft infrastructure should be facilitated for increasing competitiveness and reducing costs.

Agricultural trade is heavily dependent on better-connected villages, cities and countries worldwide. Often trade is assumed to take place among the countries based on their comparative and competitive advantages. However, in the case of the agriculture sector, trade is a means to meet the goals of food security and attaining price stability (Chand and Saxena, 2014). Because agricultural products are perishable, infrastructural facilities such as transportation and storage play a very important role. According to International Finance Corporation (IFC, 2011), due to poor transportation and storage facilities, a developing country can bear losses up to US\$ 13 billion in agriculture trade. The physical infrastructures such as airports, shipping ports, road networks, and electrification should be adequate and above the benchmark so that the agricultural exports can be transported worldwide in an efficient and cost-effective manner.

Pakistan's major agricultural and related exports are rice, citrus, mangoes, furniture, cotton fibre, clothing, textiles, sports goods, leather goods, rugs, carpets, chicken, livestock meat, wheat, powdered milk, seafood and fisheries (GoP, 2014). They made up 17% of total exports in 2015. Worldwide, Pakistan's agricultural outlook is fairly decent in spite of many weaknesses in structure. Pakistan ranks among the top eight as far as production of agriculture commodities is concerned in the countries ranking for global agricultural production (FAOSTAT, 2016). Pakistan is at the second position in production of buffalo milk, indigenous buffalo meat and oilseed, third for cottonseed and chilies, fourth for pulses, mango, cotton lint, goat milk, goat meat, tubers and roots, fifth for chick peas and spices production, sixth for sugarcane, wheat, spinach, apricots, dates

and okra, seventh for broccoli and cauliflowers, eighth for mandarins, tangerines, tobacco, onions and fresh tropical fruits; eleventh in wools and pistachios, thirteenth for rice, fourteenth in peas and bird eggs and fifteenth in lentils (GoP, 2015).

Figure 1.9 shows that the agricultural exports in Pakistan increased after 2006 as a result of the Free Trade Agreement signed between China and Pakistan that lead to an increased share of China's in total exports from 4% to 10% in upcoming years (National Tariff Commission (NTC), 2015). However, it is hovering around at the same level since 2011 and is relatively declining after 2013-14. Pakistan is facing major problems of energy shortage, weak infrastructure and higher cost of establishing businesses whereby its ranking deteriorated to 128<sup>th</sup> on the Ease of Doing Business Index of the World Bank, which was 96 in 2011. In Pakistan, the road network from farm to market is not of superior quality while rail network is insufficient and inefficient due to poor planning and management.



**Figure 1.9 : Pakistan Agricultural Exports (US\$)**  
(Source: World Trade Organization, 2016)

Competitiveness is defined in terms of institutions and elements that stabilize the level of productivity in the economy. According to Global Competitive Index (GCI) (2015) report, Pakistan is ranked at 122 out of 138 economies with a score of 3.49, which is among the bottom 20 nations. Although Pakistan is at the bottom amongst the South Asian economies according to GCI (2015), it can improve if supportive new infrastructure facilities are provided and existing resources are used efficiently. This has the potential to attract investment in the agricultural sector which can ultimately promote exports.



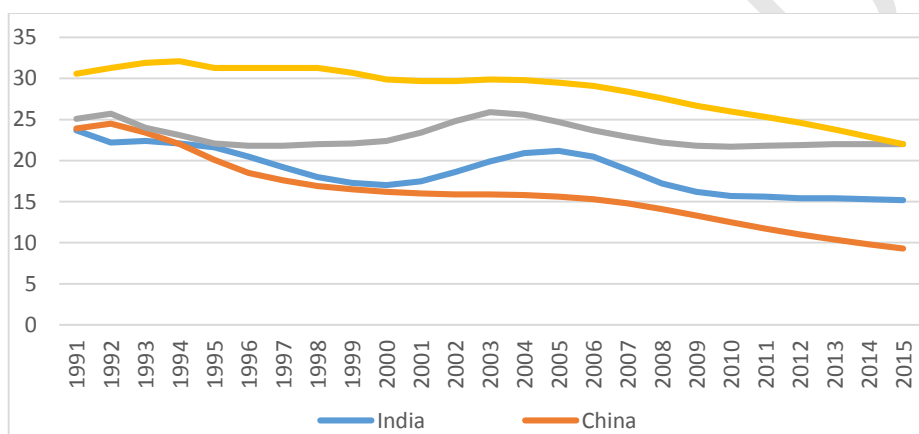
Pakistan needs substantial investment in physical infrastructure to progress delivery services and to improve its internal and international competitiveness. In Pakistan, private sector invested in energy and telecommunications sectors in recent years. However, much more infrastructure investment is required in sectors such as energy, roads, transportation & logistics, and water (Ahmed, Abbas, Ahmed and Zeshan, 2013). Physical infrastructure and logistics (such as roads, railways, and air and sea cargo), information technology (access to phone services, and internet) and energy (electrification) infrastructure contribute to enhance agricultural trade by reducing transaction and information costs.

### **1.4.3 Infrastructure and Food Security**

Food security as a concept surfaced in the mid-1970s due to world food crises (Clay, 2002). FAO defines food security as the physical, social and economic access of sufficient, safe and nutritious food to all people, at all times that meets the food preferences and dietary needs for an active and healthy life. It involves four key elements: accessibility, utilisation, availability and stability. The first element is of food accessibility, which reflects the accessibility of food across the country. If the transport infrastructure such as road and railway networks are of adequate quality connecting the various regions of the country, then food can be transported and therefore accessed more easily. In Pakistan, food production is high but due to poor infrastructure, it cannot be transported to remote areas, which raises concerns regarding food security in such regions. Therefore, an appropriate transport infrastructure is needed to secure food. The second element of food security is of food utilisation, which is determined by the ability of the people to absorb food nutrients. Infrastructure plays a crucial role in increasing food utilisation as the construction and provision of basic facilities such as access to safe drinking water supplies, adequate sanitation and healthcare centres would improve the general health of the population, thereby improving their abilities to absorb food. This increases food utilisation and ultimately strengthens food security. In Pakistan, food is not accessible at all times, especially in remote regions and the inadequate complementary amenities such as sanitation or drinking water in such areas lowers the absorption of available food leading to higher insecurity of food. The third element of food security is food availability, which is determined by the domestic production of food and amount of food imports. The last element is of food stability, which ensures that food is available and accessible to people at all times.

Pakistan, being an agricultural-based economy, has reasonable cereal, fruits and livestock production but availability at the local level does not ensure that the population is food secure. Pakistan's major production in agriculture is comprised of livestock, cotton, sugarcane and wheat (FAOSTAT, 2016). The statistics in FAO (2016) explain that in terms of food security, Pakistan needs to improve the provision and distribution of food before food insecurity becomes a significant threat. The proportion of undernourished people is 22%, which is higher than India, Mongolia and Kenya who are also categorized as states needing improvement in food provision. Cereal-surplus countries have more undernourished population than cereal-shortage countries. Pakistan has only 27% of the population who have an acceptable food consumption score. In

caloric intake, 58.4% of population are food insecure in total, 32% are deprived from minimum caloric requirement and 14% are at the borderline (Food Security Analysis (FSA), 2013). Therefore, it can be deduced that even though Pakistan produces decent amounts of food, the amount of undernourished people remains a prominent hazard, reflecting that besides increasing food production, Pakistan should also improve the food distribution. Lack of roads, rails and other infrastructure such as safe drinking water, basic health facilities and education are the vital factors that affect food consumption patterns of people. Better roads and railways can improve the food distribution. Access to safe drinking water and healthcare centres can improve the food absorption that can curb food insecurity concerns.



**Figure 1.10 : Undernourished population (percentage of total population)**  
(Source: World Development Indicators, 2016)

As clearly shown from Figure 1.10, the situation of an undernourished population has not improved enough since 1991-92 in Pakistan, although some periods of minor improvement were there. However, with a 22% prevalence of undernourishment out of the total population in 2015, Sri Lanka has succeeded at reducing undernourishment from 31% in 1991 to 22% in 2015. During the same period, China and India successfully reduced undernourishment from around 25% to 9.3% and 15%, respectively. In terms of agricultural productivity, Pakistan beats India and China but the latter countries are not only producing more food, they are also distributing it evenly among the population making food availability and access easier and efficient. In Pakistan, food price inflation is 18% (GoP, 2015), which makes the food access for poor population very difficult.

Looking at the overall food security situation globally, it is seen that most of the food consumed is grown locally. Production is not enough to meet the demands for balancing intake. Therefore, food import is needed to fill the gap. But the fact remains that distribution of commodities is uneven across the regions. Global production per capita was more than required production per capita to feed world population but even then food remained unavailable for 870 million people during 2010 to 2012. About 1.3 billion

tons of food was wasted in 2009 globally at different stages of the food business system. Most of it is wasted at the consumption, production, storage and handling stages. Out of total world hunger population, about 39% live in South Asia and Sub-Saharan Africa (Hunger Notes, 2016). So there is need to address the issue for each individual economy of the region to overcome the food insecurity situation.

Studies have shown how road infrastructure has direct effect on the availability and accessibility of food. For example, variations of transportation cost ultimately affect food prices, thus limiting access to food (Minten and Kyle, 1999; Blimpo, Harding and Wantchekon, 2013). Infrastructures such as road and railway networks strengthen food security by making provision and distribution of food easy and cost effective. Food absorption or utilisation increases with improving quality of drinking water and sanitation. Securing the lines to food access through road infrastructure, improving food production index and food imports is important to ensure food security. It is important to address the issues regarding food security in Pakistan and there is urgent need of required infrastructure facilities to be provided. This study is an effort to analyse how infrastructure contributes to food security in Pakistan.

## **1.5 Problem Statement**

The appropriate investment in infrastructure form the backbone of a country's economy. In an agricultural based economy such as Pakistan, the inappropriate investment for infrastructure weakens agriculture sector badly through effect on the agricultural productivity, trade and food security. This negative balance is directly related to the low socio economic status of the population.

In Pakistan, ill-maintained irrigation, transportation, energy, and health infrastructure pertains to low agricultural productivity. Other factors are lack of scientific knowledge and finance. Moreover, Pakistan's weak institutional infrastructure is reflected through unstable political system, unsatisfactory law and order situation and a weaker judicial forum, which has direct impact on the life of a commoner, hence affecting productivity.

Slow moving transportation systems of roads, railways, shipping and non-provision of air cargo; improper communication and power systems; also lead to lower agricultural exports. The ever-rising price of petroleum and electricity (which faces unscheduled interruptions in supply) also constitutes important factors other than transportation and ICT infrastructure, to hinder the agricultural productivity and trade

Lack of excess to the international commercial markets, improper storage, inadequate handling and custom delay, further deteriorate the already low agricultural productivity and exports. The primary effects of low agriculture productivity and less efficient trade refrains the growers from their right of proper paybacks. This also supports inflation and food insecurity, which is the cause of under nourishment. Fewer facilities of safe

drinking water, improper sanitation and dearth in health facilities directly speaks of low productivity and food insecurity.

In contrast, sufficient and well thought out investment in infrastructure improves overall efficiency and encourages the growth of private enterprises, thereby reducing inflation. Manalili and Gonzales (2009) state that adequate capital-intensive infrastructure increases farm productivity. Furthermore, investment in agricultural research and extension services should be a top priority for a highly productive agricultural system (Global Hunger Index (GHI), 2016). An efficient transport system reduces the transaction and distribution costs for farmers, resulting in increased output, profit, and a more cost-effective route to export markets. Investment in other types of infrastructure also affects the agricultural sector. For example, institutional infrastructure helps to maintain political stability, law and order and a strong judicial system, which reduces corruption and promotes stability. ICT infrastructure increases export levels by improving communication, logistics, and access to information regarding innovations in seed strains, machinery and crop diversification. Finally, investment in energy infrastructure allows for better storage and distribution of perishable products like fruits and vegetables.

A significant hindrance to Pakistan's economy is that 4% to 6% of GDP is lost per year due to inefficient transportation infrastructure. Maintaining the agricultural food production has become a challenge for rapidly increasing population in adverse climate conditions. Only 41 districts produce for 190 million population of Pakistan. As roads are inaccessible to 34% of the population, research, information and technology, and extension services do not reach to population at large. The failure to commercialise and modernise agricultural practices and infrastructure is one of the primary reasons why the country suffers from food shortages, acute malnutrition, and why production is lower than in other countries. Whereas, agricultural sector development is reliant on timely and widespread delivery to the deficient regions nationally as well as globally. These concerns to the availability and security of food for larger populations and incentive to agriculturists for quality output. By investing in different aspects of infrastructural development, these problems could be resolved more efficiently.

To increase productivity, exports and food security, Pakistan must address its infrastructural shortcomings. Currently, enough resources are not being allocated to improve the infrastructure and lives of the 62% of rural people. The improvements in infrastructure benefit agricultural production, its distribution and food security. Moreover, it generates employment and benefit the broader economy. Increasing agricultural productivity lowers the cost per unit and enables producers to compete more effectively on the world market. Consumers also stand to benefit from increased choice, abundance, and reduced prices for output. To mitigate the issues under consideration, there is a need to explore the role of infrastructure for enhancing agricultural productivity, export volume and food security.

## **1.6 Research Questions**

This study is an attempt to address the following research questions based on the problem statement:

- What are the effects of infrastructure on agricultural productivity? What type of agricultural infrastructure has the most significant impact?
- What is the role of infrastructure to affect agricultural export?
- What is the impact of infrastructure on food security?

## **1.7 Objectives of the Study**

The general objective of the study is to empirically analyse the impact of various types of infrastructure on agricultural productivity, agricultural export and food security in Pakistan for the period from 1980 to 2015. The specific objectives of the study are:

- To investigate the effect of infrastructure on agricultural productivity.
- To examine the role of infrastructure on agricultural export.
- To identify the effect of infrastructure on food security.

## **1.8 Significance of the Study**

The study contributes to the existing literature by presenting specific policy recommendations on how better infrastructure could improve agricultural productivity, exports and food security in Pakistan. Previous work examines specific factors like fertiliser or human capital or only focuses on one region. However, this study looks at the modernisation of infrastructure on a national scale rather than a regional one. In contrast to most other studies, it also uses agricultural output per unit of labour to define agricultural productivity.

The second objective investigates the impact of physical infrastructure, ICT and energy on agricultural exports from Pakistan. Some studies examine the competitiveness of agricultural exports, or how physical infrastructure and energy affect overall exports. This study contributes to the existing research by investigating the impact of transport infrastructure, ICT, and energy on total agricultural exports from Pakistan by employing a gravity model which is deficient in previous research work done.

As far as the impact of infrastructure on food security is concerned, existing studies look at the causes and consequences of low food security rather than examining the effects of infrastructure (Khan and Gill, 2009). Similarly, many current studies are only focused



on one province (Bashir, Schilizzia and Pandit, 2012 and Bashir and Schilizzi, 2015). This study differs by examining the impact of physical, healthcare, water, and sanitation infrastructure on food security in the whole of Pakistan. The study hypothesizes that improved infrastructure leads to a more cost-effective distribution of food, which is vital in addressing food security concerns.

This study is important because it can assist with policy-making and provides evidence that investing in infrastructure can alleviate poverty and malnutrition. Also, infrastructure reduces transportation and transaction costs leading to higher outputs and higher agricultural productivity. Better ports, air and railways networks, ICT facilities and energy supplies would increase the volume of agricultural exports and provide numerous other economic benefits due to improvements in efficiency. Furthermore, better infrastructure would improve food security by boosting agricultural output and making transportation more cost-effective. It is important to stress that the benefits reaped from improvements in infrastructure will have a trickle-down effect on the economy; and result in lower inflation rates, lower levels of poverty, and higher exports of manufactured goods that use agricultural products as primary inputs. This effect will no doubt improve the economy of Pakistan and the lives of its citizens, which is why policymakers involved in infrastructure projects should consider the recommendations in this study.

## **1.9 Organization of the Study**

The study is organized into six chapters. Chapter one discusses the research background, issues and challenges, problem statement, research objectives and significance of the study. The second chapter gives a brief description of infrastructure situation in Pakistan. Chapter three reviews the literature related to contribution of infrastructure to productivity, trade and food security in the economy. Chapter four describes the research methodology used to achieve the research objectives. Chapter five focusses on results and provides related discussion to identify if the objectives are achieved. The final chapter presents summary, conclusion and policy implications. It also provides recommendations for government and concerned agencies to consider while developing future infrastructure in Pakistan.

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