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# Role of Infrastructure in Agriculture Development in Developing Economies: A Systematic Literature Review

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**Abstract**

Infrastructure and agriculture development owes a significant relationship. In line with this reality, the paper reviews the literature on subject on basis of type of the infrastructure involved like the economic, social, physical transportation, institutional, market, export and financial basis. The other categorization focused on the regional categorization like the state of Jammu and Kashmir, North Indian states, Pan Indian studies, Asian studies, African studies, Brazil and South American studies and SAARC nations based studies. Similarly with regard to reasons behind uneven development of infrastructure and agricultural growth, aspects were classified as 'extent of political instability', 'epidemics', 'extent of peace', 'extent of local politics and power centers', possible 'lack of intent to bring social and technological change' and evident 'lack of knowledge dissemination mechanisms'. The studies placed under infrastructure type reflected on the possible role of diverse infrastructure in shaping agriculture production. The research concludes that across diverse perspectives infrastructure is indeed shaping agriculture development directly or laterally.

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**Keywords**: Agriculture, Infrastructure development, Economic infrastructure, Physical Infrastructure, Uneven growth.

## 1.1 The Significance of Infrastructure in Agriculture Development

Infrastructure (Kessides, 1996) comprises the long lived structures, equipment and facilities that are vital for economic production and for mobility by households. Economic infrastructure (Willoughby, 2002) has been observed to comprise the public utilities like the telecommunications, electric power, gas, water supply, waste water disposal, public works (Binswanger, 1993) like the irrigation mechanisms, roads and transport systems like railways, urban transport, ports, airports and waterways. Infrastructure availability and regional economic development have been observed as possessing a direct and lateral relationship. The infrastructure has been reported to affect the production and consumption directly in manifold ways and means. The character and accessibility of local infrastructure influences the marginal productivity of private capital being invested, casts structural impacts on supply and demand, reduces overall cost of production, ensures factor mobility as well as ensures changes in quality of life of incumbents(agriculturists in this case). The infrastructure (Binswanger, 1993) has been globally observed as shaping the prospects for rate and manner of factor utilization. Especially in context of agriculture, the studies have been unanimous in pointing out towards the reported increase in productivity of other factors of production (labor and capital). Infrastructure and its presence (Edeme, 2020) contribute to agricultural and economic development by means of increasing the productivity of factors under consideration and provide the essential amenities that enhance the overall quality of life of the people under focus. Institutional infrastructure (Kurniasih, 2020) like access to market and institutionalized credit has a reported history of promoting and deepening the agriculture and growth relationship altogether. Physical

infrastructure (Komarova, 2014) has been observed to enhance mobility as well as movement of other factors of production as regarded as vital in agriculture and horticulture. Infrastructure (Senyolo, 2009) is viewed as essential for sustainable socio-economic development and host of studies (Llanto, 2012) regard the critical role of infrastructure in enhancing and deepening the prospects for agricultural productivity in developing economies. Rural infrastructure (Osulale, 2015) along with agricultural infrastructure in particular has been observed as raising the current levels of agricultural productivity, inducing the growth across rural households, bringing about changes in agricultural wages and improvements in general conditions of life for non-farm labor as well.

### 1.2 Reflections on Relationship

The literary studies (Andersen, 2006) on subject matter elucidates the relationship as being governed by extent of uniform availability and incumbent's access to set of public works that are generally in public sector rather in private sector. Infrastructure development (Andriushchenko, 2019) in agricultural perspective often demands a long lasting commitment to agriculture production, marketing, nutrition management, environment conservation and food safety contexts across entire value chain. The agricultural infrastructure development (Asher, 2020) often reflect well in developing economies as involving the economic infrastructure, social infrastructure, financial infrastructure, institutional infrastructure, technological infrastructure and food security mechanisms.

### 1.3 Understanding the Term

The term 'infrastructure' (Senyolo, 2009) seems to imbibe multiple meanings in view of the collective utility across agriculture value chains and reach to the outputs markets in agriculture. In rural perspective, economic and agricultural infrastructure has been viewed as influencing the rural economic outcomes. The possible implications (Villanyi, 2008) could be evident in form of significant increase in agriculturist's ability to utilize the local factors of production. The other implication could be evident in form of increased mobility of factors of production leading to sustained and consistent flow of resources to rural and agricultural lands. Such an impact could lead to critical increase in ability of the agriculture economy to perform well and integrate well with geographical flows and outbound product chains. The possible impact (Shadfar, 2013) is with regard to intensity of resource utilization at local rural level. This has been witnessed as being tremendously increased in aftermath of availability of connecting and enabling infrastructure. The other possible implication (Labintan, 2012) could be in form of gradual increase (Jari, 2009) in local derived demand and development of economic exchanges and social exchanges. The resultant economic stimulus and local level flow of resources have been observed as obvious outcomes of presence of agricultural infrastructure. Agricultural infrastructure in nutshell has been regarded as essential in developing and sustaining the competitive advantage (Fernandes, 2008) across the value chain. The research gaps exist with regard to indices or the aspects being considered for mapping or quantifying the infrastructure parameters. Despite the clarity with regard to broad classification of economic and social infrastructure, the convergence is missing. In line with this research gap, the parameters considered for economic infrastructure as well as social and physical infrastructure also seem to vary considerably. A sizable studies on Indian context focus more on road and railways connectivity along with postal connectivity as vital yet studies from Asian and African perspective regards port and airport infrastructure as part of assessment. In similar aspect the significant research gap seem to persist with regard to determinants of social infrastructure, agricultural credit and institutional infrastructure indices. Thus the core purpose of this research is to reflect on the comprehensive literature review and lead to meta-analysis on infrastructure determinants as shaping agricultural production. The paper is hence organized as exploring the literature across 59 seminal papers on

subject matter, exploring the theories and the analysis methodologies been used to figure out the different approaches being undertaken to ascertain the factor operationalization differences and construct work out.

### 1.4 Literature Search and Review Method

The research relied on usage of 'key words' to figure out the related studies on the topic across Scopus database. The study delved on key words 'Infrastructure', 'Agriculture', 'Factors shaping agricultural outcomes', 'India', 'Jammu and Kashmir', 'Productivity'. The 59 studies were observed as complying to diverse aspects and were classified on the basis as explained below.

### 1.5 Literature Review: "Infrastructure" in Agriculture Development

The phenomenon of theorizing the linkages between infrastructure and agriculture growth is rather complex and challenging. Infrastructure is in itself a multi-dimensional factor and studies (Berdegue, 2001) on agriculture development indicators often regard the subject matter as heterogeneous and socially constructed in nature and scope. Infrastructure based literary studies (Prudhomme, 2004) emphasize the instrumental support extended by backbone structure as critical towards the factor utilization, factor mobility and efficiency in factor utilization rates. The discourses on 'development' essentially focus on infrastructural linkages and support as central to discussions and reflections on agriculture and related growth and productivity debates. The infrastructure (Peck, 1996) in theoretical terms refers to those basic facilities that form the collective and integrative basis of overall economic activity in a region. Infrastructure (Biehl, 1991) is often interpreted as collective in nature as these structures and facilities are leveraged by a variety of users for a wider span of economic activities and factor usage purposes. Infrastructure (Spence, 1992) is likewise regarded as integrative in nature as this involves the provision of all necessary means that ensure consistent and regular interaction across the economic agents and factors for the conduct of economic activities. Infrastructure is integrative in the sense that it ensures regular interaction across economic activities. Infrastructure has long been interpreted as public and non-substitutable input for economic growth and sustenance. Infrastructure (Fakayode, 2008) in itself recognizes as the most indispensible aspect of agricultural progress as it supports economic activities, mobility, growth, reduces poverty and make the livelihoods sustainable. Studies seem to link infrastructure availability with increase in efficiency of production and contribution to overall standard of living. Agriculture infrastructure indicators have been widely viewed as comprising the elements of irrigation and public access to water, transportation, storage services, commercial infrastructure, processing infrastructure, public services (Amir, 2020), agricultural research and extension services, communication and information services (Tanner, 2008), land conversion services (Koshti, 2013), credit and financial institutions (Goncalves, 2020), health and education services (Thippeswamy, 2013). Infrastructure has long been viewed as essential for the agriculture to materialize, for agriculture to allocate and mobilize the essential factors of production and for ensuring reach to outputs markets. A host of studies (Senyolo, 2009) seem to correlate infrastructure availability, accessibility, reliability and quality; with sustainable development of agriculture. The studies (Tanko, 2019) on agricultural infrastructural indicators underline the critical role of physical, information, mobility mechanisms as shaping the development prospects. The studies (Edeme, 2020) reflect on the manifold definitions and roles of infrastructure in shaping the agricultural production. Infrastructure is regarded as the backbone that shapes and enhances the rate of factor mobility, factor usage as well as factor based efficiency in agricultural perspective. Agriculture infrastructure and production (Komarova, 2014) have been observed as bearing a direct and lateral impact on the production prospects and economic development scenario for the concerned region. Infrastructure in agriculture development (Kurniasih, 2020) has long remained a matter of intense research and analysis. The review of

literature revealed that the studies on subject matter are equally significant yet needs to be classified and categorized as per utility and purpose in order to extract more weight age from them. The studies on subject were observed as divergent in nature and none of the reviewed literature wholly covered all the aspects as covered in the current research. For the purpose of convenience, the study categorized the existing literature on basis of type of the infrastructure involved like the economic, social, physical transportation, institutional, market, export and financial basis. The other categorization focused on the regional categorization like the state of Jammu and Kashmir, North Indian states, Pan Indian studies, Asian studies, African studies, Brazil and South American studies and SAARC nations based studies. Similarly with regard to reasons behind uneven development of infrastructure and agricultural growth, aspects were classified as 'extent of political instability', 'epidemics', 'extent of peace', 'extent of local politics and power centers', possible 'lack of intent to bring social and technological change' and evident 'lack of knowledge dissemination mechanisms'. The studies placed under infrastructure type reflected on the possible role of diverse infrastructure in shaping agriculture production; as illustrated below.

The rationale behind segregation of studies is to bring together the related studies under one head and enable easier understanding and interpretation of outcomes. The studies on economic infrastructure that is the ones which underline role of roads, connectivity, power, telecommunication, information exchanges, irrigation and inputs; were clubbed together. In similar manner studies on social infrastructure that is education and healthcare, studies on credit and financial infrastructure, market infrastructure, institutional infrastructure and export infrastructure; were placed under one head. In similar manner, geographical focus of research was considered as classification aspect. Studies were segregated on basis of Jammu and Kashmir state perspective, North Indian basis, Pan Indian perspective, Asian context, SAARC perspective and African as well as South American contexts; as illustrated below in the table.

The studies on subject also explored the reason that is ailing the regular development of infrastructure in the concerned region. The uneven growth of agricultural infrastructure along with the lopsided development of infrastructure and linkages in region is not the outcome of one single aspect yet involves multiple aspects that have led to current chaos and uneven growth patterns. The studies on subject were hence classified on basis of 'extent of political instability', 'epidemics', 'extent of peace', 'extent of local politics and power centers', possible 'lack of intent to bring social and technological change' and evident 'lack of knowledge dissemination mechanisms'.

**Different Themes Shaping Agricultural Production**

| Infrastructure Type/Influences/Usage | Studies Conducted |
|---|---|
| Economic Infrastructure | (Goel, 2003), (Fosu, 1995), (Josling, 2004), (Brooks, 2010), (Llanto, 2012), |
| Social Infrastructure | (Snieska, 2009), (Andersen, 2006) |
| Credit and Financial Infrastructure | (Edeme, 2020), (Binswanger, 1993) |
| Physical Infrastructure | (Lee, 1999), (Edeme, 2020), (Lakshmanan, 2007) |
| Market Infrastructure | (Prudhomme, 2004), (Osulale, 2015) |
| Institutional Infrastructure | (Goncalves, 2020), (Tanner, 2008) |

| | |
|---|---|
| Export Infrastructure | (Villanyi, 2008), (Shadfar, 2013) |
| Jammu and Kashmir based studies | (Khan, 2018), (Taqi, 2017), (Acharya, 2016), (Raina, 2020), (Bhagat, 2002), (Manzoor, 2018), (Narain, 2005), (Sharma, 2018), (Bagal, 2018) |
| North India based studies | (Goel, 2003) |
| Pan India based studies | (Thippeswamy, 2013) |
| Asian nations based studies | (Amir, 2020) |
| African Studies | (Osulale, 2015), (Tanko, 2019), (Senyolo, 2009), (Jari, 2009), (Berdegue, 2001) |
| Brazilian and South American Studies | (Fernandes, 2008), (Willoughby, 2002) |
| SAARC nations based studies | (Andersen, 2006) |
| Political Instability | Leadership crises and lack of integration and coordination (Amdt, 2018), Political instability and conflicts and infrastructure development (Kimenyi, 2014),Political influences on agricultural systems (Archer, 2008) |
| Epidemics | (Bloom, 2001), (Burkle, 2020) |
| Peace | (Ahmed, 1988), (Cole, 2008), (Willoughby, 2002), (Smolijan, 2010), (Mousseau, 2000) |
| Local politics and power centers | Conservative approach to market institutions and intent to maintain status quo (Poulton, 2006),Politics of food and agriculture (Daugbjerg, 2012),Politics of land degradation (Andersson, 2011) |
| Lack of intent to bring social and technological change | Political economy of change (David, 2018),Democratization and change (Montenegrodewit, 2020) |
| Lack of knowledge dissemination mechanisms | Containing spread of knowledge and constraining local mobility (Vanloqueren, 2009),Sustainable development goals (Salvia, 2019), |

Source: Self Compiled from Review of Literature

### 1.6 Different Themes Shaping Agricultural Production

#### 1.6.1 Economic Infrastructure

Economic infrastructure as mentioned earlier, identifies as irrigation and public access to water, transportation, storage services, commercial infrastructure, processing infrastructure, public services, research and extension services, communication and information services (Tanner, 2008) (Amir, 2020). The literature portrays a critical role of economic infrastructure in boosting agriculture production (Binswanger, 1993). A host of studies seem to correlate infrastructure availability, accessibility, reliability and quality; with sustainable development of agriculture (Senyolo, 2009) (Kwon, 2000). The studies on relationship between economic infrastructure and agricultural sustenance enlist a positive relationship between the two.

**Proag (2020)** explored the linkages between economic and social aspects of infrastructure and scope for agricultural prospects in rural and backward areas. The study formed a longitudinal approach and examined the impacts over a considerable period of time and observed the multi-lateral incidence of the economic infrastructure on agriculture flows and stocks.

**Swaminathan (2018)** examined the factors that are collectively shaping the agriculture future. The study reflected on the prevalence of significant impact of economic infrastructure like the power, the telecom, irrigation systems and inputs markets as shaping the agricultural productivity.

### 1.6.2 Transportation and Physical Infrastructure

Transportation and physical infrastructure refers to the mechanisms, systems or support systems that facilitate the movement of goods and services and factors of production from one place to another (Shabani, 2018). Transport mechanisms especially the surface transport and roads connectivity constitutes the vital infrastructure for agriculture (Asher, 2020). Farmer's access to all weather paved roads network and feeder roads in turn leads to differentiation, farmer's contact with local change agents, access to inputs and outputs markets, technology awareness development and access to knowledge (Rada, 2020).

Studies on agricultural sustainability enlist the roads as essential to mobilize the natural capital (soil conservation, biological pest control, manuring, composting, water harvesting), social capital( cooperatives, social values, norms), physical capital ( machinery, precision agriculture methods, improved crop varieties, low dose spraying), financial capital (post-harvest technological opportunities, value added activities), human capital ( stocks of knowledge, skills, leadership, education, health) (Talukder, 2020).

**Edeme (2020)** reflected on the infrastructure development, sustainable agricultural output and employment in ECOWAS Countries and deduced the significant role of infrastructure mechanisms and structures in ensuring the economic prospects and poverty alleviation.

**Lakshmanan (2007)** reviewed the prevalence of the wider economic benefits ensuing from the transport infrastructure investments. The study observed economy wide cost reductions and output expansion on account of infrastructure penetration. The study noticed the persistence of forward and backward linkages of road and physical connectivity infrastructure in rural hinterlands.

### 1.6.3 Credit Infrastructure

The agricultural credit and agricultural infrastructure has widely been interpreted as crucial for agricultural sustenance and growth (Duval, 2003) (Binswanger, 1993) .Institutional credit mechanism for agriculture and their existence in rural periphery have been reported to cast a positive and constructive impact on consistency of farming and agriculture (Salvia, 2019) (Bnswanger, 1992). A host of studies correlate the farmer's access to low cost credit and agricultural knowledge as shaping the propensity to engage more consistently in agriculture (Thippeswamy, 2013) (Burgess, 2005) (Cole, 2008).

The studies collectively uphold the assumption that credit institutions and financial innovations at farmer's level are accommodating the farmer's ability to differentiate and pursue agriculture more aggressively (Shivamaggi, 1997) (Tang, 2010) (Anthony, 2010). The agricultural infrastructure especially the irrigation and public access to water, transportation, storage services, commercial infrastructure, processing infrastructure, public services, agricultural research and extension services, communication and information services, land conversion services;

seems to matter most while determining agricultural productivity (Andriushchenko, 2019) (Ahmad, 2011) (Labintan, 2012) (Kurniasih, 2020) (Tanner, 2008) (Villanyi, 2008) (Amir, 2020) (Tanner, 2008) (Koshti, 2013).

Institutional infrastructure like access to financial market's low cost innovations (Kisan Credit cards, Agriculture Insurance) and institutionalized credit has a reported history of promoting and deepening the agriculture and growth relationship altogether (Kurniasih, 2020) (Saqib, 2018).

### 1.6.4 Market, Institutional and Export Infrastructure

Access to local and global inputs and outputs market figures as most prominent aspect that shapes and defines the agricultural growth and its sustenance over a period of time (Jacoby, 1998) (Amdt, 2018).

There are host of studies that seem to relate farmer's access to market institutions as fostering a regime of prosperity, information exchanges and early technology adoption (Poulton, 2006). Studies even correlate access to market infrastructure as boosting the scope for change management with regard to farming practices (Dorward, 2003).

The access to markets has been observed as fostering mindset changes, overcoming earlier inertia to change and enabling the farmer to overcome information asymmetries (Abraham, 2020). The ICT infrastructure along with access to markets has been observed as facilitating information exchanges, technology reviews and adoption of more suitable farming practices that are market oriented in nature (Devaux, 2018). Market institutional infrastructure in agriculture comprises the institutional perspective of economic activities (Swinnen, 2013).

The social embeddedness of contract administration institutions, intellectual property rights safeguarding and knowledge dissemination with regards to market orientation in agriculture; seems to matter. Market based institutional infrastructure identifies as norms, institutions and predefined procedures; that determines the framework within which economic agents seek to operate and formulate their cooperation with others (Buhr, 2009).

Institutional infrastructure in agriculture has widely been interpreted as comprising the elements of intellectual property protection, legal contract management and enforcement and mechanisms for knowledge dissemination (Kapp, 2011). Export institutional infrastructure in agriculture constitutes the export linkages, the awareness and sensitization mechanisms and incentivized support for export (Akhter, 2019).

### 1.6.5 Studies on Jammu and Kashmir Perspective

The state perspective needs serious consideration as this constitutes the in depth analysis of the aspects that actually determine the regional and local contexts of the phenomenon as being experienced in state perspective. A study on land locked regional infrastructure observed infrastructure as a relational aspect comprising features of embeddedness, transparency, reach and linked with the community practices (Ziipao, 2018).

The studies across infrastructure in landlocked regions regard economic and market infrastructure as vital for the connectivity and absorption across national supply chains and value chains (Star, 1996). Infrastructure in land locked regions recognizes as built networks that facilitate flow of goods, people, ideas and allow for exchange for economic and social purposes (Larkin, 2013).

The character and accessibility of local infrastructure in land locked regions influences the marginal productivity of private capital being invested, casts structural impacts on supply and demand, reduces overall cost of production, ensures factor mobility as well as ensures changes in quality of life of incumbents.

### 1.6.6 Studies on National Perspective

National studies would enable the interpretation of the challenge of infrastructure up till pan Indian level. The consideration of national studies is vital to ensure the deepening of the understanding of the phenomenon cross contextual and contingent realities.

**Goel (2003)** analyzed the relationship across infrastructure and agricultural outcomes at national level. The research outcomes pointed out towards the reported increase in productivity of other factors of production (labor and capital). Infrastructure and its presence were observed to contribute to agricultural and economic development by means of increasing the productivity of factors under consideration and provide the essential amenities that enhance the overall quality of life of the people under focus.

**Thippeswamy(2013)** reflected on the aspects that lead to positive impact of infrastructure on national agricultural prospects. The infrastructure investments have been observed as essential in realization of economies of scale and scope in agricultural marketing and production aspect. The agriculture infrastructure stock has been observed as facilitating the local economies of scale and acting as local growth accelerator.

**Deshpande (1998)** reflected on the policy environment for the realization of gains from the infrastructure driven investments. The study elaborated on the aspects of infrastructure and types of infrastructure across national context. The study based outcomes correlated infrastructure availability, accessibility, reliability and quality; with sustainable development of agriculture. The study reflected tremendously on agricultural infrastructural indicators as underlining the critical role of physical, information, mobility mechanisms in shaping the regional and local development prospects.

### 1.6.7 Studies on Asian Perspectives

Asian perspective on infrastructure and agricultural growth summarizes the variations in leveraging the power of infrastructure across agricultural purposes and respective challenges. The Asian nations present a collection of diverse economies which are either developing or across least developing perspective. Such a rich diversity of economies and inherent infrastructure and agricultural challenges would offer opportunities to develop insights into the continent specific problems being faced vis a vis infrastructure and resultant agricultural growth. The Asian perspective includes the studies that bring tougher the challenges, the experiences and complexities of dealing with issues of infrastructure and agriculture in diverse conditions. The studies concentrate on exploration of diversities with regard to infrastructure as influencing agricultural growth.

The infrastructure availability in rural and agricultural perspective has been reported to enhance the regional value in terms of employability, factor utilization rates and in terms of productivity levels. The studies as presented here summarize the variations with regard to effect of infrastructure on agricultural growth realization.

**Timmer (2008)** explored the role of low prices in world markets for basic agricultural commodities on account of green revolution and examined the dimension of infrastructural support for countries. The study deduced that the small scale agriculture as a source of livelihood needs to be consistently supported with inter connecting infrastructure in order to retain and enhance competitiveness.

**Econg (2014)** analyzed the role of inter-sectoral spillovers and interactions across infrastructure and agricultural productivity across a longitudinal perspective. The study noticed the prevalence of inputs as shaping the productivity over larger periods of time and space. The study observed incidence of significant linkages across the infrastructure derived competitive advantages and sustainability of returns from agricultural indulgence.

**Rosegrant (2000)** examined the prospects for infrastructure as shaping the agriculture in growth in post reform period across nations of Bangladesh and Cambodia. The study deduced that growth remained reliant on infrastructure, extent of accessibility and scope for coordination and inter-connectivity across local and regional propositions.

**Edmonds (2008)** explored the role of infrastructure in local and regional development of agricultural trade and outcomes across Mekong river delta in Vietnam. The study observed that transport costs formed the basis for land use efficiency in region. The development of transport linkages paved the way for the farmer based adoption of intensive cropping patterns and focus on cultivation of non-rice based crops.

**Holst (2006)** advocated the role of infrastructure in fostering agricultural growth, structural differentiation and regional integration. The study approached the topic from three perspectives of Keynesian growth, Ricardian growth and neoclassical propositions.

**Ishangulyyev (2018)** observed that improvements in governance infrastructure as leading to substantial changes in infrastructure productivity and outcomes governance conditions and policy framework as critical towards realization of benefits from the installed infrastructure.

### 1.6.8 Studies on African and South American Perspectives

The studies on African and South American perspectives are essential as they present the contrast with regard to practices being followed with regard to infrastructure and agricultural development. The studies constitute the differences in approaches being undertaken to overcome the loopholes and challenges as evident with regard to infrastructure and agricultural sustenance.

The studies have been chosen from across diverse geographies in order to underline the form and scope of relationship that seem to exist across the agricultural infrastructure and respective agricultural growth prospects. The problems of agricultural infrastructure and growth requirement are not limited to Asia or India alone yet they constitute the challenge across African nations and South American economies as well.

The studies seem to reflect upon the intricacies of challenge of ensuring sustainable coordination and linkages across agricultural indicators and implications for agricultural produce.

The infrastructure has been reported to affect the production and consumption directly in manifold ways and means. The character and accessibility of local infrastructure influences the marginal productivity of private capital being invested, casts structural impacts on supply and demand, reduces overall cost of production, ensures factor mobility as well as ensures changes in quality of life of incumbents across world.

The regional perspective exploration entails the benefit of developing insights into the intricacies that are regional and national in nature and scope. The agricultural infrastructure development across Brazil and African nations often reflect well in least developing nations or across low developing economies; as involving the economic infrastructure, social infrastructure, financial infrastructure, institutional infrastructure, technological infrastructure and food security mechanisms for feeding the poor.

**Fernandes (2008)** reviewed the prospects of family farm sustainability in Southern Brazil with thrust on application of agricultural-environmental indicators. The study leveraged the factor analysis methodology and observed the incidence of infrastructural health, coordination and linkages as shaping the probability of better achievement of agricultural yields.

**Willoughby (2002)** introspected the relationship between the installed economic and physical infrastructure and pro-poor growth and reflected upon possible implications of for agricultural research. The study observed the incidence of livelihood sustainability and consistency as a natural outcome of the accessible and cost effective agricultural infrastructure in local perspective.

**Daugbjerg (2012)** explored the linkages across new politics of agriculture and food vis a vis the infrastructure usage and availability in a regional context. The study explored the basis for politics emerging from access to infrastructure and about quantum of investment in economic and social infrastructure from public expenditure. The study established the basis for extent of political sensitivity of matter and the possible measures for appropriate usage of constructed infrastructure in regional perspective.

### 1.6.9 Studies on Problems Leading to Uneven Infrastructure Development

The uneven growth of agricultural infrastructure along with the lopsided development of infrastructure and linkages in region is not the outcome of one single aspect yet involves multiple aspects that have led to current chaos and uneven growth patterns.

Agriculture infrastructure indicators have been observed as bearing inconsistency in wake of disruptions in form of political will power, lack of peace and relative reasons that effect timely and consistent implementation of public policies. There are host of studies that recognize the external threats as critical towards timely realization of benefits from installed infrastructure. The studies equivocally support that consistency in farmer's access to vital inputs, farmer's application of technologies for development, reduction of loses in agricultural practices, economic development, scope for improvement of infrastructures, agricultural mechanization, social improvement, market infrastructure access, land reform and yield management (Amdt, 2018).

The studies seem to relate the level of agricultural infrastructure with the peace and tranquility in the region concerned. In general, the infrastructure development (as illustrated in figure below) and investment across roads, irrigation and electricity, identifies as the area of intervention across peace bound and conflict ridden areas.

The agricultural productivity, non-agriculture employment generation and non-agricultural productivity classifies as the natural outcomes or obvious outcomes. In peace bound areas, these outcomes are expected and observed yet across politically unstable topographies, similar outcomes might not be expected altogether. The benefits filter out across economic system across direct and indirect means.

The direct channel for transmission of benefits of infrastructure is the wage and employment which seems to possess consequences for increase in real income or stimulating the consumption at grassroots levels. The indirect transmission could be visible in form of rural economic growth that seems to pave way for supply and price determination of basic good sat rural level.

The influences would definitely vary in peaceful conditions and across conditions of rift and turbulence as well as across lack of political will for change in social and economic lifestyle. The research on subject identifies the matter as involving significant impact of leadership crises and lack of integration and coordination on the

research outcomes (Archer, 2008). The relationship across infrastructure and agricultural development is bound to differ in terms of transmission mechanisms as well as filtering of influences in both states of society.

The indicators have been observed a susceptible to influences from political willpower, stability of regimes, ideologies, and political influences on agricultural systems (Archer, 2008). In conjugation, the health conditions especially the rise of epidemics, seem to cast a negative impact on the linkages between infrastructure and agriculture as well as realization of possible gains from the installed infrastructure or construction of infrastructure(Bloom, 2001).

Studies even attribute the gains from infrastructure as being influenced by polity's conservative approach to market institutions and intent to maintain status quo, politics of food and agriculture, and evolving politics of land degradation (Andersson, 2011) (Burkle, 2020) (Poulton, 2006) (Daugbjerg, 2012). The literature on subject recognizes the problem of political economy of change (David, 2018) and democratization and change as equally shaping the impetus for infrastructure as affecting agricultural prosperity and farmer's linkages to global markets(Montenegrodewit, 2020).

The biased political efforts with regard to containing spread of knowledge and constraining local mobility, lack of focus on sustainable development goals and dwindling political commitment to public good leads to uneven results(Vanloqueren, 2009), (Salvia, 2019). The research undertaken in conditions of peace and democratic environment offers conclusion different from the ones undertaken across conflict ridden or autocratic governance mechanism.

The lack of standard research indices or benchmark for peaceful conditions and turbulent conditions further complicates the problem. Some of the prominent studies establishing the infrastructure–agriculture nexus in conflict ridden times are mentioned below.

**Amdt (2018)** focused on the exploration of key issues that matters in regional growth and integration. The study observed that leadership crises and lack of integration and coordination seem to matter while decision making with regard to infrastructure development in rural and agriculture areas.

**Kimenyi (2014)** observed the critical role of political instability and conflicts and infrastructure development. Further the study reflected on the impact of conflict and political instability on agricultural investments in Mali and Nigeria.

**Archer (2008)** analyzed the nature of political influences on agricultural systems in and across least developing countries. The study emphasized that social and political influences do exert an irreversible impact on agricultural systems.

**Smolijan (2010)** analyzed the connection between peace and tranquility in region and infrastructure development and economic prosperity. The study established that the peace and infrastructure development are mutually reinforcing in nature. The study also observed that peace and infrastructure building are dependent upon each other for the livelihood development and consistency.

**Mousseau (2000)** analyzed the scope for infrastructure development in agriculture sector with a wider range of political options like democracy in region, liberties with citizens and consolidation of mechanism. The study observed that developed market economies yielded better results than the ones which are under developed and are under autocratic rulers and governance mechanisms.

**Bloom (2001)** discussed the prospects for linkage between health and wealth. The study explored the implications for infrastructure development amidst the rising epidemics and infectious diseases. The study

observed that epidemics of infectious diseases exert considerable impact across agricultural infrastructure indicators and overall social and physical infrastructure development.

The present status of infrastructure development and its impact assessment on agricultural production in non-peaceful times is hard to decipher as the transmission mechanisms seem to differ substantially. The studies highlight the role of turbulence and uncertainty as changing the flows and filtering of the benefits. Infrastructure as agent of change is widely acclaimed as possessing a larger role in ensuring the supply side and demand side balance (Janvry, 2020).

The credit based institutional innovation, improved circulation of information with regard to crop and crop management, improved access to inputs and outputs markets and placement of social agents for innovation adoption; places a positive impact on the agricultural value chain development. The demand side aspects primarily target the contracting and coordination needs and requirements. The infrastructure accessibility and availability is not same in ties of peace and political conflict or across state of disaster or epidemics or war.

**Studies Emphasizing Impact**

**Ahmed (1988)** explored the type and scope of relationship between the rural infrastructure and agricultural development The study explored the basis for infrastructure as exerting positive impact on agricultural indicators in times of peace and political stability yet turbulent outcomes were observed in times of conflict and political instability. The study established that agricultural indicators might fail to assess the position effectively and may lead to dismal outcomes.

**Willoughby (2002)** analyzed the nature of infrastructure as supporting pro-poor growth in least developing countries with history of political conflict and political instability. The study noticed the incidence of vested groups as controlling the farmer's access to resources, mobility and political involvement and thus shaping their power over infrastructure usage.

**Poulton (2006)** adopted a conservative approach to market institutions and explored the vested intent to maintain status quo in social and economic systems. The pro-poor political agenda setting and intentionally keeping the people as poor or dependent upon subsidies and aid, identifies as traditional form of politics whereby the growth is restrained and thwarted away in order to retain own power position. Such politics often lead to dismal results and infrastructure development is minimal or usage is minimal leading to negligible impact on agricultural growth or mobility.

**Daugbjerg (2012)** reflected on the overwhelming politics of food and agriculture and political power plays. The study explored the new politics of agriculture and food and classified the options for overcoming market constraints on pro-poor agricultural growth in Sub Saharan Africa. The study reported that most of the market infrastructure related issues are an outcome of inertia to change or vested interests in not to lose the power. The study further observed that the infrastructure usage only creates the difference. The gains from infrastructure are possible when the coordinated usage is secured.

**Andersson (2011)** focused on the politics of land degradation and possible implications for infrastructure development, accessibility and agricultural over drive. The study explored the political ecology of land degradation and its consequences for infrastructure development with an eye on agricultural sustenance.

### 1.7 Different Theories and Models Used

The literature on agriculture infrastructure-growth nexus details on the intricacies of macroeconomic and microeconomic consequences. The theoretical perspective (Saeed, 1999) elaborates on the 'stock' and 'flow' concept of infrastructure in contextual perspectives. Both ways, the infrastructure development (Chakamera, 2018) has been viewed as casting a positive impact on income levels, general factor usage and overall employment potential. The subjective enhancement (Calderon, 2014) of level of infrastructure services not only increases the marginal productivity but also leads to 'crowding in' other inputs. The 'infrastructure growth' nexus has achieved tremendous research attention as summarized with aid of studies below.

A study across OECD member states revealed the prevalence of significant impact of agricultural infrastructure on the output, the level of efficiency, regional productivity, rate of private investment and overall employment rates. The study provided the theoretical insights into the linkage between public investment in agricultural infrastructure and economic growth in national perspective (Romp, 2007).

Another research across developing economies reflected on the incidence of government spending as boosting the regional GDP and changes in livelihoods (Bose, 2007). The public sector infrastructure investment was observed to boost the regional levels of agricultural outcomes and productivity prospects. The public investments identify as one of the most visible transmission channel for funneling growth.

A study stressed the role of private capital formation in agricultural perspective as contributing to the development and integration of infrastructure (Agenor, 2006). The benefits of social infrastructure were observed to map with the economic infrastructure as improvements in health and education levels seem to lead to better prospects for knowledge creation, dissemination and economic factor usage. The study based outcomes further estimated that the infrastructure influences the growth by virtue of production factor and by virtue of total factor productivity.

### 1.8 Analysis Techniques Used

| Techniques Used | Studies classified |
|---|---|
| Regression Analysis | (Peck, 1996), (Amir, 2020), (Chakamera, 2018), (Atube, 2021), (Singh, 2020) |
| Factor Analysis | (Llanto, 2012), (Costello, 2005), (Greig, 2009), (Savari, 2020), (Hosseini, 2011), (Katuwal, 2020), (Burkle, 2020) |
| Structural Equation Modeling | (Hosseini, 2011), (Greig, 2009), (Kale, 2011), (Solouki, 2015), (Costello, 2005) |
| ANOVA | (Akhter, 2019), (Greig, 2009), (Tankoo, 2020) |
| Case Study | (Abraham, 2020), (Biehl, 1991), (Calderon, 2014), (Akhter, 2019), (David, 2018), |

### 1.9 Conclusion and Implications

Agricultural infrastructure plays a vital role especially in countries like India. India still classifies as a nation where a larger percentage of population relies on agriculture for sustaining their respective livelihoods. The reported 'growth enhancing' nature of infrastructure hence warrants a closer scrutiny of the relationship between the level of agricultural development and the level of agricultural infrastructure from the regional perspective. This assumes importance as the 'agricultural sector' reportedly plays a dominant role in alleviating poverty and in shaping the overall growth trajectory of the economy in particular. Infrastructure availability, accessibility, respective affordability and level of infrastructure in agricultural perspective identifies as one of the major factors that could explain the regional balances and imbalances in the agricultural growth. This being the case, as we have already seen, our major aim here is to analyze the role of infrastructure in promoting agricultural development vis-à-vis the regional development. The research concludes that across diver perspectives infrastructure is indeed shaping agriculture development directly or laterally.

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