ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 4, Issue 4, pp: (14-24), Month: October - December 2016, Available at: www.researchpublish.com

Assessing the Impact of Rural Communities Services, Energy, Transport Infrastructure on Agricultural Production Outputs across Black Belt Region: A Conceptual Framework

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Abstract: **The effect of socioeconomic and technical changes impacting rural areas needs to be better understood in order to develop applicable policies and strategies to improve conditions for rural residents and places. The South and its Black Belt is noted for the disparities between this region and the rest of the United States in terms of having a disproportionate comparison on all social and infrastructural indicators which in turn is reflected in the extensive and prevalent nature of the region's poverty. Several studies have explored some of the subject areas such as rural community services, transport infrastructure, poverty, and the decaying social infrastructure, but significant research is yet to be undertaken on the cumulative effect of these on the agricultural production of this region. This paper proposes a conceptual framework for the impact of rural community services, energy and transportation infrastructure on production outputs across the Black Belt Region based on a detailed review of existing literature. The framework comprises six factors, namely the Institution and civil society, physical infrastructure, Agricultural Research and Technology, Farmers, and exogenous factors. It is envisaged that this theoretical model will serve as a useful tool in identifying and addressing the infrastructural gap which consequently has long-term benefits on the agricultural output of the region.**

Keywords: **Black-Belt Region, Rural-community services, physical infrastructure, conceptual model, Agricultural Output.**

1. INTRODUCTION

Several definitions and geographic delineations of the Black Belt have been made. Initially the term was associated with the region of the country distinguished by soil color; the part of the country with rich thick and naturally rich soil and much later for its racial composition (Gibbs, 2004). The black belt of 1936 as described by sociologist Arthur Raper included some 200 plantation counties with African American population of more than 50 percent bounded in a crescent shaped region from Virginia to Texas (Raper, 2004). Morris et al. (2002) described the belt as a crescent of disproportionately rural counties from eastern Virginia to northern Florida and then west to the Mississippi Delta and eastern Texas, roughly consistent to the old Plantation South described by Raper (Ibid).

The contemporary South is the largest region of the United States and is the nation's largest rural and non-metropolitan region. According to the 2010 Census, of all respondents who reported Black alone-or-in-combination, 55 percent lived in the South, 18 percent in the Midwest, 17 percent in the Northeast, and 10 percent in the West .This pattern was similar for the Black alone population. Compared to 2000, the proportions of the Black alone-or-in-combination population for the West stayed about the same, while the proportions increased in the South and decreased in the Northeast and the Midwest. The proportion of the Black alone population also increased in the South, from 55 percent in 2000 to 57 percent in 2010,

whereas the Northeast and the Midwest experienced decreases in their share of the Black alone population. The Black population is still highly concentrated in counties in the South. Current Analysis of the 2010 U.S. Census Bureau data reveal that the some counties in the states of Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, and Texas qualify as Black Belt counties based on their significant African-American population. This largely rural region is the location for much of the nation's worst socioeconomic living conditions (Wimberley and Morris, 1996; 1997).

The current debate on the relationship between investment in infrastructure and agricultural productivity, the study joins in its premise, Gibson and Rozelle (2003), Wanmali and Islam (1995), who have shown positive relationships between public investment and agricultural growth. Remoteness due to under-provision of public services and infrastructure, whether spatial, physical or even social translates into high transaction costs of producing and marketing goods in rural areas, thus perpetuating poverty. Lack of infrastructure such as roads and railway automatically lead to high costs of travel and goods transportation. A recent study by Tong et al. 2013 investigated the effects of transportation infrastructure alone on agricultural output for 44 continuous U.S. states from 1981 to 2004,findings based on their model estimates suggest that road disbursement has a significant positive direct effect on a state's agricultural output. A 1% increase in the investment and maintenance in roads in one state increases agricultural output within the same state by 0.02–0.03%. This positive trend was consistent with many previous studies (Costa et al., 1987; Munnell and Cook, 1990; Moomaw et al., 1995; Felloni et al., 2001; Pereira and Andraz, 2010).

The developed conceptual model for this research considers the effect of both endogenous (of which transportation infrastructure is a subset) and exogenous factors on agricultural output. This model would provide a more comprehensive approach than previous researches. Currently, there are no conclusive researches that investigate extensively how these variables besides transportation affect the agricultural output of this region or even the United States' agricultural landscape as a whole; hence there is crucial need to evaluate these relationships.

2. AIM OF THE PAPER

This paper proposes a conceptual model that holistically assesses the impact of infrastructure (rural community services, energy, telecommunication, transport) on agricultural output. The focus is to develop a scalable generic process that exhaustively considers both exogenous and endogenous variable impacting agricultural productivity. It is envisaged that the model can be relevant to other regions of the country.

3. REVIEW OF LITERATURE

Wimberley et al. (2001) provided basic statistical information on selected demographic and socioeconomic quality-of-life conditions for the Black Belt counties. The quality-of-life conditions included poverty, education, unemployment, and age related dependence. These data were intended for policy formulations, program applications, and/or further social scientific analyses. Veronica Womack (2013) in her Rural Poverty Research Symposium mentioned significant influence of agricultural industry with little industrial and commercial development, alarming poverty rates low-skill, low-wage jobs, high unemployment rates, low educational attainment, isolated from major transportation infrastructure, limited access to healthcare, and substandard housing units, Reliance on non-elected, unrepresentative special district bodies in local economic development

Robert M. Gibbs (2003), Joyce E. Allen-Smith et al. (2000) reviewed issues affecting southern Black Belt particularly the high poverty rate and its attendant effect with the latter focusing on the on the longstanding impoverishment of the rural South and three of its sub regions-Appalachia, the Mississippi Delta, and the Black Belt. Both researches focused on the socioeconomic conditions for several high-poverty areas of the rural South, examined the characteristics of the population in these distressed areas, and reported factors found to contribute to impoverished conditions. Dayton M. Lambert et al. (2013), the research analyzed Bundled Adoption of Precision Agriculture Technologies by Cotton Producers; the empirical analysis used data from a 2013 survey of cotton producers in Alabama, Arkansas, Florida, Georgia, Kansas, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia based on the Results from a Cotton Precision Farming Survey Across Fourteen Southern States." by Boyer et al. (2014). Wimberley (2010) focused on the problems of the South and its Black Belt particularly the disparities between the southern region and the rest of the United States in terms of having a disproportionate number of the worst quartiles of

social indicators. The research advocated three levels of solutions particularly to help alleviate the impoverishment and disparity of the Black Belt South. These are solutions aimed at the personal, community, and regional levels.

Calhoun et al. (2000) emphasized that the Black Belt region in the South is characterized by high poverty and related economic problems. The region receives above-average Federal funds per capita, mostly due to relatively high funding in metro areas. In non-metro (rural) areas of the Black Belt, Federal funds vary significantly by type of county and program, with some significant mismatches between the level of program need and assistance actually received. Non-metro Black Belt counties received substantially less funding than their metro counterparts. In addition, the non-metro Black Belt counties also got less than non-metro areas nationwide from community resource assistance, which is used for job generation and other development functions. The research concluded that some Federal policies might be considered to address these mismatches and help develop this depressed region.

A study on the persistent poverty in the south by the Carl Vinson Institute of Government at the University of Georgia,) encompassed 11 cotton-growing states in the South. The research concluded that there is indeed a Southeast Region with persistent poverty over three census periods–and it is the poorest of all regions of the country. On a variety of socio-demographic fronts–education, health, employment, and housing–the 7.5 million residents of the 242 counties in this region bear a tremendous burden from the continuous cycle of poverty. Also that the economic peril facing the Southeast Region results from, and in turn contributes to, the widespread and persistent nature of the region's poverty. This situation will continue to worsen unless and until the region gains the innate ability to produce and sustain wealth through the creation of goods and services in manufacturing, service, and/or agriculture.

While each of the aforementioned researchers have explored each of the subject areas such as rural community services, transport infrastructure, poverty, decaying social infrastructure in the Black Belt regions, significant research is yet to be undertaken on the cumulative effect of these on the agricultural production of this region. Not only will the conceptual model developed be relevant to other regions of the country but the subsequent policies developed will serve as palliative measures to address the decay in this region.

3.1 Socio-Economic Assessment: Black Belt Region:

The United States Department of Agriculture in 2000 proposed creating a federal regional commission, similar to the Appalachian Regional Commission, to address the social and economic problems of the Black Belt. It defined the region, called the Southern Black Belt, as a patchwork of 623 counties scattered throughout the South (Calhoun, 2000).

Black Belt counties are far from homogeneous in their geography and history. They include both the lower reaches of Pine Mountain, Georgia, as well as the low-lying Virginia tobacco lands whose river currents are affected by the ocean tides. They were settled over a period of several centuries, from the early 1600s in Virginia to as late as the 1840s in parts of Georgia and Alabama. Their economies exhibit a good deal of variation. Counties in the eastern portion rely more heavily on services but have high wages by southern standards. The western portion, particularly in Alabama and Mississippi, is more heavily invested in what remains of that region's low-skill manufacturing, while the steep decline in the 1990s in its still-sizable farming base is reminiscent of what happened elsewhere 30 years ago. (Gibbs,2003)

The region has been characterized typically as one of low-wage, low-skill jobs, with Blacks typically at the lowest rungs of the jobs ladder. Its job growth has chronically lagged growth in the rest of the Sunbelt, its industry mix is undiversified, its public services are often underfunded, and many of its schools turn out students less prepared than students in other parts of the country (Falk and Lyson, 1988; Greenberg and Teixeira, 1998).

There is near-consensus that very low levels of human capital are the underlying limiting factor in the region's growth and development. Actually, the share of adults who have completed high school is comparable to that in the rest of the rural South, but it is highly uneven racially. White completion rates in the Black Belt are the highest in the rural South (Over 90 percent), but less than 60 percent of Black adults have a high school diploma. Only one in 14 has a college degree. Even the human capital exchange from migration flows ends up as a net loss: in-migrants have lower education levels and higher poverty than out-migrants (Fuguitt, Fulton, and Beale, 2001).

Cynthia Duncan (1996) examines the social and economic separation of Blacks and Whites in the Delta. Her observations are applicable here as well. She views low human capital not as the first principle of lagging economic development. Rather it is a key outcome of a milieu in which the poor lack both the supports that enable them to participate fully in the working world and the access to the financial and social ties available to the middle class. The lack of support and access

dampens human capital acquisition and lowers the returns. The result is a perpetuation of economic dependence, of an inability to sustain oneself through one's own labor. It is hard to see how it could be otherwise given dependency's dual parentage: a distant agrarian past and the more recent experience of urban enclaves with their joblessness, social isolation, and receptiveness to public assistance. Gibbs (2003)

The region does not share proportionally in the prosperity enjoyed by the nation as a whole or in other U.S. regions. (Joyce E. Allen-Smith et al., 2000).

Hence establishing the relationships between rural communities' services, education, transport and energy infrastructure and smallholder farmers' agricultural production in the region will help in identifying the variables impacting the productivity of this region and addressing these deficiencies, which in the long-term contribute to developing strategies and policies that would yield a healthy and thriving economy in this region.

3.2 Infrastructure: Health, Transport, Energy and Telecommunication:

Despite the social and technical advances of the twentieth century, the disparities between the rural and Black Belt South and the rest of the country remain unresolved. The technologies for automobiles and roadways; air travel and shipping; tractors, cotton harvesters, and other agricultural technologies; electricity; modern plumbing and sanitation; refrigeration and air conditioning; radios; home appliances; telephones; television, microelectronics, mobile phones, and telecommunication systems; large and small computers; biotechnology and the genome; and space travel did not bring an end to long-standing southern impoverishment. (Wimberely, 2010).

Despite improvements in civil rights and economic well-being, the region continues to struggle with problems of inadequate employment opportunities, transportation, education, and other characteristics common to most low-income populations (Calhoun et al., 2000). The Federal Government has a large stake in the Black Belt, where per capita Federal funding exceeds the national average. However, much of the money goes to metro areas. While receiving as much in Federal funds as other non-metro counties, non-metro Black Belt counties received substantially less funding than their metro counterparts. In addition, the non-metro Black Belt counties also got less than non-metro areas nationwide from community resource assistance, which is used for job generation and other development functions. In some parts of the Black Belt, Federal funding in key functions is falling short of what is probably needed. For example, Black Belt farming counties, which especially need economic diversification, got little more than the region's non-metro average (substantially below the national non-metro average) in community resources funding. Meanwhile, Black Belt non-metro manufacturing counties got relatively little in human resources funding, though it is important for retraining the labor force to meet the manufacturing needs of the 21st century. And while poverty counties in the Black Belt got substantial funding from income security programs, they got little more than average for the region from community and human resources assistance, for which they arguably have much need.

Identifying and addressing the infrastructure gap has not only long term benefits on agricultural output of the region but equally has a spillover effect on the community. Morris et al. (2002) emphasized that Technology must be utilized fully to enable poverty areas to participate in the global economy. Jobs and economic growth are increasingly dependent on access to the Internet and use of cellular technology. Technical schools are essential to training and retraining a workforce that will need increasingly sophisticated skills. Failure to see and invest in technology as basic infrastructure will condemn this region to minimum wage, low- or no-skill jobs and will create yet another generation in poverty.

3.3 Agricultural production Output:

Agriculture is a multibillion dollar industry in the United States and is integral to the health and well-being of the nation. Most Americans enjoy an abundance of high quality food at some of the most affordable prices in the world. While much of rural America's economy is changing to meet challenges, some rural communities are struggling to survive in the modern global marketplace because of a lack of diversification. Jobs in traditional rural industries such as agriculture, timber, and mining continue to decline, yet are still important in many communities. Since the 1930s, the role of agriculture in the American workforce has been decreasing. Structural and technological changes to the farming industry have resulted in a need for fewer workers to produce more food. A general shift within agriculture toward large corporate farms and away from family owned farms has made smaller-scale farming unprofitable in many agricultural sectors. Nevertheless; agriculture remains a multibillion dollar industry in the United States and plays a significant economic role in many regions. According to a 2010 USDA report, the number of farms in the United States peaked at 6.8 million in

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International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
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1935.Although this number declined rather significantly through the 1970s, the decline began to slow by the 1980s, and farm numbers essentially remained constant through the 2000s.Contrary to popular perception, small-scale farms still comprise a majority of U.S. farms, whereas large scale farms (enterprises with more than 1,000 acres) make up only 9 percent of all farms. These large scale operations, however, account for two-thirds of the total U.S. value of agricultural production. Conversely, operations with less than 1,000 acres comprise 88 percent of all farms, but just 16 percent of production. (Hoppe et al., 2010)

For the Industries with the Largest Number of Employees; Agriculture and manufacturing continue to wane, but remain important to many rural communities.(Census Tract, 2010). John Cromartie's RCaT article (1999, Vol. 9, No. 2) noted that the region's problems stem from its long and difficult adjustment from the slave-based agrarian Southern economy to today's diverse and highly competitive global economy. The decline of agricultural activity in the south is pronounced. Identifying factors responsible for this decline and reversing this trend will revive the job employment capacity of this region.

4. CONCEPTUAL FRAMEWORK

The conceptual model developed for the purpose of this paper is based on the modification of the Andersen-Shimokawa model (Andersen et al., 2006), as depicted in figure 1

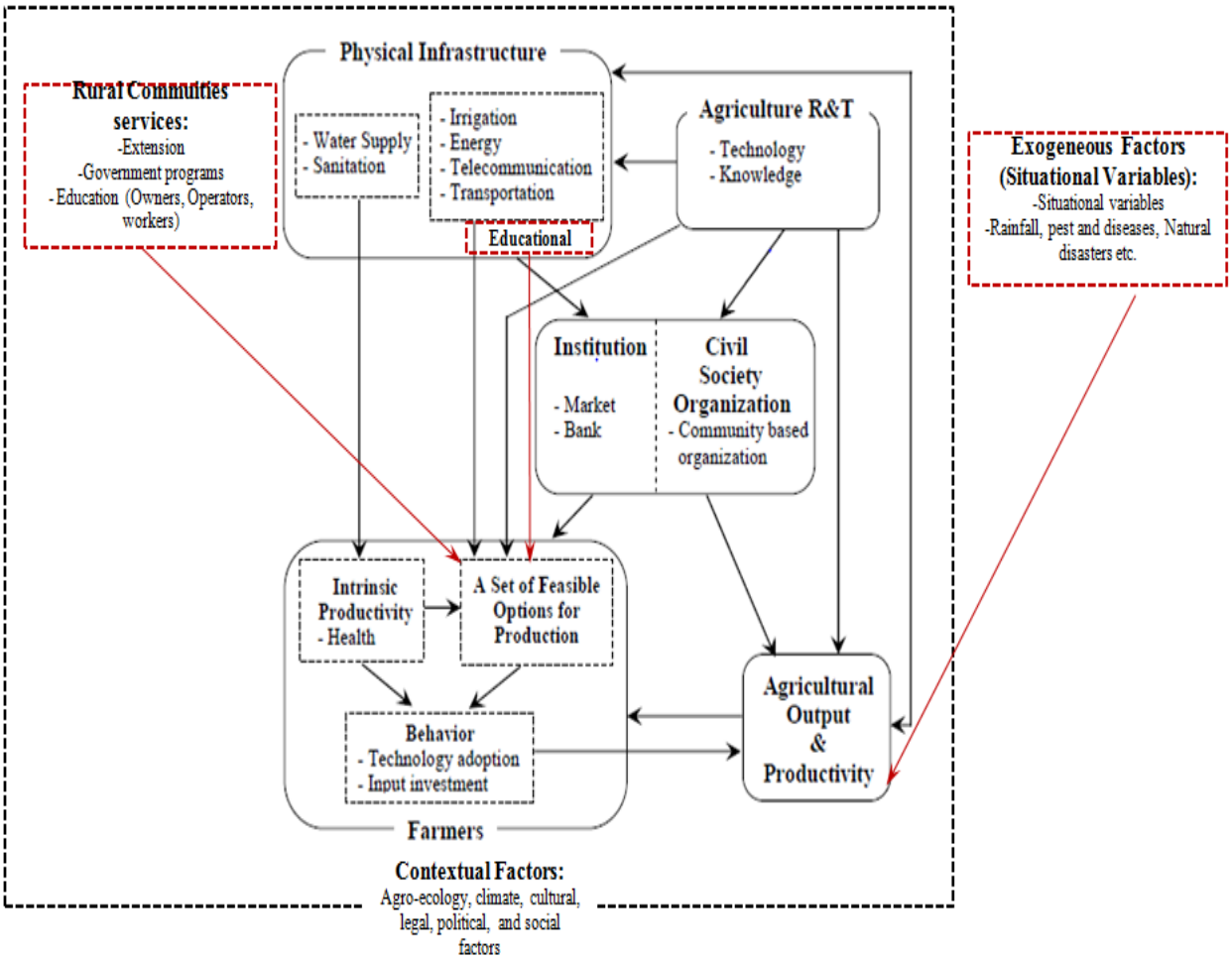

Figure 1: conceptual model

Figure 1 describes cvausal relationships between physical infrastructure, agricultural research and technology (R&T), institutions, civil society organizations, farmer's behaviors, and agricultural output and productivity. We divide physical infrastructure into two groups, water supply and sanitation sectors and other sectors (i.e., irrigation, energy, telecommunication, and transportation sectors), because the channels through which the sectors influence agricultural

development are different. While the latter contributes to more options for production, the former contributes to improving health conditions and productivity3. Based on this conceptual framework, we examine direct and indirect effects of infrastructure investments on agricultural output and productivity, market access and integration, and the development of institutions needed for successful agricultural development.

Agricultural R&T and Links to Infrastructure:

Insufficient infrastructure is one of the key bottlenecks for successful utilization of agricultural R&T because it limits farmers' options and agricultural output. Where the rural infrastructure provides a facilitating environment, economic returns to R&T are usually high. On the basis of data from 44 developing countries in three regions (Africa, Asia and Latin America), Thirtle, Lin, and Piesse (2003) found high rates of return (ROR) to agricultural research and technology.

Several econometrics studies have estimated the effects of infrastructure investment on agricultural output and productivity. Most of these studies find a positive and significant effect (see, for example, Antle 1984; Binswanger, Khandker, and Rosenzweig 1993; Mundlak, Larson, and Butzer 2002; and Fan and Zhang 2004). A key concern in these studies is how to control reverse causality from agricultural growth to infrastructure investments to obtain a consistent estimate of the causal effect of infrastructure on agricultural growth. 4 One of the most used methods to control the reverse causality is to take the difference between two time periods similar to the fixed effects model. However, the use of such a method can destroy any long-term relationship in the data, leaving only short-term impacts to be captured in the model. This causes underestimation of the effects of infrastructure (Fan and Zhang 2004 and Munnel 1992).

Exogenous Factors and Links to Agricultural Output:

Schlenker et al. (2006) linked farmland values to climatic, soil, and socioeconomic variables for counties east of the 100th meridian, the historic boundary of agriculture not primarily dependent on irrigation. The model is employed to estimate the potential impacts on farmland values for a range of recent warming scenarios.The predictions are very robust and more than 75% of the counties in our sample show a statistically significant effect, ranging from moderate gains to large losses, with losses in the aggregate that can become quite large under scenarios involving sustained heavy use of fossil fuels.

According to Ajay Kumar and Pritee Sharma (2013), In mid, high latitude and higher income countries climate change has positive impact on agricultural production or crop yield, and on the other hand, lower-latitude and lower income countries experience a negative effect on agricultural production. On the other hand, developing countries are most vulnerable compared to developed countries. There are many reasons which increase the vulnerabilities for developing countries like low level of technological progress, lack of resources to mitigate the adverse effect of climate change on agriculture; and due to their greater dependence on agriculture for livelihood of large populations (Nath and Behera, 2011).

The National Centers for Environmental Information (NCEI), reported that U.S. has sustained 200 weather and climate disasters since 1980 where overall damages/costs reached or exceeded $1 billion (including CPI adjustment to 2016). The total cost of these 200 events exceeds $1.1 trillion. In 2016 (as of September), there have been 12 weather and climate disaster events with losses exceeding $1 billion each across the United States. The year 2011 set two unwelcome records in Texas: the driest one year drought and the hottest year, as measured by 24 hour average temperature. The lack of rainfall eclipsed earlier marks set for dryness in 1956, the peak of the 1950s drought, long regarded as a watershed drought event in Texas, and 1918. The lack of rain was exacerbated by the extreme heat. Texas set a record for the contiguous United States for the hottest average 24 hour temperature. The 2011 direct financial losses for Texas crop and livestock agriculture are estimated to total $7.62 billion. That is more than $3.5 billion larger than the loss estimated for the 2006 drought, which was the previous costliest drought. The losses represented about 43% of the average value of Texas agricultural receipts over the last four years. Texas produces, on average, about $16 billion in cash receipts annually, which equals close to 6% of the nation's agricultural cash receipts (Anderson et. al, 2012). Similarly, since 2000, assessments of the physical damage sustained to the agricultural industry have been conducted and economic impacts have been estimated in eight out of 12 years for four major hurricanes, two tropical storms, three incidences of prolonged drought conditions, and one summer of excessive rains. The economic impacts associated with natural disasters have been estimated at nearly $5 billion to the Louisiana's agriculture, aquaculture, and fisheries industries. (Guidry, 2012)

Every year natural disasters, such as hurricanes, floods, fires, earthquakes, and tornadoes, challenge agricultural production. Because agriculture relies on the weather, climate, and water availability to thrive, it is easily impacted by natural events and disasters. Every year natural disasters, such as hurricanes, floods, fires, earthquakes, and tornadoes, challenge agricultural production. Because agriculture relies on the weather, climate, and water availability to thrive, it is easily impacted by natural events and disasters. Agricultural impacts from natural events and disasters most commonly include contamination of water bodies, loss of harvest or livestock, increased susceptibility to disease, and destruction of irrigation systems and other agricultural infrastructure.

These impacts can have long lasting effects on agricultural production including crops, forest growth, and arable lands, which require time to mature. The US Environmental Protection Agency suggests that learning how to prepare for and recover from natural events and disasters will decrease their long-term effects on agriculture and the environment.

Rural communities services and Links to Agricultural Output:

The roots of most American rural communities are in agriculture. The land that is now the United States was a land of great natural wealth. Some of that wealth was in minerals and timber, but most of it lay in vast plains and winding valleys of fertile farmland.

Temu A.E. et al. (2005) developed an empirical model that revealed relationships between rural services, infrastructure and agricultural productivity; suggesting that investing in education, i.e. building quality human resource, correlates positively with increases in food production. Also that community development initiatives and cooperatives had impact on agricultural productivity.

Rural Infrastructure and Links to Agricultural Output:

The important role infrastructure and services play in rural development is well documented in literature. Todaro (1989, 1992) argues that the level of capital accumulation and capital accumulation embodied in infrastructure development in a country is a crucial factor determining the pace and diversity of economic development. Although the direct link exists between productive investments and growth, social and economic infrastructure (such as roads, electricity, water and sanitation, and communications) facilitates and integrates economic activities. For example, a farmer can increase output following adoption of new technology or investing in farm machinery, but without adequate transport facilities and market institutions, the extra production may be worthless. (Chiwra, 2004)

Farmers: Human Capital Quality and Links to Agricultural Productivity:

Human capital quality in this context refers to the quality of the farming workforces as primary stakeholders based on their behavior, Education and access to knowledge, Health and options available for production. Their behavior is further assessed on their approach towards technology adoption.

Information is linked to knowledge through the data–information–knowledge hierarchy (Frické 2009) and knowledge is filtered from information. Therefore, access to agricultural knowledge is influenced by the information infrastructure needed for information dissemination. With climate change the need for agricultural knowledge has become more urgent as agricultural researchers have been working hard to adapt and mitigate the impacts.(Mtega et al.,2016). To mitigate climate change impacts, farmers need to rely on a rapidly expanding base of biological and agronomic knowledge that is often specific to certain agro-ecosystems, regions, soil types, and slopes (Tilman et al. 2002). According to Lobell and Gourdji (2012), climate change has affected crop productivity because rains have been reduced and drought periods prolonged. This has made it important for agricultural research institutions to come up with new technologies and developments to combat the impacts. In order to limit the impacts of climate change, making the right decisions at farm level in terms of input-use efficiency, human health, and resource protection is becoming an increasingly knowledge-intensive task (Tilman et al. 2002). Scholars (Czapiewski, Floriańczyk & Janc 2010) pointed out that there is a strong link between access to agricultural knowledge and agricultural development. As stated by Dodsworth et al. (2003), agricultural development requires creation and use of new knowledge; it is attained through transforming knowledge into actions. However, knowledge can only be transformed into actions if it is acquired from its sources by those who need it.

Robert Reich (1992) stresses that the economy is no longer local, or even national in scope, but is truly global. Neither communities nor nations can depend on capturing the benefits of local capital, local industries, or even locally developed technologies in a global economy. Reich outlines two fundamental strategies for national economic development in a global economy. First, he advocates investment in infrastructure, including such things as roads, bridges, airports, and telecommunications access systems. Infrastructure has two important development dimensions. Reich's second, and even

more important, development strategy is to invest in people. People who work with their minds will be the fundamental source of productivity in a knowledge-based era of the twenty-first century. This makes the local natural base less limiting, but no less important, than in previous eras of development. If a nation is to be productive in the post-industrial economy, its people must be productive. Reich apparently depends heavily on national allegiance to keep productive people working in the nation that helped them develop their minds. If agriculture is to be a cornerstone for rural community development, it must be the type of agriculture that employs the talents of thinking, innovative, productive people – it must be a sustainable agriculture. These are the types of people who can leverage a limited resource base into a vibrant, sustainable community.

The agricultural sector has undergone immense change since the publication of Agriculture at Risk in 1988. In some respects there has been improvement in the health and safety of those working in agriculture due to improved technology, personal protection, and awareness of hazards. The establishment of the NIOSH Agricultural Health and Safety Centers as a result of that effort has provided a network for the collaboration of academic health center researchers, agricultural safety educators, and agricultural engineers to institute a multi-disciplinary approach to research, outreach, and education in agricultural health and safety. The regional centers appropriately reflect the geographic variation in farming conditions and practices. Regulatory approaches to improving occupational and environmental health in agricultural practices have included the passage of the Worker Protection Standard in 1992 and the Food Quality Protection Act in 1996, both dealing exclusively with pesticides.

There is still much to be done, however, to prevent injuries and improve the health status of those working in agriculture. Even with the consolidation of agricultural operations and the increased complexity and size of farms and other agricultural operations, there is a lack of knowledge of how many people are adversely affected by their exposures, particularly long-term, low level exposures. The majority of production operations are exempted from direct OSHA regulation and as a result the medical surveillance that occurs in other industries often does not or at best, occurs sporadically in agriculture. The reporting system for occupational illnesses is still woefully inadequate which makes it almost impossible to accurately track trends, determine accurate numbers of those with illnesses that are consequences of agricultural occupational exposures, and determine long-term adverse health effects from agricultural exposures. Farmers have an increased prevalence of many acute and chronic health conditions including cardiovascular and respiratory disease, arthritis, skin cancer, hearing loss, and amputations. Other health outcomes have been little studies in the agricultural workplace, such as stress and adverse reproductive outcomes. (Brackbill, Cameron, Behrens, 1994). Three prospective cohort studies have been launched that will help answer some of the questions: The Agricultural Health Study in North Carolina and Iowa, the Keokuk Study in Iowa, and the California Farmer Cohort Study (Alvanja, Sandler, McMaster, Zahm, McDonnell, Lynch, Pennybacker, Rothman, Dosemeci, Bond, & Blair 1996).

Kirkhorn (2001) suggested that health studies must consider several modifying factors in agricultural exposures resulting in physical illnesses including work force age and ethnicity, type of commodity, work practices, engineering controls, and use of personal protective equipment. The work force has significantly changed and varies greatly by region. Principle operators tend to be Caucasian and older. There has been a slight increase in women principle operators. There has also been an increase in principle operators that work off the farm, which adds additional exposure issues (US Census of Agriculture, 1997). Hired farm workers are increasingly foreign born, younger males. It is thought that agriculture is now at a low point in agricultural labor and as the number of farms decrease, there will be an increase in the size of the agricultural labor force. According to the 1997 USDA Agricultural census the average age of principle operators is 54.3 years. Aging of the farm population may lead to increased susceptibility to the adverse effects of occupational exposures, on chronic diseases including respiratory and musculoskeletal illnesses. Many hired farm workers no longer have an agricultural background and use employment in the agricultural sector as an entry-level job. A language barrier exists which can impede following safety information on labels and training in proper work practices. Farm labor contractors instead of farm owners now hire large numbers of farm workers, raising new health and safety concerns. All of these changes may increase health and safety hazards in the agricultural workplace. Perhaps the hallmark of agricultural exposures is their enormous diversity in type, as well as in dose and duration. The ethnic variation in the agricultural workforce compounds the potential health hazards.

Institutional Infrastructure and Links to Agricultural Output:

Binswanger et al. (1993) sought to quantify the inter-relationships among the investment decisions of government, financial institutions and farmers and their joint effects on agricultural investment and output. Empirical results using district-level time-series data from India confirm the importance of input and output prices in the determination of

aggregate crop output, but also confirm that aggregate output supply elasticities are low. Education infrastructure availability and the rural banks play an overwhelming role in determining investment, input and output decisions. Availability of banks is a more important determinant of fertilizer demand and aggregate crop output than interest rates. While farmers respond to infrastructure, the governments in turn allocate their infrastructure investments in response to the agroclimatic potential of the districts and banks locate their branches where the agroclimate and the infrastructure are favorable to their operation. Agricultural output is therefore determined in a complex interactive process where farmers, government and intermediaries respond to the same factors. This sharply affects the econometric techniques which have to be used to analyze output supply.

5. CONCLUSION

This paper develops a conceptual framework for assessing the impact of infrastructure (rural community services, energy, telecommunication, transport) on agricultural output. Each of the causative variables identified are interwoven and continue to impact each other. These factors are critical and are derived from an exhaustive review of literature. It is also pertinent to mention that some of these elements have not been researched in detail in relation to the US Agricultural system or even developed economies.

It is intended that the conceptual framework will serve as a foundational basis towards the development of more advanced models in the future.

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