PATTERNS OF ACCESS TO RURAL SERVICE INFRA-STRUCTURE: THE CASE OF FARMING HOUSEHOLDS IN LIMPOPO PROVINCE

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Abstract

Inadequate infrastructure is a major development challenges in developing countries. This paper applies factor analysis to determine the pattern of access to rural service infrastructure on 158 farming households in the Limpopo Province. The nine components of access to service infrastructure (distance to Polokwane, nearest town, local government, hospital, magistrate office, post office, traditional authority, district agricultural offices and extension service) were subjected to factor analysis. The results support the concept of centre-periphery pattern of service infrastructure development. Polokwane is a major centre in the Province, and provide a composite of services. Its peripheries are regions, which have towns as centres. Health, local government and postal services are mainly found in such regional centres. The district centres provide mainly agricultural and justice services. Finally, local centres provide services of traditional authorities, agriculture and postal services. These patterns have major implication for infrastructure development policy and programs. They also need to be considered in current crafting of institutions for rural economic development.

1.   INTRODUCTION

Inadequate infrastructure is the most crucial development challenge for Africa (African Development Bank (ADB), 1999). In the past centuries infrastructure development was more of an engineering problem (Makhura, 2002), however nowadays infrastructure development goes beyond to include social capabilities (Abedian, 2002). According to Abedian (2002) social capabilities include amenities that are put to reach a certain purpose.

However, there have been major shortfalls in the delivery of infrastructure services, which are attributable to, among others, biased and flawed priorities, poor management and resources scarcity (Wasike, Kimuyu & Kimenyi, 2000). In South Africa alone, backlogs in infrastructure delivery are still very high

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(Development Bank of South Africa (DBSA), 2002) and are particularly severe in rural areas that still receive less attention despite efforts made to self-finance their infrastructure in the past (Bond & The Infrastructure Research Team (Wits), 1998). Rural households, therefore, continue to face poor access to infrastructure services, particularly social services. The objective of this paper is to determine the pattern of access to rural service infrastructure. Availability and access to service infrastructure tends to contribute to productivity of rural participants (Budlender & Dube, 1998). Such access is regarded by the poor as major factor to alleviating poverty (Kunfaa, Dogbe *et al*, 2002; Kadzandira, Khaila & Mvula, 2002; Okunmadewa *et al*, 2002).

2.   APROACHES TO RURAL INFRASRUCTURE SERVICE DELIVERY

The role of infrastructure in economic development is clear. According to Scott (2002), infrastructure builds the foundation for human and economic development. Accordingly, infrastructure facilitates improvement in the quality of life of people, realisation of individual human potential, and economic growth. This implies that decisions about infrastructure are made in the context of policy issues of growth, job creation, poverty alleviation, and environmental sustainability (DBSA, 1998).

Types of infrastructure include economic infrastructure and social infrastructure. Economic infrastructure is that part of an economy's capital stock producing services to facilitate economic production, serve as inputs to production or is consumed by household. The economic infrastructure includes public utilities, public works and other transport sub-sectors. The social infrastructure provides services such as health, education and recreation and has both direct and indirect impact on the quality of life. Directly, it supports production and trade. Indirectly, it leads to improved productivity which in turn leads to higher real incomes (Budlender *et al*, 1998; DBSA, 1998). The social infrastructure also facilitates investment in human capital by using some of the economy's physical capital stock to raise the productivity of the workforce.

Agriculture is a cornerstone of rural economies (DBSA, 2000). It has been generally argued that for agriculture to achieve its potential there is a need for investment in social infrastructure. Some studies referred in Wanmali & Islam (1997) have shown that improved and better access to infrastructure enhances better practices and farm productivity, with subsequent contribution to overall development. The DBSA (1998) confirmed the positive association between infrastructure and the society's level of development. Basically, different stages of development require different types of infrastructure,

which in turn stimulate transition to the next stage of development (Makhura, 2002).

However, what is outstanding is the extent to which the infrastructure benefits trickle down to individuals in order to remove them from poverty. The flow of benefits of infrastructure services depends on their accessibility to beneficiaries. Rural areas are normally characterised by sparse settlements, which tends to make it too costly to provide infrastructure service per population. The pattern of rural service infrastructure can be understood by employing the centre-periphery model of rural settlements. This model was implemented in Wanmali *et al* (1997) to investigate the impact of access to rural service infrastructure and the overall demand for goods and services in the rural areas of Zimbabwe and Zambia. The centre-periphery model itself as described by Friedman (1966) in Wanmali *et al* (1997) is one of many variations on a theme that imposes a structural concept of centre and periphery on what might be considered respectively 'developed' and 'backward' areas, whether on a sub-national, national or global level. The centre-periphery relationship is described as a relationship where factors of production, raw-material and agricultural goods are drawn from the periphery to the centre, where they are used to produce high value manufactured goods. In time, service infrastructure becomes concentrated in the centre (commonly towns and urban areas) and its relative availability declines in the periphery (commonly villages and rural areas).

The centre-periphery model is useful in post-apartheid context, to understand the pattern of rural service provision that exists in many rural provinces of South Africa. Even though these rural provinces as a whole are characterised as peripheries with respect to major urban centres elsewhere in the country, they contain regions, subregions and districts that have the characteristics of centres without necessarily being heavily urbanised and other areas that act as peripheries to these centres. Within these rural provinces are networks of cities, towns and villages offering a variety of services through a complex system of rural service infrastructure (Wanbali *et al*, 1997). Accordingly, it is the distribution pattern of availability of and access to the rural service infrastructure system that indicates whether an area is a centre or a periphery in terms of rural service infrastructure. It is generally so that agricultural areas (or farming households) are located in the periphery, and yet they are supposed to get service of the rural infrastructure. The South African pattern of settlements and service provision are particularly interesting in that dual development existed in parallel for homeland and what was referred to as central South Africa. However, in the post-apartheid era, there continue to be adaptation of the centre-periphery concept (Naudé, 2000). In spite, the

empirical question remains as to what extent are the rural services accessible to the farming household.

3.   STUDY AREA AND METHODOLOGY

The study applies data collected from a sample of 157 farming households in the five regions of the Limpopo Province in 1997. The study area consisted of randomly selected districts per region. From each districts wards or farming areas were randomly selected from a shuffle. Extension office provided a list of farmers in each farming area, from which farmers were randomly selected.

The information was collected in two steps; firstly, through a multi-subject structured questionnaire administered on individual head of households. A range of subjects was addressed in the questionnaire in lieu of number of respondents. While the sample size of 157 respondents cannot be claimed to be representative, the households in the various farming areas were generally more homogeneous in economic environment (as compared to demographic characteristics). This analysis focuses on economic environment in which farming households find themselves, hence the spread of respondents across the province provided additional variation. The second step involved some 22 group discussions across the study area.

The area is predominantly rural and the major economic activities are farming, complemented by some non-farm activities. However, these areas depend on the nearest regional towns or Polokwane (the Provincial capital) for their services. The appropriate services include agricultural support services provided by the district agricultural offices and extension offices. Some of the agricultural transactions such as transfer of land require the services of both the traditional authority as well as the magistrate (or justice) offices. These offices also provide other non-agricultural services, though they contribute indirectly. Similarly, farming households require services of the hospitals, post office and local government services.

Typically, access to service centres is a function of distance, road conditions and mode of transport. In this analysis, it is assumed that households in the study area have a similar mode of transportation, predominantly taxis and buses, and to a limited extent own transportation. The empirical analysis is therefore based on distance to the service infrastructure to determine the pattern in which they are located.

There were data on nine sources of reflecting households' location or distance with respect to services, namely municipality, hospital, nearest town, district

agricultural office, magistrate office, extension office, traditional authority, post office, and Polokwane. The basic question was whether services are located individually or in some combination. Factor analysis (FA) is a generally accepted method of answering such question. The procedure is applied in this study to identify dimensions in which these services are distributed.

The essential purpose of factor analysis is to describe the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors (Johnson & Wichern, 1992 and Hair, Anderson, Tatham, & Black, 1995) interpreted through weights of the variable called factor loadings organized in a matrix of factor loadings. The factor analysis model is organised in such a way that all variables within a particular group are highly correlated among themselves but have relatively small correlations with variables in another group (Makhura, Goode & Coetzee, 1997). Typically, factors used for further analysis should contain unique variables. However, such a restriction can be relaxed when the results are just intended for understanding the pattern of relationship.

The factor model can be expressed in matrix form as:

$$\mathbf{x} = \Lambda\mathbf{f} + \mathbf{e}$$

where $\mathbf{x}$ is the vector of *9* observable variables, $\mathbf{f}$ is the vector of *m* unobservable factors, Λ is called the loading matrix of the order *9xm* (loadings given by λ's) and $\mathbf{e}$ is the error vector of *9x1*. The model assumes that:

- $\mathbf{f}$: *mx1* $\sim$ N($\mathbf{0}$, $\mathbf{I_m}$); that is the m common factor variates in $\mathbf{f}$ are iid with zero mean and unit variance.

- $\mathbf{e}$: *9x1* $\sim$ N($\mathbf{0}$, $\mathbf{D}_\psi$); that is, the errors (specific factors) are normally and independently distributed with zero mean and variance

     $$Var(e_i) = \psi_i = [\mathbf{D}_\psi]_{ii}$$

- the variates $\mathbf{f}$ and $\mathbf{e}$ are independently distributed.

From above formulation, it follows that:

- Var($\mathbf{x}$) = $\Lambda\Lambda^T$ + $\mathbf{D}_\psi$, and the ith **diagonal element** of $\Lambda\Lambda^T$ is the **communality** of ith variable.

- Cov($\mathbf{x}$, $\mathbf{f}^T$.) = Λ

The aim of factor analysis is to account for the correlation or for the covariance between the response variables in terms of a smaller number of factors. In empirical analysis, the unknown parameters λ's and ψ_i require estimations. These parameters have been estimated in stages of economic development (Yotopoulous & Nugget, 1976), technology adoption (Rauniyar, 1990), sources of risk (Bullock, Ortmann & Levin, 1994) dairy management (Ford & Shonkiler, 1994), and market participation (Makhura *et al*, 1997). This study attempts to determine the pattern of relationships among location of services for rural households.

4.   EMPIRICAL RESULTS

4.1   Access to rural service infrastructure

Usually, farmers do most transactions in service centres, nodal points, business centres or major towns. Good access to such centres might imply low transaction costs. Polokwane, which is the main city of the Limpopo Province, is a major potential market centre where a variety of markets are available. For example, there are a fresh produce market, co-operatives, milling companies, and a variety of butcheries and supermarkets. So, the distance to this centre has a bearing on farmers' access to services. The typical sample household in the survey is located about 104 km away from Polokwane (Table 1). The closest household is located about 25 km from the city. These include the households in Maja and Mothiba areas located south-east of the city.

There are other towns in the various regions to which households are closer. In the Vembe (or North) region, the nearest town is Thohoyandou, Giyani is the most important centre in the Mopani (or Lowveld), Lebowakgomo in the Sekhukhune (or Southern) region, Mankweng or Pietersburg in the Capricon (or Central) region, and Potgietersrus or Ellisras in the Waterberg (or Western) region. Although these centres are not as big as Polokwane, they are regional alternatives. They have co-operatives, roller mills, supermarkets and other providers of goods and services, albeit on a relatively smaller scale compared to Polokwane. Nonetheless, due to their proximity and their potential for service delivery, farmers tend to make use of the nearest towns to meet their farming requirements. Normally farmers know more about farming institutions in the nearest towns than they do about Polokwane. Typical sample households are located about 27 km away from the nearest regional centres. The furthest household is located about 60 km away.

Table 1: Access to business and service infrastructure

Variable	N	Mean	Maximum
Distance to Polokwane (km)	158	104	287
Distance to nearest town (km)	158	27	60
Road conditions to nearest town			
Tarred (%)	158	32	
Maintained gravel (%)	158	26	
Gravel (%)	158	42	
Distance to hospital (km)	158	25	55
Distance to co-operative (km)	48	25	60
Distance to extension office (km)	158	3.27	25
Distance to agricultural office (km)	158	23	61

The conditions of the road are important in accessing these centres. About 26% of the households use maintained gravel roads to reach the nearest town, while 32% access the nearest town by tarred road. Thus, about 58% of the households use readily accessible roads to the nearest towns. About 42% of the households have to rely on gravel roads in poor condition to reach the nearest town.

Hospitals and co-operatives are other forms of market outlets for agricultural produce. Sometimes farmers need to visit hospitals because they might get tenders to supply produce to hospitals, in addition to health care. Hence, their proximity to such centres is crucial. The typical sample household in the survey is located 25 km away from the hospital and cooperatives. The furthest distance to the hospital and cooperative is about 55 km and 60 km respectively. This implies that it takes a typical farmer about 20 to 35 minutes to reach closest health facilities and cooperatives.

The distance to the local extension office is an important factor since the interaction of the farmers with the extension office is crucial in making information available. The mean distance to the extension office is 3.27 km. The number of contacts farmers have with extension officers is about three (precisely 3.26) times per month. Because farmers can obtain printed material on potential markets at the district agricultural office, the distance to the office affects the cost of searching for information. On average households are located 23 km away from district agricultural offices.

4.2   Access to service infrastructure and markets

Table 2 indicates the proportion of households participating in various markets by region. The Northern Region appears to have the largest proportion (83% of 24 households) of households participating in markets. The farmers in this region have the highest proportion of the 24 households selling maize and horticulture crops, that is 63% and 50%, respectively. This might be attributed to the fact that most of the farmers are relatively closer to Thohoyandou, the nearest town, where a typical household would be 23 km away.

In the Southern Region, 67% of the households surveyed sell some or all of the crops to markets. About 48% of the households sell other field crops, in most cases wheat and coriander produced in the Mathabatha irrigation project. About 19% of the households sell horticulture and maize crops. The market accessibility in the region could be attributed to the project being situated in Mathabatha, where farmers are supported with a focused extension service that facilitates farmers committees. Members of such committees are usually well informed about farming activities in the project. Wheat is produced and sold by farmers as a co-operative activity. As a side effect it is found that nearby farmers who are not part of the project also benefit from the arrangements in selling maize and horticulture produce.

Table 2: Percentage households selling cash & food commodities by region

Region	Distance to N Town (km)	Horti-culture	Live-stock	Maize	Other field crops	% Selling by region
Northern (N=24)	23	50	17	63	33	83
Lowveld (N=18)	20	39	22	17	0	56
Central (N=58)	39	0	23	9	9	31
Southern (N=27)	25	19	15	19	48	67
Western (N=30)	25	17	7	13	23	43
% Selling by commodity		**19**	**17**	**20**	**21**	**50**

NB: Entries are by cell (not across column nor row).

In the Lowveld region about 56% of the households sell agricultural products to the market. The commodities with a strong commercial orientation are horticulture (39%) and livestock (22%). The level of horticulture commercialisation in the region is attributable to a banana project at Homo where each farmer owns at least 7,5 ha of banana plantation. The banana

farmers also grew vegetables on the same banana plots. Other farmers involved in vegetable production are located in the Hlaneki area, about 7 km from Giyani. The livestock sellers were found at Mninginisi, approximately 25 km from Giyani. These farmers take their livestock to the feeding program before they are auctioned. Sometimes they sell them to the operator of the feedlot at a discounted price.

The extent of market participation by the households surveyed in the Central and Western Regions is substantially less. In the Western Region only 43% of the households sell any of their crops or livestock. It is surprising to find such a small proportion of households selling livestock, given that the region is ideally suited for livestock production. This may be a reflection of poor market development or high transaction costs. The Central Region has the lowest proportion (31%) of households participating in agricultural markets. About 23% of the households in the area sell livestock, and just 9% sell maize and other field crops. The Central Region is also a livestock production region, but the area south of Polokwane where the sample is taken is more of a maize production area. However, the households are located at about 39 km from the nearest town of Mankweng.

These results show a strong correlation (-0.68 pearson coefficient) between distance to the nearest town where there are services, and the proportion of households participating in markets. The next section will analyse the pattern in which rural service infrastructure is organised.

4.3   Factor results

As discussed above, it was suspected that access to rural service infrastructure is in different combinations services. To determine if this is true, the data on the nine service infrastructure were subjected to factor analysis. The principal component factor analysis extraction method was selected. This method uses the prior communalities of one, and therefore tends to inflate factor loadings, which makes identification of patterns relatively easier.

Three factors were suggested by the criterion of Eigenvalues (>1) and the three factor solution appeared reasonable. The factor patterns from the varimax rotation are presented on Table 3. The factor loadings are not unambiguous, since some items had high loadings on more than one factor. However, the ambiguity doesn't deter the focus since the paper is just set to discern such levels of overlap of services and is not aimed at using the results for further analysis. The three factors explained 67% of the variance in the nine service infrastructure components. The three factors are referred to as

General Services Infrastructure, Agricultural Support Service Infrastructure, Remote Local Service Infrastructure.

4.3.1 Factor 1: General Service Infrastructure

The first factor in the factor analysis, General Service Infrastructure, explained 41% of the total variance in the sample. Distance to local government, hospital, post office and nearest town were the service infrastructure that loaded heavily on this factor. The loadings for all the items had positive sign implying that these four services infrastructure are positively correlated or are normally found together. The regional (or nearest) towns are regarded as the centres of development in the rural provinces such as Limpopo. Most of the offices of local governments are also located in those towns. Similarly, hospitals and post offices are normally found in such centres. Apparently, these general services tend to be demanded by farming household, not necessarily for agricultural purposes.

Table 3: Rotated factor patterns for access to rural service infrastructure

Variable	Factor 1	Factor 2	Factor 3	Communality
Municipality	**0.806**	0.088	0.197	0.696
Hospital	**0.854**	0.204	0.033	0.771
Nearest Town	**0.689**	**0.557**	-0.103	0.796
District Agric Office	0.284	**0.914**	0.151	0.940
Magistrate Office	0.286	**0.905**	0.125	0.916
Extension Office	-0.240	**0.488**	**0.478**	0.524
Traditional Authority	0.115	-0.007	**0.792**	0.640
Post Office	**0.547**	0.120	**0.460**	0.526
Polokwane	-0.101	-0.130	**-0.529**	0.307
Total Variance	**41.00**	**14.40**	**12.60**	

4.3.2 Factor 2: Agricultural Support Service Infrastructure

The second factor, Agricultural Support Service Infrastructure, explained 14% of the total variance in the nine service infrastructure items. Distance to district agricultural offices, extension offices, magistrate (justice) office and nearest town loaded heavily in this factor. The nearest town in this case is the district level centre as compared to the regional centre in Factor 1. This entire service infrastructure had positive signs, which implied that households accessing services district agricultural offices were accessing magistrate offices and extension services at the same centre. The reason behind this could be that

certain agricultural transactions such as transfer of land and livestock require the service of both extension services, district agricultural offices (higher extension service level) as well as the magistrate offices (for legal endorsement). After all, farming households that require agricultural services require the service of magistrate offices such as birth, death, marriage registration as well as acquisition and amendment of identification.

4.3.3 Factor 3: Local Service Infrastructure

The third factor, Local Service Infrastructure, explained 12,6% of the variance in the nine service infrastructure items. Distance to traditional authorities, extension offices, post office and Polokwane loaded heavily in this factor. Distance to traditional authorities, extension offices and post offices had positive loadings meaning that they were typically found together in a centre. However, these centres were further away from Polokwane, the capital city of Limpopo, as evidenced by the negative loading of the distance to Polokwane. These reflect existence of small local centres, normally based on the traditional authority offices. Some of the local service infrastructure is also found in other major centre. For example, extension services are also found in district level centres, while post offices are also found in regional level centres.

5.   SUMMARY AND IMPLICATIONS

The need for provision of infrastructure has gone beyond establishment, but encompasses issues of how accessible they are. Rural household, who are particularly dependant on farming, tend to benefit more from better access to service infrastructure. In those regions were households are closer to the nearest towns (which harbour a range of services), a greater proportion of households tend to participate in agricultural markets. This implies that to improve performance of rural households, there is a need to improve their access to service infrastructure. Further, it is as crucial to understand the way such infrastructure has been organised.

There appear to be three types of centres servicing rural areas. The regional level centres provide local governments, health and postal service infrastructure (or general services). The district level centres provide agricultural support as well as justice services. The other centres are relatively localised as they are further away from provincial urban capitals, and they provide services of traditional authorities, agricultural and postal infrastructure. Some rural services are located at both regional and local level. The postal services are found in regional towns as well as in local centres.

Some extension services are found in the district centres, even if they are typically found in the local areas where farmers are operating.

We can therefore express the pattern of centre-periphery service infrastructure in a typical rural province of South Africa in four levels (as shown in Figure 1); the provincial centre (with capital city), regional centre (providing general services), district centre (providing rural support services) and local centres (providing basic services of traditional authorities, extension and post offices)

PLK   = Polokwane
RC   = Regional centres
DC   = District centres
LC   = Local centre
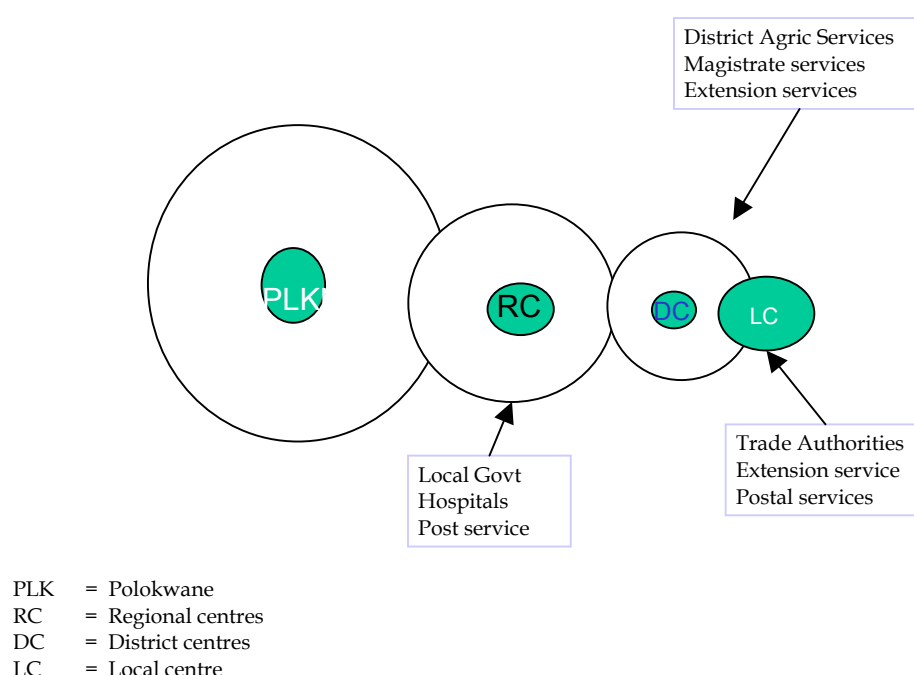
Figure 1:   Centre-periphery pattern of service infrastructure

It is also imperative to note the implications of the results. Service delivery has not been conspicuous in the rural areas, particularly in the recent decades. To explore the potential in the rural areas, there is a need to take account of patterns of service infrastructure requirement. Somehow, local government services are only visible in regional towns, yet the services are required at local level. This poses major challenges for delivery. Among options for consideration are partnerships of local government with locally based institutions such as traditional authorities. It is also plausible to establish complementary development institutions in line with regional, district and local patterns. These institutions could serve as agencies to promote delivery of service infrastructure and identify development potential.

6.   CONCLUSIONS AND FURTHER STUDIES

The centre-periphery patterns underlies general pattern of infrastructure development in South Africa and it is applicable to any level. A majority of farming households are located in villages which are peripheral to the centres identified. The local centres are peripheral to district centre, which are peripheral to regional centre and provincial centre. These patterns of development are crucial and need to be considered when programming for infrastructure support. However, the infrastructure development support should be coupled with support for productive sectors and institutional capacity, which were not in the scope of this paper. However, it was evident in the paper that proximity to service infrastructure encourages more households to participate in markets.

Obviously, the need to address infrastructure problems has been raised in a majority of research recommendations, which never went beyond mentioning the need for infrastructure investment. This paper made some attempt to address a particular perspective of infrastructure development of accessibility of service infrastructure for rural development. It has not addressed other crucial issues such as utilization thereof. It will also be interesting to evaluate patterns of other specific infrastructure services such as agricultural infrastructure (marketing, veterinary services, etc) and were possible consumption infrastructure (refuse removal, water, electricity, communication etc) for farming household. The findings of this study are applicable to all rural household in general, but are somehow biased toward farming households who are in majority in the rural areas. The theme of infrastructure development has been overlooked in rural development research, and it is high time (in line with rural regeneration vision) that some research agenda be set in agricultural economics.

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