A factor analysis of access to and use of service infrastructure amongst emerging farmers in South Africa

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Abstract

While many studies have identified infrastructure as a constraints to production in agriculture in South Africa, few have attempted to investigate the extent to which emerging farmers are able to access and utilise infrastructure services. This paper uses data collected from 500 emerging farmers across the nine provinces of South Africa to determine the accessibility and use of infrastructure by emerging farmers. Factor Analysis was applied on fifteen indicators of infrastructure. The principal components extraction method extracted four factors, namely distance to services infrastructure, tarred road conditions to the services infrastructure, visitation to general services infrastructure and agricultural support services infrastructure. The results show that services infrastructure is generally more accessible to emerging farmers than before. The factors that determine the accessibility to infrastructure services include the distance of the nearest town from the villages, the state of the roads that farmers use and the frequency of visits to the nearest town. The distance to services infrastructure is segregated from condition and usage. The results indicate that all services are in a more or less similar location and in similar condition in terms of access. The implication of this study is that policy should address farmers' access to services, which are sometimes in bundles, and the role of locating services in centres is pertinent as it stimulates agricultural and rural development.

Keywords: Emerging farmers; factor analysis; service infrastructure

1. Introduction

One of the major constraints on the growth of smallholder agriculture in African countries is high transaction costs (Machethe, 2004), largely attributable to poor infrastructure. This situation is no different in South Africa, particularly the former homelands (DBSA, 2005). A large proportion of rural households continue to lack access to basic services (Stilwell & Makhura,

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2004). Government initiatives to improve the quality and quantity of infrastructure in the rural areas through programmes such as Community Based Public Works Programme, the Consolidated Municipal Infrastructure Programme, the Poverty Relief and Infrastructure Investment Fund and the Comprehensive Agricultural Support Programme, have registered limited impact on the lives of many rural people (Everatt & Zulu, 2004; National Agricultural Directory, 2004/5).

Recent studies indicate that improved infrastructure reduces the cost of transactions for participants in the economy (Makhura, Kirsten & Delgado, 2004) and can improve overall development outcomes and economic competitiveness (DBSA, 2006). Infrastructure is the capital stock that can help to provide goods and services to the public. Wanmali (1992) categorises infrastructure services in agriculture into soft and hard infrastructure. The 'soft infrastructure' includes transportation services, finance services, animal husbandry, input distribution and marketing. This can either improve or hinder agricultural development. Roads, telecommunications, electrification and irrigation are termed 'hard infrastructure'. Infrastructure, in all its forms, is viewed as a 'means to an end' (DBSA, 2006) and efforts to improve the competitiveness of emerging farmers should take cognisance of, amongst other things, critical issues in infrastructural factors that have a direct bearing on their production activities and how they could access the market. These would ensure the generation of income, which reflects increased participation in the economy. Most studies on infrastructure and rural development have focused on industrialised countries due to the absence of data in developing countries (Yoshino & Nakahigashi, 2000).

The questions that this paper seeks to answers are: What is the accessibility to and usage of service infrastructure by emerging farmers in South Africa? How is access to agricultural services, for farmers, related to non-agricultural rural services? The main objective of this paper is, therefore, to determine the pattern of relationships in the location of services infrastructure used by emerging farmers**.** For this the study uses the principal component extraction method, which involves no assumptions about unique or error variance in the data. The principal component extraction method is appropriate where the objective is to ensure maximum ability to explain variance of observed variables (Mulaik, 1972; Jackson, 1991). This is done by first, presenting a brief literature overview of the role of infrastructure in rural and agricultural development. This is followed by a description of the sources of data used in this study, and an outline of the econometric model applied to analyse the data. Lastly, the results are discussed and some concluding remarks made.

2. Infrastructure in rural and agricultural development

The relationship between infrastructure and rural development has been studied by Wanmali (1987), DBSA (1998), Yoshino and Nakahigashi (2000), Makhura and Wasike (2003), Fan and Zhang (2004) and others. General conclusions that have emerged from these studies are that good infrastructure services are necessary for agriculture and rural development, and differences in regional economic development have been linked to differences in infrastructure investment (Fan & Zhang, 2004; Chandra & Thompson, 2000). Other studies such as Demurger (2001) found that the type of infrastructure spending can differentiate the effects on rural and agricultural development. Fan and Zhang (2004) found that education and infrastructure played a significant role in explaining the differences in non-farm productivity more than it does in agricultural productivity. The relationship between infrastructure development and agricultural development is bi-directional. Infrastructure development can stimulate agriculture and rural development, whilst on the other hand agricultural development can also stimulate improved infrastructural development. Improved infrastructure also has the potential to reduce inequality in income distribution through its effect on spatial location of economic activity.

Under normal circumstances, all infrastructure is located in the settlement system of a region, and the accessibility of these services will determine the economic activity in that region. Access to road transportation determines households' demand for production and consumption goods and services (Wanmali, 1992). If agricultural inputs and output markets are more accessible, rural households will tend to use these services more, leading to improved productivity (Kamara, 2004). Deficiencies in rural infrastructure services result in poorly functioning domestic markets with little spatial and temporal integration, low price transmission, and weak international competitiveness (Pinstrup-Anderson & Shimokawa, 2006). Economic activities in most rural areas tend to be concentrated around areas where there are banks, postal services, retail outlets and suppliers of inputs.

Poor road conditions, high transport costs and distant markets have been identified as factors that hamper improved market access for emerging farmers in South Africa (Makhura & Mokoena, 2003; Nieuwoudt & Groenewald, 2003), and also contribute towards the problem of missing markets. Factors that determine access to input and output markets include distance to the markets, the state of the roads, the cost of transportation and the frequency of visits to these markets. Rural services centres and nearby towns and cities are often an important source of inputs for farmers, and also provide a market for farm produce. According to Mabogunje (1980), the

analysis of the relationship between centre and periphery, particularly the relationship between infrastructure and people, is viewed as a centrepiece in regional development planning in the developing world.

Infrastructure directly affects human welfare and equity across community and income groups. Urban and rural households in South Africa experience widely different access to basic infrastructure services. The lowest household income groups have no or extremely limited access to infrastructure (Bogetic & Fedderke, 2005). Physical infrastructure, such as irrigation and transport and road systems, together with institutions such as banks and markets, make possible a range of production options that are translated to higher agriculture productivity through technology adoption (Pinstrup-Anderson & Shimokawa, 2006). This means that investment in infrastructure has the potential to reduce poverty and income inequality between different geographical locations.

3. Study area and data

The study uses 2005 data from a sample of 500 emerging farmers collected across the nine provinces of South Africa by the Development Bank of Southern Africa (DBSA) and the Marketing Surveys and Statistical Analysis (MSSA). In the study emerging farmers were defined as those previously disadvantaged farmers who are now participating in the market and are still facing some constraints to full participation. Farmers interviewed were drawn from a three stage sampling process based on the information provided by various agricultural industries on the cluster location of emerging farmers. Farmers were selected by first identifying the province, then the industry cluster area, and then a number per sub-area in a particular area. Attempts were made to maintain a representative quota sample. The purpose of the survey was not to estimate the number of emerging farmers per province or per industry, but to determine patterns of relationship. The information was collected through a structured questionnaire administered on individual heads of households or their proxies. The sample was distributed by province as follows; Limpopo, KwaZulu-Natal and Eastern Cape represented 14% of the sample, while Western Cape covered 12percent of the sample, Gauteng, Mpumalanga and North-West 10% and Free State and Northern Cape representing 8%.

In terms of primary farming activity, the sample was about 29% large stock (or beef), 21% vegetables, 12% small stock (goats and sheep), and 9% poultry. Both summer and winter crops and sugar cane represented 6%. The other enterprises covered in the sample were pigs, fruit, cotton, others and dairy representing in descending order from five to 2%. The high representation of livestock mainly reflects the extent to which emerging farmers already

participate in these enterprises. Even during the period of exclusion, these farmers managed to keep and market livestock for a range of reasons. On the other hand the attraction of emerging farmers to vegetable production was due to the promotion of gardens by the Department of Agriculture and the opening up of the Fresh Produce Market. Other enterprises such as sugar and cotton could be due to empowerment efforts in these industries. The subsequent analysis is primarily based on these characteristics of farmers. In fact the study focuses on the economic environment in which farming households find themselves.

The type of service infrastructure that the study investigated included agricultural support services such as agricultural extension facilities, traditional authorities and magistrates offices for land transfer services. Non-farming services, such as hospitals, post offices, banks (for financial assistance) and cooperatives, were also considered in the analysis. This information was applied in Makhura and Wasike (2003) focusing on a selected province. This study covers all the provinces. Further, in addition to information about distance from the infrastructure, respondents were also requested to indicate the conditions of the road to the services, as well as the frequency of use. The survey provided information on infrastructure related to service infrastructure, input market infrastructure and output market infrastructure. The services infrastructure reflect a household's location or distance, tarred road conditions and once-a-week visitation with respect to services, namely bank, nearest town, cooperatives, post office and agricultural extension offices.

4. The econometric model

The econometric model used for this study is factor analysis (FA). FA seeks to reduce a large set of measured variables in terms of relatively few new dimensions, known as factors. According to Johnson and Wichern (1992) and Hair *et al.* (1995), the purpose of FA is to describe the covariance relationships among many variables in terms of a few underlying, but unobservable, random quantities called factors, interpreted through weights of the variable called factor loadings organised in a matrix of factor loadings. The FA 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 *et al.*, 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 relationships. Thus, factor analysis is an appropriate method of answering the basic question of whether or not infrastructure services are located individually or in some cluster (combinations). The procedure is

applied in this study to identify dimensions in which these services are distributed.

The factor analysis model can be expressed in matrix form as:

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

Where **x** is the vector of *n* observable variables
f is the vector of *m* unobservable factors,
Λ is called the loading matrix of the order *nfm*
e is the error vector of *nx1.*

As indicated earlier, the aim of the factor analysis is to account for the correlation of the covariance between the response variables in terms of a smaller number of factors. To determine the number of factors that have to be retained, the study uses the Kaiser criterion of retaining Eigen values greater than one (>1), and also selects factors with high factor loadings scores ±0.4 or greater.

5. Results of the empirical analysis

5.1 Access to and use of rural service infrastructure by emerging farmers

Rural service infrastructure comprises roads, banks, postal services, output markets, input markets and agro-processing facilities. Makhura and Wasike (2003) found that fresh produce markets, cooperatives, milling companies and a variety of butcheries and supermarkets that are located in the nearest towns where emerging farmers operate, can provide potential market centres for rural people. The ability of farmers to access services depends on the state of the road, the transport systems, and the distances from the villages to the nearest towns, among other factors.

Table 1 indicates the distance of farmers in the sample from important services centres. Accordingly, compared to other services, the nearest town seems to be furthest to a typical farmer. That is, a typical emerging farmer would be located about 11 kilometres to the nearest town, with the closest farmer being located about a kilometre while the furthest household is located 95 kilometres away. In contrast, the post office seems to be closest to a typical farmer. This is not surprising as the post offices have been the main service infrastructure that was rolled out to rural areas. As such, it is not atypical to find a post office located in the mid of rural areas, which implies that it could be of service to farmers. The bank and cooperatives seem to be generally located at the same distance. The reason for this is not very clear, but it may either indicate that

some cooperatives provide banking services to farmers or farmers tend to use those centres where there are both cooperatives and a bank. The latter is more plausible in that farmers would normally do banking transaction before or after servicing with the cooperative. For example the farmer may want to draw money that can be used to buy inputs from the cooperative. Some of the bank and cooperatives would be found in the nearest town.

Table 1: Distance to rural service infrastructure (km)

Variable	N	Mean	Minimum	Maximum
Distance to post office	500	8.15	1	115
Distance to bank	500	9.91	1	95
Distance to cooperatives	500	9.91	1	95
Distance to agricultural extension offices	500	10.27	1	142
Distance to nearest town	500	11.35	1	95

The location of agricultural extension office is of great concern in terms of the furthest maximum distance. It appears this service is still appropriated to emerging farmers. This is not surprising given that the government has already identified the need to improve the extension service, which is increasingly associated with poor performance of emerging farmers. In general the location of these services at typical range of eight to 11 kilometres is very different from the study by Makhura and Wasike (2003) about a decade ago. Then the location of services to a typical farmer was at a range of 23 to 27 kilometres. If this were completely comparable, it could be concluded that more service infrastructure has been brought closer and closer to the farmers. However, such assertion is to be made with caution fro two reasons.

Firstly, it may be that in the process of land reform and resettlement, most of the farmers in the sample could have been those who moved closer to the services. In that case, this could be a reflection of some effectiveness of land reform that encourages farmers to be integrated with the economy. The second more plausible explanation could be that the current sample is just fundamentally different from the 1997 sample that focused on a single province. This would then mean that emerging farmers in other provinces are typically closer to the service infrastructure than Limpopo. The fact that Limpopo emanates from the integration of three former homelands serves as a good explanation for potentially high backlog in terms of emerging farmers' access to services infrastructure. Therefore, these results serve as an indication of potential progress in the provision of service infrastructure. However, what is of great concern is the fact that some of the emerging farmers are located some more than 100 kilometres away, which seems longer than the 1997 furthest location of 61 kilometres. This may imply than there may be other provinces where emerging farmers are sparsely located from service

infrastructure. A more glaring case would be Northern Cape, which is the biggest in size and smallest in population.

Sometimes the effect of the distance is ameliorated or exacerbated by the conditions of the road to the services. Table 2 indicates the conditions of the roads. The condition of the roads is normally viewed as major determinant of the hidden costs of using service infrastructure – hence this variable can determine whether farmers would use or not use the infrastructure. For example most of the transportation facilities, particularly vehicles would require high maintenance when the roads are in bad conditions. The interesting finding is that more that a majority (more than 55%) of emerging farmers have access to good roads. With the exception for the agricultural extension service, more than 60% of the emerging farmers in the sample access the services through good roads. This goes as high as 68% for cooperatives, which is not very far from the bank. This compares favourably with the 1997 survey which showed that only 32% of the farmers accessed services through tarred roads. Tarring of rural roads is indeed prevalent as it is not uncommon to find road construction projects at different places. In fact most of the provincial programmes are clear about tarring of rural roads. This level of access is encouraging and basically in line with national basic infrastructure access. This implies that programmes to improve infrastructure access are reaching the emerging farmers and this can be attributable to provincial focus and municipal mandate to improve infrastructure.

Table 2: Road conditions to services

Variable	N	% access to tarred road
Tarred road to cooperatives	202	68
Tarred road to bank	327	65
Tarred road to post office	215	63
Tarred road to nearest town	443	62
Tarred road to agricultural extension offices	107	58

The next question is whether farmers do use these services. Table 3 indicates the percentage of farmers in the sample making weekly visitations to the services. Interestingly, the percentage of emerging farmers making weekly visitation to the services is similar to the proportion of farmers accessing services through good road conditions. This confirms the assertion that the condition of the road promotes the utilisation of services.

Table 3: Visitation to service infrastructure

Variable	N	% making weekly visit
Weekly visit to cooperatives	202	68
Weekly visit to bank	327	65
Weekly visit to post office	215	63
Weekly visit to nearest town	443	62
Weekly visit to agricultural extension offices	107	58

The description above reflects access and usage of services by emerging farmers. The questions one may ask are, should agricultural services be grouped with or disaggregated from other services, and do farmers access agricultural services jointly with non-agricultural services?

5.2 Patterns of access and use of service infrastructure

The principal component factor analysis extraction method was used to analyse the patterns of access to services infrastructure. Table 4 shows the rotated factor patterns for the services infrastructure variables. The Kaiser criterion (1960) was used for selecting the number of underlying factors or principal components explaining the data. In this study, the number was decided by leaving out components with corresponding Eigen values of less than one. This is the rule of thumb when conducting Principal Component Analysis (PCA) using a correlation matrix. Because PCA uses the prior communalities of one, it tends to inflate factor loadings, which makes identification of patterns relatively easier.

Four factors were suggested by the criterion of Eigen values. These factors were previously discussed. The true factors that were retained explained 60% of the variance in the 15 service infrastructure components. The four factors are tarred road conditions to the service infrastructure, distance to the service infrastructure, visitation to the general service infrastructure and visitation to the agricultural support services.

Factor 1: Tarred road condition to the service infrastructure

The first factor, i.e., tarred road conditions to service infrastructure, explained 20% of the total variance in the service infrastructure items. Tarred road conditions to the bank, post office, agricultural extension, cooperatives and nearest town loaded heavily in this factor (factor loading scores >0.4). The loadings for all the items had positive signs, implying that road conditions of these five services infrastructure are positively correlated. That is, they are likely to be found in similar condition of roads (tarred or not tarred). The

result implies that investment in this infrastructure is normally done in similar places for most services.

Factor 2: Distance to the service infrastructure

The second factor, i.e., distance to service infrastructure, explained 18% of the total variance in the 15 services infrastructure items. Distance to bank, post office, agricultural extension office, cooperatives and nearest town loaded heavily in this factor (with factor loading scores >0.4). The loadings for all the items had positive signs, implying that these five services infrastructure are positively correlated, similarly accessible or found together.

Estimating the distance to the nearest town gives an indication of the distance that emerging farmers have to travel to access general services. The nearest town is regarded as the centre of development in rural areas. This means that farmers can save on time and travel costs by being able to access all services in one place. Banks, post office, agricultural extension offices and cooperatives are normally found there. This is consistent with findings of Makhura and Wasike (2003).

Table 4: Rotated factor patterns for access and use of services infrastructure

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality
Distance to agricultural extension offices (km)	.043	**.658**	.099	-.033	0.440
Distance to cooperatives (km)	.090	**.764**	.020	-.056	0.591
Distance to post offices (km)	-.119	**.639**	.037	.064	0.428
Distance to banks/financial offices (km)	-.028	**.878**	-.031	.004	0.775
Distance to nearest town (km)	-.010	**.776**	-.121	-.017	0.623
Tarred road to agricultural extension offices (%)	**.458**	.045	-.188	**.413**	0.458
Tarred road to cooperatives (%)	**.589**	.035	-.210	.382	0.586
Tarred road to post offices (%)	**.764**	-.058	.221	-.162	0.633
Tarred road to banks/financial offices (%)	**.870**	.021	.083	-.063	0.755
Tarred road to nearest town (%)	**.808**	-.033	.019	-.062	0.644
Once a week visitation to agricultural extension offices (%)	-.111	-.058	.080	**.828**	0.688
Once a week visitation to cooperatives (%)	-.021	.007	.370	**.586**	0.516
Once a week visitation to post offices (%)	.054	.056	**.736**	.063	0.563
Once a week visitation to banks/financial offices (%)	.034	.027	**.809**	-.049	0.587
Once a week visitation to nearest town (%)	.045	-.059	**.732**	.138	0.587
% of total variance	19.9	18.3	13.3	8.1	

Factor 3: Visitation to General Service infrastructure

The third factor in the Factor Analysis, i.e., visitation to general service infrastructure, explained 13 % of the total variance in the sample. Once a week visitations to the bank, post office and nearest town loaded heavily in this factor. The loading for all the items have positive signs, implying that these three service infrastructure factors are positively correlated or are normally visited together. Farmers frequently visiting the towns usually access more than one service at a time.

Factor 4: Agricultural support services infrastructure

The fourth factor, i.e., agricultural support services infrastructure, explained 8% of the variance in the 15 service infrastructure items. Visitation to agricultural extension office, visitation to cooperatives and the road condition to agricultural extension offices loaded heavily in this factor. This entire services infrastructure had positive signs, which implies that emerging farmers accessing agricultural extension offices were also accessing cooperatives at the same time. The reason behind this could be that certain agricultural transactions, such as access to inputs and mechanisation, require the service of both extension services and cooperatives.

6. Concluding remarks

The study has presented the type of service infrastructure that is accessed by emerging farmers. The factors that determine accessibility to infrastructure services include the following: the distance of the nearest town from the villages, the state of the roads that farmers use, and the frequency of visits to the nearest town. Investing in the growth and development of rural town centres will have positive benefits for emerging farmers by making such services more easily accessible.

The results also show that the distance to infrastructure is generally segregated from conditions and usage. The Factor Analysis results indicate that all services are in more or less similar locations and thus accessible under similar road conditions. In terms of access of the services, however, farmers tend to access these services separately. The Factor Analysis showed that farmers tended to visit cooperatives and agricultural extension offices at the same time, and other general services such as banks and post offices at the same time, but separately from extension offices and cooperatives. This may mean that, at times, farmers may travel specifically to access agricultural services, and at other times to access general services infrastructure.

The implications of this study are that it is important for policy planners to know that farmers access services in bundles and the role of locating services in the centres is pertinent, and seems to stimulate agricultural and rural development. Improved road conditions and transport systems between towns and rural areas, and within rural areas themselves, will serve many purposes by giving farmers better access to banks, post offices and other services, whilst also providing them with better access to input and output markets. This would serve as a way to facilitate the participation of emerging farmers in the market.

This study paves way for several opportunities for research. Identifying the patterns of access to infrastructure services by emerging farmers, lends an opportunity for further investigating the extent to which access to these services impact on agricultural productivity by these farmers, and also for investigating the transaction costs that farmers are faced with in accessing the services that are available. Other studies can also compare the extent to which differences in agricultural productivity in different regions can be explained by the level of infrastructure development.

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