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An econometric choice for extension-teaching methods: the Ilorin and Oyo North Agricultural Development Projects' experience

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ABSTRACT

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The appropriate combination of extension-teaching methods for rapid farm-technology diffusion and sustained productivity growth in the World-Bank-Assisted Agricultural Development Project in rural Nigeria is examined. The multiple extension-teaching methods in the Ilorin and Oyo North Projects have led to self-defeating and counterproductive results. Using principal-components analysis, the ten extension-teaching methods (variables) are transformed into a linear equation by allocating relative weights to each variable. These weights (coefficients of the equation), which are reasonably unique to each variable, measure the relative importance of the variables and therefore facilitate their ranking in each of the project districts.

The usefulness of the principal component model in the World-Bank-Assisted Agricultural Development Projects in particular, and the rural Nigerian agricultural industry in general, are briefly discussed.

1. Introduction

The agricultural extension problems in Nigeria have been identified at two levels. These include the clientele level (Kidd, 1968; Basu, 1969; Williams, 1969; Falusi, 1973; Falusi and Adubifa, 1975) and the institutional level

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(Ogunfowora, 1968; Williams and Williams, 1972; Mijinindadi and Arokoyo, 1986). The need for a strong extension base devoid of the dichotomous problems as a core solution to the food and fibre problems in Nigeria has been stressed in recent work (Idachaba, 1980; Alao, 1984; Ekpere 1984).

The general objective of the World-Bank-Assisted Agricultural Development Project (ADP) in Nigeria is predicated upon the provision of rural infrastructure for increased farm productivity within the rural setting. The major infrastructural components are a viable extension base, farm input supply centres and rural road network (Umeh, 1984). The management of Ilorin and Oyo North ADPs, in a bid to contain the perennial problems of agricultural extension in the project areas and ensure greater rural productivity, employed a number of extension-teaching methods in bridging the researcher – farmer linkage gap. The teaching methods were identified in each of the projects (Umeh, 1984). Mijindadi and Arokoyo (1986), while discussing recent achievements of agricultural research institutes in food production, listed a few extension-communications methods which have evolved through research. Ogunbameru (1986) discussed various advantages and disadvantages of a number of extension-teaching methods, while Dada (1986) indicated the need for the identification of appropriate method(s) or a combination of methods for effective dissemination of new farm techniques to the farmers.

The multiple methods employed by the projects led to some self-defeating results which are counterproductive to the aims and objectives of the projects (Oyo North Project Third Quarterly Report, 1986). The efforts of project management became thinly spread and the extension agents' efforts were stretched to the limit (Oyo North Project Second Quarterly Report, 1986). The problem manifested itself in other ADPs where poor response to technology adoption resulted. For example, adoption based on fertilizer sales level was met only in year one of the Ayangba Project, and the crop production targets for the project's penultimate investment year (1981/82) were not met (Ayangba Project Completion Report, 1984).

This study aims at facilitating a choice process by the ranking of extension-communication methods in each of the ADP districts. For this type of study, principal-components analysis serves as a useful tool (Umeh, 1987). The plan of the study is therefore as follows: The methodological approach as well as the sources of data are discussed in Section 2; the empirical results and summary of the paper are provided in Sections 3 and 4.

2. Methodological approach and sources of data

2.1 Principal-component model

Kendall (1939) applied the principal-component model in his pioneering work which involved the construction of productivity indexes for 48 countries based on the yield of ten crops. Umeh (1986) ranked 54 potential farm-input centres in the Lafia ADP using the model.

The principal component is a linear combination of regressor variables. In the process of reducing the dimensionality of the set of data, it indicates the relative contributions (coefficients) of each of the composite variables. The methodology is therefore very appropriate where a large number of variables and observations can be employed in a systematic manner and synthesized into the computed coefficients used for ranking purposes. The methodology of the model is described in Girshick (1936), Dempster (1963), Massey (1965) and Norman et al. (1975).

The first principal component (PC) may be viewed as the single best summary of linear relationships exhibited in the data. The second and subsequent PCs are defined as the second and subsequently ordered best linear combinations of variables under the condition that each is orthogonal and inferior to the previous PC.

This study explores the statistical properties of PC for the ranking of the ten extension-teaching methods in use in both Ilorin and Oyo North Project Districts. First, the first (most superior) PC is extracted from the set of data for each district. Second, the variables (extension teaching methods) are ranked in order of the magnitudes of their coefficients in the extracted PC. There are three mechanisms for the extraction of PC's, namely: the principal-axes mechanism (Pearson, 1901, Morrison, 1976), the iterative mechanism (Girshick, 1936) and the algebraic mechanism. All the mechanisms lead to the same result. The iterative mechanism is adopted in this study.

The variables for the model are as follows:

$$P_i = \Sigma A_{ij}X_j$$

where P_i is the ith PC ($i = 1, 2, \ldots, 10$), A_{ij} are the coefficients of the principal components (factor loadings), and X_1 is farm and home visits, X_2 informal contacts, X_3 full session meetings, X_4 demonstrations, X_5 group discussions, X_6 tours and field trips, X_7 posters, X_8 projected visuals, X_9 agricultural-extension news on radio, and X_{10} the agricultural campaign programme.

Factor loadings are tested for significance using the Burt-Bank test statistic. A factor loading is significant at the specified level if and only if the absolute value of the loading (A_{ij} is greater than or equal to the adjusted standard error (Burt and Banks, 1947; Banks, 1954).

2.2 *Source of data*

The data used in this study were obtained mainly from the Ilorin and Oyo North ADPs. Ilorin Project, with an area of about 11 775 km^2, occupies the southern end of Kwara State of Nigeria, while the Oyo North ADP occupies about 12 310 km^2 in the north of Oyo State. The choice of the projects is based on three criteria. The first is that the projects constitute two of the pilot projects which aim at raising the productivity of rural farmers through the establisment of rural infrastructure, prominent among which is a viable agricultural extension base.

The second criterion is that there are relevant data readily available from the questionnaires used for an economic survey for an impact study of a large number of ADPs within rural Nigeria. The survey was organized by the department of Agricultural Economics and Farm Management, University of Ilorin, in 1986, with an update in 1988. The relevant data were selected from sections of the questionnaire designed with the aim of obtaining the number of times a respondent was reached through any of the ten teaching methods. Relevant data also come from the section of the questionnaire which explored the particular extension-teaching method whose effect influenced the farmer's farm enterprise. Variables from these sections of the questionnaire were quantified using scores.

The third criterion is that the Ilorin and Oyo North ADPs are the two major projects with the highest explained proportions of total variations for the computed PCs in the set of all ADPs whose farm technology adoption is constrained by the multiple use of extension-teaching methods.

In the sampling design for the impact study, respondents were drawn from each of the projects in proportion to the population. For example, Oyo North, with a population of 727 000, produced 162 respondents, while the Ilorin ADP with 1.52 million population produced 338 respondents. The selection of respondents from each project district was also based on population characteristics. The sampling frame was mainly the base-line village listing obtained from each of the project sources. A randomized sampling technique was adopted in the final selection of respondents from the districts.

Secondary data came from the projects' quarterly and yearly reports, the projects' Administrative and Managerial Headquarters, and Kwara and Oyo States' Ministries of Agriculture and Natural Resources. Other information was gathered from the quarterly, yearly and completion reports of other World-Bank-assisted ADPs in rural Nigeria.

TABLE 1

Extracted principal components, Ilorin Project districts

Districts	Sample	Category of component	Factor loadings (A_{ij}'s)										Explained proportion of total variation (%)
			A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	
Asa	45	First	0.982*	0.882*	0.872*	0.889*	0.972*	0.840*	0.874*	0.981*	0.888*	0.894*	82.57
Ifelodun	48	First	0.882*	0.977*	0.880*	0.887*	0.884*	0.892*	0.983*	0.911*	0.878*	0.975*	83.88
Ilorin	100	First	0.989*	0.992*	0.958*	0.967*	0.852*	0.900*	0.942*	0.989*	0.844*	0.877*	86.98*
Irepodun	58	First	0.981*	0.952*	0.892*	0.980*	0.888*	0.868*	0.882*	0.871*	0.872*	0.895*	82.65
Moro	44	First	0.886*	0.887*	0.869*	0.989*	0.874*	0.889*	0.967*	0.987*	0.867*	0.882*	82.98
Oyun	43	First	0.860*	0.872*	0.882*	0.989*	0.872*	0.885*	0.869*	0.875*	0.881*	0.875*	78.62

* Significant at 1% level.

TABLE 2

Extracted principal components, Oyo North Project districts

Districts	Sample Size	Category of component	Factor loadings (A_{ij}'s)										Explained proportion of total variation (%)
			A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	
Ifelodun	55	First	0.862*	0.977*	0.912*	0.842*	0.882*	0.971*	0.981*	0.967*	0.867*	0.821*	82.82
Irepo	62	First	0.967*	0.923*	0.882*	0.932*	0.789*	0.881*	0.884*	0.978*	0.872*	0.901*	81.42
Kajola	45	First	0.911*	0.814*	0.967*	0.969*	0.868*	0.823*	0.823*	0.889*	0.864*	0.867*	77.63

* Significant at 1% level.

3. Empirical results

Tables 1 and 2 show the first principal components extracted using data from Ilorin and Oyo North Project districts. The first components are clearly superior to any others, as revealed in the large magnitudes of the explained proportion of total variation. The A_{ij}'s are the factor loadings identified with the respective extension-teaching methods (regressor variables). All the factor loadings are significant at the 1% level. The explained proportion of total variation, indicating the extraction ability of each component, range from 78.62% for Oyun district to 86.98% for the Ilorin district in the Ilorin ADP. For the Oyo North Project, the range of the components' extraction

TABLE 3

Extension teaching method ranks, Ilorin Project districts

District	First	Second	Third
Asa	Farm and home visits	Projected visuals	Group discussions
Ifelodun	Posters	Informal contacts	Agricultural campaign programme
Ilorin	Informal contacts	Farm and home visits/projected visuals	Demonstrations
Irepodun	Farm and home visits	Demonstrations	Informal contacts
Moro	Demonstrations	Projected visuals	Posters
Oyun	Demonstrations	Full session meeting	Agricultural news on radios

TABLE 4

Extension teaching method ranks, Oyo North Project districts

District	First	Second	Third
Ifedapo	Posters	Informal contact	Tours and field trips
Irepo	Projected visuals	Farm and home visits	Demonstrations
Kajola	Demonstrations	Full session meeting	Farm and home visits

ability is from 77.63% in Kajola district to 82.82% in Ifedapo district. The principal-components model, therefore, offers reasonable linear transformation of the variables for the ranking of the extension-teaching methods in the projects' districts.

Table 3 and 4 rank the first three important extension-teaching methods, in each of the project areas, based on the magnitudes of the loadings on each extension method. From Table 3, no single extension method may be chosen to be consistent with the first position in the Ilorin Project. Farm and home visits occupy the first position in both Asa and Irepodun districts, while demonstrations top the list in both Moro and Oyun districts. In any case, a closer examination of the magnitudes of the loadings reveals that demonstrations with a consistent coefficient of 0.989 in both Moro and Oyun districts may be selected as the priority method in Ilorin Project. The loadings on farm and home visits in Asa and Irepodun are 0.982 and 0.981, respectively. The projected visuals method is consistent with the second position since it features in three out of the six districts. No one method is consistent with the third position in the Ilorin Project. From Table 4, no particular method may be identified to be consistent with the ranking of methods in the Oyo North Project districts. In general, the distribution of the teaching methods across districts indicates that the three principal groups of extension-teaching methods (mass, group and individual) are adequately represented.

Many useful implications emerge from the study. The ranked order of the extension-teaching methods produced in this study is an invaluable cost-saving device. Each of the extension-teaching methods has enormous and varying fixed and variable cost implications in terms of human capital, 'liquid cash' and materials. The level of resource commitment in any particular component of the rural infrastructure depends on the availability of the investment resources and the degree of competition from other intended components. The project management may therefore find the ranked extension-teaching methods useful in allocating resources.

Extension agents who operate multiple extension-teaching methods often have a very heavy workload. They tend to be inefficient when they spread their efforts too thinly over several extension-teaching methods. Emphasis is often placed on having 'something' prepared for most, if not all the teaching methods rather than, doing a good job on one or two. The ranked order removes emphasis on the coverage of the whole spectrum of the communication methods and identifies for the agent a few of the most important extension methods. Thus the evaluation of the agents' efforts is made simpler.

The ranked order of the extension-teaching methods is also beneficial to the project management. Apart from the greater ease in appraising the efforts of the agents focused on a few areas of concentration, the management's co-ordination problem is also reduced and limited to a few of the most important aspects of the projects.

The ranked order of the methods offers some scale against which the corresponding total cost implications computed for each method could be compared for the final choice of extension methods. A particular method which occupies a top position in the scale may be of unaffordable cost, a second-best criterion may then be applied in selecting a method. In orther words, the next method which lies within the projects' financial resources may be selected.

The ranked order of the extension teaching methods facilitates the state-wide expansion of the projects. The blueprints of the state-wide projects place emphasis on narrowing the number and scope of the rural infrastructure to a few essential ones. The analysis carried out here presents an objective approach for streamlining the present pilot projects along the requirements of the state-wide project.

Some risks and uncertainties in the project area may be genuine causes for the substitution of one extension teaching method with the other. Extension staff continuity, departure or protracted ill-health of very specialized extension staff, transfer and attendance at short courses outside the project area call for the substitution of a particular extension teaching method. The knowledge of the component model in the production of a ranked order of the extension teaching methods is useful in continuing project management.

The integration of the model into the implementation process of the agricultural development projects ensures at all times the use of the most important and effective extension teaching method(s) for a rapid farm technology diffusion in the project area. Furthermore, the wide applicability of the model allows for continuing exploration of potentially useful extension teaching methods to achieve sustained productivity growth.

A comprehensive application of the component model as an instrument for the development of the national agriculture requires a much more extensive analysis than is attempted here. In particular, it requires a study which does not take a whole district as a basic unit. Furthermore, very useful results may be obtained if the model is made specific to crop activity, ecological area and season.

For completeness in the use of the model, some limitations of the principal component model as a ranking tool should be pointed out. The linearity assumption may lead to some erroneous results, especially where non-linear combination of the variables is more appropriate. The orthogonality assumption may be too restrictive in a rural agricultural economics study.

4. Summary

The agricultural-development projects' solution to the dichotomous agricultural-extension problems in Nigeria tends to assume a new, expensive and counterproductive dimension. At the current level of foreign indebtedness of Nigeria, coupled with the need to boost domestic food production through efforts of the small-scale farmers, the ranking and selection of a few of the most important extension-teaching methods for an identified group is provided here as a feasible solution. The relative importance of each of the ten extension teaching methods was evaluated using the principal-component analysis model, which linearly transformed the extension-communication methods into a single equation whose coefficients bore the relative importance of each method in the whole system. In the Ilorin Project, the most important extension teaching methods in Ifelodun and Ilorin districts are posters and informal contacts, respectively. For each of Asa and Irepodun districts, farm and home visit(s) are the most important methods, while demonstration is the most important in both Moro and Oyun districts. For Oyo North Project, posters, projected visuals and demonstrations are the most important extension-teaching methods in Ifedapo, Irepo and Kajola districts, respectively.

The model is useful in a number of ways. It is a cost-saving device, its integration into the project implementation stage ensures the substitution of any extension-teaching method at any point in time within the dynamic agricultural economy, and it can also be used to try out other potentially useful extension-teaching methods for more rapid farm-technology diffusion.

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