Examining Efficiency under Multi-Cropping Systems

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Abstract

This paper computes overall efficiency for 64 farmers practicing multi-cropping system in Ekiti State of Nigeria. These are decomposed into pure technical efficiency and scale efficiency. Results show that 34 and 40 farmers are technically and scale inefficient, respectively. Overall, 40 farmers are found to be inefficient.

1.0 Introduction

A number of previous studies have examined farmers' production efficiency and agricultural productivity in developing countries. Common to most of these studies is the assumption of mono-cropping for ease of analysis, mainly because of data availability (Kelly *et al*., 1995; and Zepeda, 2001). Similar problems have been identified in another study by Keith *et al*. (2001).

In most part of sub-Saharan Africa, efficiency and agricultural productivity analysis have been limited by the subsistence and mixed cropping pattern, lack of adequate farm records to generate reliable time series data, heavy reliance on family labor and family assets for production, and the difficulty of accounting for family input in the production system.

Carter and Weibe (1990) reported that significant imperfections in the market for labor based on the fact that only a small proportion of the marginal product of labor was actually applied on small farms. The implication of this is that price information is often lacking. However, recent studies have shown the limitations of this basic assumption in understating the efficiency of these farmers on one hand, and more importantly, implications based on such analysis tend to be quite unreliable.

Kelly *et al.* (1995) showed that data collection methods underestimate agricultural production in Africa up to 50 percent. While stating that crop by-product from the mixed cropping are not enumerated, a substantial portion of the output is consumed by the subsistent farming household and never adequately accounted for in production/efficiency analysis. Also, data on production inputs are difficult to enumerate because of the illiteracy, poor farm record keeping and therefore often ignored. In view of these problems and limitations, any analysis of efficiency in these areas must appropriately account for the cropping pattern, the production characteristics and the peculiarities of the subsistent agriculture.

To avoid the above stated pitfalls, this study examines the production efficiency of farmers in Ekiti state, in the southwestern part of Nigeria, using survey data. The peculiar production characteristics of these farmers are taken into consideration to adequately account for the mixed cropping practice. Also, efficiency measures are further decomposed into pure technical efficiency and scale efficiency.

The remaining part of this paper is organized as follows. The data and method of analysis are presented in the next section. This is followed by the presentation and discussion of the results. The paper ends with a section on the implications of findings, summary and concluding remarks.

2.0 Data and Methodology

2.1 Types and Source of Data

This study covers 64 farmers in Ekiti State in the southwestern zone of Nigeria. Survey data on land use in hectares (ha), labor (mandays), tractor (hours) and fertilizer use (grammes) were collected. Other variables include credit facilities in naira (local currency), extension visit, and demographic information (age and farming experience in years, and membership of cooperative society). Output data include yam, maize, and cassava, all in kilograms.

The zone is well suited for production of food crops such as maize, cassava, rice, yam and plantain. The bulk of agricultural products come from small-scale farmers who practice manually cultivated rain-fed crops. The growing season of over 200 days permits a sequential cultivation of a wide range of crops with differing growing and maturing periods. Majority of farmers in the area are small-scale farmers with average farm size of about one hectare (Olayide, 1980).

For this study, the selection of respondent farmers was multi-stage and involved random sampling method, as well as purposive sampling. In the first stage, the villages in the state were divided into two strata (urban and rural). The rural stratum was purposively selected, as agricultural production is more common in the rural settings than the urban areas. Within the rural stratum, two villages were randomly selected from which a total of 64 farmers were interviewed.

2.2 Summary Statistics of Data

Summary statistics of the output and inputs data across the 64 farms are presented in Table 1. This table shows that the quantities of farm outputs range from 1000-11000kg, 1000-15000kg, and 1500-9000kg for yam, maize and cassava, while those for inputs range from 0.8-4.10ha for land, 69-400 man-days for labor, 1-20 tractor hours, and 0-8000g of fertilizer. The mean for the outputs are 4514.38kg, 4512.81kg, and 4701.94kg for yam, maize and cassava, respectively. For the inputs, they are 2.37ha for land, 166.45 man-days for labor, 8.77 for tractor hours, and 828.28g for fertilizer. Labor has the highest standard deviation among the inputs with 72.46, while maize has the highest (i.e., 2756.19) among the outputs.

2.3 Analytical Method

A non-parametric, non-stochastic approach was used to analyze inter-farm efficiency differences. Efficiency measures how well a farmer is doing things correctly (Bodek, 1985). The efficiency is defined using distance functions that are estimated using Data Envelopment Analysis (Caves *et al*., 1982b; Coelli *et al*., 1998; and Ramanathan, 2003).

Following Färe *et al*. (1985) and Chavas and Aliber (1993), the Farrell's (1957) technical efficiency indicates if a farmer was using the best available technology and scale efficiency indicates if a country was on its optimal production size. These components are estimated under non-constant and constant returns to scale, respectively, and are equal to 1 if farmers are efficient or less than 1 if they are inefficient.

3.0 Result and Discussion

As shown in Table 2, the results indicate that, on average, pure technical efficiency, scale efficiency and overall technical efficiency are 0.8435, 0.8801, and 0.7424, respectively. This indicates that farmers should increase production by 15.65%, 11.99%, and 25.76% in order to be efficient.

Considering individual farmers in the entire sample, results show that 30 and 34 farmers have pure technical efficiency that is equal to and less than 1, respectively. Scale efficiency is equal to and less than 1 for 24 and 40 farmers, respectively. Also, overall efficiency is equal to and less than 1 for 24 and 40 farmers, respectively.

4.0 Implications of Findings, Summary and Conclusion

The focus of this study was to compare efficiency among farmers under a multi-cropping system of agriculture, using data on output (yam, maize, and cassava) and inputs (land, labor, tractor, and fertilizers) for 64 farmers in Ekiti State of Nigeria.

Data Envelopment Analysis was used to estimate production efficiency. Efficiency was decomposed into pure technical efficiency and scale efficiency. Farmers' efficiency averaged -15.65%, -11.99%, and -25.76 below the frontier, for pure technical efficiency, scale efficiency, and overall efficiency, respectively.

Areas of further research include incorporating a single cropping system in the study in order to compare the efficiency differences of farmers under the two farming systems. Also, it would be interesting to examine the factors responsible for the inefficiency among the farmers.

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Table 1. Summary Statistics of Data

	# Obs	Mean	Std Dev	Minimum	Maximum
Land Size (ha)	64	2.37	0.87	0.80	4.10
Labor (mandays)	64	166.45	72.46	69.00	400.00
Tractor Hour	64	8.77	4.17	1.00	20.00
Fertlizer (g)	64	828.28	1385.27	0.00	8000.00
Yam (kg)	64	4514.38	2209.54	1000.00	11000.00
Maize (kg)	64	4512.81	2756.19	1000.00	15000.00
Cassava (kg)	64	4701.94	2029.37	1500.00	9000.00

Table 2. Components of Overall Efficiency					
Pure Technical Efficiency		Scale Efficiency		Overall Technical Efficiency	
0.9417	0.7753	0.9884	0.8079	0.9307	0.6264
1.0000	0.9722	1.0000	0.2739	1.0000	0.2662
1.0000	1.0000	1.0000	0.7852	1.0000	0.7852
1.0000	0.8571	1.0000	0.8423	1.0000	0.7219
1.0000	0.6155	1.0000	0.9304	1.0000	0.5727
0.8294	0.7056	0.9199	0.9927	0.7630	0.7004
0.5842	0.6127	0.9608	0.8454	0.5614	0.5180
1.0000	0.8368	1.0000	0.9042	1.0000	0.7566
1.0000	0.6615	1.0000	0.9377	1.0000	0.6203
1.0000	0.6773	1.0000	0.9998	1.0000	0.6772
0.8901	0.8720	0.9988	0.6372	0.8891	0.5556
0.4368	0.7791	0.9280	0.6994	0.4054	0.5449
0.6977	0.5593	0.4970	0.8850	0.3468	0.4950
1.0000	0.8927	1.0000	0.9626	1.0000	0.8594
0.8039	1.0000	0.9461	1.0000	0.7606	1.0000
1.0000	1.0000	0.6395	1.0000	0.6395	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.6228	0.5479	0.8744	0.8860	0.5446	0.4855
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.4543	1.0000	0.4621	1.0000	0.2099	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.9226	1.0000	0.8669	0.9510	0.7998	0.9510
0.8195	1.0000	0.5171	1.0000	0.4238	1.0000
0.8013	1.0000	0.8773	1.0000	0.7029	1.0000
1.0000	1.0000	1.0000	0.9867	1.0000	0.9867
0.9306	0.6107	0.9660	0.7330	0.8990	0.4476
1.0000	0.6098	1.0000	0.8781	1.0000	0.5355
1.0000	0.7815	0.8333	0.9785	0.8333	0.7647
1.0000	1.0000	0.7456	1.0000	0.7456	1.0000
0.9394	0.5210	0.9992	0.8756	0.9387	0.4562
0.7682	0.8933	0.7847	0.9203	0.6028	0.8221
1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Mean: 0.8435		0.8801		0.7424	