

Land Fragmentation, Land Size and Productivity: Empirical Evidence from Irrigated Settlements of Sri Lanka

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Introduction

Land is not only the main factor of agricultural production, but it is also a means of social security, status and an identity in many developing countries. Land fragmentation, where a single farm is divided into numerous individual parcels of land, is a common feature in many agrarian societies. The most frequently cited forces that contribute to land fragmentation are inheritance, population pressure and government redistribution of land (Blarel, 1992). Land fragmentation lead to farm operations with a number of small land parcels in dispersed locations.

The theoretical debate on the effects of land fragmentation on agricultural productivity is two-fold. On one hand, it has been argued that land fragmentation acts as an obstacle in agricultural development because it hinders mechanization; increase the cost of production and increase the travel time of the farmer between fields (Niroula & Thapa, 2005). On the other hand, it has been argued that fragmentation facilitates crop diversification, reduces production risk, and exploits land parcels of differing quality (Bentley, 1987).

Empirical findings on the relationship between land fragmentation and productivity are also mixed and inconclusive. Blarel et al. (1992) in Ghana applying a systems of equations concludes that land fragmentation has no significant impact on productivity, because of the diversity in biophysical condition in fragmented plots allow small farmers to grow a range of crops. Similar results were obtained by Wu Z. et al. (2005). According to Rahaman and Rahaman (2008), Falco et al. (2010), Kawasaki (2010), and Lon et.al. (2011), land fragmentation reduces productivity as fragmented land parcels discourage farmers from adopting agricultural innovations.

Objectives of the Study

The overall objective of this study to assess the effects of land fragmentation on paddy land productivity in irrigated settlements in Sri Lanka. The study specifically assesses the effects of farm size, number of plots managed by an individual farmer, and size and shape of the plots on land productivity.

Methodology

Two separate functions were estimated treating productivity of the plots and that of the farms as dependent variables. In order to capture a quadratic relationship between land productivity and size, square terms for size were included. Sizes of plots and farms, number of plots per farm and shape of the plot were included to capture the key effects of fragmentation. The equations were estimated with corrections for heteroscedasticity using robust standard errors. The specifications are given below:

$$\text{ProPlot} = \alpha_0 + \alpha_1 \text{PlotSize} + \alpha_2 \text{PlotSize}^2 + \alpha_3 \text{NumPlot} + \alpha_4 \text{Distance} + \alpha_5 \text{Shape} + \alpha_6 \text{Soil} + \alpha_7 \text{Labor} + \alpha_8 \text{Seeds} + \alpha_9 \text{Machinery} + \alpha_{10} \text{Age} + \alpha_{11} \text{Edu} + e_1 \quad (1)$$

$$\text{ProFarm} = \beta_0 + \beta_1 \text{FarmSize} + \beta_2 \text{FarmSize}^2 + \beta_3 \text{NumPlot} + \beta_4 \text{AvgDistance} + \beta_5 \text{Labor} + \beta_6 \text{Age} + \beta_7 \text{Edu} + e_2 \quad (2)$$

Where, ProPlot is land productivity of the plot (output of the plot/plot size measured in kg per acre), ProFarm is land productivity of the farm which consists of all the plots cultivated by a single farmer (total output of the farm/farmsize measured in kg per acre), PlotSize is land size of the plot (acres), FarmSize is size of a farm (acres), Labor is labour (man days per acre), Distance is distance from home to a plot (meters), AvgDistance is average distance from home to plot (meters), NumPlot is number of land plots and Age is the age of the farmer (years), Edu is number of years of education. The binary variables included are: Soil is soil quality (1= if fertile, 0= other) Seeds is variety of seed (1=if samba, 0=other), Machinery is use of machinery (1 = if use, 0= other), Shape (1= if regular, 0= other), e_1 and e_2 are the error terms.

Study Area and Data

Irrigated agriculture is considered as one of the principal beneficiaries of public sector investments in agriculture in Sri Lanka. At the inception of land redistribution schemes, landless farmers were granted equal sized low lands of three acres in irrigated settlements in the dry zone areas. Subsequently, the initial land allocation was sub-divided and distributed among the second and third generation farmers. With this process of sub-division, certain farmers started to operate small land parcels sometimes in dispersed locations. The decline of operational size of land was found to be varied from 45 percent to 60 percent in irrigated settlements (Wanigaratne, 1995). The population covered in this study are the paddy farmers in irrigated settlements in Anuradhapura District where three acres of low land were alienated per farmer at the inception of the settlement. Data was gathered from a systematic random sample of 306 paddy farmers cultivating 409 lowland plots. Face to face interviews were conducted using a structured questionnaire to collect data.

Key Findings

The average size of a land plot is 1.5 acres, which coincidentally is the minimum allowable legal size in irrigated settlements. It was found that of the 409 plots, 194 are smaller plots (below 1.5 acre in extent) and 215 are larger plots (equal and above 1.5 acres). Out of 194 smaller plots, the majority are (171 plots) cultivated by farmers who cultivate more than one plot and their average productivity level is significantly lower (1666 kg/acre) than that of the rest (1948 kg/acre).

The average size of a farm was found to be 1.7 acres. Four categories of farms were identified according to the number of plots in a farm. Table 1 presents the number of farms in each category, the average size of the farm, and the average productivities. The results of Table 1 indicate that the average productivity in farms with single plot is significantly higher than farms with multiple plots.

Table 1: No of Plots in a Farm, Average Size and Average Productivity of The Farm

No of Plots in a Farm	Number of Farms	Average Size of the Farm (Acres)	Average Productivity of the Farm (Kg/Acre)
1	222	2.0	1950.87
2	65	1.7	1705.30
3	17	2.7	1697.02
4	2	3.6	1662.50
Total	306	1.6*	1882.70

The key outcomes of estimation results of model (1) clearly indicate that size of the land plot has a positive and significant effect on productivity of plots and an increase in land size by one acre will increase land productivity by 108.8 kg/acre. The number of plots has a statistically significant and negative effect on productivity of plots indicating that when farmers operate more than a single plot, they become inefficient in managing the scattered plots. An increase in one meter distance from home will decrease land productivity by 0.02 kg/acre indicating that farms with longer distance from home are less productive. Regular shaped plots are more productive than the others.

The key outcomes of estimation results of model (2) reveal that the relationship between total extent of the farm and land productivity of farm is quadratic. Farm productivity increases until 3.66 acres and it declines thereafter. The number of plots has a statistically significant and negative effect on productivity of farm as well. An increase in a plot in a farm will decrease land productivity by 162.91 kg/acres. This implies that farmers are inefficient in managing farms with multiple plots. The results also reveal that the average distance from home to plot is statistically significant and has a negative impact on productivity. An increase in one meter distance from home will decrease land productivity by 0.02 kg/acre.

Conclusion

The results of the estimations clearly reveal that the larger plots are more productive and there exists a quadratic relationship between land

productivity and farm size. When farm size increases the land productivity of farm increase up to 3.66 acres and further increase in farm size decreases land productivity. The results also indicate that an increase in the number of plots in a farm is an influential predictor of loss of productivity. This could be due to inherent inefficiencies associated with managing scattered plots and constraints with respect to use of machines. Land plots with longer distance from farmers home are less productive and increase both the travel time and the cost of inputs. Overall, the results suggest that land fragmentation adversely affects the land productivity. Policies and programs that lead to increase in plot size and decrease in number of plots owned by a farmer improves land productivity in irrigated settlements in Sri Lanka.

Keywords: Agrarian Societies; Irrigated Settlements; Land Fragmentation; Land Productivity; Land Size

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