

Land Fragmentation and Land Productivity: Empirical Evidence from Land Distribution Schemes of Sri Lanka

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ABSTRACT

The purpose of this study is to assess the effects of land fragmentation on paddy land productivity in Land distribution schemes in Sri Lanka. At the inception, landless farmers were granted with equal sized low lands. Subsequently, the initial land allocation was sub-divided and distributed among the children. Currently, the contribution to Gross domestic product is gradually declining. Using systematic random sample method, 935 paddy farmers were selected who were cultivating 1230 lowland plots in Anuradhapura district in Sri Lanka. Face to face interviews were conducted using a structured questionnaire to collect data. The results clearly indicate that the size of the land plot has a positive and significant effect on land productivity. The number of plots and distance has a statistically significant and negative effect on productivity. 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 in order to improve land productivity in land distribution schemes in Sri Lanka.

Key words: Land Fragmentation, Land Size, Land Productivity, Land Distribution Schemes, Irrigated Settlements, Sri Lanka.

INTRODUCTION

Land is not only the main factor of agricultural production, but also it is a source of wealth, a means of social security, a status and an identity in many developing countries. Particularly in South Asian countries, land has a closer link with the livelihoods of the people as majority depends on agricultural activities. In agrarian economies, land reforms such as land redistribution can play a pivotal role in land inequity. However, many of such programs experience the increasing land fragmentation, decreasing land size and decreasing trend in productivities. Land fragmentation is a common feature in many agrarian societies and in simple terms, defined as a single farm is divided into numerous individual parcels of land. The word fragmentation is derived from 'fragment', which the Oxford Dictionary refers to an incomplete part, or a piece that

is detached or isolated from a whole it originally belonged to. However, land fragmentation implies any one or a combination of the following: (i) non-contiguous land parcels that are owned and tilled as a single enterprise (ii) parcels that are distant from the owner's home or from each other (iii) or, ownership of very small parcels (Sabastes-Wheeler, 2002).

Institutional policy matters coupled with customary practices is observed in paddy lands in the land distribution schemes (irrigated settlements) of Sri Lanka. Irrigated agriculture is considered as one of the principal beneficiaries of public sector investments in agriculture in Sri Lanka. During the periods of 1970 – 1980 around 65% of the domestic paddy production was supplied by these settlements, while at present it is reduced to 45% of domestic supply. (Land Commissioner Reports 2000-2009). It is also observed a gradual

reduction of the land sizes allocated to settlers. At the inception of land redistribution schemes, landless farmers were granted with equal sized low lands of five, three and two 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% to 60 % in irrigated settlements (Wanigaratne, 1995). The extent of decreasing land sizes, ownership of number of plots, distance from home to plot, defined as land fragmentation and the effects on land productivity has not adequately being addressed in the country.

OBJECTIVES

The overall objective of this study to assess the effects of land fragmentation on paddy land productivity in land distribution schemes of Sri Lanka. The study specifically assesses the effects of plot size, number of plots operated by an individual farmer, and the distance from home to plots on land productivity.

The rest of the paper is organized as follows. The section two presents the causes of land fragmentation and the theoretical and empirical debates on the effects of land fragmentation on productivity. The history of land settlements in Sri Lanka and the current status is explained in section three. Section four of the paper uses to discuss the methods applied and section five details out the study area and the data. The characteristics of plots are explained in section six whereas section seven presents the results of the econometric estimations. The last section is use to

present the conclusions and policy implications.

THEORETICAL CONSIDERATIONS AND EMPIRICAL EVIDENCE

Causes of land fragmentation

Policy makers find difficulties in treating land fragmentation unless they do not aware of the real causes or the after effects of fragmentation. Several forces have been extensively cited as causing or contributing to boost up land fragmentation in country to country and region to region. The most frequently cited are partial inheritance, government land redistribution and population pressure followed by land scarcity (Blarel et al., 1992; Tan et al., 2006). In China land re-allocation is often required when the registered population of a village changes. An example is when a child is born or a local student enters university. It is well known that the population in China is on the increase and due to industrialization and urbanization; arable land is in the decline. Given China's territorial size and varying population density, it is not surprising to find that the degree of land fragmentation varies substantially from region to region (Wan and Cheng, 2001).

In many of the developing countries the paternal cultural inheritance practices widely contributed to physical land fragmentation (Niroula and Thapa, 2005). Children especially sons when they separated from parents believe that it is their right to get a share of paternal property. This is more peculiar when sons separated from parents would have face difficulties with severe economic problems. In some countries there's inheritance law. Islamic law requires an equal division of paternal property among all heirs after the death of the landowner. When heirs hunt for equal land parcels, it increases the fragmentation. The Islamic law in Bangladesh is an example for such

process (Lusho and Papa, 1998). Rahaman and Rahaman, (2008) observed a rapid decline in the farm sizes coupled with an increase in the number of operational holdings. Further, they observe the number of small farms increased dramatically at the expense of a reduction in the number of large and medium sized farms.

In some countries it is not the inheritance but relate to the objective of achieving equitable distribution of land among the people. This kind of fragmentation is driven by the local institutions in the country (Falco et al., 2010). Institutions are governed by the state. Later, these lands are subjected to traditional customary land transformations. At the end of this process the situation becomes worst, because a fragmented land has fragmented again. According to Lusho and Papa (1998), with agrarian reforms in 1945, in Albania the larger landholdings which included merchants and religious institutions, were expropriated and their lands were distributed among the peasants. These lands were given to 70 000 families who did not own the land or owned very little. At the end of the redistribution process the ownerships changed and the land sizes too.

EMPIRICAL FINDINGS

The empirical findings of land fragmentation can be discussed in two directions. Although land fragmentation has a documentary history since from 1950 when Binn (1950) wrote why land fragmentation occurs, the Schultz's (1964) theory of the inverse relationship between land size and productivity attracted many scholars' attention. Therefore, more over the majority of findings focus on their relationship between land holding size and productivity. Empirical findings on the relationship between land size and

productivity are mixed and inconclusive. Toufique (2005) and Vadivelu et al., (2006) has revealed an inverse relationship between farm size and land productivity in Bangladesh and in India respectively. The authors indicated that the inverse relationship was due to the availability of family labor at low or zero opportunity cost for small scale farmers. The small farmers use only family labor, which has strong incentives to work as they expect to inherit the farm in the long run. Conversely, Obasi (2007), Chen *et.al*, (2011), Matchaya, (2007) and Tamel (2011) revealed a positive relationship between land size and productivity in Nigeria, China, Malawi and US respectively. This reveal that the later studies discuss the size productivity inverse relationship is disappearing with the technological development all around the world. However, Rahaman and Rahaman (2008) argue that the relationship of size-productivity is positive in technologically advanced regions, whereas the typical inverse relationship still exists in backward areas. Niroula and Thapa (2005) pointed out that the long debated theory of inverse relationship between farm size and productivity holds less value when small landholdings further fragmented into numerous small parcels scattered over a wide area.

With this background majority of the studies concentrated on land fragmentation and productivity. 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. Hence, farmers do not consider it as a problem. Similar results were obtained by Wu Z et al., (2005).

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, increase the travel time of the farmer between fields and the loss of lands in boundaries (Niroula and Thapa, 2005; Falco et al., 2010). Distance between parcels, small sizes, irregular shapes and lack of access are some of the disadvantages continuously discussed. When parcels are spatially dispersed, travel time as well as costs in moving labor, machines from one parcel to another increased (Blarel et al., 1992). With land fragmentation the ownership of production resources such as animal power and family labor also reduce and can adversely affect on productivity (Wan and Cheng, 2001; Rahaman and Rahaman, 2008). The main argument in favor of resource ownership such as family labor is the overuse of family labor by the small holders which in turn result in higher productivity. Farmers having number of plots here and there losses the efficient use of human labor on time. In addition, land fragmentation involves a complicated boundary lines and the margins of the parcel is not utilized hence there is land wastage. Use of machinery may be impossible for tiny parcels and require excessive amount of manual work. Moreover, the irregular shape limited again the use of machinery. The inadequate road network to provide access to each smaller parcel is another disadvantage. Limited access to parcels prohibits the development of some of the infrastructure such as irrigation canals. On one hand it may incur a higher cost (Kawasaki, 2010). On the other hand due to the lack of compromise between land holders there would not be space, because the owners with quality lands never agree

to provide space for such activities. Consequently, proper distribution of irrigated water among the farmers may arise and the secondary and tertiary canals may not in line since land is fragmented to further small plots (Niroula and Thapa, 2005). This may give rise to social conflicts between farmers. Another detrimental effect is with many plots the management become impossible. Giving services to lands such as during the time of disease, on time provision of inputs and preparation of soil, the possible time a farmer can spend will naturally reduces.

Beside the above problems another unnoticed but important affect is the loss of property rights to all land holders in an equal basis with land fragmentation. During the subdivisions and distributions of lands to heirs the full rights may not transfer. Especially in lands alienated through government strategy there are certain restrictions in transformation of lands. Kakwagh et.al (2011) in their study pointed out that land fragmentation has severe consequences for agricultural development and lack of security of land tenure is significant. Therefore, inadequate rights continue with all sorts of transfers of these lands. If there are limited rights the result is less tenure security.

It is generally accepted that all above issues associated with land fragmentation usually act as obstacles to rational agricultural development. Even though the physical land fragmentation has negative connotations, it is not necessarily an accused in all cases (Blaral et al., 1992; Van Dijk, 2003) and there are beneficial effects. Land fragmentation might however, drive towards crop diversification, which act as a risk reduction strategy of the farmer. Another beneficial effect is land fragmentation offer the land parcels of differing quality (Blarel et.al., 1992; Hung, 2006). Lands in various ecological zones

offers different climatic conditions, differing soil quality therefore crop scheduling occurs at different times. During the natural disaster such as flooding or droughts this diversified nature of growing pattern minimizes the potential risk of the farmer.

Contradict to the above results a study done by Hung (2007) in Vietnam using the number of plots as a proxy for land fragmentation found that the coefficient of number of plots was negative and statistically significant. Therefore, the results suggest fragmentation has a negative impact on crop productivity. The coefficient of interaction terms between the number of plots and family labor also negative and significant suggesting that fragmentation has an effect on increasing family labour cost and use of other expenses. Similar results identified by Falco et al (2010) on land fragmentation and farm productivity in Bulgaria. The study found that land fragmentation plays a detrimental role on farm profitability. On these circumstances they conclude that the farms with fragmented lands are less profitable.

The conclusion drawn on negative results of fragmentation is further supported by a very recent study by Austin et.al (2012) in Nigeria. The land fragmentation was captured by using the Januszewski's fragmentation index (JI), which is a combined indicator, and identified the JI index has a negative effect on productivity. Similar results were identified by Rahaman and Rahaman (2008) in Bangladesh. The study tried the fragmentation effects on both productivity and efficiency among rice producers. The study used primary data on a farm survey and a number of plots used as the proxy for land fragmentation. The results demonstrate that land fragmentation is an influential predictor of technical inefficiency and loss of productivity.

Some of the studies specifically focus to identify whether fragmentation increases the cost of production. One of such studies conducted by Kawasaki (2010) in Japanese rice farms. Kawasaki pointed that land fragmentation is a harmful phenomenon as a whole than beneficial. A very recent study by Deininger et al. (2014) concludes that land fragmentation increases the cost of production. This study was done in India in 240 villages using the secondary data on around 17 000 plots. They have considered not only the distance from home to plot but also the time taken to travel as well. According to the econometric results the study concludes that fragmentation is not neutral, but disproportionately increases the cost and it is significant in smallest farm size classes.

LAND FRAGMENTATION IN LAND DISTRIBUTION SCHEMES IN SRI LANKA

In Sri Lanka the history of settling people by alienation of government lands goes back to the early decades of the 20th century. This became a popular rural strategy in allocating lands to rural poor during the pre and post independence (before and after 1948) eras. There were other strategies but the major settlements known as irrigated settlements or major colonization were subjected to more debate due to the significant contribution of the settlements to the society and to the economy of the country. Government initially expected to achieve number of objectives through the strategy. Among them (i) to protect the peasant farmer (ii) to alleviate land hunger among the poorest of the poor (iii) to relieve the population pressure of the villages in the wet zone of the country (iv) to increase the food production, particularly paddy (v) to develop the scarcely populated dry zone of the country are some of them. With the aim of such objectives, heavy investments

were done to the water reservoirs, constructing the irrigated networks such as canals, some of the primary needs such as schools, hospitals etc. The settlers have access to free water supply through the canal system managed by a separate irrigated office for each settlement. Except a very few settlements initiated at early 1930's all other settlements have a residential project office. This is use to conduct monthly meetings with the representatives of the settlers sharing the information.

The landless peasants were allocated with both highlands and low lands. Almost all the settlers were granted with two acres of highlands and the extent of paddy lands was varied. The early settlers had five acres whereas the next had three acres and two acres respectively. In order to protect the settler provisions were introduced through a government enacted law, called as Land Development Ordinance of Number 19 in 1935 (LDO). The provisions provided by the ordinance restricted further subdivisions and all forms of transactions. Later, amendments were introduced as the minimum legal size of the low land plot is as 1.5 acres in extent and a farmer with a valid deed has the transfer rights subjected to the sanction of the government administrative officer of the respective settlement area. The settlers earlier had a document called 'permit' to prove their tenure and the permits were transferred to a deed in 1985. When a land is subdivided into legally acceptable extents a permit is given and taking into consideration of the performance of the land holder it is transferred to a deed within a time period of one year.

The empirical situation in settlements is much more complex than what was expected from the provisions provided by the LDO and what was expected by the

government. It is observed a 45% decrease in land sizes after thirty years period of the establishment of settlements (Wanigarathne, 1995; Chandrasiri, 2009). Despite the restrictions imposed by law, there are informal sales, private mortgages, and land transformations through inheritances. The current land sizes in paddy lands have been subdivided into 0.25 acres in some cases in transferring to next generations. Since the young generation has to begin work with comparatively smaller plot, there is a tendency to seek acquiring more land plots either in temporary or permanent basis. Therefore, the characteristics of land fragmentation are observed.

METHODS

VARIABLES

To assess the effects of fragmentation on productivity a production function was estimated treating plot specific characteristics, conventional input usage and farmer specific characteristics as vectors of independent variables. In order to capture a quadratic relationship between land productivity and size, square terms for size were included. The function was estimated treating productivity of the plots as dependent variable. Size of plot, number of plots per farm, distance from home to plot was included to capture the key effects of fragmentation. The equation was estimated with corrections for heteroscedasticity using robust standard errors. The specifications are given below:

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

Where, ProPlot is land productivity of the plot (output of the plot/plot size measured in kilogram per acre), PlotSize is land size of the plot (acres), Labor is labour (man days per acre), Distance is distance from

home to a plot (meters), , NumPlot is number of land plots and Age is the age of the farmer (years), Edu is number of years in 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

The study population is the paddy farmers in irrigated settlements in Anuradhapura district in the dry zone of Sri Lanka. Three irrigated settlements were selected according to the paddy land allocation as five, three and two acres in extent. A systematic randomized sample was selected from each settlement covering the head end, tail end and from the middle considering the distance from the main irrigation source. Data was gathered on plot level basis, from 935 paddy farmers cultivating 1230 lowland plots. The sample was drawn proportionately to the extent of low lands, a farmer holds within the settlement boundaries. Face to face interviews were conducted using a structured questionnaire to collect data.

The questionnaire comprised of four sections such as demographic characteristics of the farmer, plot specific characteristics, cost and quantity of conventional inputs, and tenure arrangement. In order to avoid the inclusion of the area used for other crops in paddy lands questions were used to inquire the extent owned but used for other cultivations than paddy. To verify the actual output produced by each plot, the cross information on the amounts kept for consumption and for selling purpose were used.

ANALYSIS

Characteristics of the plot and farm in three settlements

The analysis was performed on 1230 plots belongs to 935 farms. As the minimum allowable extent in the settlements is 1.5 acres it was analyzed to identify the current distribution pattern of the plots in three settlements. The results are as in Table 1. Information in Table 1 revealed that majority of the plots i.e. 54% are in single ownership and 46% are with multiple ownerships. However majority of the multiple ownerships are smaller plots. It is 35% from the total number of plots and 76% of the total multiple owned plots. This implies that farmers with smaller ownerships are more likely to acquire more lands. It is also reveals that majority of the larger plots are operated by single owners and it is 53% out of the total plots and 80% out of total plots in single ownership. The Table 2 presents the information on the average productivities in between the two land extent categories. The independent sample t -test results indicate (t statistics 14.55) the average productivities in the smaller lands are significantly lower than the rest.

Results of the Econometric Estimation

The econometric estimated result of equation (1) is presented in Table 3. The results 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 75 kilogram per acre.

The estimated results indicate that the number of plots is statistically significant and has a negative impact on productivity as expected. An increase in a land plot will decrease land productivity by 56 kg/acre. This indicates that when farmers operate more than a single plot becomes inefficient in managing the scattered plots. Therefore, farmers with

single plots are better compared to farmers with multiple plots. An increase in one meter distance from home will decrease land productivity by 0.05 kilogram per acre indicating that farms with longer distance from home are less productive.

The estimated results reveal that the shape of the plot is statistically significant and has a positive impact on land productivity. The regular shaped plots facilitate mechanization. The results indicate that labor days are statistically significant and have a positive effect on productivity and imply an increase in a man day in labor will increase land productivity by 2.17 kilogram per acre. The variety of seeds, mechanization and the quality of soil has statistically significant effects on productivity. With respect to farmer characteristics; age and the number of years in education are statistically significant and have a positive effect on productivity. This implies that older generation is more productive than younger generation. Similarly better performances are observed in educated farmers.

CONCLUSIONS AND POLICY IMPLICATIONS

The results of the estimations clearly reveal that the larger plots are more productive. The results also indicate that an increase in the number of plots operated by a farmer 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.

It is evident that there should be approximate measures to control land

fragmentation in land distributions schemes in order to achieve the policy objectives that was scheduled at the introduction of the land alienation strategy. Low land plots with unaccepted sizes should be treated under the policy implications, which are involved in land fragmentation. Provisions could be provided under the regulations to form family associations in special cases where there are more dependents on a same land. In this method the members in the association can share all the benefits and the cost. This would automatically control the continuity of subdivisions into smaller units of the land. Further, policies and programs that lead to increase in plot size and decrease in number of plots owned by a farmer in order to improve land productivity in Land Distribution Schemes in Sri Lanka.

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Table 1: Distribution of number of plots according to single and multiple ownerships

Land size (acres)	With multiple ownership	Single ownership	Total
Below 1.5	435	134	569
Equal and above 1.5	136	525	661
Total	571	659	1230

Table 2: Average productivities of the two land extent categories.

Land size	Number of plots	Average Productivity (kg/acre)
Below 1.5	569	1733.84
Equal and above 1.5	661	1921.27

Table 3: Descriptive statistics and the estimated coefficient values - Equation (1)

	Variable	Measure	Mean value	Std deviation	Coefficient t	P value
Dependent variable	Productivity Output (kg) per acre		1834.56			
	R ²					0.55
	N					1230
	Constant				1438.3	0.000
Plot specific characteristics	Size of plot	Acres	1.5	.8481	75.38 (24.10)	0.002***
	Size of plot ²	Acres	2.9	3.417	-5.93 (4.86)	0.223
	Distance from home	Meters	1485.23		-0.05848 (.0057)	0.000***
	Soil Quality	Dummy (1= if fertilized, 0= other)			72.47 (10.93)	0.000***
	Shape of the plot	Dummy (1= if regular 0= other)			27.10 (15.00)	0.071*
Conventional Inputs	Mechanization	Dummy (1= if use, 0 = other)			52.10 (11.64)	0.000***
	Labor	Persons days/acre	25	7.54	4.31 (1.09)	0.000***
	Variety of Seeds	Dummy(1=if samba, 0=other)			160.41 (11.59)	0.000***
Farmer characteristics	Age	Years	49	11.55	2.39 (.4694)	0.000***
	Education	Years	4	2.93	8.32 (2.13)	0.000***
	Number of plots operate	Number	1.6	.8152	-56.66 (6.54)	0.000***
Settlement Variability	Dk=dummy for Kagama				-6.84 (15.40)	0.657
	Dm= dummy for Mahakanadarawa				-8.40 (12.13)	0.489

*-significant at 10% **-significant at 5% ***-significant at 1% (Figures in parenthesis represent std. errors)