Long-Term Farming Trends. An Inquiry Using Agricultural Censuses

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Abstract

This paper provides a long-term and global view at current farming trends by analyzing a specially created database of farming characteristics of 17 countries across 43 different agricultural censuses representing the different developing regions of the world. The study shows that while agricultural land appears to be a constraint in central and East Asia, it has been under expansion in Latin America, Northern Africa, and most of Sub Saharan Africa. We also estimate that 9 out of 10 farms are "small" (i.e. smaller than 2 ha). These farms are more specialized in staple crops than their larger counterparts, and exhibit slower productivity growth.

Key Words: Small Farms, land distribution, agricultural census, productivity.

JEL: Q10 – Q15

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I.- Introduction

When it is estimated that 3 out of 4 persons in the poorest fifth of the world population (i.e. the poorest 1.2 billion persons) live in rural areas (IFAD (2001)), where agriculture is the main source of livelihood, any serious analysis of the prospect of reducing rural and overall poverty requires a clear understanding of this farming population, their characteristics and the obstacles they face.

Among development specialist several trends have been mentioned as possible threats to agricultural and rural development in developing nations. Many of these threats are endogenous, and with the right policy environment, or with an "investment push" can be solved, like low levels of public and private investments in infrastructure and human capital. Other threats however, are exogenous and therefore more worrisome. It is generally argued that farms are fragmenting to a point in which their own economic viability is at risk. Similarly, others argue that prevalent land distributions may block the diffusion of the benefits of agricultural development.

In this paper we attempt to provide a long-term and global view at these exogenous trends in farming. For this purpose we constructed a database of farming characteristics of 17 countries across 43 different agricultural censuses, from three different continents. The complete list of agricultural censuses considered is displayed in Table 1. For every country we studied at least two censuses to identify long-term trends. With this organized data source we explore different questions relating to the ability of agriculture to act as an enabler of development, or the possible barriers to the growth of agriculture, with a special emphasis in the small and usually poor farm. We want to see if the agricultural censuses support the generalized concern of fragmenting small farms. A related question is whether the limit on available agricultural land has been reached, and hence agricultural output will be constrained by the lack of availability of agricultural land. Furthermore, we want to study the evolution of the small farm. For example, have small farms been able to move away from staple crops into higher value crops, and how specialized are they in staple crops.

In the next section, we first study the evolution of available agricultural and total farm land, focusing on the determinants of the evolution of land use. Next, we explore the issue of land distribution to show regional differences, and to expose possible barriers to agricultural development. In the fourth section of this paper we identify the small farmers and the landless rural population to discover not only how prevalent they are, across developing regions, but what are the differences in their access to land, and their ability to diversify in to higher value output. Finally, we show the differences in productivity between farm sizes, with special attention to the evolution of productivity.

II.- Global Trends in Agricultural Land

Before we can start describing the trends in farm land, we have to be clear in what we are defining as farm land. With the aid of Figure 1 we can describe the different components of what we usually call farm land. A farm holding may contain forests, grassland, unusable land, and agricultural or arable land[2]. These differences are very important, as different types of land may display different patterns of evolution. For example, in Chile in the inter-censal period 1975-1997 agricultural land contracted, while total farm land expanded. The difference is explained by an expansion in both grasslands (livestock) and forestry operations. Any measure of inequality of holdings will vary depending on the type of land considered. For example, if one considers total land, and includes large cattle farms and forestry operations, one would probably observe higher measures of inequality than by calculating inequality using agricultural land alone.

The general trend in the available agricultural censuses is to have the different types of lands described in Latin America, while in Africa agricultural censuses generally describe only planted land, and in Asia results are presented for agricultural land. As much as possible, in what follows we try to compare results for agricultural land, the focus of our study.

The evolution of unused agricultural land is also relevant, because agricultural land may be unused due to agro-ecological reasons, when it is left as fallow, or to economic reasons, when there are not enough resources or the relative prices do not make profitable the use of all the available agricultural land. Finally, when farms are smaller, like in Asia, the difference between these different types of land is less relevant.

In Figure 2, we present the evolution of total farm land. The figure shows big expansion in total land in Latin America, while in South Asia there is a mixed picture,

[2] The term “arable land” is generally used to refer to two related but different things: (*i*) potentially cultivable land; and (*ii*) land most of the time under temporary crops. In this paper “agricultural land” is comparable to the second definition.

almost no changes in India, a contraction of total land in Bangladesh, and small expansion in Pakistan. In Figure 3, we describe the evolution of agricultural land. The figure shows that in both Brazil and Chile, the latest trend is toward reduction in agricultural land, while we observe huge increases of agricultural land in most Sub Saharan countries (SSA), with the exception of Malawi, as well as in Mexico. In the case of Mexico, we can compare the evolution of total land, and observe that most of the expansion of agricultural land has occurred within the holdings, as total farm land has had a more modest growth compared to the more than doubling of agricultural land. Results for Ethiopia should be read with care, as not exactly the same area was sampled in each census. Agricultural land has expanded considerably in North Africa, as the evolution of agricultural land in Egypt and Algeria (DZA) shows.

In Table 2, we attempt to uncover the determinants of the evolution of farm land. Before commenting the results, we have to admit we are skating on thin ice. Our first limitation is the scarcity of degrees of freedom. We also suffer from missing variable bias, as probably the availability of land that can be transformed into agricultural production is a key variable that explains the evolution of farm land[3]. Additionally, our holding inequality is inconsistent because it measures inequality of different types of land. In spite of these severe limitations, the results are sensible and appealing. In the first panel, we see that our proxy of availability of land is positively correlated with total farm land expansion. The agricultural openness (Agricultural Imports + Exports over Agricultural GDP) in the ending period also pushes total farm land expansion. This result makes sense because our sample is made of developing countries, which should have a comparative advantage in the export of agricultural goods. Finally, inequality also pushes total farm land expansion. In the second column, we observe that openness does not promote expansion of agricultural land. This result seems reasonable, because the comparative advantage could be in the livestock sector, which expansion would not be accompanied by growth of agricultural land. Finally, we see that inequality is also positively correlated with the expansion of agricultural land.

[3] Although we do not have this variable, we use (Country Area / Country Population), i.e. the inverse of the population density, as a proxy of agricultural land available.

III.- Land Distribution and Inequality

A.- Bimodal Land Distributions

During the 1970's the economist Bruce Johnston disseminated the notions of unimodal and bimodal agricultural development strategies, and unimodal and bimodal institutions (Johnston and Kilby (1975); Johnston and Clark (1982)). In a bimodal development strategy there is agricultural development through increases in productivity and output of a minority of large farmers using capital intensive technologies imported from developed countries, while a unimodal development strategy allows the majority of households to enjoy increased output through productivity growth of labor using and capital saving technology, like the Asian "Green Revolution." Johnston and Kilby (1975) use Taiwan and Colombia as two diverging examples of unimodal and bimodal agricultural development respectively. A different issue is the institutional setting which enables either development strategy. This is related to the land distribution. If land is extremely unequally distributed, most farms would be small and a few would be large. The manifestation of this structure in a land distribution plot would be bimodal in the sense that land would be distributed with a mode at large land plots, while the distribution of farms would exhibit a different mode at lower levels of land. If on the contrary land was equitably distributed both the distribution of farms and land would share a mode around the mean plot level. A bimodal land structure predisposes a political economy environment in which the privileged few can steer public policy in their favor. This is why bimodality is an institutional framework, more than just an asset distribution.

The corollary of this dual characterization of the rural world is that unimodal strategies are much more successful at reducing poverty. The weakness of Johnston's analysis is that unimodality is not a policy, but a result; and the institutional setting is not deterministic, for example it is perfectly conceivable to have unimodal agricultural development within a bimodal institutional setting. In spite of these shortcomings, Johnston's analytical framework was very influential, even as a justification for land reform, and can still be applied to understand different development outcomes.

In Figure 4 we show the land distribution of a selection of four countries, two from Sub Saharan Africa, and two from Latin America. In Panels a) and b) we can see that the land distributions of Botswana and Ethiopia are unimodal, in the sense that both the farm and land distribution follow the same pattern across land categories (although strictly speaking the distribution of land in Botswana is bimodal, with two modes). These countries reflect a general trend of the seven Sub Saharan countries analyzed; they show, in general terms, unimodal land distributions in the Johnston sense. Panels c) and d) show the land distributions of two Latin American countries, Brazil and Chile. Strictly speaking the land distributions are multimodal, but they are bimodal in the Johnston sense, the distribution of farms in both cases is concentrated in the lower tail, while the distribution of land is concentrated in the upper tail. This bimodality was the characteristic of the other Latin American countries considered in this study (Panama and Ecuador). In spite of its bimodality, the Latin American countries in Figure 4 where much better agricultural performers with per capita agricultural GDP growth of 20 and 48% (for Brazil and Chile respectively) while agricultural GDP per capita fell both in Botswana and Ethiopia (-45 and -16% respectively) during the period of 1980-2000.

The difference in performance of the agricultural sector does not mean that bimodality favors agricultural development, it just shows that there is no deterministic relationship. It still remains true, as Johnston argues that more egalitarian land distributions will make the benefits of agricultural development better distributed across the population, and thus make agriculture more pro-poor. Also, the political economy of the bimodal institutional setting provides grounds for policies that favor large scale farming, and not necessarily small farms. For example, Brazil, which has more acute bimodality has been less successful than Chile in reducing rural poverty (World Bank (2003); Anríquez and López (2007)).

B.- Land Inequality

Furthermore, the initial land distribution matters, because it is unlikely that the land market alone will produce the Pareto enhancing trades (Binswanger and Deininger (1997)). Land in many settings has a value considerably above the current value of expected farms profits[4]. Land may have additional value beyond its agricultural use because it provides other services like: serve as collateral in the presence of imperfect capital markets, serve as a source of social and political power, serve a an inflation or tax shelter, serve as a mean of access to subsidized credit or other public benefits. Additionally, the covariance of risk of agricultural production

[4] See Binswanger et al. (1995), and Anríquez and Valdés (2006) for an example.

further promotes concentration, because during agricultural "bad" years, the price of land goes down, and only the very wealthy or those with urban incomes can access this cheaper land. As land markets are generally unable to replicate an efficient distribution of land, inequality in land distribution may have important aggregate effects.

The economic literature has addressed this issue generally finding that more unequal land distributions affect development in several ways. Deininger and Squire (1998) use a cross section of countries to show that economies that initially have more unequal land distributions grow less. Vollrath (2007) shows that agricultural productivity (measured as is usually done in the literature as value of output per unit of land) grows more slowly in countries with less egalitarian land distributions. Erickson and Vollrath (2004) show that land inequality is correlated with weaker financial and public institutions (the Johnston hypothesis re-visited). It is also hypothesized that land inequality may diminish long-term development by decreasing access to education, but this relationship has not been empirically corroborated.

C.- Evolution of Land Inequality

In Table 3 we describe the evolution of inequality of farm land distribution and the evolution of farms. One of the results that immediately strikes from the table is the general correlation between shrinking average farm sizes and improvements in inequality. Most of the countries that exhibit rapid relative fall in farm average size, like Chile, Malawi, Tanzania, Panama, and Egypt, also show improvements in farm land inequality, i.e. a fall in the GINI index. This is an important result, because it indicates that improvements in land inequality may actually be the bearer of bad news, land distribution becomes more equal as farmers become more similarly smaller[5].

This general trend is contradicted precisely by the country which had the highest relative decline in the farm average size, Bangladesh. The case of Bangladesh is very insightful, because it exposes the limits in comparability of agricultural census data. In Table 3, we also show the evolution of landless households which is approximated by the difference of the rural households obtained from the population census and the farm households surveyed in the agricultural census. It shows that Bangladesh had an awe-striking reduction in landlessness from 86.8% to 31.7%. This

[5] The simple correlation (removing the observation of Bangladesh, see below) is 0.2.

dramatic change is hard to believe. Part of the reduction in landlessness is real, as there was a land reform started in the early 1970's that did redistribute some land (Rahman et al. (1983)). Unfortunately, most of this reduction in landlessness is an statistical artifact, as Hossain (1986) argues. What happens is that the 1977 agricultural census, as opposed to the 1960 and 1996 agricultural censuses, did not enumerate the very small and tiny plots, i.e. the rural household with a small family orchard. In Figure 5, this is shown graphically, where the 1996 census based land distribution shows a big spike just below the half hectare which is absent in the 1977 distribution. Thus, the case of Bangladesh exposes the limitation of agricultural census based inequality measures, tiny differences in implementation can cause big differences in observed results. The inconsistencies of the agricultural census based inequality measures unfortunately pervades the empirical literature that studies development and land inequality issues; which calls for care in the evaluation of their conclusions. This is particularly true in studies that use the evolution of inequality, which produces much weaker and inconsistent measures, much more than pooling inequality for different types of land as is usually done[6].

This positive correlation between change in average farm size and inequality requires a more careful inspection. In Table 4 we explore this correlation in a multivariate regression. The table shows the changes in land inequality as explained by changes in average farm size, change in total farm land, and changes in total number of farms. The correlations are statistically strong and sensible. We observe that the correlation between changes in average farm size and changes in inequality, as initially argued, is statistically positive. At the same time correlation between the change in total number of farms and land inequality is also positive and significant; while the correlation between changes in total available farm land and inequality is, as expected, statistically negative. However after removing the dubious Bangladesh observation, results change strongly, and we observe that only changes in farm size (as argued initially) and changes in the total land are statistically correlated with changes in land inequality.

In the light of the results presented in Table 4 we can reinterpret the evolution of inequality in Bangladesh. Given the reduction in average farm size, inequality

[6] For example Deininger and Squire (1998) fail to confirm the popular Kuznets hypothesis that relates inequality to development, however their tests which uses a dynamic panel has very low power due to the inconsistencies explained above.

should have decreased in Bangladesh; however, this effect gets overwhelmed by the sharp (and artificial) expansion in the number of farms, particularly in the lower tail of the land distribution, which causes an overall increase in farm land inequality. We can generalize these results. For a given number of farms, reductions in farm size (fragmentation) are associated with improvements in the inequality of land distribution. For a given number of farms, expansion in total farm land reduces inequality.

D.- Land Inequality and Landlessness

If in one country two farmers each owns half of the total agricultural land, and the rest of the population owned none, the land GINI would be 0, that is, perfect equality. This happens because the way in which land inequality is measured, which only accounts for landholders, people without access to land are not considered[7]. In this section we attempt to correct this problem by accounting landless households and re-estimating inequality considering the landless group. The first problem to solve is who should be considered as landless. Clearly not everybody that does not own (or have access to) land is landless (constrained) in an economic sense. Some households are landless because they are constrained financially or culturally, while others are landless because they are employing their assets and skills in higher-paying non-agricultural activities. For an ideal inequality measure we would like to count just the former households; however there just does not exist an internationally comparable source to identify households linked/dependant on agriculture.

In Table 3 we identified landless by using all rural households as a proxy of the population linked to agriculture. From official population censuses we identify the total number of rural households. Then we interpolate the number of households that should have existed the year of the agricultural census, and finally we approximate as landless the difference between all rural households and the total number of farms / households counted in the agricultural census. The limitations of this choice are obvious, middle income countries, all things equal will have more landless, as these countries have more households that have moved away from agriculture; while in poorer economies, where agriculture is the main rural economic activity the estimated landless number will be more accurate.

[7] Also, as we have explained above, not even all of those with access to agricultural land get counted always.

The table shows that landlessness is particularly acute (>50%) in Pakistan, Botswana and initially in Bangladesh. The land inequality GINI that accounts for landlessness is larger than the inequality obtained from agricultural censuses in every reported case, except for Brazil 1996 and Pakistan 1990, where the former GINI is smaller[8]. The direction of the change in the inequality measure is the same in every country reported with the exception of Brazil, where GINI with landless falls while the landholdings GINI increased. In general, both inequality measures are surprisingly similar, with the exception of Bangladesh, Malawi, Guinea, countries where the GINI with landless is more than 20% larger than the traditional inequality measure. Of these latter countries, Bangladesh and Malawi are countries that exhibited the highest reductions in their share of landless households, in the first case we have a dubious observation as we explain above, and in the second we have measurement issues, as we are comparing a full agricultural census with the results of a household survey.

IV.- Evolution of the Small Farm

The small farm is a relative concept. What constitutes a small farm in the Argentinean Patagonia is very different in size to what constitutes a small farm in Indian and Bangladeshi Bengal; in this exaggerated example the first farm is many times larger than the second one. The small farm as an a economically viable unit that can provide livelihood to a household will vary in size depending on the productivity of land, the availability of public goods, and agroecological conditions among others. In this section however, we want to provide a global view of the small farm, so we make the crude assumption that small farms are everywhere those units that operate less than 2 ha of land. Due to data limitations, we can not use this same threshold in all countries, for example, in the case of Chile the threshold used is 1 ha, and in Bangladesh 2.5 acres (1.01 ha). In Table 5 we provide a global view of the relative prevalence of the small farm around the world. At a global level almost 90% of farms are small farms, however there are important regional differences. For, example in Latin America the share of small farmers is much lower (consistent with higher average farm sizes as shown in Table 3) only 27%, compared to other regions where 80% or more of farms are small. East Asia, has the highest prevalence of small farms at 95%, a rate strongly

[8] This counter-intuitive result of reducing the GINI by accounting the landless is mathematically possible. An intuitive explanation is that in both cases, Pakistan and Brazil the share of landless is large, and their inclusion causes a downward equalizing effect.

influenced by China, where 98% of farms are small. In the rest of the global regions about 80% of farms are small. The land held by small farmers has a higher variability. In Latin America where both distributions are very unequal, and the small farm prevalence is low, small farmers hold less than 1% of farm land. The highest share of land held by small farmers is observed in Sub Saharan Africa, where small farmers hold 56% of farm land (an indicator of more equality in the distribution of land). Overall, small farmers hold 15% of the global farm land.

In Figure 6 we describe the evolution of the land under small holders. We see that in Latin America, the small holder sector is relatively shrinking, while in South Asia, and high density SSA countries (Ethiopia and Malawi) small farms are relatively growing. In South Asia, the relative expansion of the small holder sector has been particularly fast (even if we ignore the dubious Bangladesh change). Of course, the relative growth of the small sector is highly correlated with population density: we calculate a simple correlation coefficient of 0.78.

A.- Fragmentation

An issue of concern for the rural development scholar is the fragmentation of small farms. Small farms may continue to get smaller to a scale in which the economic viability of the farm is at risk. To review fragmentation, we define it at the aggregate level as the case where the average size of the small farm is decreasing, while at the same time the absolute amount of land under small farms is increasing. This is a bit more general definition than what is generally understood as fragmentation, i.e. the case where the number of small farms increases, and the amount of land they hold stays constant. Figure 7 shows why this definition is warranted. The mean size of small farms may be decreasing because the smaller farms are being left behind, while some farms either grow or are being bought-off, as would be the case in the South-West quadrant of the plot where Brazil and Chile lie. In the North West quadrant, where most countries lie, we have fragmentation, both the mean size of small farms is falling and the land under the small sector is growing. Bangladesh's level of fragmentation is over-stated, but it is most probable present, because it shares the characteristic of countries where fragmentation is occurring, that is high population densities. Furthermore, fragmentation is happening in the other South Asian countries, India and Pakistan. Fragmentation is not observed in Sub Saharan countries with the exception of Malawi, the Sub Saharan Africa country with the highest population density of those considered (122 persons / km^2). The south east quadrant shows an expansion of the small sector, as land under small holders is falling and the mean size of the small farm is growing. Only in Botswana small farms are expanding.

B.- Crop Diversification

A perhaps desirable feature of agricultural development would be a diversification from low value traditional crops towards higher value crops, in order to promote the increase of rural households' income. Anecdotal evidence suggests that the success stories in the small holder sector are limited and would be hard to observe at the national level. We explore this issue here with agricultural census data.

Defining high value crops is not a clear cut task. What is a high value crop in one agro-ecological zone may not be such in another less productive one. Also, what was a high value crop in 1970's may not be a high value crop anymore. However, defining main or staple crops is much easier, and can be done by looking at the amount of land these crops occupy. In Table 6 we show which crops where considered main crops and the share of land they occupy. In tropical countries with more than 1 agricultural season per year this share could be greater than 100%, because we are calculating shares over physical land instead of crop land (the sum of land planted in both seasons). We chose this rule because using crop land, land shares could change just by a composition change of crops towards year round crops, even if the amount of physical land used was not changing. The table shows that some crops are tradables, like wheat, but none could be described as a high value crop. Thus, observing the evolution of main crops, we can indirectly say something about diversification into high value crops. In particular, if the share of main crops is increasing, we know there is intensification in non high-value crops.

The first issue we explore is whether small farmers are more specialized in main crops vis-à-vis larger farmers. In Figure 8, we plot with bars the ratio of the share of land under main crops of small farmers over the share of land under main crops for larger farms. In the same plot, a line tracks the share of land under small holders for each country. The first inference that can be obtained from the figure is that in general small farms are more specialized in staple crops than large farms. The graph also shows a clear trend: when the share of land under small holders is low, these are highly specialized in main crops. As small farmers become more prevalent, the farmers start to become more diversified than larger farms. There are is one important exception, Algeria (DZA), where small farms are more diversified, even though the share of land under small holders is relatively low.

In Figure 9, we show that there exists a negative correlation between agricultural openness and the share of land under main crops. We explore this correlation with a simple multivariate regression in Table 7, where we show that the share of land with main crops is smaller in more open countries, but larger in those with higher population density. In spite of its simplicity, this regression allows us to make a very important prediction: an increase in agricultural openness, i.e. a reduction in agricultural subsidies in OECD countries as it is currently being discussed, would increase diversification in low density countries, like Guinea and Panama, but would do little to reduce the specialization in rice in Bangladesh or in maize in Malawi.

V.- The Inverse Relationship in Agricultural Censuses

One of the topics that has most captivated the rural development, and the agricultural economics literature is the issue of what was initially called the *inverse relationship*. This refers to an inverse relationship between productivity and farm size, i.e. small farms are more productive than large farms. There is no comprehensive literature survey to refer to, so we try to introduce the main findings of this literature by providing a brief historical sketch.

The inverse relationship was first found in India. Using data from Farm Management Studies from the mid fifties researchers found that productivity, measured as value of output divided by land (i.e. partial land productivity) was negatively related to farm size (Sen (1962); Sen (1964); Khusro (1964)). Some initially took these results as evidence of lack of constant returns to scale in agriculture, when obviously one partial productivity indicator is not an indicator of scale economies in production, which refers to all of the factors of production.

This early Indian literature, neatly summarized in Bhagwati and Chakravarty (1969) identified the possible causes of this intriguing result that would return in the literature in many different shapes. First, the inverse relationship could be explained by differences in soil fertility (i.e. land quality, its natural productivity), as Khusro (1964) argued. This is one important cause for the phenomenon, because it is reasonable to expect that more productive land is more valuable, and therefore, more likely to be fragmented into smaller plots. The corollary is that if land quality is inversely related to plot size, this would explain the inverse relationship. The second explanation is that the family farmer as compared to the capitalist farm (using Sen (1964) language) provides labor to a the level of zero cost of opportunity, or at the very least to a level of productivity below the latter farmer. This effect was later formalized by Bhalla (1979) by showing that the small farm faces cheaper labor costs and therefore oversupplies labor. Barrett (1996), provides a second formal explanation for Sen's argument when he showed that, under uncertainty, the very poor and constrained farmer optimally over-supplies labor to a point below its cost of opportunity. The third possibility is that large farms have an absentee landlord, and therefore under-provide managerial services and are less productive, as argued by Khusro (1964). This argument, expressed in more updated economist talk, as the issue of moral hazard in labor contracts was later formalized by Feder (1985). The author showed that if effort provides disutility, then hired labor will supply less labor effort than family labor, and if supervision is costly, the larger farm would be less efficient. Clearly these three causes for the inverse relationship have very different policy implications. If the cause of the inverse relationship is differences in soil quality, redistributing larger farms into smaller ones would not improve efficiency, while if small farms are more efficient due to labor or management advantages, then there can be important aggregate efficiency gains by redistributing land.

The work of Berry and Cline (1979), which collected several empirical studies on farm size and productivity helped to popularize the notion of the inverse relationship in the field, which fueled the already hot debate on land reform, particularly in Latin America. As empirical methods for studying technology evolved, with Data Envelopment Analysis and Stochastic Frontier models, the focus shifted from partial land productivity to total factor productivity (TFP). Current methods consist in estimating TFP, and in a second stage determining if a negative correlation exists between TFP and farm operation size. Even though these latter methods measure something different, the results have been consistent with the previous literature.

Today the inverse relationship is usually taken as an undisputed characteristic of agricultural production in the developing world; however, a brief survey of the empirical literature would show that this is far from true. In South Asia, the inverse relationship seems to be prevalent: in addition to the early work in India, it has been shown to exist in Bangladesh (Hossain (1977)) and Pakistan (Khan (1977)). Even after accounting for soil differences, the inverse relationship is still present: in Pakistan (Heltberg (1998)); and while it is diminished, it is still shown to be present in India (Bhalla and Roy (1988) and Lamb (2003)). The inverse relationship does not seem to be present in modern agricultural operations, as shown for wine grape growers in South Africa (Townsend et al. (1998)), and New Zealand's milk farming industries (Jaforullah and Devlin (1996)). The rest of the empirical evidence is mixed. In Sub Saharan Africa, Dorward (1999) shows that there is a positive relationship between farm size and productivity among small farmers in Malawi, while in Java the inverse relationship disappears after considering differences in land quality (Benjamin (1995)). Recent research from Brazil and Nigeria suggests that the relationship between farm productivity and farm size is U-shaped, with an inverse relationship up to a certain threshold and a positive relationship for larger farms (Hefland and Levine (2004); Kimhi (2006)).

In Figures 10-12 we present the contribution that agricultural censuses can provide to this discussion. Unfortunately output is not measured in agricultural censuses in Asia, and in most African countries. This leaves us with information on yield mostly for Latin America. In the figures we plot yields for crops that are likely be prevalent in small farms: Beans in Chile, Maize in Brazil, and Sorghum in Botswana. In Brazil and in Chile we see that yields display the U-shaped relationship previously described in the literature, but in Botswana this U-shaped relationship is not clearly identifiable. We believe that this U-shaped relationship should be the expected one, because as farms become larger, whatever the source of inverse relationship: land quality differences, or hired/family labor productivity differential starts to become relatively less important than the productivity advantage of highly technology and capital intensive operations. However, what is truly an striking conclusion from this census data, is that productivity of larger farmers is growing faster than productivity of small farmers. This result which is common across the three countries where data is available requires further examination, but is an important warning sign into the future ability to compete of the small farm.

We contrast this intriguing result further by looking at the evolution of yields in Asia, but here we have to rely on household surveys. In Figure 13 we show the evolution of rice yields in Vietnam by farm size. Here we see that smaller farm still enjoy an advantage in yields, but at about 2 ha yields start growing, but they never surpass the smaller farms yields, but note however that there are no large farms in

Vietnam. In Chile larger farms are more productive in beans above 10 ha, in Botswana and Brazil the turn-around is roughly at 7 ha; in Vietnam those type of farms do not exist. In this country, larger farms also seem to show faster productivity gains (these differences however are not statistically significant using this sample survey data).

VI.- Conclusions

Our global investigation into farming trends has revealed many significant trends. Agricultural land is in expansion in Latin America and Africa, while the little relative changes in agricultural land in South Asia reveal that the expansion limits (at current technology and farming practices) have been reached in the region. In this latter region as well, there is acute landlessness (particularly in Pakistan), and fragmentation of the small farm.

We estimate that roughly 9 out of 10 farms in the world are small, that is, smaller than 2 ha. In general farms are smaller as expected in high density areas; therefore small farms are much more prevalent in South and East Asia. We found that small farms are more specialized in staple crop than their larger counterparts. We also found encouraging signs that openness is correlated with diversification away from staple crops; however, specialization in staples is also highly correlated with population densities (or smaller farms as both go hand-in-hand). Thus, as we look into future rounds of the WTO and the eventual liberalization of agricultural markets, we can predict that the benefits of trade opening in high value crops will not be evenly spread.

Finally, the study of partial productivity, alas based in a minimal sample, raises important warning signs into the future ability to compete of the small farm. We show, as has been argued since the 1960's that the partial productivity of small farmers is larger than that of medium farms. However, large farms (greater than 10 ha) not only show higher partial productivity; but when observed across time, larger farms display larger expansion in their productivity. Given the overarching relevance of this result for rural development and poverty reduction in developing regions, it demands further examination with more in-depth case studies.

Tables

Table 1. Agricultural Censuses Considered in this Study

Continent	Country Name	Census Year				
Africa	Algeria	1973	2001			
	Botswana	1982	1993			
	Egypt	1990	2000			
	Ethiopia	1977*	1990*	2002		
	Guinea	1989	1995*			
	Malawi	1981*	1993*			
	Tanzania	1971	1996*			
	Togo	1982	1996			
America	Chile	1975	1997			
	Brazil	1970	1975	1980	1985	1996
	Ecuador	1974	2000			
	Mexico	1970	1991			
	Panama	1980	1990	2001		
Asia	Bangladesh	1977	1996			
	India	1970	1975	1985	1990	1995
	Pakistan	1980	1990	2000		
	Thailand	1978	1993			

* Agricultural Sample Survey used instead.

Table 2. Determinants of the Evolution of Farm Land

	Total Land Change		Agricultural Land Change	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**
Available Land Proxy: Country Area / Total Pop.	54.8**	20.8	16.4	14.7
Agricultural Openness (t+s)	4.8**	1.8	-3.7	4.1
Land Holding Inequality (GINI)	9.0*	4.6	17.9*	9.8
4 Region Dummies Included				
R^2	81		51	
Observations	17		22	

Note: White heteroscedasticity consistent standard errors reported. ** Coefficient significant at 95%, and * 10%.

Table 3. Evolution of Inequality Mean Farm Size and Population

		Land Holdings GINI Inequality		Land GINI Including Landless		Average Farm Size (ha)		Rural Landless Households (%)	
Country	Years	Start	End	Start	End	Start	End	Start	End
Thailand (T)	1978-93	43.5	46.7	52.9	53.1	3.6	2.9	38.1	44.1
Brazil (T)	1970-96	74.8	76.6	75.0	74.0	4.2	10.3	33.2	37.9
Chile (A)	1975-97	60.7	58.2	67.7	62.4	10.7	7.0	23.0	41.9
Ecuador (T)	1974-00	69.3	71.2		74.0	4.2	3.5		23.6
Panama (T)	1990-01	77.1	74.5	79.0	75.9	3.1	2.9	3.5	4.1
Algeria (A)	1973-01	64.9	60.2			5.8	8.3		
Egypt (T)	1990-00	46.5	37.8			0.9	0.8		
Bangladesh (T)	1977-96	43.1	48.3	54.2	58.9	1.3	0.6	86.8	31.7
India (T)	1970-75	52.6	50.4	57.9	53.6	2.2	1.9	9.9	6.6
Pakistan (T)	1980-90	50.3	53.5	52.3	53.3	4.4	3.6	53.2	51.8
Botswana (P)	1982-93	39.3	40.5	44.4	42.5	3.3	4.8	58.0	60.6
Ethiopia (T)	1977-90	61.7	41.5			1.1	0.9		
Guinea (T)	1989-95	44.6	40.9	57.0	53.3	1.9	2.0	35.3	44.8
Malawi (P)†	1981-93	34.4	33.2	49.9	44.6	1.2	0.7	32.7	13.8
Tanzania (P)	1971-96	40.5	37.6			1.3	1.0		
Togo (P)	1983-96	47.8	42.1			1.5	2.0		

Notes: Author's calculations using agricultural and population censuses and sample surveys. A, P, T denotes that the inequality measure was calculated using agricultural, planted, and total farm land, respectively.
† The second distribution measure was approximated using the IHS2 2004/2005 household survey.

Table 4. Changes in Farm Land Inequality (GINI)

	%Δ GINI of Farm Land			
			Without Bangladesh	
	Coefficient	*Standard Error*	*Coefficient*	*Standard Error*
%Δ Average Farm Size	0.445***	0.105	0.415*	0.216
%Δ Farm Land	-0.385***	0.071	-0.358*	0.185
%Δ Number of Farms	0.336***	0.051	0.307	0.218
Constant	-1.795	1.081	-1.721	1.162
Mean Dependent Variable	-1.73			-2.38
Standard Error of Regression	5.41			5.54
Observations	22			21
R^2	31.3			12

Notes: *** Significant at the 99%, ** 95%, and * 90% level..

Table 5. Relative Prevalence of the Small Farm

Country / Region	Year	Share of Small Farms (%)		Total Farms / Households	Threshold (ha)
		Number	Land		
East Asia & Pacific					
China	1997	97.9	n/a	193,446,000	2
Lao PDR	1999	73.5	42.8	668,000	2
Myanmar	1993	56.7	20.7	2,924,898	2.02
Philippines	1991	65.1	23.4	4,610,041	2
Thailand	1993	32.9	7.6	5,647,490	1.6
Vietnam	2001	94.8	n/a	10,689,753	2
Average		**70.2**	**23.6**		
Weighted Average†		**94.7**	**15.9**		
Europe & Central Asia					
Albania	1998	90.0	17.3	466,809	2
Latin America & Caribbean					
Argentina	1988	15.1	0.1	378,357	5
Brazil	1996	20.2	1.6	4,859,865	2
Chile	1997	13.5	0.6	329,563	1
Colombia	2001	41.1	2.0	2,021,895	3
Ecuador	2000	43.4	2.0	842,882	2
Nicaragua	2001	19.8	0.6	199,549	1.8
Panama	2001	63.0	1.6	236,613	2
Uruguay	2000	11.0	0.1	57,131	4
Venezuela, RB	1997	22.6	0.3	500,979	2
Average		**27.7**	**1.0**		
Weighted Average†		**27.5**	**0.7**		
Middle East & North Africa					
Algeria	2001	28.9	2.7	1,023,799	2
Egypt, Arab Rep.	2000	95.8	57.5	4,541,884	2.1
Jordan	1997	67.0	10.0	92,258	2
Lebanon	1998	86.8	34.9	194,829	2
Morocco	1996	55.3	12.3	1,496,349	3
Average		**66.8**	**23.5**		
Weighted Average†		**77.6**	**16.1**		
South Asia					
Bangladesh	1996	95.5	68.8	17,828,187	2.02
India	1995	80.3	36.0	115,579,000	2
Nepal	2002	92.4	68.7	3,364,139	2
Pakistan	2000	57.6	15.5	6,620,224	2
Average		**81.5**	**47.3**		
Weighted Average†		**81.4**	**35.8**		

Table 5 (cont.)

Country / Region	Year	Share of Small Farms (%) Number	Land	Total Farms / Households	Threshold (ha)
Sub-Saharan Africa					
Botswana	1993	25.0	5.5	56,214	2
Ethiopia	2002	87.1	70.9	10,758,597	2
Guinea	1995	65.2	32.2	442,168	2
Malawi	1993	95.0	70.3	1,561,420	2
Namibia	1997	38.9	15.8	102,357	2
Senegal	1999	37.5	8.1	437,037	2
Tanzania	1996	88.3	57.6	3,994,882	2
Togo	1996	59.0	29.3	429,534	2
Average		**62.0**	**36.2**		
Weighted Average†		**85.2**	**55.8**		
Global Average		**58.1**	**23.1**		
Global Weighted Average†		**87.6**	**14.9**		

Source: National Agricultural Censuses
† The Share of small farms is weighted by the number of farms of the country, while the land under small farms is weighted by the total farm land of the country.

Table 6. Main Crops and their Land Shares by Country

Country	Main Crops							Share of Land	Year	Type of Land
Algeria	Cereals							47.3	2001	A
Botswana	Maize	Sorghum	Millet	Beans/Pulses				98.0	1993	P
Egypt	Wheat	Rice	Maize					83.1	2000	A
Ethiopia	Teff	Barley	Wheat	Maize	Sorghum			77.3	2002	P
Guinea	Rice	Maize	Millet	Groundnut	Cassava			99.3	1995	T
Malawi	Maize							78.2	1993	P
Tanzania	Maize	Paddy	Sorghum	Millet	Beans			68.0	1996	P
Togo	Maize	Sorghum	Millet	Yam	Groundnut			83.6	1996	P
Brazil	Rice	Sugarcane	Soy	Beans	Manioc	Wheat	Maize	50.4	1996	A
Chile	Wheat	Maize	Potatoes	Oats				27.9	1997	A
Ecuador	Rice	Maize	Potatoes					24.9	2000	A
Mexico	Beans	Maize	Sorghum	Wheat				45.3	1991	A
Panama	Rice	Maize	Sorghum	Beans	Sugarcane	Yucca		30.8	2001	A
Bangladesh	Aman Rice	Aus Rice	Boro Rice	Wheat	Pulses			133.3	1996	A
India	Rice	Sorghum	Millet	Wheat	Pulses			69.4	1995	T
Pakistan	Wheat	Rice	Maize	Sorghum/Millet	Pulses			88.8	2000	A
Thailand	Rice							55.4	1993	T

Notes: A, P, T indicates that the share of land is calculated over agricultural, planted, and total land respectively.

Table 7. Determinants of the Share of Land under Main Crops

	Coefficient	Standard Error
Agricultural Openness	-29.5***	9.82
Population Density	0.119***	.02
Constant	68.4***	6.92
R^2	59	
Observations	36	

Note: White heteroscedasticity consistent standard errors reported. *** Coefficient significant at 99%.

Figures

Figure 1. Farm Land

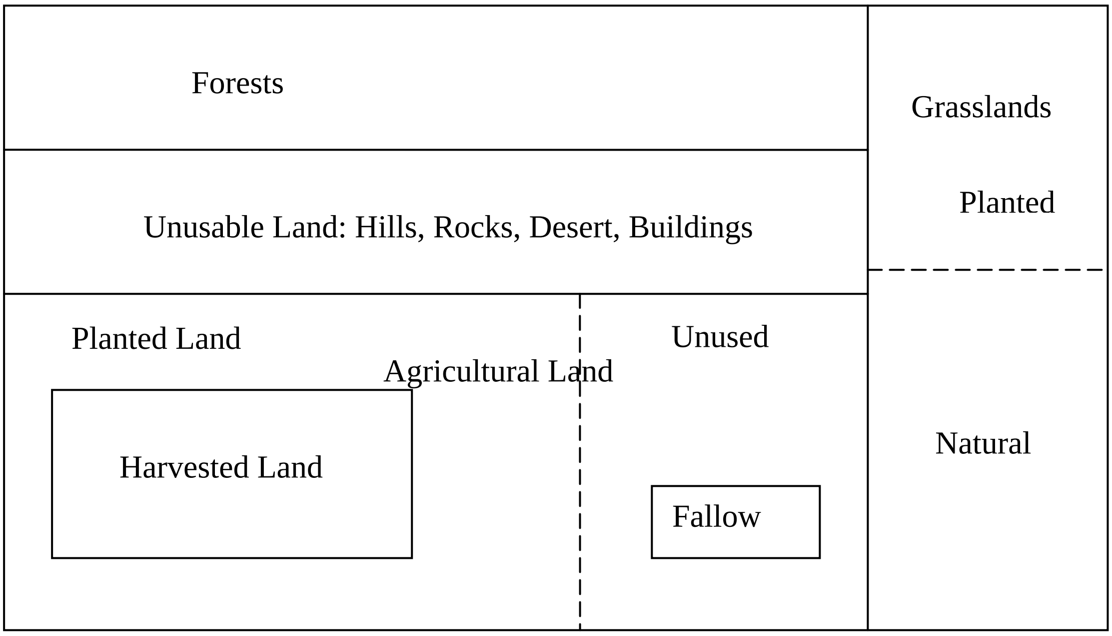


Figure 2. Evolution of Total Farm Land

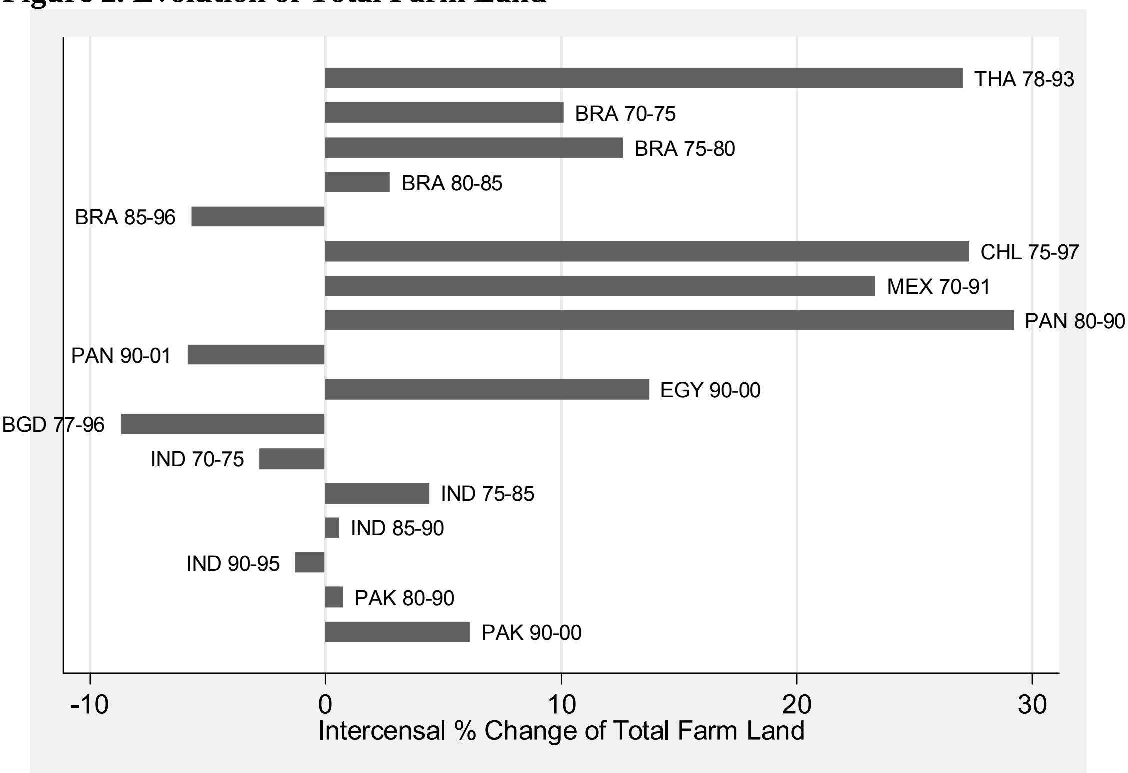


Figure 3. Evolution of Agricultural Land

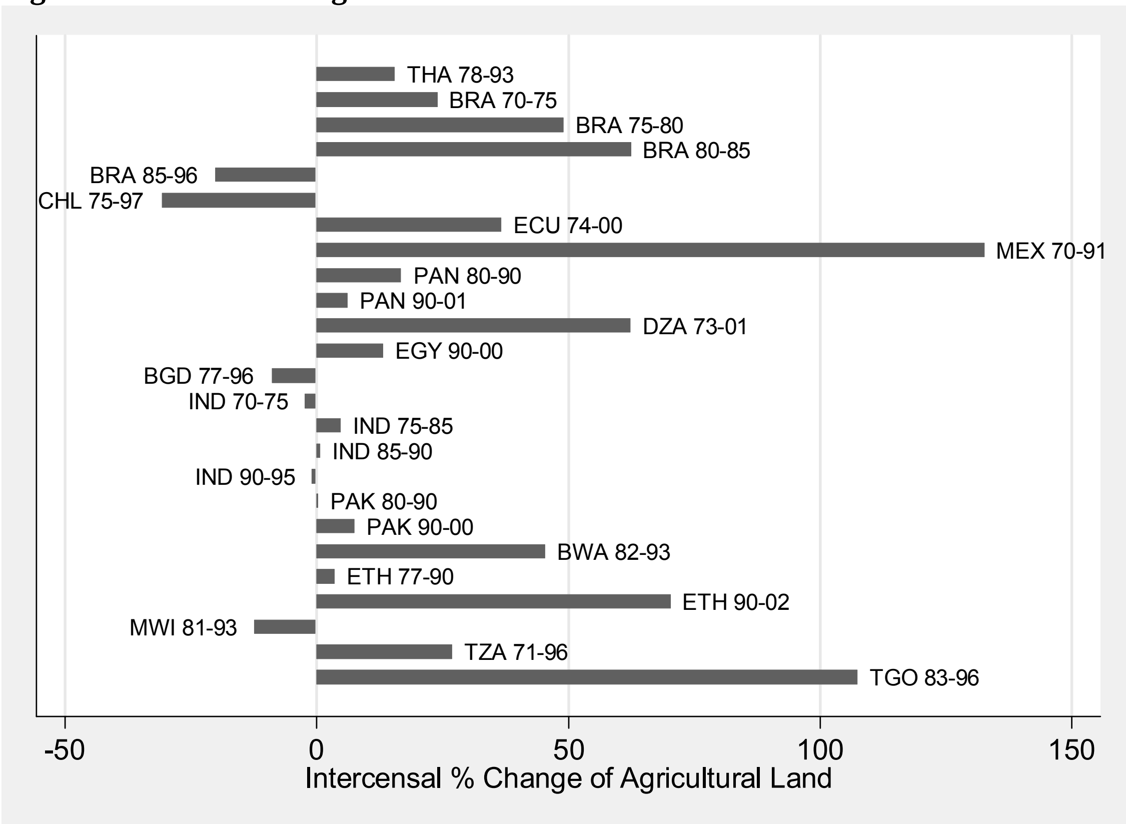
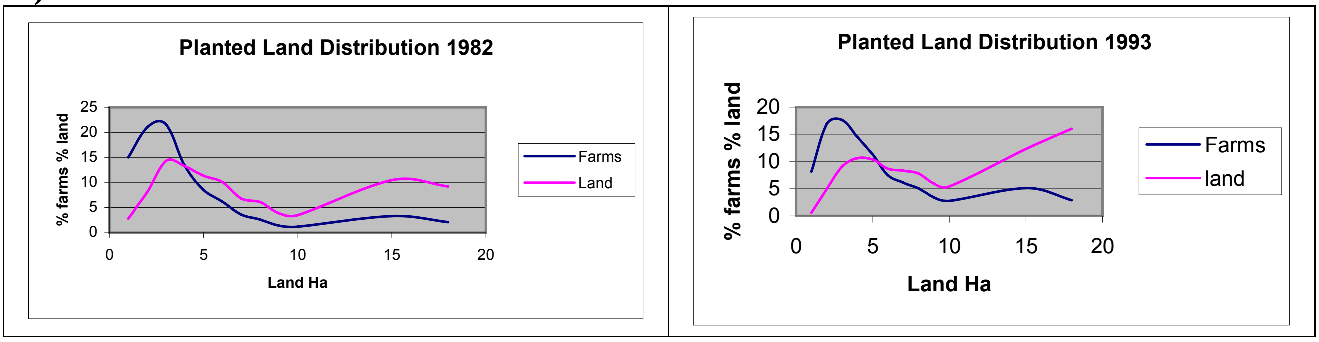
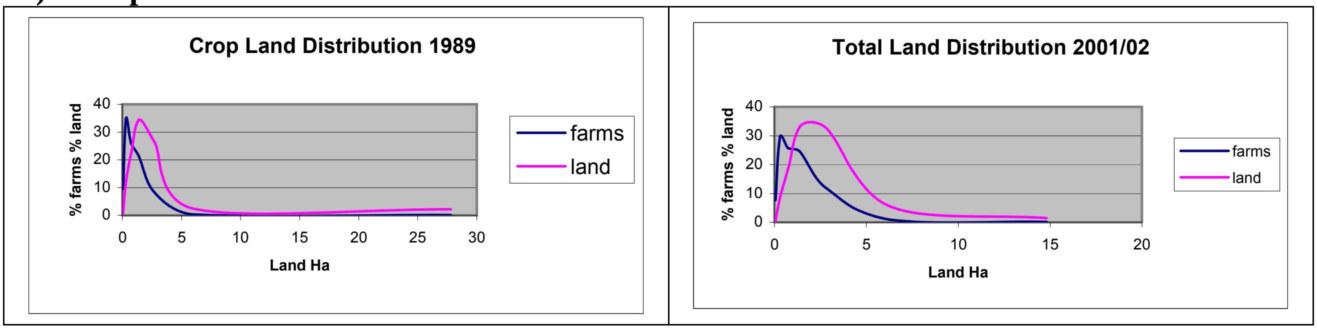


Figure 4. Land Distributions in Sub-Saharan Africa and Latin America

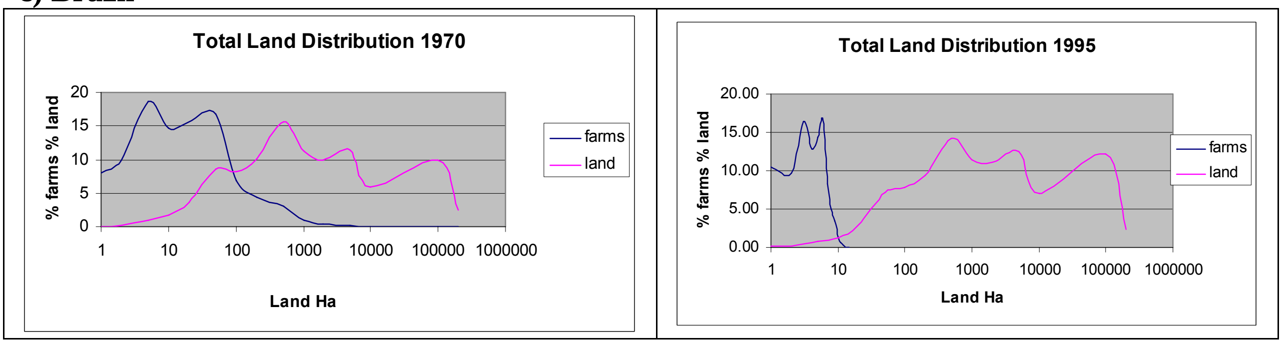
a) Botswana



b) Ethiopia



c) Brazil



d) Chile

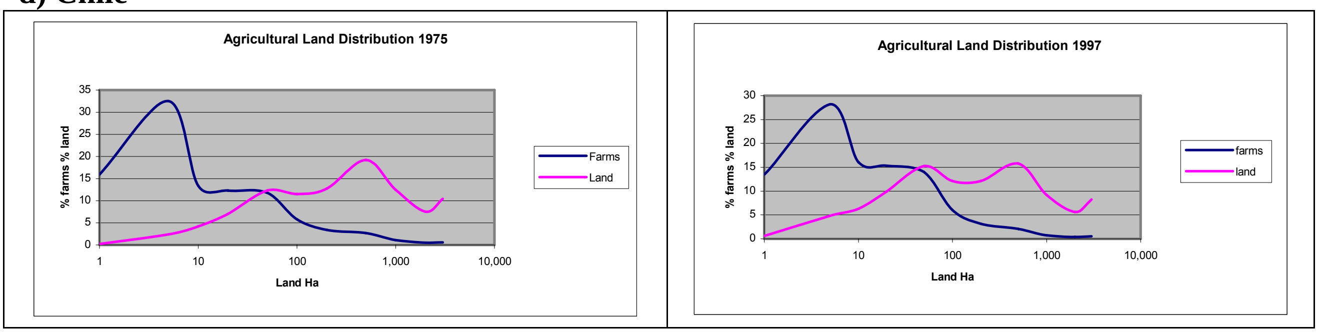


Figure 5. Land Distributions in Bangladesh

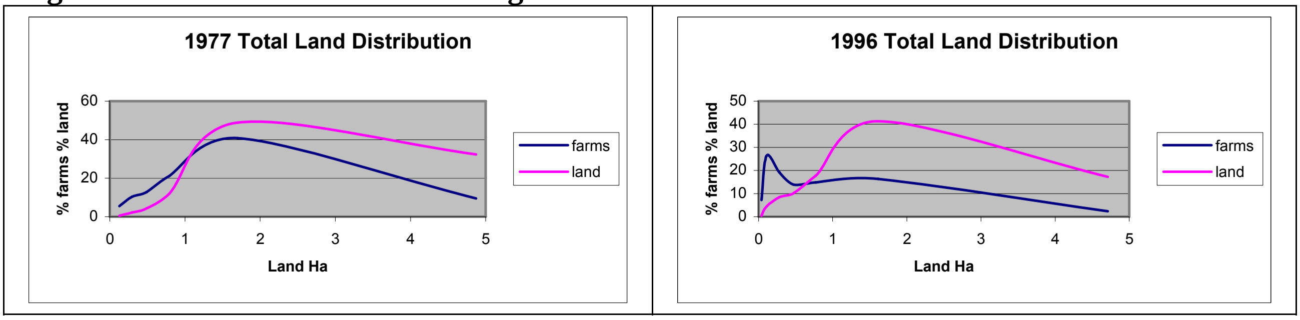


Figure 6. Change in Land Under Small Holders

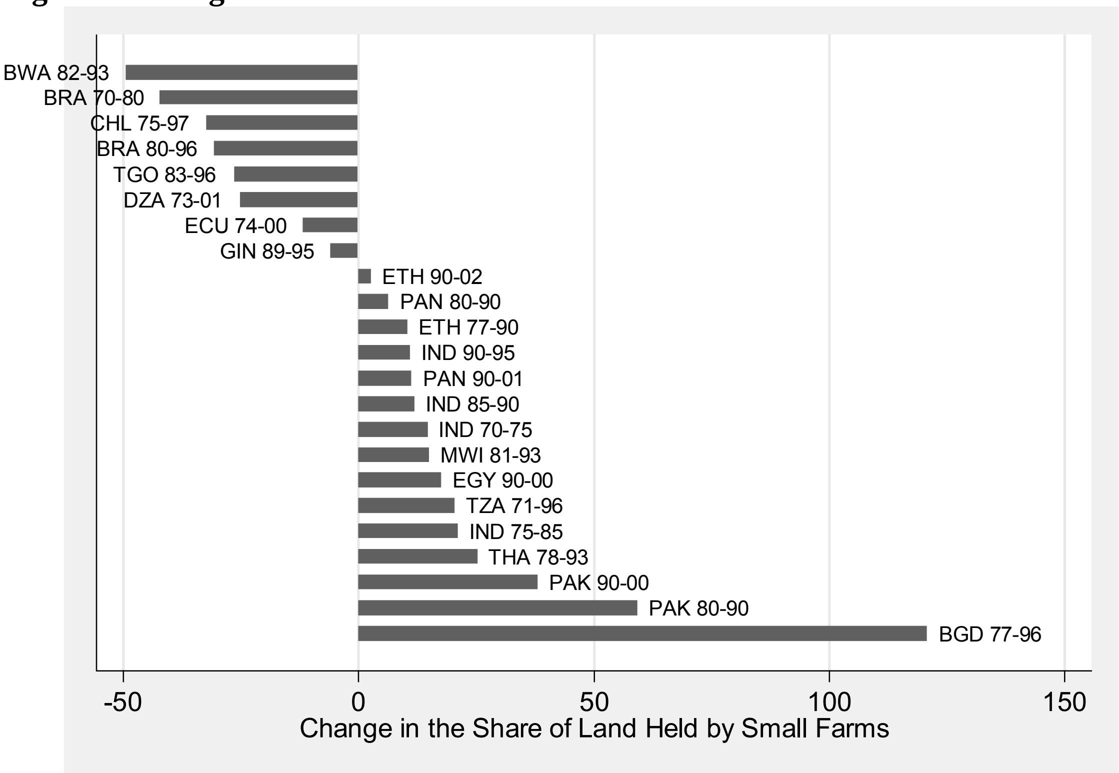


Figure 7. Small Farm Fragmentation

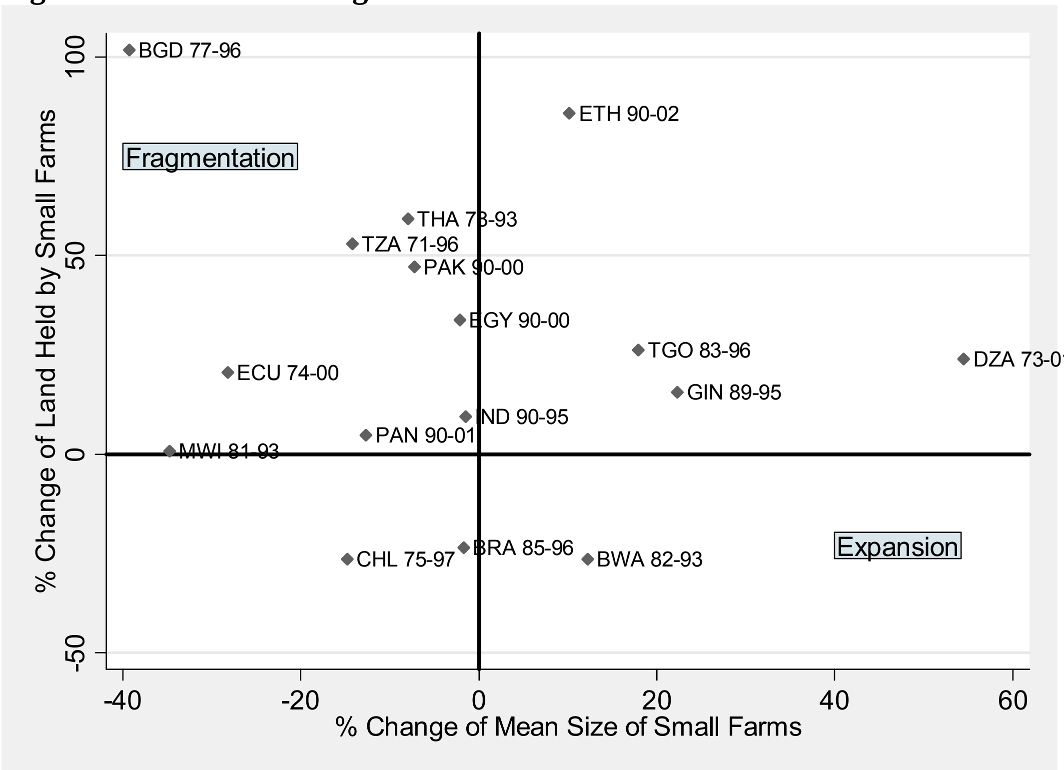


Figure 8. Specialization in Main Crops Small Farmers vs. Larger Farms

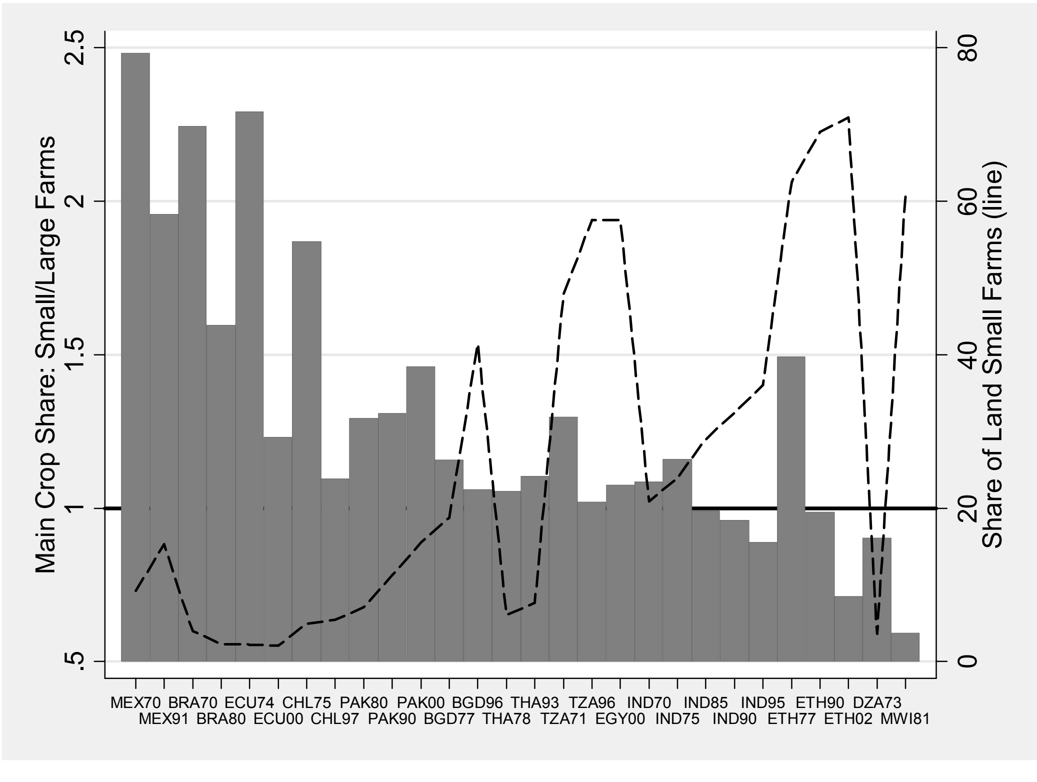


Figure 9. Correlation between Specialization in Main Crops and Openness

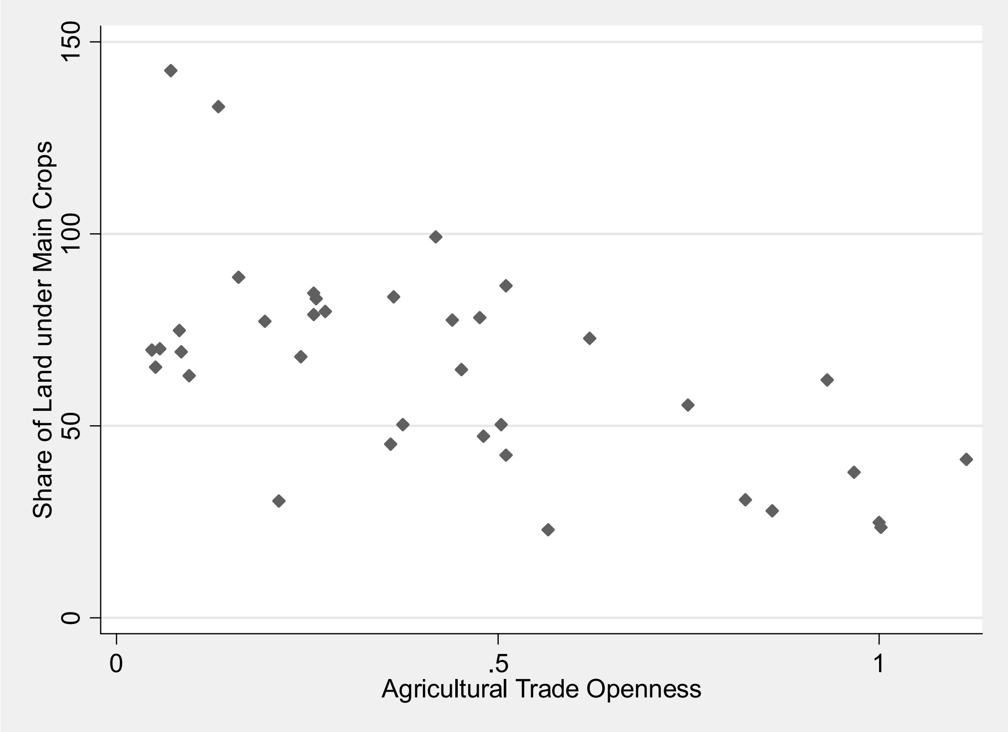
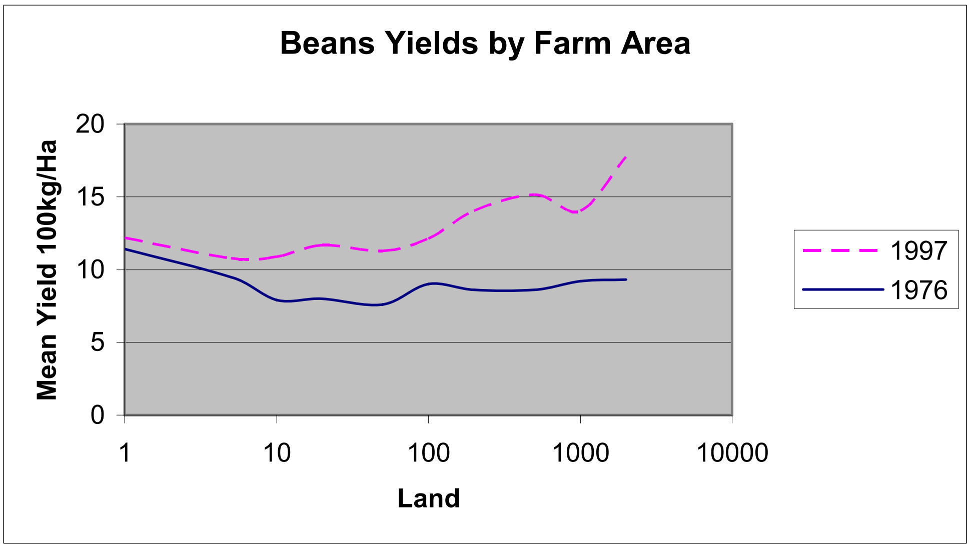
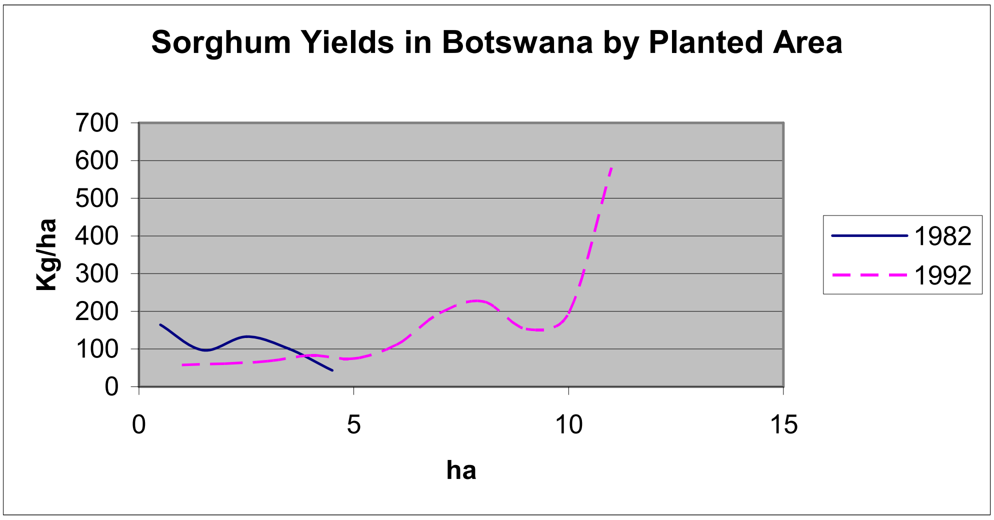


Figure 10. Bean Yields in Chile



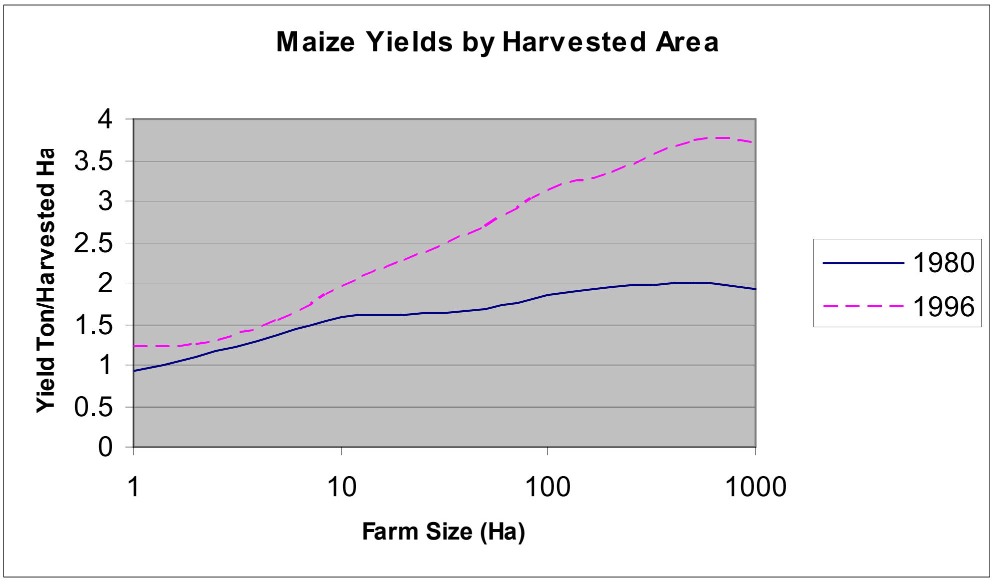
Authors' calculations base on National Agricultural Censuses

Figure 11. Sorghum Yields in Botswana



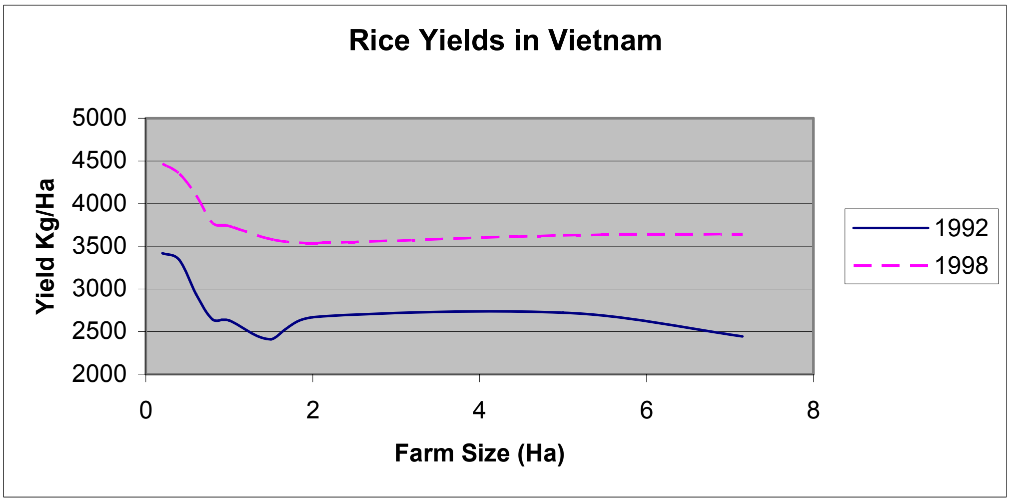
Authors' calculations base on National Agricultural Censuses

Figure 12. Maize Yields in Brazil



Authors' calculations based on National Agricultural Censuses

Figure 13. Rice Yields in Vietnam (Kg/Ha)



Note: Author’s calculations using LSMS household surveys.

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