UNITED NATIONS UNIVERSITY
UNU-WIDER

WIDER Working Paper 2016/11

# Inter- and intra-farm land fragmentation in Viet Nam

Thomas Markussen,[1] Finn Tarp,[1,2] Do Huy Thiep,[3]
Nguyen Do Anh Tuan[3]

March 2016

United Nations University World Institute for Development Economics Research
wider.unu.edu

**Abstract:** This paper uses panel data at commune, household, and plot levels to study the causes and effects of agricultural land fragmentation in rural Viet Nam. We focus on both inter-farm fragmentation (the division of land into many small farms) and intra-farm fragmentation (the division of each farm into many small plots). In both these dimensions, land holdings in Viet Nam are highly fragmented. Results show strong effects of both inter- and intra-farm fragmentation on labour input per hectare in agriculture. When productivity is measured by profits per hectare, we estimate a positive effect of farm size on productivity. Results on the determinants of fragmentation show that land sales markets reduce inter-farm fragmentation in the south of Viet Nam but not in the north. Administrative land consolidation programmes have some positive impact on land consolidation in the north but not in the south.

**Keywords:** land fragmentation, consolidation, farm size, productivity, land markets, Viet Nam

**Tables:** at the end of the paper.

**Acknowledgements:** We thank Danida and the Royal Danish Embassy in Viet Nam for support, the Institute for Labour Science and Social Affairs (ILSSA) for collecting the data, the Central Institute for Economic Management (CIEM) for research cooperation and Frida Nanneson as well as Maria Fibæk for excellent research assistance. The usual caveats apply.

[1] Development Economics Research Group (DERG), University of Copenhagen, Denmark; [2] UNU-WIDER, Helsinki, Finland, corresponding author: tarp@wider.unu.edu; [3] Centre for Agricultural Policy (CAP), Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), Hanoi, Viet Nam.

This study has been prepared within the UNU-WIDER project on 'Structural Transformation and Inclusive Growth in Vietnam'.



Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-054-6

Typescript prepared by the authors and Anna-Mari Vesterinen.



Katajanokanlaituri 6 B, 00160 Helsinki, Finland

# 1 Introduction

Land fragmentation is an important issue in many developing countries. Rural population growth—in combination with practices of common inheritance (equal division)—leads to ever smaller farms and ever smaller land plots. Viet Nam exhibits very high levels of land fragmentation by international standards. Statistics for the year 2004 show that Viet Nam has approximately 75 million land plots (Marsh et al. 2007); on average, a household owns five different plots and about 10 per cent of these plots are smaller than 100 square meters. Average farm size varies between regions, but in general, most farms in Viet Nam have a production scale of less than 1 hectare. In some provinces, such as Ha Tay in the Red River Delta, the average farm size is only 2,400 square meters.

Land fragmentation potentially has significant, negative effects on agricultural productivity and growth (e.g. Niroula and Thapa 2005). Fragmentation prevents the use of modern, mechanized equipment, such as tractors and harvesters. It may prevent the adoption of crops, which can only be grown profitably at a certain scale. Fragmentation also often increases labour requirements, both because of the difficulties of using mechanized equipment and because substantial amounts of time is spent on transport between plots and on maintaining boundary demarcations. Production for commercial purposes (rather than own consumption) may only make sense if a certain scale of production is reached because commercialization comes with fixed costs of marketing (for example investment in drying equipment) and because traders require minimum amounts of product before entering into transactions.

We may distinguish between inter- and intra-farm land fragmentations. Inter-farm fragmentation implies that land is divided between many, small farms. Intra-farm fragmentation, on the other hand, means that land on each farm is divided into many plots. This paper studies the determinants as well as the effects of both types of land fragmentation in rural Viet Nam, using plot-, household-, and commune-level panel data from 12 provinces.

A priori, the effects of inter-farm land fragmentation are not clear. A classic thesis in development economics is the inverse farm size-productivity relation (e.g. Bardhan 1973; Carter 1984; Benjamin 1995; Ali and Deininger 2014). If small farms are more productive than large farms, then high levels of inter-farm fragmentation should be good for productivity. Furthermore, an equal land distribution has in many cases a positive effect on the political economy of a society (e.g. Rodrik 1995; Sokoloff and Engermann 2000). On the other hand, there may well be increasing returns to scale in agriculture, at least at some levels of farm size (e.g. Foster and Rosenzweig 2010). Since farms in Viet Nam are very small, the hypothesis of increasing returns is quite plausible. In particular, the theory of an inverse farm size–productivity relation is typically based on the view that large farms need to hire large amounts of labour, which is less productive than family labour, due to difficulties of monitoring. In Viet Nam, however, very few farms are beyond the scale where most work can be carried out by members of the family. While hiring labour during times of planting and harvest is common, the bulk of agricultural labour is supplied by the family. So, the inverse farm size-productivity relation may not apply in a country such as Viet Nam.

Focusing on the effects of intra-farm fragmentation, it is clear that production is more troublesome at more fragmented farms, due to the need to move labour and equipment between plots, and maintain plot boundaries (cf. Rahman and Rahman 2008; Deininger et al. 2012; Deininger et al. 2014). On the other hand, a fragmented holding may to some extent insure the owner against the risks of crop failure, flooding, and so on. This insurance may in turn increase willingness to experiment with new crops and other technologies and may in that sense also have

a positive effect on productivity (Blarel et al. 1992). Hence, for both inter- and intra-farm fragmentations, there is no clear, a priori prediction regarding effects on productivity.

In terms of the determinants of land fragmentation, it is clear that in the case of Viet Nam, egalitarian government land allocation policies at the time of agricultural de-collectivization in the late 1980s and early 1990s is a major reason behind current levels of fragmentation, although population pressure and inheritance practices also play important roles (Ravallion and van de Walle 2004, 2006). Similarly, Tan et al. (2006) conclude that government land allocation practices are a major driver of land fragmentation in China. Reductions in land fragmentation may be brought about by either markets, or by government and community interventions. We study the effects of land sales and rental markets and government land consolidation programmes on levels of inter- as well as intra-farm land fragmentation.

The paper is organized as follows: Section 2 presents the dataset used, key variable definitions, and descriptive statistics. Section 3 presents multivariate, household-level analyses of the *effects* of land fragmentation on outputs, inputs, and profits in crop agriculture. Section 4 shows results of plot level analyses. Section 5 investigates the *determinants* of both inter- and intra-farmland fragmentation. Section 6 concludes.

## 2 Data set, variable definitions, and descriptive statistics

### 2.1 Data set

We make use of a household panel data set collected in the Vietnam Access to Resources Household Survey (VARHS). The survey was implemented in 12 provinces in Viet Nam between July and September 2008 and between June and August 2010. It re-interviewed rural households sampled for the income and expenditure modules of the 2002 and 2004 Viet Nam Household Living Standards Survey (VHLSS) in the 12 provinces.[1] Provinces were selected to facilitate the use of the survey as an evaluation tool for Danida-supported programmes in Viet Nam. Seven of the 12 provinces are covered by the Danida business sector programme support (BSPS), and five provinces are covered by the agricultural and rural development (ARD) programme. The provinces supported by the agricultural support programme are located in the North West and Central Highlands, so these relatively poor and sparsely populated regions are over-sampled. The sample is statistically representative at the provincial but not at the national level.

The 2008 round of the VARHS survey covered 2,278 households originally sampled for VHLSS 2002 or VHLSS 2004. Out of these households, 2,233 were identified and resurveyed in 2010 (implying an attrition rate of two per cent).[2] Of these, 2,113 own or operate agricultural land. The household survey collected detailed information on farm size, number of plots, other land characteristics, agricultural inputs and outputs, land market transactions, and general information about individuals and households. A commune questionnaire was also administered, collecting

[1] See CIEM et al. (2009) for further background information and details. The sampled provinces are, by region: Red River Delta: Ha Tay; North East: Lao Cai, Phu Tho; North West: Lai Chau, Dien Bien; North Central Coast: Nghe Anh; South Central Coast: Quang Nam, Khanh Hoa; Central Highlands: Dak Lak, Dak Nong, Lam Dong; Mekong River Delta: Long An.

[2] In addition, 991 households in selected upland communes were interviewed in 2008; 951 of these were re-interviewed in 2010. These households were included for the purpose of evaluating a Danida policy programme being implemented in these areas. Since this sample is not statistically representative, we do not use it.

data on commune land distribution, land consolidation programmes, and a number of other variables.

## 2.2 Key variables

To study the effects of inter-farm land fragmentation, we conduct household as well as plot level analyses and focus on the effects of farm size on productivity, labour input, mechanization, and crop choice. A main dilemma is whether to measure farm size by the area of owned agricultural land, or the area of operated land (owned land plus land rented in minus land rented out). Since we are mainly interested in the inputs and outputs of agricultural production, we use the operated area, and note that only about 5 per cent of land is rented, so the choice between owned or operated land only affects results moderately. Residential plots are included in the operated area if and only if they are used for cultivation.

Measuring intra-farm land fragmentation is more complicated. The number, size distribution, and spatial distribution of plots are all potentially relevant. A priori, it is not clear which of these dimensions are most important. For example, if the main problem related to intra-farm land fragmentation is traveling time between plots, and between home and plots, then spatial distribution should matter a great deal. On the other hand, if the main issue related to fragmentation is the effort needed to maintain boundary demarcations (fences, dykes, etc.), then distances between plots and the household home are less important. In household level analyses, we employ three different measures of intra-farm land fragmentation. First, the number of plots operated. Second the Simpson index of fragmentation, which is defined as $1-\sum_{i=1}^{N} s_i^2$, where $s_i$ is the share of total farm area covered by plot *i* and *N* is the total number of plots operated by the household. Higher values imply higher levels of fragmentation. This measure takes into account the size distribution but not the spatial distribution of plots. Finally, we calculate the sum of distances between the household home and each plot. While this measure ignores the size distribution it does account for the number of plots and their spatial distribution.

A key concern is the potential effect of land fragmentation on agricultural productivity. Addressing this issue requires a definition of productivity. Alternative studies have used yields, value of output per hectare, income per hectare, and profits per hectare as measures of productivity. By 'income' we here mean the value of output minus the value of purchased inputs. 'Profits', on the other hand, are defined as the value of output minus the value of purchased inputs as well as family labour. As the results presented below make clear, the conclusions reached about the effects of fragmentation on productivity depends critically on which measure of productivity is employed. From the point of view of economic theory, there is little doubt that the most satisfying measure of productivity is profits. Yield, value of output, and income are all partial, or incomplete, measures of productivity because they ignore the cost of one of more inputs in production. The reason many researchers have nevertheless declined to use profits as a measure of productivity is the severe practical problems related to measuring profits. In particular, most farms in developing countries, including Viet Nam, rely heavily on the use of family labour. Obtaining a monetary estimate of profits requires monetary valuation of family labour inputs. The standard approach is to value family labour by the local wage rate for unskilled, agricultural labourers. However, this methodology may be flawed. In most agricultural practices, labour demands vary heavily over the seasonal cycle. Labour intensity is high during planting and harvesting and low in between. This is particularly true for paddy rice farming, which is prevalent in Viet Nam. Employment of hired, agricultural labourers is much higher in the months of planting and harvesting than in other months. Therefore, the wages recorded mainly reflect conditions during the months of peak labour demand, where wages are higher

than in other months. On the other hand, when surveys, such as the VARHS, ask households about the number of days they have worked in agriculture, respondents with no occupation besides agriculture are likely to include most days of the year, including many days during the slack season. Valuing this labour by the measured, local wage rates is likely to overestimate the real, shadow value of agricultural labour. These issues are dealt with here by assuming that shadow wages equal local wage rates in the busy season and are zero in the slack season. The typical Vietnamese farmer grows two crops per year. If each planting and each harvest season is 15 days, the busy season is at most 60 days per crop. Accordingly, we value family labour at the going wage rate for at most 60 days per crop and zero for additional time beyond that.[3]

The descriptive statistics presented in Table 2 indicate that average profits by this definition are close to zero, consistent with assumptions of optimizing behaviour and competitive labour markets in the busy season and surplus labour in the slack season.

We are also interested in measuring the effects of productivity on labour input in agriculture. This is interesting both because of the effect of labour use on agricultural profits, and in its own right. From a macroeconomic perspective, continued economic growth and industrialization in Viet Nam requires massive movement of labour from the primary to the secondary and tertiary sectors. This process is facilitated by the adoption of less labour-intensive techniques in agriculture. In terms of measuring total labour inputs, one minor concern stems from the fact that the VARHS did not measures days of hired labour use; only the value of hired labour. The days of hired labour employed is estimated as the value of hired labour divided by the local wage rate for unskilled agricultural workers (valuing hired labour by the going wage rate is much less problematic than doing the same for family labour). For most households, family labour is much more important than hired labour.

### 2.3 Regional heterogeneity

Conditions for agriculture differ substantially across the regions of Viet Nam. To take this heterogeneity into account, we divide the 12 provinces in the VARHS sample into four categories, namely the Northern lowlands (ex-Ha Tay, Phu Tho, and Nghe An provinces); Northern highlands (Lao Cai, Dien Bien and Lai Chau); Central highlands (Dak Lak, Dak Nong, and Lam Dong); and Southern lowlands (Quang Nam, Khanh Hoa, and Long An). The categorization is somewhat rough. For example, parts of Phu Tho and Nghe An provinces are best characterized as 'highland', although most people in these provinces live in the lowlands. Nevertheless, the distinction captures significant variation along the important dimensions of north–south and highland–lowland. Most analyses in the paper are conducted separately for each region and important differences between regions do emerge.

### 2.4 Descriptive statistics

Table 1 presents descriptive statistics on inter- and intra-farm land fragmentation in 2010, by region. The results document the very high levels of fragmentation characterizing Vietnamese land distribution, especially in northern parts of the country. In the northern plains, median farm size is less than a quarter of a hectare. Nevertheless, farm land is on average divided into 5.5 different plots. Intra-farm fragmentation is even higher in the Northern highlands, although average farm size in the highlands is higher than in the lowlands, largely reflecting much lower

[3] Of course, the duration of the busy season depends to some extent on the type of crop grown and the amount of operated land. These factors are ignored in the calculation of the labour value, but controlled for in the regression analyses presented.

quality of land in the hills. Fragmentation is significantly less pronounced in the south. Farms are larger, but nevertheless divided into fewer plots. This pattern has long historical roots. Population density, and therefore land scarcity, and land fragmentation were much more pronounced in the northern than in the southern plains, even during colonial and pre-colonial times (Gourou 1936/1965; Popkin 1979). However, as discussed in the introduction, the main factor behind current levels of land fragmentation is government land allocation policy in the context of de-collectivization. Egalitarian principles of land allocation meant that farm land was distributed evenly among households and that all households were supposed to receive land of high quality as well as lower quality. Because collectivization had progressed much further in the north than in the south, this process affected the north more than the south (Ravallion and van de Walle 2008a). Apart from government policies, land fragmentation is also affected by land inheritance practices and the functioning of land markets, an issue to which we return in Section 4. Even if land distribution in Viet Nam is equal by international standards, there is some inequality. The land distribution displays the right-skewed shape characteristic of almost any asset or income distribution, which explains why the mean landholding is higher than the mean in all regions.

Table 2 presents statistics on inputs and outputs in agriculture, by five categories of farm size. This is the first step in our analysis of the effects of inter-farm land fragmentation. Table A1 in the Appendix presents results separately by region. Value of output, value of non-labour inputs, labour days and profits are all affected by outliers. Therefore, the top and bottom 1 per cent of these variables are trimmed, similar to the approach taken in Hsieh and Klenow (2009). Results show strong effects of farm size. The value of output per hectare declines steadily with the amount of land operated. This may in part reflect variations in land quality, which we therefore try to control for in the regression analyses presented below. On aggregate, the value of non-labour inputs per hectare is not strongly affected by farm size. However, this result masks significant inter-regional diversity. In the north, the value of non-labour inputs per hectare is in fact much higher on small farms than on large, whereas in the south there is a weaker tendency in the opposite direction. This may indicate that input markets function more efficiently in the south than in the north. Most strikingly, farm size has an extremely strong, negative effect on the amount of labour applied per hectare. Labour intensity is more than five times higher in the smallest than in the largest farm-size category.

Results also show that profits (as defined above) increase monotonically with farm size. Estimated profits are negative for farms smaller than 0.5 hectares. These results are consistent with recent results for India, where farm size is also found to have a significant, positive effect on agricultural profits (Foster and Rosenzweig 2010) but goes against the conventional wisdom of an inverse farm-size productivity relation.

Table 2 also presents results for two types of mechanical equipment (tractors and harvesters) and for crop choice (the share of land planted in at least one season with rice and the share planted with perennial crops). Results show a strong, positive effect of farm size on the probability of owning a tractor, confirming the expectation that land fragmentation reduces mechanization in agriculture. On the other hand, medium sized farms are more likely to own a harvester than both the smallest and the largest farms. This probably reflects the fact that harvesters are used for harvesting rice, which is rarely grown on the largest farms. Farm size is strongly correlated with crop choice (of course, in many cases there is no 'choice', because rice growing is mandated by land use plans, cf. Markussen et al. 2011). Smaller farms are more likely to grow rice and less likely to grow perennial crops.

Table 3 presents the same set of agricultural input and output variables as Table 2, but in this case by categories of intra-farm land fragmentation. Table A2 in the Appendix presents results

by region. This is the first element in our analysis of the effects of intra-farm fragmentation, here measured by the number of plots operated. With the exception of crop choice, the effects of intra-farm fragmentation are not nearly as strong as the effects of farm size presented in Table 2. Also, the effects of intra-farm fragmentation are in several cases non-monotonous. Value of output per hectare is smallest on farms with only one plot. It is highest on farms with two plots and then declines. Similar patterns are found for non-labour inputs per hectare and profits per hectare. Profits per hectare actually increase among farms with more than four plots. In terms of labour inputs, the highest labour intensity is found on farms with only one plot, and the second highest on farms with more than nine plots. Labour intensity increases moderately and monotonically from farms with two to three plots to farms with more than nine plots. Appendix Table A2, however, shows that this result is reversed when regions are considered separately. Therefore, these descriptive statistics do not immediately support the view that intra-farm fragmentation is associated with higher labour intensity and lower productivity. The relationship between the number of plots and ownership of tractors is non-monotonous. A higher plot number increases the probability of owning a harvester. There is not support in these results, then, for the view that intra-farm fragmentation reduces mechanization. However, we should be careful about drawing inferences about causality from these descriptive tables. Intra-farm land fragmentation is positively and strongly correlated with growing rice. Conversely, fragmented farms are much less likely than consolidated ones to grow perennial crops.

## 3 Multivariate analyses of the effects of fragmentation

To be able to control for the potential influence of 'third' variables, which may confound estimates of the effects of land fragmentation, we turn to multiple regression analyses. These analyses exploit the 2008–10 VARHS-panel. In this section, we present household-level regressions for profits, value of output, value of non-labour inputs, and labour input. For the last three variables, we use logarithmic specifications which reduce the influence of outliers and lead to better model fit. However, since the profit measure includes many negative values, a logarithmic specification is not appropriate. Random effects regressions are presented. Province dummies are included in all specifications (not shown). Standard errors are clustered at commune level. Control variables include land and household characteristics, measures of cropping patterns and a year indicator.

Table 4 presents regressions for profit per hectare. Regression 1, 2, and 3 use data for all regions and each includes an alternative measure of intra-farm fragmentation (number of plots, Simpson index, and total distance). Results confirm the patterns found in Table 2: larger farms are more profitable, implying that inter-farm land consolidation improves efficiency in Vietnamese agriculture. Interestingly, the effect of farm size is stronger and only significant in the north. This indicates that land consolidation is a more pressing issue in the north, where farms are indeed smaller (as shown in Table 1) and land sales markets are much thinner than in the south (see e.g. Brandt 2006; Khai et al. 2013).[4]

[4] One potential reason why larger farms are more profitable is that they are more likely to sell their output on the market. Commercialization may increase profitability because of competitive pressure and because market participation provides information about performance relative to other producers. A measure of whether the household sells any crops is available, but not included in the regressions in Tables 4–7 because it is likely to be highly endogenous (a good harvest increases the likelyhood of selling some of the output on the market). If the indicator is nevertheless included, the estimated effects of land fragmentation are not substantially altered. In some regions, particularly the Central highlands, the share of land with perennial crops can probably be viewed as a proxy for commercialization.

Surprisingly, regressions 1 to 3 all show a *positive* effect of intra-farm land fragmentation on profits. This is in sharp contrast with the prediction of a negative effect of intra-farm fragmentation on efficiency (see Marsh et al. 2007). One methodological explanation may be that land quality is not appropriately controlled for, and that more fragmented farms have higher land quality. However, note that the regressions include controls for irrigation, slope of land, and an indicator for the share of land exhibiting any of a list of 'problems' (gullies, sedimentation, landslides, dry or stony soil, or other problems). For a substantive (rather than methodological) explanation we may speculate, as done in the introduction, that more fragmented farms are less exposed to risks of crop disease, flooding, and so on, and that lower exposure to risk increases farmers' readiness to experiment with new, potentially more profitable techniques of production.

Results for control variables generally conform to expectations. A higher share of land with perennial crops is associated with higher profits, but region-specific analyses show that this effect is only significant in the Central highlands, the main coffee-growing area. Irrigation, other dimensions of land quality, and the household head's years of schooling are also significant determinants of profits. Profits were higher in 2008 than in 2010, probably an effect of the global price hike in cereal prices during 2007–08.

Table 5 presents regressions for the value of output. Again, the results on the effects of farm size in Table 2 are confirmed. Smaller farms have significantly higher value of output per hectare than large farms. This result holds in all regions. For two of the three measure of intra-farm fragmentation, there is a positive effect of fragmentation on value of output.

Table 6 presents regressions for the value of non-labour inputs. In contrast with the results in Table 2, the results show a significant, negative effect of farm size and a significant, positive effect of intra-farm fragmentation on input intensity. Hence, intensity of non-labour inputs may contribute to explaining why larger farms are more profitable.

Table 7 shows regressions for labour intensity. Results confirm the impression emerging from Table 2 of an extremely strong and significant, negative effect of farm size on labour use per hectare. This result holds in all regions. Two of the three measures of intra-farm fragmentation have a strong and highly significant, positive effect on labour intensity. In contrast with the bi-variate results in Table 3, these results confirm the expectation that more fragmented farms use more labour, all else equal.

To summarize, the most important result emerging from these analyses is the strong effect of both intra- and inter-farm land fragmentation on labour intensity in agriculture, and the negative effect of inter-farm land fragmentation on profits. In other words, the relation between farm size and productivity is positive, rather than inverse. For intra-farm fragmentation, on the other hand, a somewhat surprising, positive effect of fragmentation on profits emerges.

## 4 Plot level analysis

The VARHS data set used in this paper is distinguished by the availability of detailed data at the household and at the plot level. Here this data is exploited to investigate effects of intra-farm fragmentation in more detail. For non-labour inputs, data on whether each type of input was used or not is available for the five largest plots in each household. Data on the exact quantities and values of these inputs is not available at the plot level. Data on labour inputs is also not available at the plot level. Therefore, the outcome variables used here are measures of crop output. First, we use the value of total crop production per square meter. Second, we focus on plots sown with rice and measure the total quantity of rice produced per square meter (i.e. the

yield of rice). Since these variables are quite strongly affected by outliers (probably mostly because of measurement and recording errors), the variables are 'trimmed' by dropping the 1 per cent highest and the 1 per cent lowest observations As mentioned above, a similar method was used in Hsieh and Klenow (2009). We use three measures of intra-farm fragmentation. The first is the area of the plot. If intra-farm fragmentation harms productivity by preventing use of machinery, then small plots should be less productive than large plots, all else equal. Second, we use the distance of the plot from the family home. If fragmentation is harmful because high travel time prevents plots from being tended to in an optimal manner by farmers, then more distant plots should be less productive. Plots sharing a border with other plots operated by the household should suffer less than other plots from high travel times. Therefore, we also include a dummy for sharing a border with another plot belonging to the household.

Results are shown in Table 8. A series of control variables is used, including the share of the plot planted with annual rather than perennial crops, plot ownership status, restrictions on crop choice, when the plot was acquired, the number of harvests per year, irrigation, recent investment in soil and water conservation, whether the plot was affected by a natural disaster in the last year, plot slope and plot problems (gullies, sedimentation, etc.). Indicators for using a number of different non-labour inputs (seeds, saplings, chemical fertilizer, etc.) are included in regressions 2 and 4. However, since these variables are only available for the five largest plots in each household, some plots are dropped from these analyses. Therefore, specifications without input indicators are also included (regression 1 and 3). Due to space constraints, some control variables are not shown. A year indicator is also included. Importantly, household fixed effects are introduced to neutralize the impact of household-level determinants of productivity, such as household labour force, farming skills, and so on.

Results show that plot size has a significant, *negative* effect on productivity both in models for total value of output and for rice yields. One potential explanation is that small plots are more fertile. Note, however, that the regressions control for a large number of factors related to fertility. The conclusion that sub-division of plots increases productivity is clearly not warranted. On the other hand, the results lend no support to the view that merging plots would increase production. The results are consistent with the findings in Table 5 that intra-farm plot fragmentation is associated with higher value of output per hectare at the household level.

Looking at the distance variable, a different picture emerges. More distant plots are indeed significantly less productive than other plots, in line with the view that intra-farm fragmentation reduces efficiency. The estimates for sharing a border with other plots are insignificant. These results suggest potentially important policy implications for the specific design of land consolidation programmes. It appears to be more important to reduce travel time than to merge small plots into larger units.

Results for control variables are also interesting. Estimates suggest significant positive effects of Land Use Certificates (Red Books) and significant, negative effects of crop choice restrictions (see Markussen et al. 2011). These findings stress the importance of land property rights for agricultural productivity. They also underline, the strong, negative effect of natural disasters in crop output.

In conclusion, plot level analyses generate a more nuanced picture of the effects of intra-farm land fragmentation than the household-level regressions above. While there is no evidence that small plots are less productive than large plots (indeed, the results indicate the opposite), long distances between home and plot do in fact appear to be harmful for agricultural production.

## 5 Determinants of fragmentation

Having studied the effects of land fragmentation, we now turn to analysing the determinants of fragmentation/consolidation. An issue of key importance is whether and when land market transactions facilitate consolidation. Another important question is whether administrative land reform is an effective means to increased consolidation. Since administrative reforms explicitly aimed at moving land from small to large farms are likely to be highly controversial, administrative reform is more relevant in the context of intra-farm fragmentation. Indeed, programmes to decrease plot-level fragmentation have been implemented in many communes in Viet Nam and one aim of the analysis that follows is to assess the effects of such programmes.

### 5.1 Inter-farm fragmentation

To study the determinants of inter-farm land consolidation we exploit the VARHS commune level data from 2008 and 2010. The VARHS commune questionnaire collects data on the commune land distribution, land market transactions, and many other commune characteristics. The measure of land consolidation used is the share of households in the commune owning more than two hectares of land (data on operated land is not available at commune level). Regressions for this variable are presented in Table 9. The most important explanatory variable is the number of land sales registered in the commune per household. Now, communes with a more fragmented land distribution typically have a higher number of plots and for that reason also more land transactions. Hence, there is a reverse, negative effect of consolidation on land market transactions. To remove this effect from the analyses, commune fixed effects are included. In regressions with fixed effects, only variation over time within each commune is driving the results. The regressions answer the question: does an increase in land markets activity (or in any of the other, explanatory variables) lead to higher consolidation or to more fragmentation? Another important question, apart from the direct effect of land markets, is whether integration into the market economy more generally facilitates land consolidation. In particular, if people have better opportunities of finding gainful employment outside agriculture, we would expect that marginal farmers are more willing to sell their land and rely on the non-farm sector. Therefore, regressions also include the following measures of off-farm opportunity: the presence of a permanent market in the commune, the daily wage for male construction workers, and the number of enterprises per 1,000 inhabitants in the commune. Finally, a measure of population density (number of households per hectare of agricultural land) is included.

Results of the fixed effects regressions show a significant, positive effect of land sales on consolidation. Communes with increasing numbers of land sales also experience an increase in the share of farms above two hectares. Interestingly, this effect is only present in the south. Hence, although the analysis presented above indicated that efficiency gains from land consolidation are highest in the north, results in Table 9 indicate that markets only facilitate consolidation in the south. This is testimony to the highly imperfect functioning of land sales markets in the north (Khai et al. 2010). One barrier to land markets in many provinces is the 'land ceiling' of two (sometimes three) hectares, which implies that land holdings in excess of two (three) hectares is subject to taxation. Removing this obvious barrier to land consolidation might change the results in Table 8.

The results offer only weak support for the idea that market integration facilitates land consolidation. None of the off-farm opportunity indicators are significant, although the construction wage variable is almost significant in regression 2.

## 5.2 Intra-farm fragmentation

To study the determinants of intra-farm fragmentation, we turn again to household-level regressions. We choose the Simpson index as the measure of intra-farm fragmentation and investigate whether administrative land consolidation programmes and land rental-and sales markets transactions reduce or increase this variable. Again, severe endogeneity problems mean that the inclusion of fixed effects is important. In particular, land consolidation programmes are disproportionately implemented in communes with a high level of land fragmentation, inducing a positive, cross-sectional correlation between consolidation programmes and fragmentation. Therefore, regressions for the Simpson index include household fixed effects. Analysing the effects of land market transactions is somewhat complicated. Clearly, a farm that buys land/rents in land is going to increase its level of fragmentation. Conversely, selling/renting out land reduces fragmentation. However, if purchased or rented plots are merged with other plots, or if they are located closer to the home of the receiving household than to the home of the supplying household, transactions may lead to a net decline in fragmentation. Therefore, indicators for selling and buying land in the last two years, and for renting land in or out, respectively, are included in the regressions. To check the total effect of land transactions on fragmentation, we test whether the *sum* of the coefficients for buying and selling (renting in and out) is positive, implying that land markets increase fragmentation, or negative, which would imply that market transactions lead to consolidation.

Results, presented in Table 10, show that the presence of a land consolidation programme does have the expected, negative effect on the Simpson index. However, in the regressions for all regions, the effect is not significant. It is also insignificant in all individual regions, except for the Northern lowlands. On average, therefore, land consolidation programmes appear to have only a moderate effect. However, where intra-farm land fragmentation is arguably most acute, in the northern plains, the programmes do have an impact.

For land market transactions, selling and renting out have the expected, negative effects on fragmentation, while buying and renting in have the equally predictable, positive effects. In all regressions, the negative effect of renting out is numerically higher than the positive effect of renting in. This difference is significant in the random effects regression and almost significant in the fixed effect regression for all regions, providing weak evidence that rental markets may contribute to reducing the fragmentation of operational holdings. For sales markets transactions, on the other hand, the positive effect of buying land is always higher than the negative effect of selling. The difference is significant in the random effects regression but insignificant in the fixed effects models. Hence, there is no evidence from these analyses that land sales markets contribute to reducing intra-farm land fragmentation.

# 6 Conclusion

The paper has investigated the determinants as well as the effects of intra- and inter-farm land fragmentation in rural Viet Nam. In terms of the effects of fragmentation, the most important result is the very strong effect of especially inter- but also intra-farm land fragmentation on labour use in agriculture. While this conclusion is not surprising, the estimated size of the effect is striking. Labour input per hectare is more than five times higher on the smallest farms than on the largest. This implies that land consolidation has the potential to release massive amounts of labour from agriculture. As countries such as Viet Nam and China continue to industrialize, land consolidation can be a key element in a strategy to maintain competitiveness in industrial exports by maintaining abundant labour supply.

Another notable result is the positive effect of farm size on agricultural profits. Note that even if there is reason to doubt that recorded market wages in agriculture correctly reflect the shadow cost of family labour, the opportunity cost of labour is likely to grow in the future, as labour demand in other sectors increases. Therefore, the positive effect of farm size on profitability is likely to grow even stronger in the future. Results also confirm the view that land consolidation facilitates at least some types of mechanization in agriculture, and that land consolidation is associated with crop diversification away from paddy.

In terms of the potential for land market transactions and government interventions to reduce land fragmentation, results show that land sales markets do indeed on average function to increase the share of farms with relatively large land holdings. However, this effect is only present in the southern parts of Viet Nam, where land fragmentation is arguably less of a problem than in the north. This underlines the need to further facilitate the functioning of land sales markets, especially in northern Viet Nam. However, it is important to note that land consolidation depends not only on land markets. Inducing marginal farmers to sell their holdings requires well-functioning labour markets as well. Labour markets, in turn, function more smoothly if people can move between regions legally and without administrative hassle, if vocational training is cheap and widely available, and if housing in urban areas is available and affordable. Land sales are also facilitated by improved provision of insurance products, because land in many cases is held as a hedge against negative shocks.

For intra-farm land fragmentation, results show that in most regions, the effect of government land consolidation programmes is modest. However in the Northern lowlands, where land fragmentation is more extreme than anywhere else, such programmes have in fact been effective, implying that there is a potential for administrative land consolidation programmes to make an impact. On other hand, there is little evidence that land sales markets have any effect on intra-farm fragmentation. There is some evidence that land rental markets may contribute to reducing fragmentation.

In sum, reducing inter-farm land consolidation is an important means to reducing labour use and increasing efficiency in agriculture. While land markets have the potential to facilitate consolidation, this potential is currently only being exploited in that part of Viet Nam (the south) where it matters the least. Reducing intra-farm land fragmentation is perhaps less important than consolidating total holdings. On the other hand, if diversification of cropping patterns and reduced labour intensity are important goals in themselves, then reducing intra-farm fragmentation is a reasonable, strategic goal, and administrative land consolidation programmes may play a role in this. If consolidation programmes are implemented, our findings suggest that they should focus on reducing distances between family homes and plots, rather than merging smaller plots into larger ones.

## References


Ali, D.A., and K. Deininger (2014). 'Is there a farm-size productivity relationship in African agriculture? Evidence from Rwanda'. World Bank Policy Research Working Paper 6770. Washington, DC: World Bank.

Bardhan, P.K. (1973). 'Size, productivity and returns to scale: An analysis of farm-level data in Indian agriculture'. *Journal of Political Economy*, 81: 1370–86.

Benjamin, D. (19959. 'Can unobservable land quality explain the inverse productivity relationship? *Journal of Development Economics*, 46: 51–84.

Blarel, B., P. Hazell, F. Place, J. Quiggin (1992). 'The economics of farm fragmentation: evidence from Ghana and Rwanda'. *World Bank Economic Review*, 6: 233–54.

Brandt, L. (2006). 'Land access, land markets and their distributional implications in rural Vietnam'. Summary report. Toronto: University of Toronto.

Carter, M.R. (1984). 'Identification of the inverse relationship between farm size and productivity: An empirical analysis of peasant agriculture production', *Oxford Economic Papers* 36: 131–45.

CIEM, DOE, ILSSA, and IPSARD (2009). 'Vietnam Access to Resources Household Survey: Characteristics of the Vietnamese Rural Economy'. Hanoi: Statistical Publishing House.

Deininger, K., S. Savastano, and C. Calogero (2012). 'Land fragmentation, cropland abandonment, and land market operation in Albania'. World Bank policy Research Working Paper 6032. Washington, DC: World Bank.

Deininger, K., D. Monchuk, H.K. Nagarajan, and S.K. Singh (2014). 'Does land fragmentation increase the cost of cultivation? Evidence from India'. World Bank policy Research Working Paper 7085. Washington, DC: World Bank.

Foster, A., and M. Rosenzweig (2010). 'Is there surplus labor in rural India?'. Yale University Economics Department Working Paper 85. Yale University. Rochester, NY: Yale University.

Gourou, P. (1936/1965). *Les Paysans du Delta Tonkinois*. Paris: Mouton & Co, and Maison Des Science de L'Homme.

Hsieh, C.T., and P.J. Klenow (2009). 'Misallocation and manufacturing TFP in China and India'. *Quarterly Journal of Economics*, 124: 1403–48.

Khai, L.D., T. Markussen, S. McCoy, and F. Tarp (2013). 'Access to land. market- and non-market land: Transactions in rural Viet Nam'. In S. Holden., K. Otsuka, and K. Deininger (eds), *Land Tenure Reform in Asia and Africa—Assessing Impacts on Poverty and Natural Resource Management*. Basingstoke: Palgrave Macmillan.

Markussen, T., F. Tarp, and K. van den Broeck (2011). 'The forgotten property rights: Evidence on land use rights in Vietnam'. *World Development*, 39: 839–50.

Marsh, S., G. Macauley, P.V. Hung (2007). 'The economics of land fragmentation in the north of Vietnam'. *Australian Journal of Agricultural and Resource Economics*, 51: 195–211.

Niroula, G.S., and G.B. Thapa (2005). 'Impacts and causes of land fragmentation, and lessons learned from land consolidation in South Asia'. *Land Use Policy*, 22: 358–72.

Popkin, S.L. (1979). *The Rational Peasant: The Political Economy of Rural Society in Vietnam*. Berkeley, CA: University of California Press.

Rahman, S., and M. Rahman (2008). 'Impact of land fragmentation and resource ownership on productivity and efficiency: The case of rice producers in Bangladesh'. *Land Use Policy*, 26: 95–103.

Ravallion, M., and D. van de Walle (2004). 'Breaking up the collective farms. Welfare outcomes of Vietnam's massive land privatization'. *Economics of Transition*, 12: 201–36.

Ravallion, M., and D. van de Walle (2006). 'Land reallocation in an agrarian transition'. *Economic Journal*, 116: 924–42.

Ravallion, M., and D. van de Walle (2008a). 'Does rising landlessness signal success or failure for Vietnams agrarian transition?'. *Journal of Development Economics*, 87: 191–209.

Ravallion, M., and D. van de Walle (2008b). *Land in transition: Reform and poverty in rural Vietnam*. Washington, DC: World Bank.

Rodrik, D. (1995). 'Getting interventions right: how South Korea and Taiwan grew rich'. *Economic Policy*, 10: 55–107.

Sokoloff, K.L., and S.L. Engerman (2000). 'Institutions, factor endowments, and paths of development in the new world'. *Journal of Economic Perspectives*, 14: 217–32.

Tan, S., N. Heerink, and F Qu (2006). 'Land fragmentation and its driving forces in China'. *Land Use Policy*, 23: 272–85.

## Tables

**Table 1: Land fragmentation, 2010**

| *Region* | Farm size, operated, ha. (mean) | Farm size, operated, ha. (median) | Number of operated plots (mean) | Number of operated plots (median) | Simpson index | Sum of home-to-plot distances (meters) |
|---|---|---|---|---|---|---|
| Northern lowlands | 0.41 | 0.22 | 5.5 | 5 | 0.59 | 4,034 |
| Northern highlands | 1.06 | 0.83 | 5.5 | 5 | 0.66 | 9,602 |
| Central highlands | 1.83 | 1.25 | 3.4 | 3 | 0.46 | 6,066 |
| Southern lowlands | 0.94 | 0.36 | 3.7 | 3 | 0.49 | 2,828 |
| Total | 0.85 | 0.36 | 4.7 | 4 | 0.55 | 4,766 |

Source: Authors' calculations based on VARHS
Note: N = 1995

**Table 2: Farming inputs and outputs, by farm size**

| .. | Value of output per ha. | Value of non-labor, variable inputs per ha. | Labor days per ha. | Profit per ha. | Has tractor | Has harvester | Share of land with rice** | Share of land with perennial crops | Number of plots, operated |
|---|---|---|---|---|---|---|---|---|---|
| < 0.25 ha | 40,818 | 13,258 | 649 | -4,587 | 0.00 | 0.04 | 0.62 | 0.18 | 3.5 |
| 0.25-0.5 ha | 35,791 | 12,160 | 522 | -288 | 0.01 | 0.12 | 0.61 | 0.21 | 6.0 |
| 0.5-1 ha | 27,487 | 9,778 | 306 | 1,728 | 0.01 | 0.11 | 0.47 | 0.30 | 5.5 |
| 1-3 ha | 25,906 | 10,130 | 183 | 5,490 | 0.06 | 0.08 | 0.36 | 0.43 | 5.3 |
| >3 ha | 21,902 | 10,938 | 88 | 5,361 | 0.12 | 0.13 | 0.31 | 0.58 | 5.4 |
| Total | 33,518 | 11,683 | 431 | 176 | 0.02 | 0.08 | 0.53 | 0.28 | 4.9 |
| N | 3,791 | 3,724 | 3,535 | 3,512 | 4,006 | 4,006 | 3,889 | 3,967 | 4,006 |

Source: authors' calculations based on VARHS.
Note: **Share of net sown area planted with rice in some or all seasons; money values in '000 VND.

**Table 3: Farming inputs and outputs, by number of plots**

| Number of plots (operated) | Value of output per ha. | Value of non-labor, variable inputs per ha. | Labor days per ha. | Profit per ha. | Has tractor | Has harvester | Share of land with rice* | Share of land with perennial crops |
|---|---|---|---|---|---|---|---|---|
| 1 plot | 29,387 | 11,059 | 476 | -4,163 | 0.01 | 0.01 | 0.29 | 0.43 |
| 2-3 plots | 37,180 | 13,729 | 399 | 1,586 | 0.03 | 0.03 | 0.49 | 0.34 |
| 4-5 plots | 32,991 | 11,793 | 416 | -34 | 0.03 | 0.08 | 0.58 | 0.23 |
| 6-9 plots | 32,200 | 10,344 | 443 | 67 | 0.02 | 0.14 | 0.58 | 0.21 |
| > 9 plots | 33,009 | 10,279 | 489 | 638 | 0.01 | 0.16 | 0.62 | 0.21 |
| Total | 33,518 | 11,683 | 431 | 176 | 0.02 | 0.08 | 0.53 | 0.28 |
| N | 3,791 | 3,724 | 3,535 | 3,512 | 4,006 | 4,006 | 3,889 | 3,967 |

Source: authors' calculations based on VARHS.

Note: money values in '000 VND. Data for 2010.

**Table 4: Land fragmentation and profits from crop agriculture**

| | *Dependent variable: Profits per ha.* | | | | | | |
|---|---|---|---|---|---|---|---|
| | All | All | All | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| Operated area, ha. | 449** | 605*** | 665*** | 1,013*** | 1,908*** | 408 | 79 |
| | (2.39) | (3.19) | (3.21) | (3.41) | (2.80) | (1.23) | (0.42) |
| No. Plots, operated | 589*** | | | 638*** | 200 | 973** | 628*** |
| | (5.47) | | | (4.69) | (0.66) | (2.33) | (3.14) |
| Simpson index | | 6,676*** | | | | | |
| | | (4.50) | | | | | |
| Total distance | | | 0.108*** | | | | |
| | | | (2.82) | | | | |
| Rice share | -1576 | -1976 | -1247 | -2,554 | 7,976*** | -7,344** | -800 |
| | (1.15) | (1.45) | (0.88) | (1.12) | (3.99) | (2.38) | (0.31) |
| Perennial share | 1,938* | 2,704** | 1,533 | -3,511* | 3,328 | 7,326*** | -2288 |
| | (1.69) | (2.33) | (1.31) | (1.66) | (1.37) | (3.40) | (1.17) |
| Share of land with problem | -2,912*** | -2,912*** | -2,720*** | -4,372*** | 3,879** | -7,265*** | -4,484*** |
| | (3.52) | (3.53) | (3.26) | (3.18) | (2.51) | (4.84) | (2.89) |
| Hh members 15 to 65 | -618*** | -520** | -473** | -236 | -1,161*** | -583 | -1,037*** |
| | (2.88) | (2.47) | (2.21) | (0.65) | (3.14) | (1.08) | (2.71) |
| Share of land irrigated | 5,093*** | 5,018*** | 4,970*** | 1,389 | 193 | 9,398*** | 3,221 |
| | (4.93) | (4.94) | (4.80) | (0.73) | (0.08) | (5.61) | (1.52) |
| Share of land with slight slope | 423 | 581 | 688 | 2,920** | -4,506** | 449 | -2,038 |
| | (0.46) | (0.63) | (0.74) | (2.08) | (2.29) | (0.22) | (1.05) |
| Share of land with medium slope | 2,576** | 2,825** | 2,363* | 5,143** | -4,237** | 3,927 | 4,544 |
| | (2.12) | (2.36) | (1.95) | (2.43) | (1.99) | (1.48) | (1.18) |
| Share of land with steep slope | 643 | 362 | 537 | -1,057 | 3,288 | -684 | -5,649 |
| | (0.26) | (0.15) | (0.22) | (0.26) | (1.03) | (0.15) | (1.11) |
| Age of head | -154 | -152 | -157 | -165 | -471* | 51 | -147 |
| | (1.19) | (1.16) | (1.20) | (0.65) | (1.87) | (0.13) | (0.59) |
| Age of head, squared | 2.00 | 2.00 | 2.00 | 2.00 | 4* | 0.00 | 2.00 |
| | (1.53) | (1.50) | (1.53) | (0.95) | (1.69) | (0.07) | (0.74) |
| Years of schooling, head | 197** | 204** | 199** | 206 | -69 | 459* | 164 |
| | (2.16) | (2.25) | (2.16) | (1.42) | (0.55) | (1.92) | (0.86) |
| Female hh head | -1,469* | -1369 | -1,780** | -919 | 1401 | -1,103 | -2089 |
| | (1.72) | (1.60) | (2.00) | (0.76) | (0.43) | (0.56) | (1.37) |
| Year = 2010 | -7,586*** | -7,572** | -7,678** | -10,729** | -2,053* | -7,559*** | -6,829*** |
| | (9.68) | (9.66) | (9.60) | (8.73) | (1.79) | (5.53) | (4.10) |
| Observations | 3,494 | 3,494 | 3,457 | 1,545 | 565 | 525 | 859 |
| Number of households | 1878 | 1878 | 1865 | 839 | 290 | 281 | 468 |

Source: authors' calculations based on VARHS.
Note: robust z statistics in brackets. Data for 2008 and 2010. Random effects regressions. Province dummies included (not shown). Monetary values in '00 VND. * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 5: Land fragmentation and value of output from crop agriculture**

| | *Dependent variable: Value of output per ha., log* | | | | | | |
|---|---|---|---|---|---|---|---|
| | All | All | All | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| Operated area, ha., log | -0.278*** | -0.303*** | -0.214*** | -0.377*** | -0.487*** | -0.266*** | -0.212*** |
| | (8.74) | (10.86) | (7.20) | (7.15) | (11.52) | (3.65) | (4.15) |
| No. Plots, operated | 0.036*** | | | 0.045*** | 0.057*** | 0.064** | 0.040** |
| | (4.91) | | | (4.69) | (4.35) | (2.32) | (2.34) |
| Simpson index | | 0.794*** | | | | | |
| | | (8.67) | | | | | |
| Total distance | | | 0.000 | | | | |
| | | | (0.51) | | | | |
| Rice share | 0.647*** | 0.568*** | 0.669*** | 0.717*** | 0.532*** | 0.08 | 0.818*** |
| | (8.33) | (7.48) | (8.46) | (6.75) | (4.93) | (0.40) | (4.96) |
| Perennial share | -0.243*** | -0.137* | -0.276*** | -0.11 | -0.276** | 0.131 | -0.864*** |
| | (3.20) | (1.78) | (3.72) | (0.92) | (2.23) | (1.00) | (5.93) |
| Share of land with problem | -0.169*** | -0.174*** | -0.177*** | -0.153*** | 0.009 | -0.300*** | -0.278*** |
| | (3.70) | (3.82) | (3.84) | (2.70) | (0.16) | (3.42) | (2.58) |
| Hh members 15 to 65, log | 0.063* | 0.059* | 0.092*** | 0.132*** | 0.026 | 0.037 | -0.002 |
| | (1.84) | (1.75) | (2.62) | (2.59) | (0.52) | (0.37) | (0.02) |
| Share of land irrigated | 0.475*** | 0.464*** | 0.459*** | 0.244*** | 0.102 | 0.906*** | 0.17 |
| | (7.75) | (7.79) | (7.70) | (4.01) | (1.12) | (6.68) | (1.30) |
| Share of land with slight slope | -0.04 | -0.028 | -0.04 | 0.00 | -0.195** | 0.007 | -0.13 |
| | (0.80) | (0.56) | (0.83) | (0.06) | (2.58) | (0.06) | (1.00) |
| Share of land with medium slope | -0.02 | 0.01 | -0.04 | 0.06 | -0.377*** | 0.379** | -0.22 |
| | (0.19) | (0.12) | (0.49) | (0.37) | (4.17) | (2.54) | (0.58) |
| Share of land with steep slope | -0.084 | -0.117 | -0.088 | 0.01 | -0.18 | -0.05 | -0.16 |
| | (0.55) | (0.80) | (0.59) | (0.05) | (0.70) | (0.16) | (0.61) |
| Age of head | 0.001 | 0.003 | 0 | 0.002 | 0.007 | 0.005 | -0.001 |
| | (0.14) | (0.40) | (0.04) | (0.17) | (0.53) | (0.25) | (0.07) |
| Age of head, squared | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | (0.04) | (0.26) | (0.12) | (0.07) | (0.50) | (0.53) | (0.10) |
| Years of schooling, head | 0.009** | 0.011** | 0.010** | 0.001 | -0.001 | 0.015 | 0.008 |
| | (1.97) | (2.32) | (2.04) | (0.08) | (0.13) | (1.17) | (0.71) |
| Female hh head | -0.059 | -0.043 | -0.063 | -0.04 | 0.071 | -0.18 | -0.085 |
| | (1.43) | (1.06) | (1.54) | (0.73) | (0.91) | (1.43) | (1.00) |
| Year = 2010 | -0.066** | -0.062* | -0.066* | -0.161*** | 0.013 | -0.087 | 0.053 |
| | (1.97) | (1.84) | (1.93) | (3.71) | (0.28) | (1.33) | (0.58) |
| Observations | 3,632 | 3,632 | 3,593 | 1,598 | 572 | 539 | 923 |
| Number of households | 1914 | 1914 | 1902 | 850 | 291 | 282 | 491 |

Source: authors' calculations based on VARHS.
Note: Robust z statistics in brackets. Data for 2008 and 2010. Random effects regressions. Province dummies included (not shown). Monetary values in '00 VND. * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 6: Land fragmentation and non-labor inputs in crop agriculture**

| | *Dependent variable: Value of non-labor inputs per ha., log* | | | | | | |
|---|---|---|---|---|---|---|---|
| | All | All | All | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| Operated area, ha., log | -0.246*** | -0.282*** | -0.159*** | -0.327*** | -0.649*** | 0 | 0 |
| | (5.51) | (7.71) | (4.07) | (4.77) | (11.16) | (1.45) | (0.87) |
| No. Plots, operated | 0.043*** | | | 0.045*** | 0.094*** | 0.078** | 0.023 |
| | (4.31) | | | (3.26) | (4.63) | (2.39) | (1.32) |
| Simpson index | | 1.026*** | | | | | |
| | | (9.70) | | | | | |
| Total distance | | | 0.000 | | | | |
| | | | (1.54) | | | | |
| Rice share | 0.689*** | 0.601*** | 0.732*** | 0.654*** | 0.063 | 0.408* | 1.055*** |
| | (7.73) | (7.02) | (8.08) | (4.80) | (0.37) | (1.65) | (6.97) |
| Perennial share | -0.247*** | -0.119* | -0.294*** | -0.360*** | -0.465** | 0.176 | -0.536*** |
| | (3.35) | (1.65) | (3.93) | (2.72) | (2.54) | (0.94) | (5.00) |
| Share of land with problem | 0.087** | 0.080** | 0.081** | 0.086 | 0.162* | -0.055 | -0.007 |
| | (2.30) | (2.14) | (2.16) | (1.46) | (1.68) | (0.59) | (0.14) |
| Hh members 15 to 65, log | -0.033 | -0.04 | 0.004 | 0.02 | -0.107 | -0.059 | -0.079 |
| | (0.84) | (1.03) | (0.11) | (0.33) | (1.10) | (0.51) | (1.22) |
| Share of land irrigated | 0.703*** | 0.690*** | 0.678*** | 0.524*** | 0.475*** | 0.928*** | 0.428*** |
| | (10.13) | (10.08) | (9.82) | (5.37) | (3.82) | (5.55) | (3.64) |
| Share of land with slight slope | -0.100* | -0.082 | -0.115* | -0.08 | -0.162 | 0.009 | -0.215** |
| | (1.70) | (1.40) | (1.93) | (0.96) | (1.16) | (0.07) | (2.01) |
| Share of land with medium slope | -0.13 | -0.10 | -0.15 | -0.23 | -0.366** | 0.19 | 0.03 |
| | (1.30) | (1.01) | (1.44) | (1.02) | (2.22) | (1.00) | (0.20) |
| Share of land with steep slope | -0.356* | -0.388* | -0.364* | -0.14 | -0.15 | -0.06 | -1.863*** |
| | (1.73) | (1.88) | (1.77) | (0.41) | (0.41) | (0.19) | (3.14) |
| Age of head | 0.019** | 0.021** | 0.017** | 0.015 | 0.038* | -0.003 | 0.029** |
| | (2.17) | (2.51) | (1.97) | (1.06) | (1.92) | (0.09) | (1.99) |
| Age of head, squared | -0.000** | -0.000** | -0.000* | 0 | -0.000* | 0 | -0.000* |
| | (2.03) | (2.34) | (1.86) | (1.05) | (1.71) | (0.16) | (1.91) |
| Years of schooling, head | 0.011* | 0.013** | 0.011* | -0.001 | 0.014 | 0.039*** | -0.002 |
| | (1.87) | (2.26) | (1.84) | (0.13) | (1.37) | (2.62) | (0.14) |
| Female hh head | -0.035 | -0.016 | -0.036 | -0.03 | -0.001 | -0.03 | -0.123** |
| | (0.90) | (0.41) | (0.92) | (0.47) | (0.01) | (0.24) | (2.01) |
| Year = 2010 | 0.049 | 0.056* | 0.042 | -0.016 | 0.298*** | 0.217*** | -0.072 |
| | (1.52) | (1.75) | (1.27) | (0.31) | (4.22) | (3.19) | (1.19) |
| Observations | 3,574 | 3,574 | 3,534 | 1,595 | 571 | 531 | 877 |
| Number of households | 1888 | 1888 | 1876 | 848 | 291 | 279 | 470 |

Source: authors' calculations based on VARHS.
Note: Robust z statistics in brackets. Data for 2008 and 2010. Random effects regressions. Province dummies included (not shown). Monetary values in '00 VND. * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 7: Land fragmentation and labor input in crop agriculture**

| | *Dependent variable: Labor days per ha., log* | | | | | | |
|---|---|---|---|---|---|---|---|
| | All | All | All | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| Operated area, ha., log | -0.535*** | -0.533*** | -0.456*** | -0.510*** | -0.677*** | -0.535*** | -0.560*** |
| | (18.89) | (21.60) | (14.86) | (9.12) | (24.46) | (8.64) | (10.69) |
| No. Plots, operated | 0.047*** | | | 0.045*** | 0.059*** | 0.048*** | 0.050*** |
| | (7.02) | | | (4.93) | (5.80) | (2.90) | (3.60) |
| Simpson index | | 0.747*** | | | | | |
| | | (9.43) | | | | | |
| Total distance | | | 0.000 | | | | |
| | | | (0.36) | | | | |
| Rice share | 0.367*** | 0.317*** | 0.394*** | 0.489*** | 0.153 | 0.09 | 0.482*** |
| | (5.38) | (4.82) | (5.53) | (4.97) | (1.44) | (0.50) | (3.50) |
| Perennial share | -0.200*** | -0.099 | -0.245*** | -0.05 | -0.399*** | -0.031 | -0.479*** |
| | (3.21) | (1.61) | (4.06) | (0.45) | (2.89) | (0.27) | (3.72) |
| Share of land with problem | -0.047 | -0.051 | -0.051 | -0.01 | -0.199*** | 0.01 | -0.075 |
| | (1.36) | (1.49) | (1.45) | (0.21) | (3.05) | (0.12) | (0.98) |
| Hh members 15 to 65, log | 0.273*** | 0.279*** | 0.305*** | 0.187*** | 0.353*** | 0.338*** | 0.291*** |
| | (8.38) | (8.79) | (9.02) | (3.99) | (5.97) | (3.67) | (4.75) |
| Share of land irrigated | 0.271*** | 0.260*** | 0.266*** | 0.273*** | 0.007 | 0.273*** | 0.235* |
| | (5.21) | (5.07) | (4.96) | (3.59) | (0.07) | (3.36) | (1.70) |
| Share of land with slight slope | 0.01 | 0.023 | 0 | 0.00 | 0.077 | 0.031 | -0.07 |
| | (0.22) | (0.53) | (0.01) | (0.04) | (0.89) | (0.42) | (0.63) |
| Share of land with medium slope | 0.03 | 0.06 | 0.01 | 0.07 | 0.039 | 0.08 | -0.31 |
| | (0.52) | (0.90) | (0.08) | (0.50) | (0.40) | (0.66) | (1.29) |
| Share of land with steep slope | 0.093 | 0.055 | 0.071 | 0.508** | -0.467** | 0.05 | 0.12 |
| | (0.71) | (0.44) | (0.55) | (2.47) | (2.20) | (0.31) | (0.28) |
| Age of head | 0.007 | 0.008 | 0.006 | 0.008 | 0.006 | -0.019 | 0.02 |
| | (0.93) | (1.19) | (0.79) | (0.83) | (0.38) | (1.33) | (1.16) |
| Age of head, squared | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | *Dependent variable: Labor days per ha., log* | | | | | | |
|---|---|---|---|---|---|---|---|
| | All | All | All | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| | (1.40) | (1.63) | (1.26) | (0.92) | (0.51) | (0.90) | (1.46) |
| Years of schooling, head | -0.008** | -0.007* | -0.008** | 0.004 | -0.002 | -0.023*** | -0.019** |
| | (2.08) | (1.77) | (1.98) | (0.75) | (0.26) | (2.62) | (2.08) |
| Female hh head | -0.011 | 0.007 | -0.013 | 0.01 | -0.113 | -0.197** | 0.031 |
| | (0.32) | (0.22) | (0.38) | (0.19) | (1.10) | (2.05) | (0.46) |
| Year = 2010 | -0.142*** | -0.139*** | -0.149*** | -0.353*** | -0.033 | -0.195*** | 0.218** |
| | (3.77) | (3.64) | (3.93) | (10.04) | (0.55) | (3.00) | (2.24) |
| Observations | 3,521 | 3,521 | 3,479 | 1,550 | 566 | 544 | 861 |
| Number of households | 1872 | 1872 | 1860 | 834 | 290 | 281 | 467 |

Source: authors' calculation based on VARHS.

Note: Robust z statistics in brackets. Data for 2008 and 2010. Random effects regressions. Province dummies included (not shown). Monetary values in '00 VND. * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 8: Agricultural output at plot level**

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Value of output per sqm., log | | Quantity of rice per sqm, log | |
| Plot area, log | -0.0847*** | -0.123*** | -0.0569*** | -0.0862*** |
| | (0.00952) | (0.0167) | (0.00827) | (0.0149) |
| Distance to family home (km) | -0.0228** | -0.0265** | -0.0164** | -0.0172* |
| | (0.0097) | (0.0121) | (0.0077) | (0.0097) |
| Share sown with annual crops | 1.629*** | 1.620*** | | |
| | (0.406) | (0.444) | | |
| Redbook | 0.0951*** | 0.0926*** | 0.0355* | 0.0472** |
| | (0.0231) | (0.0272) | (0.0186) | (0.0224) |
| Owned | -0.0862*** | -0.0565* | -0.0488** | -0.0201 |
| | (0.0258) | (0.0310) | (0.0228) | (0.0266) |
| Restrictions | -0.0549*** | -0.0766*** | -0.0166 | -0.0398* |
| | (0.0191) | (0.0239) | (0.0201) | (0.0242) |
| Investment in soil and water cons. | 0.0702*** | 0.0601*** | 0.0735*** | 0.0719*** |
| | (0.0196) | (0.0229) | (0.0186) | (0.0219) |
| Plot acquired before 1992 | 0.110 | 0.209* | 0.0860 | 0.156 |
| | (0.101) | (0.118) | (0.0971) | (0.112) |
| Years used by hh | -0.00175 | -0.00408 | -0.00120 | -0.00384 |
| | (0.00232) | (0.00282) | (0.00203) | (0.00246) |
| Shares border with other plots | 0.0172 | -0.00889 | 0.0168 | -0.0165 |
| | (0.0271) | (0.0346) | (0.0253) | (0.0333) |
| Number of seasons | 0.373*** | 0.391*** | 0.250*** | 0.287*** |
| | (0.0174) | (0.0224) | (0.0169) | (0.0207) |
| Irrigated | 0.198*** | 0.188*** | 0.208*** | 0.241*** |
| | (0.0330) | (0.0433) | (0.0326) | (0.0423) |
| Disaster on plot | -0.104*** | -0.104*** | -0.0656*** | -0.0743*** |
| | (0.0161) | (0.0204) | (0.0150) | (0.0193) |
| Constant | -0.938* | -1.181** | -0.746*** | -0.766*** |
| | (0.507) | (0.568) | (0.173) | (0.224) |

| | *Dependent variable:* | | | |
|---|---|---|---|---|
| | Value of output per sqm., log | | Quantity of rice per sqm, log | |
| Household and year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 5,308 | 3,727 | 5,286 | 3,707 |
| R-squared | 0.720 | 0.755 | 0.700 | 0.743 |

Source: authors' calculations based on VARHS.

Note: OLS regressions. Robust standard errors. Dummies for slope (flat, slight, moderately steep, steep), plot problems (gullies, dry land, low-lying land, sedimentation, landslide, stony soils, other problems) and year are also included but not shown. In regressions 2 and 4, dummies for input use (seeds, saplings, chemical fertilizer, organic fertilizer, pesticides/herbicides, hired labor, rented equipment, rented draught animals) are also included but not shown. * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 9: Determinants of inter-farm land consolidation**

| | *Dependent variable: Share of households owning at least 2 ha. agricultural Land* | | | | | |
|---|---|---|---|---|---|---|
| | *All* | *All* | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| Land sales per hh | 7.045 | 41.653** | 28.968 | 34.873 | 91.923* | 39.403** |
| | (0.53) | (2.26) | (0.24) | (0.09) | (1.69) | (2.06) |
| Male wage, construction | 1.763 | 3.324 | 1.627 | 0.107 | 8.79 | 5.435 |
| | (1.07) | (1.63) | (0.93) | (0.02) | (1.21) | (1.32) |
| Permanent market | -0.113 | 0.114 | -0.404 | -9.551 | 10.216 | -2.031 |
| | (0.08) | (0.04) | (0.17) | (0.81) | (1.10) | (0.38) |
| Enterprises per 1000 hh in commune | -0.016 | -0.038 | -0.005 | -0.069 | -0.097 | 0.253 |
| | (0.56) | (0.99) | (0.15) | (0.53) | (1.16) | (1.00) |
| Population density (log) | -3.385*** | -1.171 | -0.976 | -1.997 | -2.439 | 2.144 |
| | (5.58) | (1.15) | (0.84) | (0.82) | (1.06) | (0.85) |
| Fixed effects | Province | Household | Household | Household | Household | Household |
| Observations | 795 | 795 | 280 | 136 | 187 | 192 |
| Number of communes | 487 | 487 | 185 | 89 | 102 | 111 |

Source: authors' calculation based on VARHS.
Note: Absolute value of z statistics in brackets. Commune level regressions. The first regression is a random effects model, others are fixed effects regressions. * significant at 10%; ** significant at 5%; *** significant at 1%

**Table 10: Determinants of intra-farm land consolidation**

| | *Dependent variable: Simpson index of intra-farm fragmentation of operated area* | | | | | |
|---|---|---|---|---|---|---|
| | *All* | *All* | Northern lowlands | Northern highlands | Central highlands | Southern lowlands |
| Land consolidation program | -0.01 | -0.008 | -0.022* | 0.003 | 0.018 | 0.008 |
| | (1.33) | (0.97) | (1.89) | (0.16) | (0.66) | (0.52) |
| Rents in land | 0.129*** | 0.116*** | 0.108*** | 0.023 | 0.063 | 0.170*** |
| | (14.03) | (10.14) | (7.02) | (0.75) | (1.48) | (6.83) |
| Rents out land | -0.168*** | -0.144*** | -0.143*** | -0.085*** | -0.126*** | -0.178*** |
| | (15.53) | (10.88) | (7.15) | (3.33) | (3.18) | (6.72) |
| Bought land in last 2 yrs | 0.088*** | 0.065*** | 0.044 | 0.034 | 0.058** | 0.099** |
| | (5.28) | (3.55) | (1.04) | (0.61) | (2.29) | (2.52) |
| Sold land in last 2 yrs | -0.038** | -0.037** | 0.023 | -0.102 | -0.067** | -0.057 |
| | (2.25) | (2.02) | (0.64) | (1.61) | (2.37) | (1.56) |
| Fixed effects | Province | Household | Household | Household | Household | Household |
| Test: rents in + rents out = 0 (p-value) | 0.01*** | 0.11 | 0.17 | 0.12 | 0.26 | 0.82 |
| Test: bought + sold = 0 (p-value) | 0.03** | 0.27 | 0.23 | 0.34 | 0.83 | 0.44 |
| Observations | 4006 | 4006 | 1777 | 587 | 567 | 1075 |
| Number of household | 2075 | 2075 | 930 | 296 | 290 | 559 |

Source: authors' calculations based on VARHS.
Note: Absolute value of z statistics in brackets. The first regression is a random effects model, others are fixed effects regressions. * significant at 10%; ** significant at 5%; *** significant at 1%

## Appendix

**Table A1: Farming inputs and outputs, by farm size and region**

| Farm size (operated area) | Value of output per ha. | Value of non-labor, variable inputs per ha. | Labor days per ha. | Profit per ha. | Has tractor | Has harvester | Share of land with rice* | Share of land with perennial crops | Number of plots, operated |
|---|---|---|---|---|---|---|---|---|---|
| NORTHEN LOWLANDS | | | | | | | | | |
| < 0.25 ha | 43,925 | 13,925 | 718 | -6,043 | 0.00 | 0.04 | 0.69 | 0.14 | 4.2 |
| 0.25-0.5 ha | 40,173 | 13,337 | 625 | -1,355 | 0.01 | 0.14 | 0.66 | 0.19 | 7.4 |
| 0.5-1 ha | 27,010 | 8,736 | 369 | 161 | 0.00 | 0.21 | 0.41 | 0.37 | 7.7 |
| 1-3 ha | 10,347 | 3,178 | 150 | 295 | 0.01 | 0.12 | 0.27 | 0.47 | 8.1 |
| >3 ha | 4,226 | 1,486 | 49 | 170 | 0.03 | 0.09 | 0.07 | 0.75 | 8.9 |
| Total | 38,965 | 12,560 | 613 | -3,486 | 0.01 | 0.09 | 0.63 | 0.20 | 5.8 |
| N | 1,674 | 1,664 | 1,555 | 1,554 | 1,777 | 1,777 | 1,714 | 1,762 | 1,777 |
| NORTHEN HIGHLANDS | | | | | | | | | |
| < 0.25 ha | 36,513 | 6,837 | 593 | -4,845 | 0.00 | 0.00 | 0.51 | 0.21 | 2.6 |
| 0.25-0.5 ha | 26,372 | 5,490 | 447 | -1,136 | 0.00 | 0.03 | 0.60 | 0.14 | 4.7 |
| 0.5-1 ha | 18,835 | 3,336 | 300 | 564 | 0.00 | 0.08 | 0.55 | 0.11 | 5.6 |
| 1-3 ha | 11,719 | 1,892 | 172 | 1,527 | 0.00 | 0.06 | 0.48 | 0.16 | 6.7 |
| >3 ha | 8,276 | 1,827 | 94 | 2,389 | 0.00 | 0.11 | 0.27 | 0.34 | 8.0 |
| Total | 18,925 | 3,489 | 294 | 258 | 0.00 | 0.06 | 0.51 | 0.15 | 5.6 |
| N | 581 | 579 | 567 | 566 | 587 | 587 | 585 | 586 | 587 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CENTRAL HIGHLANDS | | | | | | | | | |
| < 0.25 ha | 27,582 | 9,366 | 604 | 2,225 | 0.03 | 0.00 | 0.30 | 0.52 | 1.4 |
| 0.25-0.5 ha | 44,458 | 16,202 | 579 | -104 | 0.00 | 0.02 | 0.19 | 0.57 | 2.3 |
| 0.5-1 ha | 39,712 | 15,781 | 339 | 2,344 | 0.06 | 0.04 | 0.16 | 0.69 | 2.9 |
| 1-3 ha | 38,750 | 15,303 | 229 | 9,307 | 0.14 | 0.08 | 0.13 | 0.72 | 3.8 |
| >3 ha | 30,546 | 12,060 | 130 | 10,126 | 0.23 | 0.07 | 0.06 | 0.86 | 3.8 |
| Total | 37,691 | 14,705 | 288 | 6,846 | 0.12 | 0.06 | 0.14 | 0.71 | 3.3 |
| N | 544 | 536 | 544 | 519 | 567 | 567 | 560 | 562 | 567 |
| SOUTHERN LOWLANDS | | | | | | | | | |
| < 0.25 ha | 34,111 | 12,759 | 441 | -507 | 0.00 | 0.02 | 0.48 | 0.25 | 2.1 |
| 0.25-0.5 ha | 29,481 | 11,990 | 319 | 2,369 | 0.00 | 0.13 | 0.58 | 0.23 | 4.4 |
| 0.5-1 ha | 28,598 | 12,985 | 239 | 3,771 | 0.00 | 0.11 | 0.63 | 0.20 | 5.3 |
| 1-3 ha | 30,408 | 16,237 | 123 | 7,200 | 0.00 | 0.09 | 0.67 | 0.24 | 4.6 |
| >3 ha | 24,989 | 16,907 | 59 | 3,608 | 0.08 | 0.20 | 0.65 | 0.33 | 4.9 |
| Total | 30,586 | 13,445 | 283 | 2,677 | 0.01 | 0.09 | 0.57 | 0.24 | 3.8 |
| N | 992 | 945 | 869 | 873 | 1,075 | 1,075 | 1,030 | 1,057 | 1,075 |

Source: authors' calculations based on VARHS.

Note: share of net sown area planted with rice in some or all seasons. Money values in '000 VND.

**Table A2: Farming inputs and outputs, by number of plots and region**

| Number of plots (operated) | Value of output per ha. | Value of non-labor, variable inputs per ha. | Labor days per ha. | Profit per ha. | Has tractor | Has harvester | Share of land with rice* | Share of land with perennial crops |
|---|---|---|---|---|---|---|---|---|
| NORTHERN LOWLANDS | | | | | | | | |
| 1 plot | 31,072 | 9,651 | 674 | -12,152 | 0.00 | 0.00 | 0.28 | 0.32 |
| 2-3 plots | 41,927 | 13,977 | 624 | -4,581 | 0.00 | 0.02 | 0.65 | 0.18 |
| 4-5 plots | 40,837 | 13,497 | 628 | -4,428 | 0.00 | 0.07 | 0.69 | 0.17 |
| 6-9 plots | 38,757 | 12,335 | 598 | -2,367 | 0.01 | 0.15 | 0.64 | 0.20 |
| > 9 plots | 37,677 | 11,546 | 590 | -154 | 0.00 | 0.17 | 0.68 | 0.20 |
| Total | 38,965 | 12,560 | 613 | -3,486 | 0.01 | 0.09 | 0.63 | 0.20 |
| N | 1,674 | 1,664 | 1,555 | 1,554 | 1,777 | 1,777 | 1,714 | 1,762 |
| NORTHERN HIGHLANDS | | | | | | | | |
| 1 plot | 25,067 | 4,861 | 496 | -1,847 | 0.00 | 0.00 | 0.31 | 0.34 |
| 2-3 plots | 25,240 | 4,377 | 418 | -2,116 | 0.00 | 0.01 | 0.56 | 0.16 |
| 4-5 plots | 18,485 | 3,350 | 300 | 41 | 0.00 | 0.05 | 0.55 | 0.10 |
| 6-9 plots | 16,772 | 3,079 | 240 | 1,121 | 0.00 | 0.08 | 0.50 | 0.17 |
| > 9 plots | 17,602 | 4,067 | 271 | 1,486 | 0.00 | 0.07 | 0.49 | 0.20 |
| Total | 18,925 | 3,489 | 294 | 258 | 0.00 | 0.06 | 0.51 | 0.15 |
| N | 581 | 579 | 567 | 566 | 587 | 587 | 585 | 586 |
| CENTRAL HIGHLANDS | | | | | | | | |
| 1 plot | 38,784 | 16,451 | 384 | 6,470 | 0.03 | 0.01 | 0.15 | 0.76 |
| 2-3 plots | 40,482 | 14,570 | 311 | 6,834 | 0.10 | 0.04 | 0.10 | 0.75 |
| 4-5 plots | 33,863 | 14,292 | 230 | 6,686 | 0.15 | 0.07 | 0.16 | 0.68 |
| 6-9 plots | 34,013 | 14,486 | 232 | 7,564 | 0.21 | 0.17 | 0.24 | 0.53 |
| > 9 plots | 39,864 | 18,561 | 280 | 6,933 | 0.00 | 0.00 | 0.67 | 0.33 |
| Total | 37,691 | 14,705 | 288 | 6,846 | 0.12 | 0.06 | 0.14 | 0.71 |
| N | 544 | 536 | 544 | 519 | 567 | 567 | 560 | 562 |
| SOUTHERN LOWLANDS | | | | | | | | |
| 1 plot | 24,549 | 10,999 | 325 | -2,853 | 0.00 | 0.01 | 0.34 | 0.45 |
| 2-3 plots | 34,120 | 15,001 | 309 | 2,881 | 0.00 | 0.04 | 0.62 | 0.21 |
| 4-5 plots | 30,798 | 14,430 | 251 | 3,515 | 0.02 | 0.16 | 0.66 | 0.18 |
| 6-9 plots | 29,702 | 11,701 | 268 | 4,126 | 0.00 | 0.15 | 0.60 | 0.15 |
| > 9 plots | 24,074 | 9,173 | 225 | 3,187 | 0.02 | 0.24 | 0.48 | 0.25 |
| Total | 30,586 | 13,445 | 283 | 2,677 | 0.01 | 0.09 | 0.57 | 0.24 |
| N | 992 | 945 | 869 | 873 | 1,075 | 1,075 | 1,030 | 1,057 |

Source: authors' calculations based on VARHS. Money values in '000 VND.

Note: share of net sown area planted with rice in some or all seasons.

Money values are in '000 VND.