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Land Fragmentation, Production Diversification, and Food Security: A Case Study from Rural Albania

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We analyze the impact of land fragmentation on production diversification and its implications for food security of farm households in rural Albania. Albania represents a particularly interesting case for studying land fragmentation as the fragmentation is a direct outcome of land reforms. The results indicate that land fragmentation is an important driver of production diversification of farm households in Albania. We find that land fragmentation stimulates significantly more diversification for subsistence farm households than for market-oriented households. Our findings have two key policy implications: (i) the consolidation policies that relocate and enlarge plots would have a significant impact on reducing agricultural production diversification; and (ii) land fragmentation contributes to the food security improvement by increasing the variety of foodstuffs produced by subsistence farm households.

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1. Introduction

Countries in Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS) have implemented massive land reform over the past decades. The land reform was implemented as part of the transition process from the centralized system to a market-driven economy. The reform aimed, with varying degree, at transferring property rights from the state and collective ownership to private individuals. In several countries, an unintended effect of this reform process was fragmentation of land in use, ownership, or both. Albania implemented a radical land reform which caused one of the most fragmented land structures among CIS and CEE countries (Civici 2003). The causes of land fragmentation in Albania date back to the land privatization implemented in 1991. There are three main factors that shaped farm structures in the country: (i) land distribution based on a per capita basis, (ii) split of distributed land by its type (e.g., arable land, orchards, irrigation facilities), and (iii) land scarcity relative to density of rural population. These factors led to both ownership and use fragmentation of land. Due to the rigid functioning of land markets and subsistence farming, land fragmentation persists also in present days (Lusho and Papa 1998; Cungu and Swinnen 1999; Deininger, Savastano and Carletto 2012; Zhllima and Guri 2013).

Although farm land fragmentation is mostly understood as a high number of farmed plots or as a high number of plot co-owners, this phenomenon is more complex. It includes plot size; the shape of individual plots; distance of plots from farm buildings; and distances between plots (Latruffe and Piet, 2013). Whether or not land fragmentation yields net benefits is not clear a priori because it may generate both positive and negative effects, specific to each case considered. For example, more fragmented farmed plots are likely to enhance biodiversity, thus increasing the value the society places on landscape. On the other hand, however, the longer distance a farmer needs to travel to reach a plot, the higher his or her direct (e.g., fuel) as well as opportunity costs (e.g., time spent) are.

Because the quantification of several dimensions of land fragmentation simultaneously is challenging, most studies measure farm land fragmentation only based on one dimension (e.g., the number of plots or their average size). If more than one dimension is considered, this is typically done by means of land fragmentation indices such as the Simpson or the Januszewski index. However, these indices ignore critical spatial variables such as the shape of parcels as well as non-spatial variables, for example, ownership type and the existence or absence of road access for each land parcel. To improve on the measurement of land fragmentation, Demetriou et al. (2013) introduced a new global land fragmentation index that combines a multi-attribute decision-making method with a geographic information system. Applied to a case study area in Cyprus, the new index outperforms the existing indices in terms of reliability.

The issue of land fragmentation in Central and Eastern Europe has been a subject of a significant body of literature (e.g., Thomas 2006; Sklenicka et al. 2009; Sikor et al. 2009). The general finding of this literature is that a high degree of agricultural land fragmentation in the Central European countries hampers the emergence of a private commercial farming structure (Van Dijk, 2003) as well as agricultural and rural development when both land ownership and land use is highly fragmented (Hartvigsen 2014).

There is a rich literature on farm diversification in agriculture. Two strands of research on diversification can be distinguished: (i) farm level and (ii) aggregate agricultural sector level (e.g., Bhattacharyya 2008; Saraswati et al. 2011). Although, both literatures seemingly address the same issue, the two strands of analysis are not equivalent. In fact, they may diverge, meaning that farms might be highly specialized in a given country, whereas the degree of diversification of the aggregate agricultural sector in the same country might be high. Pingali and Rosegrant (1995) argue that economic growth and commercialization of the agricultural sector lead to an increase in the diversity of marketed products at the aggregate country level, while they lead to increasing regional and farm level specialization. According to Bhattacharyya (2008) and Saraswati et al. (2011), important drivers of aggregate diversification are, among others, demand-side factors, rural infrastructure, and market institutions.

In this paper, we focus on the farm level production diversification. The main factors affecting farm production diversification identified in the literature include risk, crop rotation, cost complementarities, farm size, and production for household self-consumption (Irwin 1972; Pope and Prescott 1980; Benin al. 2004; Culas 2005; Bowman and Zilberman 2013; Sichoongwe et al. 2014). Empirical studies mostly focus on the relationship between diversification and farm size, yielding mixed results, however. For example, White and Irwin (1972) found that larger farms have less diversified production; on the other hand, Pope and Prescott (1980), Culas (2005), and Sichoongwe et al. (2014) find the opposite relationship. Weiss and Briglauer (2000) focus on the dynamics and the importance of off-farm employment for production diversification. They find that off-farm income reduces the degree of diversification; they also find that farms operated by older, less educated, part-time farmers show a lower degree of diversification and a stronger reduction in diversification over time. Empirical literature also finds different micro-level variables that affect diversification choices such as farm household characteristics, farm organization, technological changes, geographical location, labor, experience, wealth, education (Benin et al. 2004; Culas 2005; Sichoongwe et al. 2014).

Despite a considerable number of studies analyzing determinants of farm production diversification, there are few empirical studies estimating the relationship between land fragmentation and production diversification (Benin et al. 2004; Sichoongwe et al. 2014). Land fragmentation is often induced by polices (land reforms) and can have important implications for farmers' production choices and overall rural development. The available studies do not focus on policy-induced fragmentation and its impact on diversification. Moreover, those few available studies find mixed evidence. For example, Benin et al. (2004) found positive impact of land fragmentation on cereal crop diversity of farms in Ethiopia, but Sichoongwe et al. (2014) finds a statistically insignificant impact of land fragmentation on the diversification among smallholders in Zambia. Studies on land fragmentation in Albania analyzed the impact of fragmentation on abandonment of cropland cultivation (Sikor, Muller and Stahl 2009) and productivity (Deininger, Savastano and Carletto 2012) with a mixed evidence and rather insignificant effects. Deininger, Savastano and Carletto (2012) find no support for the argument that land fragmentation reduces productivity. The results of Sikor, Muller and Stahl (2009) reveal a rather counterintuitive effect of land fragmentation—villages with more fragmented land holdings tend to have lower abandonment rates in the early transition period but no effect was observed in the latter period in 1996–2003.

The main objective of this paper is to analyze the impact of land fragmentation on production diversification in Albania. We also investigate the implications of land fragmentation for food security of rural households. We derive our econometric estimations from a survey of 1018 farm households in three Albanian regions in 2013.

Our paper has important policy implications for land consolidation policies and rural food security. State-regulated consolidation is often perceived as a key measure to tackle the land fragmentation problem with the expectation of generating productivity gains (Lusho and Papa 1998). Land consolidation might be justifiable if land structure dispersed in many small plots constraints the functioning of land markets and if it represents an impediment for productivity and efficiency gains (Deininger, Savastano and Carletto 2012). One of the important consequences of land fragmentation could be diversification of farm production activities. If this is indeed the case, then land consolidation policies may have indirect consequences for farmer's production structure choices, potentially contributing to specialization of production into a smaller number of products. On the other hand, land fragmentation may contribute to the provision of a less expensive and more heterogeneous food basket to subsistence farmers, thus contributing to the food security of rural households in Albania. The objective of this paper is to provide insight into these issues.

2. Land reform in Albania

Three waves of radical land reforms were implemented in Albania during the last century: (i) land reforms before the second world war, (ii) collectivization, and (iii) the land reform of 1991 (de-collectivization). These reforms produced opposing effects on farming systems and land structures. The first reform aimed at redistributing land from big landlords to rural peasants as a means to correct the huge ownership inequality inherited from the Ottoman Empire (Civici 2003). However, this reform succeeded only partially in redistributing the land as most of it remained under the control of big landowners. Following other communist regimes in the region, Albania implemented a large scale collectivization and nationalization process of land after the WW II. By 1976, most land was either in state or collective ownership and agricultural production was organized in large farming conglomerates (cooperatives and state farms) with an average size of more than 1,000 hectares (Civici 1997; Guri et al. 2011).

Collectivization of land led to the collapse of the Albanian agricultural sector. There were serious shortages of basic foodstuffs, causing widespread discontent in the general population (Cungu and Swinnen 1999). Food shortage and inefficiencies associated with the state and collective ownership of assets generated pressure for de-collectivization and introduction of private property after the fall of the communist regime in 1990 (de Waal 2004). Under these pressures, a third radical land reform was implemented in 1991. The reform process pursued the principle of social equity among rural population (Guri et al. 2011). This is in contrast to the reform approach implemented in most other CEE countries which also attempted to correct the historical injustice of expropriation of private properties during the communist regime (Civici 2003).

The privatization process distributed land in the same quantity and quality to all rural inhabitants. The reform was implemented at the village level where a land distribution commission, elected by village inhabitants, was responsible for carrying out the distribution process. The reform distributed more than 700,000 hectares of agricultural land, previously controlled by the state and collective farms, to 490,000 families living in the rural areas. The de-collectivization process was not applied in the same way in all areas. In northern regions, the expropriated owners received back all their land. In other regions, where the equity rule was applied, a limited farm structure (1 ha on average), high level of fragmentation (3–5 plots by farms), and the land insecurity[1] resulted in agricultural sector being in a stand-off situation in terms of productivity and investments. Thus, in less than thirty years (1976–1991) agricultural land in Albania changed its legal status from full state ownership to private ownership and became stranded in small farm household units.

3. Conceptual framework and hypothesis

Farm production diversification refers to farm choices about the number of activities carried out on the farm. A rational farm household chooses a production structure that maximizes household's utility. Adding an additional production line to farm operation induces both costs and benefits. Other things being equal, if the benefit is larger than the opportunity cost of resource use in an alternative activity, a farmer will have an incentive to expand the production structure.

There are several factors which may affect farms' production choices and determine the degree of production structure diversity. A key driver of diversification, extensively analyzed in the literature, is linked to the strategy of farms to cope with risk. Diversification can be instrumental in reducing the overall production risk if farm selects a mixture of activities with negatively correlated performance. As a result, in a risky environment risk-averse farmers will tend to diversify their production more compared to a more stable environment (Bowman and Zilberman 2013).

Production diversification could be a result of economies of scope, that is, when it is more profitable to produce several goods jointly instead of producing each of them separately. For example, this effect can be a result of crop rotation. Crops are usually cultivated in different rotation systems where a series of different crops are grown on the same area in sequential

[1] The former landlords still claim their land because they have not been compensated for their property loss until present days.

multi-year periods. The crop rotation enriches nutrient quality of soil which increases the overall farm productivity. The crop rotation affects the number of crops grown on farm, thus also determining production diversification. The number of crops rotated depends on the rotation system which may differ across farms and regions due to soil quality differences and farm specialization (e.g., cereal *versus* horticultural specialization) (e.g., Weiss and Briglauer 2000).

The economies of scope may also emerge due to cost complementarities. The cost complementarity refers to a situation when the marginal costs are lower for a production activity once the input factors have been used for producing of others. This could be the case when different products have different timing of tasks through the growing season which allows more efficient use of farm resources throughout the season (e.g., machinery and labor). A similar complementary effect may exist when farms combine crop and livestock production. The benefit of combined production can go both ways from livestock to crop production and *vice versa*. The livestock can provide manure which enriches nutrient quality of farmland, whereas crop production may supply crop residues as fodder for livestock feeding. In both cases, input costs are reduced hence stimulating more diversified operation (Weiss and Briglauer 2000).

Farm size could also be an important determinant of production diversification. Larger farms may increase production diversity by increasing the capacity of households to allocate land to try out other crops and varieties (Benin et al. 2004).

Benin et al. (2004) shows that when consumption and production of household decision-making are non-separable (i.e., in the presence of markets imperfections), the diversity of production is affected not only by farm related characteristics (e.g., those mentioned above), as it would be in the case of a market-oriented commercial farmers, but also by household-specific characteristics and by other factors related to the costs of transacting in markets such as household size, age, education, or market access.

3.1. Land fragmentation

Land fragmentation may lead to a greater degree of diversification because of efficiency-driven motives of farmers. A profit maximizing farmer will allocate the land to its best use. Given that soil suitability differs between crops, the number of crops grown by a rational farmer will increase with heterogeneity of plots. According to Benin et al. (2004), the more plots a farmer has, the more he is able to diversify. A greater heterogeneity of plots in terms of quality (e.g., land type, fertility, location) and fragmentation are expected to increase diversity, while greater homogeneity is expected to reduce diversity.

Land fragmentation is very significant in Albania, and is a direct outcome of the land reform of 1991. The reform caused the split of land into many small plots and of heterogeneous quality. This effect was determined by the egalitarian principle applied for the land distribution. The land distribution aimed to ensure that all households in a given village receive land of the same quality and quantity per head of household member.

Three main criteria were used to differentiate land quality: (i) land type (e.g., arable land, olives groves, vineyards, vegetable gardens near the house), (ii) location (the distance from household house or village), and (iii) physical condition of land (e.g., flat, and mountainous land, irrigation facilities, fertility). Each household was allocated a set of plots of different quality, depending on the number of household members. First, the size of land parcels was defined in different quality groups at the village level. The per capita plot size of each quality group was determined by the total available area of the given quality and the number of eligible persons. Then the number of family members determined the size of agricultural land and sometimes even the number of plots that each household was allocated. The head of the household was recognized as the official owner of the land.

This land distribution was implemented at village level and the land availability per village determined how much land could be distributed. Finally, land parcels were distributed to each household in different sizes, qualities and places, usually scattered throughout the village. In this manner, households at the end of the process had in ownership plots of different sizes, types and locations. The land de collectivization was applied to a dominant part of agricultural land and, as a result, the agricultural sector is dominated by small farm household units operating land area divided into small plots and scattered throughout the village (Lusho and Papa 1998).

Table 1 reports the development of land fragmentation in Albania. Before the implementation of the 1991 land reform, land was controlled by 420 collective and state farms with more than 1,000 hectares per farm. The reform distributed land to 490,000 families in approximately 1.9 million small parcels, with an average area of 0.25 hectares per parcel and with an average of about 3.3 separately located parcels for each farm household. The average farm size was around 1 hectare. This land structure remained largely unchanged until present days with minimal changes taking place since the completion of the reform in 1994 (Grace 1995; Cungu and Swinnen 1998; Sabates-Wheeler 2002; MAFCP 2011; Zhllima and Guri 2013).

Figure 1 shows the development of farm size and the average plot size between years 2000 and 2012. The farm size and plot size increased by 15 and 30 percent, respectively, over the period. In absolute values, this is an increase from 1.04 hectares in 2000 to 1.20 hectares in 2012 for farm size, and from 0.2 to 0.26 hectares for the plot size.

One main reason that may explain the persistence of land fragmentation and the minimal change in the Albanian land structure is non-functional land markets. Well functioning land markets may facilitate the exchange of land between rural households and may remedy (at least) partially the problem of fragmentation induced by land policies. Rental and sale markets are very thin in Albania. Land renting represents only around 10 percent of total land (Swinnen et al. 2006). Qineti et al. (2014) report a 15 percent land renting rate based on a survey conducted in four villages in Albania in 2013. However, the vast majority of rental arrangements among family relatives (more than 70 percent of rented land).

Sale markets do almost not exist in Albania. Most of them developed on the coastal and suburb areas for urbanization purposes (Guri (2008)). Less than 3 percent of the total agricultural land was exchanged through sales between households since the end of the privatization process in early 1990s (Qineti et al. 2014). Qineti et al. (2014) also report that in the surveyed villages more than 88 percent of land in 2013 had the same owner who received it through the land reform process in the period 1991 – 1993. Similarly, Deininger, Savastano and Carletto (2012) report 7 percent of land sales, whereas land acquisition through privatization and inheritance represents 70 and 30 percent, respectively, based on the 2005 Albanian Living Standards Survey.

Overall, this data indicate high land use fragmentation caused by the 1991 land reform and this situation persists up to now. However, given that most land is used by landowners in Albania, land ownership fragmentation is also high. According to the official data, each farm has land split on average in nearly 5 plots with an average area of 0.26 ha per plot (INSTAT 2012).

3.2. Self-consumption of farm products

While rigid land markets may contribute to the persistence of fragmented land structure and small farm size in Albania, subsistence farming and self-consumption of farm products may have also contributed to the preference of this situation by farm households. From a political economy point of view, the dispersal of land into several parcels may originate from individual and community decisions and political support for this type of reform in reaction to the socioeconomic environment (Sikor, Muller and Stahl 2009). In an unstable environment of the transition period and food insecurity, the land fragmentation may be desired by population as it may contribute to the less expensive supply of a more diversified basket of food for household self-consumption. Indeed, Cungu and Swinnen (1999) argue that rural households (as opposed to former landowners and rural nomenklatura[2]) was the actual group which determined the political choice of full distribution of land given that this stratum represented majority of rural population and was the one with the lowest income and the one able to increase agricultural output in a relatively short term period.

Subsistence farms devote a significant share of their production to household consumption instead of selling it and using the income earned for acquiring food on the market. Subsistence farms operate as self-contained units and produce a major part of their food requirements which has a direct implication for the number of production activities carried out on the farm. They have an incentive to operate a more diversified production in order to satisfy household nutrient requirements. Such an operation may lead to efficiency losses if plots are not sufficiently heterogeneous and if their cultivation does not correspond to crop soil suitability requirements. However, if a household owns a heterogeneous set of plots in terms of soil quality, the supply of heterogeneous food basket may become less expensive and can better sustain production diversity.[3]

4. Empirical approach

The existing literature studying farm production diversification applied a number of estimation methods, depending on the type of measure they use for the diversification (i.e., depending on the properties of the diversification variable). Sichoongwe et al. (2014) employ

[2] Rural nomenklatura includes communist leaders and former state farms' managers (Cungu and Swinnen 1999)

[3] This reasoning implies that commercial farms will tend to have less diversified production. Commercial farms' production choices are driven by economic drivers rather than by household food requirements, leading to specialization into economically profitable activities. Commercialization reduces the need to fulfil household food needs and thus tends to reduce the degree of farm diversification (Pingali and Rosegrant 1995).

the Tobit double-hurdle model to estimate their diversification equation defined by subtracting the Herfindahl index from one. Culas and Mahendrarajah (2005) employ ordinary least squares (OLS), fixed-effects, and random-effects regressions to explain causes of a set of diversification measures such as the Herfindahl index, the number of products, the index of maximum proportion and the entropy index. In contrast, Ashfaq et al. (2008) and Saraswati et al. (2011) define the production diversification by the composite entropy index and apply a multiple linear regression approach. Similarly, Ibrahim et al. (2009) apply the Simpson index of diversification and use the standard OLS in estimations.

We use a standard variable to measure production diversification defined by calculating the total number of goods produced by households. To handle count dependent variables, we apply a Poisson regression model because of the non-negativity and the discrete character of the dependent variable. A Poisson regression was used for instance by Zanoli et al. (2013) to analyze the determinants of sanctions imposed by the organic certification body on organic farms in Italy, where the dependent variable is a count variable defined as the number of sections imposed on farms. Similarly, Wale and Virchow (2003) applied a Poisson regression to explain farmers' motivations to cultivate traditional varieties of sorghum in Ethiopia where the dependent variable is represented by the number of traditional produced varieties on a farm.

A Poisson regression has several advantages over the OLS regression. The Poisson model allows for a skewed and discrete distribution and for the non-negativity of the dependent variable. In contrast to the OLS, it assumes that the errors follow a Poisson and not a normal distribution. Second, rather than modeling dependent variable, y_i, as a linear function of the explanatory variables, x_i, the Poisson regression models the natural log of the dependent variable as a linear function of the explanatory variables (Gardner, Mulvey and Shaw 1995; Long 1997). The density function for the Poisson regression is defined as follows:

(1) $$f(y_i/x_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}, \qquad y_i = 0, 1, 2, \dots n$$

where λ is the shape parameter that indicates the average number of events in the given time interval and the subscript *i* denotes a household and *n* is the total number of products.

The mean value of the dependent variable is a function of the explanatory variables x_i, and a parameter vector, β:

(2) $$E[y_i|x_i] = \lambda_i = \exp(x_i'\beta)$$

Given independent observations, the model to be estimated is defined as follows:

(3) $y_i = e^{x_i'\beta} + \varepsilon_i = e^{(\beta_0+\beta_1 x_{1i}+\beta_2 x_{2i}+\dots+\beta_k x_{ki})} + \varepsilon_i$

The Poisson model is, however, typically restrictive as it imposes the condition that all the probabilities and higher moments of the Poisson distribution are determined entirely by the mean:

(4) $var(y_i / x_i, \beta) = E(y_i / x_i, \beta)$

Equation (4) implies that the variance should be equal to the mean of dependent variable. If this is not the case, the model may suffer from over- or under-dispersion. This condition is often violated in most empirical studies and the data admit more (or less) variability than expected under the assumed distribution. If the restriction (4) does not hold, the estimated standard errors and test statistics will be distorted. Following Winkelmann (1995), we use the Poisson model with the robust (sandwich) covariance matrix in order to solve this problem. The robust methods of estimating Poisson models rely on computing the Huber/White robust standard errors.[4]

5. Data and model specification

We use survey data collected among farm households in Albania in 2013. The survey was coordinated by the Joint Research Centre of the European Commission and it was implemented by the Agricultural University of Tirana. In total, 1034 farm households were interviewed face-to-face in three representative agricultural regions of the country: Berat, Elbasan, and Lezhë. After cleaning the data, the final database consists of 1018 observations. The sampling criterion used for sample distribution between regions and villages is based on the area distribution. Figure 2 shows the selected region and the sample distribution among different municipalities of each region (Guri et al. 2014).

5.1. Model specification

The variables considered in the estimation model are listed in Table 2. The dependent variable, y_i, is the total number of crop and livestock products produced on a farm. According to Benin et al. (2004), when consumption and production of household decision-making is

[4] Beside the regular Poisson model, we have also tested the Zero Truncated Poisson (ZTP) model. The ZTP is used to model count data for which the zero value of the dependent variable cannot occur. There are no zero values of the dependent variable in our sample. However, in reality they cannot be excluded as hypothetically households may rent out all land and thus may have no production activity. The estimated results using ZTP generate consistent with the regular Poisson model for our dataset.

non-separable, the household production choices are affected by both household-specific characteristics and farm characteristics. The explanatory variables, x_i, capturing household-specific characteristics, include: number of household members, age and education of household head, non-agricultural income, loan repayment and different variables measuring share of households' self-consumption of farm products. The farm characteristics include farm size, irrigated area, livestock production share, plot distance from market, plot distance from household house, the average plot size and the number of plots. We also consider district dummies to account for other region-specific drivers of production diversification (e.g., agronomic conditions, soil quality, or infrastructure).

The main variable of interest in this_paper is the number of plots per household. A positive estimated coefficient associated to this variable would indicate that the production diversification increases with the number of plots. The second variable of interest is the interaction term between the number of plots and households' self-consumption of farm products. For this reason, we include two distinct variables to measure the food self-consumption: the share of self-consumption of food in total household agricultural production (self-consumption share in production) and the share of self-consumption of food in total household income (self-consumption share in HH income). We consider as well interaction variables between the number of plots and the self-consumption variables. The interaction variables measure the extent to which the number of plots available on farm household together with the food demand of households stimulates production diversification. A positive coefficient for these interaction variables would indicate that households with a larger number of plots and a higher self-consumption share of farm products have more diversified production structure. In total, we estimate five models differentiated by the type of variable used to measure the self-consumption (models 1–4). Because the size of the household may also capture the effect of self-consumption, we also include model 5 in which we interact the number of plots with the number of household members.

According to the descriptive statistics reported in Table 2, the average number of plots per household is 5.8. On average households have 4.8 members but the household size can increase to 14 given that households often include extended family relatives. The average age of the head of household is 59 years and varies between 18 and 92 years. The average duration of education of household head is 8.7 years. Non-agricultural income consists only 6 percent of the total household income. Loan payments are insignificant, representing less than

1 percent of the total household expenditures. Irrigated area represents 0.35 hectares and the share of livestock production is relatively sizable at 33 percent in total agricultural production.

5.2. Land fragmentation and diversification

Summary statistics on land fragmentation indicators for surveyed farm households are reported in Table 3. The land use fragmentation is visible from small average farm size and relatively large number of small plots per farm prevalent across households in the study villages. The average farm size is 1.16 hectares, and it varies between 0.02 and 19.7 hectares. The average number of plots per farm is 3.7, and it goes as high as 10 plots per household with an average size of 0.32 hectares per plot.[5] Given that land renting is low (only 2 percent of utilized agricultural area, UAA), land use fragmentation also closely corresponds to the landownership fragmentation.

Following the implementation of the 1991 land reform, households with a larger number of members were allocated larger surfaces located in more parcels. According to the survey data depicted in Figure 3, a household with one member uses on average 2.3 plots, whereas a household with 14 members uses more than twice as many, 6.3 plots. The average size of plots slightly decreases with the number of household members: from an average of 0.6 hectares for a household with one member to an average of 0.23 hectares for a household of 14. Larger households tend also to operate a larger farm which is a direct outcome of the per capita land distribution principle of the 1991 reform (Figure 3).

Similar correlations are visible for the number of plots reported Figure 4. More plots are associated with larger households, whereas households using fewer plots have larger plots on average. Households with fewer plots operate smaller farms.

The dispersion of plots from household house is quite significant. On average, plots are located 1.39 kilometers away from the household house; for some farms the distance goes up to 70 kilometers. The average distance of plots to the nearest market place is 10 kilometers and it varies between 0 and 73 kilometers (Table 3).

Farm production is well diversified in the surveyed households. Farmers carry out on average 5.8 production activities. The maximum amount of products is 12 (Table 3). Most common products include fruits and vegetables, wheat, olives, milk, and meat. Households with a larger number of members have on average more products (3.9 products for a household with

[5] Both farm and plot size are consistent with the country average reported in Table 1.

one member *versus* 7.3 products for households with 14 members) (Figure 3) and households with more plots have on average a larger number of products (four products in household with one plot versus 11 products in households with ten plots) (Figure 4).

5.3. Self-consumption

One of the primary purposes of agricultural production represents the provision of food to own household members in the surveyed households. According to the results reported in Table 4, own food consumption represents 27 percent in the total agricultural production and 25 percent the in total household income. Food is a key item in total household expenditures. Households devote 55 percent of their total income to food consumption. Out of the total household food consumption, 45 percent comes from own production. The heterogeneity of households is very wide for all consumption indicators reported in Table 4. Households vary from being fully self-sufficient (i.e., producing only for household self-consumption) to being fully market-oriented (i.e., selling the whole production on the market).

6. Results

The Poisson regression results are reported in Table 5. Our model may suffer from under-dispersion because the variance of the dependent variable is 20 percent smaller than the mean. To check for this problem in our data, we use the likelihood ratio test of the dispersion parameter alpha. Based on the test results, the dispersion parameter is not significantly different from zero, implying that the under-dispersion is not a concern in our model. Further, to ensure that the estimated model fits the data well, we employ Deviance and Pearson goodness-of-fit tests. Both tests show that the model does not indicate the goodness-of-fit problem, meaning that the estimated models follow the Poisson distribution.

The results show that the following variables have a statistically significant effect on production diversification at least in one of the tested models: number of household members, age, non-agricultural income, UAA, livestock production share, plot distance from household house, average plot size, number of plots, self-consumption indicators, and the interaction variables but with a varying degree of significance across the six model specifications. Only the livestock production share, the number of plots and the interaction variables are significant across all five models. The rest of variables not listed above (e.g., *education*) are not statistically significant in the models.

Our estimates show that a higher number of household members leads to higher production diversification. Only in model 5, where the interaction variable between the number of household members and the number of agricultural productions is considered, we estimated a negative relationship. The positive estimated coefficients could be explained by a higher need of a more diversified food consumption basket likely due to greater heterogeneity in preferences within household when there are more members. Everything else equal, the number of household members may also capture a larger need for production of food for self-consumption (instead of acquiring it on the market) which also may stimulate food diversification in order to satisfy the household nutrient needs. The negative coefficient in model 5 likely reflects that self-consumption interacts with plot fragmentation, motivating households to maintain a more diversified production structure and it does not impact diversification directly.

Non-agricultural income tends to have a negative impact on the production diversification (models 1, 3, and 4). This result is consistent with Weiss and Briglauer (2000) who also find that off-farm income reduces the degree of diversification. According to Weiss and Briglauer (2000), if non-agricultural income is earned from off-farm employment, part-time farms have less time to devote to the production of a greater agricultural product mix. Also, off-farm income may be a strategy to diversify employment risks and thus it reduces the necessity to diversify the on-farm production structure. We also find some evidence that education and age of the head of household reduces the degree diversification. This is consistent with estimates of Weiss and Briglauer (2000).

The variable capturing the household farm size (UAA) shows some evidence that it decreases the production diversification which is consistent with estimates of White and Irwin (1972) but in contradiction with Pope and Prescott (1980), Culas (2005), and Sichoongwe et al. (2014). The plot size (*average plot size*) stimulates positively the production diversification. This effect likely captures the production diversification within plots. The positive coefficient implies that, everything else equal, households produce more crops on a larger plot than on a small one. This is because it may be economically more sustainable to split a larger plot into more distinct production operations than a smaller one.

A longer distance of plots from the farm house (*plot distance HH house*) leads to lower diversification likely because of the cost associated with operating a farm with a wider spread of plots from the farm centre. A larger share of livestock production in total household production (*livestock production share*) is associated with a higher level of diversification, potentially due to cost complementarity effects of the combined crop-livestock production as well as due to the need to produce animal feed within the farm. This result indicates that households with livestock production tend to produce both crop and livestock products and do not become fully specialized in livestock production.

The variables for different districts (*Kuçove*, *Skrapar*, *Elbasan*, *Gramsh*, *Librazhd*, *Peqin*, *Kurbin*, *Lezhë*, and *Mirdite*) are regional dummy covariates meant to capture any regional differences not accounted for by the other variables. The district Berat serves a counterfactual with respect to other districts. Several of these dummy variables have statistically significant coefficients, implying that structural regional differences such as agronomic conditions, soil quality, or quality of infrastructure have an impact on the degree of production diversification.

The positive and significant coefficient for the number of plots a household cultivates indicates that a household with a larger number of plots is more likely to produce more types of different products. As explained above, this could be driven by efficiency reasons or subsistence motives. The efficiency reasons could be determined by the profit maximization behavior leading the allocation of land to its best use, thus causing a more heterogeneous production structure when household land is split in more and heterogeneous plots. The subsistence motive is driven by the food demand for household self-consumption. In order to test this second effect we have interacted the number of plots with two different measures of household self-consumption of farm products (models 2 and 4). The estimates show that the different interaction variables are positive and statistically significant in both models, indicating that the diversification is co-determined by land fragmentation and household food needs. In other words, the land fragmentation stimulates significantly more the diversification in households which use a larger proportion of agricultural production for household self-consumption than in more market-oriented households. Model 5 also supports this argument where the interaction variable between the number of household members and the number of plots is positive and statistically significant. Everything else equal, a larger family has higher food needs and this indicates that land fragmentation leads to stronger diversification for larger households.

Note that the direct effect of the number of plots remains significant in all model specifications, also when the interaction variables are considered. These results indicate that both the efficiency reasons and subsistence motives likely drive the diversification. Furthermore, the direct effect of households' self-consumption tends to be negative both with and without the interaction variable considered. Also the coefficient associated with the variable accounting for the household size (*number of HH members*) becomes negative in model 5 when the interaction term is considered. These results indicate that self-consumption decreases production diversification. This is a rather unexpected result; one would expect an opposite effect because a higher production for household's self-consumption would imply that households rely to a lesser extent on the markets and thus most nutrients need to be satisfied from own production, likely demanding higher diversity of the product mix. This could be explained by the fact that the self-consumption impact on the diversification works predominantly through land fragmentation as it allows households to supply food more efficiently when households own more and heterogeneous plots.

7. Conclusions

In this paper, we analyze land fragmentation and its implications for production diversification in rural Albania. We also investigate the consequences of land fragmentation for food security of rural households. Albania represents a particularly interesting case for studying land fragmentation. Land fragmentation is an outcome of land policy reform implemented in the early 1990s. Albania implemented a very radical land reform which caused one of the most fragmented land structures among CIS and CEE countries. The impacts of the reform can still be observed in the agricultural sector of the country more than two decades later.

The results indicate that land fragmentation is an important driver of production diversification of farm households in Albania. We find that land fragmentation stimulates significantly more diversification for households which use a larger proportion of agricultural production for self-consumption than for more market-oriented households. This finding supports the argument that the fragmentation was conducive to promoting food security of rural households in Albania.

Our estimates also indicate that different farm characteristics (number of household members, non-agricultural income, age, education) and farm-related factors (farm size, livestock production share, plot distance from household house, average plot size) also impact the degree of diversification indirectly, indicating non-separability of consumption and production decisions of farm households and the presence of markets imperfections in rural Albania.

The paper has important policy implications for land consolidation policies and food security. Our findings suggest that consolidation policies which enforce the relocation and enlargement of plots indirectly would also have a significant impact on reducing the degree of production diversification of farm households in Albania.

Whether the production diversification is costly or beneficial to farm households in Albania is a wider concept and it is not linked only to issues covered in this paper. A diversified production structure driven by policies rather than market signals may inflict efficiency losses to farm operations due to potential suboptimal use of machinery and inability of farms to fully benefit from specialization. On the other hand, by operating fragmented and heterogeneous plots, subsistence farmers (as it is the case for many farms in Albania) may gain more efficient supply of a diversified food basket for self-consumption which, however, may be in conflict with the consolidation policy. Thus, the choice whether to implement land consolidation in a given region or village needs to consider to what extent the production diversification issue is relevant for the local community, that is whether diversification is beneficial or detrimental to farm households in the respective region or village. Our findings are consistent with the argument of Sikor, Muller and Stahl (2009) for the need to consider of a broader socio-economic context when analyzing implications of land fragmentation and consolidation policy. Land fragmentation might be conducive to production diversification which may help to cope with risk in an unstable economic environment during the transition period; it can also potentially provide a more diversified set of food items for subsistence needs of rural households. Indeed, our estimates indicate that the land fragmentation contributed to food security improvement by increasing the variety of on-farm produced foods for household self-consumption, thus ensuring a higher likelihood of meeting nutrient requirements that can promote good health of rural population in Albania. In such a situation, there might an argument against less scope for consolidation policies.

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Tables and Figures

Table 1: Land indicators in Albania (1993-2012)

Fragmentation indicators	Unit	1993-1994	2004	2012
Average farm size	hectare	1	1.13	1.20
Average plot size	hectare	0.2-0.3	0.20	0.26
Average number of parcels		3.3	4.5	4.9
Private farms with <1 hectare	%	n/a	45.53	54.44
Total number of farms	million	0.49	0.37	0.35
Total number of parcels	million	1.9	1.65	1.7

Source: Calculated based on the data from Grace (1995), (MoAFCP 2004; INSTAT 2012)

Table 2. Descriptive statistics

Variable	Description	Unit	Mean	Std. Dev.	Min	Max
Dependent variable						
Number of products	Number of produced products (crop and livestock products)		5.84	2.20	1.00	12.00
Explanatory variables						
Number of HH members	Number of household members		4.78	1.83	1.00	14.00
Age	Age of household head	years	59.31	11.62	18.00	92.00
Education	Education of household head	years	8.73	2.73	4.00	17.00
Non agric. income	Share of non-agricultural income in total income	%	0.06	0.16	0.00	0.98
Loan repayment	Share of total HH expenses that is used to repay the loans	%	0.00	0.01	0.00	0.20
UAA	Total area of household	ha	1.16	0.94	0.02	19.70
Irrigated area	Surface of irrigated area	ha	0.35	0.52	0.00	10.00
Livestock production share	Share of livestock production value in total production value	%	0.33	0.23	0.00	0.92
Plot distance from market	Average distance of plots from the nearest market or product collection facility	km	10.06	9.23	0.00	73.00
Plot distance from HH house	Average plot distance from the farm center (from HH house)	km	1.39	3.21	0.00	70.00
Average plot size	Average area of plots	ha	0.32	0.26	0.02	3.94
Number of plots	Number of plots		3.68	1.57	1.00	10.00
Self-consumption share in production	Share of self-consumption of food in total HH agricultural production	%	0.27	0.21	0.00	1.00
(Number of plots) * (Self-consumption share in production)	Interaction variable	int.	1.49	1.21	0.00	9.96
Self-consumption share in HH income	Share of self-consumption of food in total HH income	%	0.25	0.21	0.00	1.00
(Number of plots) *(Self-consumption share in HH income)	Interaction variable		1.41	1.19	0.00	9.96
(Number of HH members)*(Number of products)	Interaction variable		28.78	17.28	2.00	154.00
Districts						
Kuçove	Dummy variable for Kuçove		0.06	0.23	0.00	1.00
Skrapar	Dummy variable for Skrapar		0.05	0.21	0.00	1.00
Elbasan	Dummy variable for Elbasan		0.22	0.41	0.00	1.00
Gramsh	Dummy variable for Gramsh		0.07	0.26	0.00	1.00
Librazhd	Dummy variable for Librazhd		0.10	0.30	0.00	1.00
Peqin	Dummy variable for Peqin		0.10	0.30	0.00	1.00
Kurbin	Dummy variable for Kurbin		0.07	0.26	0.00	1.00
Lezhë	Dummy variable for Lezhë		0.12	0.32	0.00	1.00
Mirdite	Dummy variable for Mirdite		0.06	0.23	0.00	1.00
Berat	Benchmark district		0.16	0.37	0.00	1.00

Notes: HH: household

Table 3. Land fragmentation and diversification (survey results)

	Mean	Std. Dev.	Min	Max
UAA (ha)	1.16	0.94	0.02	19.70
Rented in land (ha)	0.04	0.60	0.00	18.00
Rented out land (ha)	0.02	0.14	0.00	1.90
Owned UAA (ha)	1.12	0.71	0.00	4.50
Average plot size (ha)	0.32	0.26	0.02	3.94
Share of rented in area on UAA (%)	0.02	0.10	0.00	1.00
Share of rented out area on UAA (%)	0.02	0.09	0.00	1.00
Share of own area on UAA (%)	0.98	0.10	0.00	1.00
Number of plots per household	3.68	1.57	1.00	10.00
Average distance of plots from the farmer house (km)	1.39	3.21	0.00	70.00
Average distance of plots from the nearest market (km)	10.06	9.23	0.00	73.00
Total number of products	5.84	2.20	1.00	12.00

Note: The number of observations in all cases is 1018.

Table 4. Self-consumption food (survey results)

	Mean	Std. Dev.	Min	Max
Food consumption in total HH income (%)	0.55	0.19	0.01	1
Self-consumption of food in total HH income (%)	0.25	0.21	0	1
Self-consumption of food in total HH food consumption (%)	0.45	0.27	0	1
Self-consumption of food in total HH agricultural production (%)	0.27	0.21	0	1

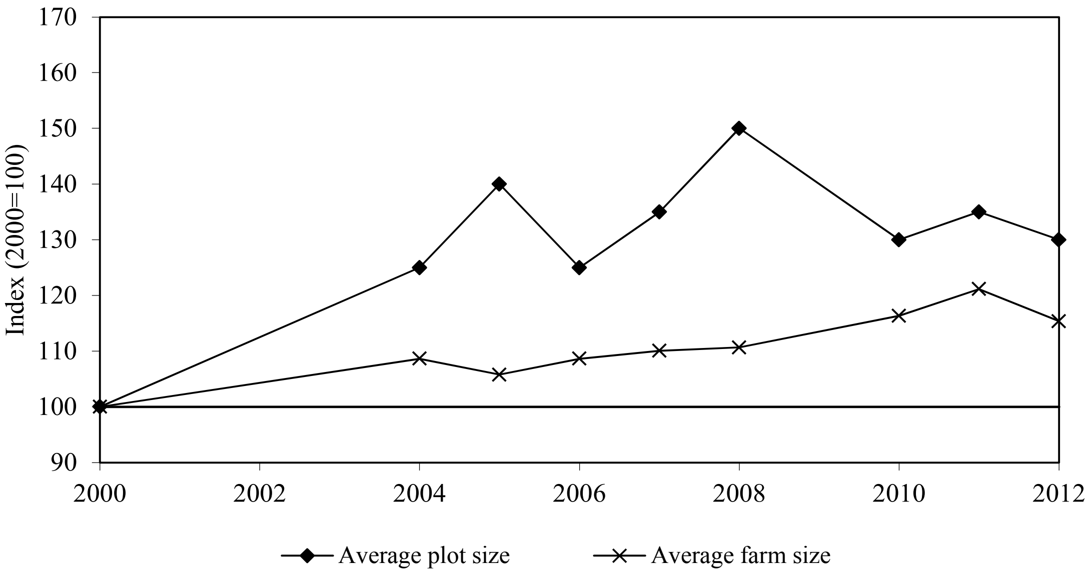
Note: The number of observations in all cases is 1018. HH: household

Table 5. Poisson regression results (dependent variable: number of products)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Number of HH members	0.00807	0.00846**	0.00802	0.00828**	-0.166***
Age	-0.00132	-0.000700	-0.00130	-0.000562	-0.000853*
Education	-0.00709**	-0.00376	-0.00696**	-0.00409	-0.000324
Non agric. income	-0.121*	-0.0617	-0.196***	-0.161**	-0.0393
Loan repayment	0.789	0.672	0.798	0.623	0.0950
UAA	-0.00285	-0.00327	-0.00292	-0.00343*	0.00176
Irrigated area	-0.00849	0.00833	-0.00784	0.00675	0.0193
Livestock production share	0.615***	0.373***	0.615***	0.392***	0.330***
Plot distance from market	0.000862	-0.000857	0.000898	-0.00100	3.91e-05
Plot distance from HH house	-0.0102*	-0.00561	-0.0102*	-0.00559	-0.00467
Average plot size	0.282***	0.178**	0.285***	0.191**	-0.0101
Number of plots	0.117***	0.0810***	0.118***	0.0852***	0.0228***
Self-consumption share in agri. production	-0.200***	-1.677***			
(Number of plots) x (Self-consumption share in agri. production)		0.298***			
Self-consumption share in HH income			-0.187***	-1.690***	
(Number of plots) x (Self-consumption share in HH income)				0.298***	
(Number of HH members) x (Number of products)					0.0244***
Kuçove	-0.0952*	-0.0812*	-0.0958*	-0.0867**	-0.0375
Skrapar	0.235***	0.142***	0.233***	0.127***	0.0340
Elbasan	0.0476	0.0705***	0.0464	0.0586**	-0.00547
Gramsh	-0.0207	0.0110	-0.0220	0.00771	0.0456
Librazhd	0.0705*	-0.000822	0.0660*	0.00489	0.0625***
Peqin	0.115***	0.0862***	0.115***	0.0827***	0.0588***
Kurbin	0.121***	0.0695**	0.120***	0.0605*	0.0317
Lezhë	0.110***	0.0858***	0.107***	0.0803***	0.0544**
Mirdite	0.350***	-0.0416	0.342***	-0.0452	0.0553**
Constant	1.131***	1.285***	1.124***	1.268***	1.616***

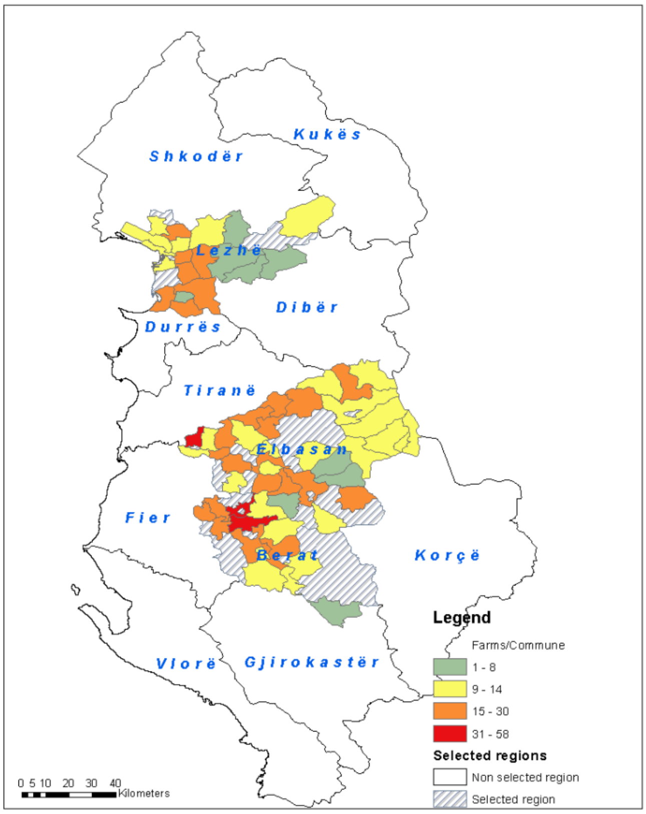
Notes: *** Significant at 1%; ** Significant at 5% and * Significant at 10%.

Figure 1. Development of average land size and plot size in Albania (2000-2012)



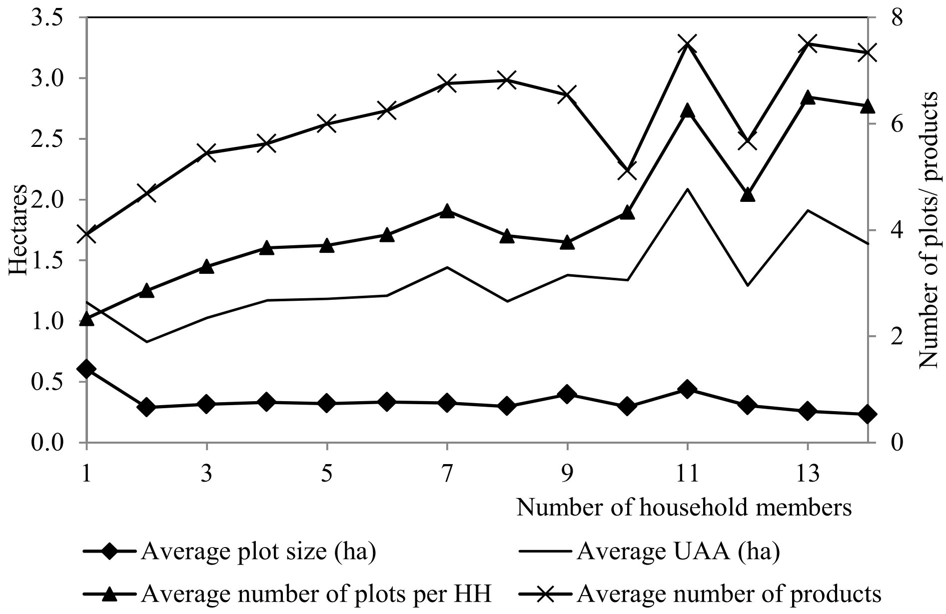
Source: Calculated based on data from Statistical Yearbook of Albania

Figure 2. Sample distribution in commune level



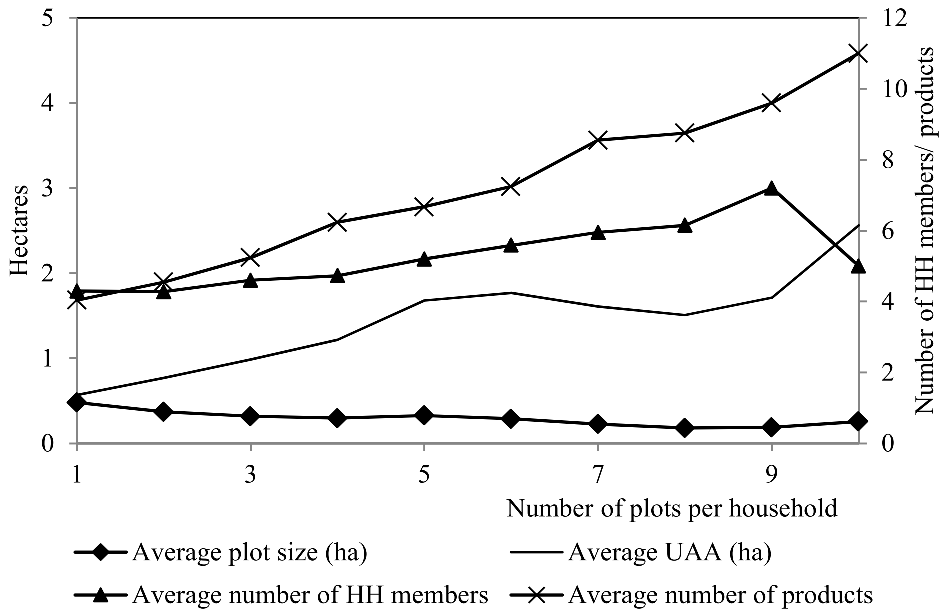
Source: Guri et al. (2014)

Figure 3. Number of HH members and average values of selected HH characteristics



Notes: HH: Household

Figure 4. Number of plots per HH and average values of selected HH characteristics



Notes: HH: Household