

Changes in Women's Operation of Agricultural Units in Peru: Economic Advance or Impoverishment of Female Farmers?

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Figures from the last two agricultural censuses in Peru indicate significant changes in the presence of women conducting agricultural units. Altogether, women went from controlling 20% in 1994 to 31% of total agricultural units in 2012. In the conventional discourse, this is mostly assumed to be clear evidence for the “economic advance for women”, linked mainly to the increased access to agricultural land. This trend, however, can also be associated with a process of impoverishment, especially if women control increasingly smaller and low productivity agricultural units, and face unsurmountable barriers for better education, financing of high value crops and cattle, formal titling and other key services. In this paper we use a panel of districts from these two censuses to disentangle the occurrence of both processes in the asset and market access dimensions. We find evidence of very different processes occurring for women with and without male partners. We conclude that more control of agricultural units by women does not necessarily imply greater economic progress, especially if there are not specific policies in place to offset gender biases in the access to key agricultural assets, rural institutions and markets.

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INTRODUCTION

The term “agriculture feminization” is used in a broader sense in the literature about women's participation in agricultural activities. Feminization may occur for land owners, land operators, wage laborers and family workers (World Bank, 2016; De Brauw et al., 2013). Thus, an important part of feminization is related to the composition of farmers controlling agricultural units (owners and operators). In this article we look at part of the process of feminization in Peruvian agriculture, focusing on women who operate land. We use the agricultural census definition that identifies the sex of the household member who is considered the main decision maker for each agricultural unit¹.

According to the agricultural censuses, there have been significant changes in terms of the presence of women

¹Peru's agricultural censuses do not allow for distinguishing between operators and owners of individual plots. So, in this work we only can consider female participation as the main decision maker of the aggregate agricultural unit (this can include more than one plot). For a critical view of this restricted way to collect agricultural census data from a gender perspective, see Doss (2014), and Deere and León (2012).

in the operation of agricultural units. Altogether, women farmers went from controlling 20.4% of units in 1994 to 30.8% in 2012, as we can see in the following table (Table 1).

The general increase of women controlling agricultural units hides differences in the change depending on the presence of a male partner or not². Much of the increase between the two censuses (334,000 additional female driven units), were led by women without partners (297,000 increase), while units controlled by women with a partner only increased by 38,000. This indicates that the process of change has consisted basically of a significant increase of agricultural units of non-partnered women.

There are alternative ways to assess this process of feminization. On one hand, it can be seen as an increase in access to a key asset as land (Deere et al., 2012; Lastarria-Cornhiel et al., 2014), indicating improvements in productive assets and reduction of the corresponding asset gender gap. This is conventionally associated with a general trend of economic advance for women having an expanded access to land (Lastarria, 2006). On the other hand, the same change can be hiding a process of impoverishment of a specific sector of agricultural units led by women (Tafur et al., 2015; Velazco & Fuertes, 2017). This interpretation would be valid if agricultural units that women control tend to be smaller, have less quality and productive capacity, or are exposed to precarious access to markets and institutions which are more accessible to males. In this case, the connotation of greater female economic advance can be relativized, or, in any case, be considered among different threads within the general change.

In this work we evaluate the process of greater female control of agricultural units in Peru taking into account both interpretations. We want to evaluate whether structural factors like asset endowments, access to markets and to rural institutions are associated with this change, and to extent these factors can be related to the economic advance and/or impoverishment interpretation. We also pay special attention to the possibility of distinguishing different processes within the general change, with special attention paid to whether women have a partner or not on the farm.

THE SPATIAL DISTRIBUTION OF CHANGES IN FEMALE AGRICULTURAL OPERATION

In order to describe the process of change in female agricultural operation between the two censuses we first use a geographical approach. We want to find out if there are specific geographic patterns in the observed change. The implications are different if the change is distributed in a more or less random way across the territory, versus if there are identifiable agglomerations or geographically dispersed patterns. To perform this type of geographic analysis we use the district as the unit of analysis, which is the smallest comparable geographic unit

Table 1. Changes in the female operation of agricultural units 1994-2012

	Total units	Women total	Single women	Women with male partner
Census 1994	1,750,640	357,176	104,111	253,065
% of total 1994		20.4%	5.9%	14.5%
Census 2012	2,246,702	691,921	400,961	290,960
% of total 2012		30.8%	17.8%	13.0%
Change in agricultural units	496,062	334,745	296,850	37,895
Change as percentage points (p.p.)		10.4	11.9	-1.5

Sources: III and IV Agricultural Censuses, INEI.

²Although the agricultural census of 2012 identifies the marital status of the farmer and the presence of the partner in the farm, the 1994 census does not identify such status and presence. Therefore, for 1994 we constructed the presence of a male partner using the question regarding adult male family labor in the farm. The other important limitation of both censuses is that these do not identify the migration status of family members including partners. Due to these limitations, we could not include these two crucial variables: marital and migration status of farmers and of their partners in the dynamic analysis we carry out in this study.

between the two censuses³.

In the two following figure we can see the percentage of women operating agricultural units in 1994 and 2012 (both maps have the same intensity of color scale for comparison) (Figure 1).

We observe that the process of change in female presence has been more marked throughout almost all the Highland region⁴, especially in the Southern and Northern Highlands. There are also some important areas in the Southern Amazon region and to a lesser extent in the Coastal region. The following table shows changes by region (Table 2).

The general change in the Highlands represents 68% of total change in women's operation of agricultural units. Although the percentage changes have been important in the Coast and Amazon regions, these are registered upon a small basis in 1994. In this sense, what has happened in the Highlands has been the main driver of the observed general change in women's participation.

To identify specific geographic patterns we calculated the Anselin's Index⁵ (also known as Localized Moran's Index), that identifies areas with a high presence of positive changes (*hot spots*) or negative changes (*cold spots*). There are also areas that combine both trends, and zones for which there is no statistically significant agglomeration pattern. The Anselin's Index can be seen in the following figure for both groups of women operating ag-

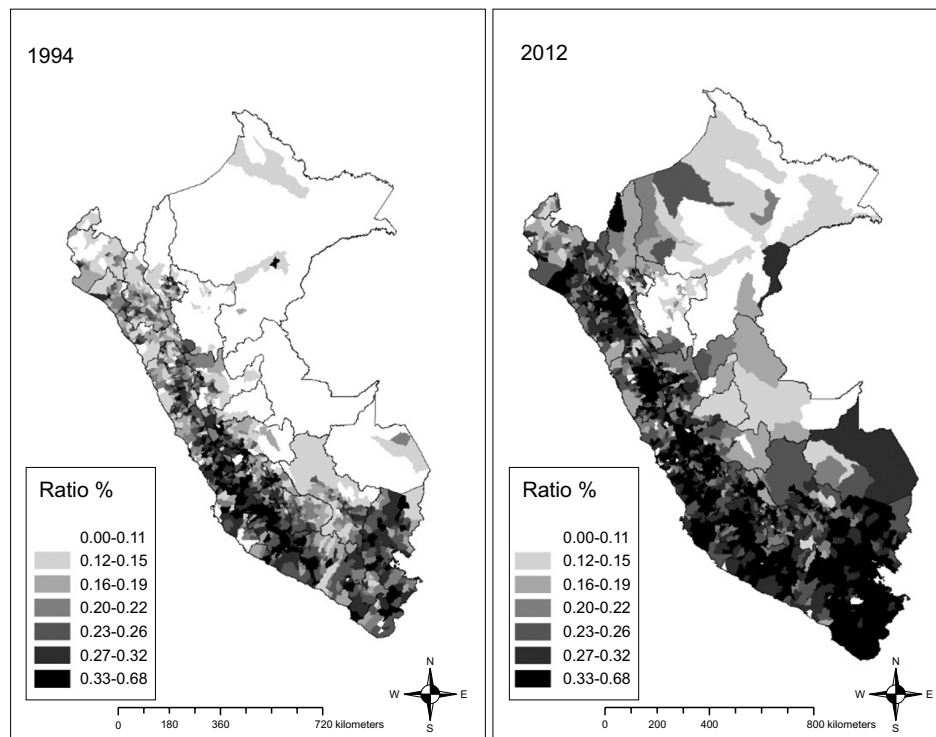


Fig. 1. Percentage of women operating agricultural units.

³Due to the fact that new districts were created between 1994 and 2012 (basically a process of subdivision), we used as a baseline the list of districts existing in 1994, and consolidated the ones created afterwards into their original unit. This allows us to have the same territorial units (comparable districts) between 1994 and 2012.

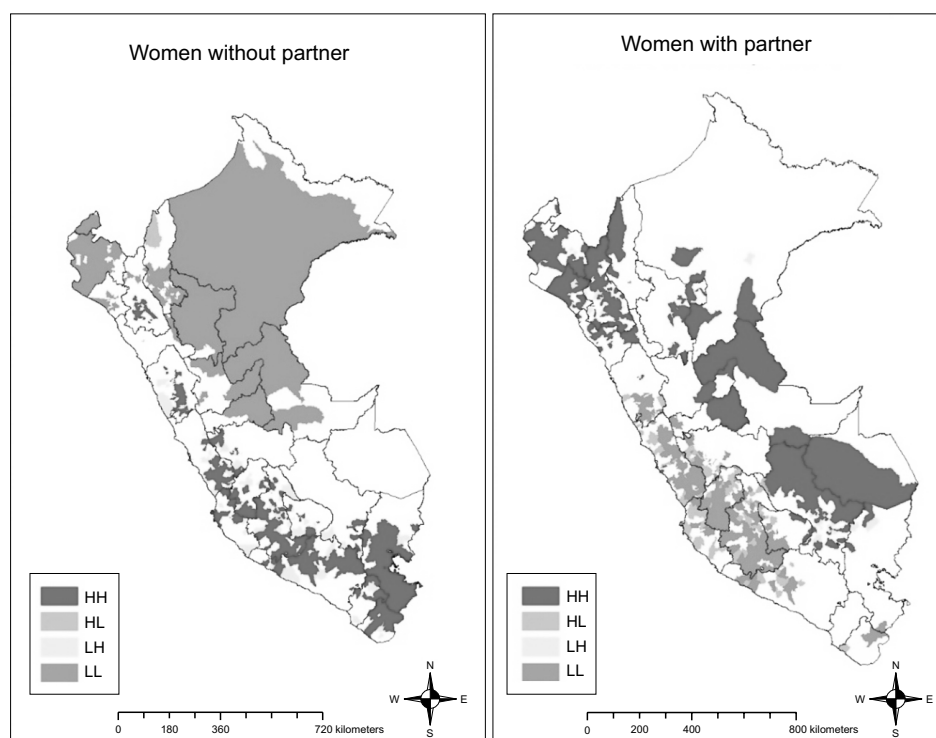
⁴There are three distinct regions in Peru: (i) Coast, a western fringe located along the Pacific Ocean which is the more populated and were the capital of the country, Lima, is located; (ii) Highlands (Andean) that crosses the country from north to south along the central Andean mountains and is the poorer region; (iii) Amazon (Jungle), the eastern and larger part of the country, but with low population density.

⁵We used © ESRI ArcMap 10.1. for this analysis. The routine for calculating the index uses the Euclidean distance among districts and an inverse distance function in which near districts have more weight than districts located farther away. The program used 159 km as the maximum distance for searching relevant districts in building the index. The display shows the regions where statistical significant correlations are found in the analyzed variable (in this case the percentage of female land operation at the district level).

Table 2. Changes in female operation by geographic region

	Coast	Highlands	Amazon	Total
Total women				
1994	49,447	276,772	30,957	357,176
2012	95,189	505,787	90,945	691,921
Change in units	45,742	229,015	59,988	334,745
% of change	14%	68%	18%	100%
Women without partner				
1994	14,111	81,990	8,010	104,111
2012	48,527	305,500	46,934	400,961
Change in units	34,416	223,510	38,924	296,850
% of change	12%	75%	13%	100%
Women with partner				
1994	35,336	194,782	22,947	253,065
2012	46,662	200,287	44,011	290,960
Change in units	11,326	5,505	21,064	37,895
% of change	30%	15%	56%	100%

Source: Agricultural censuses 1994 & 2012.

**Fig. 2.** Geographical analysis of general trend for both groups of women.

gricultural land (with and without partner) (Figure 2).

In the case of women without a male partner (left panel), it can be seen that in large parts of the southern and central Highland region there has occurred a significant process of increased female operation (*hot spots*). On the other side, the northern Amazon and Coast show a reduced or zero rate of change in non-partnered women operating agricultural units.

The geographical distribution of change for women with a male partner (right panel) is very different from the one for single women. The areas in which this process has been more intense has been the Coast and northern Highlands, and large parts of the central and southern Amazon. The central Highlands, by contrast, is clearly a *cold spot* in this process, while the southern Highland does not show a definite trend.

Overall, our initial descriptive and geographical analyses indicate: (i) the general process of change in female operation of agricultural units has been marked by what happened in the Highlands, especially north and south (which are the poorer regions); (ii) the group of women without a partner has been much more important than the partnered group in the overall picture of change, particularly in the south and central areas of the Highlands; (iii) the change in partnered women has been less important, and has occurred more in the Coast and northern Highlands, as well as areas in the central and southern Amazon. The geographic distribution of these changes has been significantly different, which is an initial indicator of processes with potentially distinct driving factors, which is to what we turn to in the following section.

ESTIMATING MODELS FOR WOMEN'S PARTICIPATION IN LAND OPERATION

Different models and hypotheses can be proposed to explain the process of change in female operation of agricultural units in Peru. In this article, we only consider agricultural census variables that can potentially characterize the process⁶. For this, we will estimate regression models that relate the participation of women in land operation to census variables related to agricultural assets, farmers' characteristics and access to markets. As we want to investigate factors affecting the observed change, we use a panel type specification of the data in the following way.

$$y_{it} = x_{it}\beta_k + z_i\delta + u_i + \varepsilon_{it} \quad (1)$$

where:

y_{it} is the proportion of women operating units in "i" district for "t" period (1994 or 2012);

x_{it} are k average census variables that vary in time for each district "i" in period "t";

z_i are average census variables that do not vary in time for each district "i" in period "t";

u_i is an individual effect at the district level;

ε_{it} is a random variable with known distribution and not correlated with y.

Expression (1) allows estimating β_k coefficients, which indicate the degree of importance or influence of each census variable in the proportion of female operating landholdings. An estimation option for (1) is to assume that time "t" does not matter, and both census periods are considered independent. This modeling is known as "pooled OLS regression" and basically does not take into account the temporal structure of the data. This specification does not exploit information about the changes in the variables over time and only uses variation between districts for the two periods.

A more appropriate specification for estimating (1) are panel models, in this case at the district level (districts are the panel units⁷). Depending on the assumptions about the individual effect u_i , these models can be "fixed effects" or "random effects". In the case of "fixed effects", it is assumed that there is a significant correlation between u_i , x_{it} and z_i , whereas for "random effects" it is assumed that there is no such correlation.

Regarding the variables that we will use for the estimation, the main limitation is availability of data in both agricultural censuses. We will use variables that characterize demographic processes (age), education, land fragmentation (we build a Januszski index⁸), distribution of agricultural assets, community access, titling and access

⁶We recognize that an important explanatory factor behind the feminization process, male migration, is not considered. Lack of these data do not allow us to include this crucial factor in the analysis.

⁷It is not possible to construct panel units at a lower level than districts in the Peruvian Agricultural Censuses of 1994 and 2012.

to markets for products and services. All the variables are taken from the censuses and aggregated at the district level by simple averages. The average values for the variables are shown in Table 3.

We estimate regressions⁹ for three dependent variables: (i) ratio of general female operating land, (ii) ratio of women without a male partner operating land; (iii) ratio of women with partner operating land. First we estimate the regression consolidating the data for both censuses without using the panel structure (*pooled OLS regression*); and then we estimate panel models of two types: fixed effects and random effects.

The results of the three type of estimates are presented in the Appendix¹⁰. As a whole, it can be seen that the coefficients of the simple pooled regression model and the random effects model tend to be more similar than those obtained with the fixed effects model. However, we consider the fixed effects model as the most reliable in this context¹¹, as we have at least one potentially very important omitted variable (male migration) and probably other variables too. Most coefficients are statistically significant at conventional levels of confidence. The signs of the coefficients for the second (preferred) fixed effects type of model are presented in Table 4.

Table 3. Mean values for variables used in analysis (at district level)

	1994	2012	Total
Dependent variables			
Percentage of all women conducting (%)	21.7	30.1	25.9
Percentage single women conducting (%)	6.2	18.3	12.3
Percentage women with partner conducting (%)	15.5	11.8	13.7
Independent variables			
Average age (years)	49.1	51.4	50.2
Average education level (1-7)	2.72	4.24	3.48
Average Januszkeski index (fragmentation)	0.77	0.77	0.77
Average agricultural area (Has)	2.91	4.06	3.48
Average irrigated area (Has)	1.33	1.98	1.65
Cattle (units)	7.13	8.69	7.91
Sheep (units)	15.9	15.1	15.5
Alpacas (units)	1.8	13.6	7.7
Percentage of communal land (%)	27.6	13.6	20.6
Percentage perennial crop (%)	13.7	22.0	17.9
Percentage titled area (%)	20.8	19.9	20.4
Percentage cropped area to market (%)	22.0	16.9	19.5
Percentage with access to technical assistance (%)	10.5	11.4	10.9
Percentage with access to agricultural credit (%)	6.3	7.6	6.9
Observations (districts)	1,767	1,767	3,534

Source: Agricultural Censuses 1994 & 2012.

⁸The Januwszesky Index measures fragmentation of agricultural units (Escobal, 2017): “(...) This indicator is calculated at the agricultural unit level as follows $J = \sqrt{\sum si / \sum \sqrt{si}}$, where “T” is the number of plots and si is the area of each plot. It ranges between 0 and 1. $J = 1$ means that the land is concentrated in only one plot. If the value of J tends towards 0, it means that the land of the agricultural unit is distributed among many plots” (p. 24, our translation). In our case, we calculated this Index for each agricultural unit in the census and then we got the Index means for each district and census period.

⁹We used © Stata Software, Version 13.0 for estimating all the regressions in this paper.

¹⁰We only analyze the signs and significance of the coefficients as we are mainly using the regressions to construct a stylized interpretation of the underlying processes. We do not intend to measure the specific impacts of each factor in the process, or assess how policy variables may impact outcomes.

¹¹The fixed effect model is more appropriate in this context as it drops variables that do not change across time. This also ameliorates problems of spatial autocorrelation if these are assumed to be constant in time. However, the fixed effect model does not solve the bias for omitted variables that do change with time. We thank one anonymous referee for calling our attention to these advantages of the fixed effect model in this context.

Table 4. Signs of estimated coefficients in Appendix for fixed effects panel model

	Total	No partner	With Partner
Age	+	+	0
Education	+	+	–
Januszeski index	0	0	0
Agriculture land	–	–	0
Irrigated area	+	+	0
Cattle	–	0	0
Sheep	0	+	–
Alpacas	0	+	–
Community land	0	–	+
Perennial crops	–	–	+
Titling	+	–	+
Market orientation	0	+	–
Technical assistance	–	0	–
Agricultural credit	–	–	+

Source: Table in Appendix.

The average age of farmers is positively associated with greater general female participation in land operation and for each group of women. That is, the change has been more intense in districts with higher average age. This result is consistent with what was found by Huang (2016) for China, which can be related to specific male migration patterns. In terms of education, the general coefficient is positive but the signs are differentiated by groups: the relationship is positive for non-partnered women and negative for women with a partner. This implies that for this latter group the greater female participation has occurred in districts with a lower educational levels while that of non-partnered women has been more intense in districts with a higher educational level.

There are no major effects from the land fragmentation index. The index has had little change in the intercensal period which also reduces its ability to explain general changes in a fixed effect model. More access to irrigated area is positively associated with more female participation (general and for non-partnered group). According to this result, there seems to be some process that has facilitated greater access to irrigated land for non-partnered women (a positive development). Access to bovine livestock, on the other hand, tends to have a negative correlation with general presence of women in land operation. This interesting effect, however, disappears for each of the specific groups.

In the case of sheep and alpacas, though the general coefficient is statistically null, coefficients for the specific groups show different signs: positive for non-partnered women and negative for women with a partner. Apparently, access to non-bovine livestock is positively associated with greater participation of non-partnered women, whereas is null for cattle as mentioned before. It is known that single women have more difficulties in raising cattle, especially as they have less land and family labor to work with this type of livestock than other farmers.

The coefficient of community land has different signs per group, and is negative for single women and positive for women with a partner. This indicates that there is a tendency in indigenous communities (in the Highlands) to accept fewer women as single operators of land, which can reflect a male bias in these rural institutions.

Having more access to perennial crops is negatively associated with the general change and of the non-partnered group, but is positively correlated with the partnered group. These are higher value crops, that are more profitable in the long term, but require financing to which rural women (especially single) have less access (see below).

The percentage of titled area is positively associated with the change in female participation in general, but

the relationship is clearly differentiated by group: it is negative for single women and positive for women with a partner. This indicates that there has been more change in single women participation where there has been less titling and vice versa. This calls attention to a key policy variable like titling, in which there seems to be a problem attending areas with more presence of non-partnered farming women.

Areas with more orientation (or access) to markets have had no impact in general, and is positive for the non-partnered group and negative for the partnered one. This can have different interpretations. On one hand, it may reflect a better integration of single women to markets, but on the other hand it may reflect also a higher dependency on market access given limited assets.

In the case of access to technical assistance, coefficients are negative for the general case and the partnered group, that is, female operation has increased more in areas where there has been less access to technical assistance. The effect disappears for single women, however. This also indicates problems for the service of technical assistance in attending areas where there are more agricultural units led by partnered women. In contrast, areas with greater access to credit have had less change in women's land operation in general and for single women (not for partnered ones). This clearly indicates that single women are facing less access to credit when accessing land, which also limits the ability to plant perennial crops and raise bovine stock. These are areas in which single women seem to be facing processes of impoverishment rather than economic advance after accessing land.

CONCLUSIONS

Overall, the relationships found in this research indicate that the process of change in the general female operation of agricultural units in Peruvian agriculture has been mixed in terms of assets, markets and institutions related to economic advance and/or impoverishment. We find evidence for both interpretations. For instance, in the general case (grouping all women), feminization is associated with aging, less bovine stock, less perennial crops and less access to credit and technical assistance. These are clearly related to a process of impoverishment. On the other hand, the process is also associated to more education, irrigated area and access to title, which can be considered a part of economic advance.

The evidence also shows there are important differences in the dynamics of two groups of women, single non-partnered and with a male partner. The areas with increases in the presence of single women (which is the larger group) are associated with aging, less community land, less high value perennial crops and titling, and less access to credit. On the other hand, in these areas there is higher average education levels, and access to irrigated land and non-bovine cattle. These also show more areas oriented to markets. As can be seen, the picture is also highly mixed, and we find both positive and negative relationships in terms of economic advance and impoverishment.

In the other (smaller) group of partnered women, we find that in these areas the education level is lower, there is less market orientation and access to technical assistance. On the other hand, there is no aging effect, and there is more access to community land, perennial crops and titling, as well as more access to credit. In the balance, partnered women seem to be doing a little better than non-partnered ones within the general process of agricultural feminization.

These results indicate the need for specific policies specially targeted to single women farmers. This group is very significant in absolute and relative terms, and the evidence is pointing to the fact that they are getting access to land in a context that tilts more to impoverishment. Particularly important is the need to eliminate biases in access to credit, titling, communal land and bovine assets. These biases tend to reduce the "economic advance of women" interpretation of the observed change. A less biased context for rural women in assets, institutions and markets will make increased women's participation a clearer and unambiguous process of economic improvement.

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Appendix. Estimation results for three alternative specifications

	Pooled OLS regression			Fixed effects			Random effects		
	General	Single	Partner	General	Single	Partner	General	Single	Partner
Age	0.423*** -0.04	0.109*** -0.033	0.321*** -0.031	0.111** -0.048	0.117*** -0.042	-0.005 -0.043	0.328*** -0.03	0.091*** -0.021	0.300*** -0.023
Education	4.087*** -0.232	5.091*** -0.163	-1.000*** -0.156	5.167*** -0.174	7.477*** -0.149	-2.310*** -0.155	4.618*** -0.148	5.505*** -0.12	-1.450*** -0.125
Januszeski index	-9.737*** -1.425	-6.675*** -1.072	-2.989*** -1.016	-1.117 -2.002	-2.175 -1.718	1.028 -1.781	-9.535*** -1.233	-6.873*** -0.868	-2.743*** -0.953
Agricultural area	-0.268*** -0.066	-0.070*** -0.021	-0.197*** -0.065	-0.133*** -0.043	-0.076** -0.037	-0.058 -0.038	-0.246*** -0.034	-0.062** -0.026	-0.202*** -0.028
Irrigated area	0.229*** -0.083	0.074* -0.04	0.143** -0.071	0.237*** -0.055	0.201*** -0.048	0.042 -0.05	0.273*** -0.043	0.081** -0.034	0.164*** -0.036
Livestock	-0.080** -0.033	-0.053** -0.023	-0.025** -0.012	-0.023** -0.012	-0.014 -0.01	-0.01 -0.011	-0.054*** -0.01	-0.050*** -0.008	-0.019** -0.008
Sheep	0.019** -0.009	0.008 -0.007	0.011*** -0.004	-0.016 -0.011	0.039*** -0.01	-0.055*** -0.01	0.011* -0.006	0.008** -0.004	0.005 -0.005
Alpacas	0.009 -0.006	0.015 -0.01	-0.006 -0.004	-0.001 -0.005	0.021*** -0.004	-0.023*** -0.004	0.009*** -0.003	0.015*** -0.003	-0.007** -0.003
Communal land	-2.164*** -0.567	-2.474*** -0.406	0.314 -0.436	0.577 -0.696	-1.683*** -0.597	2.267*** -0.619	-0.938* -0.537	-2.531*** -0.403	0.983** -0.433
Area with perennial crops	-7.653*** -0.714	-4.694*** -0.486	-3.024*** -0.516	-4.643*** -1.071	-8.376*** -0.925	3.823*** -0.959	-7.478*** -0.682	-5.061*** -0.485	-2.206*** -0.531
Area titled	6.873*** -0.988	-1.241* -0.748	7.991*** -0.734	5.291*** -0.943	-1.492* -0.81	6.810*** -0.839	5.885*** -0.782	-1.545** -0.61	8.041*** -0.648
Area to market	-6.172*** -0.991	-4.999*** -0.684	-1.106* -0.647	0.437 -1.104	5.495*** -0.947	-5.077*** -0.982	-4.786*** -0.819	-4.360*** -0.618	-1.932*** -0.663
Technical assistance	-3.292 -2.218	-3.449** -1.506	-0.082 -1.285	-9.347*** -1.621	-2.279 -1.391	-7.021*** -1.443	-7.607*** -1.269	-4.035*** -0.975	-1.634 -1.041
Credit	-19.301*** -2.779	-13.645*** -2.045	-5.415*** -1.572	-3.694 -2.3	-10.128*** -2.054	5.948*** -2.129	-13.380*** -1.818	-13.744*** -1.402	-2.013 -1.499
Constant	2.137 -2.385	-1.573 -1.966	3.307* -1.7	4.581 -2.883	-16.636*** -2.473	21.223*** -2.564	4.370** -1.816	-1.946 -1.293	5.558*** -1.413
N	3535	3534	3534	3535	3534	3534	3535	3534	3534
R2	0.423	0.502	0.197	0.496	0.74	0.279			
Log-likelihood	-13,000	-11,000	-12,000	-9,900	-9,400	-9,500			
Sigma_e				5.81	4.984	5.167	5.81	4.984	5.167
Sigma_u				8.998	6.451	7.062	6.315	2.22	3.431