AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

ISSN 2521-7259

Food and Agriculture Organization of the United Nations

18

FAO AGRICULTURAL DEVELOPMENT ECONOMICS TECHNICAL STUDY

Agricultural transformation: trends in farm size, crop diversification and mechanization in Nicaragua and Peru

18

Agricultural transformation: trends in farm size, crop diversification and mechanization in Nicaragua and Peru

By

Sinduja V. Srinivasan
Economic Affairs Officer, Economic Commission for Latin America and the Caribbeans (ECLAC), Santiago

Milagro Saborío
Consultant, ECLAC, Santiago

Cristian Morales Opazo
Senior Economist, Food and Agriculture Organization of the United Nations (FAO), Rome

Food and Agriculture Organization of the United Nations
Rome, 2022

Required citation:

Srinivasan, S.V., Saborío, M. & Morales Opazo, C. 2022. *Agricultural transformation: trends in farm size, crop diversification and mechanization in Nicaragua and Peru.* FAO Agricultural Development Economics Technical Studies, No. 18. Rome, FAO. https://doi.org/10.4060/cc1723en

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dashed lines on maps represent approximate border lines for which there may not yet be full agreement. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

ISSN 2521-7240 [Print]

ISSN 2521-7259 [Online]

ISBN 978-92-5-136797-1

© FAO, 2022

Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; https://creativecommons.org/licenses/by-nc-sa/3.0/igo).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons license. If a translation of this work is created, it must include the following disclaimer along with the required citation: "This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original English edition shall be the authoritative edition.

Any mediation relating to disputes arising under the licence shall be conducted in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL) as at present in force.

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org. Requests for commercial use should be submitted via: www.fao.org/contact-us/licence-request. Queries regarding rights and licensing should be submitted to: copyright@fao.org.

Cover photo: © FAO/Saul Palma

Contents

Figures

Tables

Preface

The present study is a result of the collaboration between the Agricultural Development Unit – Division of Production, Productivity and Management of the Economic Commission for Latin America and the Caribbean (UDA/DDPM-ECLAC) and the Food and Agriculture Organization of the United Nations (FAO).

The study includes a comparative analysis and policy recommendations based on the two most recent agricultural censuses administered in Nicaragua (2001 and 2011) and Peru (1994 and 2012). Processing and analyzing information from these censuses contribute to identify dimensions and information available to study the process of structural change in Latin America over the last 20 years.

Evidence-based policymaking is increasingly more at the core of UN and member countries' activity. In the case of FAO, this type of studies is crucial to build the knowledge body on which projects and activities are carried forward. The Hand-in-Hand (HiH) initiative is a key example in this context, as it aims at quantitatively identifying high-impact and high-agricultural potential areas in which to invest within developing countries. As Nicaragua and Peru are HiH's target countries, this study will show very useful to learn about their recent experiences in agricultural transformations.

Acknowledgements

This report was elaborated by Sinduja V. Srinivasan (Economic Affairs Officer, Agricultural Development Unit/Division of Production, Productivity and Management of the Economic Commission for Latin America and the Caribbeans [ADU/DPPM-ECLAC]), Milagro Saborío (Consultant, ECLAC) and Cristian Morales Opazo (Senior Economist, Agrifood Economics Division [ESA], FAO), with contributions from Francisco Cerecera, Andrés Mondaini and Bernardo Mayorga (ESA, FAO).

A special thanks is extended to Marco V. Sánchez (Deputy Director, ESA, FAO) and Adrián G. Rodríguez (Chief, ADU/DPPM-ECLAC), for the overall guidance of the process and coordination to move forward with this publication.

This report benefited from the comments provided by David Dawe (Senior Economist, FAO Regional Office for Asia and the Pacific [RAP]) and Emiliano Magrini (Economist, ESA, FAO).

The authors would also like to thank Ana María Díaz-González and Enrico Nano (ESA, FAO) for the last revisions, Karen Smulder, who copy-edited the study and Daniela Verona (ESA, FAO) for design and publishing coordination.

Acronyms

ANAR	Nicaraguan Rice Association
CAFTA	Central American Free Trade Agreement
COMTRADE	United Nations International Trade Statistics Database
ECLAC	Economic Commission for Latin America and the Caribbean
FAO	Food and Agriculture Organization of the United Nations
IICA	Inter-American Institute for Cooperation on Agriculture
PAPA	Rice Producers' Support Programme
USD	United States dollar

Executive summary

Structural change is a process in which the amount of labour, capital, and land dedicated to agriculture (and other sectors) changes over time. In this study, we focus on the cases of Peru and Nicaragua using their two most recently administered agricultural censuses. The agricultural censuses permit us to identify dimensions and information available to study the process of structural change in Latin America over the last 20 years.

In Section1, we provide an overview of the theory of structural change and identify agricultural trends of specific interest to this study. The literature on structural change focuses on drivers that cause the proportion of labour in agriculture to decrease, a phenomenon observed in many countries along their path of economic growth and development. Growth models provide two explanations for decreased agricultural employment within closed economies. The first is demand-driven: as countries transition from pre-industrial economies to industrial ones, relative demand for agricultural goods decreases, causing agricultural employment to contract. On the supply side, growth models suggest that as technology results in increased agricultural productivity, demand for agricultural labour decreases. An increase in labour productivity is the most common trend documented in the context of decreased agricultural employment and rapid growth (Timmer, 1988). Decreased employment in agriculture may stem from out-migration and a move to another sector, such as manufacturing or services. Utilization of the same amount of land with less labour may result in a concentration of land ownership. In the data, we observe that the distribution of farm sizes sets in two extremes in both Nicaragua and Peru, in the sense that most farms are either small or big, with very few farms in the middle of the distribution. We also observe socioeconomic differences across this bipolarization: small farms are family farms in contrast to the bigger, commercial farms. Therefore, the bipolarization of the distribution may be matched by a difference in management practices and other key elements of production.

In Section 2 we discuss political and sectoral trends that affected the process of agricultural structural change in Nicaragua and Peru. Nicaragua elected a democratic government in 1990, which implemented a process of land redistribution, reallocating land from state farms cooperatives to individuals.[1] However, the expansion of the agricultural frontier in formerly state-owned lands and other institutional factors created conditions of uncertainty about land tenure; many owners lacked a registered title and some plots have more than one registered owner (Baumeister, 2012). After 1990, the government eliminated price controls, and macroeconomic policy was directed towards stabilizing the economy and reducing the size of the state, resulting in small farms having little or no access to credit (Pérez and Féguin-Gresh, 2014; Jonakin, 1996). Uncertainty about property rights and exclusion from credit markets may have affected investment decisions and crop selection, which we consider in our analysis.

In Peru, we also concentrate on the post-1990 period, which marks the start of Fujimori's government. The government implemented a new law removing previous rules dictating size limits, restrictions to sell land, and the prohibition of indirect management (Remy and de los Ríos, 2012 and Burneo, 2011). Normally, such changes would accelerate land concentration, but by 1994 land was more equally distributed (Remy and de los Ríos, 2012). From 1991 to 2009, arable land increased from 1.8 to 3.1 million hectares, driven mainly by irrigation projects, increased investment, and exports (Velazco and Velazco, 2012). Credit programs and tax exemptions were used to promote agriculture, providing farmers with access to loans

[1] In fact, land reform was implemented in both previous governments, the Somoza dictatorship (1963) and the Sandinistas (1979–1984).

and easier terms for tax payments. These policies and trends indicate a likely expansion of the agricultural sector, possibly skewed towards small farmers. We examine this in detail in our analysis.

In Section 3 we analyse the process of structural change in Nicaragua, between 2001 and 2011, in five areas: i) land use; ii) the crop and farm size distribution; iii) land tenure; iv) labour trends; and v) mechanization. We find that although the total amount of land allocated for agricultural use declined slightly between 2001 and 2011, a much higher percentage of land was used for cultivation and pastures (likely for livestock), which was accompanied by some deforestation. Three traditional crops (corn, beans and coffee) continued to dominate throughout the country. Although land inequality increased slightly, there was almost a 33 percent increase in the share of producers with small farms (0–7 ha), and the share of land in this size category more than doubled as well. This trend was complemented by a nearly 60 percent increase in the number of farms in the 0-7 ha category, and a 120 percent increase in the number of temporary workers employed on these farms. Finally, mechanization in farms smaller than 7 ha increased greatly as well, because of an expansion in the use of agricultural tools and machines. Combined, these trends indicate that in Nicaragua, agriculture is an expanding sector, attracting both labour and capital.

In Section 4 we undertake our analysis of agricultural structural change in Peru, between 1994 and 2012, with respect to i) land use and crops; ii) farm size distribution; iii) land tenure; iv) labour; and v) mechanization. Over two decades, Peru saw its total agricultural land increase by about 10 percent. The distribution within the total was skewed towards land allocated for "permanent use" (perennial cultivation), which more than doubled its share, a trend experienced in all regions. The shift in land use correlates with the principal crops cultivated in Peru (corn, potatoes, coffee and rice), which comprised about half of all cultivated land by 2012. However, more agricultural land and increased cultivation did not translate to a more equal distribution of farmland. In particular, land shifted from the smallest farms (less than 7 ha) to larger farms. As noted in Section 3, trends in land distribution and use were probably affected by changes in land tenure. While the overall share of farms with registered land rights increased, a higher share of large farms (greater than 350 ha) reported having registered rights than small farms, in both 1994 and 2012. Increases in total land and cultivation correlate with increases in labour (Section 4), a doubling or more in the number of temporary farm employees, across all size categories, which was accompanied by an increase in mechanization (Section 5).

We close our analysis for agricultural structural change in Peru and Nicaragua in Section 5, with a series of policy recommendations. As with their economic and development histories, also the agricultural trends were largely similar between Nicaragua and Peru. Both countries have been experiencing slow to no structural change processes, with agriculture remaining or even increasing its role as the most prominent sector of the economy and destination for land use. Both Peru and Nicaragua also saw stable crop distributions and economic reforms seem to have attracted small farmers to the agricultural sector. The main difference stems from the stability of land tenancy rights, especially for small farmers, which are stronger in Nicaragua. With regards to employment trends, both countries extensively utilized temporary labour, with Nicaragua also relying more than Peru on permanent labour. For Nicaragua and Peru to pursue sustainable and equitable agricultural transformation, we recommend: i) increased sustainability of land use; ii) increased land security; iii) increased job security for agricultural employees; and iv) increased (re)training and skills acquisition programs to facilitate the transition to non-farm employment.

1 Introduction

Structural change is a process in which the amount of labour, capital and land dedicated to agriculture (and other sectors) changes over time. The drivers of such change are numerous and interrelated, and they merit study in concrete contexts in order to understand some of the key drivers of development.

In this section, we present some of these drivers and discuss their connectedness. Utilizing the economic theory of structural change, we aim to identify the national or regional (sub-national) trends in agriculture that are more compelling to be further analyzed in this study, for the particular contexts of Peru and Nicaragua.

1.1 Theories about structural change

The literature on structural change focuses on drivers that cause the proportion of labour in agriculture to decrease, a phenomenon observed in many countries along their path of economic growth and development. We summarize the literature according to three strands. The first strand discusses growth models, climate change is introduced in the second, and the last strand examines the role of institutions.

Growth models provide two explanations for decreased agricultural employment within closed economies. The first describes the transition from a pre-industrial economy to an industrial one. In this context, consumer preferences are biased towards agricultural goods (Kongsamut, Rebelo and Xie, 2001). This bias stems from a mechanism that requires a minimum consumption (subsistence level) of agricultural goods. Once the threshold is reached, any subsequent income growth consumers experience results in the demand for non-agricultural goods increasing at a faster rate than that for agricultural goods.[2] Consequently, labour demand and wages increase faster in the non-agricultural sector than in the agricultural sector, so agricultural employment declines. The nineteenth century economic boom experience in the United States is the typical example of industrialization within a closed economy.

The second explanation provided by growth models analysing the closed economy context is linked to the supply or production side. Matsuyama (1992) formalizes this theory using a model in which agricultural technological progress increases labour productivity.[3] Such technological progress explains the trends observed in the Green Revolution (Matsuyama, 1992); however, other processes altering the agricultural production function and costs could play the same role in the model, with a similar effect on agricultural employment and productivity.

Growth models also consider the open economy case where international factors drive declines in agricultural employment. Murata (2008) pinpoints the driver absent from closed models: trade costs (e.g. transportation costs, trade tariffs and other trade barriers).[4]

[2] This result rests on assumption that the income elasticity of demand is greater than one for non-agricultural goods and lower than one for agricultural goods.

[3] In Matsuyama (1992), agricultural employment declines because consumers are similarly biased toward agricultural goods as mentioned previously. However, there are models in which this bias in preferences is not assumed: Echeverria (1997), Ngai and Pisarrides (2007) and Acemoglu and Guerrieri (2008).

[4] Matsuyama (1992) also develops some consequences of structural change in a context of an open economy. However, the question he answers is how structural change affects the growth of the non-agricultural sector if the economy is open and has comparative advantage in agriculture.

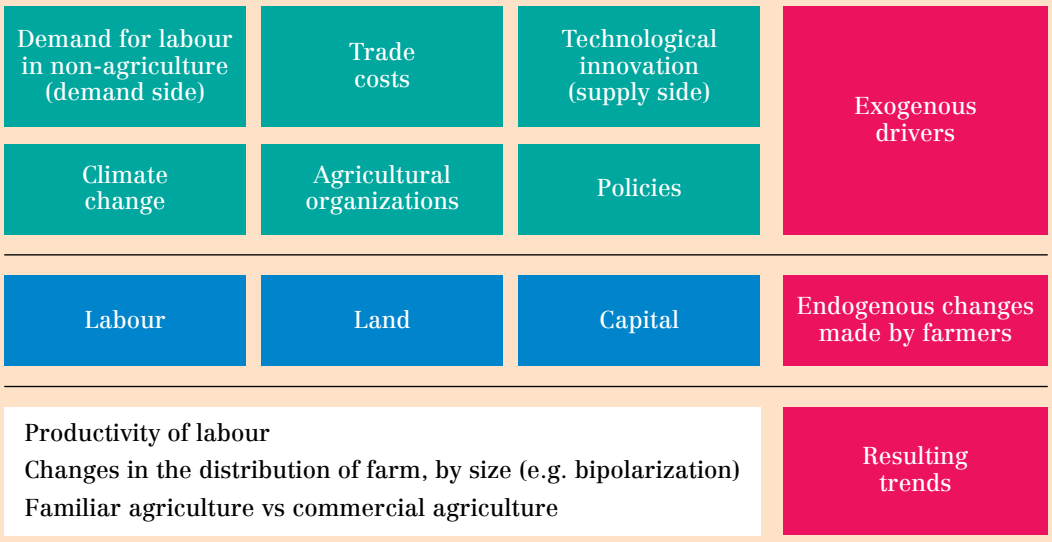
As trade costs for manufactured goods fall, so do their prices, thus increasing demand. The subsequent impact on agricultural employment is the same as from an increase in income: labour is reallocated from agriculture to non-agriculture. Thus, trade may be a driver of structural change because it expands the final markets.

The second strand of literature on structural change analyses the impact of climate change on agriculture. To the extent of our knowledge, both strands have not been linked in a theoretical growth model of structural change. However, the link is easy to construct. Mendelsohn, Nordhaus and Shaw (1996) study the impact of climate change on agriculture. In their Ricardian model, changes in temperature and rain exogenously affect agricultural productivity, resulting in a reallocation towards crops that are relatively more profitable. However, structural change models predict that exogenous changes in productivity (such as a technological innovation in Matsuyama [1992]) drive a decline of labour in agriculture. Consequently, the former implies that climate change may modify the agricultural landscape, while the latter implies that the location and use of labour and capital may also change.

Finally, the last strand of the literature considers the role of institutions. We highlight the role of agricultural prices and organizations. Specifically, agricultural producers (individual farmers or commercial farms) may engage in activities to control prices and reduce their volatility. If these practices affect the cost structure at the national or regional level, the impact will be equivalent to a technological innovation, shifting the share of labour employed in agriculture. Institutional effects are bidirectional in their impact on structural change. The integration of value chains, which are an alliance-based governance structure to improve logistics and the flow of products, result in reduced risk and increased profits in the United States, thus affecting the share of labour in agriculture, as well as farm sizes (Boehle, 1999). However, Chavas (2011) argues that establishing agricultural organizations has stabilized some agricultural prices and reduced income uncertainty in such a way that investment in the sector has been increased.

Figure 1 summarizes the drivers of structural change: demand for labour in non-agriculture, technological innovation, trade costs, climate change and agricultural organizations. Also, we account for the role of public policies, since they can affect any of the other drivers, intentionally or incidentally.

FIGURE 1 Conceptual framework



Source: Authors' own elaboration.

1.2 Agricultural trends of interest

The literature on structural change explains the decline of agricultural labour in developed countries in a general equilibrium context. However, to have a perspective about the trends observed in agricultural employment in developing economies, it is also necessary to examine other factors.

In this study, we research structural change in Peru and Nicaragua, utilizing the two most recent agricultural censuses administered in each country. The direct empirical evidence on structural change discusses temporal changes in the use of labour in agriculture, the use of physical capital (e.g. mechanization of farming practices), and the allocation of land to different uses, for example forest versus agricultural land. Additionally, these changes may be accompanied by modifications in the bundle of agricultural products. Reallocation of labour, capital and land may influence trends in labour productivity, and farm size.

An increase in labour productivity is the most common trend documented in the context of decreased agricultural employment and rapid growth (Timmer, 1988). For example, China (Cao and Birchenall, 2013) and India (Grabowski, 2013) experienced increased labour productivity while their economies were growing quickly. In China, the use of labour in agriculture, measured as hours per hectare, dropped, while at the same time the use of inputs (e.g. fertilizers) and mechanization increased (Chen *et al.*, 2009).

One of the central issues of study, in the context of structural change, is trends in farm size. Decreasing employment in agriculture may imply out-migration and a move to another productive sector, such as manufacturing or services. The exploitation of the same land with less labour may result in a concentration of land ownership. However, it may be the concentration of land ownership driving out-migration and an increase in labour in other sectors. In any case, the average farm size may change. Chavas (2011) identifies the major drivers of a concentration in land ownership (increased farm size) as technological change, economies of scale, economies of scope and farm organization. Iraizoz, Gorton and Davidova (2007) argue for a trend that creates a bipolar distribution of farm sizes, where farms are either small or big, with very few medium-sized farms.

Finally, small farms in the distribution could be family farms while big farms may be mostly commercial farms. Therefore, the bipolarization of the distribution may be accompanied by a difference in management and, probably, access to credit, training and technology. Additionally, a change in the number of family farms is of interest because they constitute a central part of the agricultural landscape and rural culture.

2 National contexts

KEY MESSAGES

- During the Sandinista government in Nicaragua (1979 to 1990), and in line with socialist principles, the state had a great role in production and markets were largely controlled. However, since 1990, Nicaragua became more integrated with international markets, with greater private ownership of land and firms.
- Peru has also experienced democratic and non-democratic governments since 1950. In addition, guerrilla conflicts decreased with the imprisonment of the Sendero Luminoso leader in 1992. In the years following, exports and investment in agriculture were promoted.
- The alternation between different regimes had contrasting impacts on agricultural trends in both Nicaragua and Peru.
- The impact on land distribution, for example, is ambiguous: depending on the relative effects of farmers' access credit, land tenure and certain policies (i.e. the lifting of farm size restrictions and export promotion).
- In contrast, and regardless of the policies implemented, a shift towards cash crops was observed in both countries.

This section summarizes different trends in Nicaragua and Peru related to land reform and agricultural production, especially in the period between 1990 and 2010. Based on these trends, we propose preliminary hypotheses about the process of agricultural structural change in Peru and Nicaragua.

2.1 Nicaragua

Recent Nicaraguan history can be divided in three periods. The first, from 1950 to 1979, is characterized by the rule of the Somoza family. In the second period, 1979 to 1990, the Sandinista government was in power. Finally, after 1990 a democratic period started. The role of markets and the state differs in each period: in the first and last periods, Nicaragua became more integrated with international markets, with greater private ownership of land and firms. During the Sandinista government, in line with socialist principles, the state had a greater role in production and markets were more controlled. In this section, we describe the dominant policies and economic trends, especially for the era starting in 1990.[5]

Land reform

Land reform started in 1963, during Somoza's government, at a moment in which 1.5 percent of farms owned 41.2 percent of the cultivated land (Pérez and Fréguin-Gresh, 2014). In the

[5] The census data we analyze is from 2001 and 2011.

following years, the total cultivated area expanded, but the distribution of land remained polarized until 1978, despite the enactment of an expropriation law in 1976 (Austin, Fox and Kruger, 1985; Pérez and Fréguin-Gresh, 2014).

The process of land reform was restarted during the Sandinista government. According to Austin, Fox and Kruger (1985), from 1979 to 1984, the reform was organized as follows:

- Immediately after the revolution, the state took control of 23 percent of the arable land that formerly belonged to the Somoza family. The *Asociación de Trabajadores del Campo* (Association of Countryside Workers) played a role in the organization of production. This association had 120,000 members in 1980.
- The Ministry of Agrarian Reform lead the creation of state-owned enterprises.
- The Land Reform Act of 1981 established that productive (farming) land could not be reformed.
- By regulating rent prices, the government increased access to rented land. It also prohibited sharecropping.
- Through the establishment of cooperatives, the government promoted collective production.

As the process of land reform progressed, farmers demanded greater access to land. Thus in 1986, the Land Reform Act was modified, and more land was allocated to individual farmers (Pérez and Fréguin-Gresh, 2014 and Baumeister, 2012). With reference to the 1978–1988 period, Baumeister (2012) reports that 81.6 percent of land reallocated in the reform initially belonged to estates with 350 hectares (ha) or more. The reallocated land was directed to state-owned firms and cooperatives, which received 42.1 percent and 49.6 percent of the reformed land, respectively.

In 1990, the newly elected democratic government passed laws to regulate and implement a redistribution of land previously already reformed under the Sandinistas. Some collective lands, owned by cooperatives and other organizations, were parcelled into individual plots (Jonakin, 1996). Additionally, some lands were returned to the previous owners (Pérez and Fréguin-Gresh, 2014). Pérez and Fréguin-Gresh (2014) estimate that by 2001, 75 percent of the reformed land was not owned by the original beneficiaries of the reform. In fact, Baumeister (2012) estimates that the land reallocated between 1988 and 2001 (land that was formerly owned by state farms and cooperatives) was distributed in 2001 as follows: 6.6 percent of farms with fewer than 7 ha, 15.6 percent of farms between 7 and 35 ha, 63.6 percent of farms between 35 and 350 ha, and 14.2 percent of farms with more than 350 ha. However, the overall result of the land reform seems to be positive. In 1963 41.2 percent of cultivated land was in farms with more than 350 ha, while in 2001 and 2011, that percentage was 19.8 and 19.2, respectively (Pérez and Féguin-Gresh [2014] with census data).

The reallocation of reformed land, after 1990, the existence of collective ownership of land, in indigenous communities, the expansion of the agricultural frontier in formerly state-owned lands, and other institutional factors have created conditions of uncertainty about land tenure, as for example, owners lacking a registered title and plots having more than one registered owner (Baumeister, 2012). Uncertainty about property rights may affect investment decisions and selection of crops, so this is an important aspect to be considered in future analyses.

Sectoral trends

The Nicaraguan economy has long been linked to international markets (Pérez and Féguin-Gresh, 2014). In Somoza´s government, traditional exports, such as cotton, coffee, meat, sugar cane and tobacco, were supported with policies that included investment in infrastructure,

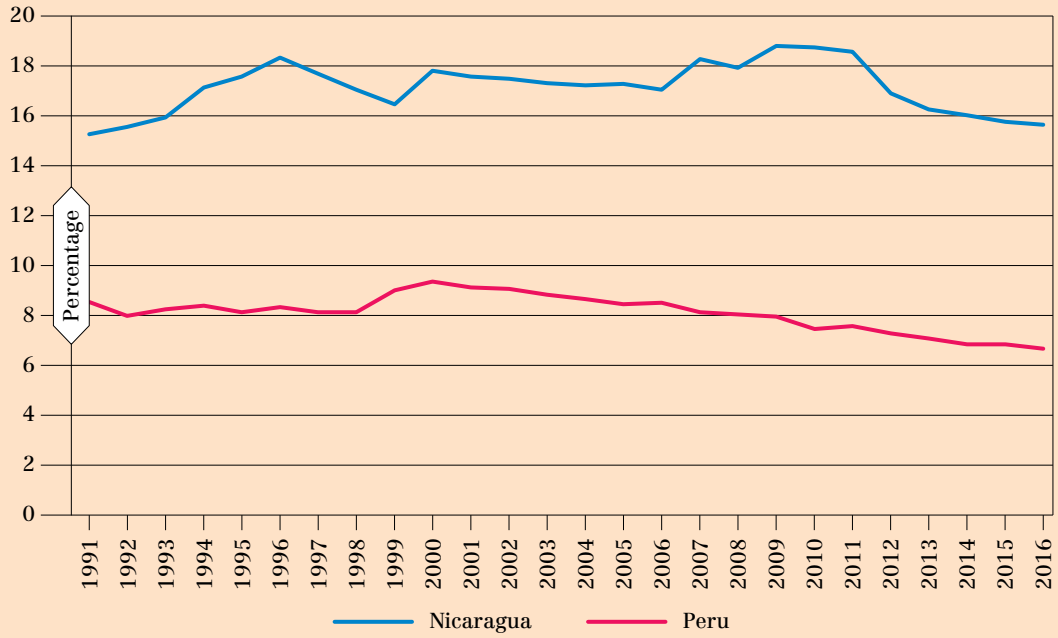
such as roads and storage, processing and marketing facilities, expansion of the maxiumum amount of credit, favorable exchange rates and price controls (Austin, 1985). After 1990, the promotion of exports was again a priority, especially for coffee, meat, soya and sugar cane (Pérez and Féguin-Gresh, 2014).

After 1990, the government eliminated price controls, and macroeconomic policy was directed to stabilizing the economy and reducing the size of the state (Pérez and Féguin-Gresh, 2014). One of the services affected was credit. During the Sandinista government, BANDES (National Development Bank) managed agricultural credit. After 1990 small farmers had little or no access, due to the introduction of tight eligibility rules (Jonakin, 1996).

After 1990 the amount of arable land expanded, especially for basic grains production (increasing by 105 percent between 1987 and 2005) and new pastures for livestock (Baumeister, 2012).[6] Part of the expansion of arable land occurred along the agricultural frontier, where farmers acquired property rights over the forest they then converted to agricultural land (Baumeister, 2012). In terms of production after 2000, Baumeister (2012) reports projects in the following areas: reforestation, cattle, oil palm, sugar cane and oranges, which are mainly for the external market.

The trends experienced by the agricultural sector occurred while the whole economy was growing. Between 1991 and 2011, the average annual growth rate of the Total Value Added was 3.2 percent, while the economically active population's average annual growth 3.0 percent (see Table A3 in the Annex). In this context, the share of the agricultural value added to the total value added increased from 15.3 percent in 1990 to around 18 percent, in the 2007–2011 period. After 2012, the share decreased to 15.6 percent, but the latter period is not part of this study.

FIGURE 2 Nicaragua and Peru: Agricultural value added as percentage of the economy's total value added, 1991–2016



Source: Authors' own elaboration with data from ECLAC. 2019. CEPALSTAT. In: ECLAC. New York, USA. Cited 30 November 2019. https://statistics.cepal.org/portal/cepalstat/index.html?lang=en

6 Particularly in Chontales, Matagalpa and the Autonomous regions (Baumeister, 2012).

2.2 Peru

Peru, like Nicaragua, experienced democratic and non-democratic governments since 1950. Here we pay special attention to the period after 1990,[7] a year that marks the beginning of Fujimori's government and the end of a debt crisis and hyperinflation. In addition, guerrilla conflicts decreased with the imprisonment of the Sendero Luminoso leader in 1992. Further, Fujimori's government changed the rules of land ownership. In the years following, exports and investment in agriculture were promoted.

Land reform

Land reform in Peru was implemented from 1962 to 1979, a period in which Peru was mostly ruled by military, non-democratic governments. Between 1969 and 1979, a total of 8.5 million hectares were reallocated to final owners that were mainly cooperatives and farm associations (Eguren, 2006). The government established limits on farm sizes; in addition, reformed land could not be sold (Meynard, 2014; Remy and de los Ríos 2012). The reform was intended to promote a collective management of land that would generate employment and produce food. Consequently, only a small amount of reformed land (7.7 percent) was reallocated to individual farmers and the law prohibited "indirect management" (former business groups managing cooperatives or farm associations), so that only members of these associations could play a role in management decisions (Remy and de los Ríos, 2012).

In 1980, the democratically elected government enacted a new law parcelling most of the land that was formerly organized in cooperatives. This especially affected irrigated lands on the Coast, except those producing sugar cane (Remy and de los Ríos, 2012 and Burneo, 2011). Cooperative lands were equally shared among members, according to rules that created small and dispersed plots (Remy and de los Ríos, 2012).

In 1995, after Fujimori's government enacted a new Constitution, a new law removed the previous rules dictating size limits, restrictions to sell land and the prohibition of indirect management (Remy and de los Ríos, 2012 and Burneo, 2011). In this context, Burneo (2011) hypothesized that a process of land concentration took place, with three main drivers: the new legislation that permitted the concession of irrigated land, low dynamism in the land market and the privatization of sugar cooperatives. However, using census data from 1961 and 1994, Remy and de los Ríos (2012) find that the land Gini decreased: land became more equally distributed.

Sectoral trends

Starting in 1990, Peru implemented economic stabilization and adjustment programs, macroeconomic policies emphasizing tax reforms, reductions in government expenditures, and market determination of exchange rate and interest rates (Velazco and Velazco, 2012).

From 1991 to 2009, arable land increased from 1.8 to 3.1 million hectares, driven mainly by irrigation projects, increased investment and exports (Velazco and Velazco, 2012). Regarding irrigation projects, state-owned unproductive lands with irrigation potential were developed by the state or by concessionary firms (Remy and de los Ríos, 2012 and Burneo 2011).

During these years policies promoting traditional and non-traditional agricultural exports had a clear impact as the share of exports to value added in agriculture increased from 21 percent, in 2000, to 38 percent in 2010 (Velazco and Velazco, 2012). Within traditional exports, coffee experienced the greatest growth in total area, due to programs replacing illegal crops with legal ones, an increased role of cooperatives, high export prices and access

[7] The census data we analyze is from 1994 and 2012.

to international markets. Among the non-traditional exports, the main crops were asparagus, artichokes, mangoes, beans, bananas, grapes, avocados, onions, olives and quinoa (Velazco and Velazco, 2012). Additionally, the promotion of biofuels bolstered sugar cane and oil palm production (Burneo, 2011).

The government also used credit and tax exemptions to promote agriculture. "Fondeagro", an agricultural credit program, provided USD280 million in loans from 1992 to 1994 (Velazco, 2001). In 1995, a "Special Taxation Program" (PERT) provided farmers, livestock producers, and agribusinesses with easier terms for tax payments (Velazco, 2001).

Labour market

Between 1994 and 2012, the Peruvian economy experienced high rates of GDP growth, with an average annual rate equal to 5.3 percent (see Table A3 in the Annex). Consequently, the economically active population expanded at an average annual rate of 2.9 percent. Moller *et al.* (2010) estimate that between 2002 and 2008 the Peruvian labour force increased from 12 to 15.1 million workers, and the dynamism of the labour mark*et al*so implied high migration between regions (6 percent of the population). The contribution of agriculture to the total value added of the economy decreased from 8.4 percent in 1994, to 7.3 percent in 2012.

According to Moller *et al.* (2010), employment in Peru is characterized by low productivity and high informality (three in every four jobs are informal). Economic growth may have reduced the rate of informal employment (76 percent in 1997 to 73 percent in 2008) (Moller *et al.*, 2010). However, changes in the formality of employment may also reflect two institutional changes: i) the creation in 2003 of a regime for micro and small firms that reduced firms' non-wage costs (such as vacations and liquidation payments) per employee, and ii) an improvement in the monitoring of labour benefits (Chacaltana, 2016).

2.3 Summary of possible hypotheses

With a better understanding of the political and economic factors at play in both countries, we infer a series of hypotheses about agricultural structural transformation in Nicaragua and Peru.

Nicaragua

Between 2001 and 2011, we anticipate the following trends in Nicaragua:

HN1 Ambiguous impact on land distribution: The various land reforms attempted to improve land equality. However, uncertainty about land tenure and the inability of farmers to access credit could mean that small farmers sell their land and leave agriculture altogether, thus increasing land inequality.

HN2 Decreased land ownership: Those small farmers who remained may have wanted the flexibility to leave agriculture quickly, so more of them are renting land.

HN3 Crop distribution skewed towards cash crops: Without credit and working on rented land, small farmers, now having a shorter planning horizon, may turn to cash crops, which will affect the crop distribution and, potentially, the types of crops exported.

HN4 Deforestation: We also expect to see more land used for agricultural purposes, as forests are converted to arable land.

Peru

For Peru, we expect the following to occur, between 1994 and 2012:

HP1 Ambiguous impact on land distribution and median farm size: The lifting of farm size restrictions may cause an increase in land concentration (increasing the median farm size). However, the increased access to credit may allow small farmers to enter agriculture more easily (reducing the median farm size).

HP2 Changes in the crop distribution: Export policies and a reduction in illegal crops could see farmers planting a very different set of crops in 2012 versus 1994.

HP3 Depending on how these factors combine, the number of people employed in agriculture could increase or decrease.

HN4 Deforestation: We also expect to see more land used for agricultural purposes, as forests are converted to arable land.

3 Nicaragua

KEY MESSAGES

- Agriculture is an expanding sector in Nicaragua and is attracting both labour and capital.
- Although the total amount of land allocated for agricultural use declined slightly between 2001 and 2011, a much higher percentage of land was used for cultivation and pastures, which was accompanied by some deforestation.
- The number of farms in the 0–7 ha category increased approximately by 60 percent.
- Similarly, the number of temporary workers employed on these farms increased by 120 percent.
- Mechanization in farms smaller than 7 ha increased slightly throughout the period, mainly because of an expansion in the use of agricultural tools and machines.
- Overall, structural transformation did not seem to occur in Nicaragua between 2001 and 2011, with agriculture remaining the economy's dominant sector and even increasing its prominence, while the share of land devoted to non-agricultural uses decreased by more than 10 percent.

Here we discuss our analysis of Nicaragua's agricultural censuses (from 2001 and 2011) on i) land use; ii) the crop and farm size distribution; iii) land tenure; iv) labour trends; and v) mechanization. We find that although the total amount of land allocated for agricultural use declined slightly between 2001 and 2011, a much higher percentage of land was used for cultivation and pastures (likely for livestock), which was accompanied by some deforestation. Three traditional crops (corn, beans and coffee) continued to dominate throughout the country. Although land inequality increased slightly, there was almost a 33 percent increase in the share of producers with small farms (0–7 ha), and the share of land in this size category more than doubled as well. This trend translated into a nearly 60 percent increase in the number of farms in the 0–7 ha category, and a 120 percent increase in the number of temporary workers employed on these farms. Finally, mechanization in farms smaller than 7 ha increased greatly as well, because of an expansion in the use of agricultural tools and machines. Combined, these trends indicate that in Nicaragua, agriculture is an expanding sector, attracting both labour and capital.

3.1 Trends in land use and the crop distribution

Between 2001 and 2011, the total amount of agricultural land in Nicaragua decreased by 3.8 percent (Table 1, with regional details given in Table A4). The allocation among the different land uses reveals a transformation in the sector. The total land devoted to annual

and permanent crops increased by nearly 13 percent, with a nearly equivalent percentage increase in cultivated pastures (12 percent). The negative result for total agricultural land is due to forest and fallow land decreasing by 10.3 percent and 41.3 percent, respectively.

TABLE 1 Nicaragua: Distribution of total agricultural land by use, 2001 and 2011

Use	2001 (ha)	2011 (ha)	2001–2011 (growth rates, %)
Agricultural uses	**1 910 856**	**2 050 691**	**7.3**
Annual crops	674 956	737 218	9.2
Permanent and semi-permanent crops	297 631	359 641	20.8
Cultivated pastures	938 269	953 832	1.7
Natural pastures	**2 066 755**	**2 317 868**	**12.2**
Fallow land	**1 194 815**	**701 880**	**-41.3**
Non-agricultural uses	**1 123 297**	**984 431**	**-12.4**
Forests	895 220	803 504	-10.2
Infrastructure (buildings and roads)	71 163	70 406	-1.1
Swamps	113 171	110 521	-2.3
Affected by natural disasters	43 743		n.d.
Total agricultural land	**6 295 723**	**6 054 870**	**-3.8**

Notes: The data presented do not include incomplete surveys (see the glossary for more information on complete versus incomplete surveys). n.d.: no data.

Source: Authors' own elaboration.

Most of the land devoted to annual and permanent crops was in the Pacific and Central regions: by 2011 these regions contained 76 percent of the area used for annual crops and 83 percent of the area in permanent crops (Table 2). In 2011, the Central region contributed most of the area utilized for annual and permanent crop cultivation, as well as the area devoted to pastures and forests. In contrast, the Atlantic region contained a lower share of annual and permanent crops, although a large share of the total pastures and forest land were in that region in 2011 (Table 2).

The transformation of Nicaraguan agriculture from 2001 to 2011 was characterized by the addition of pasturelands and the utilization of land that was formerly fallow. In all regions, the amount of fallow land decreased (Figure 3). In contrast, the pastureland expansion occurred exclusively in the Atlantic region; the area devoted to pastures decreased in the Pacific and Central regions (Figure 3). In the Atlantic region, the expansion of pastureland was accompanied by a contraction of fallow and forest land. This indicates that in the process of agricultural expansion, fallow land and forests are being converted to pastures, which is consistent with the transformation process discussed by Pérez and Fréguin-Gresh (2014) and Baumeister (2012) and hypothesis HN4.

The additional area dedicated to annual crops was concentrated in the Central region, with some area also added in the Pacific. In the Atlantic region, the area for annual crops decreased. Land for permanent crops increased in all the regions, but most of the expansion took place in the Central region. In sum, the trends in the expansion of annual and permanent crops contributed to the pre-eminence of the Central Region as the agricultural hub of the country.

TABLE 2 Nicaragua: Distribution of total agricultural land in regions by use, 2001 and 2011

Use	2001 (%)			2011 (%)			2001–2011 (growth rates, %)		
	Pacific	Central	Atlantic	Pacific	Central	Atlantic	Pacific	Central	Atlantic
Agricultural uses	**26.6**	**43.0**	**30.4**	**26.0**	**45.0**	**29.0**	**4.8**	**12.4**	**2.4**
Annual crops	31.1	41.1	27.8	30.7	45.8	23.6	7.8	21.6	-7.4
Permanent and semi-permanent crops	38.8	45.4	15.8	33.7	49.1	17.2	4.7	30.9	31.4
Cultivated pastures	19.5	43.6	36.9	19.4	42.9	37.7	1.3	0.0	3.8
Natural pastures	**16.9**	**52.9**	**30.3**	**14.1**	**46.8**	**39.2**	**-6.5**	**-0.8**	**45.1**
Fallow land	**21.5**	**38.6**	**39.9**	**22.7**	**40.0**	**37.3**	**-38.2**	**-39.1**	**-45.0**
Non-agricultural uses	**18.6**	**38.4**	**43.0**	**21.8**	**44.4**	**33.8**	**2.5**	**1.3**	**-31.0**
Forests	14.4	37.6	48.0	19.6	44.9	35.5	22.3	7.3	-33.8
Infrastructure (buildings and roads)	31.9	41.1	27.0	33.4	40.3	26.3	3.8	-3.0	-3.9
Swamps	36.6	41.6	21.8	30.1	43.3	26.6	-19.6	1.6	19.1
Affected by natural disasters	37.1	43.2	19.7				-100.0	-100.0	-100.0
Total agricultural land	**21.0**	**44.6**	**34.4**	**20.4**	**45.0**	**34.6**	**-6.9**	**-2.9**	**-3.1**

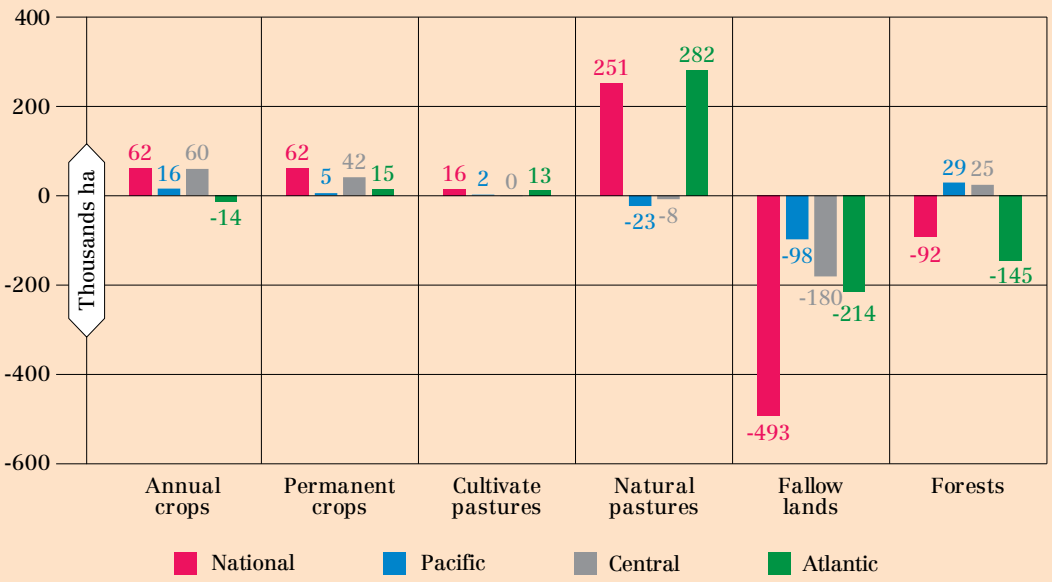
Notes: The data presented do not include incomplete surveys (see the glossary for more information on complete versus incomplete surveys). n.d.: no data.

Source: Authors' own elaboration.

Overall, cultivated land is used mainly for traditional crops. Corns, beans, coffee, rice, sugar cane and plantains, and others comprised 78 percent of the land in annual and permanent crops in 2011. From the traditional crops, the three with the greatest area, i.e. corn, beans and coffee, took up 61 percent of the land. Between 2001 and 2011, the area dedicated to traditional crops increased from 62 percent to 78 percent, indicating that the expansion of agricultural land was mainly used for the cultivation of these crops. Among the traditional crops, coffee, sugar and beans are among the most important exports (in nominal value) according to United Nations international trade data (COMTRADE).

Other crops gained importance in the period of interest. The area devoted to palm, groundnut, cacao and cassava expanded considerably between 2001 and 2011: palm cultivation increased 486 percent (Table 3).

FIGURE 3 Nicaragua: Absolute changes in land use, by region, 2001 and 2011



Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

TABLE 3 Nicaragua: Area and contribution to the total cultivated land of main crops, 2001 and 2011

Crop	Area (ha)		Growth rates (%)	Contribution (%)	
	2001	2011	2001–2011	2001	2011
Corn	244 863	310 906	27	25	28
Beans	138 998	226 283	63	14	21
Coffee	91 979	127 013	38	9	12
Rice	37 181	69 054	86	4	6
Sugar cane	43 459	63 544	46	4	6
Bananas (plantains and others)	45 066	54 461	21	5	5
Sorghum	37 654	34 782	-8	4	3
Groundnut	14 901	33 080	122	2	3
Cassava	10 835	22 130	104	1	2
Palm	2 265	13 261	486	0	1
Cacao	5 009	11 106	122	1	1
Citrus	7 919	10 063	27	1	1
Total cultivated land (annual and permanent)	**972 588**	**1 096 859**	**13**		

Notes: The data presented do not include incomplete surveys. The total area in annual and permanent crops is the national total (calculated with data in Table A1), which include other crops that are not in the table. The contribution is calculated with respect to that total area, so that the sum is not equal to 100 percent.
Source: Authors' own elaboration.

3.2 Farm size distribution

National and regional trends

To understand the trends in land distribution, we calculated land Gini coefficients across years and regions (Table 4). In general, land inequality, as measured by the Gini, increased. To gain additional insight about the land distribution, we calculated the share of producers and the share of land area in six farm size categories, as shown in Table 4. At the national level and in every region, the share of producers with less than 7 ha was greater in 2011 than in 2001, while the share of producers with more than 7 ha decreased. In the three regions, the share of land in farms with fewer than 35 ha increased and in contrast, the share of land in farms with more than 35 ha generally decreased. In the Atlantic region, the share of farms with more than 350 ha grew from 16.9 percent to 21.8 percent, indicating a clear pattern of land concentration towards the biggest farms in this region.

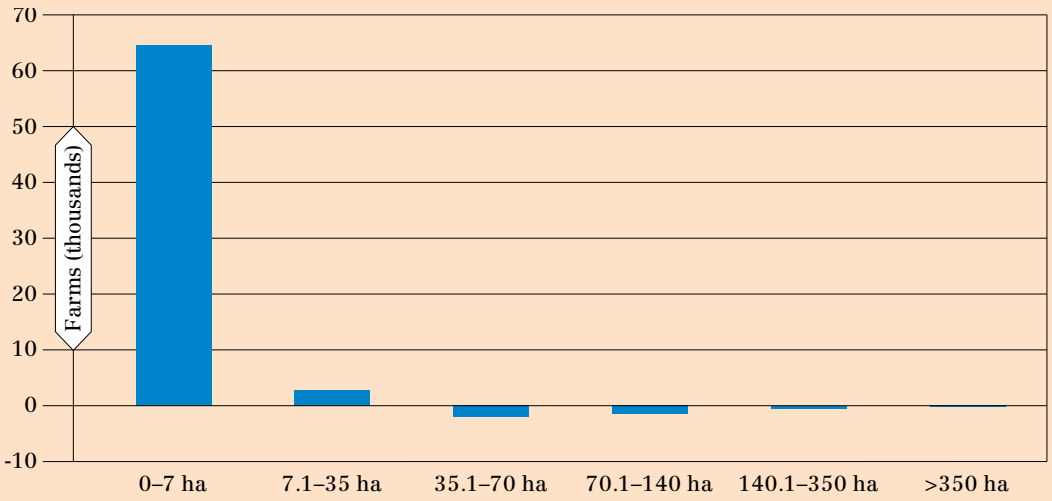
The observed trends for the share of producers and share of land within each farm size category imply that the increased inequality indicated by the Gini index is due to an expansion of the smaller agricultural units. Between 2001 and 2011, the number of farms increased only in the small size categories. In the 0–7 ha and 7–35 ha categories, approximately 67 000 "new" farms were created, of which 64 000 were in the 0–7 ha category (Figure 4). These farms added an area of 130 000 ha. In contrast, there were fewer farms with more 350 ha, and the total area in those farms decreased by 139 000 ha, reducing their share in the total land dedicated to agriculture (Figure 5).

TABLE 4 Nicaragua: Indicators of farm size distribution, 2001 and 2011

	National		Pacific		Central		Atlantic	
	2001	2011	2001	2011	2001	2011	2001	2011
Land (Gini index)	0.7	0.8	0.8	0.9	0.7	0.8	0.6	0.6
Share of producers (%)								
0–7 ha	43.3	57.5	62.9	74.4	42.8	58.4	13.1	43.3
7.1–35 ha	33.1	26.2	26.3	18.6	36.2	27.3	36.4	33.1
35.1–70 ha	12.4	8.6	5.4	3.6	11.3	7.7	26.3	12.4
70.1–140 ha	6.9	4.6	2.9	1.9	6.0	4.1	15.5	6.9
140.1–350 ha	3.4	2.4	1.7	1.1	3.0	2.1	7.2	3.4
>350 ha	1.0	0.7	0.9	0.5	0.8	0.6	1.5	1.0
Share of land area (%)								
0–7 ha	3.3	5.0	6.3	8.8	3.8	6.1	0.7	3.2
7.1–35 ha	17.0	18.8	18.8	20.0	19.9	20.9	12.1	17.0
35.1–70 ha	17.7	17.4	12.0	12.1	17.7	17.4	21.2	17.7
70.1–140 ha	19.3	18.3	12.7	12.1	18.4	18.0	24.8	19.3
140.1–350 ha	21.0	20.6	17.0	16.1	20.0	20.0	24.7	20.9
>350 ha	21.8	20.4	33.2	30.9	20.3	17.7	16.9	21.8

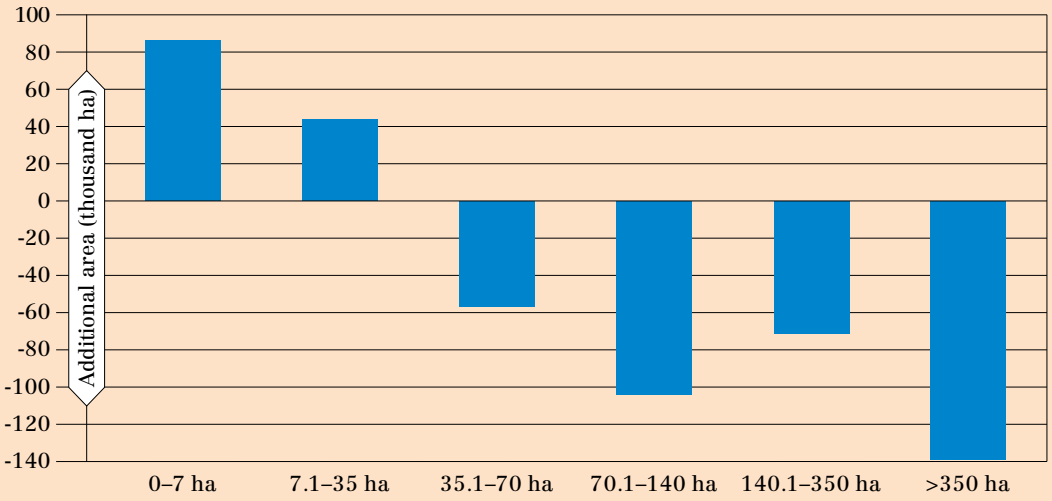
Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

FIGURE 4 **Nicaragua: Absolute change in the number farms by farm size, 2001 and 2011**



Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

FIGURE 5 **Nicaragua: Absolute change in area by farm size, 2001 and 2011**



Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

To get a more complete description of the changes in the distribution of farm sizes, we calculated the median farm size within each farm size category (Table 5). In the smaller farm size ranges (0–7 ha and 7–35 ha) both the number of farms and the total area increased between 2001 and 2011, making it difficult to hypothesize if the median farm size increased or decreased a priori. Table 3 shows that, at the national level, the median farm size diminished for farms in the 0–7 ha range and remained the same for farms in the 7–35 ha range, which is consistent with the increase in the number of small farms. In the Pacific and Central regions, the results are similar, while in the Atlantic region, the median farm size decreased for farms in the 0–7 ha range and in the 7–35 ha range.

TABLE 5 Nicaragua: Median farm size, 2001 and 2011

Farm size	National (ha)		Pacific (ha)		Central (ha)		Atlantic (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011
0–7 ha	2.1	1.4	1.8	1.1	2.1	1.6	2.8	2.5
7.1–35 ha	14.1	14.1	13.0	13.1	14.1	14.1	17.6	16.9
35.1–70 ha	42.3	43.7	44.4	45.8	42.3	44.4	42.3	42.7
70.1–140 ha	84.6	85.0	86.0	86.7	84.6	86.0	81.1	84.6
140.1–350 ha	176.3	183.3	197.4	197.4	176.3	181.4	176.3	179.4
>350 ha	493.5	493.5	564.0	549.9	479.4	492.4	423.0	443.4

Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

For farms with more than 35 ha, both the number of farms and the total area were smaller in 2011 than in 2001, again resulting in an ambiguous impact on the median farm size. At the national level and in every region, the median farm size increased for farms in the 35–70 ha category. For the other categories, regions differed. In the 70–140 ha category, the median size increased in the Pacific and Atlantic region, while it shrunk in the Central region. For categories above 140 ha, the median farm size increased in the Central and Atlantic regions. In the Pacific region, the median farm size was unchanged in the 140–350 ha category and increased among farms with more than 350 ha.

In sum, using median farm size as indicator of land inequality, the Central and Atlantic land distributions became more unequal, because in the bottom part of the distribution, farms became smaller, while in the upper part, farm size increased. In the Pacific region, the trend is not clear, because the median size decreased or stagnated in the 0–7 ha and above 140 ha size categories; the median size increased in the middle of the distribution, but the changes were small.

The different regional trends are consistent with hypothesis HN1, ambiguity of the impact of land reforms and other factors on the land distribution. The interactions of climate, expansion in the number of farms, changes in land use, and the selection of crops in each region distinctly affected distribution of land between small and large farms, resulting in some regions facing less land inequality, while others experienced greater land concentration.

Changes in land use and farm sizes

The trends in median size and the farm size distribution are linked to transformations in land use (Table 6). Between 2001 and 2011, an additional 82 422 ha were employed in the production of annual crops. Of this total, 77 percent were in farms with less than 35 ha, while the rest were in farms with more than 350 ha. The additional area devoted to permanent crops was similarly allocated, mainly to farms with less than 35 ha (53.5 percent) and more than 350 ha. Thus, farms in the middle part of the size distribution (between 35 and 350 ha) were not contributing to the increased production of annual or permanent crops. In contrast, the additional pastoral area came mainly from farms with 7 to 350 ha.

While pastures and cultivated land expanded, fallow land decreased in all the farm size categories, especially in farms with more than 7 ha (Table 6). The contraction of forest land was concentrated in farms with more than 70 ha; among farms with less than 35 ha, the amount of forest increased. Table 6 shows a clear pattern differentiating farms in the below and above 35 ha categories.

TABLE 6 Nicaragua: Contribution of the different farm sizes to absolute changes in area, 2001 and 2011

	Increase in area				Decrease in area	
	Annual crops	Permanent crops	Pastures	Forest	Forest	Fallow land
Absolute change (ha)	82 422	67 062	274 567	34 967	-126 684	-492 935
Farm size (contribution, %)						
0–7 ha	58.8	22.5	5.8	22.0		1.0
7.1–35 ha	18.2	31.0	31.1	78.0		19.5
35.1–70 ha		6.6	24.5		6.0	21.9
70.1–140 ha		0.2	12.7		19.7	20.7
140.1–350 ha			25.8		24.8	18.5
>350 ha	23.0	39.6			49.4	18.5

Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

The evidence in Table 6 indicates that the dynamics of land use differed across farm size categories. In Tables 7, 8 and 9, we summarize information on the predominant crops by region and farm size to describe the mix of agricultural activities carried out. We list the top 5 crops cultivated, from greatest to least area in 2001 and 2011.

In the Pacific region (Table 7), corn, beans and sorghum were among the top five crops in farms with less than 70 ha, in 2001 and 2011. Within these farms, rice is gaining importance. Bananas (plantains and others) were among the top five crops in the farms with less than 35 ha. The top crops by area were not so different for the farms with more than 70 ha, among which were corn, sorghum and rice. Groundnut was also important in all categories above 70 ha and sugar cane was important in farms with more than 140 ha.

In the Central region (Table 8), the top five crops for all farms smaller than 350 ha included corn, beans, coffee and bananas (plantains and others). From this bundle, corn, beans and coffee were also among the top five crops in the farms with more than 350 ha. There was a pattern of differentiation, with sorghum belonging to the set of top five crops only among farms smaller than 35ha, rice being in the top five in farms with more than 35 ha and, in 2011, palm gaining a position in the top five in farms with more than 350 ha.

In the Atlantic region (Table 9), farms in all categories, except for those with more than 350 ha, shared the same bundle of crops, which included corn, beans, bananas (plantains and others), rice and cassava. Among farms with more than 350 ha, corn, beans and bananas (plantains and others) were also in the top five crops, but cacao (in 2001), cassava (in 2011) and palm (in both years) were also important.

TABLE 7 Pacific region: Top five crops by farm size, 2001 and 2011

2001			2011		
Crop	Area (ha)	Contribution (%)	Crop	Area (ha)	Contribution (%)
Farm size: 0–7 ha					
Corn	15 166	27	Corn	23 749	35
Beans	7 765	14	Beans	11 805	17
Bananas (plantains and others)	4 340	8	Bananas (plantains and others)	7 429	11
Sorghum	2 622	5	Sorghum	3 766	6
Coffee	2 374	4	Rice	3 735	6
Total crops	56 784		Total crops	67 754	
Pasturelands	11 652		Pasturelands	17 343	
Ratio crops/ pastureland	487		Ratio crops/ pastureland	391	
Farm size: 7.1–35 ha					
Corn	19 105	24	Corn	22 769	29
Sorghum	7 593	10	Beans	10 020	13
Beans	7 305	9	Sorghum	7 040	9
Bananas (plantains and others)	4 788	6	Bananas (plantains and others)	6 199	8
Coffee	3 286	4	Rice	4 115	5
Total crops	79 876		Total crops	77 190	
Pasturelands	91 892		Pasturelands	105 351	
Ratio crops/ pastureland	87		Ratio crops/ pastureland	73	
Farm size: 35.1–70 ha					
Corn	5 195	15	Corn	6 510	22
Sorghum	3 835	11	Sorghum	3 301	11
Coffee	3 061	9	Beans	2 758	9
Beans	2 024	6	Coffee	2 505	8
Sugar cane	1 842	5	Rice	2 315	8
Total crops	34 023		Total crops	29 601	
Pasturelands	70 192		Pasturelands	74 063	
Ratio crops/ pastureland	48		Ratio crops/ pastureland	40	
Farm size: 70.1–140 ha					
Corn	3 910	12	Rice	4 423	15
Sorghum	3 590	11	Corn	4 038	14
Sugar cane	2 839	9	Groundnut	3 361	11
Coffee	2 784	8	Sorghum	3 042	10
Groundnut	2 430	7	Coffee	2 881	10
Total crops	33 096		Total crops	29 604	
Pasturelands	76 071		Pasturelands	72 305	
Ratio crops/ pastureland	44		Ratio crops/ pastureland	41	

TABLE 7 (cont.) Pacific region: Top five crops by farm size, 2001 and 2011

2001			2011		
Crop	Area (ha)	Contribution (%)	Crop	Area (ha)	Contribution (%)
Farm size: 140.1–350 ha					
Sugar cane	6 766	14	Groundnut	7 465	21
Sorghum	5 866	12	Rice	6 517	18
Groundnut	5 400	11	Corn	3 698	10
Corn	4 065	9	Sorghum	3 594	10
Rice	2 923	6	Sugar cane	3 559	10
Total crops	47 049		Total crops	35 965	
Pasturelands	95 089		Pasturelands	92 036	
Ratio crops/ pastureland	49		Ratio crops/ pastureland	39	
Farm size: >350 ha					
Sugar cane	26 543	36	Sugar cane	50 415	47
Rice	6 350	9	Groundnut	19 176	18
Sorghum	6 139	8	Rice	13 336	12
Groundnut	4 984	7	Corn	4 151	4
Corn	3 680	5	Sorghum	3 747	4
Total crops	74 455		Total crops	107 039	
Pasturelands	186 866		Pasturelands	150 451	
Ratio crops/ pastureland	40		Ratio crops/ pastureland	71	

Note: Total crops is the sum of annual and permanent. Ratio is total crops/pasturelands and contribution (%) is the contribution of the crop with respect to total crops.

Source: Authors' own elaboration.

TABLE 8 Central region: Top five crops by farm size, 2001 and 2011

2001			2011		
Crop	Area (ha)	Contribution (%)	Crop	Area (ha)	Contribution (%)
Farm size: 0–7 ha					
Corn	20 636	31	Beans	45 739	40
Beans	17 830	27	Corn	44 524	39
Coffee	11 730	17	Coffee	24156	21
Bananas (plantains and others)	1 713	3	Bananas (plantains and others)	3 222	3
Sorghum	1 666	2	Sorghum	2 803	2
Total crops	67 236		Total crops	114 699	
Pasturelands	18 412		Pasturelands	25 744	
Ratio crops/ pastureland	365		Ratio crops/ pastureland	446	
Farm size: 7.1–35 ha					
Corn	46 136	31	Corn	65 495	36
Beans	34 650	23	Beans	58 651	33
Coffee	22 392	15	Coffee	36 491	20

TABLE 8 (cont.) Central region: Top five crops by farm size, 2001 and 2011

2001			2011		
Crop	Area (ha)	Contribution (%)	Crop	Area (ha)	Contribution (%)
Bananas (plantains and others)	4 387	3	Bananas (plantains and others)	7 284	4
Sorghum	2 953	2	Sorghum	3 557	2
Total crops	148 955		Total crops	179 445	
Pasturelands	225 131		Pasturelands	245 200	
Ratio crops/ pastureland	66		Ratio crops/ pastureland	73	
Farm size: 35.1–70 ha					
Corn	20 173	29	Corn	25 728	33
Beans	13 448	20	Beans	21 786	28
Coffee	9 931	14	Coffee	14 498	19
Bananas (plantains and others)	2 438	4	Rice	3 519	5
Rice	1 190	2	Bananas (plantains and others)	3 269	4
Total crops	68 872		Total crops	77 530	
Pasturelands	262 790		Pasturelands	269 416	
Ratio crops/ pastureland	26		Ratio crops/ pastureland	29	
Farm size: 70.1–140 ha					
Corn	12 182	25	Corn	15 486	30
Coffee	9 085	19	Beans	12 344	24
Beans	7 932	16	Coffee	11 688	22
Rice	2 337	5	Rice	2 903	6
Bananas (plantains and others)	1 731	4	Bananas (plantains and others)	2 080	4
Total crops	48 201		Total crops	52 086	
Pasturelands	324 010		Pasturelands	311 330	
Ratio crops/ pastureland	15		Ratio crops/ pastureland	17	
Farm size: 140.1–350 ha					
Coffee	11 231	28	Coffee	13 003	31
Corn	7 798	19	Corn	9 491	23
Beans	4 905	12	Beans	6 926	17
Rice	3 492	9	Rice	3 609	9
Bananas (plantains and others)	1 257	3	Bananas (plantains and others)	1 459	4
Total crops	40 545		Total crops	41 374	
Pasturelands	367 175		Pasturelands	363 184	
Ratio crops/ pastureland	11		Ratio crops/ pastureland	11	
Farm size: >350 ha					
Coffee	8 793	23	Rice	10 933	22
Corn	5 355	14	Coffee	10 457	21

TABLE 8 (cont.) Central region: Top five crops by farm size, 2001 and 2011

2001			2011		
Crop	Area (ha)	Contribution (%)	Crop	Area (ha)	Contribution (%)
Rice	4 789	12	Corn	4 779	10
Beans	3 435	9	Beans	4 532	9
Citrus	1 652	4	Palm	3 915	8
Total crops	38 649		Total crops	48 943	
Pasturelands	303 985		Pasturelands	278 037	
Ratio crops/ pastureland	13		Ratio crops/ pastureland	18	

Note: Total crops is the sum of annual and permanent. Ratio is total crops/pasturelands and contribution (%) is the contribution of the crop with respect to total crops.

Source: Authors' own elaboration.

TABLE 9 Atlantic region: Top five crops by farm size, 2001 and 2011

2001			2011		
Crop	Area (ha)	Contribution (%)	Crop	Area (ha)	Contribution (%)
Farm size: 0–7 ha					
Corn	3 085	34	Corn	4 752	34
Beans	1 814	20	Beans	3 570	25
Bananas (plantains and others)	840	9	Rice	1 321	9
Rice	360	4	Bananas (plantains and others)	1 284	9
Cassava	284	3	Cassava	1 264	9
Total crops	8 951		Total crops	14 081	
Pasturelands	2 381		Pasturelands	5 187	
Ratio crops/ pastureland	376		Ratio crops/ pastureland	271	
Farm size: 7.1–35 ha					
Corn	22 366	36	Corn	25 823	37
Beans	11 263	18	Beans	16 565	24
Bananas (plantains and others)	4 646	8	Bananas (plantains and others)	5 461	8
Rice	1 914	3	Cassava	4 773	7
Cassava	1 768	3	Rice	3 416	5
Total crops	61 432		Total crops	69 434	
Pasturelands	93 783		Pasturelands	145 682	
Ratio crops/ pastureland	66		Ratio crops/ pastureland	48	
Farm size: 35.1–70 ha					
Corn	22 882	36	Corn	20 609	35
Beans	10 728	17	Beans	12 602	22
Bananas (plantains and others)	4 776	7	Bananas (plantains and others)	4 241	7

TABLE 9 (cont.) **Atlantic region: Top five crops by farm size, 2001 and 2011**

2001			2011		
Crop	**Area (ha)**	**Contribution (%)**	**Crop**	**Area (ha)**	**Contribution (%)**
Cassava	1 879	3	Cassava	4 066	7
Rice	1 788	3	Rice	2 426	4
Total crops	63 956		Total crops	58 491	
Pasturelands	189 862		Pasturelands	246 753	
Ratio crops/ pastureland	34		Ratio crops/ pastureland	24	
Farm size: 70.1–140 ha					
Corn	18 074	36	Corn	15 775	36
Beans	7 148	14	Beans	8 222	19
Bananas (plantains and others)	3 842	8	Cassava	2 787	6
Cassava	1 388	3	Bananas (plantains and others)	2 774	6
Rice	1 268	3	Rice	1 320	3
Total crops	50 390		Total crops	43 931	
Pasturelands	246 496		Pasturelands	297 897	
Ratio crops/ pastureland	20		Ratio crops/ pastureland	15	
Farm size: 140.1–350 ha					
Corn	11 130	34	Corn	10 058	34
Beans	4 046	12	Beans	4 783	16
Bananas (plantains and others)	2 306	7	Bananas (plantains and others)	1 808	6
Rice	847	3	Cassava	1 471	5
Cassava	834	3	Rice	844	3
Total crops	32 561		Total crops	29 474	
Pasturelands	264 032		Pasturelands	342 042	
Ratio crops/ pastureland	12		Ratio crops/ pastureland	9	
Farm size: >350 ha					
Corn	3 924	22	Palm	8 119	40
Beans	1 582	9	Corn	3 472	17
Bananas (plantains and others)	1 522	9	Beans	1 575	8
Coco	1 028	6	Bananas (plantains and others)	627	3
Palm	914	5	Cassava	537	3
Total crops	17 557		Total crops	20 221	
Pasturelands	175 207		Pasturelands	229 680	
Ratio crops/ pastureland	10		Ratio crops/ pastureland	9	

Note: Total crops is the sum of annual and permanent. Ratio is total crops/pasturelands and contribution (%) is the contribution of the crop with respect to total crops.

Source: Authors' own elaboration.

Overall, there was a consistency in the annual and permanent crops cultivated. In the Central and Atlantic regions, corn, beans and bananas (plantains and others) were important in all years and farm size categories. Coffee was among the top crops in the Central region, across all farm size categories. Cassava's importance was exclusive to the Atlantic region, independent of farm size. Rice was among the top five crops across the three regions, but not across all farm sizes, being more important in farms with more than 35 ha. Sorghum and groundnut were important in the Pacific region, among farms with less than 35 ha and more than 70 ha, respectively. These patterns by region and farm size were consistent between 2001 and 2011: the set of crops comprising most of the cultivated land remained almost the same in every region and size category, as shown in Tables 7, 8 and 9. As such, the additional land allocated to cultivation between 2001 and 2011, was used to produce the same crops as in 2001. Furthermore, traditional crops, as corn, beans, coffee and bananas (plantains and others), continued to dominate the agricultural landscape.

However nationally, the trend for pastures was not as consistent as for crops. In the Atlantic region, the area devoted to pastures increased for all farm size categories, between 2001 and 2011 (Tables 7, 8 and 9). In contrast, in the Pacific and Central regions, the pasture area increased only in farms with less than 140 ha and 70 ha, respectively, and it decreased in the other size categories. We calculated the ratio of the area in annual and permanent crops to the area in pastures for every size category and region (Tables 7, 8 and 9). For all regions and for farms with more than 7 ha, the area devoted to annual and permanent crops was smaller than the pastoral area. This result reflects a pattern of specialization in all regions, with the land in small farms (0–7 ha) devoted mainly to annual and permanent crops, while pastures was the main land use in farms larger than 7 ha.

Comparing the national crop distribution (Table 3) to the disaggregated crop distributions (Tables 7, 8 and 9) reveals an interesting trend. Nationally, the crop distribution remained stable between 2001 and 2011, with corn, beans, coffee, rice and sugar cane being the top five crops in both years. However, for most farms in 2001, rice and sugar cane do not appear in the top five crops. Table 10 shows the differences between cultivated areas in the disaggregated crop distribution in each region and the actual area dedicated to these five crops at the national level. Within each region and for each census year, the amount of area cultivated is summed across farm size categories for each of the top five crops listed in the aggregated national crop distribution in Table 3. These regional figures are summed in the fourth column, to give the "derived national cultivation distribution", which we then compare to the "actual cultivation distribution."

At first glance these differences may seem difficult to reconcile. However, the figures are quite revelatory. Within the crop distribution for individual farms, corn and beans have been consistently important, hence the ratio of the derived to the actual national distribution is 1 (or nearly 1) in 2001 and 2011. Conversely, coffee, rice and sugar cane did not dominate the crop distribution within farms in 2001. Rather, it seems many farms cultivated these crops on a small scale; when all these cultivated acres were summed together, then coffee, rice and sugar cane become important at the national level. However, by 2011, rice and sugar cane gained importance within farms, as evidence by the derived-to-actual cultivation ratio approaching 1. We interpret this increase in the ratio as a homogenization in the crop distribution on individual farms. Rather than specializing in one or two crops (namely corn and beans) and having a diversified crop distribution across the rest of their acreage, farms in Nicaragua converged on the five crops of corn, beans, coffee, rice and sugar cane by 2011.

The convergence of the derived and national rice productions is especially interesting. There are two types of rice cultivated in Nicaragua: i) upland (paddy) rice, which is grown by small producers who often have little resources; and ii) irrigated rice, which is cultivated by large producers and dominates Nicaraguan rice production. Further irrigated rice producers

are highly organized within the Nicaraguan Rice Association (ANAR), which controls the entire vertical chain of production, from individual farms to the international market (ECLAC, 2010). In 2001, ANAR established the Rice Producers' Support Programme (PAPA) to control rice production and ensure ANAR producers receive a higher price (ECLAC, 2010). These protections combined with the paddy rice quotas imposed by the Central American Free Trade Agreement (CAFTA), effectively meant that small rice producers were pushed out of the market.

In response, we would expect to see an increase in rice cultivation amongst large-scale farmers. This is exactly what Tables 7, 8 and 9 exhibit, particularly in the Pacific and Central regions. As rice came to dominate the crop distribution within large farms, the disaggregated production approached the national production, resulting in the increased ratio as shown in Table 10.

Thus, we see that nationally, the Nicaraguan crop distribution in 2001 and 2011 exhibited stability. However, delving into individual crop distributions, we find that farms shifted towards both staples (rice) and cash crops (coffee and sugar cane), which HN3 did not predict. Rather, farmers are cultivating more homogenized distributions, in response to domestic organization of the production chain and external market forces.

◆ TABLE 10 Nicaragua: National and regional crop distribution comparison, 2001 and 2011

Top five crops	Pacific cultivation: Top five crops (sum of Table 7) (ha)		Central cultivation: Top five crops (sum of Table 8) (ha)		Atlantic cultivation: Top five crops (sum of Table 9) (ha)		Derived national cultivation distribution (sum Tables 7–8) (ha)		Actual national cultivation distribution (Table 3) (ha)		Ratio of derived to actual cultivation distribution (shares, %)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Corn	51 121	65 300	112 280	165 503	81 461	80 489	244 862	311 292	244 863	310 906	1.00	1.00
Beans	17 094	24 583	82 200	149 978	36 581	47 317	135 875	221 878	138 998	226 283	0.98	0.98
Coffee	5 845	5 386	73 162	110 293	n.t.	n.t.	79 007	115 679	91 979	127 013	0.86	0.91
Rice	n.t.	10 165	11 808	20 964	6 177	9 327	17 985	40 456	37 181	69 054	0.48	0.59
Sugar cane	33 309	53 974	n.t.	n.t.	n.t.	n.t.	33 309	53 974	43 459	63 544	0.77	0.85

Note: n.t.: not in the top five crops (with respect to cultivated area), in these regions/years.
Source: Authors' own elaboration.

3.3 Land tenure

As mentioned in the Introduction, although legislation to secure and improve tenure rights was passed in 1990, some problems persisted with respect to the legalization and registration of tenure rights (Pérez and Fréguin-Gresh, 2014 and Baumeister, 2012). Census data reflect this in the proportion of farmers who own land and how many of them have registered rights for their land. In 2001, 90 percent of the farmers owned the land they farmed, but only 49 percent (of all farmers) had a registered right over all their land. In 2011, a smaller share of farmers owned the land (86 percent), but the percentage of those with a registered land right was nearly the same (50 percent). Therefore, the national figures indicate that more farmers were renting, lending, or having another form of tenure in 2011 than in 2001, and the proportion with registered rights had not improved. In the Pacific and Central

regions, the changes in land tenure reflect the national results. In contrast, in the Atlantic region, the roportion of farmers owning their land who also had registered rights increased between 2001 and 2011.

TABLE 11 Nicaragua: Classification of farmers according to land tenure by region, 2001 and 2011

Region	2001			2011		
	Owned		Others	Owned		Others
	All registered	Not all registered		All registered	Not all registered	
Number of farmers						
National	97 529	82 372	19 547	130 390	95 502	36 654
Pacific	34 024	22 151	7 141	43 164	28 145	16 186
Central	49 524	38 424	8 913	66 741	47 787	17 268
Atlantic	13 981	21 797	3 493	20 485	19 570	3 200
Distribution (%)						
National	49	41	10	50	36	14
Pacific	54	35	11	49	32	18
Central	51	40	9	51	36	13
Atlantic	36	56	9	47	45	7

Notes: The data presented do not include incomplete surveys. "All registered" indicates that a farmer had a registered right of all the plots owned, "not all registered" indicates that a farmer did not have a registered right of a least one of the plots owned, "other" comprises any case in which at least one plot was rented or loaned (i.e. at least one plot was not owned).

Source: Authors' own elaboration.

Looking at land tenure according to farm size provides an additional understanding of national trends. First, comparing small and big farms, the latter had a greater proportion of farmers owning land and having a registered right in both 2001 and 2011 (Table 12). Second, the proportion of farmers with 0–7 ha who did not own the land, because they rented it or loaned it, was greater in 2011 than in 2001. Interestingly, most of the additional farmers entering agriculture were in this farm size category and the censuses reflect that a large share of the small farmers entering did not own part of the land they were cultivating or did not have a registered right.

These trends are consistent with hypothesis HN2, although through a different channel than the one suggested. Rather than existing small farmers becoming renters, it seems that small farmers entering agriculture do not have the resources or support to purchase land outright. This will have implications for the crop distribution and income inequality in the future.

TABLE 12 Nicaragua: Classification of farmers according to land tenure by farm size, 2001 and 2011

Farm size	2001				2011			
	Owned		Others	Total	Owned		Others	Total
	All registered	Not all registered			All registered	Not all registered		
Number of farmers								
0–7 ha	39 783	34 588	12 039	86 410	66 699	53 181	31 079	150 959
7.1–35 ha	30 924	30 017	5 028	65 969	36 828	27 676	4 214	68 718
35.1–70 ha	12 813	10 489	1 339	24 641	13 427	8 433	764	22 624
70.1–140 ha	8 063	4 930	682	13 675	7 818	4 030	338	12 186
140.1–350 ha	4 544	1 915	344	6 803	4 392	1 725	181	6 298
>350 ha	1 402	433	115	1 950	1 226	457	78	1 761
Total	97 529	82 372	19 547	199 448	130 390	95 502	36 654	262 546
Distribution (%)								
0–7 ha	46	40	14	100	44	35	21	100
7.1–35 ha	47	46	8	100	54	40	6	100
35.1–70 ha	52	43	5	100	59	37	3	100
70.1–140 ha	59	36	5	100	64	33	3	100
140.1–350 ha	67	28	5	100	70	27	3	100
>350 ha	72	22	6	100	70	26	4	100
Total	49	41	10	100	50	36	14	100

Notes: The data presented do not include incomplete surveys. "All registered" indicates that a farmer had a registered right of all the plots owned, "not all registered" indicates that a farmer did not have a registered right of a least one of the plots owned, "other" comprises any case in which at least one plot was rented or loaned (i.e. at least one plot was not owned).

Source: Authors' own elaboration.

3.4 Labour

The Nicaraguan agricultural censuses provide data on the hired labour, permanent and temporary, used by each farm, as well as the number of household members contributing to farming activities. We also use the data to calculate the number of farmers working on their own farms. To do so, we counted the household heads that directly manage their farms and did not work in any activity outside of the farm. The results are in Table 13. Between 2001 and 2011, the number of farmers (as defined by our measure) increased for farms in the 0–7 ha category. Household labour also had the same trend, with expansion in the farm size category 0–7 ha. Both results are consistent with the entry of small-scale farms into agriculture, as noted in previous sections. This boosted the demand for permanent and temporary labour among small farms (Table 13), so that the ratio of total labour to total area increased from 2001–2011 (Table 14), even though the total land area also increased in the same period.

Permanent and temporary hired labour was higher in 2011 than in 2001, but the temporary labour increased in all farm size categories (Table 13), as did the labour to land

ratio (Table 14). In contrast, the demand for permanent labour increased only in farms with fewer than 35 ha and in farms with at least 350 ha (Table 13).

TABLE 13 Nicaragua: Labour indicators by farm size, 2001 and 2011

Farm size	2001 (units)	2011 (units)	2001–2011 (growth rates, %)	2001 (units)	2011 (units)	2001–2011 (growth rates, %)
	Farmers*			Total household labour**		
0–7 ha	63 450	99 520	57	213 478	407 612	91
7.1–35 ha	54 496	54 925	1	197 014	173 458	-12
35.1–70 ha	20 297	18 365	-10	79 572	50 240	-37
70.1–140 ha	10 408	9 299	-11	45 165	25 523	-43
140.1–350 ha	4 282	4 306	1	21 413	13 651	-36
>350 ha	799	893	12	5 130	3 952	-23
Total	153 732	187 308	22	561 772	674 436	20
	Permanent			Temporary		
0–7 ha	16 233	23 039	42	117 574	262 698	123
7.1–35 ha	27 439	29 381	7	166 811	255 273	53
35.1–70 ha	18 277	17 575	-4	78 586	94 400	20
70.1–140 ha	21 186	18 390	-13	66 601	72 519	9
140.1–350 ha	23 130	20 307	-12	68 138	73 261	8
>350 ha	19 536	23 753	22	54 199	59 444	10
Total	125 801	132 445	5	551 909	817 595	48

Notes: The data presented do not include incomplete surveys. * Farmers is calculated as the heads of the household who directly managing the farm and who did not work in other activities. ** Total household labour corresponds to all the household members older than 12, working on the farm. See Annex 2 for more details.

Source: Authors' own elaboration.

TABLE 14 Nicaragua: Ratio labour units to hectares by farm size, 2001 and 2011

Farm size	2001 (units/ha)	2011 (units/ha)	2001–2011 (growth rates, %)	2001 (units/ha)	2011 (units/ha)	2001–2011 (growth rates, %)
	Permanent			Temporary		
0–7 ha	0.079	0.077	-3	0.574	0.874	52
7.1–35 ha	0.026	0.026	3	0.156	0.230	47
35.1–70 ha	0.016	0.017	2	0.071	0.090	27
70.1–140 ha	0.017	0.017	-5	0.055	0.065	19
140.1–350 ha	0.018	0.016	-7	0.052	0.059	14
>350 ha	0.014	0.019	36	0.039	0.048	22
Total	0.020	0.022	10	0.088	0.135	54

Notes: The data presented do not include incomplete surveys. See Annex 2 for more details.

Source: Authors' own elaboration.

3.5 Mechanization

In this section, we describe trends in mechanization. The agricultural censuses provide information about the use of 24 tools/technologies. We calculated the average ratio of the number of units (for each tool) available for use per hectare of farmland. The results are shown in Table 15 for the tools with the highest use ratio in 2011. For these tools, the ratio increased starkly from 2001 to 2011. In 2001, 0.136 harvesters/ha were used, while in 2011 the ratio was 27.57 harvesters/ha. The reason behind this change was a sharp decrease in the total area of farms using harvesters, which dropped from 197.8 ha to 17.28 ha. The same result occurs for the other tools listed, as shown in Table A6 in the Annex, and for all items when the ratio is calculated by region (Tables A7 to A9).

Among small farms, the results for the ratio units/ha in Table 15 reflect an improvement in access to machinery and tools. However, between 2001 and 2011, the share of farmers using the different technologies increased only in 10 out of the 26 technologies listed (Table 16). Further, the items listed are used only by a small proportion of all farms.

TABLE 15 Nicaragua: Use of agricultural machinery and tools, average ratio units to hectares and average area of farms using the items, for selected items, 2001 and 2011

Item	Average (units/ha)		Average area (ha)	
	2001	2011	2001	2011
Harvester	0.136	27.570	197.80	17.28
Dryer	0.488	19.597	96.43	21.35
Tractor	0.284	13.309	78.92	19.68
Irrigation pumps	0.200	11.536	119.89	22.24
Electric engine	0.147	10.040	149.49	24.02

Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

TABLE 16 Nicaragua: Use of agricultural machinery and tools, percentage of farms using items, for selected items with positive change in the percentage, 2001 and 2011

	Item	Farms using (%)		Growth rates (%)
		2001	2011	2001–2011
1	Grass and sugar cane cutter	1.2	3.0	153.8
2	Electric generator	0.5	1.0	85.1
3	Saw	3.8	6.7	75.4
4	Non-manual fumigating pump	2.8	4.5	62.2
5	Electric engine	1.3	2.0	57.2
6	Dryer	0.3	0.5	56.3
7	Coffee mill	0.4	0.5	42.2
8	Decorticator	0.1	0.1	31.0
9	Irrigation pumps	1.5	2.0	30.4
10	Manual fumigating pump	50.9	57.0	12.1

Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

The patterns of machinery and tool use differ across farm size. Table 17 shows the average ratio units/ha for a set of technologies, for the smallest and biggest farm sizes (Table A10 has the use ratios for all farm size categories). The average size of farms utilizing these technologies decreased not only for farms in the 0–7 ha range, but also for those with more than 350 ha. Generally, farms with more than 350 ha had a greater unit/ha ratio in 2011 than in 2001.

TABLE 17 Nicaragua: Use of agricultural machinery and tools, average ratio units to hectares and average area of farms using the items, for selected items and two farm size categories, 2001 and 2011

Item	Average (units/ha)		Average area (ha)	
	2001	2011	2001	2011
Farm size: 0–7 ha				
Harvester	0.548	38.683	3.29	1.72
Dryer	1.335	33.060	3.25	2.23
Tractor	0.597	19.014	2.89	1.73
Irrigation pumps	0.561	17.551	3.09	1.76
Electric engine	0.641	17.126	3.20	2.00
Rice mill	0.646	16.402	3.25	1.80
Non-manual fumigating pump	0.631	14.772	3.10	2.07
Truck	0.868	14.743	2.90	1.93
Agricultural wagon	0.723	14.015	2.88	1.92
Wood plough	0.650	12.610	2.86	1.93
Farm size: >350 ha				
Dryer	0.003	0.004	967.43	567.20
Harvester	0.003	0.003	1 109.22	525.08
Electric engine	0.004	0.003	974.68	590.35
Manual fumigating pump	0.007	0.003	671.95	666.62
Truck	0.003	0.003	1 028.70	493.32
Electric generator	0.003	0.003	1 066.06	659.49
Non-manual fumigating pump	0.006	0.003	895.09	616.17
Boat	0.004	0.003	1 243.03	795.97
Wood plough	0.004	0.003	630.09	761.34
Pulper machine	0.004	0.002	621.35	542.07

Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

For farms smaller than 7 ha and larger than 350 ha, Table 18 shows the percentage of farms using the different technologies, when the usage rate is at least 2 percent in 2011 (Table A10 presents all the technologies). In the 0–7 ha category, the 2011 technology usage

rate was higher than in 2001 for all tools except wood plough, tractors and threshing machines (manual) (not shown in Table 18). In contrast, among farms with more than 350 ha, the usage rate decreased for all tools. As a result, in 2011 the proportion of farms using the items was similar, across these two farm size categories, while in 2001, the farms with more than 350 ha used the items at a higher rate.

TABLE 18 Nicaragua: Percentage of farms using agricultural machinery and tools, for selected items and two farm size categories, 2001 and 2011

Item	Farm size: 0–7 ha (%)		Farm size: >350 ha (%)	
	2001	2011	2001	2011
Manual fumigating pump	43.6	55.0	77.0	57.5
Saw	0.9	4.6	27.9	11.4
Agricultural wagon	9.9	12.2	28.3	11.1
Wood plough	19.9	12.9	21.4	9.0
Non-manual fumigating pump	1.6	4.4	13.4	5.8
Truck	2.1	4.0	29.0	4.8
Grass and sugar cane cutter	0.2	2.5	10.8	4.5
Irrigation pumps	1.0	2.2	10.7	2.9
Pulper machine	6.9	7.7	6.7	2.7
Electric engine	0.5	2.0	12.2	2.7
Tractor	3.6	2.5	19.0	2.4
Iron plough	2.6	2.7	9.7	2.3
Boat			6.9	2.6

Note: The data presented do not include incomplete surveys.
Source: Authors' own elaboration.

4 Peru

KEY MESSAGES

- Total agricultural land increased about 10 percent in Peru over the last two decades.
- The principal crops cultivated in Peru are corn, potatoes, coffee and rice, which covered about half of all cultivated land by 2012.
- These two trends were complemented with increases both in agricultural labour and mechanization.
- Overall, the analysis suggests that little to no structural change occurred in Peru between 1994 and 2012: despite a slight increase in the share of land devoted to non-agricultural uses, the share devoted to agricultural uses increased much more, and while total household labour decreased overall, the number of farmers has increased over time.

This section analyses Peru's agricultural censuses (1994 and 2012) with respect to i) land use and crops; ii) farm size distribution; iii) land tenure; iv) labour; and v) mechanization. Over two decades, Peru saw its total agricultural land increase by about 10 percent. The distribution within the total was skewed towards land allocated for "permanent use" (perennial cultivation), which more than doubled its share, a trend experienced in all regions. The shift in land use correlates with the principal crops cultivated in Peru (corn, potatoes, coffee and rice), which comprised about half of all cultivated land by 2012. However, more agricultural land and increased cultivation did not translate into a more equal distribution of farmland. In particular, land shifted from the smallest farms (less than 7 ha) to larger farms. As noted in Section 3, trends in land distribution and use were probably affected by changes in land tenure. While the overall share of farms with registered land rights increased, a higher share of large farms (greater than 350 ha) reported having registered rights than small farms, in both 1994 and 2012. Increases in total land and cultivation correlated with increases in labour (Section 4), a doubling or more in the number of temporary farm employees, across size categories, which was accompanied by an increase in mechanization (Section 5).

4.1 Trends in land use and crops

In Peru, the total land allocated to agricultural units (farms) amounted to 38.7 million hectares in 2012, with the land mainly devoted to non-managed natural pastures, forests and arable land (Table 19; Table A5 provides the regional details). Between 1994 and 2012, the main change was the increase in land allocated towards permanent uses, especially the area for permanent crops. The area in managed natural pastures also expanded. In contrast, the following uses experienced a contraction: associated crops, annual crops and other non-agricultural uses.

TABLE 19 Peru: Distribution of total agricultural land by uses, 1994 and 2012

Use	1994 (ha)	2012 (ha)	1994–2012 (growth rates, %)
Agricultural uses	**3 277 854.7**	**4 155 678.1**	**26.8**
Annual crops	2 115 226.3	1 912 989.4	-9.6
Permanent crops	494 137.3	1 234 632.7	149.9
Associated crops	270 310.2	229 994.1	-14.9
Cultivated pastures	398 181.0	778 061.9	95.4
Natural pastures	**16 906 470.5**	**18 018 794.9**	**6.6**
Managed natural pastures	628 245.0	1 559 337.5	148.2
Non-managed pastures	16 278 225.6	16 459 457.4	1.1
Fallow lands	**2 199 121.9**	**2 969 329.7**	**35.0**
Fallow lands (to be cropped)	936 246.1	1 431 640.1	52.9
Other fallow lands	550 957.2	762 807.3	38.5
Not cropped agricultural land	711 918.6	774 882.3	8.8
Non-agricultural use	**12 998 362.0**	**13 598 662.5**	**4.6**
Forests	9 053 705.6	10 939 274.6	20.8
Other	3 944 656.4	2 659 388.0	-32.6
Total agricultural land	**35 381 809.2**	**38 742 465.1**	**9.5**

Notes: Among the fallow category there are three uncultivated type of uses: i) fallow lands; ii) to be cropped, which is land that will be cultivated within the agricultural year; and iii) not to be cultivated, which is land that the farmers cannot cultivate due to different reasons as lack of water, lack of credit and others.

Source: Authors' own elaboration.

Table 20 depicts the area devoted to the different uses, disaggregated by region. In 2012, the Selva region contained 31.1 percent of the total area dedicated to permanent crops in the country, while the other regions contained 43.0 percent (Sierra region) and 25.9 percent (Costa region). With respect to annual crop area, the Selva region only contributed 13.7 percent in 2012, with the majority in the Costa (38.7 percent) and Sierra (47.6 percent) regions. Between 1994 and 2012 all regions saw growth in the area allocated to permanent crops, with the largest change occurring in the Selva region. Nationally and in the Selva and Sierra regions, the area of annual crops dropped, while in the Costa region, the area increased 27.3 percent from 1994 to 2012. Natural pastures and forests expanded in all the regions, but natural pastures were mainly located in Costa and Sierra regions, while most of the forests were in Selva and Sierra regions (Table 20).

In Table 21, we show the top 20 crops, which comprised 83 percent of the total area devoted to annual and permanent crops. Four crops (corn, coffee, potatoes and rice) comprised 46 percent of the cultivated area in 1994. Each one of these crops was allocated more area in 2012: together, they reached 49 percent of the total cultivated area. Additionally, the following crops at least doubled in area between 1994 and 2012: cacao, avocado, grapes, asparagus and mangoes. These results are somewhat consistent with hypothesis HP2. Although the same crops dominated in 1994 and 2012, the additional area allocated to them could indicate the transition away from illegal crops to legal products.

TABLE 20 Peru: Distribution of total agricultural land in regions by uses, 1994 and 2012

Use	1994 (ha)			2012 (ha)			1994–2012 (growth rates, %)		
	Selva	Coast	Sierra	Selva	Coast	Sierra	Selva	Coast	Sierra
Agricultural uses	**21.7**	**25.6**	**52.7**	**22.2**	**32.9**	**44.9**	**30.0**	**63.0**	**7.9**
Annual crops	18.7	27.5	53.8	13.7	38.7	47.5	-33.6	27.3	-20.1
Permanent crops	18.4	21.0	60.6	31.1	25.9	43.0	321.7	208.6	77.2
Associated crops	24.3	20.7	55.0	31.3	21.6	47.1	9.5	-11.2	-27.1
Cultivated pastures	39.7	24.3	36.0	26.3	32.9	40.8	29.4	164.7	121.3
Natural pastures	**2.2**	**35.3**	**62.4**	**3.0**	**37.4**	**59.6**	**42.5**	**12.9**	**1.7**
Managed natural pastures	13.5	18.8	67.8	13.2	23.6	63.2	142.9	212.4	131.5
Non-managed pastures	1.8	36.0	62.2	2.0	38.7	59.2	13.7	8.8	-3.7
Fallow lands	**14.2**	**23.6**	**62.2**	**11.1**	**34.2**	**54.6**	**6.1**	**95.3**	**18.7**
Fallow lands (to be cropped)	10.2	32.1	57.7	13.3	36.6	50.1	98.6	74.4	32.9
Other fallow lands	0.0	16.4	83.6	0.9	21.2	77.9	5102.8	79.5	29.0
Not cropped agricultural land	30.4	18.2	51.4	17.3	42.6	40.1	-38.0	154.7	-15.1
Non-agricultural use	**48.8**	**21.7**	**29.6**	**55.4**	**15.1**	**29.5**	**18.7**	**-27.0**	**4.5**
Forests	67.7	7.8	24.5	67.8	7.3	24.9	21.0	13.2	22.8
Other	5.3	53.5	41.1	4.2	47.3	48.5	-46.9	-40.5	-20.5
Total agricultural land	**21.9**	**28.7**	**49.4**	**24.1**	**28.9**	**47.1**	**20.4**	**10.2**	**4.3**

Notes: Among the fallow category there are three uncultivated type of uses: i) fallow lands; ii) to be cropped, which is land that will be cultivated within the agricultural year; and iii) not to be cultivated, which is land that the farmers cannot cultivate due to different reasons as lack of water, lack of credit and others.

Source: Authors' own elaboration.

TABLE 21 Peru: Area and contribution to the total cultivated land of main crops, 1994–2012

Crop	Area (ha)		Growth rates (%)	Contribution (%)	
	1994	2012	1994–2012	1994	2012
Corn	483 853	575 737	19	18.8	18.5
Coffee	203 033	425 416	110	7.9	13.7
Potatoes	341 590	367 657	8	13.3	11.8
Rice	135 405	167 093	23	5.3	5.4

TABLE 21 (cont.) Peru: Area and contribution to the total cultivated land of main crops, 1994–2012

Crop	Area (ha)		Growth rates (%)	Contribution (%)	
	1994	2012	1994–2012	1994	2012
Sugar cane	125 201	151 809	21	4.9	4.9
Plantain	154 851	145 737	-6	6.0	4.7
Cacao	48 768	144 232	196	1.9	4.6
Cassava	129 415	94 646	-27	5.0	3.0
Fodder/feed crops	35 803	82 317	130	1.4	2.7
Avocado	7 852	65 658	736	0.3	2.1
Broad beans	55 942	45 787	-18	2.2	1.5
Barley	125 848	45 367	-64	4.9	1.5
Wheat	98 615	45 249	-54	3.8	1.5
Beans	39 715	44 288	12	1.5	1.4
Grapes	10 731	43 820	308	0.4	1.4
Asparagus	15 041	39 629	163	0.6	1.3
Mangoes	9 087	39 036	330	0.4	1.3
Pea	32 294	31 214	-3	1.3	1.0
Cotton	87 998	27 141	-69	3.4	0.9
Palm	8 691	26 740	208	0.3	0.9
Total annual + permanent	2 576 777	3 103 839	20		

Source: Authors' own elaboration.

4.2 Farm size distribution

The farm size distribution was more unequal in 2012 than in 1994 (Table 22). The Gini index increased nationally and in every region. Further, compared to 1994, the share of producers with farms smaller than 7 ha increased in 2012, while for all farms larger than 7 ha, the share of producers in these categories dropped. Nationally the share of land in farms smaller than 350 ha decreased, with the Sierra and Costa regions following the national trend. In the Selva region, the trend differed slightly, with the share of area in farms with 0–7 ha increasing, instead of decreasing.

The changes observed in the farm size distribution reflect a reconfiguration in Peruvian agriculture. Between 1994 and 2012, the number of farms increased by 28.1 percent, nearly 500 000 "new" farms (Table 23). However, the aggregate figure hides the fact that the number of farms increased only in the 0–7 ha category, while in the other categories, the number of farms decreased, especially in the 7–35 ha range.

The concentration of land in farms with more than 350 ha is due to the additional area accrued by the biggest farms (Table 22). The national median size for farms larger than 350 ha increased by 3 percent between 1994 and 2012 (Table 24). In the Selva and Sierra regions, the median farm size in this category was also greater in 2012 than in 1994, but in the Costa region, the median farm size dropped for the farms with more than 350 ha.

TABLE 22 Peru: Indicators of farm size distribution, 1994 and 2012

	National		Selva		Costa		Sierra	
	1994	2012	1994	2012	1994	2012	1994	2012
Land (Gini index)	0.90	0.93	0.87	0.90	0.92	0.95	0.89	0.92
Share of producers (%)								
0–7 ha	80.04	86.54	55.33	65.74	88.01	92.88	81.20	87.74
7.1–35 ha	16.03	10.69	35.13	27.48	10.02	5.85	15.08	9.60
35.1–70 ha	2.00	1.42	6.19	4.68	0.67	0.39	1.79	1.25
70.1–140 ha	0.92	0.61	2.22	1.34	0.43	0.23	0.89	0.64
140.1–350 ha	0.54	0.38	0.66	0.36	0.43	0.28	0.56	0.43
>350 ha	0.48	0.36	0.48	0.40	0.45	0.38	0.49	0.34
Share of land area (%)								
0–7 ha	8.57	8.15	4.29	4.94	9.47	8.33	9.90	9.57
7.1–35 ha	11.75	9.21	14.70	12.59	6.55	4.47	12.94	9.92
35.1–70 ha	4.91	4.09	7.78	6.36	1.71	1.18	5.21	4.43
70.1–140 ha	4.44	3.47	5.40	3.55	2.19	1.39	5.09	4.44
140.1–350 ha	5.82	4.79	3.57	2.07	5.03	3.94	7.11	6.47
>350 ha	64.51	70.29	64.27	70.48	75.05	80.70	59.76	65.15

Source: Authors' own elaboration.

TABLE 23 Peru: Absolute changes in farms and area by farm size, between 1994 and 2012

Farm size	Farms (thousands)	Area (ha)
0–7 ha	544.0	126.8
7.1–35 ha	-41.3	-587.8
35.1–70 ha	-3.1	-154.4
70.1–140 ha	-2.3	-225.7
140.1–350 ha	-0.8	-205.1
>350 ha	-0.4	4 406.8
Total	496.1	3 360.7

Source: Authors' own elaboration.

For farms in intermediate categories (between 7 ha and 350 ha), the trend in median farm size differed across regions. In the Selva region, the median farm size either decreased or remained the same. In the Sierra region, the median farm size either increased or was unchanged. In the Costa region, there was a small decrease in the median size for farms with 7–35 ha. For farms in the 35–70 ha and 140–350 ha categories the median size increased, especially in the latter category, while the median farm size in the 70–140 ha category did not change.

These results are somewhat consistent with hypothesis HP1. Although Peru experienced an unambiguous increase in land inequality between 1994 and 2012, the impact on median farm size is not so straightforward. Land concentration generally increased the median farm size for the largest farms, but the influx of famers into agriculture had distinct effects on median farm size, depending on the region and farm size category.

TABLE 24 Peru: Median farm size, 1994 and 2012

	National (ha)		Selva (ha)		Costa (ha)		Sierra (ha)	
Farm size	1994	2012	1994	2012	1994	2012	1994	2012
0–7 ha	1.6	1.0	3.0	2.0	1.5	1.0	1.5	1.0
7.1–35 ha	12.0	12.0	14.5	14.5	10.5	10.0	12.0	12.0
35.1–70 ha	49.6	50.0	50.0	48.0	49.0	50.0	49.0	50.0
70.1–140 ha	98.1	97.5	96.0	90.0	100.0	100.0	97.5	99.5
140.1–350 ha	200.0	200.0	200.0	200.0	203.0	215.0	200.0	200.0
>350 ha	949.7	980.0	2 440.1	2 605.0	928.8	860.0	860.4	900.0

Source: Authors' own elaboration.

4.3 Land tenure

In Peru, changes in land tenure legislation were likely drivers of trends in land use, the entry of producers into agriculture, the addition of area into agriculture and the crop distribution. Nationally, there were three distinct changes in land tenure. First, the proportion of farmers with a communal right decreased from 27 percent to 14 percent. Second, the share of farmers with a registered right increased from 17 percent to 25 percent. Third, there were more farmers with other types of tenure (e.g. renting land) in 2012 (16 percent) than in 1994 (10 percent). The changes in the Costa and Sierra regions followed the national pattern. In contrast, in the Selva region, the percentage of farmers with a communal right decreased only slightly (from 18 percent to 16 percent), and the percentage of farmers with registered right increased from 11 percent to 52 percent (Table 25). Analysis of land tenure by farm size (Table 26) reveals that a lower proportion of small farmers own the land. For example, in 2012, nearly 90 percent of farms larger than 350 ha were owned outright; in contrast, the ownership rate was less than 70 percent for farms under 7 ha. Between 1994 and 2012, the share of farmers with communal rights decreased, while the share with other types of tenure increased, in all size categories (Table 26).

TABLE 25 Peru: Description of national and regional distribution of farms according to land tenure, 1994 and 2012

Region	1994				2012			
	Owned		Communal right	Others	Owned		Communal right	Others
	All registered	Not all registered			All registered	Not all registered		
Number of farms								
National	303 070	805 897	468 635	168 172	545 156	990 564	310 642	364 606
Selva	22 474	101 493	35 608	36 410	131 494	41 757	40 551	41 047
Costa	109 562	192 455	97 579	44 399	168 093	217 572	62 312	125 800
Sierra	171 034	511 949	335 448	87 363	245 569	731 235	207 779	197 759
Distribution (%)								
National	17	46	27	10	25	45	14	16
Selva	11	52	18	19	52	16	16	16
Costa	25	43	22	10	29	38	11	22
Sierra	15	46	30	8	18	53	15	14

Notes: "All registered" indicates that a farmer had a registered right of all the plots owned, "not all registered" indicates that a farmer did not have a registered right of a least one of the plots owned, "communal right" means that the farmers owns at least one plot with right that is collective; "other" comprises any case in which at least one plot was rented or loaned (i.e. at least one plot was not owned).

Source: Authors' own elaboration.

TABLE 26 Peru: Distribution of farms according to land tenure by farm size, 1994 and 2012

Farm size	1994					2012				
	Owned		Communal right	Others	Total	Owned		Communal right	Others	Total
	All registered	Not all registered				All registered	Not all registered			
Number of farms										
0–7 ha	234 047	628 453	395 268	135 806	1 257 768	448 067	879 475	270 001	320 335	1 597 543
7.1–35 ha	51 352	142 344	62 661	26 507	256 357	76 562	87 935	33 052	35 730	197 549
35.1–70 ha	7 330	18 489	6 072	3 340	31 891	10 779	10 007	4 677	4 779	25 463
70.1–140 ha	3 764	8 147	2 878	1 396	14 789	4 201	5 267	1 808	1 967	11 276
140.1–350 ha	2 648	4 575	1 399	822	8 622	2 571	4 009	823	1 053	7 403
>350 ha	3 929	3 889	357	301	8 175	2 976	3 871	281	742	7 128
Total	303 070	805 897	468 635	168 172	1 577 602	545 156	990 564	310 642	364 606	1 846 362

TABLE 26 (cont.) Peru: Distribution of farms according to land tenure by farm size, 1994 and 2012

Farm size	1994					2012				
	Owned		Communal right	Others	Total	Owned		Communal right	Others	Total
	All registered	Not all registered				All registered	Not all registered			
Distribution (%)										
0–7 ha	17	45	28	10	100	23	46	14	17	83
7.1–35 ha	18	50	22	9	100	33	38	14	15	85
35.1–70 ha	21	52	17	9	100	36	33	15	16	84
70.1–140 ha	23	50	18	9	100	32	40	14	15	85
140.1–350 ha	28	48	15	9	100	30	47	10	12	88
>350 ha	46	46	4	4	100	38	49	4	9	91
Total	17	46	27	10	100	25	45	14	16	84

Notes: "All registered" indicates that a farmer had a registered right of all the plots owned, "not all registered" indicates that a farmer did not have a registered right of a least one of the plots owned, "communal right" means that the farmers owns at least one plot with right that is collective; "other" comprises any case in which at least one plot was rented or loaned (i.e. at least one plot was not owned).

Source: Authors' own elaboration.

4.4 Labour

The expansion in the number of farms that occurred exclusively among farms with less than 7 ha (noted in Section 4.2) was accompanied by an expansion in the number of farmers within this category. In other categories, the number of farmers decreased between 1994 and 2012 (Table 27). We derived the number of farmers by counting the individual producers who did not earn additional income from activities outside the farm. We also calculated if other household members were involved in agricultural activities on the farm. In the period of study, the number of household members involved decreased for all farms, including those with less than 7 ha.

Apart from relying on household labour, farms also utilized paid labour (Table 28). The amount of paid permanent labour is relatively small, compared with the number of farmers and the amount of paid temporary labour. The use of paid permanent labour decreased in farms with less than 35 ha and increased among the other categories. In contrast, between 1994 and 2012, every farm size category saw the use of paid temporary labour increase at a fast rate.

We also calculated the ratio of employed labour units per hectare (Table 28). The employment ratio for paid permanent labour increased only in farms above 70 ha. The ratio of paid temporary labour to area increased for all farms.

TABLE 27 Peru: Labour indicators by farm size, 1994 and 2012

Farm size	1994 (units)	2012 (units)	1994–2012 (growth rates, %)	1994 (units)	2012 (units)	1994–2012 (growth rates, %)
	Farmers*			Total household labour**		
0–7 ha	1 006 400	1 134 727	13	3 311 874	2 195 100	-34
7.1–35 ha	210 350	150 229	-29	776 881	320 338	-59
35.1–70 ha	24 943	19 393	-22	97 272	41 758	-57
70.1–140 ha	10 832	7 866	-27	43 981	17 770	-60
140.1–350 ha	5 285	4 514	-15	24 086	10 894	-55
>350 ha	1 720	1 814	5	8 651	4 501	-48
Total	1 259 530	1 318 543	5	4 262 745	2 590 361	-39
	Permanent			Temporary		
0–7 ha	96 809	57 172	-41	4 997 469	9 600 152	92
7.1–35 ha	56 400	36 541	-35	1 893 209	3 393 624	79
35.1–70 ha	11 281	13 205	17	230 134	450 342	96
70.1–140 ha	7 376	10 605	44	94 642	190 574	101
140.1–350 ha	5 185	14 299	176	45 975	125 450	173
>350 ha	17 789	48 756	174	42 305	107 248	154
Total	194 840	180 578	-7	7 303 734	13 867 390	90

Notes: * Farmers is calculated as heads of the household directly managing the farm and who do not work to get off-farm income. ** Household labour is calculated as members of the household older than 15 working on the farm and it does not include the head. More information about the definitions of labour are Annex 2.

Source: Authors' own elaboration.

TABLE 28 Peru: Ratio labour units to hectares by farm size, 1994 and 2012

Farm size	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %)	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %)
	Permanent			Temporary		
0–7 ha	0.031	0.018	-41	1.649	3.040	84
7.1–35 ha	0.016	0.010	-35	0.455	0.951	109
35.1–70 ha	0.007	0.008	17	0.132	0.284	115
70.1–140 ha	0.005	0.008	44	0.060	0.142	135
140.1–350 ha	0.003	0.008	176	0.022	0.068	203
>350 ha	0.001	0.002	174	0.002	0.004	112
Total	0.005	0.005	-7	1.159	0.358	-69

Note: More information about the definitions of labour are in Annex 2.

Source: Authors' own elaboration.

4.5 Mechanization

For additional insight on trends in Peruvian agriculture, we turn to the ownership of agricultural tools and machinery. The agricultural census allows a comparison of eight different items (Table 29). Overall, between 1994 and 2012, the share of farmers owning these items, and the ratio of technological units used per hectare (the use ratio) increased, indicating a process of mechanization. The exceptions were (Tables 30, 31 and 32):

- Chaquitaclla (Andean foot plough): The share of farmers owning this tool, but not the average ratio of units per hectare, decreased nationally and in the Costa and Sierra regions. The share of farmers owning chaquitacllas and the use ratio decreased in all the farm size categories above 7 ha, while in farms with less than 7 ha, the share of use decreased and the average ratio units/area increased (Tables 30, 31 and 32).
- Plough: Nationally and across the regions, the percentage of farmers owning ploughs, made of iron or wood, decreased, except for iron ploughs in the Sierra region. The ownership rate for both plough technologies decreased for all farms. The use ratio for both plough types also decreased, except among farms under 70 ha and with more than 350 ha; iron plough use increased in the 7–35 ha category.
- Non-manual fumigating pump: The use ratio decreased at the national level, due to decreases in the 0–7 ha farm size category and for all farms in the Costa region.
- Manual fumigating pump: The use ratio decreased in Selva region; the ownership rate dropped among farms with more than 350 ha.
- Well pump: The national decrease in the use ratio was driven by the Costa region and farms smaller than 140 ha.
- Truck: The use ratio decreased in the Selva region. The share of farmers owning this item decreased in the Sierra region and among farmers with more than 350 ha.
- Grain mill: The use ratio decreased in all farms above 35 ha, except for the 140–350 ha category, in which it remained the same.

TABLE 29 Peru: Shares of farms owning equipment and average units per hectare by item, 1994 and 2012

Item	Share of farmers			Average units/ha*		
	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %
Manual fumigating pump	17.0	32.6	92	1.57	2.40	53
Chaquitacllas	22.5	16.5	-27	2.49	6.23	150
Grain mill	1.5	3.2	116	0.52	1.48	187
Iron plough	4.0	3.1	-24	1.60	2.01	26
Wood plough	32.0	3.1	-90	1.46	3.38	131
Non-manual fumigating pump	1.0	2.5	149	1.43	0.93	-35
Truck	1.6	1.7	3	0.84	1.34	60
Well pump	0.4	0.7	76	1.17	1.11	-5

Note: * Units per hectare are calculated at the farm level and averaged over the farms with positive ownership.
Source: Authors' own elaboration.

TABLE 30 Peru: Regional shares of farms owning equipment and average units per hectare by item, 1994 and 2012

Item	Share of farmers			Average units/ha*		
	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %
Selva						
Manual fumigating pump	14.3	29.6	106	0.76	0.37	-51
Grain mill	2.3	5.0	119	0.22	0.39	77
Non-manual fumigating pump	0.8	2.8	236	0.17	0.38	125
Iron plough	1.9	0.9	-54	0.20	0.41	103
Wood plough	6.3	0.9	-86	0.34	0.51	51
Truck	0.6	0.8	41	0.34	0.24	-29
Well pump	0.1	0.3	426	0.11	0.35	210
Chaquitacllas	0.2	0.3	37	1.31	3.90	199
Costa						
Manual fumigating pump	25.9	43.4	68	2.21	3.66	66
Iron plough	11.1	7.3	-34	1.76	1.98	12
Wood plough	23.1	7.3	-68	2.24	5.80	159
Non-manual fumigating pump	2.7	6.6	145	1.81	0.94	-48
Chaquitacllas	6.4	4.1	-36	3.99	7.97	100
Truck	3.2	3.4	4	0.88	1.54	75
Well pump	1.1	1.5	42	1.47	0.90	-39
Grain mill	0.7	1.0	39	1.09	3.04	180
Sierra						
Manual fumigating pump	13.8	28.7	107	1.24	2.00	61
Chaquitacllas	33.0	24.6	-25	2.38	6.12	157
Grain mill	1.6	3.8	130	0.49	1.57	223
Iron plough	1.6	1.7	8	1.44	2.23	55
Wood plough	40.1	1.7	-96	1.31	2.82	115
Truck	1.2	1.1	-2	0.83	1.25	50
Non-manual fumigating pump	0.4	0.8	112	0.80	1.30	63
Well pump	0.2	0.4	135	0.49	1.56	216

Note: * Units per hectare are calculated at the farm level and averaged over the farms with positive ownership.
Source: Authors' own elaboration.

TABLE 31 Peru: Shares of farms owning equipment and average units per hectare by farm size and item, 1994 and 2012

Item	Share of farmers			Average units/ha*		
	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %
Farm size: 0–7 ha						
Manual fumigating pump	15.5	31.0	101	2.119	2.893	37
Chaquitacllas	24.1	16.8	-30	2.884	7.023	144
Iron plough	3.9	3.1	-22	2.031	2.301	13
Wood plough	32.6	3.1	-91	1.756	3.697	111
Grain mill	1.0	2.7	171	0.911	2.028	123
Non-manual fumigating pump	0.7	2.0	185	2.490	1.299	-48
Truck	1.2	1.2	7	1.425	2.081	46
Well pump	0.3	0.5	64	1.846	1.670	-9
Farm size: 7.1–35 ha						
Manual fumigating pump	23.3	45.0	93	0.118	0.130	10
Chaquitacllas	16.5	14.4	-13	0.191	0.169	-12
Grain mill	3.5	6.8	93	0.087	0.086	-1
Non-manual fumigating pump	2.1	5.8	177	0.099	0.126	27
Truck	3.2	4.4	39	0.092	0.096	4
Iron plough	5.0	3.3	-35	0.119	0.122	2
Wood plough	32.3	3.3	-90	0.167	0.152	-9
Well pump	0.7	1.7	140	0.105	0.099	-5
Farm size: 35.1–70 ha						
Manual fumigating pump	23.5	41.0	74	0.033	0.037	13
Chaquitacllas	14.7	13.4	-8	0.048	0.043	-10
Grain mill	3.9	7.4	91	0.026	0.024	-7
Non-manual fumigating pump	2.6	5.3	103	0.031	0.038	23
Truck	4.3	4.7	11	0.028	0.029	4
Iron plough	2.9	2.2	-25	0.034	0.031	-9
Wood plough	20.5	2.2	-89	0.045	0.040	-10
Well pump	0.8	1.9	132	0.031	0.031	-2
Farm size: 7.01–140 ha						
Manual fumigating pump	22.6	36.6	62	0.018	0.022	25

TABLE 31 (cont.) **Peru: Shares of farms owning equipment and average units per hectare by farm size and item, 1994 and 2012**

Item	Share of farmers			Average units/ha*		
	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %	1994 (units/ha)	2012 (units/ha)	1994–2012 (growth rates, %
Chaquitacllas	17.7	14.9	-16	0.024	0.022	-9
Non-manual fumigating pump	3.3	6.9	112	0.016	0.020	29
Grain mill	3.3	6.8	102	0.013	0.013	-5
Truck	4.8	5.8	22	0.014	0.015	6
Well pump	0.7	2.7	292	0.022	0.019	-14
Iron plough	2.3	1.9	-21	0.020	0.015	-23
Wood plough	17.0	1.9	-89	0.023	0.020	-13
Farm size: 140.1–350 ha						
Manual fumigating pump	17.6	23.1	31	0.009	0.014	56
Chaquitacllas	17.7	12.6	-29	0.012	0.011	-13
Truck	5.4	6.3	16	0.007	0.010	39
Non-manual fumigating pump	2.7	5.8	114	0.008	0.011	32
Grain mill	2.8	4.0	42	0.006	0.006	0
Well pump	0.6	2.8	369	0.012	0.012	4
Iron plough	1.9	1.3	-32	0.010	0.009	-10
Wood plough	11.9	1.3	-89	0.012	0.010	-17
Farm size: >350 ha						
Manual fumigating pump	16.6	14.6	-12	0.002	0.006	153
Chaquitacllas	9.7	7.2	-26	0.006	0.005	-28
Truck	7.6	5.5	-27	0.001	0.004	157
Non-manual fumigating pump	2.5	3.4	38	0.002	0.004	143
Well pump	0.3	2.4	616	0.004	0.006	55
Grain mill	2.4	2.3	-6	0.002	0.002	-3
Iron plough	2.5	2.1	-16	0.002	0.005	89
Wood plough	7.4	2.1	-71	0.004	0.004	2

Note: * Units per hectare are calculated at the farm level and averaged over the farms with positive ownership.
Source: Authors' own elaboration.

With respect to tractors, the available information is about use, in contrast with ownership, as in the case of the other agricultural tools and machines. The use of tractors is shown in Table 32. for every farm size and region. In all the cases, the percentage of farms increased between 1994 and 2012, except in Selva region among the farms with more than 350 ha. In sum, this evidence also indicates a process of mechanization.

TABLE 32 Peru: Shares of farms using tractors by farm size, 1994 and 2012

Farm size	1994 (units)	2012 (units)	1994–2012 (growth rates, %)	1994 (units)	2012 (units)	1994–2012 (growth rates, %)
	National			Selva		
0–7 ha	11.0	22.3	102	1.4	4.3	207
7.1–35 ha	12.7	23.5	85	2.9	5.1	74
35.1–70 ha	9.0	16.0	77	2.7	4.0	44
70.1–140 ha	8.4	17.0	102	3.2	6.0	85
140.1–350 ha	7.8	14.5	86	5.2	7.5	46
>350 ha	9.9	12.4	25	4.8	2.6	-46
Total	11.2	22.3	99	2.1	4.5	116
	Costa			Sierra		
0–7 ha	16.9	28.9	71	9.6	21.9	128
7.1–35 ha	32.7	55.3	69	11.4	25.2	121
35.1–70 ha	30.0	40.9	36	9.7	21.1	118
70.1–140 ha	18.3	31.5	72	8.8	19.1	117
140.1–350 ha	7.3	19.3	165	8.5	14.3	68
>350 ha	6.9	14.0	103	11.9	13.8	15
Total	18.5	30.4	65	9.9	22.1	124

Source: Authors' own elaboration.

5 Comparative analysis and policy discussion

KEY MESSAGES

- Peru and Nicaragua experienced similar alternating periods of non-democratic and democratic governments, which affected the agricultural sector through access to land (land reform policies), market integration, wages and labour supply.
- The process of agricultural structural transformation was similar in Nicaragua and Peru. However, the main difference stems from the stability of land tenancy rights, especially for small farmers. In Peru a lower rate of registered rights in the 0–7 ha category translated to a reliance on temporary labour; in Nicaragua, where tenancy rights are stronger, small farmers utilize both permanent and temporary labour.
- A recommendation for Nicaragua and Peru to continue their sustainable and equitable agricultural transformation is to increase sustainability of land use, land security and job security for agricultural employees.

In the final section of this report, we undertake a comparative analysis, to understand the similarities and differences of structural transformation in Peru and Nicaragua. We then outline a series of policy options to ensure those employed in the sector are not only supported but thrive in agriculture.

5.1 Comparative analysis

Peru and Nicaragua have faced similar growth and development paths. Both countries experienced alternating periods of non-democratic and democratic governments, which affected the agricultural sector through access to land (land reform policies), market integration and wages/labour supply. This section compares the process of agricultural structural transformation in both countries.

Trends in land use

In both countries three agricultural regions are identified: i) a coastal region (Pacific in Nicaragua and Coast in Peru), which in both countries is characterized by dry conditions; ii) a central region (Central in Nicaragua and Sierra in Peru), with land of higher altitudes vis-à-vis the other two regions; and iii) a western region (Atlantic in Nicaragua and Selva in Peru), which can be characterized as "frontier agricultural" regions.

Farmland decreased in Nicaragua, by around 4 percent nationally, and in all agricultural regions, with the largest decrease in the Pacific Region (close to 7 percent). On the contrary, farmland in Peru increased, nationally by around 7 percent, with the largest increase in the Selva region at just over 20 percent. However, both countries experienced net increases in

the total amount of land dedicated to agricultural uses: in Nicaragua about 7 percent, and in Peru about 27 percent; but the mechanism of expansion differed across the countries. At the national level, agricultural land in Nicaragua increased through deforestation and a reduction in fallow land, which were then used for annual/permanent crops and pastures (Table 1). In Peru, both fallow land and forest land increased, but land allocated for annual crops decreased by 10 percent, land used for associated crops decreased by nearly 15 percent, and land in the "residual" category other uses in non-agricultural uses decreased by almost 33 percent (Table 19).

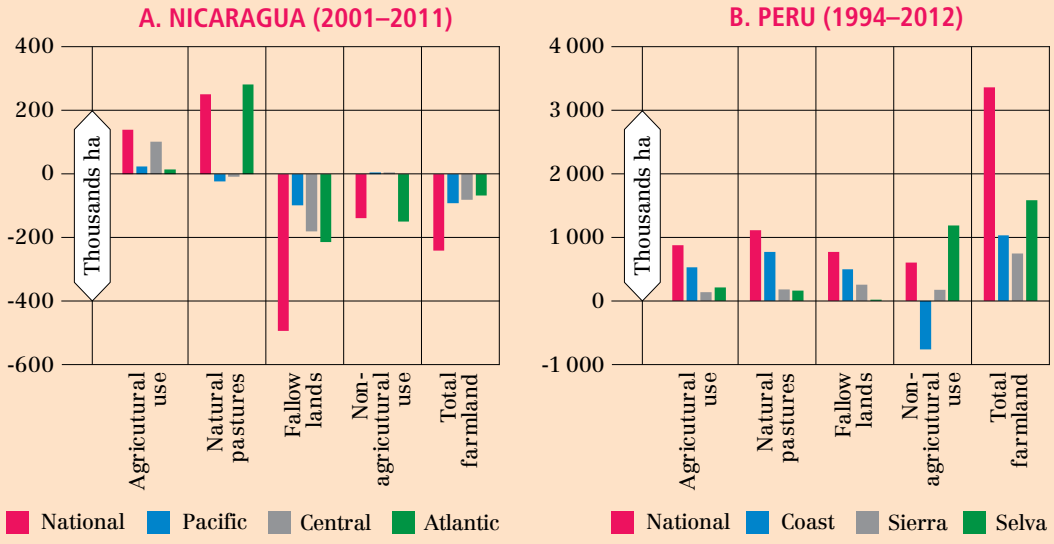
Table 33 and Figure 6 summarize the trends in land use in Nicaragua and Peru, at the national level, and by region.

TABLE 33 Nicaragua and Peru: Summary of trends in land use categories by region

Item	Nicaragua (2001–2011)				Peru (1994–2012)			
	National	Pacific	Central	Atlantic	National	Coast	Sierra	Selva
Agricultural land (farmland)	↓	↓	↓	↓	↑	↑	↑	↑
In agricultural uses	↑	↑	↑	↑	↑	↑	↑	↑
Annual crops	↑	↑	↑	↓	↓	↑	↓	↓
Permanent crops	↑	↑	↑	↑	↑	↑	↑	↑
Natural pastures	↑	↓	↓	↑	↑	↑	↑	↑
Fallow lands	↓	↓	↓	↓	↑	↑	↑	↑
In non-agricultural uses	↓	↑	↑	↓	↑	↓	↑	↑
Forest	↓	↑	↑	↓	↑	↑	↑	↑

Source: Authors' own elaboration.

FIGURE 6 Nicaragua and Peru: Changes in aggregate land use categories by region



Source: Authors' own elaboration.

Trends in crop production

Whatever the source of the additional agricultural land, both countries saw it used for increased cultivation of staples (e.g. corn, beans and rice) and cash crops, specifically coffee. Corn saw the second largest increase in area in Nicaragua and the third largest in Peru; coffee was third in Nicaragua and the first in Peru. Table 34 provides a summary of the area changes by region and farm sizes in both countries.

TABLE 34 Nicaragua and Peru: Changes in crop production by region and farm size

	Nicaragua (2001–2011) (three crops with the largest absolute increases in area out of the ten most important)			Peru (1994–2012) (three crops with the largest absolute increases in area out of the ten most important)		
Farm size	Pacific	Central	Atlantic	Coast	Sierra	Selva
0–7 ha	Corn Beans Bananas and plantains	Beans Corn Coffee	Beans Corn Cassava	Corn Rice Potatoes	Corn Potatoes Coffee	Coffee Corn Rice
7.1–35 ha	Corn Beans Bananas and plantains	Beans Corn Coffee	Beans Corn Cassava	Rice Corn Cotton	Coffee Oats Rice	Coffee Corn Rice
35.1–70 ha	Corn Rice Beans	Beans Corn Coffee	Cassava Beans Rice	Corn Rice Cotton	Oats Corn Rice	Corn Coffee Rice
70.1–140 ha	Rice Groundnut Corn	Beans Coffee Corn	Cassava Beans Rice	Avocado Cacao Mango	Corn Oats Rice	Rice Corn Coffee
140.1–350 ha	Rice Groundnut	Beans Coffee Corn	Beans Cassava	Corn Grape wines Cacao	Corn Potatoes Oats	Rice Coffee Corn
>350 ha	Sugar cane Groundnut Rice	Palm Rice Beans	Beans Palm	Avocado Potatoes Corn Grape wines	Corn Potatoes Avocado	Corn Rice Coffee
National (crops with the largest increase in area)	1) beans; 2) corn; 3) coffee; 4) rice; 5) sugar cane; 6) groundnut; 7) cassava; 8) palm 9) bananas; 10) cacao; 11) citrus			1) coffee; 2) cacao; 3) corn; 4) avocado; 5) fodder/feed crops; 6) grape wines; 7) rice; 8) mangoes; 9) sugar cane; 9) potatoes; 11) asparagus; 12) palm		

Source: Authors' own elaboration.

Five crops are important in both countries: two staple crops (rice and corn) and three cash crops (coffee, cacao and sugar cane). The dynamic of these crops by regions and farm size are summarized as follows:[8]

[8] The census data do not provide price information. Thus, we take production changes as an indicator for a crop's profitability/value.

- **Corn:** In Nicaragua, the increase in area occurred mainly in small and medium sized farms (less than 70 ha), in all regions. In Peru increases in area took place in all regions and across all farm sizes.
- **Rice:** In Nicaragua, the area dedicated to rice increased significantly in the Pacific and Atlantic regions, specifically in medium to large farms (over 35 ha), while in the Central region increases occurred only among the largest farms (over 350 ha). In Peru the dynamics differed in each region: in the Coast, increases were concentrated in small and medium sized farms (less than 70 ha), in the Sierra in farms between 7 and 140 ha, while in the Selva region the rice area increased across all farm sizes.
- **Coffee:** In Nicaragua, the increase in coffee was limited to the Central region, across all farm sizes (except those with more than 350 ha). In Peru trends were regional: the coffee area increased in farms with less than 35 ha in the Sierra and in all farm sizes in the Selva region.
- **Cacao:** The increase in cacao area was significant in Peru (it is the crop with the second largest area increase), more than in Nicaragua (crop with the tenth largest increase). In Peru, the increases took place mid-sized farms (70–350 ha) in the Coastal region.
- **Sugar cane:** The crop with the fifth largest increase in Nicaragua and ninth in Peru. In Nicaragua, the increases were noticeable only in farms over 350 ha in the Pacific region. In Peru, sugar cane did not appear among the three crops with the largest increase in cultivated area in any region.

There are other crops which are country specific. In Nicaragua:

- **Beans** are an important staple crop and it is one of the three crops with largest increases in the Pacific region, among farms with less than 70 ha, and among all farm sizes in the Central and Atlantic regions.
- **Cassava** is also an important staple crop, with significant production increases in the Atlantic region among farms with less than 350 ha.
- **Groundnuts** exhibited significant increases in farms over 7 ha in the Coastal region.
- **Palm** showed significant increases in the largest farms (over 350 ha) in the Central and Atlantic regions.

In Peru:

- **Oats** were one of the three crops with the largest area increases in the Sierra region, in medium sized farms (7–350 ha).
- **Avocados, mangos and grapes** are the three cash crops that gained in area, especially among larger Coastal farms: avocados in farms over 70 ha (and over 350 ha in the Sierra), mangoes in farms 70–140 ha, and grapes in farms over 140 ha.

There are also some similarities across regions and farm size categories:

- **Corn and rice** were among the crops with largest increases in cultivated area among farms with less than 70 ha in the Pacific region of Nicaragua and the Coastal region of Peru.
- **Coffee** area increased in farms with less than 35 ha in the Central region of Nicaragua and the Sierra region of Peru.
- **Corn** increased in farms with less than 35 ha in Nicaragua (Atlantic region) and Peru (Sierra region).
- **Rice** showed significant increases in farms 35–70 ha in the Atlantic region of Nicaragua and Sierra region of Peru.

Trends in inequality

In general, land inequality (given by the Gini) increased in both Nicaragua and Peru. While there may have been some regional differences within each country, overall, both nations also saw an increase in the share of producers with small farms (with less than 7 ha), and a decrease in the proportion of producers with more than 7 ha. However, there were differences in the distribution of land across the farm size categories. In Nicaragua, the share of land in farms with fewer than 35 ha increased, presumably taking land from larger farms. These increases in shares did not translate to larger farms: median farm size decreased for the 0–7 ha category. In Peru, only farms in the 7–35 ha and greater than 350 ha categories saw increases in their share of total agricultural land. The latter category saw the median farm size increase about 3 percent. This suggests the increased land inequality in Nicaragua stems from the observed influx of small-scale farmers into agriculture, while in Peru there was more land concentration.

Table 35 and Table 36 summarize the information about the land-to-producer ratio, by region and farm size, for each country. The ratios (share of land area over share of land producers) are an indicator of inequality in the land distribution: a ratio less than 1 indicates less land per producer, while a figure more than 1 indicates producers have more land. In both countries there is insufficient land for the share of producers with less than 35 ha (the ratio is less than 1). Across both countries, the ratios do not differ significantly (between 2 and 6) in medium farm (35–140 ha). However, in large farms (over 140 ha) inequality is higher in Peru: the results hold for all regions.

TABLE 35 Nicaragua: Indicators of land concentration, 2001 and 2011

	National		Pacific		Central		Atlantic	
	2001	2011	2001	2011	2001	2011	2001	2011
Farm size	(ratio, share of land area/share of producers)							
0–7 ha	0.075	0.086	0.100	0.119	0.088	0.105	0.053	0.075
7.1–35 ha	0.513	0.702	0.715	1.076	0.550	0.766	0.333	0.513
35.1–70 ha	1.431	2.020	2.249	3.389	1.564	2.266	0.805	1.431
70.1–140 ha	2.819	3.950	4.418	6.541	3.094	4.440	1.582	2.819
140.1–350 ha	6.141	8.567	9.947	14.771	6.688	9.505	3.419	6.141
>350 ha	22.286	30.403	38.126	61.760	24.482	31.518	11.059	22.286

Source: Authors' own elaboration.

TABLE 36 Peru: Indicators of land concentration, 1994 and 2012

	National		Coast		Sierra		Selva	
	1994	2012	1994	2012	1994	2012	1994	2012
Farm size	(ratio, share of land area/share of producers)							
0–7 ha	0.107	0.094	0.108	0.078	0.075	0.090	0.122	0.109
7.1–35 ha	0.733	0.862	0.654	0.418	0.458	0.764	0.858	1.033
35.1–70 ha	2.455	2.880	2.552	1.257	1.359	3.026	2.911	3.544
70.1–140 ha	4.826	5.689	5.093	2.432	2.649	6.043	5.719	6.938
140.1–350 ha	10.778	12.605	11.698	5.409	5.750	14.071	12.696	15.047
>350 ha	134.396	195.250	166.778	133.896	176.200	212.368	121.959	191.618

Source: Authors' own elaboration.

Trends in land tenure

In both Nicaragua and Peru, small farms have had less secure land rights. However, in Peru, the share of farms with registered land rights is half that of Nicaragua (25 percent versus 50 percent in the most recent census year). This trend is likely related to the entry of small farmers into agriculture in the two countries. In fact, there was nearly a 60 percent increase in the number of farmers with 0–7 ha in Nicaragua, between 2001 and 2011 (other farm size categories faced at most an increase one-fifth as large or saw a contraction). In Peru, the increase in the number of registered farmers with 0–7 ha was about 13 percent. But, like Nicaragua, the other farm size categories experienced a decrease in the number of farmers with registered land rights. Table 37 provides a summary of trends in land tenure in both countries by region.

TABLE 37 Nicaragua and Peru: Summary of trends in land tenure by region

Item	Nicaragua (2001–2011)				Peru (1994–2012)			
	National	Pacific	Central	Atlantic	National	Coast	Sierra	Selva
Owned –registered	↔	↓	↔	↓	↑	↑	↑	↑
Owned –not registered	↓	↓	↓	↓	↔	↓	↑	↓
Communal rights	n.a.	n.a.	n.a.	n.a.	↓	↓	↓	↓
Other	↑	↑	↑	↓	↑	↑	↑	↓

Note: n.a.: no data available.
Source: Authors' own elaboration.

Trends in labour

The farmers entering agriculture did hire additional labour, mainly temporary, to support their farms. In Nicaragua, the number of temporary employees working on farms with less than 7 ha more than doubled between 2001 and 2011, a trend nearly matched in Peru. However, in Peru permanent labour on these smaller farms decreased by 50 percent, while in Nicaragua permanent labour on farms 0–7 ha increased by almost 50 percent. It may be that because small farms in Peru lack security in their land rights, they have a shorter planning horizon. As such they cannot contract permanent employees over the long-term and are forced to rely on temporary labour.[9]

Table 38 summarizes the labour trends in both countries, by farm size. The number of farmers trends similarly: there was an increase in small (less than 7 ha) and large (over 350 ha) farms, while mid-sized farms faced no change, or a decrease. Family labour in both countries decreased in farms with more than 7 ha. Temporary labour increased in all farm sizes in both countries. In Nicaragua permanent labour increased in farms less than 35 ha and decreased in farms with more than 35 ha; Peru experienced exactly the opposite trend.

[9] In Nicaragua, the census question asks for hired employment and in Peru for paid employment. Therefore, since the questions are different, the comparison between countries is tentative.

TABLE 38 Nicaragua and Peru: Summary of trends in labour by farm size

Item	0–7 ha	7.1–35 ha	35.1–70 ha	70.1–140 ha	140.1–350 ha	>350 ha	Total
Farmers							
Nicaragua (2001–2011)	↑	↔	↓	↓	↔	↑	↑
Peru (1994–2012)	↑	↓	↓	↓	↓	↑	↑
Family labour							
Nicaragua (2001–2011)	↑	↓	↓	↓	↓	↓	↑
Peru (1994–2012)	↓	↓	↓	↓	↓	↓	↓
Permanent labour							
Nicaragua (2001–2011)	↑	↑	↓	↓	↓	↑	↑
Peru (1994–2012)	↓	↓	↑	↑	↑	↑	↓
Temporary labour							
Nicaragua (2001–2011)	↑	↑	↑	↑	↑	↑	↑
Peru (1994–2012)	↑	↑	↑	↑	↑	↑	↑

Source: Authors' own elaboration.

5.2 Policy discussion

Like their economic and development histories, the process of agricultural structural transformation was similar in Nicaragua and Peru. Both countries saw stable crop distributions, and economic reforms seem to have attracted small farmers to the agricultural sector. The main difference stems from the stability of land tenancy rights, especially for small farmers. In Peru, a lower rate of registered rights in the 0–7 ha category translated to a reliance on temporary labour instead of permanent labour. Tenancy rights are stronger in Nicaragua, and small farmers utilize permanent and temporary labour. For Nicaragua and Peru to continue their sustainable and equitable land use, to increase land and job security, as well as to transition to non-farm employment, we outline several policy implications.[10]

Increased sustainability of land use

For an agricultural sector to expand, there must be arable land available to cultivate. Extensive deforestation accompanied by an increase in annual crops could lead to soil degradation, requiring the increased use of fertilizers and pesticides, eventually making the land unsuitable for cultivation. In contrast, permanent crops form deeper root systems, which reduces nutrient leaching, allowing for increased agricultural productivity over a longer period. Between 1994 and 2012, Peru increased the amount of forest land, fallow land, and the land dedicated to permanent crops, while decreasing the land used for annual crops. Continuing these trends will ensure that Peruvian farmers will have enough arable land in the future. However, between 2001 and 2011 in Nicaragua, land dedicated to permanent crops

[10] This list of policy recommendations is not meant to be exhaustive, but limited to the scope of the study and the considerations that can be drawn from the available data. There may by other relevant policies not mentioned in the present study.

increased at the expense of forest and fallow land. Further, land used to cultivate annual crops in Nicaragua also increased. If Nicaragua maintains this trajectory in the absence of other policies (e.g. agro-environmental, sustainable intensification), soil degradation could lead to agricultural instability.

Relatedly, both countries saw increases in the total amount of pastureland, implying that farms are raising more livestock. Increases in livestock can have negative environmental implications: it requires the cultivation of additional animal feed, which are the very annual crops that are environmentally destructive (staples such as corn, rice, wheat and oats). Further, more animals will increase ambient methane levels, contributing to the greenhouse gas effect.

Apart from its inherent importance, increased sustainability of land use is relevant for the following SDG related targets:

- **Target 2.4:** By 2030, ensure sustainable food production systems and implement **resilient agricultural practices** that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.
- **Target 5.3:** By 2030, combat desertification, **restore degraded land and soil**, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

Increased land security

As discussed in Sections 3.3 and 4.3, small farmers in Nicaragua and Peru have lower security with respect to land and tenancy rights, compared to their large farm counterparts. Farmers facing high land insecurity will not have the liberty to pursue a long-term land development strategy. In fact, insecure land rights could impede the development of a land market and could lead farmers to engage in practices that ensure high returns in the short-run (such as deforestation, high pesticide and fertilizer use, and a reliance on non-permanent crops), but are detrimental to their own agricultural livelihoods and the environment in the long-run. By ensuring small farmers own their land, governments will exhibit a strong commitment to equitable development in the agricultural sector and ensure the income security of small farmers. Secure land tenure rights will also contribute to the development of land markets and could spur farmers to engage in forward looking agro-environmental practices.

Further, governments that combine increased land security with a greater understanding of small farm operations can implement a comprehensive policy package to address the needs of small farmers. For example, our analysis of the predominant technological practices in Peru indicates that by 2012 small farmers essentially stopped using wood ploughs but continue to rely on manual fumigating pumps. Nicaragua experienced a similar (but less pronounced) trend. What remains to be understood is why small farms experience these trends. With this information, governments can assist small farms in their technological transition, by providing access to credit to allow farmers to purchase new technologies and technological training as well.

Therefore, governments should make effort to grant small farmers land ownership rights and facilitate their technological transition.

Increased land tenure security is relevant for the following SDG related targets:

- **Target 1.4:** By 2030, ensure that all men and women, in particular the poor and the vulnerable, have **equal rights to economic resources**, as well as access to basic services, **ownership and control over land** and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance.

- **Target 2.3:** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through **secure and equal access to land**, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- **Target 5.a:** Undertake reforms to give women equal rights to economic resources, as well as **access to ownership and control over land** and other forms of property, financial services, inheritance and natural resources, in accordance with national laws.

Increased job security for agricultural employees

This issue is closely linked to that of land security. Depending on the type of crop, if growers are not secure in their own land rights, they cannot offer permanent/long-term contracts to employees. Without job security, agricultural laborers may be forced to leave the sector altogether. Governments can improve agricultural job security by maintaining a register of employees and their contract status, and helping workers find work in other sectors during the agricultural off-season.

Increased job security for agricultural employees is relevant for the following SDG related targets:

- **Target 8.5:** By 2030, achieve full and **productive employment and decent work for all women and men**, including for young people and persons with disabilities, and equal pay for work of equal value.

Increased (re)training and skills acquisition programs to facilitate the transition to non-farm employment

Although the agricultural censuses do not provide information on rural labour markets, recent evidence from household surveys indicates that those leaving agriculture could face difficulties transitioning to remunerated non-farm activities due to a lack of skills (ECLAC, FAO & IICA, 2017).

People leaving agriculture must have access to training and retraining programs, so they have the appropriate skills for non-agricultural work. Therefore, as indicated in ECLAC, FAO and IICA (2017), designing these skills acquisition programs in conjunction with the private sector ensures workers will have the skills firms are demanding. Further, it will reduce government costs if firms are providing the training. In the short-term, workers will be able to manage the transition from agriculture to non-agriculture more easily, without facing extended unemployment. In the long run, these additional skills can support socioeconomic mobility. Governments can incentivize corporate participation in employee training by providing tax credits for firms offering retraining courses or working with training centres to design effective curricula.

Increased temporary employment in small-scale farms and lack of remunerated job opportunities in other sectors is relevant for the following SDG related targets:

- **Target 4.4:** By 2030, substantially increase the number of youth and adults who have **relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship**.
- **Target 8.b:** By 2020, develop and operationalize a global strategy for **youth employment** and implement the Global Jobs Pact of the International Labour Organization.

References

Acemoglu, D. & Guerrieri, V. 2008. Capital Deepening and Nonbalanced Economic Growth. *Journal of Political Economy*, 116(3): 467–98.

Austin, J., Fox, J. & Kruger, W. 1985. The Role of the Revolutionary State in the Nicaraguan Food System. *World Development*, 13(1): 15–40.

Baumeister, E. 2012. El caso de Nicaragua. *In* F. Soto Barquero & S. Gómez, eds. *Dinámicas del Mercado de la Tierra en América Latina y el Caribe*. Rome, FAO.

Boehlje, M. 1999. Structural change in the agricultural industries: how do we measure, analyze and understand them? *American Journal of Agricultural Economics*, 81(5): 1028–1041.

Burneo, Z. 2011. El Proceso de Concentración de La Tierra En El Perú. *In* CEPES, CIRAD & International land coalition, eds. *Presiones comerciales sobre la tierra*.

Cao, K.H. & Birchenall, J.A. 2013. Agricultural Productivity, Structural Change, and Economic Growth in Post-Reform China. *Journal of Development Economics*, 104: 165–80.

Chacaltana, J. 2016. Perú, 2002-2012: Crecimiento, Cambio Estructural y Formalización. *Cepal Review 2016*, 119: 47–68.

Chavas, J.P. 2001. Structural change in agricultural production: economics, technology and policy. *In* Gardner & Rousser, eds. *Handbook of Agricultural Economics*, 1(Part A), pp. 263–285.

Chen, Y., Li, X., Tian, X. & Tan, M. 2009. Structural Change of Agricultural Land Use Intensity and Its Regional Disparity in China. *Journal of Geographical Sciences*, 19(5): 545–556.

ECLAC (Economic Commission for Latin America and the Caribbean), FAO & IICA (Instituto Interamericano de Cooperación para la Agricultura). 2017. *The Outlook for Agriculture and Rural Development in the Americas: A Perspective on Latin America and the Caribbean 2017-2018*. San Jose.

Echevarría, C. 1997. Changes in sectoral composition associated with economic growth. *International Economic Review*, 38: 431–452.

ECLAC. 2010. *Transmisión de precios en los mercados de maíz y arroz en América Latina*. Santiago.

ECLAC. 2019. CEPALSTAT. In: *ECLAC*. New York, USA. Cited 30 November 2019. https://statistics.cepal.org/portal/cepalstat/index.html?lang=en

Eguren, F. 2006. La reforma agraria en el Perú. *Debate Agrario*, 44: 63–100.

Fréguin-Gresh, S. & Pérez, F. 2014. *Classifying Agricultural Holdings in Nicaragua: Proposal of a Typology Based on the IV Agricultural Census*. Managua.

Fujita, M., Krugman, P. & Venables, A. 1999. *The spatial economy: Cities, Regions and International trade*. MIT Press, Cambridge, UK.

Grabowski, R. 2013. Agricultural Distortions and Structural Change. *Journal of Asian Economics*, 24: 17–25.

Iraizoz, B., Gorton, M. & Davidova, S. 2007. Segmenting Farms for Analysing Agricultural Trajectories: A Case Study of the Navarra Region in Spain. *Agricultural Systems*, 93(1–3): 143–69.

Jonakin, J. 1996. The Impact of Structural Adjustment and Property Rights Conflicts on Nicaraguan Agrarian Reform Beneficiaries. *World Development*, 24(7): 1179–91.

Kongsamut, P., Rebelo, S. & Xie, D. 2011. Beyond Balanced Growth. *Review of Economic Dynamics*, 68(4): 869–82.

Matsuyama, K. 1992. Agricultural productivity, comparative advantage, and economic growth. *Journal of Economic Theory*, 58: 317–334.

Mendelsohn, R., Nordhaus, W.D. & Shaw, D. 1994. The Impact of Global Warning on Agriculture: A Ricardian Analysis. *American Economic Review*, 84(4): 753–771.

Meynard, F. 2014. Perú: A La Espera de Políticas Específicas para la Agricultura Familar. *In* E. Sabourin, M. Samper & O. Sotomayor, eds. *Políticas Públicas y Agriculturas Familiares en América Latina y el Caribe: Balance, Desafíos y Perspectivas*, pp. 257–274. Santiago.

Moller, L., Silva-Jauregui, C., Chaves, R., Jaramillo, C. & Cox, P. 2010. *El Mercado Laboral Peruano durante el Auge y Caída*. Washington, DC.

Murata, Y. 2008. Engel's Law, Petty's Law, and Agglomeration. *Journal of Development Economics*, 87(1): 161–177.

Ngai, L.R. & Pissarides, C.A. 2007. Structural Change in a Multisector Model of Growth. *American Economic Review*, 97(1): 429–443.

Pérez, F.J. & Fréguin-Gresh, S. 2014. Nicaragua: evoluciones y perspectivas. *In* E. Sabourin, M. Samper & O. Sotomayor, eds. *Políticas Públicas y Agriculturas Familiares en América Latina y el Caribe: Balance, Desafíos y Perspectivas*, pp. 231–256. Santiago.

Puga, D. 1999. The Rise and Fall of Regional Inequalities. *European Economic Review*, 43(2): 303–334.

Remy, M.I. & de los Ríos, C. 2012. El caso de Perú. *In* F. Soto Barquero & S. Gómez, eds. *Dinámicas del Mercado de la Tierra en América Latina y el Caribe*. Rome, FAO.

Ruiz, A. & Marín, Y. 2005. *Revisitando el Agro Nicaraguense: Tipologia de los Sistemas de Produccion y Zonificacion Agro-Socioeconomica*. Managua.

Timmer, C.P. 1988. The agricultural transformation. *In* Chennery & Srinivasan, eds. *Handbook of development economics*, pp. 275–331.

Velazco, J. & Velazco, J. 2012. Características del Empleo Agrícola en el Perú. *In* C. Garavito & I. Muñoz, eds. *Empleo y Protección Social*, 1st ed., pp. 161–211. Lima, Departamento de Economía, Pontificia Universidad Católica del Perú.

Velazco, J. 2001. Agricultural Production in Peru (1950–1995): Sources of Growth. *In* L. Zepeda, eds. *Agricultural Investment and Productivity in Developing Countries*, pp. 93–119. Rome, FAO.

Annexes

Annex 1. Complementary tables to text

TABLE A1 Nicaragua: Distribution of departments by region

Pacific	Central	Atlantic
Chinandega	Nueva Segovia	Región Autónoma Atlántico Norte (RAAN)
León	Jinoteca	Región Autónoma Atlántico Sur (RAAS)
Managua	Madriz	
Masaya	Estelí	
Granada	Matagalpa	
Carazo	Boaco	
Rivas	Chontales	
	Rio San Juan	

Source: Authors' own elaboration.

TABLE A2 Peru: Distribution of provinces by region

Pacific	Central		Atlantic	
Amazonas	Ancash	Tacna	Ayacucho	Puno
Loreto	Arequipa	Tumbes	Cajamarca	Junin
Madre de Dios	Callao	Moquegua	Cuzco	La Libertad
Ucayali	Ica	Piura	Huancavelica	
San Martin	Lambayeque	Apurimac	Huanuco	
	Lima		Pasco	

Source: Authors' own elaboration.

TABLE A3 Nicaragua and Perú: total value added and economic active population, 1990–2016

Year	Nicaragua				Peru			
	Total value added (million USD)	Growth rates (%)	PEA (number of people)	Growth rates (%)	Total value added (million USD)	Growth rates (%)	PEA (number of people)	Growth rates (%)
1990	4 385		1 365 544		54 254		8 145 796	
1991	4 299	-2.0	1 405 486	2.9	55 350	2.0	8 442 235	3.6
1992	4 346	1.1	1 447 931	3.0	55 091	-0.5	8 752 086	3.7
1993	4 323	-0.5	1 491 969	3.0	57 885	5.1	9 071 962	3.7
1994	4 457	3.1	1 536 724	3.0	64 898	12.1	9 398 219	3.6
1995	4 725	6.0	1 581 385	2.9	69 508	7.1	9 726 976	3.5
1996	4 954	4.8	1 626 398	2.8	71 605	3.0	10 055 589	3.4
1997	5 098	2.9	1 672 970	2.9	76 116	6.3	10 385 469	3.3

TABLE A3 (cont.) Nicaragua and Perú: total value added and economic active population, 1990–2016

Year	Nicaragua				Peru			
	Total value added (million USD)	Growth rates (%)	PEA (number of people)	Growth rates (%)	Total value added (million USD)	Growth rates (%)	PEA (number of people)	Growth rates (%)
1998	5 273	3.4	1 721 533	2.9	75 708	-0.5	10 718 303	3.2
1999	5 786	9.7	1 772 734	3.0	77 176	1.9	11 055 600	3.1
2000	6 004	3.8	1 827 138	3.1	79 287	2.7	11 398 739	3.1
2001	6 239	3.9	1 885 386	3.2	79 741	0.6	11 745 463	3.0
2002	6 258	0.3	1 947 844	3.3	84 144	5.5	12 092 301	3.0
2003	6 439	2.9	2 014 012	3.4	87 562	4.1	12 438 987	2.9
2004	6 849	6.4	2 082 795	3.4	91 804	4.8	12 785 556	2.8
2005	7 140	4.2	2 152 828	3.4	97 327	6.0	13 132 408	2.7
2006	7 409	3.8	2 223 365	3.3	104 831	7.7	13 480 153	2.6
2007	7 718	4.2	2 293 689	3.2	113 910	8.7	13 827 565	2.6
2008	7 901	2.4	2 363 097	3.0	123 879	8.8	14 174 170	2.5
2009	7 666	-3.0	2 431 051	2.9	125 309	1.2	14 516 831	2.4
2010	7 925	3.4	2 497 207	2.7	135 052	7.8	14 853 464	2.3
2011	8 408	6.1	2 561 826	2.6	143 961	6.6	15 186 068	2.2
2012	8 860	5.4	2 625 316	2.5	152 378	5.8	15 516 096	2.2
2013	9 279	4.7	2 687 576	2.4	160 976	5.6	15 840 890	2.1
2014	9 716	4.7	2 748 489	2.3	164 760	2.4	16 157 753	2.0
2015	10 149	4.5	2 807 904	2.2	170 540	3.5	16 463 991	1.9
2016	10 600	4.4	2 865 956	2.1	177 130	3.9	16 759 438	1.8
Average								
1991–2011		3.2		3.0				
1991–2012						4.9		3.0
Study period		3.1		3.1		5.3		2.9

Source: Authors' own elaboration.

TABLE A4 Nicaragua: Distribution of total agricultural land in regions by uses, 2001 and 2011

Use	Pacific (ha)		Central (ha)		Atlantic (ha)	
	2001	2011	2001	2011	2001	2011
Agricultural uses	508 069	532 305	821 620	923 142	581 167	595 246
Annual crops	209 674	226 071	277 477	337 325	187 805	173 823
Permanent and semi-permanent crops	115 609	121 081	134 980	176 752	47 043	61 808
Cultivated pastures	182 787	185 153	409 163	409 065	346 320	359 614

TABLE A4 (cont.) Nicaragua: Distribution of total agricultural land in regions by uses, 2001 and 2011

Use	Pacific (ha)		Central (ha)		Atlantic (ha)	
	2001	2011	2001	2011	2001	2011
Natural pastures	348 976	326 397	1 092 339	1 083 845	625 440	907 626
Fallow land	257 388	159 107	461 016	280 808	476 411	261 965
Non-agricultural use	209 244	214 505	431 379	437 063	482 674	332 862
Forests	128 931	157 701	336 173	360 879	430 115	284 923
Infrastructure (buildings and roads)	22 669	23 530	29 246	28 372	19 248	18 504
Swamps	41 410	33 274	47 049	47 812	24 712	29 435
Affected by natural disasters	16 234	0	18 910	0	8 599	0
Total agricultural land	1 323 677	1 232 314	2 806 353	2 724 858	2 165 693	2 097 698

Notes: The data presented do not include incomplete surveys (see Annex 3 for more information on complete versus incomplete surveys). n.d.: no data.

Source: Authors' own elaboration.

TABLE A5 Peru: Distribution of total agricultural land in regions by uses, 1994 and 2012

Use	Selva (ha)		Costa (ha)		Sierra (ha)	
	1994	2012	1994	2012	1994	2012
Agricultural uses	710 415	923 385	838 644	1 367 353	1 728 797	1 864 941
Annual crops	395 497	262 796	582 130	741 126	1 137 600	909 067
Permanent crops	91 070	384 038	103 789	320 269	299 279	530 326
Associated crops	65 804	72 035	55 900	49 620	148 607	108 339
Cultivated pastures	158 045	204 516	96 825	256 337	143 311	317 209
Natural pastures	379 412	540 574	5 976 089	6 744 842	10 550 970	10 733 379
Managed natural pastures	84 512	205 256	117 916	368 336	425 818	985 746
Non-managed pastures	294 900	335 319	5 858 173	6 376 506	10 125 153	9 747 633
Fallow lands	312 118	331 043	520 048	1 015 650	1 366 956	1 622 637
Fallow lands (to be cropped)	95 735	190 132	300 272	523 790	540 240	717 719
Other fallow lands	132	6 849	90 294	162 074	460 532	593 884
Not cropped agricultural land	216 252	134 062	129 482	329 786	366 184	311 035
Non-agricultural use	6 339 407	7 527 785	2 817 102	2 056 068	3 841 853	4 014 810
Forests	6 128 783	7 415 862	705 779	799 145	2 219 144	2 724 267
Other	210 624	111 923	2 111 323	1 256 923	1 622 709	1 290 543
Total agricultural land	7 741 352	9 322 787	10 151 882	11 183 912	17 488 577	18 235 767

Note: Among the fallow category there are three uncultivated type of uses: i) fallow lands; ii) to be cropped, which is land that will be cultivated within the agricultural year; and iii) not to be cultivated, which is land that the farmers cannot cultivate due to different reasons as lack of water, lack of credit and others.

Source: Authors' own elaboration.

TABLE A6 Nicaragua: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Agricultural wagon	0.313	9.055	22 081	28 574	11.1	10.9	25 136	33 524	48.92	19.82
Iron plough	0.255	7.658	6 447	6 425	3.2	2.4	7 966	7 527	55.38	20.64
Wood plough	0.323	8.396	39 376	29 270	19.7	11.1	48 030	35 489	28.98	17.45
Manual fumigating pump	0.321	6.776	101 423	149 678	50.9	57.0	137 224	214 810	40.15	23.75
Non-manual fumigating pump	0.200	8.296	5 522	11 790	2.8	4.5	8 068	16 547	84.88	25.22
Threshing machines (manual)	0.192	6.626	3 603	2 566	1.8	1.0	3 997	3 088	54.47	20.37
Threshing machines (mechanical)	0.241	4.022	1 154	1 355	0.6	0.5	1 237	1 439	57.08	17.31
Tractor	0.284	13.309	7 412	5 386	3.7	2.1	9 365	8 095	78.92	19.68
Harvester	0.136	27.570	553	663	0.3	0.3	835	1 283	197.80	17.28
Electric engine	0.147	10.040	2 531	5 237	1.3	2.0	4 593	8 321	149.49	24.02
Electric generator	0.086	6.668	1 034	2 519	0.5	1.0	1 276	2 912	236.11	27.38
Grass and sugar cane cutter	0.056	5.425	2 397	8 007	1.2	3.0	2 591	8 595	133.47	32.42
Pulper machine	0.252	3.488	16 199	17 896	8.1	6.8	17 500	19 312	28.42	12.63
Coffee mill	0.162	3.142	750	1 404	0.4	0.5	792	1 520	59.61	12.35
Rice mill	0.171	9.292	131	163	0.1	0.1	150	275	389.89	19.34
Dryer	0.488	19.597	608	1 251	0.3	0.5	2 537	5 944	96.43	21.35
Saw	0.090	4.588	7 630	17 621	3.8	6.7	8 604	19 408	121.03	36.83
Camioneta	0.218	7.427	8 436	10 149	4.2	3.9	10 060	12 480	106.10	22.70
Truck	0.220	9.272	1 747	2 237	0.9	0.9	2 479	3 591	151.55	21.98
Boat	0.214	4.447	2 108	2 478	1.1	0.9	2 819	3 176	124.93	45.88
Irrigation pump	0.200	11.536	2 985	5 125	1.5	2.0	4 253	7 430	119.89	22.24
Decorticator	0.112	5.566	178	307	0.1	0.1	232	413	132.20	28.78
Sugar cane mill	0.067	5.995	798	601	0.4	0.2	822	632	87.79	30.53
Light aircraft	0.182	3.560	40	48	0.0	0.0	83	64	421.79	20.05

Source: Authors' own elaboration.

TABLE A7 Nicaragua, Pacific region: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Agricultural wagon	0.397	13.211	12 948	14 156	20.4	16.2	14 740	16 194	37.23	15.36
Iron plough	0.337	9.744	3 523	3 219	5.6	3.7	4 459	3 730	37.40	17.81
Wood plough	0.401	10.376	19 095	16 373	30.2	18.7	23 231	19 306	23.20	16.04
Manual fumigating pump	0.512	12.092	31 403	40 313	49.6	46.1	42 552	54 255	29.31	14.56
Non-manual fumigating pump	0.257	16.971	3 101	3 364	4.9	3.8	4 288	4 820	76.72	16.79
Threshing machines (manual)	0.271	10.936	1 708	931	2.7	1.1	1 915	1 124	38.37	11.30
Threshing machines (mechanical)	0.254	5.252	755	814	1.2	0.9	803	870	55.60	19.79
Tractor	0.298	15.598	5 697	4 210	9.0	4.8	7 281	6 499	66.31	17.53
Harvester	0.130	34.323	391	495	0.6	0.6	625	1 052	209.68	16.44
Electric engine	0.228	18.165	881	1 918	1.4	2.2	2 219	3 978	179.98	19.26
Electric generator	0.121	12.915	353	805	0.6	0.9	445	998	307.42	23.56
Grass and sugar cane cutter	0.054	12.671	714	1 471	1.1	1.7	804	1 604	174.69	19.34
Pulper machine	0.100	11.732	175	129	0.3	0.1	226	153	119.24	12.12
Coffee mill	0.112	14.159	37	36	0.1	0.0	54	47	321.71	7.12
Rice mill	0.200	22.683	51	59	0.1	0.1	62	65	318.33	10.59
Dryer	0.217	14.200	78	109	0.1	0.1	107	135	286.15	35.25
Saw	0.173	12.899	1 689	3 445	2.7	3.9	1 923	3 879	127.11	23.15
Camioneta	0.401	13.281	3 534	3 522	5.6	4.0	4 332	4 640	87.82	15.50
Truck	0.367	14.620	811	939	1.3	1.1	1 300	1 786	151.60	14.87
Boat	0.442	16.398	290	322	0.5	0.4	422	509	158.10	21.56
Irrigation pump	0.221	13.486	1 154	2 494	1.8	2.9	1 926	3 847	164.43	17.08
Decorticator	0.095	14.274	40	60	0.1	0.1	60	72	284.90	29.26
Sugar cane mill	0.126	15.837	125	92	0.2	0.1	136	104	109.22	10.54
Light aircraft	0.057	1.106	18	14	0.0	0.0	49	20	646.72	22.94

Source: Authors' own elaboration.

TABLE A8 Nicaragua, Central region: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Agricultural wagon	0.204	5.538	8 382	12 623	8.7	9.6	9 435	15 121	59.26	20.49
Iron plough	0.168	6.057	2 635	2 931	2.7	2.2	3 151	3 448	69.91	19.01
Wood plough	0.260	6.204	19 210	11 962	19.8	9.1	23 582	14 996	31.78	16.85
Manual fumigating pump	0.283	5.885	55 388	85 557	57.2	64.9	77 607	127 468	36.47	20.72
Non-manual fumigating pump	0.134	5.686	2 215	6 887	2.3	5.2	3 546	9 742	94.71	21.21
Threshing machines (manual)	0.143	4.686	1 465	1 278	1.5	1.0	1 612	1 535	63.30	18.62
Threshing machines (mechanical)	0.223	2.227	380	526	0.4	0.4	405	551	55.66	12.54
Tractor	0.241	5.370	1 652	1 112	1.7	0.8	1 963	1 525	117.20	27.17
Harvester	0.155	8.116	155	158	0.2	0.1	201	219	160.80	18.86
Electric engine	0.108	6.162	1 566	2 859	1.6	2.2	2 279	3 836	117.33	21.50
Electric generator	0.071	4.461	624	1 310	0.6	1.0	769	1 479	194.19	22.28
Grass and sugar cane cutter	0.058	4.359	1 614	5 451	1.7	4.1	1 713	5 842	114.49	31.41
Pulper machine	0.260	3.464	15 437	17 308	15.9	13.1	16 665	18 678	26.88	12.41
Coffee mill	0.170	2.947	685	1 318	0.7	1.0	709	1 418	45.64	12.29
Rice mill	0.173	2.130	69	82	0.1	0.1	77	188	168.33	22.96
Dryer	0.583	23.308	471	969	0.5	0.7	2 306	5 459	63.81	16.43
Saw	0.079	3.508	4 079	8 642	4.2	6.6	4 645	9 576	109.84	29.72
Camioneta	0.092	4.793	4 508	5 864	4.7	4.4	5 294	6 984	109.59	22.12
Truck	0.093	6.169	856	1 104	0.9	0.8	1 077	1 548	151.62	24.05
Boat	0.173	3.565	750	799	0.8	0.6	1 011	987	154.14	60.14
Irrigation pump	0.191	10.319	1 769	2 405	1.8	1.8	2 250	3 283	88.59	23.27
Decorticator	0.150	4.797	49	175	0.1	0.1	68	262	86.85	20.08
Sugar cane mill	0.068	6.020	486	348	0.5	0.3	495	360	76.43	20.00
Light aircraft	0.311	5.536	20	28	0.0	0.0	32	38	256.96	13.70

Source: Authors' own elaboration.

TABLE A9 Nicaragua, Atlantic region: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Agricultural wagon	0.077	1.017	751	1 795	1.9	4.1	961	2 209	135.10	50.37
Iron plough	0.053	0.314	289	275	0.7	0.6	356	349	142.05	71.08
Wood plough	0.060	1.772	1 071	935	2.7	2.2	1 217	1 187	81.71	49.70
Manual fumigating pump	0.053	0.973	14 632	23 808	37.3	55.0	17 065	33 087	77.36	50.22
Non-manual fumigating pump	0.048	1.017	206	1 539	0.5	3.6	234	1 985	101.89	61.59
Threshing machines (manual)	0.044	2.333	430	357	1.1	0.8	470	429	88.38	50.24
Threshing machines (mechanical)	0.072	0.200	19	15	0.0	0.0	29	18	144.25	50.19
Tractor	0.057	0.695	63	64	0.2	0.1	121	71	215.86	30.60
Harvester	0.018	0.658	7	10	0.0	0.0	9	12	353.81	34.25
Electric engine	0.033	0.265	84	460	0.2	1.1	95	507	429.32	59.52
Electric generator	0.035	1.373	57	404	0.1	0.9	62	435	253.31	51.53
Grass and sugar cane cutter	0.034	0.959	69	1 085	0.2	2.5	74	1 149	150.68	55.25
Pulper machine	0.105	2.083	587	459	1.5	1.1	609	481	41.75	20.91
Coffee mill	0.043	0.363	28	50	0.1	0.1	29	55	54.84	17.65
Rice mill	0.022	0.079	11	22	0.0	0.1	11	22	2 111.48	29.31
Dryer	0.095	2.210	59	173	0.2	0.4	124	350	106.06	40.18
Saw	0.040	1.101	1 862	5 534	4.7	12.8	2 036	5 953	140.02	56.44
Camioneta	0.026	0.653	394	763	1.0	1.8	434	856	230.23	60.37
Truck	0.075	1.044	80	194	0.2	0.4	102	257	150.27	44.59
Boat	0.181	2.131	1 068	1 357	2.7	3.1	1 386	1 680	95.40	43.25
Irrigation pump	0.056	2.961	62	226	0.2	0.5	77	300	183.81	68.21
Decorticator	0.099	0.179	89	72	0.2	0.2	104	79	88.54	49.51
Sugar cane mill	0.026	0.315	187	161	0.5	0.4	191	168	102.99	64.73
Light aircraft	0.026	0.064	2	6	0.0	0.0	2	6	45.83	42.95

Source: Authors' own elaboration.

TABLE A10 Nicaragua: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by farm size category and item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Farm size: 0-7 ha										
Agricultural wagon	0.723	14.015	8 525	18 413	9.9	12.2	9 012	21 512	2.88	1.92
Iron plough	0.638	11.922	2 205	4 114	2.6	2.7	2 429	4 779	3.00	1.97
Wood plough	0.650	12.610	17 183	19 431	19.9	12.9	18 495	23 288	2.86	1.93
Manual fumigating pump	0.758	12.149	37 673	83 053	43.6	55.0	42 819	119 195	2.78	2.08
Non-manual fumigating pump	0.631	14.772	1 399	6 597	1.6	4.4	1 538	9 550	3.10	2.07
Threshing machines (manual)	0.557	11.033	1 011	1 535	1.2	1.0	1 059	1 842	3.20	2.06
Threshing machines (mechanical)	0.515	5.674	468	956	0.5	0.6	472	1 004	3.08	2.12
Tractor	0.597	19.014	3 145	3 763	3.6	2.5	3 258	5 768	2.89	1.73
Harvester	0.548	38.683	104	472	0.1	0.3	110	946	3.29	1.72
Electric engine	0.641	17.126	414	3 060	0.5	2.0	495	4 894	3.20	2.00
Electric generator	0.530	12.177	116	1 374	0.1	0.9	134	1 619	3.37	2.09
Grass and sugar cane cutter	0.428	11.473	170	3 767	0.2	2.5	174	4 037	3.69	2.11
Pulper machine	0.582	5.329	5 944	11 628	6.9	7.7	5 996	12 564	3.10	2.31
Coffee mill	0.469	4.824	201	907	0.2	0.6	205	985	3.25	2.38
Rice mill	0.646	16.402	29	92	0.0	0.1	35	178	3.25	1.80
Dryer	1.335	33.060	144	737	0.2	0.5	457	3 852	3.25	2.23
Saw	0.639	11.606	756	6 919	0.9	4.6	811	7 743	3.22	2.21
Camioneta	0.870	12.395	1 830	6 061	2.1	4.0	2 037	7 707	2.98	1.94
Truck	0.868	14.743	382	1 403	0.4	0.9	483	2 453	2.90	1.93
Boat	0.714	11.479	532	953	0.6	0.6	629	1 264	3.40	2.40
Irrigation pump	0.561	17.551	880	3 361	1.0	2.2	982	5 006	3.09	1.76
Decorticator	0.531	11.793	26	144	0.0	0.1	30	210	3.62	2.07
Sugar cane mill	0.327	12.078	74	297	0.1	0.2	74	320	3.74	2.03
Light aircraft	1.462	7.035	4	24	0.0	0.0	10	32	2.38	2.10
Farm size: 7.1-35 ha										
Agricultural wagon	0.084	0.093	7 699	6 688	11.7	9.7	8 391	7 912	16.02	15.66
Iron plough	0.088	0.094	2 271	1 549	3.4	2.3	2 609	1 840	16.03	15.51
Wood plough	0.095	0.099	14 529	6 823	22.0	9.9	17 705	8 449	15.71	15.42
Manual fumigating pump	0.096	0.111	34 704	40 990	52.6	59.6	44 631	59 095	16.43	16.20

TABLE A10 (cont.) Nicaragua: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by farm size category and item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Non-manual fumigating pump	0.092	0.104	1 955	3 090	3.0	4.5	2 386	4 198	16.53	16.40
Threshing machines (manual)	0.079	0.095	1 376	626	2.1	0.9	1 475	779	16.86	16.29
Threshing machines (mechanical)	0.082	0.084	402	281	0.6	0.4	412	304	15.54	15.65
Tractor	0.087	0.111	2 193	1 091	3.3	1.6	2 403	1 484	15.49	15.28
Harvester	0.083	0.152	174	124	0.3	0.2	204	217	17.64	15.10
Electric engine	0.102	0.112	781	1 342	1.2	2.0	1 009	1 923	17.08	15.83
Electric generator	0.086	0.084	233	670	0.4	1.0	264	748	16.71	16.27
Grass and sugar cane cutter	0.068	0.080	614	2 378	0.9	3.5	649	2 566	19.19	16.69
Pulper machine	0.081	0.090	6 957	4 834	10.5	7.0	7 270	5 207	15.77	14.79
Coffee mill	0.079	0.089	301	390	0.5	0.6	306	424	16.02	15.16
Rice mill	0.077	0.131	38	37	0.1	0.1	38	54	16.80	15.95
Dryer	0.377	0.421	250	342	0.4	0.5	1 227	1 684	16.24	14.70
Saw	0.072	0.080	1 944	5 709	2.9	8.3	2 141	6 269	18.84	17.14
Camioneta	0.080	0.092	2 412	2 484	3.7	3.6	2 702	2 911	17.32	15.99
Truck	0.085	0.101	475	497	0.7	0.7	564	671	17.77	16.38
Boat	0.092	0.088	601	740	0.9	1.1	735	940	16.85	17.55
Irrigation pump	0.093	0.107	904	1 111	1.4	1.6	1 132	1 487	16.59	15.50
Decorticator	0.084	0.095	56	97	0.1	0.1	65	123	17.06	16.92
Sugar cane mill	0.073	0.080	316	171	0.5	0.2	323	177	17.63	16.21
Light aircraft	0.116	0.111	10	17	0.0	0.0	24	23	21.68	14.96
Farm size: 35.1-70 ha										
Agricultural wagon	0.026	0.026	2 502	1 732	10.2	7.7	2 941	2 036	47.12	47.12
Iron plough	0.028	0.026	824	375	3.3	1.7	1 026	438	46.98	47.00
Wood plough	0.030	0.027	4 012	1 562	16.3	6.9	5 427	1 925	46.43	47.39
Manual fumigating pump	0.031	0.032	13 901	13 495	56.4	59.6	19 214	19 074	46.10	46.61
Non-manual fumigating pump	0.031	0.030	811	1 046	3.3	4.6	1 143	1 390	47.13	46.66
Threshing machines (manual)	0.025	0.026	528	214	2.1	0.9	589	247	46.25	45.67
Threshing machines (mechanical)	0.025	0.022	101	61	0.4	0.3	116	63	47.39	47.83
Tractor	0.027	0.034	649	241	2.6	1.1	802	382	47.37	47.54

TABLE A10 (cont.) Nicaragua: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by farm size category and item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Harvester	0.028	0.040	62	25	0.3	0.1	82	47	49.58	45.66
Electric engine	0.047	0.029	352	409	1.4	1.8	925	534	47.82	46.85
Electric generator	0.023	0.025	139	236	0.6	1.0	149	265	49.18	46.57
Grass and sugar cane cutter	0.023	0.023	520	902	2.1	4.0	549	949	48.16	47.21
Pulper machine	0.025	0.023	1 848	869	7.5	3.8	2 053	906	46.01	46.60
Coffee mill	0.025	0.023	107	64	0.4	0.3	117	66	46.50	46.85
Rice mill	0.024	0.035	16	21	0.1	0.1	17	30	46.73	42.65
Dryer	0.092	0.051	70	86	0.3	0.4	273	198	45.37	47.15
Saw	0.024	0.024	1 603	2 528	6.5	11.2	1 739	2 742	47.15	46.61
Camioneta	0.025	0.025	1 244	810	5.0	3.6	1 456	929	48.29	46.91
Truck	0.026	0.031	231	152	0.9	0.7	286	209	48.60	46.44
Boat	0.027	0.029	340	388	1.4	1.7	414	501	46.40	45.59
Irrigation pump	0.030	0.035	365	296	1.5	1.3	508	467	48.72	47.37
Decorticator	0.030	0.027	29	34	0.1	0.2	42	43	48.77	48.95
Sugar cane mill	0.023	0.022	203	58	0.8	0.3	209	58	46.69	47.04
Light aircraft	0.020	0.028	6	4	0.0	0.0	6	6	53.05	55.87
Farm size: 70.1–140 ha										
Agricultural wagon	0.014	0.013	1 672	987	12.2	8.1	2 047	1 157	92.48	92.05
Iron plough	0.020	0.014	563	218	4.1	1.8	1 001	267	92.47	92.65
Wood plough	0.018	0.014	2 101	802	15.4	6.6	3 219	991	90.51	92.89
Manual fumigating pump	0.019	0.016	8 739	7 362	63.9	60.4	14 449	10 538	90.27	91.19
Non-manual fumigating pump	0.018	0.015	607	626	4.4	5.1	1 014	849	95.53	91.31
Threshing machines (manual)	0.014	0.012	371	119	2.7	1.0	451	131	91.62	93.43
Threshing machines (mechanical)	0.011	0.011	77	33	0.6	0.3	80	34	94.17	92.00
Tractor	0.017	0.020	552	148	4.0	1.2	856	265	95.67	91.54
Harvester	0.014	0.021	53	23	0.4	0.2	69	41	98.26	92.07
Electric engine	0.016	0.041	354	235	2.6	1.9	522	730	97.58	92.59
Electric generator	0.014	0.013	171	137	1.3	1.1	221	154	97.33	91.36
Grass and sugar cane cutter	0.012	0.012	472	572	3.5	4.7	504	618	95.83	90.98
Pulper machine	0.015	0.012	860	380	6.3	3.1	1 118	403	90.41	92.19

TABLE A10 (cont.) Nicaragua: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by farm size category and item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Coffee mill	0.011	0.012	71	29	0.5	0.2	72	30	95.38	92.32
Rice mill	0.011	0.012	16	10	0.1	0.1	16	10	91.08	89.32
Dryer	0.047	0.033	68	55	0.5	0.5	314	150	96.33	91.30
Saw	0.012	0.012	1 513	1 491	11.1	12.2	1 643	1 593	93.38	90.74
Camioneta	0.013	0.013	1 270	495	9.3	4.1	1 514	569	94.53	91.99
Truck	0.014	0.015	237	112	1.7	0.9	298	148	97.03	91.11
Boat	0.015	0.014	285	222	2.1	1.8	377	265	89.91	90.96
Irrigation pump	0.016	0.015	340	201	2.5	1.6	502	259	95.01	91.00
Decorticator	0.015	0.014	27	18	0.2	0.1	39	21	97.79	93.03
Sugar cane mill	0.011	0.011	120	42	0.9	0.3	120	42	91.10	91.91
Light aircraft	0.018	0.008	4	2	0.0	0.0	6	2	87.07	118.44
Farm size: 140.1–350 ha										
Agricultural wagon	0.007	0.007	1 132	559	16.6	8.9	1 571	681	202.01	197.77
Iron plough	0.007	0.007	394	128	5.8	2.0	565	156	204.43	190.26
Wood plough	0.010	0.007	1 134	493	16.7	7.8	2 205	630	197.89	199.69
Manual fumigating pump	0.011	0.008	4 904	3 765	72.1	59.8	10 310	5 349	195.34	197.34
Non-manual fumigating pump	0.011	0.007	488	329	7.2	5.2	1 030	420	207.61	195.16
Threshing machines (manual)	0.007	0.007	220	62	3.2	1.0	278	79	196.36	201.01
Threshing machines (mechanical)	0.006	0.007	67	20	1.0	0.3	77	28	203.44	209.06
Tractor	0.009	0.007	503	101	7.4	1.6	956	141	210.08	207.84
Harvester	0.011	0.009	89	14	1.3	0.2	190	24	212.79	206.33
Electric engine	0.010	0.006	393	143	5.8	2.3	783	171	206.93	204.00
Electric generator	0.006	0.006	215	77	3.2	1.2	253	93	213.03	197.50
Grass and sugar cane cutter	0.006	0.006	410	308	6.0	4.9	449	344	206.26	196.33
Pulper machine	0.009	0.007	460	137	6.8	2.2	769	177	192.78	189.78
Coffee mill	0.006	0.007	50	9	0.7	0.1	59	10	206.04	168.95
Rice mill	0.005	0.005	14	3	0.2	0.0	14	3	215.03	202.51
Dryer	0.022	0.009	39	18	0.6	0.3	197	31	220.05	199.37
Saw	0.006	0.006	1 270	773	18.7	12.3	1 456	845	199.52	199.44
Camioneta	0.007	0.007	1 115	215	16.4	3.4	1 404	268	203.44	196.59
Truck	0.008	0.009	259	50	3.8	0.8	383	80	205.81	194.15

TABLE A10 (cont.) Nicaragua: Average units per hectare, number of users, shares of farms owning equipment, total items used and average area by farm size category and item, 2001 and 2011

Item	Average (units/ha)		Users (units)		Percentage of users (%)		Total items used (units)		Average area (ha)	
	2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
Boat	0.009	0.006	215	130	3.2	2.1	347	145	196.30	190.07
Irrigation pump	0.008	0.007	288	105	4.2	1.7	423	146	204.17	198.75
Decorticator	0.006	0.007	28	12	0.4	0.2	33	14	206.46	194.14
Sugar cane mill	0.006	0.006	62	26	0.9	0.4	64	28	202.22	188.54
Light aircraft	0.011	0.005	7	1	0.1	0.0	18	1	240.91	197.40
Farm size: >350 ha										
Agricultural wagon	0.003	0.002	551	195	28.3	11.1	1 174	226	782.54	735.15
Iron plough	0.003	0.002	190	41	9.7	2.3	336	47	751.06	933.68
Wood plough	0.004	0.003	417	159	21.4	9.0	979	206	630.09	761.34
Manual fumigating pump	0.007	0.003	1 502	1 013	77.0	57.5	5 801	1 559	671.95	666.62
Non-manual fumigating pump	0.006	0.003	262	102	13.4	5.8	957	140	895.09	616.17
Threshing machines (manual)	0.003	0.002	97	10	5.0	0.6	145	10	703.42	554.17
Threshing machines (mechanical)	0.003	0.002	39	4	2.0	0.2	80	6	833.72	1 724.30
Tractor	0.004	0.002	370	42	19.0	2.4	1 090	55	953.16	876.62
Harvester	0.003	0.003	71	5	3.6	0.3	180	8	1 109.22	525.08
Electric engine	0.004	0.003	237	48	12.2	2.7	859	69	974.68	590.35
Electric generator	0.003	0.003	160	25	8.2	1.4	255	33	1 066.06	659.49
Grass and sugar cane cutter	0.002	0.002	211	80	10.8	4.5	266	81	723.57	710.93
Pulper machine	0.004	0.002	130	48	6.7	2.7	294	55	621.35	542.07
Coffee mill	0.002	0.002	20	5	1.0	0.3	33	5	858.98	413.84
Rice mill	0.001		18	0	0.9	0.0	30	0	2 507.08	
Dryer	0.003	0.004	37	13	1.9	0.7	69	29	967.43	567.20
Saw	0.003	0.002	544	201	27.9	11.4	814	216	761.24	639.38
Camioneta	0.003	0.002	565	84	29.0	4.8	947	96	780.38	631.56
Truck	0.003	0.003	163	23	8.4	1.3	465	30	1 028.70	493.32
Boat	0.004	0.003	135	45	6.9	2.6	317	61	1 243.03	795.97
Irrigation pump	0.004	0.002	208	51	10.7	2.9	706	65	1 111.83	738.50
Decorticator	0.002	0.002	12	2	0.6	0.1	23	2	1 053.86	613.70
Sugar cane mill	0.002	0.002	23	7	1.2	0.4	32	7	1 359.19	497.53
Light aircraft	0.002		9	0	0.5	0.0	19	0	1 588.06	

Source: Authors' own elaboration.

Annex 2. Identifying different types of labour

Nicaraguan censuses

In Nicaragua, the questions about hired labour are divided in two categories: permanent (hired six or more months in the farm) and temporary (hired less than six months). The questions asked in 2001 and 2011 are the same.

There are separate questions about household members working on the agricultural unit, which differ across censuses. The 2001 census asked about the number of household members involved, including the head of the household. The answer was reported for members (male and female) younger and older than 12 years. In 2011, the question was asked to every member older than 10 years old. In both censuses, the question refers to all agriculture and livestock related tasks. To have a uniform indicator, we create a variable with all the household members, including the head, who are older than 12 and work in the farm.

Finally, we calculate the number of farmers, which is not explicitly reported in the censuses. Individual producers are identified, but some individual producers may devote their time to other economic activities. Therefore, we approximate the number of farmers by counting the agricultural units in which: i) the interviewee declares directly working the farm, and ii) the interviewee does not work off-farm. In doing so, our calculation may underestimate the labour of farmers. Both censuses used the same wording for the relevant questions.

Table A11 lists all the questions used in these calculations.

Peruvian censuses

In Peru, the questions about hired labour are divided in two categories: permanent and temporary. The questions asked in 1994 and 2012 are the same.

As in Nicaragua, the questions about household labour differ across censuses. In 1994, the question is about the whole household, and the answers reported as the total number of male and female members involved in farm activities, separated between those older and younger than 15. In 2011, the question was asked to every household member older than 6. The wording of the questions is similar. We calculate farm labour of household members (other than the head) older than 15.

Finally, to calculate the number of farmers, we use criteria like Nicaragua. We count the individual producers meeting the following conditions: i) absence of a remunerated farm manager, and ii) the interviewee does not work off-farm to gain extra income. Both censuses used similar wording for the relevant questions.

Table A11 lists all the questions used in these calculations.

TABLE A11 Spanish version of the questions about labour in every census and country

Nicaragua	2001	2011
Permanent labour	*¿Cuántas personas se contrataron para trabajar permanentemente, por seis meses o más, en las labores agrícolas y/o ganaderas, durante el año agrícola 2000-2001?*	*¿Cuántas personas se contrataron para trabajar permanentemente, por seis meses o más, en las labores agrícolas y/o ganaderas, durante el año agrícola 2010-2011?*

TABLE A11 (cont.) Spanish version of the questions about labour in every census and country

Nicaragua	2001	2011
Temporary labour	*¿Cuántas personas se contrataron para trabajar temporalmente, por menos de seis meses, en las labores agrícolas y/o ganaderas, durante el año agrícola 2010-2001?*	*¿Cuántas personas se contrataron para trabajar temporalmente, por menos de seis, en las labores agrícolas y/o ganaderas, durante el año agrícola 2010-2001?*
Household labour in the farm (includes the head)	*Incluyéndose usted, ¿cuántas personas de su hogar trabajaron en labores agrícolas o ganaderas en su EA durante el año 2000-2001?* *(Llenar tabla con el número de hombres y mujeres menores y mayores de 12 años)*	*Se preguntó a cada miembro del hogar:* *-Edad* *-(Mayores de 10 años) ¿Durante este año agrícola, trabajó en actividades agropecuarias dentro de la EA?*
Identification of farmers	(Working directly on the farm) *¿Quién está manejando la explotación agropecuaria?* *(Opción de respuesta 1)* *El productor o productora directamente.* *(Off-farm labour supply)* *Durante el año agrícola 2000–2001, además de trabajar como productor(a) agropecuario, ¿realizó otro trabajo dentro o fuera de la explotación agropecuaria?*	(Working directly on the farm) *¿Quién está manejando la explotación agropecuaria?* *(Opción de respuesta 1)* *El productor o productora directamente.* *(Off-farm labour supply)* *¿Durante el año agrícola 2010–2011, además de trabajar como productor(a) agropecuario, realizó otro trabajo dentro o fuera de la explotación agropecuaria?*
Peru	**1994**	**2012**
Permanent and temporary labour	*(Durante la campaña anterior)* *¿Cuántos trabajadores remunerados, hombres y mujeres, ha tenido permanentemente o de manera eventual la UA? (Incluye al administrador)* *(Llenar una tabla con el total de permanentes y eventuales, separados en hombres y mujeres)*	*En la última campaña agrícola, de agosto 2011 a julio 2011, ¿ha tenido trabajadores remunerados?* *(Llenar una tabla con el total de permanentes y eventuales, separados en hombres y mujeres)*
Household labour in the farm (does not include the head)	*¿Cuántas personas conforman el hogar censal y de ellas cuántas participan en labores agrícolas o pecuarias de su UA?* *(Llenar tabla con el número de hombres y mujeres menores y mayores de 15 años, separados en hijos/as y otros)*	*Se preguntó a cada miembro del hogar:* *-Edad* *-(Mayores de 6 años) ¿Participa en las labores agrícolas de sus parcelas o chacras o en la crianza de sus animales?*

Source: Authors' own elaboration.

Annex 3. Glossary

TABLE A12 Definition of land use categories

Concept	Nicaragua		Perú	
	Concept (Spanish)	Definition	Concept (Spanish)	Definition
Annual crops	Cultivos anuales y temporales	Crops with a less than one-year growing cycle and which must be newly sown or planted for further production after the harvest. (1) and (2)	Cultivos transitorios	Crops with a less than one-year growing cycle and which must be newly sown or planted for further production after the harvest. (3)
Fallow land	Tierras en descanso y tacotales	Area no cultivated for a period of three to five years that will be cultivated in the future and was cultivated in the past. (1) and (2)	En descanso	Land that is not used during a period larger than a year and which could be if 15 years. The purpose is to recover fertility. This category was recorded only in Selva region. (3)
To be cropped Not cropped			En barbecho Tierras agrícolas no trabajas	Land that will be cultivated withing the agricultural year. (3) This land will not be cultivated due to problems as lack of water, lack of credit and lack of labour. (3)
Permanent and semi-permanent crops	Cultivos permanentes y semipermanentes	In 2001, it is defined as crops that no need to be replanted after every harvest, the growing cycle lasts more than one year, and the crop is compactly distributed in the area. (1) In 2011, it is defined as crops that no need to be replanted after every harvest, the growing cycle lasts more than one year. These crops may be of any age (productive or not). (2)	Cultivos permanentes propiamente dichos	The productive cycle is longer than a year and require an investment. Include cacao, coffee and production of fruits
Cultivated pastures	Pastos cultivados	Area mostly dedicated to pastures cultivated for livestock or harvesting and under some agricultural practice. (1) and (2)	Pastos en la categoría de cultivos permanentes	Cultivated pastures, with alfalfa, rye grass and others. (3)

TABLE A12 (cont.) Definition of land use categories

Concept	Nicaragua		Perú	
	Concept (Spanish)	Definition	Concept (Spanish)	Definition
Forest plantations			Cultivos forestales	Forest plantations. (3)
Forests	Bosques	In 2001, it is defined as the area covered with bushes or trees growing naturally or planted, that could have value because of the production of firewood, wood, or other forest products. (1) In 2011, it is defined as the area mostly covered by trees of at least five meters height growing naturally or planted, that could have value because of the production of firewood, wood, or other forest products. (2)		
Natural pastures	Pastos naturales	Area mostly dedicated to pastures established and developed spontaneously. (1) and (2)		
Infrastructure (buildings and roads)	Instalaciones y viales	Infrastructure built in the agricultural unit; for example, houses, roads, storage facilities, etc. (1) and (2)		
Swamps	Pantanos, pedregales y otras	Land that cannot be cultivated because it is covered by low water or loose stones. (1) and (2)		
Affected by natural disasters	Afectado por desastres naturales	Area affected by floods, storms, hurricanes, etc. (1)		
Arable land			Tierras de labranza	Comprises annual crops, fallow land, not to be cropped and to be cropped. (3)
Permanent uses			Cultivos permanentes	Comprise permanents crops, permanent pastures and forest plantations. (3)
Associated crops			Cultivos asociados	Crops cultivated in the same area for which it is impossible to calculate the area separately (3)
Non-agricultural land			Superficie no agrícola	Natural pastures, forests and others. (3)

Source: Authors' own elaboration.

TABLE A13 Names employed for machinery and tools

English	Nicaragua	Perú
Agricultural wagon	Carreta	
Iron plough	Arado de hierro de tracción animal (mejorado)	Arado de hierro
Wood plough	Arado de madera de tracción animal(tradicional)	Arado de palo
Manual fumigating pump	Bombas de fumigación manual	Fumigadora manual
Non-manual fumigating pump	Bombas de fumigación a motor	Fumigadora a motor
Threshing machines (manual)	Desgranadora manual	
Threshing machines (mechanical)	Desgranadora mecánica	
Tractor	Tractor	
Harvester	Cosechadora	
Electric engine	Motor eléctrico	
Electric generator	Generador eléctrico	
Grass and sugar cane cutter	Picadora de pasto y/o caña	
Pulper machine	Despulpadora	
Coffee mill	Trilladora de cafe (Beneficio)	
Rice mill	Trilladora de arroz (Beneficio)	
Dryer	Secadoras	
Saw	Motosierra	
Truck	Jeep / Camioneta Camión	Camioneta
Boat	Bote / Lancha o Panga	
Irrigation pump	Bombas de riego	
Decorticator	Descortezadora	
Sugar cane mill	Trapiche	
Light aircraft	Avioneta	
Well pump		Bomba para pozo
Chaquitacllas		Chaquitacllas
Grain mill		Molino para grano

Source: Authors' own elaboration.

Structural change is a process in which the amount of labour, capital and land dedicated to agriculture (and other sectors) changes over time. In this study, we focus on the cases of Peru and Nicaragua using their two most recently administered agricultural censuses. The agricultural censuses permit us to identify dimensions and information available to study the process of structural change in Latin America over the last 20 years.

The study includes a comparative analysis and policy recommendations based on the two most recent agricultural censuses administered in Nicaragua (2001 and 2011) and Peru (1994 and 2012). Processing and analysing information from these censuses contribute to identifying dimensions and information available to study the process of structural change in Latin America over the last 20 years.

Evidence-based policymaking is increasingly more at the core of the United Nations and member countries' activity. In the case of FAO, this type of study is crucial to build the knowledge body on which projects and activities are carried forward. The Hand-in-Hand (HiH) initiative is a key example in this context, as it aims at quantitatively identifying high-impact and high-agricultural potential areas in which to invest within developing countries. As Nicaragua and Peru are HiH's target countries, this study will show very useful to learn about their recent experiences in agricultural transformations.

18

FAO AGRICULTURAL DEVELOPMENT ECONOMICS TECHNICAL STUDY

The FAO Agricultural Development Economics Technical Study series collects technical papers addressing policy-oriented assessments of economic and social aspects of food security and nutrition, sustainable agriculture and rural development.

The series is available at www.fao.org/economic/esa/technical-studies

FOR FURTHER INFORMATION

Agrifood Economics - Economic and Social Development

- www.fao.org/economic/esa
- ESA-Director@fao.org

Food and Agriculture Organization of the United Nations (FAO)

Rome, Italy

ISBN 978-92-5-136797-1 ISSN 2521-7240

9 789251 367971

CC1723EN/1/08.22