

Guinea Pig Breeding, Consumption, Prices, and Exports in Peru: What Do the Statistical Sources Say?¹

To my dear friends from San Juan de Pacota

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Abstract. This article aims to compile and estimate the stock, breeding, and consumption of guinea pigs in Peru from a long-term perspective, using data from agricultural censuses and a market perspective based on household surveys, agricultural surveys, and export data. The objective is to provide a quantitative and market-oriented approach to the current situation of guinea pig breeding and consumption in Peru. The guinea pig is an important source of protein and holds significant historical and cultural value, as it was one of the first animals domesticated in pre-Hispanic times.

The results reveal a lack of diversification in export markets, which are primarily concentrated in the United States. Additionally, it is revealed that companies exporting guinea pigs are often multiproduct exporters for which guinea pig is not the main product but a complementary one.

Despite the significant price increases in the Peruvian agricultural sector, it is not evident that breeders directly benefit from this rise due to the high level of self-consumption. As regards sales, the main places where consumers buy guinea pigs are retail markets and street vendors. Therefore, a strategy focused on selling large quantities of guinea pigs should consider retail markets, while a strategy targeting higher prices but lower volumes could

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focus on exports and sales to restaurants, which have higher prices but lower sales volumes in kilograms. This study also finds that sales of guinea pigs are more regular than self-consumption.

The main contribution of this article is to offer different estimates of guinea pig sales, consumption, and stock based on agricultural censuses, agricultural surveys, and household surveys, opening up the possibility for similar research on other important animal stocks. This can allow entrepreneurs, researchers, and policymakers to make more realistic projections and ground-based strategies to generate value and promote welfare. Understanding the sales and consumption patterns of these animals will help improve productivity policies and market integration for those engaged in livestock breeding.

Keywords: guinea pigs, husbandry policy, husbandry in international trade, agricultural markets and marketing, agribusiness

Cría, Consumo, Precios y Exportaciones de Cuyes en el Perú: ¿Qué Dicen las Fuentes Estadísticas?

Resumen. Este artículo tiene como objetivo compilar y estimar el stock, la cría y el consumo de cuyes en el Perú desde una perspectiva a largo plazo, utilizando datos de censos agropecuarios y una perspectiva de mercado basada en encuestas de hogares, encuestas agropecuarias y datos de exportación. El objetivo es proporcionar un enfoque cuantitativo y orientado al mercado sobre la situación actual de la cría y el consumo de cuyes en el Perú. El cuy es una fuente importante de proteínas y posee un significativo valor histórico y cultural, ya que fue uno de los primeros animales domesticados en tiempos prehispánicos.

Los resultados revelan una falta de diversificación en los mercados de exportación, los cuales están principalmente concentrados en Estados Unidos. Además, se observa que las empresas exportadoras de cuyes suelen ser exportadoras multiproducto, para las cuales el cuy no es el producto principal, sino uno complementario.

A pesar de los aumentos significativos en los precios del sector agropecuario peruano, no es evidente que los criadores se beneficien directamente de este incremento debido al alto nivel de autoconsumo. En cuanto a las ventas, los principales puntos donde los consumidores adquieren cuyes son los mercados minoristas y los vendedores ambulantes. Por lo tanto, una estrategia enfocada en la venta de grandes cantidades de cuyes debería considerar los mercados minoristas, mientras que una estrategia orientada a precios más altos pero menores volúmenes podría enfocarse en las exportaciones y las ventas a restaurantes, donde los precios son

más altos pero los volúmenes de venta en kilogramos son menores. Este estudio también encuentra que las ventas de cuyes son más regulares que el autoconsumo.

La principal contribución de este artículo es ofrecer diferentes estimaciones sobre las ventas, el consumo y el stock de cuyes basadas en censos agropecuarios, encuestas agropecuarias y encuestas de hogares, abriendo la posibilidad de investigaciones similares sobre otros animales importantes. Esto puede permitir a empresarios, investigadores y formuladores de políticas realizar proyecciones más realistas y estrategias basadas en la realidad para generar valor y promover el bienestar. Comprender los patrones de venta y consumo de estos animales ayudará a mejorar las políticas de productividad y la integración de mercados para quienes se dedican a la crianza de ganado.

Palabras clave: cuyes, políticas de crianza, crianza en el comercio internacional, mercados y comercialización agropecuaria, agronegocios.

Introduction

The discussion on Peru's total stock of guinea pigs is abundant in the literature. Experts on the issue have arrived at different estimates. In the 1990s Aliaga, in the introduction to a document prepared by the National Agrarian Research Institute (Instituto Nacional de Investigación Agraria, 1994), quoted the figure of 1,278,100 guinea pigs published in *El Agro en Cifras*, the monthly bulletin of the Ministry of Agriculture and Irrigation. On the other hand, Morales, citing Zaldívar and Chauca (1990), referred to a National Institute of Agrarian and Agroindustrial Research (INIAA) estimate of around 30 million guinea pigs (Morales, 1994). Thus, there have never been single, nor even close, estimates of the overall number of these animals.

The guinea pig, along with the native duck, llama, alpaca, and dog, were domesticated by Andean people before the arrival of the Spaniards (Gade, 1967), so their study is crucial for historical reasons. However, the guinea pig is also worthy of study for economic reasons (Morales, 1994): in many parts of Peru it is one of the few sources—or sometimes the only source—of protein, and, as will be seen later, it represents a growing though still incipient market.

Understanding guinea pig stock levels, breeding, consumption habits, and export trends will allow producers to serve the market more efficiently and humanely, while also improving our strategies for poverty alleviation and wealth generation. It is not enough for small-scale Peruvian producers to simply surpass certain definitions of poverty; they should also aspire to producing high-quality animals with greater profit margins, better integration into commercial chains, and greater environmental sustainability. It is also vital that the inherent advantages of the goods they produce and sell are complemented by management improvements with an emphasis on food safety and logistical efficiency.

Besides the report on the guinea pig value chain (Ministerio de Desarrollo Agrario y Riego, 2023) and attempts to estimate guinea pig demand (Castillo, 2019), thus far the literature has not fully utilized National Household Surveys (ENAHOs) or National Agricultural Surveys (ENAs) to conduct diagnoses of the guinea pig market. This is a gap this study fills. And although the aforementioned study on the value chain (Ministerio de Desarrollo Agrario y Riego, 2023) did use the agricultural census, it did not complement this with techniques such as geoprocessing. With exploratory spatial data analysis, spatial trends and corridors of guinea pig production can be found at a highly granular level.

This study aims to conduct an explanatory data analysis of the stock, consumption, prices, and export of guinea pigs, as well as associated trends,

based on the available statistics. It seeks to present the data, discuss market trends, and provide some recommendations. The data sources are agricultural census, export data compiled by ADEX, Peru's export association; household surveys; and agricultural surveys. Besides this introduction, the references and appendix, the article is organized into four sections. Section 1 provides a review of the recent literature on guinea pigs. Section 2 discusses the data cleaning process required for the working datasets. Section 3 provides the estimates. Finally, section 4 provides the conclusions and recommendations.

I. Recent literature on guinea pigs

In the international business literature on guinea-pig production, 78 theses or other university-related documents and only 7 journal articles were identified. Of these, only 75 are citable (published), spanning 2004 to 2024. The number of identified publications by country is as follows: Peru (47), Ecuador (20), Bolivia (5), Venezuela (2), and Colombia (1). These documents were found through searches on JSTOR, Google Scholar, and EBSCO. However, notably, only Google Scholar yielded significant documentation. Most results of a keyword search for “guinea pig” were unrelated to business, with articles in the fields of medicine or experimentation predominating. Therefore, “cuyes,” the South American Spanish term for the animal, was ultimately selected as the keyword.

Two of the documents reviewed, both theses published by Universidad Peruana del Norte, identified multiple documents—30 and 20 articles, respectively—as part of a systematic review of guinea pig exports (Marchena & Salcedo, 2023; Ramos, 2020). Both studies found that Peru and Ecuador have more publications on the subject than any other country, providing an earlier indicator that these are the countries in which this field of research is most significant. In the present article, 19 documents related to exports and 32 to the domestic market were found. Of these, 45 documents were business plans or descriptive studies focusing primarily on the domestic market. Key examples include Adrianzen (2023), Diaz et al. (2023), Quijada et al. (2023), and Reyes et al., (2024). Only one thesis used Peru's National Household Survey to attempt to estimate demand for guinea pigs (Castillo, 2019). Two documents studied the relations between mining social responsibility projects and guinea pig promotion (Diez, 2016; Injoque, 2024). Seven explored the connection between association membership and strategies or competitiveness in guinea pig breeding (Anaya, 2020; Briceño & Mas, 2017; Gutiérrez, 2023; Lopez & Merma, 2024; Luna & Padilla, 2015; Pazmino & Vásconez, 2014; Puetate, 2016).

Overall, Peru exports more guinea pigs than Ecuador and the United States is the main buyer (Taípe-Lucas et al., 2021). Of the 7 journal articles identified, 2 focused on exports (Estrada & Velastegui, 2021; Taípe-Lucas et al., 2021) and the rest on the domestic market. Studies have centered on the degrees of acceptance of different forms of guinea pig meat (Argote et al., 2009) and on new forms of processing guinea pig and rabbit meat, such as curing (Pallarico, 2018), though evidence of the potential for sustainable demand remains unclear. Other analyzed the guinea pig value chains at different levels (Aliaga Balbín, 2016; Fernandez & Iliquin, 2022; Ministerio de Desarrollo Agrario y Riego, 2023; Rivera, 2020).

In turn, some studies have explored the Lima market for guinea pigs (Chirinos et al., 2008; Corpus & Morón, 2022; Farje et al., 2021; Ordóñez Noriega, 2003; Yataco et al., 2022). Most of these studies conducted surveys based on their own methodologies and did not draw on ENAs or ENAHOs which, in general, have larger samples of interviewees. Other studies sought to determine the feasibility of processing plants (Astudillo & Millingale, 2022; Camacho, 2011; Luna & Padilla, 2015; Salazar et al., 2024). As useful as this research is, understanding the overall stock of guinea pigs would improve focalization and inform decisions on where to locate these kinds of investments. Finally, although there are studies that explore the relationship between development and guinea pigs, these account for a small minority (Castro, 2018; Condori, 2010).

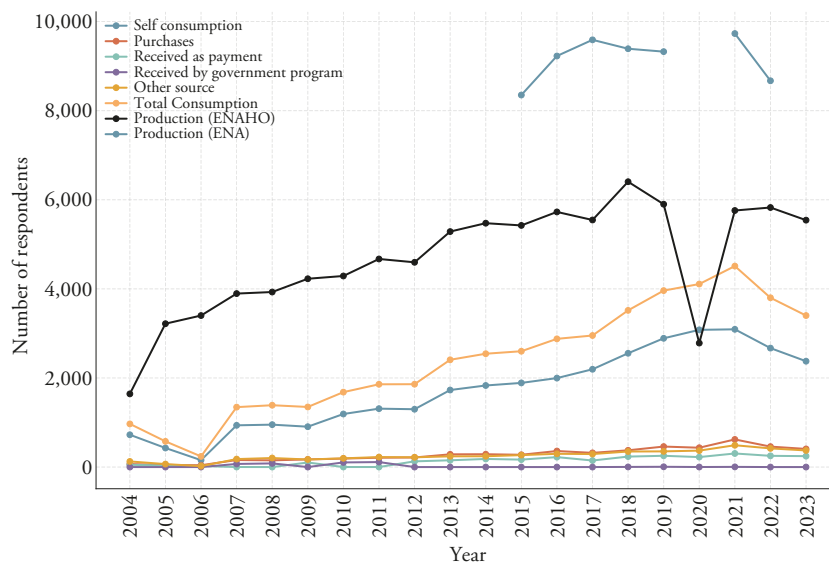
II. Data cleaning

In the present study the data sources are of four types: census, surveys, administrative records, and reports. The census, in theory, reflects the total stock. Surveys are based on samples. Administrative records only record what is formal. Reports, normally, are based on a combination of the other sources. Figure 1, below, shows the data collected by the surveys on guinea pig consumption and production. As can be seen, most entries are for the ENA, followed by the ENAHO module related to production and then by the ENAHO consumption module. It is important to note that in 2020 there was no ENA and that the entries for the production module of the ENAHO dropped significantly.

Overall, the number of respondents increased over time, but the majority of entries are for ENA, production ENAHO, and self-consumption ENAHO. The information prior to 2007 does not appear reliable for the case of consumption. The data cleaning process is complex because there are no consistent or consensual ways of classifying guinea pig consumption under ENAHO. The data is somewhat raw, so collecting, cleaning, and curating

represents a key step before any analysis and discussion. Still, acknowledging all the pitfalls of these data sources, they remain valuable. It is important to note that specific cleaning processes would have to be performed if This study were to be replicated for other agricultural products.

Figure 1
Number of ENA and ENAHO respondents reporting consumption or production of guinea pigs, by categories (2004–2023)



Source: Prepared by the author using data from the livestock production modules (INEI, 2004a, 2005a, 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a, 2013a, 2014a, 2015a, 2016a, 2017a, 2018a, 2019a, 2020a, 2021a, 2022a, 2023a) as well as the consumption modules reported by the household head (INEI, 2004b, 2005b, 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b, 2013b, 2014b, 2015b, 2016b, 2017b, 2018b, 2019b, 2020b, 2021b, 2022b, 2023b) from ENA and the ENAHO (INEI, 2015c, 2016c, 2017c, 2018c, 2019c, 2021c, 2022c)

Note: There was no ENA in 2020 due to the COVID-19 outbreak.

2.1 Guinea Pig Stock

As noted, when it comes to the stock of guinea pigs, there are two main sources of annual surveys. The first is the agricultural production module of the ENAHO, and the second one is the ENA. To this should be added the National Census of Agriculture, which to date has been conducted four times. On this basis, a long-term estimate of the total numbers of guinea pigs can be generated. The main difference between the consumption and the production modules is that the measurement units differ. The former utilizes kilograms of guinea pigs consumed whereas the latter focuses on the number of guinea pigs. Therefore, comparisons between the two are

not straightforward. In the ENAHO, Variable P2500B contains the code for each species of animal, while Value 3802 is the specific code for guinea pigs. The filtering process is straightforward for all the years. The codes are presented in Appendix, Part 1.

In the case of the ENA, there is available information from 2014. However, the variable that contains the estimated stock of guinea pigs is missing for that year, while from 2015 to 2022 the information on the stock of guinea pigs is contained in Variable P401A, with 7 being the code for guinea pigs. The filtering process can be seen in the Appendix, Part 3.

In the case of the microdata from the 2012 Agricultural Census, Question P067_01 contains information on the codes for each animal, that for guinea pigs being 757. Because the dataset has more than 9 million observations, the data is collapsed to ascertain how many agricultural units there are per “agricultural numeration sector”, how many in turn produce guinea pigs, and the number of guinea pigs per SEA. The code to extract the information from the module related to animals in the census is provided in the Appendix, part 4.

2.2 National Consumption and Exports

The ENAHO contains a module with information on the population's consumption. Each year, this module has two variables, p601a and produc61, which denote the product code and the National Institute of Statistics and Informatics (INEI) reclassification of that code, respectively. Since 2007 a further variable has been included in the ENAHO: P601X, which is the label as it appeared in the survey. Because guinea pig tends not to be consumed regularly and is therefore not a major meat in the Peruvian diet, it was necessary to analyze all reported forms of purchase and consumption. Therefore, as a stage prior to the data cleaning process, all forms of guinea pig meat labeled using P601X were identified. Unfortunately, this could not be done prior to 2007 or in 2011, for which there is no information on that variable. Therefore, all the responses in which respondents explicitly reported guinea pig consumption were filtered. For 2011 and the years prior to 2007, the information contained in P601A and produc61 was used to identify guinea pig consumption. The code filtered for each year can be seen in Appendix 1, Part 2. It should also be noted that the expansion factors matter, and a different one was chosen for 2020.

For exports, the database systematized by ADEX (2024) was used. Before conducting any analysis of exports, it was necessary to identify the corresponding tariff codes. In the case of guinea pigs, two product categories have been established:

- 1) Live guinea pigs: 0106190000
- 2) Vacuum-packed guinea pigs: 0208900000 up to August 2022 and 0208900010 after that month (Supreme Decree No. 194-2022-EF, 2022).

III. Estimates

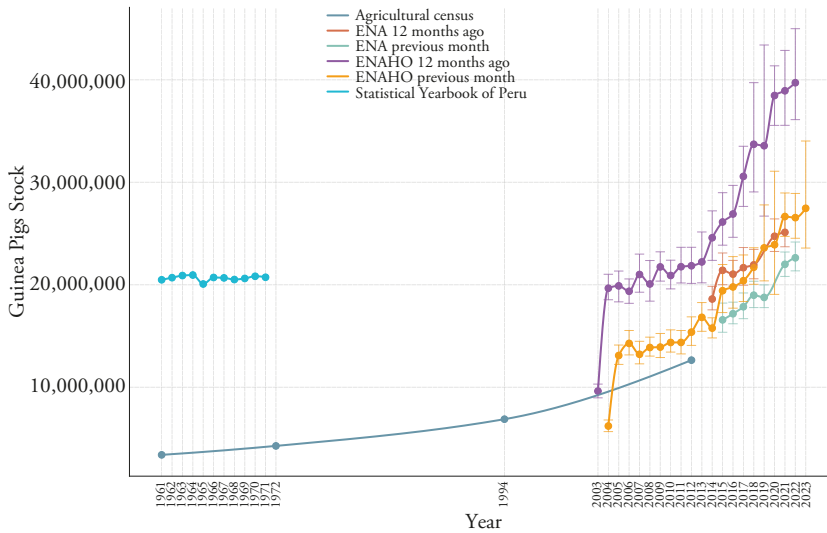
This section provides estimates of guinea pig stock, consumption, and exports based on the datasets cleaned previously. Each of these estimates were prepared using Python with the exception of those presented in Figure 4, which were prepared using ArcGIS Pro.

3.1 Guinea Pig Production: Not a Unique Number

Estimating Peru's guinea pig stock is problematic. According to the country's First National Agricultural Census, in 1961 there were around 3,400,000 guinea pigs (Dirección Nacional de Estadística y Censos, 1964), while the Statistics Office of the Ministry of Agriculture, cited in the *Anuario Estadístico del Perú 1971* (Presidencia de la República–Primer Ministro, 1971), found that there were 20,485,000 guinea pigs in 1971. Moreover, some experts of the day (Lozano et al., 1970) found there were around 21 million animals in 1965, whereas the Statistical Yearbook reported 20,076,000 (Presidencia de la República-Primer Ministro, 1971).

Figure 2 shows the different sources from which the guinea pig stock is calculated. Confidence intervals have been added for the data drawn from surveys. Both household and agricultural surveys contain information about the previous month and information from 12 months previously. The highest estimates were found using the ENAHO question about quantities produced 12 months ago. It is interesting to note that the ENA estimates for 12 months previously and the ENAHO estimates for one month previously render statistically equal estimates from 2015. Something similar happens with the ENA previous month and the ENAHO previous month estimates. In any case, the stock shows an upward trend across all estimates as the years go on. In the most recent years, estimates of guinea pig stocks range from a little more than 20 million in 2022 to a little under 45 million the same year depending on the method of counting. These differences could be related to a high degree of stock volatility throughout the year (with seasonality, for example). Therefore, a census—measured faster than surveys—will vary depending on the dates, whereas the surveys may be more stable because they are conducted quarterly.

Figure 2
Evolution of guinea pig stocks in Peru, 1961–2023

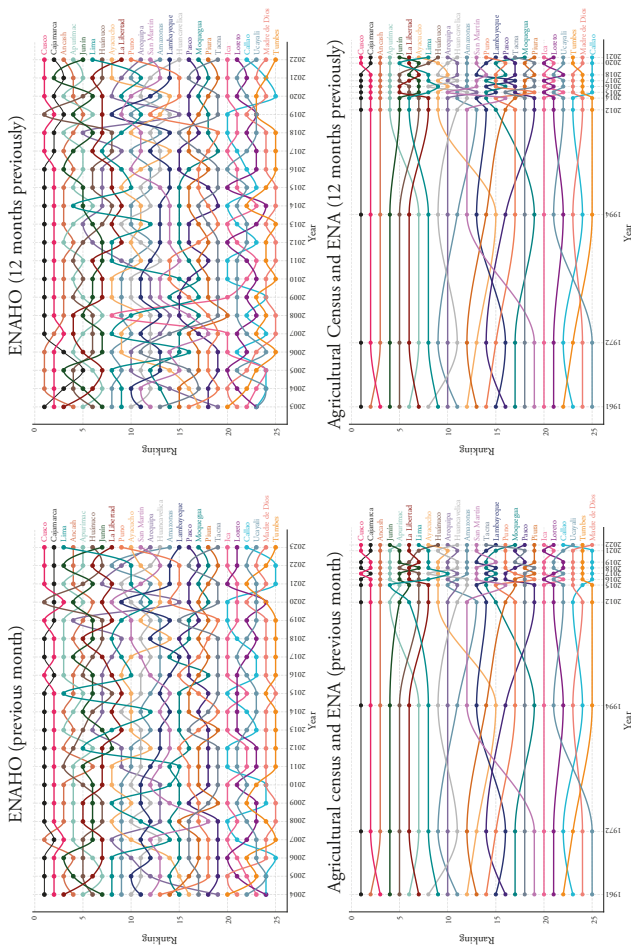


Source: Prepared by the author using data from agricultural censuses (Dirección Nacional de Estadística y Censos, 1964; INEI, 1994, 2012c; ONEC, 1975); the livestock production modules (INEI, 2004a, 2005a, 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a, 2013a, 2014a, 2015a, 2016a, 2017a, 2018a, 2019a, 2020a, 2021a, 2022a, 2023a) and the consumption modules reported by the household head (INEI, 2004b, 2005b, 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b, 2013b, 2014b, 2015b, 2016b, 2017b, 2018b, 2019b, 2020b, 2021b, 2022b, 2023b) from the ENAHO and the ENA (INEI, 2015c, 2016c, 2017c, 2018c, 2019c, 2021c, 2022c); and the guinea pig stock report from the *Anuario Estadístico del Perú 1971* (Presidencia de la República–Primer Ministro, 1971).

Note: The information between census years as well as for 2020 (previous month) and 2019 (12 months previously) from the ENA were interpolated using monotonic cubic interpolations with the PchipInterpolator from the *scipy.interpolate* library in Python. Confidence intervals for the surveys were calculated using bootstrapping with 95% confidence.

Figure 3 presents the regional ranking of guinea pig stocks in four panels. Panels 1 and 2 provide the ENAHO information. Panels 3 and 4 provide the ENA and the Agricultural Census information. Ica, Loreto, Callao, Ucayali, Madre de Dios, and Tumbes are regions in which the stock of guinea pigs is negligible. Cusco, Cajamarca, and Ancash are the regions with the largest guinea pig stocks since 1961, with only Panel 1 ranking Lima among the top three more recently. The figures for the other regions vary depending on the measurement approach used and the year. Confidence intervals were not added so as not to further complicate the analysis. However, there are some orders that are consistent, particularly in the top and the bottom.

Figure 3
Regional guinea pig Production Regional Ranking in Peru, 1961-2023



Source: Prepared by the author using data from agricultural censuses (Dirección Nacional de Estadística y Censos, 1964; INEI, 1994, 2012; ONEC, 1975), the livestock production modules (INEI, 2004a, 2005a, 2006a, 2007a, 2008a, 2009a, 2010a, 2011a, 2012a, 2013a, 2014a, 2015a, 2016a, 2017a, 2018a, 2019a, 2020a, 2021a, 2022a, 2023a) as well as the consumption modules reported by the household head (INEI, 2004b, 2005b, 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b, 2013b, 2014b, 2015b, 2016b, 2017b, 2018b, 2019b, 2020b, 2021b, 2022b, 2023b) from the ENAHOs and ENAs (INEI, 2015c, 2016c, 2017c, 2018c, 2019c, 2021c, 2022c).

Census data was used for the more granular level of analysis. In the census, districts are divided into “agricultural enumeration sectors” (SEAs); since guinea pig data at the SEA level do not have a bell-shaped distribution, it was necessary to process them. To this end, the following transformation was used:

$$\widehat{Stock}_i = \log_2 \left(\frac{Stock_i}{Area_i} + 1 \right) \dots (1)$$

Where:

$Stock_i$ is the guinea pig stock for SEA i.

$Area_i$ is the default area measured in square degrees for the polygon of each SEA i.

$\widehat{Stock}_i$ is the guinea pig density measured in units by square degree SEA i.

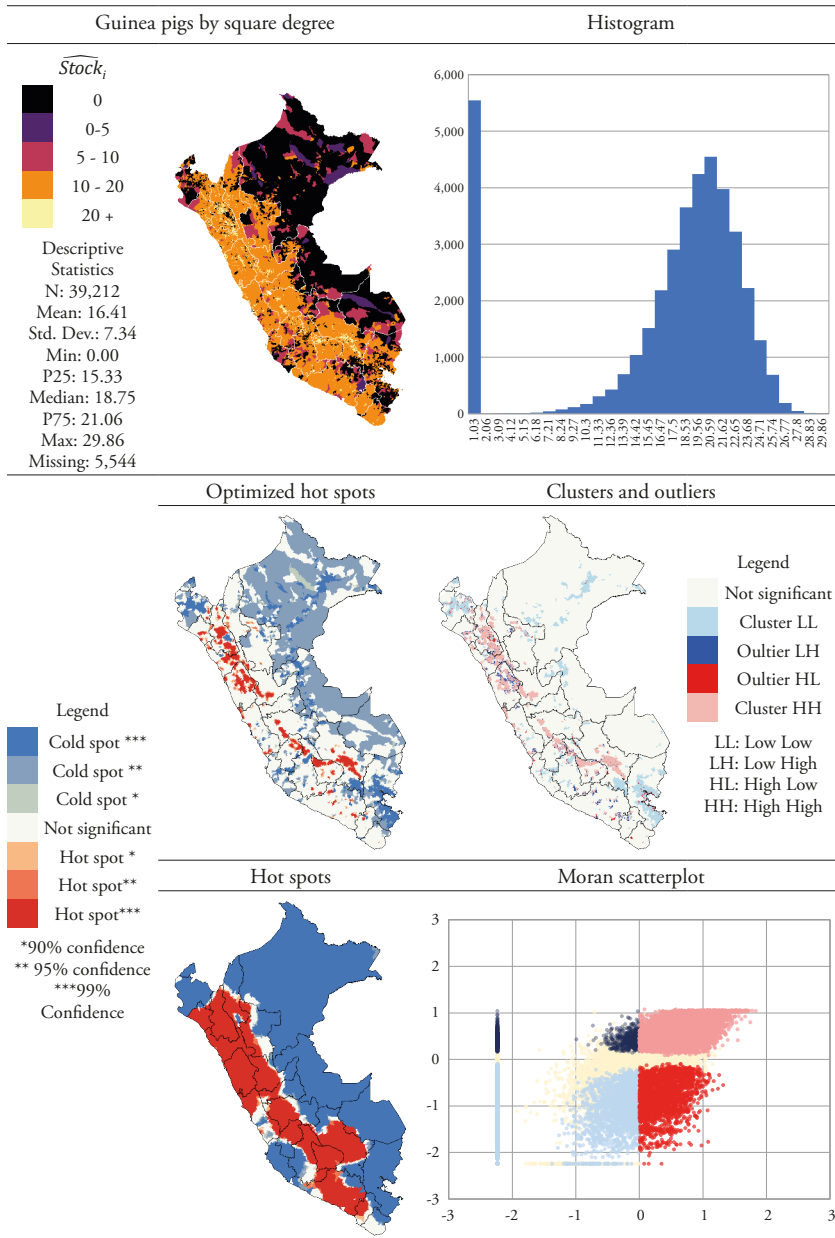
The base-2 logarithm was used because it informs about the complexity, understood as stock density, of the indicator as it doubles (Boserup, 1976). Thus, the stock densities, which provide more information than the stock data alone, are what is mapped. Thereafter, cluster and outlier analysis (ArcGIS Pro 3.0, 2022c), optimized hot spot analysis (ArcGIS Pro 3.0, 2022b), and simple hot spot analysis (ArcGIS Pro 3.0, 2022a) were performed. These exploratory spatial data analysis techniques allow identification of whether high values of a variable are adjacent to other high values and whether low values are adjacent to other low values, as well as whether low extreme values are adjacent to high values and vice versa (Getis & Ord, 1992; Ord & Getis, 1995).

Figure 4 represents the variable $\widehat{Stock}_i$ which is not interpreted in absolute terms but in relative terms. There are six panels in this figure. In Panel 1, the value of the indicator in each SEA has its own color, as explained in the legend. The places where the SEAs are yellow are the places with the highest densities of stock. Other measurements of density, such as the number of guinea pigs per number of agricultural units inside each SEA, require similar transformations, as in Equation (1). The results and patterns remain similar. The same also holds true when dividing by the human population. The main difficulty with this last method is that only agricultural laborers are counted rather than the total population, because human population at the SEA level is not available. However, all patterns are similar. It should be noted that there are many SEAs in which there are no guinea pigs, as can clearly be seen in the histogram (the first column is the number equal to 0). The local Moran scatterplot shows the different kinds of SEA present in the cluster and outlier map.

Figure 4 allows identification of a high-density guinea pig route of “optimized hot spots” that stretches from Junín to Cusco, and another that passes through Cajamarca, La Libertad, Áncash, and Huánuco (second panel from the left). Additionally, the guinea pig stock is statistically cold or of low density in Puno, Amazonia, and the coastal desert in all our measurements (classic and optimized hot spots). Guinea pig breeding in Lima is concentrated in a few specific locations. Similarly, guinea pig breeding in Arequipa does not appear to create corridors; rather, there are unusually high values surrounded by essentially cold zones. This micro-spatial analysis is consistent with the historical and survey analysis shown in Figure 3.

The optimized hot spots could inform the design of “guinea pig routes” and, in turn, inspire specific academic studies on these stocks and their characteristics, investment opportunities for businesses, and state intervention strategies to increase quality and income at central and local levels. High densities of animal stocks tend to be clustered around roads. These maps are not included in this article due to space limitations. Moreover, understanding why there are hotspots associated with this variable goes beyond the scope of this article.

Figure 4
Guinea pig stock density: Hotspot analysis and extreme values in 2012



Source: Compiled by author based on the 2012 National Census of Agriculture (INEI, 2012c).

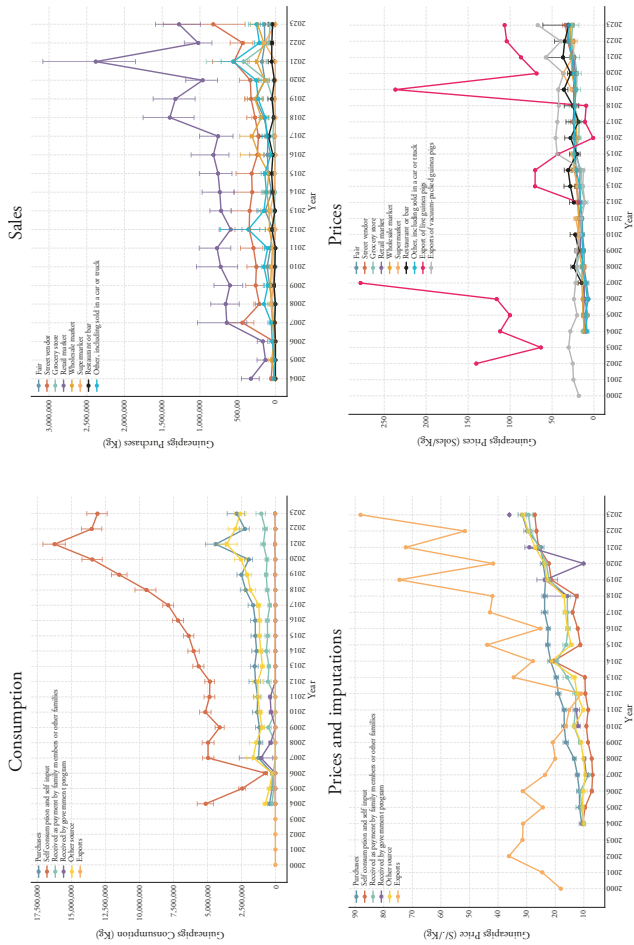
3.2 National Consumption and exports: A large internal market, a small external market

This section sheds light on key features of guinea pig consumption and purchases together with consumption habits and prices. In Figure 5, four panels related to this issue are plotted. Panel 1 on the left explores the consumption of Peruvian guinea pigs. It can be seen clearly that most consumption of guinea pigs is related to self-consumption or self-input. This difference is statistically significant since the confidence intervals do not overlap. Exports are negligible in terms of kilograms. On the second panel on the left, prices can be seen. The highest prices are for exports, before local sales prices. The rest of the prices are imputations by the INEI. As can be seen, the imputed prices are far lower than the average prices and, in general, the differences are statistically significant, except for some years. Self-consumption represents between, roughly, 300 million soles and 400 million soles. Sales never went beyond 100 million soles in the average estimates and seldom became statistically different than the “others” category.

It is worth noting that guinea pigs are also used as payment or gift to others. However, it's worrisome that a huge amount of consumption is grouped in the other source category. Analyzing the sum of consumption since 2004, the potential market size has increased markedly from a value of 70 million soles to 552 million soles in 2023. Overall, sales have never been higher than 27% of total consumption. The percentage is even smaller if purchase price is used to value self-consumption. Exports overall are lower than 1% of total consumption. The exception is 2006 when they were 2.13%, but this may be more related to the underestimation of total consumption for the reasons explained in the data cleaning section. However, still, many business plans are related to exports because of the high prices.

In the right panels, most sales to the final consumer are either through retail markets or street vendors rather than the wholesale market. Moreover, supermarkets and restaurants appear irrelevant. Future studies analyzing restaurants and supermarkets are required because the ENAHO may not capture the consumption there. To focus on the last panel, export prices of live guinea pigs are the highest but they are not stable. Exports of vacuum-packed guinea pig follow. The next-highest prices are obtained at restaurants and supermarkets, but the confidence intervals are too wide and overlap with the other prices in wholesale, retail, etc. This means that there is no statistical difference in the price paid, except for exports. However, there are no confidence intervals for exports, so this article cannot be categorical in this regard. Some restaurants may be worth engaging with, but not all of them. Reflection on the fact that restaurants have their own profits should make guinea-pig breeders aware that they may not capture the entire restaurant price if they supply to this market.

Figure 5.
Guinea pig consumption and sales by source



Source: Prepared by the author using data from the consumption modules of the ENAHO for the years 2004–2023 (INEI, 2004b, 2005b, 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b, 2013b, 2014b, 2015b, 2016b, 2017b, 2018b, 2019b, 2020b, 2021b, 2022b, 2023b) and the export data from the Peruvian Customs Office Peru compiled by the Association of Exporters (ADEX, 2024). The official exchange rate set by the Peruvian Central Bank was used (BCRP, 2024).
Note: Confidence intervals for the surveys were calculated using bootstrapping with 95% confidence.

It has already been noted that internal prices are similar across all scenarios. Therefore, essentially, it does not matter so much where the product is sold; what does matter is that the price is increasing. Moreover, it is important to not only focus on the price motive but to think about quality too. Guinea pigs are subject to serious sanitary problems (Cuba, 2018). The cold chain is problematic (Fernández & Rivera, 2018) not just for exports but also for local consumption. The common preference for live guinea pigs due to the perception they are fresher is problematic because transportation in unsanitary conditions could lead to potential outbreaks of disease and high mortality during transportation as with other forms of livestock, such as poultry (Sturm-Ramirez et al., 2004). Indeed, the same belief was once held about chicken, and it has been proven that wet markets contribute to influenza outbreaks in Hong Kong. Therefore, there is a need to promote quality, taking advantage of the price and consumption increases, and to study ways of doing so.

In the case of live guinea pig exports, there was a period (2008-2011) for which no data is available, and two years, 2012 or 2018, in which there were no significant exports. In general, many companies have ventured into exporting guinea pigs. However, the number of companies that have exported more than 1,000 dollars' worth is between one and five at most. The kilograms exported are minimal, not exceeding 13,010 kilograms, and total exports have not surpassed 232,000 dollars. On the market side the situation is also uncertain because it is highly concentrated. The main market is the United States, but China and Thailand have also emerged as buyers of live guinea pigs. It remains to be seen whether there are growth opportunities in these countries. Additionally, it is important to identify the purpose of the exports to these countries. Peru has accumulated 12 years of export experience with the United States, but less than 5 years with China, Thailand, and others. Most likely, the short-term future of this tariff line lies in the United States and Asia. It is therefore crucial to understand the sanitary requirements for entry into these markets and to better understand their consumption habits.

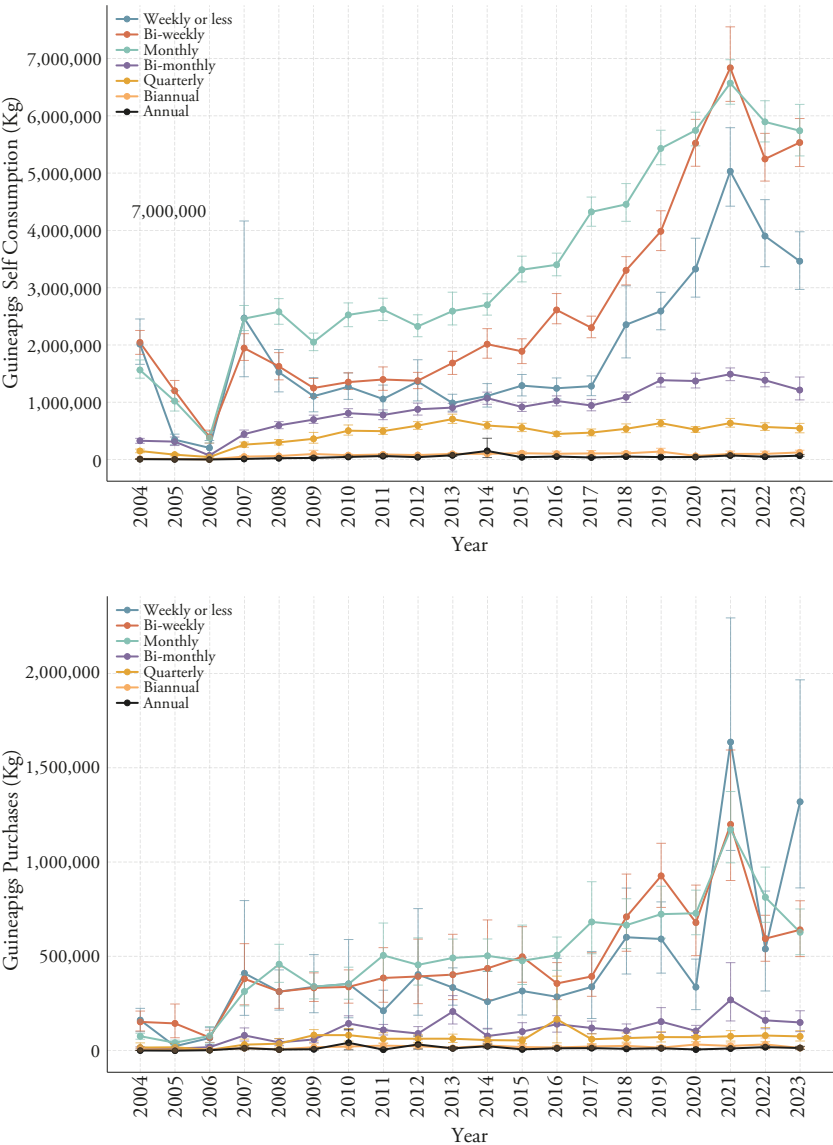
The vacuum-packed guinea pig export market, from the perspective of company analysis, is less concentrated than the live guinea pig market. It is also worth noting that there was significant growth until 2007, when exports dropped by half and then returned to 2003 levels. In 2017, another peak in vacuum-packed guinea pig exports was reached, followed by a slow-down. On the other hand, the price per kilogram has grown substantially. The increases in exports can be attributed to both the rise in price and the increase in export volumes, although the maximum volume exported was

in 2014 with 23 tons, followed by a decline in volume. This market is more stable and competitive than the live guinea pig market. The price is also relatively stable. Preliminary findings indicate that the companies concerned are multi-product exporters, and guinea pig is not the main item in their portfolio. These companies are able to leverage the knowledge they possess of the economies of scale involved in exporting other products, as well as the established routes. Preliminary conclusions suggest that the international trade in guinea pig is precarious and highly concentrated. Although the market for vacuum-packed meat is not as concentrated as that for live guinea pig, it exhibits more stability and has three clear leaders. While it is true that, when it comes to the companies involved, guinea pig exports are diffuse, this is not the case of the destination countries: Almost all exports are bound for the United States. Japan appeared to be emerging as another market at one point, but exports to that country have ceased.

The average local sales price increased from 10.76 soles per animal in 2004 to 31.54 soles in 2023. Meanwhile, the export price of vacuum-packed guinea pig rose from 18.05 soles per kilogram to 67.05 soles in 2023. The price of live guinea pig has evolved more erratically, from 140 soles in 2022 to 106.55 soles in 2023, peaking at 278 soles in 2007. This represents an opportunity to increase the quality of the meat sold, in which Peru experience many difficulties. The guinea pig industry should develop a strategy that considers selling large quantities in retail markets based on high quality and sanitary standards as well as contracts of exclusivity with restaurants that can meet the required standards. Another issue is that even overall sales to supermarkets or restaurants may seem insignificant overall but they still require high volumes from individual suppliers individually. However, this general requirement may not apply to small or medium-sized producers, who, even individually, may struggle to meet demand.

Figure 6.

Guinea pig self-consumption and purchases by frequency



Source: Prepared by the author using data from the consumption modules of the ENAHO for years 2004–2023 (INEI, 2004b, 2005b, 2006b, 2007b, 2008b, 2009b, 2010b, 2011b, 2012b, 2013b, 2014b, 2015b, 2016b, 2017b, 2018b, 2019b, 2020b, 2021b, 2022b, 2023b).

Note: Confidence intervals for the surveys were calculated using bootstrapping with 95% confidence.

Frequency of consumption is key for planning breeding. Historically, as shown in Figure 6, self-consumption was mostly reported as being monthly, but now self-consumption in kilograms over a 15-day period is not significantly different from monthly consumption. Since 2017, weekly self-consumption has increased significantly. On the other hand, purchases in kilograms are statistically similar on a weekly, bi-weekly, and monthly basis. Therefore, sales planning should be carried out to ensure that monthly demand can be met. Bi-monthly, quarterly, biannual, and annual consumption has stagnated, indicating that celebratory consumption is not the primary form of consumption. However, consumption in these frequencies is higher in the case of self-consumption, which may suggest that such celebrations are more important in communities where self-consumption is prevalent. Future studies are needed to estimate quarterly consumption. This could be achieved using the quarterly version of the ENAHO survey, but goes beyond the scope of this article.

IV. Conclusions and recommendations

There are many estimates of guinea pig stocks and consumption, and they vary depending on the source, the method, and even the question in any given dataset. The focus should therefore not be on one specific number but on a range of numbers and trends across different intervals. Estimates can go as low as 20 million and as high as 45 million. Discrepancies may arise because of the high rotation and reproduction levels of guinea pigs. Monthly changes could explain the discrepancy because in any single source, data from 12 months ago is very different to the information from one month ago. In this regard, one recommendation for future studies would be to repeat the same exercise using quarterly information from the same sources used in this study.

Regions such as Ica, Loreto, Callao, Ucayali, Madre de Dios, and Tumbes have relatively low and insignificant guinea pig stocks. In contrast, Cusco, Cajamarca, and Ancash have consistently had the highest guinea pig stocks since 1961, with Lima appearing among the top three in recent years for only in one of the estimates presented in this essay. This clearly shows the comparative advantages of the top regions in terms of guinea pig production. High density stocks of guinea pig are concentrated in specific routes. Junín to Cusco in the center and south and the contiguous area encompassing Cajamarca, La Libertad, Áncash, Huánuco in the north are paramount areas for guinea pig rearing. Areas with low stocks were identified using the microdata of the 2012 agricultural census and are all in Cusco, the coastal desert areas of Peru. Arequipa shows high densities values surrounded by

low values. Attempting to understand the spatial determinants of guinea pig density goes beyond the scope of this study. Future studies could explore how eating habits differ across different ethnic groups, climates, access to forage or animal feed, access to roads, and other factors, and could draw on data from the 2012 Agricultural Census.

With regard to consumption habits, self-consumption accounts for the largest share. Exports are marginal; even though exports prices are the highest of all categories, the number of exported kilograms is negligible. In recent years, self-consumption has ranged between 300 million and 400 million soles. On the other hand, sales have never exceeded an average of 100 million soles and are often like other categories. The measurement of market potential, understood as the sum of all forms of consumption, has grown substantially from 70 million soles in 2004 to 552 million soles in 2023, with sales representing no more than 27% of total consumption. Exports generally account for less than 1% of total consumption. Sales mainly come from retail markets and street vendors, and internal prices are largely uniform. Only exports seem high enough to consider producing there. Market strategies should take this into account, but they should also recall that guinea pig is not the main focus of those companies that do export them (at least not vacuum-packed exports). Supermarkets and some restaurants could represent niche markets, as the volumes they sell are relatively small compared to the overall market, but their prices are only a little higher than the other internal prices and some way behind export prices.

Quality remains an issue for live guinea pig, which commands the highest price but remains unstable. The vacuum-packaged product comes next, and is somewhat more stable. The local price for guinea pigs has significantly increased, and there is an opportunity to enhance meat quality and establish strategies for high-quality retail and restaurant sales. Small and medium-sized producers should be cautious about targeting supermarkets and restaurants due to the high demands. Attending the retail market is key because it is there where more volumes of guinea pigs are sold. It's important to notice, though, that prices are increasing. However, a strategy to promote sustainable breeding should go beyond just price analysis.

It is important to note that self-consumption is outstripped in terms of frequency by purchasing. Historically, self-consumption has been mostly monthly, but now 15-day regularities are increasing. Weekly consumption is high, but does not represent the majority. When it comes to purchasing, monthly, 15-day, and weekly or less are statistically similar. If these trends continue, planning for a smooth supply (perhaps even weekly) of products will become even more important in the future. Lower frequencies of con-

sumption are not so important and remain stagnant. Regular consumption is increasing. There are therefore opportunities that businesses could take advantage of, but they should be cautious of market developments.

Future research on the issue is required and important for the Peruvian case because this is high-potential market worth 500 million soles or more depending on how the value of self-consumption is calculated. Many business plans have been written, but few rely on representative data. Data-driven decisions are needed to promote productive investments. The same is true of state interventions aimed at promoting food security or development: all should be based on data. Similar studies could be conducted in Ecuador or Bolivia, provided that their household or agricultural surveys have similar ways of identifying the consumption of guinea pig as those in Peru.

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Appendix: Data filtering code

1. Guineapigs entries in the production modules of ENAHO

https://raw.githubusercontent.com/Favioleiva/Appendix_JB_V16/refs/heads/main/1.%20production_enaho.txt

2. Guineapig entries in food consumption modules of ENAHO

https://raw.githubusercontent.com/Favioleiva/Appendix_JB_V16/refs/heads/main/2.%20production_enaho.txt

3. Guineapig entries in the ENA

https://raw.githubusercontent.com/Favioleiva/Appendix_JB_V16/refs/heads/main/3.%20production_ena.txt

4. Data in 2012 Agricultural Census

https://raw.githubusercontent.com/Favioleiva/Appendix_JB_V16/refs/heads/main/4.%20census_map.txt

