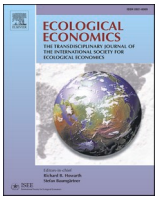
Ecological Economics 212 (2023) 107929

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon



How to boost the local trade of participatory guarantee system (PGS)-certified produce? A value chain perspective in Huánuco, Peru

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ARTICLE INFO

Keywords:
Local food system
Short food supply chains
Agroecology
Participatory guarantee systems
Synthetic pesticides
Latin America

ABSTRACT

To address issues of synthetic pesticides misuse, participatory guarantee systems (PGS) have been promoted as an inclusive certification mechanism in local value chains in many emerging economies. Most scientific studies and development programmes on PGS focus on operational aspects or supply side issues. On the contrary, demand side and the buying of PGS-certified produce have received far less attention. Our study contributes to this gap by applying a value chain perspective to identify potential incentives and obstacles to boost the trade of PGS-certified vegetables in Huánuco, central Peru. Using a mixed methods research approach, we map the value chain and describe actors' social practices and perceptions of synthetic pesticides. Our results show that the vegetable value chain is strongly dominated by local food and traditional (i.e. non-modern) distribution channels. We find that farmers, traders and consumers are aware of the health risks associated with synthetic pesticides, but note important mismatches between their perceptions on pesticide-free vegetables. Better collaboration and coordination among value chain actors, for instance under the form of a farmer cooperative and/or contracts with traders, may boost the trade of PGS-certified produce, but care should be paid to ensure regular supply of high-quality vegetables at a fair price.

1. Introduction

Since the early 1970s, synthetic pesticides have been considered an important tool for increasing food production and meeting the demand of an ever growing global population (Ecobichon, 2001; Hammond Wagner et al., 2016). Associated environmental and public health issues have since then been acknowledged widely (Kim et al., 2017; World Commission on Environment and Development, 1987). Yet, in many emerging economies, farmers have been shown to still misuse synthetic pesticides, which is partly due to limited government oversight (Feola and Binder, 2010; Galagarza et al., 2021; Hammond Wagner et al., 2016).

Ensuring traceability and the transfer of trustworthy information on synthetic pesticide use in local value chains is no easy feat. While environmental and food safety issues are addressed through strict standards and controls by third-party certification bodies in "modern" value chains (e.g. supermarkets), these certification schemes are often costly and complex, and therefore tend to exclude poor small-scale farmers and consumers (Beghin et al., 2015; German et al., 2020). In contrast, participatory guarantee systems (PGS) have been promoted as an inclusive pro-poor[1] certification mechanism in local "traditional" value chains. PGS differ from third-party certification in two ways: 1) production methods are monitored internally by intergroups of farmers, consumers and local authorities, and 2) requirements are simpler to implement and entail a lower administrative burden (López Cifuentes et al., 2018; Sacchi et al., 2015). Each PGS relies on its own standards but generally certifies organic or agroecological practices,[2] which imply a ban or important reduction in synthetic pesticide use. One of the main purposes of PGS certification in emerging economies is for organic or agroecological farmers to be recognised on the local market and for

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[1] Pro-poor interventions aim at "making market work for the poor" (Hellin et al., 2009; Stamm and von Drachenfels, 2011).

[2] According to a recent literature review, agroecology is founded on 13 key principles: farm recycling; input reduction (including synthetic and toxic pesticides); soil health; animal health; biodiversity; synergy; economic diversification; co-creation of knowledge; social values and diets; fairness; connectivity; land and natural resource governance; and participation (Wezel et al., 2020).

https://doi.org/10.1016/j.ecolecon.2023.107929
Received 20 May 2022; Received in revised form 20 April 2023; Accepted 29 June 2023
Available online 9 July 2023

consumers to be certain that the food they purchase contains no or low levels of pesticide residues (Carrion et al., 2013; IFOAM Organics International, 2018).[3]

Over the past two decades PGS have been considered a promising alternative to tackle environmental and food safety issues linked to synthetic pesticides (Farreras and Salvador, 2022; Roggio and Evans, 2022). However, challenges in their implementation have been highlighted, including their legal recognition, their dependence on institutional support, the often limited involvement of producers and consumers, internal organisation efficiency issues, the lack of trust among actors, and difficulties in the selling of PGS-certified produce (Bellante, 2017; Hruschka et al., 2021; Kaufmann et al., 2020, 2022; Nelson et al., 2016; Thamchaisophis, 2021; Truong et al., 2022). Most studies on PGS focus on supply side issues (i.e. how to boost the production of organic or agroecological produce) or on structural and operational aspects of the certification system (mostly on their benefits and challenges) (e.g. Anselmi and Vignola, 2021; Bellante, 2017; Binder and Vogl, 2018; De La Cruz and Dessein, 2021; Home et al., 2017; Loconto and Hatanaka, 2018; López Cifuentes et al., 2018; Nelson et al., 2016). On the contrary, the demand side and buying of PGS-certified produce have received far less attention. This observation does not only apply to scientific scholars, but also to NGOs and other development organisations (Erquínigo Zorrilla, 2020; Rikolto, 2018).

Our study contributes to the literature by applying a value chain perspective to identify the potential incentives and obstacles to the inclusion of PGS-certified produce on the local market. We take a case study approach and focus on the fresh vegetable value chain in the region of Huánuco, central Peru. In Huánuco, one of the first PGS of the country emerged in the early 2000s to improve food safety by banning synthetic pesticides. Yet, PGS-certified famers have struggled to find a viable market for their produce (Erquínigo Zorrilla, 2020). By studying all actors involved in the value chain, we derive in-depth insights to better identify possible mismatches between supply and demand and how to overcome them. Moreover, we focus on actors' perceptions of food safety risks posed by synthetic pesticides, as organic or agroecological practices promoted and guaranteed by PGS mostly allow to avoid health risks linked to these products used in-field (Baudry et al., 2019). Food safety issues may also arise from biological contamination (including bacteria, parasites and viruses), but this may occur at all stages of the food value chain (i.e. production, storage, transport, transformation and preparation) and can therefore not solely be addressed by adapting production practices (Borchers et al., 2010).

Our study entails three objectives. First, we map the local vegetable value chain of Huánuco, providing an overview of the actors, distribution channels, produce flows, share of regional produce sold on the local market, and positioning PGS-certified farmers within the value chain. Second, we describe actors' characteristics (i.e. farmers, traders and consumers) and their practices in the vegetable value chain using a social practices approach. Third, we assess the perceptions of the different value chain actors regarding synthetic pesticides and their consequences on human health. In turn, the results of our three objectives enable us to address our main research question: how to boost the trade of PGS-certified vegetables in the local value chain in Huánuco? While our research takes a case-study approach, our findings may be applicable to similar contexts, especially to other PGS initiatives in emerging economies.

[3] In high-income economies – where food safety issues are generally addressed through public regulation – PGS mostly aim to highlight the local identity of agri-food produce.

2. Methods

2.1. Research area and case study

The region of Huánuco, in central Peru, is home to about 760,000 inhabitants, with 40% living in its capital province, Huánuco (INEI, 2020). The region comprises 11 mountainous (*Sierra*) and tropical moist forest (*Selva alta*) provinces. Data collection was performed in the provinces surrounding Huánuco city – in Huánuco province –, at an altitude ranging between 2000- and 4000-m, with a mild semi-arid climate (Gobierno Regional de Huánuco, 2008; Perú Ministerio del Ambiente, 2020). The agricultural sector of the region is dominated by small-scale farmers (non-mechanised family farming), with 72% of all regional producers cultivating on <5 ha, with an average of 1.3 ha (INEI, 2014). In addition to the fact that Huánuco ranks the sixth poorest region of Peru, poverty in rural areas reaches even higher levels than urban areas – 40.9% and 27.8% of the regional population is not able to meet its basic food and non-food needs with their expenditures, respectively, in 2021 (Instituto Peruano de Economía, 2022).

To address the well-known and widespread issue of synthetic pesticide misuse in the Andes (Galagarza et al., 2021; Hammond Wagner et al., 2016; Jørs et al., 2006), governments, development agencies and NGOs have promoted agroecology across South America (Altieri and Toledo, 2011). In Peru, the agroecological movement started in the 1980s, and in the early 2000s, the two first PGS were established in the regions of Huancayo and Huánuco. By 2018, Peru counted eight operational PGS and four under development, regrouping over 3000 farmers (Binder and Vogl, 2018). According to the official Peruvian PGS procedures' manual, one of the main purposes of PGS certification is to "promote and encourage the consumption of guaranteed healthy and safe products to the Peruvian population in general" (translated from Spanish) (Ravello Gutiérrez et al., 2015).

In the region of Huánuco, the Institute for Development and Environment (IDMA) and other partner associations set up a PGS in 2005, which is currently the only guarantee system certifying agroecological or organic practices in the region. The PGS in Huánuco includes a ban on synthetic pesticide use in vegetable production. Fifteen years after the launch of the initiative, the picture is mixed: despite an initial enthusiasm, farmers seem to have lost motivation to participate, with a steady decline in the number of certified producers (barely 120 in 2020, compared to about 400 in 2015). A recent survey conducted by IDMA and its local partner NGO shows that one of the main reasons for abandoning the PGS is the low perceived demand and difficulty of selling of PGS-certified produce (Erquínigo Zorrilla, 2020).

2.2. Theoretical concepts: value chains and social practices

We apply two main concepts in our research: value chain mapping and social practices theory. First, the term value chain refers to the complex range of activities realised by several actors (including primary producers, processors, and traders) to convert raw material through different stages, from production to delivery to final consumers and disposal after use (Kaplinsky, 2000). Value chain mapping consists of representing a value chain in a visual picture that summarizes the structure and relationships between actors within a value chain (McKague and Siddiquee, 2014). Here, the vegetable value chain of the region of Huánuco is mapped to get a basic overview of the actors, activities, flows of regional produce and position of PGS-certified farmers within the value chain. The value chain map represents a firm basis to further investigate the practices and perceptions of the different actors regarding synthetic pesticides and their impact on human health.

Second, social practices theory argues that practices are, on the one hand, embedded in and enabled by the surrounding system (institutional dimension), and, on the other hand, strongly anchored in individual everyday life habits (agency dimension) (Spaargaren, 2003). Thus, when analysing social practices, two angles may be used: on the one

hand, looking at the ways in which practices are influenced by the wider context or system; on the other hand, focusing on the specific lifestyle habits and perceptions of individual actors affecting their choices. Applied to food value chains, the practices of farmers and traders that shape the chain constitute the institutional dimension, while deliberate consumer choices constitute the agency dimension (Wertheim-Heck et al., 2014a). Here we consider the social practices of selling and buying vegetables in Huánuco province at the junction between the supply side – made up of farmers, traders – and the demand side – influenced by habits and perceptions of consumers (Wertheim-Heck, 2015).

2.3. Sampling strategy and data collection

We conduct mixed methods research, using both qualitative and quantitative data collection methods (Fig. 1, adapted from Wertheim-Heck et al., 2014a).

First, we conducted in-depth interviews with key informants of local institutions: four NGO staff and two municipality agents managing the main vegetable wholesaler market of Huánuco. Moreover, we made initial observations at markets and vegetable selling venues. This provided us with preliminary information on the history of the PGS in Huánuco, and the general structure and dynamics of the local vegetable value chain.

For the analysis of the institutional dimension (i.e. supply side), data were collected from farmers and traders. Farmers were divided into two groups: conventional farmers (i.e. who were never involved in the PGS programme and apply synthetic pesticides without restrictions), and PGS-certified farmers, supported by local NGOs. To get insights from the first group, we approached farmers purposively (in different districts and cultivating different crops) in the field while they were working, and conducted 18 semi-structured interviews. With the second group, we organised six focus group discussions (with four to ten farmers), conducted four semi-structured interviews at an agroecological fair, participated in four individual PGS control visits and one PGS training (with 15 farmers), and attended a PGS cooperative meeting (with 30 farmers). The selection of farmers from this second group was done based on convenience sampling (i.e. selected and requested to participate by the NGOs supporting our study).

To get insights from traders, we worked in two phases. To begin with, we conducted semi-structured interviews with 14 purposively selected wholesalers and vendors (selling different produce and volumes of vegetables) at the main vegetable wholesaler market of Huánuco (hereafter referred to as “wholesaler market”). Based on the interview results, we designed a trader survey to estimate vegetable flows in Huánuco (i.e. produce, volumes traded daily, and origin). Our final sample consists of 112 traders – including the 14 that were previously interviewed more in-depth –, representing 50% of all wholesalers and vendors selling at the wholesaler market. Participant selection for the survey was done using a convenience sampling strategy, walking through the wholesaler market and interviewing a trader (willing-to-respond) at every other stall. This provides us with a non-probability sample, and may thus lead to bias in the traded volume estimations (Bernard, 2006). However, as a census of traders at the market was not available at the time of data collection, we could not perform probability sampling based on an official sampling frame.

We applied a similar approach to collect data among consumers. We started with eight in-depth purposive semi-structured interviews with consumers at the central traditional market of Huánuco and at a farmers' market selling PGS-certified produce in order to design a larger intercept consumer survey. For the survey, we used a two-stage stratified sampling strategy. In the first stage we purposely selected four important vegetable selling venues in the city attracting consumers with possibly different socio-economic profiles: the central traditional market (covered, operating every day, managed by local authorities), the two main farmers' markets[4] (open-air, operating on Saturdays only, managed by local authorities), and a small independent supermarket (open from Monday to Saturday, privately owned and managed). In the second stage, we conveniently approached consumers while they were purchasing vegetables at each venue, leading to four non-probability sub-samples of about 50 consumers. Care was taken to intercept the next person walking by, in an effort to minimise sampling bias on the part of the interviewer. Sample inclusion criteria were defined as being an adult (of minimum 18 years old) and purchasing vegetables at one (or more) of the selected venues. While we cannot claim the sample to be representative of the population of Huánuco, the survey still provides insights into urban consumers' diets, vegetable purchasing habits and selection criteria, and perceptions of synthetic pesticides. Detailed observations of buying practices and interactions with traders were made both at the wholesaler market and at these various vegetable selling venues.

Field work took place between June and August 2021. All primary data were collected by the first author, except for the consumer survey, for which three local enumerators were also involved. All interviews and focus group discussions were conducted in Spanish.

2.4. Data analysis

Data analysis in mixed methods research involves first a separate analysis of qualitative data and quantitative data. It then unites the two types of data by combining and integrating them (Creswell and Plano Clark, 2018).

To analyse our qualitative data, we performed content analysis, based on the theoretical concepts of value chains and social practices. We first went through a process of hand coding (i.e. grouping evidence and labelling recurring ideas in our hand-written field-notes), identification of emergent themes, and interrelation of themes. We then started with within-case analyses (relating the data from each focus group discussion or interview to itself) before conducting cross-case analyses (relating the data from different discussions and interviews, among and across actors. The content that provided us with insights into our research question was used to design our trader and consumer surveys, and is summarised in this article.

The quantitative data are derived from the trader and consumer surveys. The estimation of the total daily incoming volume of vegetables sold on the local market (with a distinction between regional and non-regional produce) is calculated by extrapolating the volume sold by the traders' sample to the entire population. The estimation of the volume of vegetables sold to consumers at supermarkets and farmers' markets is based on visual assessments. For supermarkets, the assessment was done by counting the number of cases of each vegetable on shelves (and estimating their volume) at the only two large supermarkets once a week during four weeks at the same hour and calculating an average.[5] For the two Saturday farmers' markets, one farmer at every ten stalls was asked how many kilogrammes of each vegetable (visible on their stall) they sold on average each Saturday at the market. This average volume was then multiplied by the total number of stalls counted on each market. This assessment was done once at each of the

[4] One farmers' market takes place in the centre of the city of Huánuco, while the other takes place closer to the peri-urban area.

[5] This strategy may affect data accuracy due to the convenient selection of days and hours, but was chosen for practical reasons. Still, based on observations at the different selling locations during the entire research stay (two months), it was clear that vegetable volumes sold at supermarkets in Huánuco are extremely low compared to volumes traded at traditional markets, street stalls and shops. Hence, we do not believe that this factor would affect our results and conclusions significantly.

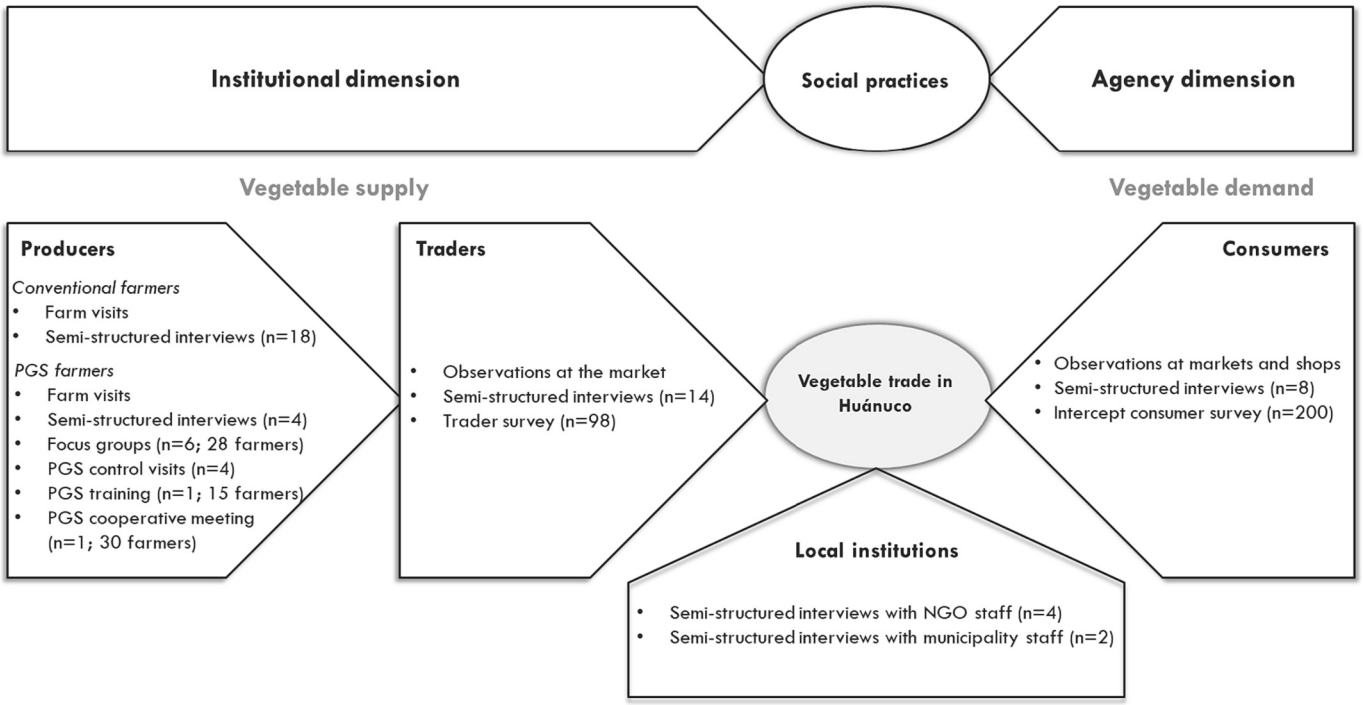

Fig. 1. Theoretical framework and associated data collection methods (adapted from Wertheim-Heck et al., 2014a).

two markets, since farmers were asked about the average volume sold every week. In turn, the estimation of the percentage of vegetables sold at traditional markets, street stalls and small informal shops called "bodegas" (i.e. traditional venues) is obtained by subtracting the estimated daily average volume of vegetables sold at Huánuco's supermarkets and farmers' markets from the total volume of vegetables needed to feed the inhabitants of Huánuco province (100 g/day per person according to the National Institute of Statistics and Informatics of Peru, multiplied by the number of inhabitants of Huánuco province, 310,000) (INEI, 2009). The volume of direct deliveries could not be estimated precisely due to the lack of available information on this distribution channel. We want to stress that all volumes are estimations, as census data about the exact quantities are missing. The aim is rather to derive the relative importance of the different distribution channels.

For the consumer survey, we performed tests for equality of two proportions (pr-test) in STATA 16 software, to evaluate whether different groups of consumers (based on their interview location) present the same proportion for each binary variable under study (i.e. each vegetable buying criteria, main perceived food safety risk in vegetables, and indicator of vegetable safety). The test for equality of two proportions uses an asymptotically normally distributed test statistic (StataCorp, 2019). Significant differences are reported below a *p*-value of 0.1.

3. Results

We start with the description of the vegetable value chain and the position of PGS-certified and conventional farmers within it, including the different distribution channels used by each. We follow by presenting social practices surrounding the trade of PGS-certified and conventional vegetables in Huánuco for each actor (farmers, traders and consumers). Finally, we present our findings related to the different actors' perceptions of synthetic pesticides and their impact on human health.

3.1. The vegetable value chain in Huánuco

Our study reveals the diversity of distribution channels within the vegetable value chain of Huánuco and the predominance of regional produce sold on the local market (about 65% of the total vegetable incoming volume) (Fig. 2). While this is a snapshot estimate, we assume this number to remain fairly constant throughout the year due to the stable regional climate (i.e. all vegetables grow all year round). Because we used non-probability sampling methods, this share might be biased if we over- or under-sampled local vegetable traders. Therefore, we are careful in interpreting this share in an absolute way, but we do believe (based on visual assessments at the different markets) that the majority of vegetables traded in Huánuco city comes from the region.

To sell their vegetables, conventional farmers may use one or several channels simultaneously. Farmers may sell their produce on-farm to intermediaries supplying other regions (generally truck drivers working for food trading companies), or to local collectors (mostly farmers or relatives gathering vegetables from several farms) supplying the wholesaler market. Another option is to bring their produce in person to the wholesaler market and trade with wholesalers and vendors directly. Finally, farmers may sell directly to consumers at farmers' markets or through deliveries (farmers bringing produce to urban consumers who placed orders, generally when coming to the city for their own provisioning), but these direct sales are estimated to represent <4% of the total vegetable volume consumed in Huánuco province.[6]

The latter two channels (farmers' markets and deliveries) are currently the only channels used by PGS-certified farmers, which we estimate to contribute <2% of the fresh vegetable supply in the province. This is likely due to the fact that PGS-certified farmers generally live in remote, high altitude areas, with poor road conditions. Most do

[6] Direct deliveries were mentioned by one consumer out of the eight that were interviewed in depth prior to the consumer survey. Hence, we decided to include deliveries as an existing distribution channel in Figure 2, but as it seems that deliveries are still quite rare, the share of volume sold through them is added to the share sold though farmers' markets, since they represent a direct-to-consumer channel.

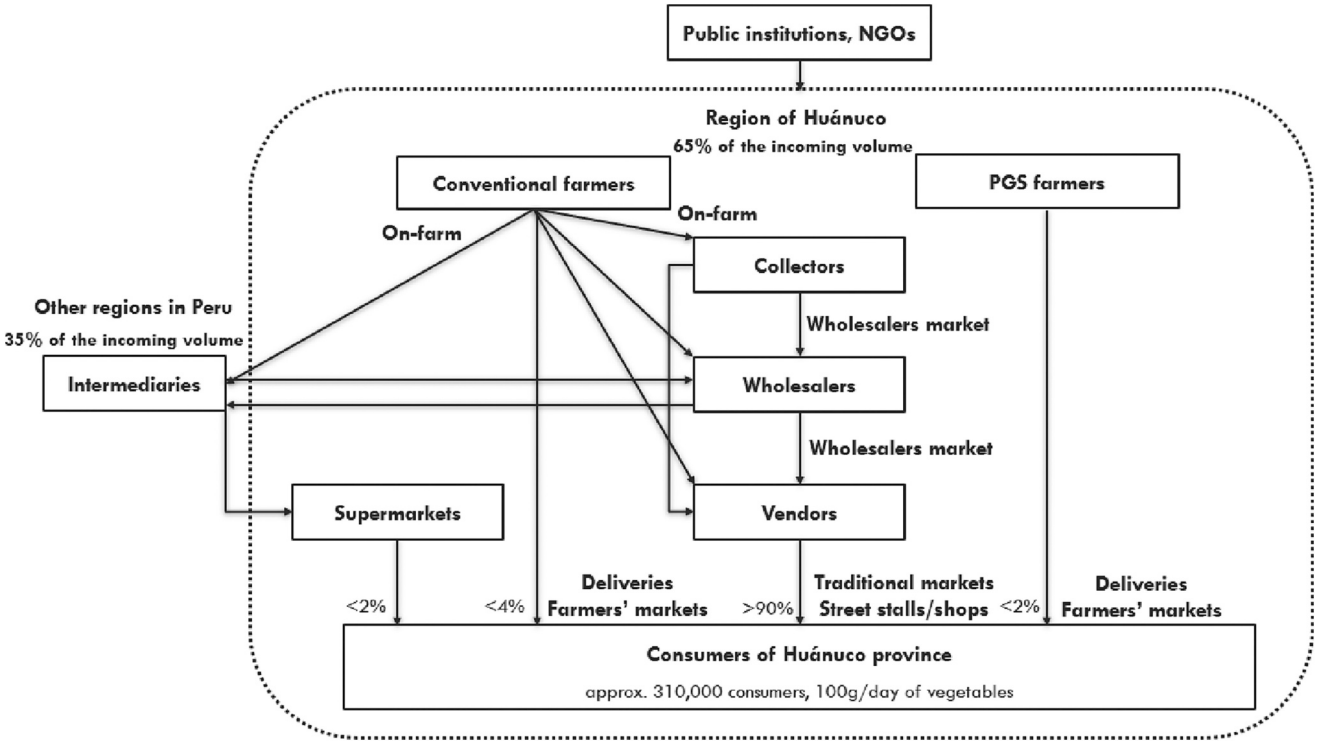

Fig. 2. Vegetable value chain of Huánuco (Source: authors 2021; percentages of incoming volumes (i.e. mass) are estimated based on the trader survey; percentages of sales to consumers through the different channels are estimated based on rough visual assessments of volumes sold at supermarkets and farmers' markets and deducing the volume sold through traditional markets, street stalls and informal shops; the value of per capita consumption of vegetables by consumers of Huánuco comes from the National Institute of Statistics and Informatics report, INEI, 2009).

not have their own means of transportation. Thus, these farmers are excluded from the main traditional vegetable value chain partly because intermediaries and collectors do not reach their farms, and because high transaction costs impede them to go to Huánuco city on a daily basis. Hence, supply of PGS-certified produce to the city is not constant. When PGS-certified farmers do come down to Huánuco to sell their produce at a farmers' market, they compete directly with conventional farmers and do not receive a premium for their produce. Even though their produce are sold on a separate part of the farmers' market, consumers do not seem to notice the distinction with conventional produce, as PGS certificates are not shown clearly and there are no banners promoting the produce.

> "*Consumers say that because it (vegetables) is (sold) at the market, it has to be as cheap*" – PGS-certified farmer.

The wholesaler market is a major hub for trade, where intermediaries from other regions enter and leave with large volumes of different types of vegetables on a daily basis. It is a spot market with high competition and cash spot transactions. Regional produce traded consists of herbs (e.g. cilantro, parsley, basil, mint), green leafy vegetables (lettuce, spinach, celery, leek, beans, cabbage), broccoli, cauliflower, cucumber, pepper, chilli, squash, beetroot, carrot and corn. Produce imported from other regions are essentially tomato, onion, garlic, ginger, carrot and corn. To our knowledge, fresh vegetables entering Huánuco are not imported from abroad.

The two large supermarkets in Huánuco (belonging to supermarket chains Tottus and Plaza Vea) do not buy vegetables directly from regional farmers or collectors; they are supplied by intermediaries from a storage centre in Lima (Peru's capital). One small independent supermarket does occasionally buy from local suppliers (directly from farmers bringing in the vegetables, or collectors). We tried to obtain more precise information on the vegetable supply of Huánuco's supermarkets, but this was impossible due to confidentiality policies. In any case, we estimate that supermarkets supply <2% of the vegetables consumed in Huánuco province.

Finally, we find that Huánuco's consumers purchase the large majority of their vegetables from vendors at traditional venues, where produce are sold through cash transactions following informal negotiation between the buyer and trader (>90% of volume bought).

3.2. Social practices

3.2.1. Farmers

There are several distinctions between conventional and PGS-certified farmers that explain why the former may misuse pesticides. First, conventional farmers mostly work on plots located at lower altitudes than PGS-certified farmers. At these altitudes, crops are more affected by pests, according to both types of farmers. Second, while several conventional farmers rent out their plot (6 out of 18 interviewed farmers), all PGS-certified farmers own their own land. Third, PGS-certified farmers are trained and supported by local NGOs to ease their transition. As collaboration and cooperation between farmers in the region is limited, transfer of knowledge does not seem to have taken place between conventional and PGS-certified farmers. Fourth, conventional farmers are convinced that traders and consumers would not buy smaller, lighter coloured vegetables that they believe would result from not using synthetic pesticides.

> *"If you don't spray (*synthetic pesticides*), they (*vegetables*) don't grow."* – Peri-urban conventional farmers.

> *"Without chemicals, there is no harvest. There are many pests. Engineers don't come. We don't know what products to put on our field."* – Peri-urban conventional farmers.

In our research area, none of the interviewed farmers reported being part of a cooperative involved in collective marketing. Still, a new cooperative regrouping 44 PGS-certified farmers was established in

2019 with the support of local NGOs. While still in its infancy, this cooperative aims at improving market access for PGS-certified produce. Yet, many challenges lie ahead for the cooperative to succeed. These include: the need to create an internal charter, build trust among members, foster the active involvement of all members, solve communication issues (e.g. limited cell phone usage by several farmers), deal with the geographical distance between farmers, and coordinate production (i.e. diversity of produce offered to consumers, constant supply, and quality). During the PGS cooperative meeting that we attended (second meeting of this new cooperative) and focus group discussions with PGS-certified farmers, several farmers declared to be eager to develop collective marketing strategies, if trust is truly established among them.

3.2.2. Traders

Our survey among 112 wholesalers and vendors shows that the large majority of vegetable traders in our sample are women (82%), underlining their important role in the trade of food produce.

About 38% of traders in our sample sells vegetables at the wholesaler market since its establishment in 1999, and 46% sells at least part of their produce from their own farm. Stalls are passed (i.e. the right to sell vegetables) from generation to generation in the same family. It is not possible to get access to a stall otherwise (i.e. there is no waiting list or new stalls being created). Stalls display a large variety of vegetables, with a median of 5 produce per stall. A distinction can be made between wholesalers (selling >1 t per day, representing 32% of the sample), medium size traders (selling between 200 kg and 1 t per day, representing 38% of the sample), and vendors (selling <200 kg per day, representing 29% of the sample). There is no (linear or quadratic) correlation between the volume and number of different vegetables sold.

Vertical coordination and contracts (mostly informal agreements) between farmers and traders are rare but do exist. Intermediaries from other regions may offer a (lower than market) farmgate price for vegetables to farmers, but ensure that the harvest is sold. This entails advantages to farmers, as they do not to have to go to the market themselves and pay an entrance fee and transportation costs. In addition, several traders (mostly wholesalers) at the wholesaler market place orders to intermediaries from other regions by phone a day or two in advance. In all cases, transactions are made in cash, without a receipt.

3.2.3. Consumers

To analyse urban consumers' vegetable purchasing habits, we divide our sample into three groups based on the venue at which they were interviewed: traditional buyers (interviewed at the central traditional market of Huánuco), direct buyers (interviewed at a farmers' market), and supermarket buyers (interviewed at a small independent supermarket). Over 75% percent of respondents are women, which highlights their potentially large influence in food purchasing decisions.

When purchasing vegetables (Table 1), over half of the consumers in our sample (53%) mainly focuses on the produce's perceived freshness. A significantly larger share of respondents among supermarket buyers (71%) and direct buyers (51%) pays attention to the freshness of vegetables compared to traditional buyers (37%). Low price and proximity to a selling venue are mentioned as main purchasing criteria by 39% and 32% of the consumers, respectively. A significantly higher share of consumers among direct buyers (47%) shows particular interest in a low price for vegetables than among supermarket buyers (26%). In addition, among supermarket buyers, a significantly lower share of respondents (16%) seems to be influenced by the safety of the vegetables they purchase than among direct (30%) and traditional (29%) buyers. As mentioned before, consumers are not aware about the PGS certificate and hence do not take this into account in their purchasing decisions.

3.3. Perceptions of synthetic pesticides and human health impact

3.3.1. Farmers

Concerns regarding synthetic pesticides vary among conventional farmers, with some more worried than others about the impact of these products on their own health and that of consumers. All PGS-certified farmers on the other hand seem to be well aware of, and concerned about health risks associated with the use of these products. Still, synthetic pesticides are generally referred to by both conventional and PGS-certified farmers as "veneno" (venom, poison), highlighting their awareness of these products' toxicity. Yet, conventional farmers do not generally use effective protective gear when spraying.

> *"For our own consumption, we produce organically. But to sell, we use chemicals. It will affect the health of people in Huánuco (*consumers*) but not ours"*. – Conventional farmer.

> *"We produce this way (*agroecologically*) because it does not affect our health; to eat healthy (…) especially for the children"*. – PGS-certified farmer.

3.3.2. Traders

As for conventional farmers, the health risk associated with pesticides in vegetables seems to worry some traders at the wholesaler market more than others, mostly those who also sell part of their own production on the market.

Traders state that consumers currently select their vegetables based on their appearance. Consequently, traders commonly believe that there is no demand for vegetables grown without synthetic pesticides, due to their supposedly bad look (i.e. small-sized, with defects, less colourful). In addition, traders do not ask questions about production methods when buying vegetables from intermediaries or farmers.

> "*If they (*farmers*) do not use chemicals, vegetables do not look good. And currently people rely on appearance to buy."* – Trader, wholesaler market, Huánuco.

> "*I don't ask them (*farmers*) whether they apply chemicals on their vegetables. Without chemicals no one buys*." – Trader, wholesaler market, Huánuco.

Traders believe vegetables from other regions to contain more synthetic pesticides, as, according to them, they rotten more quickly due to these products.

> "*The ones (*vegetables*) from Lima go bad, not from here because they (*regional farmers*) do not use much chemicals here*." – Trader, wholesaler market, Huánuco.

> *"Produce from Lima come with chemicals, from Huánuco it is natural, it doesn't go bad."* – Trader, wholesaler market, Huánuco.

Thus, traders are inconsistent in the way they perceive the effect of pesticides on vegetables. On the one hand, they believe that *without* synthetic pesticides, vegetables' appearance is *diminished*. On the other hand, they consider vegetables from the region of Huánuco to contain *less* synthetic pesticides than vegetables from other regions, leading to *better* quality and appearance, based on the belief that pesticides reduce vegetables' shelf life. This contradiction may reflect a sense of belonging to the region, generating a biased opinion on regional vegetable quality and safety.

3.3.3. Consumers

In our consumer survey, one question asked respondents what they perceived as the main food safety risk in vegetables (Table 2). We find that over 60% of our sample considers synthetic pesticides to be the most dangerous type of contamination to their health. A larger share of respondents among direct buyers (70%) is mostly concerned about synthetic pesticides than among supermarket (55%) and traditional buyers

Table 1
Main buying criteria per interview location (% of respondents) – maximum 2 choices (Source: consumer survey); Stars indicate the significance of the difference across groups based on pr-tests (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

	Whole sample (n = 200)	Traditional buyers (1) ($n = 52$)	Direct buyers (2) ($n = 90$)	Supermarket buyers (3) ($n = 58$)	(1)–(2)	(1)–(3)	(2)–(3)
Freshness	53.00	36.54	51.11	70.69	*	***	**
Low price	38.50	38.46	46.67	25.86			**
Proximity	31.50	28.85	36.67	25.86			
Food safety	25.50	28.85	30.00	15.52		*	**
Variety	13.50	15.38	10.00	17.24			

Table 2
Main perceived food safety risk in vegetables per interview location (% respondents) (Source: consumer survey, $n = 200$); Stars indicate the significance of the difference across groups based on pr-tests (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

Contamination	Whole sample (n = 200)	Traditional buyers ($n = 52$)	Direct buyers ($n = 90$)	Supermarket buyers ($n = 58$)	Difference traditional – direct buyers	Difference traditional – supermarket buyers	Difference direct – supermarket buyers
Synthetic pesticides	60.50	50.00	70.00	55.17	**		*
Bacteria and bugs	23.50	28.85	15.65	31.03	*		**
In food preparation	7.50	6.62	8.89	3.45			
In storage & transport	5.50	3.85	3.33	10.34			*
No risk	3.00	7.69	2.22	0.00		**	

(50%). Contamination by bacteria and bugs in-field is reported as the largest perceived food safety risk in vegetables by 24% of respondents, with a significantly lower share among direct buyers (16%) than among supermarket (31%) and traditional buyers (29%). Contamination during food preparation due to poor hygiene practices, or during storage and transport is perceived as the main food safety risk in vegetables by <8% and 6% of respondents, respectively. Only 3% of respondents believe that there is no food safety risk associated with vegetable consumption, with a significantly higher share among traditional buyers (8%) than supermarket buyers (0%).

Several indicators – classified into three categories: appearance, advisor, and origin – may influence consumers' confidence about the safety of vegetables (Table 3). Consumers were asked about their evaluation of these indicators in a separate question for each category (i.e. "*What makes you more confident about the safety of the vegetables you buy*"? – select one of the possible answers given).

First, in terms of external appearance, a bright colour and clean look seem to be the most convincing sign of vegetable safety (57% of respondents). Still, a significantly lower share of respondents among direct buyers (52%) believes this is the first sign of vegetable safety, than among supermarket buyers (67%). Twenty-three percent of respondents are not confident about the safety of large sized vegetables, with a significantly larger proportion among direct buyers (29%) than among supermarket buyers (14%).

> "*When they (*the vegetables*) are this big, it means that they (*farmers*) put a lot of chemicals, hormones. So, I'm wary of large vegetables*." – Consumer, small independent supermarket in Huánuco.

Second, to be confident about the safety of vegetables, consumers mainly rely on their own opinion (52%), while certification is considered as most trustworthy regarding food safety by only 28% of respondents (with no significant differences across groups).

Third, about 75% of respondents are confident about the safety of vegetables originating from the region of Huánuco more than from any other region (again, with no significant difference across groups). Thus, similarly to traders' perception, the concept of localness seems to be associated with vegetable safety.

> "*I buy my vegetables here because the produce come from the farms; they are natural.*" – Consumer, Saturday farmers' market.

Finally, 83% of consumers in our sample state that they would be willing to pay more for vegetables grown without synthetic pesticides, if

Table 3
Indicators of vegetable safety according to consumers, and willingness-to-pay (WTP) for vegetables grown without synthetic pesticides (% consumers; source: consumer survey, $n = 200$); Stars indicate the significance of the difference across groups based on pr-tests (* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$).

		Whole sample (n = 200)	Traditional buyers (1) ($n = 52$)	Direct buyers (2) ($n = 90$)	Supermarket buyers (3) ($n = 58$)	(1)–(2)	(1)–(3)	(2)–(3)
Appearance	Bright colour, clean	57.00	53.85	52.22	67.24			*
	Small size	23.00	23.08	28.89	13.79			**
	Light colour, defects	17.00	19.23	15.56	17.24			
	Large size	3.00	3.85	3.33	1.72			
Advisor	Own opinion	52.00	48.08	54.44	51.72			
	Certificate	27.50	32.69	23.33	29.31			
	Family/friends	13.50	13.46	12.22	15.52			
	Vendor	7.00	5.77	10.00	3.45			
Origin	Huánuco	74.50	71.15	80.00	68.97			
	No matter	25.00	28.85	20.00	29.31			
	Other region	0.50	0.00	0.00	1.72			
WTP	Yes	83.00	78.85	80.00	91.38			
	No	17.00	21.15	20.00	8.62			

they were able to trust this claim (with no significant difference between groups).

4. Discussion

We find two major prerequisites that could enable a better local trade of PGS-certified vegetables. First, the vegetable value chain in Huánuco is strongly dominated by local food and traditional (i.e. non-modern) marketing channels. Our results are in line with several other studies estimating the share of regional vegetables sold on urban markets in low-income and emerging economies (Sokhen et al., 2004; Wertheim-Heck et al., 2014a; Zhou et al., 2012).[7] All studies show that leafy vegetables predominantly come from the city's surrounding region, which is likely due to their high perishability and often limited means of refrigeration and transport infrastructure. Research also shows that consumers in low-income and emerging economies mostly purchase fresh food at traditional venues typically implying spot transactions and direct-to-consumer sales (Reardon et al., 2009, 2012; Schipmann and Qaim, 2010; Wertheim-Heck et al., 2014a).

Second, we note a general concern of the health risks associated with synthetic pesticides among all actors of the local vegetable value chain. Farmers are commonly aware of the hazards associated with their use for their own health and that of consumers. Hence, even conventional farmers may be open to transition to agroecological practices. Still, based on findings by Cole et al. (2011) and Hammond Wagner et al. (2016) who investigate pesticide lock-in in small-scale Andean agriculture, conventional farmers in Huánuco may be worried about several commonly perceived difficulties linked to this transition (i.e. the belief that without pesticides they would not be able to deal with pests; the lack of physical resources to transition (time, energy, capital); the lack of sufficient information and/or training on alternatives; the lack of collaboration among farmers; and the lack of consumers' demand and market for produce grown without synthetic pesticides).

Traders also seem to be aware of the health risks posed by synthetic pesticides misuse. This may be linked to the fact that almost half of the traders selling at the wholesaler market are farmers too (selling part of their production at the wholesaler market, and keeping the rest for their own family consumption at home.

Consumers are clearly concerned about the potential impact of synthetic pesticides on their own health (more than about any other food safety risk) and state to be willing to pay more for vegetables grown without these products. However, respondents' stated preferences may not reflect their actual behaviour due to social desirability effects, so we need to be careful in interpreting this result. Our findings are in line with research on consumer food safety perceptions in other emerging economies (e.g. Cheng et al., 2016; Wertheim-Heck et al., 2014a), showing that consumers are more concerned about “chemical” contamination (including from synthetic pesticides) than microbial contamination. Other studies investigate consumers' willingness-to-pay (WTP) for vegetables grown without synthetic pesticides in urban areas and confirm that there is a high interest in pesticide-free vegetables (Alphonce and Alfnes (2012); Krishna and Qaim (2008); Lagerkvist et al. (2013); Mergenthaler et al. (2009); Vidogbéna et al. (2015)). Thus, based on all actors' concerns regarding synthetic pesticide misuse, there seems to be a strong need for vegetables produced in a way that is considered “safe” (i.e. without synthetic pesticides).

While these two conditions (importance of local food and concerns about synthetic pesticides' misuse) are important prerequisites to boost the trade of PGS-certified vegetables, there is one major obstacle. Currently, distribution channels for PGS-certified vegetables are rather limited and overlap with those of conventional vegetables, making it impossible for PGS-certified farmers to charge a price premium. Even though PGS-certified vegetables are sold on a separate part of the farmers' markets, consumers do not seem to notice the difference with conventional produce, as PGS-certified produce are not clearly advertised. As a consequence, PGS certification is not known among consumers and they do not take this into account when making purchasing decisions.

To address these issues, we identify four mechanisms that could be put in place in Huánuco to improve the local trade of PGS-certified vegetables, based on our results and related literature in similar contexts. First, one idea that was mentioned by PGS-certified farmers during the new cooperative's meeting and focus group discussions is collective marketing. This horizontal coordination strategy has increasingly been promoted by policy-makers and development institutions to sustain the functioning of a pro-poor market (Hellin et al., 2009). In fact, through their literature review, Kaufmann et al. (2020) find that collective marketing is relatively common in PGS around the world. Acting collectively for market access (e.g. through a well-functioning cooperative[8]) may help farmers deal with high transaction costs (especially in the case of perishable produce) and reach steady high quality standards (Markelova et al., 2009). For this strategy to work, PGS-certified farmers need to provide vegetables of consistent supply and quality, and that can be easily identified (e.g. through a banner at selling points or a label) (Beverland, 2007; Kaufmann et al., 2022). In this sense, it may also be interesting for PGS-certified farmers to invest in collective vegetable cleaning facilities and refrigerated transportation means to meet consumers' specific demand and gain their trust.

Second, there may be potential for vertical coordination in the vegetable value chain through contracts between traders and PGS-certified farmers. As one of PGS-certified farmers' current difficulties is to access the urban market physically due to the remoteness of their farms, they may be interested in collaborating with local collectors. However, there also needs to be an incentive for traders to enter into such contracts. This first requires traders to be aware of the observed existing demand for synthetic pesticide-free vegetables. Moreover, trust between farmers and traders should be built to ensure commitment and optimise mutually beneficial contracts (Ayari and Zaibet, 2019; Haji, 2010). This represents a serious challenge given the recurrent lack of trust observed among food value chain actors in Peru (Fournier et al., 2020; Thiele et al., 2011). Local institutions, including NGOs, could step in to foster trust relations between farmers and traders, for instance by establishing multi-stakeholder platforms. It may be possible to combine collective marketing and vertical integration, as it has been shown in other contexts that many buyers prefer to work with farmer groups who are generally better suited than individual farmers to provide stable supply of quality produce (Markelova et al., 2009).

Third, based on the observed factors that are particularly important to consumers in their purchasing decision (i.e. freshness and price of vegetables, and the proximity to a selling venue), PGS-certified farmers should be encouraged to select and sell clean, well-looking vegetables, keeping the less attractive produce for their own consumption. Furthermore, multiplying PGS-certified produce selling points may attract more consumers, provided that costs associated with their establishment and functioning are amortised over time. Also, to assess the safety of vegetables, consumers in Huánuco rely on their own opinion more than anything else (including certification). This may be due to trust related issues within the Peruvian society and/or local communities (Bertelsmann Stifung, 2022), or to the fact that certification is still uncommon in the region, with PGS as the only guarantee system certifying agroecological or organic produce up to now. Therefore, trying to involve consumers more into the PGS-certification process, including through farm visits, workshops and events at the marketplace for instance, is essential (Kaufmann et al., 2022). Still, low active consumer participation in PGS (and even awareness of its

[7] None of these studies focus on a South American city.

[8] See Soboh et al. (2009) for a review on factors influencing farmer cooperatives' performance and efficiency.

existence) has been highlighted as an important issue and daunting challenge, in particular in South America (Kaufmann et al., 2020, 2022). Consumers in Huánuco are more confident about the safety of regional vegetables than from other regions, which has been reported elsewhere: consumers generally trust nationally or regionally produced produce more than imported ones in terms of food safety, and most express the highest confidence in buying "natural" produce directly from farmers (Cheng et al., 2016; Wertheim-Heck et al., 2014a). Even more so, Truong et al. (2022) find that, in Vietnam, consumers' trust in vegetable safety is more related to direct contact with regional farmers (made possible by PGS), rather than to the PGS-certificate itself. As both traders and consumers believe regional vegetables to be produced by farmers with less synthetic pesticides, "localness" could act as an incentive to foster trust in PGS-certified vegetables and consequently boost their trade.

Fourth, to ensure a regular supply of enough high-quality PGS-certified vegetables in the long-term, more conventional farmers will need to transition to agroecology. To foster this transition, the support of local institutions may be highly valuable. If priorities are to be set, it may be wise to first focus on supporting conventional farmers producing at higher altitudes (where pests seem to be less abundant in crops, according to farmers) and on farmers who possess their own farm (who are more able to reap the future long-term benefits of the transition) (Hammond Wagner et al., 2016). Not possessing their own plots may indeed not incentivise farmers to look towards the future benefits of a potentially difficult transition to agroecology. Moreover, encouraging cooperation between already PGS-certified farmers and conventional farmers (for example through farm visits and knowledge sharing) may reassure conventional farmers in initiating their transition.

5. Conclusion

In this study, we identify potential incentives and obstacles to boosting the trade of PGS-certified vegetables on the local market in the region of Huánuco, in central Peru. Applying a mixed methods research approach, we map the local vegetable value chain, describe key actors' social practices surrounding vegetable trade, and assess their perceptions of synthetic pesticides and their impact on human health. We show the diversity of distribution channels within the vegetable value chain of Huánuco and the predominance of regional produce sold on the local market, especially through traditional channels (i.e. traditional markets, street stalls and small informal shops). Furthermore, we find that all actors of the value chain are well aware of the risks associated with synthetic pesticides. In this context, PGS, as a pro-poor locally focused certification mechanism, may be of relevance to foster the uptake of agroecological produce on the local market. Yet, there are mismatches between actors' perceptions of vegetables grown without synthetic pesticides, making it difficult for PGS-certified farmers to sell their produce and charge a price premium. Although farmers and traders do not believe that consumers in Huánuco would be willing to pay more for synthetic pesticide-free vegetables, we show that there exists a demand for such produce. Increased collaboration and coordination among value chain actors, for example under the form of a farmer cooperative, and/or contracts with local traders, may help boost the local trade of PGS-certified vegetables. However, special attention should be given to ensuring a steady supply of high-quality, identifiable produce at a fair price to gain the confidence of buyers.

So far, the focus of scientific studies on pro-poor agricultural value chain interventions has been on the inclusion of poor farmers into "modern" high-value markets (e.g. Tobin et al., 2016; Van den Broeck et al., 2017). We contribute to the literature by providing an analysis of a pro-poor intervention (namely PGS-certification) in a local traditional food value chain. In addition, social practices approach to analyse food value chains have focused on either farmers' choices of production practices (e.g. Mengistie et al., 2017; Aniah et al., 2021), *or* on traders' and consumers' perspectives (e.g. Wertheim-Heck et al., 2014a, 2014b). Hence, our study of social practices surrounding the trade of vegetables in Huánuco is innovative, as it includes the perspective of both producers and traders, *and* consumers.

Our study presents some limitations and scope for further research. We did not collect detailed demographic information on each type of actor, such as gender or age. Exploring women's and youth's potential role in the trade of PGS-certified vegetables may be particularly interesting. Moreover, evaluating the precise value of consumers' WTP (i.e. premium they would be ready to pay for synthetic pesticide-free vegetables) may help PGS-certified farmers establish a common price for their produce in the case of collective marketing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgement

We acknowledge funding from the Fond National de la Recherche Scientifique (Belgium), through a FRIA Doctoral Grant. We gratefully thank Iles de Paix (IDP), Islas de Paz Peru (IDPP), and the Instituto de Desarrollo y Medio Ambiente (IDMA) for their assistance in data collection and sharing their insights into the vegetable sector and PGS in Huánuco – in particular Gaël de Bellefroid and Octavio Mayhua. We also thank farmers, traders, and consumers for their participation in the interviews, focus group discussion, and surveys. Finally, we thank the editor and four anonymous reviewers for their constructive comments.

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