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International PhD Program for Agricultural Economics, Bioeconomy and Sustainable Food
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**Critical analysis of socio-natural dynamics driven by the agricultural commodity boom:
the case of Hass avocado in northern Caldas, Colombia**

DISSERTATION

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DECLARATION

According to the §17 of the Doctoral Examination Regulations of the Faculty 09, from July 7 2004, last changed on May 29 2019

I declare this dissertation submitted is a work of my own, written without any illegitimate help by any third party and only with materials indicated in the dissertation. I have indicated in the text where I have used texts from already published sources, either word for word or in substance, and where I have made statements based on oral information given to me. At any time during the investigations carried out by me and described in the dissertation, I followed the principles of good scientific practice as defined in the “Statutes of the Justus Liebig University Giessen for the Safeguarding of Good Scientific Practice”.

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Date

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Andres Suarez

Zusammenfassung

Diese erklärende Studie untersucht die Expansion von Hass-Avocado-Plantagen (HAP) und deren transformative Auswirkungen auf die sozio-natürlichen Dynamiken in Salamina, Caldas, Kolumbien. Die zentrale Forschungsfrage – Warum breiten sich die Hass-Avocado-Plantagen aus und verändern die sozio-natürliche Dynamik im globalen Süden? – wird durch einen systematischen Ansatz beantwortet, der auf interdisziplinären Rahmenwerken und Methoden basiert.

Zur Beantwortung dieser übergeordneten Frage wurde zunächst ein solides theoretisches Rahmenwerk entwickelt, um die sozio-natürlichen Interaktionen zu analysieren, die diesen Transformationen zugrunde liegen. Die Studie nutzte dann vier Teilfragen, um das Thema systematisch zu untersuchen. Die erste Teilfrage betrachtete das Phänomen aus einer Perspektive des Globalen Südens, gefolgt von zwei Teilfragen, die sich auf die spezifischen Gegebenheiten des Falls Salamina konzentrierten. Die abschließende Teilfrage rekontextualisierte die Ergebnisse im Rahmen der globalen Transformation von Lebensmittelsystemen und bot Einblicke in die Dynamik dieser Veränderungen als Teil eines größeren Lernprozesses.

Diese interdisziplinäre Forschung basiert auf Kritischem Realismus und integriert theoretische und konzeptionelle Ansätze aus der Politischen Ökologie, der Kritischen Ressourcen-Geographie und der Kritischen Politischen Ökonomie. Ein mehrstufiges Design wurde genutzt, um die vier Teilfragen zu adressieren, wobei für jede Frage spezifische Sub-Designs angewandt wurden. Das übergeordnete Ziel der Studie war erklärend: Es ging nicht nur darum, die sozioökonomischen und ökologischen Implikationen der HAP-Expansion aufzuzeigen, sondern auch die soziohistorischen, wirtschaftlichen und politischen Strukturen zu analysieren, die dieses Phänomen ermöglichen.

Methodisch wurde ein Mixed-Methods-Ansatz durch ein sequenzielles Design angewandt, bei dem qualitative und quantitative Daten gleichzeitig erhoben und analysiert wurden, bevor sie bei der Interpretation integriert wurden. Eine einzelne erklärende Querschnittsfallstudie vertiefte die Analyse.

Die Ergebnisse zeigen eine komplexe Landschaft sozioökonomischer und ökologischer Dynamiken im HAP-Sektor Kolumbiens. Während die Plantagen das Wirtschaftswachstum und die Beschäftigung in Salamina und Caldas vorangetrieben haben, brachten sie auch erhebliche ökologische und soziale Herausforderungen mit sich. Kolumbien steht an einem kritischen Wendepunkt, an dem wirtschaftliche Entwicklung mit ökologischer Nachhaltigkeit und sozialer Verantwortung in Einklang gebracht werden muss. Politikgestalter, Umweltbehörden und die landwirtschaftliche Gemeinschaft müssen entschlossen handeln, um dieses Gleichgewicht zu erreichen. Dabei gilt es, das wirtschaftliche Potenzial von Hass-Avocados zu nutzen und gleichzeitig die ökologischen Systeme und das kulturelle Erbe zu schützen. Die Entwicklung und Durchsetzung nachhaltiger öffentlicher Politiken wird entscheidend sein, um diese vielschichtige Herausforderung zu bewältigen.

Summary

This explanatory study investigates the expansion of Hass avocado plantations (HAP) and their transformative impact on the socio-natural dynamics in Salamina, Caldas, Colombia. The central research question—Why are Hass avocado plantations expanding and transforming the socio-natural dynamics in the Global South?—is addressed through a systematic approach grounded in interdisciplinary frameworks and methods.

To address this overarching question, a robust theoretical framework was first developed to analyze the socio-natural interactions underlying these transformations. The study then employed four sub-questions to explore the issue systematically. The first sub-question examined the phenomenon from a Global South perspective, followed by two sub-questions focusing on the specifics of the Salamina case. The final sub-question recontextualized the findings within the broader global transformations of food systems, offering insights into the dynamics of these changes as part of a larger learning process.

This interdisciplinary research is underpinned by Critical Realism, integrating theoretical and conceptual approaches from political ecology, critical resource geography, and critical political economy. A multilevel design was utilized to address the four sub-questions, employing tailored sub-designs for each. The study's overarching objective was explanatory: not only to elucidate the socio-economic and environmental implications of HAP expansion but also to analyze the socio-historical, economic, and political structures enabling this phenomenon.

Methodologically, a mixed-methods approach was employed through a sequential design, balancing qualitative and quantitative data collected and analyzed simultaneously before integration during interpretation. A single cross-sectional explanatory case study further deepened the analysis.

Findings reveal a complex landscape of socio-economic and environmental dynamics in Colombia's HAP sector. While the plantations have driven economic growth and employment in Salamina and Caldas, they have also introduced significant environmental and social challenges. Colombia faces a critical juncture where economic development must align with environmental sustainability and social responsibility. Policymakers, environmental agencies, and the agricultural community must act decisively to achieve this balance, leveraging the economic potential of Hass avocados while safeguarding ecological systems and cultural heritage. The development and enforcement of sustainable public policies will be essential to navigating this multifaceted challenge.

List of peer-reviewed publications

Throughout the *International PhD Program for Agricultural Economics, Bioeconomy and Sustainable Food Systems* (IPPAE), the opportunity arose to consolidate the dissertation through four scientific articles. Of these, three have been published, and the fourth is currently undergoing a second round of peer review in a recognized international journal. In addition to these four articles, I have developed two additional papers, which are not included in the thesis¹.

Below is the list of articles that are part of this dissertation:

1. Suarez, Andres, & Gwozdz, W. (2023). On the relation between monocultures and ecosystem services in the Global South: A review. *Biological Conservation*, 278, 109870.
2. Suarez, Andres. (2024). Critical overview of the expansion of Hass avocado plantations in Salamina, northern Caldas, Colombia. *Journal of Land Use Science*, 19(1), 230-238.
3. Suarez, A. (2025). (Re)making landscapes into resources: the role of Hass avocado plantations in Salamina, Colombia. *World Development Perspectives*, 39, 100695.
4. Suarez, Andres, & Ume, C. (2024). Transforming food systems in the Global South: a radical approach. *Frontiers in Sustainable Food Systems*, 8, 1397100.

¹ -Suarez, Andres (2024). Understanding the normalization of plantation agriculture: The case of Hass avocado in Colombia. *Land*, 13(11), 1911. Available at: <https://www.mdpi.com/2073-445X/13/11/1911>

-Suarez, A. (2025). The Hass Avocado Boom as a Catalyst for Socio-Natural Regime Transitions in the Global South: Insights from Northern Caldas, Colombia. *Journal of Latin American Geography*, 24(1), 159-170. Available at: <https://muse.jhu.edu/pub/15/article/962806/summary>

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Chapter 1. Extended Summary

1.1. Introduction

In the last decade, the Hass avocado (*Persea americana* mil cv. 'Hass') has gained significant attention in the global market due to its unique flavor, high nutritional value, and distinctive shape (Fulgoni et al., 2013). As a result, large-scale corporations have increasingly promoted Hass avocado plantations (HAP)¹, mainly in the Global South. The Hass avocado business has become a major driver of employment, contributing to poverty alleviation and reducing human migration between countries (Denvir et al., 2021). Now widely perceived as a superfood (Magrach & Sanz, 2020), Hass avocados are experiencing a rapidly increasing demand in the Global North. This price surge has turned Hass avocado cultivation into a highly promising and lucrative industry (Arias et al., 2018). However, the expansion of HAP has also triggered multiple socioeconomic and environmental challenges in producing countries (Budds, 2004, 2008; Friedmann & McNair, 2009; Khan et al., 2021; Panez-Pinto et al., 2018; Ramírez-Mejía et al., 2022).

The literature indicates that the expansion of HAP perpetuates the existing neoliberal food regime (Atucha et al., 2013; Barsimantov & Navia Antezana, 2012; Denvir et al., 2021; Duran-Llacer et al., 2020; Khan et al., 2021). Large plantations have primarily been associated with conflicts due to their impact on small farmers and peasant communities, as well as the depletion of natural resources (Bolados et al., 2018; Budds, 2004, 2008; Duran-Llacer et al., 2020; Panez-Pinto et al., 2017). Furthermore, the literature provides explanations grounded in institutional changes that facilitate environmental exploitation (Budds, 2004, 2008) and shape land tenure dynamics (Friedmann & McNair, 2009).

In Colombia, HAP have gained a significant share of both national production and the global market. Between 2015 and 2020, Hass avocado production increased by 89%, driven by a 62% expansion in harvested area and a 17% improvement in yield (MADR, 2020). According to data from the Ministry of Agriculture and Rural Development (MADR, 2020), production of the Hass variety reached 167,724 tons in 2020, with a planted area of 23,000 hectares and a harvested area of 16,772 hectares. The estimated yield is 10 tons per hectare. Projections suggest that 70% of the total planted area has reached full productivity, while the remaining 30% is still developing. This growth has positioned Colombia as a key exporting country, primarily supplying markets in China and Japan, as well as 32 other destinations, including the Netherlands, Spain, the United Kingdom, the United States, and France.

A particularly striking aspect is Colombia's transformation from being virtually unknown in the international avocado market in 2010 to becoming one of the world's top five avocado producers over the past decade (Hass Avocado Board, 2022). By 2020, the country exported 44,600 tons of Hass avocados, trailing only Mexico and Peru, which exported over one million and 350,000 tons, respectively. Projections suggest that Colombia could secure second place in global exports, significantly increasing its share of the international market (Escobar & Betancur, 2021). Additionally, Colombia has approximately 3.19 million hectares of land suitable for Hass avocado production, offering substantial opportunities for further expansion.

However, some avocado production activities in Colombia have been suspended due to alleged environmental impacts². Although the country is known for its abundant water resources, Erazo-Mesa et al.

¹ In this dissertation, the concepts of monocultures and plantations are used, but not as synonyms. When referring to monocultures, I focus on specific practices associated with a single-specie crop that extends spatially. However, I place particular emphasis on addressing the idea of plantations as a social system that encompasses aspects beyond the specific practice of avocado cultivation. Here, plantations are understood as systems characterized by hierarchies, distinctions between those with and without capital, and as economic institutions primarily focused on extractivism.

² Caracol radio 2021. Suspenden actividad de multinacional aguacatera en Pijao, Quindío. Available at: <https://bit.ly/3yQlcwH>

(2021) argue that precipitation alone may not suffice, making irrigation necessary for avocado cultivation. This could impose additional pressure on already stressed water resources³. Another critical issue is the construction of roads in hilly terrain, which results in substantial environmental damage. High water consumption, contamination of water sources, and the large number of water concessions granted to avocado producers have generated tensions, particularly in Colombia's coffee-growing region⁴.

These negative consequences stem from the dominance of large-scale plantations in Hass avocado production, which shape both the production sector and the landscape (De la Vega-Rivera & Merino-Pérez, 2021; Denvir et al., 2021; Khan et al., 2021). The concentration of land in the hands of large-scale producers has led to conflicts with family farming units seeking a fair distribution of productive land, resembling land grabbing. Both scientific (Serrano & Brooks, 2019) and journalistic sources⁵ have emphasized the impact of large-scale avocado production on traditional producers, whose participation in the domestic market has been adversely affected.

Therefore, I argue that HAP in Colombia should be a key focus of academic debate for two main reasons. First, the rapid expansion of Hass avocado cultivation in the country has raised concerns in producing areas (Suarez, 2024). Second, Colombia is one of the most unequal countries in the world (World Bank, 2021) and faces multiple social and environmental conflicts, particularly in rural areas (Rincón-Ruiz et al., 2019). In these areas, Hass avocado cultivation exacerbates social grievances (Serrano & Brooks, 2019; Suarez, 2024). Through this research, I provide insights into these pressing issues.

1.1.1. Research gaps and contributions

This research not only aims to empirically examine the environmental and social impacts of large-scale monoculture expansion, using Hass avocado as an example, but also seeks to generate knowledge about the conditions that enable these phenomena and how to address their root causes. Building on the contributions of each chapter, this dissertation primarily seeks to explain why the commodity boom driven by HAP transforms the socio-natural dynamics of traditional agricultural landscapes.

Following Milles (2017), this dissertation addresses geographical, empirical, methodological, and knowledge-based gaps (Table 1). Regarding the empirical gap, this research contributes by providing insights into the implications of monoculture expansion in the Global South. This gap is significant because there is currently no systematic analysis in the literature on the relationship between large-scale monoculture practices and their ecological context, nor a clear methodology for reporting this issue. As much of the world's food production is expected to become concentrated in the Global South in the coming years, understanding this regional context is crucial. To address this gap, I provide a comprehensive approach in Chapter 2, which also examines the correlation between monoculture practices and deforestation in biodiversity-rich countries, highlighting the extent to which monocultures threaten ecological stability in these vulnerable regions.

By focusing on a specific case study—Salamina, Colombia—this dissertation not only generates insights into a distinct geographical context (geographical gap) but also addresses an empirical gap concerning the effects of HAP on traditional agricultural landscapes. Chapter 3 bridges this gap using field observations and data obtained from local authorities. Furthermore, I address a knowledge gap regarding the unique

³ La Patria 2018. Aguacate por fuentes de agua en Aguadas (Caldas). Available at: <https://bit.ly/3yYTFu>

⁴ El Espectador 2021. El lío ambiental que empieza a dejar la exportación de aguacate. Available at: <https://bit.ly/3ySuYys>

⁵ El Espectador 2021. El lío ambiental que empieza a dejar la exportación de aguacate. Available at: <https://bit.ly/3ySuYys>

expansion patterns of HAP in Colombia, which contrast with those documented in Mexico and Chile⁶. The literature lacks a clear understanding of how plantations like Hass avocado drive rapid transformations in traditional agricultural landscapes of significant environmental, historical, and cultural value. This issue is the focus of Chapter 4.

Table 1. Research gaps and contributions

Chapter	Gap	Contribution
Chapter 2	Empirical gap	-Correlation between monocultures and deforestation in high biodiverse countries.
Chapter 3	Geographical gap	-Information about impacts of HAP in Salamina, Colombia.
	Empirical gap	-Data related to social and ecological impacts related to HAP.
Chapter 4	Methodological gap	-An approach to understanding how land is made as a resource for use by proposing a comprehensive design that includes elements of context, triggers and outcomes.
	Empirical gap	-Data related to land use change and societal response.
	Knowledge-based gap	-Understanding of the conditions allowing HAP expansion given historical dynamics, land materiality and pre-existing socio-economic conditions.
Chapter 5	Knowledge-based gap	-Understanding how to transform food systems through a radical approach.

Source: Own elaboration.

One pressing issue is the transformation of food systems, particularly within and originating from the Global South. Guerrero et al. (2023) raised the question on how to transform food systems, and I offer my response in Chapter 5. Accordingly, this dissertation systematically addresses these gaps, offering a comprehensive analysis that enhances the understanding and potential resolution of the challenges associated with large-scale plantations. As a cumulative dissertation, Chapter 1 serves as an extended summary, consolidating the knowledge and contributions gathered throughout the research process.

1.2. Research questions

The present research discusses both theoretically and empirically the dynamics generated by the expansion of Hass avocado plantations (HAP) in Colombia. The overarching research question is as follows: *Why are Hass avocado plantations expanding and transforming the socio-natural dynamics in the Global South?* In order to address this general question, the research presents four research sub-questions, which allow me to provide systematic answers and to take a step forward in terms of how to address the analyzed problem:

- *RQ₁. How is the relationship between monocultures and ecosystem services in the Global South?*
- *RQ₂. What are the implications of the expansion of Hass plantations in Colombia?*
- *RQ₃. How do Hass plantations make the landscape a source of large-scale exploitation in Salamina, Caldas?*
- *RQ₄. What is needed to achieve food system's transformation toward sustainability in the Global South?*

⁶ In Mexico, the expansion of HAP has directly resulted in the conversion of forested areas into plantations, illustrating substantial shifts in land-use patterns (Barsimantov & Navia Antezana, 2012; Bravo-Espinosa et al., 2014; Campos-Campos et al., 2018; Cho et al., 2021; De la Vega-Rivera & Merino-Pérez, 2021; Denvir et al., 2021; Friedmann & McNair, 2009; Pérez-Llorente et al., 2019; Ramírez-Mejía et al., 2022). In contrast, Chile highlights a more gradual but equally transformative expansion of plantation cultivation. The literature describes how avocado plantations have progressively replaced traditional land uses, converting areas previously dedicated to annual crops for domestic markets into large-scale monocultures. This shift is primarily attributed to the influence of neoliberal policies, which have redefined agricultural priorities and land-use practices (Bolados et al., 2018; Budds, 2004, 2008; Panes Pinto et al., 2018).

1.3. Philosophical underpinnings

The research questions, analytical framework, and theorization process in this dissertation are explicitly guided by Critical Realism⁷, ensuring a rigorous examination of the complex interactions between socio-natural dynamics and large-scale monoculture expansion. I then provide insights into the core elements of Critical Realism used in this research.

1.3.1. Ontology and epistemology in Critical Realism

In Critical Realism, ontology concerns the nature of reality, emphasizing that reality exists independently of beliefs or knowledge about it⁸. This perspective challenges mechanical or linear understandings of reality, proposing instead that it is organic and historically co-produced by different structures and agencies. Nature and society, therefore, are not separate domains but rather a collective phenomenon in which biophysical and social realities, while distinct, are interconnected. This interconnectedness follows a layered ontology (Table 2), where different levels of reality interact to form a contextual whole (Bhaskar, 2008; Danemark et al., 2004). Within this framework, reality is empirical (measurable through observation), actual (characterized by flows and consequences that, although not predictable, can be explained), and real (composed of underlying structures and powers that shape phenomena) (Danemark et al., 2004; Fletcher, 2017; Mukumbang, 2021).

Table 2. Layers of reality

	Real	Actual	Empirical
Mechanisms	•		
Events	•	•	
Experiences	•	•	•

Source: Bhaskar (2008).

This ontological position informs the epistemological approach of the research, guiding it beyond mere empirical evidence to uncover causal mechanisms. Critical Realism recognizes the fallibility of knowledge, emphasizing the need for critical engagement with both empirical observations and theoretical explanations. It also highlights the importance of context in socio-natural systems, asserting that knowledge is always situated within specific historical and material conditions (Price & Lotz-Sisitka, 2016). The goal of this research, therefore, is to describe and clarify the relationship between observed experiences, events, and mechanisms, as Critical Realism proposes (Lawani, 2020).

⁷ Critical Realism suggest that science is a process where two dimensions relate dialectically; the intransitive (ontology) and the transitive domain (epistemology) of knowledge (Bhaskar, 2008). Bhaskar argued that a common problem in science is the so-called epistemic fallacy, which consists of conflating being with knowledge about being (Bhaskar, 2008, 2014). The denotation of this is that, while approaching the understanding (i.e. transitive/epistemological) of the real existing structures and mechanisms, researchers continuously assume this knowledge provides a real account of being (i.e. intransitive/ontological). However, as stressed by Bhaskar et al. (2017), “the transitive dimension is that aspect of knowledge that involves people and their beliefs, or scientists and their theories... []... However, we also have a world which exists independently of people and their beliefs and this is the intransitive dimension (Bhaskar et al., 2017:28). Therefore, propositions, ideas and theoretical frameworks make up the transitive domain of science, which is transient given the constant process of scientific discovery and theoretical refinement.

⁸ From a critical realist perspective, social reality emerges from the dynamic interplay between social structures and human agency.

1.3.2. Implications for research design

This research necessitates an approach that accounts for ontological depth, moving beyond the mere collection of empirical data to explore the structures and mechanisms underlying observed phenomena (Danemark et al., 2019; Fletcher, 2017; Wynn et al., 2012). The inferential process plays a crucial role in this approach, requiring reasoning at different stages of the research to ensure that explanations align with critical realist principles (Danemark et al., 2019; Price & Lotz-Sisitka, 2016). As Bhaskar et al. (2017: 82) note, "*Epistemologically, Critical Realism is more inclusive than other philosophies, as it demonstrates both why we need statistics and why we need to look at discourse, and it fits these different approaches into a more comprehensive account of the scientific process.*" This inclusivity underscores the relevance of Critical Realism for research that seeks to integrate diverse methodological perspectives while maintaining coherence in its theoretical framework.

1.3.3. Why Critical Realism is suitable for this study

This approach enables the generation of knowledge that accurately represents the reality of Salamina through a process of theoretical consolidation. In other words, it allows for an explanation that goes beyond the quantitative and qualitative manifestations associated with a specific typology of land use and a social system such as HAP. This approach facilitates the identification of how socio-natural dynamics are shaped by focusing on phenomena that transcend mere empirical observation, such as environmental impacts or social conflicts. That is, it not only examines the conditions that enable these phenomena to materialize but, more importantly, allows for theorizing about the causal mechanisms that generate them. In this way, it provides a more comprehensive understanding of Salamina's reality. Additionally, Critical Realism is useful to examine how knowledge is generated, explanations are constructed, and scientific reasoning accounts for complex realities.

1.4. Research design and methods

This section presents the research design of this dissertation. I begin by explaining the type of research and its methodological approach. Additionally, I outline the research strategy, which follows a case study approach. Subsequently, I explain how the research was structured to provide a logical and systematic order. In this section, I also describe the data analysis process and the inferential approach used for theorization. Finally, I reflect on my positionality within this research and highlight ethical considerations.

I adopted a multilevel research design, as this explanatory study not only identifies and describes HAP's impacts but also analyzes the socio-historical, economic, and political structures that have facilitated its expansion (Nichol et al., 2023). From a methodological standpoint, I employed a mixed-methods approach with a sequential design (Creswell & Creswell, 2018), emphasizing qualitative data to support my explanatory aims.

Mixed methods are particularly valuable when combined with Critical Realism, as they enable a structured and systematic understanding of reality (Zachariadis et al., 2013). This approach allows analysis at multiple levels of abstraction: quantitative methods capture measurable aspects of reality, while qualitative methods offer deeper insights into underlying phenomena. By integrating data through a sequential design, this research captures multiple layers of reality, providing a comprehensive analysis of the complex dynamics associated with HAP expansion.

Additionally, I used a singular cross-sectional explanatory case study that served as an empirical approach, focusing on (a) a contemporary case, (b) the significance of context, and (c) the explanation of causal links

in real-world interventions (Yin, 2013, 2018). Specifically, I structured the design around the four main research sub-questions. As this is a cumulative thesis, I designed distinct phases and methods to address each sub-research question. In particular, I proposed three phases to systematically address my main research question (Figure 1).

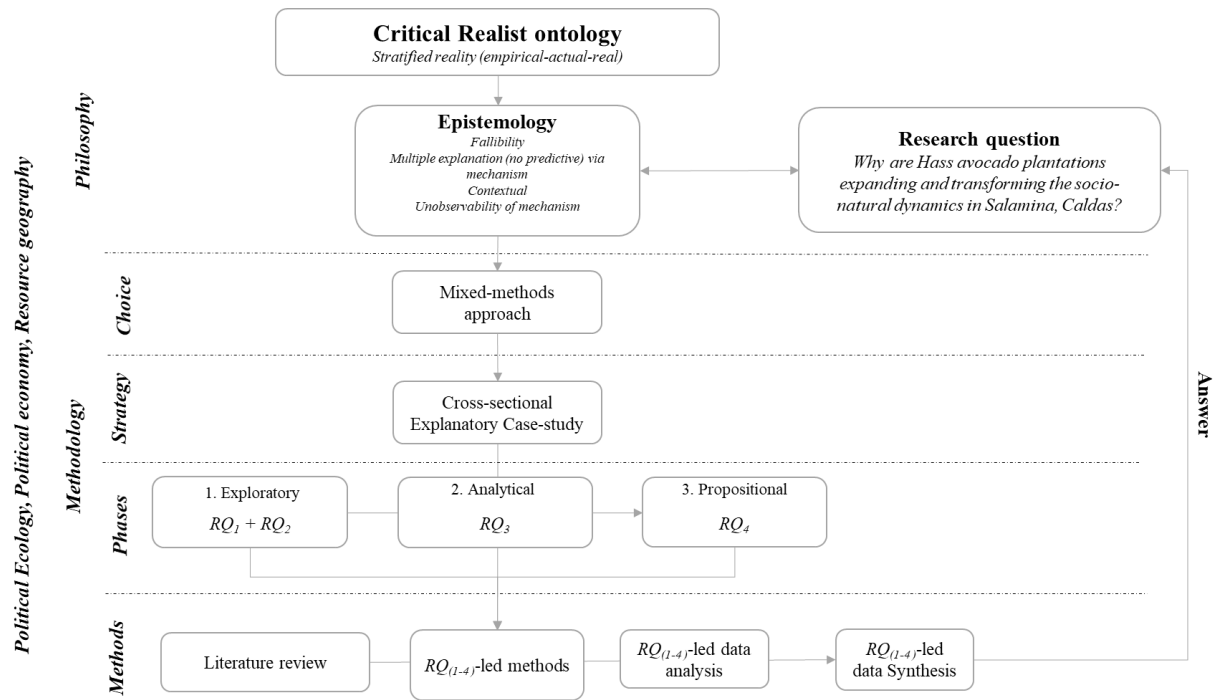


Figure 1. Overall research design. Own elaboration.

- *Phase 1. Exploratory*

The first phase was exploratory, involving an initial investigation into the underlying principles of monocultures in the Global South, followed by an in-depth examination of specific dynamics in Salamina as a case study. The first research question (RQ_1) focused on the relationship between monocultures and ecosystem services in the Global South. To address this, I conducted a systematic literature review using the SCOPUS database as the primary source. This analysis was further enriched with a quantitative review of secondary data from global organizations such as FAO and the World Bank. By integrating these complementary sources, I identified links between the historical expansion of monocultures and the loss, using deforestation as a proxy for assessing the impact of large-scale plantations on ecosystems in the Global South. This approach provided a robust foundation for understanding the environmental consequences of monoculture expansion at regional and global scales.

This design allows for a thorough examination of how monoculture practices impact ecological functions and services at the level of the Global South. The second research question (RQ_2) focuses on the local context of Salamina, Caldas, Colombia. Here, the study assesses the implications of the expanding HAP by reviewing regional agricultural statistics and local policies. Qualitative data on complaints and sanctions provides further insight into the social repercussions, contributing to a comprehensive understanding of how the plantation model disrupts local dynamics.

- *Phase 2. Analytical*

In the second phase, defined as analytical, I aimed to generate both exploratory and detailed knowledge to build elements toward achieving my explanatory objective. Therefore, with the third research question (*RQ₃*), I delved deeper into the socio-political, economic, and material factors that make landscape susceptible to large-scale exploitation. This question combines quantitative reviews of regional agricultural and environmental statistics. It also incorporates qualitative data from interviews with local inhabitants and representatives of public agencies. For *RQ₂* and *RQ₃*, I designed a protocol for collecting empirical data in the field (see Appendix 1).

- *Phase 3. Propositional*

Finally, the fourth research question (*RQ₄*) expands the scope to explore the requirements for achieving food system transformations toward sustainability in the Global South. This is the propositional phase, which presents an approach to address the transformation needs identified in the previous phases. Through a literature review, I proposed the conditions necessary for such transformations, drawing on critical realist theoretical frameworks. Each research question follows a distinct methodological approach, spanning global to local scales, combining qualitative and quantitative methods to provide a comprehensive understanding of both the specific case in Colombia and the broader global challenges of monocultures and sustainability transitions in the Global South.

Since I employed a mixed-methods approach with a sequential design, data integration was crucial to addressing the overarching research question. While each research question had specific methods and analyses, the final integration provided a comprehensive understanding of the phenomenon under investigation. This process involved systematically incorporating information to build a comprehensive and nuanced understanding of the analyzed context.

With each methodical step, I progressively gained a deeper understanding of the subject. First, by examining the broader impacts of monocultures through a systematic review. Then, I analyzed the specific implications of HAP at the local level using field observations, interviews, and secondary sources. Finally, I investigated the conditions that enabled the consolidation of plantations in Salamina through additional interviews and secondary data analysis. Once this broader landscape was established, the next step focused on synthesizing the collected data and developing an abstraction process. This final stage was crucial for formulating well-founded explanations regarding the expansion of HAP and its transformative effects on traditional agricultural landscapes.

1.4.1. Data analysis for the dissertation

After identifying empirical patterns, I adopted a broader analytical approach, going beyond data-driven analysis. Through multiple rounds of observation, I asked: *What distinct events explain the empirical data I have gathered?* This expanded categorization allowed me to uncover and explore the underlying systemic forces shaping HAP's interference in socio-natural dynamics in Salamina. By taking this broader perspective, I aimed to provide a more comprehensive understanding of the factors driving these transformations.

According to Critical Realism, reality is influenced by theory but not determined by it (Fletcher, 2017). Following this principle, I applied analytical generalization, using a pre-existing theoretical framework to compare against the empirical results of my case study (Tight, 2022; Yin, 2018). I relied on abductive and

retroductive reasoning⁹, complementary inference methods that enhance theoretical explanations by linking them to their contextual foundations (Danemark et al., 2019). As Mukumbang (2021) states, "*abductive and retroductive inferences are required to move from a social phenomenon to a theory, which can account for that phenomenon*" (p. 5).

To explore the underlying structures influencing HAP expansion, I employed retroduction—a method for identifying causal mechanisms¹⁰. A mechanism, as defined by Blom & Morén (2011), is a non-observable, trans-factual entity that explains why empirical events occur. Sayer (1984) describes retroduction as "*a mode of inference in which events are explained by postulating (and identifying) mechanisms capable of producing them*" (p. 107). This approach allowed me to identify and hypothesize the causal mechanisms shaping HAP expansion and its socio-natural transformations. Specifically, I asked: *What conditions must be met for HAP to expand and transform socio-natural dynamics?*

Critical Realism acknowledges the fallibility of knowledge while promoting rigorous inquiry by prioritizing plausibility, credibility, and explanatory depth over mere accuracy or consistency (Bhaskar, 2008; Zachariadis et al., 2013). In this study, I enhanced validity by developing plausible explanations for HAP expansion and socio-natural changes. First, I employed multiple methods to gather diverse evidence, strengthening my conclusions. Second, I contextualized findings within historical, social, and environmental conditions. Next, I identified the mechanisms underlying observable events through abductive and retroductive reasoning. Finally, I refined my theoretical framework through iterative testing against empirical data to ensure both coherence and applicability.

1.4.2. Positionality

This dissertation is interdisciplinary; its main scholarly foundations lie in political ecology, critical resource geography, and critical political economy. From political ecology, I draw on perspectives advocating a normative political commitment to social justice and structural political change (Benjaminsen & Svarstad, 2009; Bryant, 2017; Perreault et al., 2015). Critical resource geography offers tools to analyze resource systems and their historical and contemporary geographies through a critical lens (Valdivia et al., 2022). Meanwhile, critical political economy (Wigger, 2022) informs my understanding of the real world by adopting a critical epistemology that contrasts with the neoclassical approach, which seeks to replicate the formalism and universalism of the natural sciences (Stilwell et al., 2022).

I reject the notion of "value-free" scientific research, recognizing that science is inherently embedded in and accountable to the broader society that sustains it (Douglas, 2016). Since this research is rooted in the social sciences, I do not conflate my specific research problem with the characteristics of the natural sciences, which operate in a value-neutral framework where objects merely exist without moral or ethical implications (Danemark et al., 2019). Beyond its epistemological critique, this dissertation also takes a political stance, acknowledging the necessity of fostering societal change (Mingers, 2014).

⁹ According to Danmark et al. (2019), *abduction* is the process of generating explanatory hypotheses to interpret observed phenomena, often by applying theoretical frameworks to empirical data. It allows researchers to construct meaningful explanations without necessarily proving causation. *Retroduction*, on the other hand, goes deeper by identifying the underlying causal mechanisms and structures that make a phenomenon possible. It involves reasoning backward from observations to uncover the fundamental conditions that produce them. While abduction helps formulate theories, retroduction seeks to reveal the hidden generative forces shaping reality.

¹⁰ In Critical Realism, a mechanism refers to the underlying structures, powers, or processes that generate observable events and experiences. These mechanisms are not always directly observable but are inferred through their effects (c.f. Bhaskar et al., 2017; Danmark et al., 2019).

From a purely economic perspective, plantations—understood as a specific form of agribusiness organization (Greaves, 1958; Pryor, 1982)—are often seen as successful due to their efficiency (Hayami, 2010), their ability to leverage economies of scale, and their capacity to manage coordination challenges effectively (Binswanger & Rosenzweig, 1986). However, my research adopts a critical perspective that preemptively addresses criticisms. Two key counterarguments may arise regarding: (1) a supposed overemphasis on the exploitative dynamics of avocado plantations, and (2) the perceived neglect of the market's role in generating benefits for local populations.

From a non-critical realist standpoint, the discussion could highlight both the exploitative aspects and the potential advantages of plantation expansion, such as technological innovations, improved agricultural practices, and increased food production. Likewise, a non-critical realist perspective might emphasize the market's capacity to allocate resources efficiently, promote economic growth, and contribute to poverty reduction. However, my approach prioritizes examining who gains and who loses from plantations, how these benefits are distributed, and why these disparities arise. This opens multiple avenues of analysis within the framework of my research.

While I acknowledge the potential economic benefits of introducing plantation-based agricultural production into traditional agricultural landscapes measured quantitatively in terms of employment generation and revenue, I also examine power dynamics and conflicts. Therefore, beyond presenting a rigorous methodological design rooted in systematic research practices and sound scientific principles, this dissertation offers a critical and in-depth diagnosis of the socio-political conditions that enable the negative implications of mainstream, hegemonic development strategies such as plantation agriculture in the Global South.

1.4.3. Ethical considerations

This research was explicitly designed to answer specific research questions, with a commitment to data integrity, ensuring no fabrication or falsification (Jenn, 2006). Additionally, this study adhered to ethical principles, including informed consent procedures as needed, minimizing potential harm to participants, and ensuring privacy and confidentiality (Fouka & Mantzourou, 2011). Given that this study involved human subjects through focus groups and interviews, informed consent was duly obtained. To uphold rigorous ethical research standards, the project was submitted to the Ethics Committee of the Universidad de la Costa, Colombia, and received approval under Minute #146, issued on June 18, 2023 (see Appendix 2).

Finally, I disclose that for this dissertation, I utilized artificial intelligence tools to enhance grammar and readability. These tools helped refine clarity, coherence, and grammatical accuracy, ensuring a polished presentation of the research findings, as English is not my native language. However, all substantive content, including the research design, papers, analysis, and conclusions, remains entirely my own work.

1.4.4. Study area selection

I selected the case study for this research based on several criteria. Although approximately 12 departments in Colombia are considered suitable for extensive Hass avocado production, four departments are leading the way: Antioquia, Caldas, Tolima, and Quindío (Figure 2). My focus was to analyze the implications of HAP, which involved identifying areas in Colombia with significant avocado expansion processes and selecting a specific area for the case study. While Antioquia is the leading producer in Colombia, I chose Caldas (the second in the list) due to additional criteria such as familiarity with the region and previous research conducted there (Suarez et al., 2021, 2022).

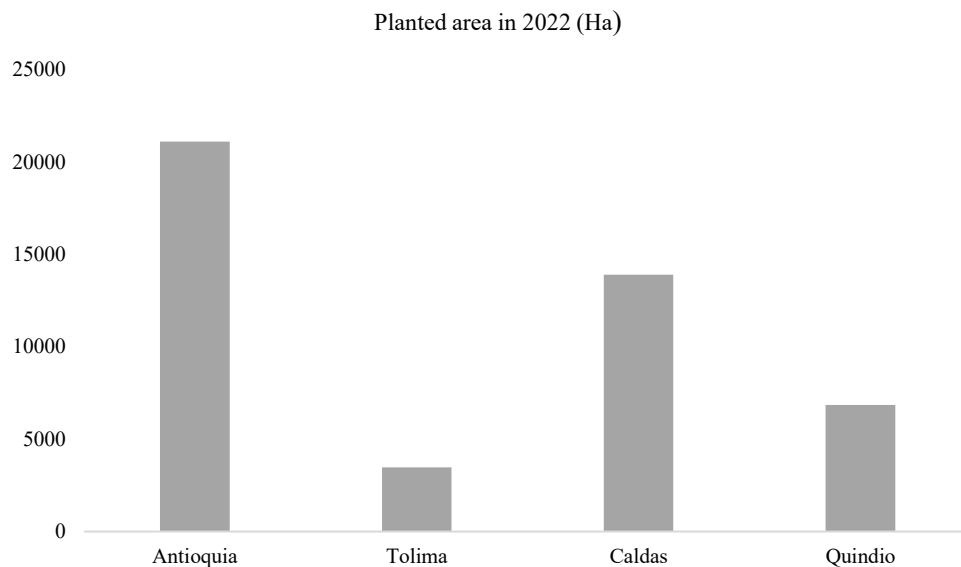


Figure 2. Planted are in Hass avocado in the main producer Departments from Colombia

After selecting Caldas, I applied additional criteria to identify the specific case study area. Caldas is divided into six sub-regions and 27 municipalities, with the northern sub-region experiencing the most significant expansion of plantations. This sub-region (Figure 3) is particularly relevant as it concentrates the highest density of HAP. Covering approximately 127,000 hectares, it includes the municipalities of Aguadas, Pácora, Salamina, and Aranzazu.

The region spans a broad altitudinal range, from 550 to 3,750 meters above sea level, encompassing multiple climatic zones and diverse biomes. However, human activities have significantly altered its landscape. Today, much of the region lies within the high agricultural development zone of the Colombian coffee axis, where coffee cultivation predominates alongside livestock, avocado plantations, and pasturelands.

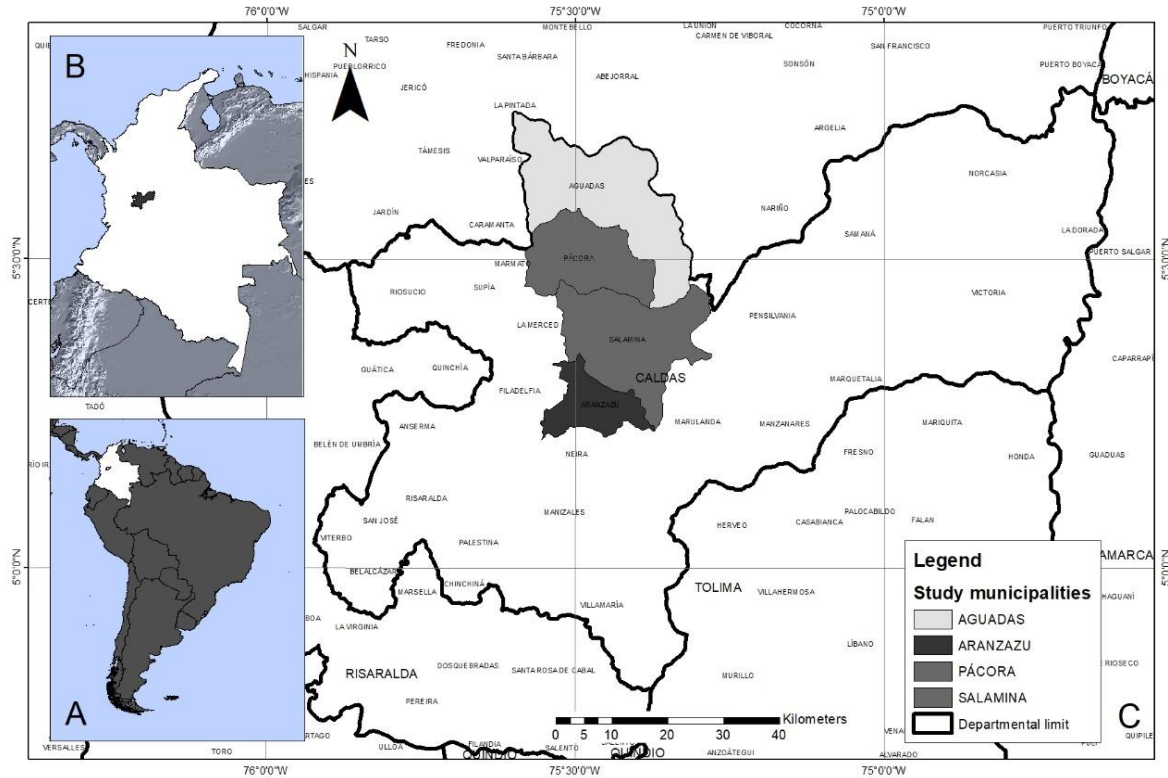


Figure 3. Study area. Northern Caldas, Colombia

Caldas and other departments in Colombia's coffee region have been recognized by UNESCO as part of the Coffee Cultural Landscape for their cultural and scenic value. The Coffee Cultural Landscape represents an outstanding example of human adaptation to difficult geographic conditions, where hillside and mountain coffee farming developed. According to UNESCO¹¹, the criteria for designating these areas as Cultural Landscapes are:

- To be an outstanding example of a traditional human settlement, land-use, or sea-use that represents a culture (or cultures), or human interaction with the environment particularly when affected by irreversible change;
- To be directly or tangibly associated with events or living traditions, ideas, beliefs, or artistic and literary works that hold outstanding universal significance.

Given this context, I selected the municipality of Salamina for this dissertation because it has experienced a significant increase in avocado cultivation and production within Caldas while reflecting similar dynamics observed in other municipalities of the sub-region and the Coffee Cultural Landscape as a whole. Moreover, the main reason for selecting Salamina was that it has several competing claims against corporate avocado growth. Due to corporate-led HAP, Salamina has incurred the highest number of legal sanctions against corporations (13 sanctions or preventive measures) and ranks second in complaints (6 complaints) in Caldas in 2022.

¹¹ For further information: <https://whc.unesco.org/en/criteria/>

1.5. Theoretical approach

I conducted a preliminary analysis of the study area and empirical data. Over time, I refined this into an *ex post* approach, which does not address specific sub-questions but provides a comprehensive understanding of the overarching research question: the spread of HAP and the transformation of socio-natural dynamics. This section lays the conceptual foundations for analyzing these transformations. First, I define the "social" and "natural" components within socio-natural interactions. Then, I examine the role of power dynamics. Finally, I introduce a stratified model that explains how these factors interact to shape land-use transformations.

1.5.1. The "social" in the context of socio-natural

To analyze how HAP transforms socio-natural dynamics, I first define the "social" as the interplay between structure and agency. Social structures enduring, objective features of the social world, shape and constrain human actions. Conversely, human agents, through intentional actions and interactions, can either reproduce or transform these structures. This reciprocal relationship implies that while structures enable and limit agency, agency, in turn, can reinforce or reshape structures (Archer, 1995; Bhaskar, 2014; Lawson, 2015). In this dissertation, structure and agency are linked to land use and agricultural processes.

1.5.2. The "natural" in the context of socio-natural

I distinguish between "environmental" and "natural" in this study. *Environmental* refers to the biophysical conditions in Salamina and their positive or negative impacts. *Natural*, however, is an analytical category highlighting how the biophysical is socially constructed, assigned specific significance through historical and contextual factors. While this dissertation does not adopt a purely social constructionist approach, the term *natural* acknowledges both material conditions and social meanings.

Socio-natural dynamics cannot be reduced to a simple dialectic between land use structure and human agency. Instead, they must be analyzed through Bhaskar's (2011) concept of *ecological asymmetry*, which rests on three principles: (i) the biophysical operates independently of society; (ii) society depends on the biophysical for material resources essential to reproduction, and (iii) humans are integral to the biophysical due to their elemental composition. Following Tilzey (2018), I conceptualize socio-natural dynamics as a dialectical configuration within a specific historical moment, where social structures, human agency, and the biophysical co-evolve and co-produce.

1.5.3. How to understand socio-natural dynamics

To analyze socio-natural dynamics, I employ Danemark et al.'s (2019) explanatory structural analysis, which distinguishes between internal (defining) and external (contingent) relations. Drawing on Sayer (1984) and Danemark et al. (2019), I identify two types of relations: substantial internal relations (what socio-natural dynamics are), and substantial external relations (how they function).

To illustrate this, I propose three fundamental elements, referred to as the Analytical Trinity¹² (Figure 4). This trinity consists of three interconnected entities: (r1) biophysical, (r2) social structure, and (r3) human

¹² The analytical trinity illustrates a framework for structural analysis, where each dimension holds distinct properties. Within this framework, various internal relations exist. For example, the relationships between the biophysical realm, social structure, and agency are asymmetrical. This is because the biophysical (r1) supports both social structures (r2) and agency (r3), but they do not reciprocate in sustaining the biophysical. In contrast, the relationship between social structure and agency is symmetrical: without structure, there can be no agency, and without agency, no structure. R = Real, A = Actual, and E = Empirical. Own elaboration.

agency. Together, these form the internal substantial relations necessary for socio-natural dynamics to exist. The removal of any of these elements would render socio-natural dynamics impossible.

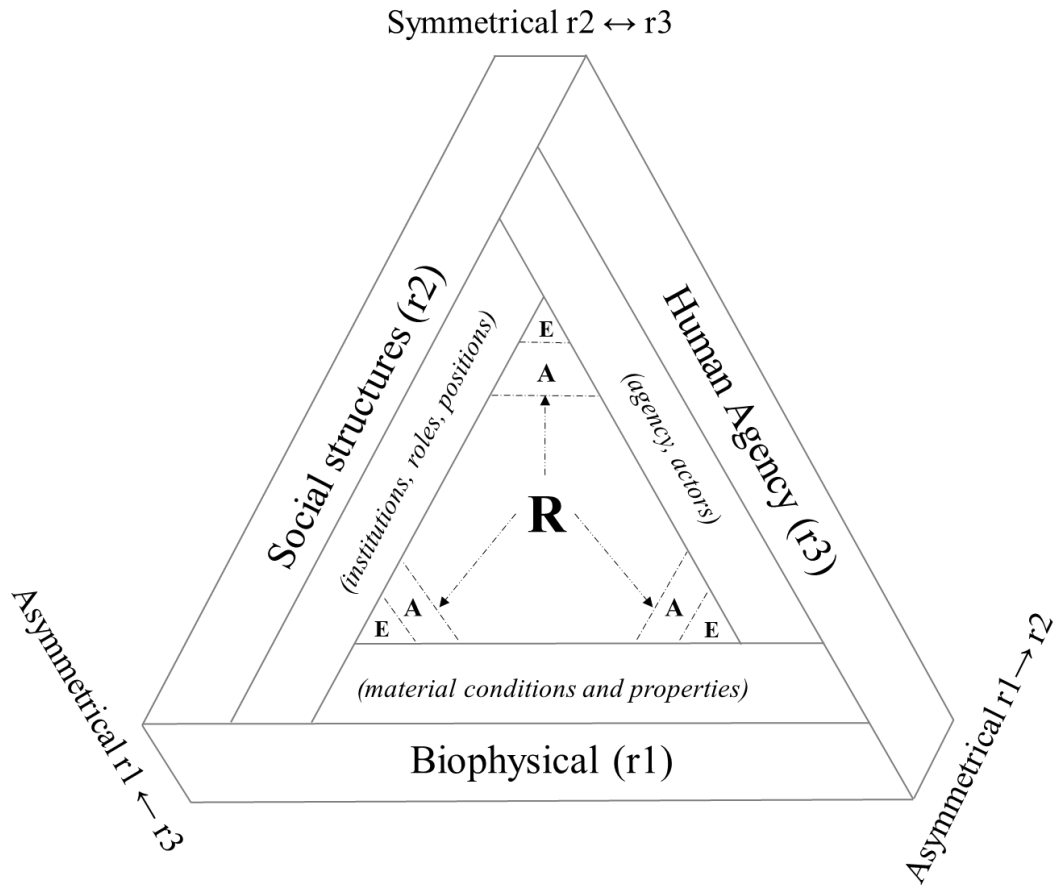


Figure 4. The analytical trinity for socio-natural dynamics. Own elaboration (based on Tilzey, 2018; Archer, 1995; Bhaskar, 2014).

Having established the internal relations between the biophysical (r1), social structures (r2), and human agency (r3), it is equally critical to examine the *how*: the external relations that drive and constrain socio-natural transformations. Tilzey's (2018) framework provides a valuable lens for this analysis, identifying two key categories of power and causality in socio-nature systems: allocative power and authoritative power.

- Allocative power (hard power) refers to material control over biophysical elements such as land, water, and other natural resources. By controlling these resources, actors exert influence over individuals and communities that depend on them. This form of power is directly linked to the material conditions of socio-natural dynamics, shaping how resources are accessed, managed, and exploited.
- Authoritative power (soft power) operates through non-material means, including ideologies, discourses, and symbolic systems. It influences how societies perceive, value, and interact with the biophysical world, shaping the norms, policies, and cultural frameworks that either legitimize or contest existing socio-natural configurations.

Allocative and authoritative power represent the contradictions and "productions" that drive socio-natural transformations. They reveal how socio-natural dynamics are not merely the outcome of material

interactions but are also deeply embedded in power and control systems. For instance, the commodification of land and resources reflects the interplay of these powers, as material control (allocative power) is often justified and sustained through ideological frameworks (authoritative power).

The social realm, while dependent on material (biophysical) prerequisites ($r1 > r2, r3$), is fundamentally shaped by socio-economic systems governed by authoritative power structures, such as capitalism. Capitalism, in particular, is characterized by a profound reliance on the biophysical (Wennerlind, 2024), yet it generates significant contradictions, especially in its relationship with nature ($r2, r3 > r1$). The process of capital accumulation relies on the exploitation of the biophysical base (allocative power), often leading to environmental degradation and socio-ecological crises (Petras & Veltmeyer, 2023; Tilzey, 2018; Veltmeyer & Lau, 2020).

This dynamic is central to the concept of socio-nature, which highlights how capital reproduces itself by reconfiguring biophysical conditions to sustain growth. Boyd et al. (2001) describe this as the "problem of nature" in capital accumulation, where nature serves as a resource and a limit for capitalist expansion. Moore (2015) expands on this through the concept of the "double internality," wherein capital not only produces new forms of nature but also depends on nature to sustain its accumulation processes. In this sense, socio-nature is not a static backdrop but an active, co-produced dimension of capitalist development.

1.5.4. Stratification of socio-natural dynamics

It is crucial to emphasize that socio-natural dynamics are stratified and emergent, meaning they operate across multiple levels of reality without being reducible to lower levels. This stratified understanding provides a robust framework for analyzing complex phenomena, such as the large-scale exploitation of Hass avocados, which involves interactions across biophysical, socio-natural, and social levels. Drawing on Tilzey’s model, I conceptualize these dynamics through a multi-level analytical framework (Table 3), which includes:

Table 3. Stratification of socio-natural dynamics

Level/strata	Example	Configuration
Level 1: An extra-human reality	<ul style="list-style-type: none"> Land as a biophysical entity (physical-chemical properties of soil, topography, biogeography etc.). Fruits and products of the land independent of human interventions. 	<ul style="list-style-type: none"> Biophysical $r1(r2, 23)$
Level 2: Trans-historical significance for humans	<ul style="list-style-type: none"> Land as social construction (landscape). Fruits and products of the land with use value for humans. 	<ul style="list-style-type: none"> Socio-natural $(r1, r2, r3)$
Level 3: Historically specific (allocative power)	<ul style="list-style-type: none"> Landscape commodification. Fruits and products commodification. 	<ul style="list-style-type: none"> Socio-natural $(r1, r2, r3)$
Level 4: Political dynamics of accumulation (authoritative power)	<ul style="list-style-type: none"> Political logic of surplus production and extraction from land and fruits. 	<ul style="list-style-type: none"> Social $r2, 23 > r1$

Source: Based on Tilzey (2018).

The political logic of surplus extraction (Level 4), driven by authoritative power, plays a fundamental role in shaping how land and its resources are understood, valued, and exploited. This level is entirely constituted by social forces, including ideologies, policies, and institutional arrangements, which exert causal power

over lower levels. Understanding this logic is crucial, as it illuminates the political and economic motivations behind land use transformations, offering critical insights into why phenomena like the expansion of HAP take place.

At Level 3, the political logic of surplus extraction materializes through landscape transformations and the commodification of land. Land is increasingly treated as an economic asset, with its value dictated by market forces rather than its ecological or social significance. For example, in regions where HAP expands, forests and diverse ecosystems are often replaced with monoculture avocado orchards. This transformation is not merely a biophysical change but also a socio-political process driven by the demand for profitable agricultural exports. Moreover, the logic of commodification extends beyond land itself, it reconfigures the fruits and products of the land, stripping them of their original contexts of use and sustainability and integrating them into global commodity chains. A striking example is the Hass avocado, one of the first trees to be patented (Miller, 2020). This case illustrates how naturally occurring species are absorbed into the capitalist logic of accumulation.

The Hass avocado has been transformed into a high-value global commodity, driven by its popularity in international markets, particularly in North America and Europe. This commodification process is facilitated by allocative power, the material control over land, water, and labor, which enables the large-scale production and export of avocados. However, this expansion often overlooks its ecological and social costs, including water depletion, deforestation, and the displacement of local communities.

Within this politico-economic dynamic, land is no longer viewed as a biophysical support system but as a resource for economic exploitation. Even naturally occurring products, such as wild avocados, are commodified and integrated into profit-driven systems. A key example is Michoacán, Mexico, the world's largest producer of Hass avocados, the expansion of HAP has led to significant environmental degradation, including deforestation and water scarcity. Simultaneously, it has exacerbated social inequalities, as small-scale farmers are often marginalized by large agribusinesses (Denvir et al., 2021; Friedmann & McNair, 2009; Pérez-Llorente et al., 2019; Ramírez-Mejía et al., 2022).

1.5.5. Theoretical framework and research questions

I approached the present dissertation through a socio-natural lens. By understanding the entities illustrated in Figure 4 and considering their stratification (Table 3), it becomes possible to address the key issues raised in the research question. The first aspect seeks to understand why HAP expands, which, in theoretical terms, I attribute to authoritative power. This power shapes the non-material specifications that must be enacted to accumulate surplus. Building on this, the second component of my research question focuses on why HAP transforms socio-natural dynamics. Here, I propose that this transformation is driven by material control over the biophysical environment, exemplified through a specific model: plantation agriculture.

Moreover, this theoretical framework establishes a foundation for addressing the sub-research questions by illuminating the interplay between socio-natural dynamics, power structures, and the commodification of land and resources. For Sub-Research Question 1 (**RQ1**), which examines the relationship between monocultures and ecosystem services in the Global South, the framework highlights how the expansion of monocultures like HAP disrupts ecosystem services through extensive landscape transformations and resource extraction. By focusing on the biophysical domain (Level 1) and its interaction with socio-natural processes (Level 2), the framework reveals how monocultures diminish biodiversity, water cycles, and soil health, while also emphasizing the role of allocative power as a driving force behind these changes.

In addressing Sub-Research Question 2 (**RQ2**), which explores the implications of Hass avocado expansion in Colombia, the framework illuminates the socio-political and economic forces driving this phenomenon. At Level 3, process of commodifying land and resources is central to understanding how HAP transforms local landscapes into sites of large-scale agricultural production. The framework also highlights the role of authoritative power (Level 4) in shaping policies and discourses that legitimize and facilitate this expansion, often marginalizing local communities and intensifying environmental degradation.

For Sub-Research Question 3 (**RQ3**), which investigates how HAP in a Colombian case study reflect a complex assemblage of socio-political, economic, and material factors, the framework provides a multi-scalar analysis. It reveals how socio-natural processes (Level 2) interact with commodification (Level 3), both of which are shaped by the political dynamics of accumulation (Level 4); ultimately reshaping biophysical conditions (Level 1). The framework underscores how land becomes a site of large-scale exploitation through the interplay of allocative power (material control) and authoritative power (ideological and institutional forces). In Colombia, for instance, the expansion of HAP is not merely an agricultural shift but a deeply embedded socio-political transformation driven by global trade networks, local elites, and state policies that prioritize export-oriented agribusiness over ecological and social well-being.

Finally, for Sub-Research Question 4 (**RQ4**), which examines the prerequisites for achieving food system transformation toward sustainability in the Global South, the framework emphasizes the need to address the root causes of socio-natural exploitation. By highlighting the role of authoritative power in institutionalizing unsustainable practices, the framework calls for systemic policy transformations that prioritize ecological integrity and social equity over profit-driven agribusiness models. It also underscores the importance of challenging the commodification of land and resources through agroecology, which offers an alternative paradigm centered on biodiversity, food sovereignty, and just socio-ecological relations.

1.6. Summary of results

In this section, I address each of the sub-research questions and present the key findings that emerged from them. As previously mentioned, this research takes a systematic approach, constructing an explanation that progresses from broader to more specific elements to answer the general research question. The overall research question seeks to explain why HAP expands and transforms the socio-natural dynamics in Salamina. Through the first three sub-questions, I develop an answer by first examining how biophysical aspects are affected by specific activities, such as monoculture farming. Next, I explore how HAP reshapes socio-natural dynamics at multiple levels.

In this section, I address each sub-research questions and present the key findings that emerged from them. As previously noted, this research follows a systematic approach, constructing an explanation that progresses from general to specific elements to answer the main research question. The overall research question seeks to explain why HAP expands and transforms socio-natural dynamics in Salamina. Through the first three sub-questions, I develop an answer by first examining how biophysical aspects are affected by specific activities, such as monoculture farming. Next, I broaden the scope of analysis to determine how and why HAP spreads. Finally, I will explain why HAP fundamentally reshapes a range of socio-natural dynamics.

1.6.1. On the relation between monocultures and ecosystem services in the Global South: A review

I submitted this paper to *Biological Conservation*. The paper was co-authored (Suarez and Gwozdz, 2023) with the following contributions: I conceived the study, designed the methodology, and wrote the original draft; Gwozdz reviewed and edited the manuscript. The paper was published in issue 278 in 2023 and addresses the first research sub-question (*RQ1*): how is the relation between monocultures and ecosystem services in the Global South? The goal of the paper was to understand how socio-natural dynamics, exemplified by the concept of ecosystem services, are influenced by monocultures in general. I chose not to focus specifically on Hass avocado, as I aimed to provide a broader understanding of monoculture practices in a region like the Global South, which faces significant challenges and pressures due to its dependence on the agricultural sector. For the development of this article, we conducted a systematic literature review, which we later supplemented with a review of secondary information. This information was primarily statistical, providing us with insights into two main topics. First, the areas covered by monocultures in the Global South, and second, changes in forested areas. These aspects were analyzed from a historical perspective, allowing us to observe correlations between the expansion of monoculture areas and the decline in forested areas. We used this as a proxy to identify the impact of monocultures.

The findings from this review reveal a conflicting trend: the expansion of monocultures is often negatively correlated with forest cover, especially in biodiversity-rich countries. This suggests that as monocultures spread, deforestation becomes more prevalent, leading to a loss of crucial ecosystem services such as biodiversity conservation, water purification, and carbon sequestration. While monocultures contribute significantly to food production, this benefit comes with substantial ecological trade-offs. Finally, the paper emphasizes the urgent need for more research to understand the implications of monoculture practices in the Global South. It argues that sustainable agricultural practices must be prioritized to ensure that economic development does not come at the expense of the environment. The paper calls for a balance between agricultural productivity and ecological preservation, highlighting the importance of addressing these issues in future policies and practices.

Key findings from this paper were:

- A significant negative correlation was found between harvested monoculture areas and forest cover, especially in megadiverse countries like Brazil, Colombia, Indonesia, and Peru.
- Monocultures rely heavily on ecosystem services like water supply, nutrient regulation, pest control, pollination, and shade.
- While monocultures contribute to material (e.g., food, raw materials) and some non-material services (e.g., scenic value), they often negatively affect regulating services like biodiversity, water regulation, and soil fertility.
- Synergies associated with monocultures include CO₂ sequestration and climate regulation in crops like palm oil and rice.
- Trade-offs involve biodiversity loss, soil degradation, and negative impacts on water resources and pest control mechanisms.

While this paper afforded me a substantial comprehension of the trade-offs inherent to monocultures, as well as an appreciation for the underlying rationale behind their proliferation, it became evident that further exploration was necessary. Consequently, I concentrated on the Hass avocado monoculture, employing deductive logic: monocultures in the Global South have a detrimental impact on social and biophysical

conditions. Given that Hass avocado is a monoculture in Colombia, a country located in the Global South, the avocado monoculture harms the social and biophysical conditions in Colombia. I then addressed this issue in my second paper.

1.6.2. Critical overview of the expansion of Hass avocado plantations in Salamina, northern Caldas, Colombia

This paper was published in the *Journal of Land Use Science* in 2024 as a single-authored paper. The objective of this paper was to answer my second research sub-question (*RQ₂*), which I posed regarding the implications of the expansion of plantations in Colombia¹³. With this paper, I zoomed in on a specific case study focusing on Hass avocado and its implications, and then moved forward the reach of the first sub-research question. I found that the rapid expansion of HAP illustrates the swift changes occurring in local agricultural landscapes in the Global South. This transformation is partly a response to the crisis in the Colombian coffee sector, which has seen decreasing prices and rising production costs. The study uses Salamina as a case study to provide empirical evidence of the impacts of this agricultural shift and to highlight the need for more sustainable governance strategies to manage the emerging socio-economic and environmental challenges.

I observed that since 2018, Salamina has undergone a significant transformation from a peasant-based, coffee-centric economy to one dominated by capital- and labor-intensive Hass avocado cultivation. This shift has altered the local landscape, with extensive areas previously devoted to coffee production and pastures now repurposed for avocado farming. While the Hass avocado has emerged as a major economic driver, creating employment opportunities and enhancing local incomes, it has also intensified social grievances and inequalities among local communities.

This shift has led to a notable reduction in coffee, livestock and other production systems. However, the expansion of HAP has intensified land ownership inequality and increased foreign land ownership. Large-scale corporations, often from countries like Chile and Peru, dominate the industry, acquiring vast tracts of land and consolidating their holdings. This has resulted in environmental concerns, including the impact on water sources and the alteration of traditional landscapes. Local communities have filed numerous complaints regarding environmental impacts and the adverse effects on their livelihoods. Issues such as water contamination, unauthorized logging, and sedimentation from road construction have been highlighted, leading to various legal sanctions against some corporate growers.

The study underscores the need for improved governance strategies to address these challenges and promote sustainable and equitable agricultural development. The paper calls for more effective coordination efforts to safeguard the well-being of local communities and preserve the cultural heritage embedded in traditional agricultural practices.

Some key findings from this paper were:

- HAP grew by over 500% between 2018 and 2022, replacing pastures. Currently, they cover more than 2,000 ha, with potential for expansion to over 9,000 ha.

¹³ I want to highlight two significant changes I made when developing this paper. First, I moved away from using the ecosystem services approach, as it was not sufficiently effective for addressing the next steps of my thesis in a way that aligns with the critical perspective employed in this research. Second, I replaced the term "monocultures" with "plantations," as the latter concept was more appropriate for aligning with the proposed social ontology.

- HAP has become a significant economic driver, creating jobs and attracting investment. However, it has also exacerbated land inequality, with land concentration increasing among corporate growers, many of which are foreign companies. The GINI land index in Salamina is high (0.76–0.84), reflecting severe land inequality.
- Protected areas that are critical for Salamina’s water supply have now partially been used for avocado cultivation, raising concerns about water quality and availability.

At this stage of the dissertation, I have explored the impacts of monocultures in general and specifically examined the implications of Hass avocado plantations in a particular case study. So far, I have been able to provide information regarding how HAP have expanded. However, this understanding is still insufficient to fully address the main research question. This is why it was necessary to delve deeper into the issue of Hass avocado plantations, aiming to comprehend the conditions under which land is transformed into a resource for large-scale exploitation. In the next paper, I provide a comprehensive answer to this aspect.

1.6.3. (Re)making land as a resource through the assemblage of Hass avocado plantations in Salamina, Colombia

The manuscript was published in *World Development Perspectives* as a single-authored paper and addresses the third research sub-question (**RQ₃**), which explores how the expansion of Hass avocado plantations in a Colombian case study reflects a complex assemblage of socio-political, economic, and material factors that reshape landscape into a resource for large-scale exploitation. The article is grounded in critical resource geography and emphasizes the role of policy instruments in facilitating land from traditional agricultural uses to large-scale commodity production. To develop this article, I applied a mixed-methods approach, utilizing qualitative data from interviews and secondary information, as well as a statistical review of land-use changes and agricultural data.

Considering the results of **RQ₂**, I then examined the transformation of land in Salamina, Colombia, under the growing influence of Hass avocado plantations (HAP). I adopt a resource-making framework that explores how land, once a vital resource for peasant communities, has shifted from a foundation of local, subsistence agriculture to a market-driven asset centered on ecological surplus and exchange values. In this paper, I delve into the concept of land as a resource, particularly how it has been redefined through the lens of the global avocado market. Traditionally, land in Salamina was seen as a source of "land use-values," supporting the livelihoods of local communities through small-scale, subsistence farming. However, with the rise of the Hass avocado boom, land has increasingly been viewed as a source of "land exchange-values," where market-oriented production for profit takes precedence.

I argue that HAP's expansion in Salamina represents a complex assemblage of socio-political, economic, and material factors. This assemblage is characterized by the concentration of land ownership in the hands of large corporations, which has marginalized small-scale farmers and transformed the agricultural landscape of Salamina. The promotion of Hass avocado as a cash crop has intensified land use, leading to the appropriation of land that was once used for traditional agriculture and social reproduction.

I conclude that the making of land as a resource in Salamina is a process driven by market compulsions and the pursuit of ecological surplus¹⁴. A range of socio-political, economic, and material factors, which together constitute HAP's assemblage, facilitates this transformation. The implications of this transformation are far-reaching, affecting not only the livelihoods of local communities but also the broader environmental and social fabric of the region.

From the paper, I highlight the next findings:

- Landscape use in Salamina has shifted from traditional agricultural uses (coffee, plantain, livestock) to HAP, driven by public policies promoting land suitability for avocado cultivation.
- Tensions exist between corporate interests and local communities, particularly over land access, water rights, and cultural heritage. The commodification of land has sparked disputes between traditional land values and market-driven exploitation.
- The Colombian government and regional authorities have facilitated HAP through policies such as land suitability mapping and agricultural incentives, often favoring corporate interests over local communities.

So far, I have amassed sufficient evidence and information to provide a comprehensive response to my overarching research question. However, as a further consideration (in the propositional phase), I have proposed research sub-question number 4, given the identified necessity to provide transformations, not only in the context of Hass avocado cultivation but more broadly within the domain of food systems. I will present an account of this undertaking in the subsequent paper.

1.6.4. Transforming food systems in the Global South: A radical approach

This paper was co-authored (Suarez and Ume, 2024). I was responsible for writing the original draft and for review and editing, while the co-author contributed to the review and editing of the manuscript. In addressing my final research sub-question (*RQ4*), which examines what is required to achieve a radical transformation of food systems in the Global South toward sustainability, I presented a comprehensive paper published in *Frontiers in Sustainable Food Systems* in 2024. In this paper, I argued that sustainability in food systems demands more than modifications to agricultural practices or consumer behaviors. It is therefore imperative to address the underlying social, economic and environmental challenges that are deeply embedded in these systems, which are often shaped by capitalist values and global power dynamics. We developed a theoretical approach in this perspective-type article. This approach was primarily based on secondary information and reflections grounded in critical realism and agroecology.

I highlight the significant impact of the state-capital nexus, especially in the Global South, where extractive practices by the Global North perpetuate environmental impacts and social inequities. The paper proposes that radical political agroecology, a strategy that integrates social resistance and challenges the state-capital nexus, is essential for promoting sustainability. This approach not only focuses on ecological practices but also emphasizes the importance of social justice, particularly the role of peasant resistance in opposing neoliberal food regimes.

¹⁴ The concept of "ecological surplus" is central to this discussion. Ecological surplus refers to the ability to generate surplus value from the land through intensified agricultural practices. In the case of Hass avocados, this surplus is extracted through market-compulsive production, which prioritizes exchange-values over use-values.

Further, I explore the complexity of food systems through a critical realist framework, which helps to understand the interconnectedness of social, natural, and economic factors. The argument proposes that transformation efforts must consider the multi-scalar nature of food systems, where changes at one level can have far-reaching effects across other levels. In this sense, the paper calls for a radical transformation of food systems that goes beyond superficial changes and addresses the root causes of unsustainability. This transformation is seen as crucial for achieving equitable and sustainable food systems in the Global South, with agroecology and peasant-led resistance playing central roles in this process.

1.7. Discussion

Colombia is one of the world's most significant producers of Hass avocados. However, the scientific literature remains scarce on explaining HAP expansion. While extensive research exists on the dynamics of HAP in other producer countries, such as Mexico and Chile, Colombia's case presents distinct characteristics that require further analysis.

In Mexico, HAP expansion has led directly to the conversion of forested areas into plantations, illustrating substantial shifts in land-use patterns (Barsimantov & Navia Antezana, 2012; Bravo-Espinosa et al., 2014; Campos-Campos et al., 2018; Cho et al., 2021; De la Vega-Rivera & Merino-Pérez, 2021; Denvir et al., 2021; Friedmann & McNair, 2009; Pérez-Llorente et al., 2019; Ramírez-Mejía et al., 2022). In Chile, the transformation has been more gradual but equally significant. Avocado plantations have progressively replaced traditional land uses, shifting areas previously dedicated to annual crops for domestic markets into large-scale monocultures. This transition is largely attributed to neoliberal policies, which have redefined agricultural priorities and land-use practices (Bolados et al., 2018; Budds, 2004, 2008; Panez Pinto et al., 2018).

In Colombia, the expansion of HAP follows a progressive trajectory that capitalizes on the economic crisis in the primary sector, the historical legacy of land concentration, and the productive potential linked to land suitability. This dissertation contributes by offering a nuanced understanding of how HAP expansion varies, and shapes local communities in different ways. While international literature often focuses on the global rise of HAP, it often overlooks Colombia's unique conditions.

In this section, I will add to the current knowledge by defining how a commodity boom and its socio-natural effects are constituted. First, I present the results obtained in a general manner, and then I delve into the significance of these findings, given that this is an explanatory research study. Consequently, the most important findings gathered throughout the different sub-research questions are as follows:

- From a biophysical perspective, there has been a transformation of the agricultural landscape, shifting from predominantly pasture-covered areas to concentrations of Hass avocado shrubs.
- Additionally, as presented in Suarez (2024), the most important permanent crops have decreased between 2019 and 2023, with only plantain and Hass avocado increasing, the latter experiencing exponential growth (over 500%).
- Economically, significant changes have occurred, as the plantations have generated employment, leading to collateral effects such as inflationary dynamics in land prices and other services, as well as the proletarianization of the countryside (Suarez, 2025).
- Socio-culturally, the transformation of the coffee cultural landscape, which is symbolic and representative of Salamina, stands out (Suarez, 2025).

- Finally, from a socio-natural dimension, a series of conflicts have arisen associated with the expansion of HAP, stemming from its consolidation process of land, concentration in areas important for water provision, and various ecological effects (cf. Suarez, 2024, Suarez, 2025).

1.7.1. Enabling conditions

From an economic perspective, strong arguments support the existence of plantations as an effective strategy for agricultural development in Global South countries. The economic rationale underpinning plantations is fundamentally based on economies of scale and their ability to solve coordination problems between production and marketing stages (Deininger & Byerlee, 2011). Furthermore, the logic for establishing large-scale plantations lies in their capacity to internalize the costs associated with developing the infrastructure required for exploitation. An additional aspect recognized in these systems is that the creation of plantations often necessitates the concession of large tracts of land by local elites with political power (Hayami, 2010). In this regard, Binswanger and Rosenzweig (1986) noted that plantations predominate in contexts where historically large plots of land could be acquired. This is where plantations exploit open resources, such as available land. In the specific case of Salamina, this fulfils the expansion requirement explained by Pryor (1982), where land is considered "financially empty", referring to areas made available due to the lack of financial capacity among local producers to develop viable alternatives (e.g., pastures). While these arguments explain the presence of plantations, this discussion seeks to add further elements that emerge from the ontology proposed earlier.

1.7.1.1. Why HAP expands

Let me now address the explanations for my research question. First, I focus on the **(i)** expansion of HAP and then on the processes of **(ii)** transformation of socio-natural dynamics. HAP expands, primarily because certain actors in Salamina have been positioned as owners of the means of production. However, property alone, without the availability of actors who can be positioned as labor power, does not fully explain the expansion of HAP. Thus, the first element that helps explain this expansion is the dialectic between workers and the means of production. This occurs because the land (as a means of production), the product resulting from the land (Hass avocado), and the labor force converge in a scenario where property rights are exchanged, namely, the market.

This does not mean that property rights and markets for land, products, and labor were absent before the introduction of HAP. On the contrary, these existing structures created a favorable environment for HAP's expansion. Before HAP, Salamina's labor market was predominantly informal, driven by small-scale coffee and plantain production (Suarez, 2025), which primarily served the local market. Although a land market existed, it was largely stagnant. It is important to note that private land ownership in Salamina is not uniform, with landowners being differentiated (see Suarez, 2025). This differentiation played a critical role, as the existing land concentration dynamics in Salamina ($GINI > 0.7-0.8$) reduced transaction costs for corporate buyers (cf. Hasudungan & Neilson, 2020). Negotiating with a specific group of customary elites, such as cattle and pasture owners, facilitated and expedited land acquisition processes. In contrast, dealing with numerous small-scale traditional producers, such as coffee or plantain farmers (with an average of 3–4 hectares), would have been slow, costly, and uncertain. However, questions remain about the factors driving HAP's expansion. HAP grows not only due to private property and markets but also due to the relentless drive for capital accumulation, which, regardless of the activity, becomes an end in itself (Bieler et al., 2022).

Capitalism has evolved into an imperial stage, creating dependency structures where centers of capital accumulation and consumption coexist with peripheries that provide the material conditions for surplus extraction (Tilzey, 2024a, 2024b; Tilzey & Sugden, 2024). This capital accumulation process poses various challenges, addressed through strategies designed to manage these crises. For instance, spatial fixes emerge from capitalism's internal crises, seeking resolution through processes of expansion and geographical restructuring (Harvey, 2001). This is where the second aspect of the research question, regarding the transformation of socio-natural dynamics in Salamina, becomes relevant.

1.7.1.2. Why HAP transforms socio-natural dynamics

I delve into the material contradictions of capitalism (Wennerlind, 2024), which are reflected in Salamina and HAP. Firstly, I acknowledge the involvement of companies from Peru, Chile, and Colombia (external to Salamina) in this situation. The rapid acquisition of over 2,000 hectares in Salamina exemplifies the interaction between economies of scale and spatial diseconomies (Bunker & Ciccantell, 2003). This dynamic illustrates multinational corporations' pursuit of increasing Hass avocado production by exploring new areas for resource exploitation, thereby sustaining economic growth. Another element, as stressed by Ye et al. (2020), relates to the shift in extractive practices toward new domains and locations when a resource nears depletion, as evidenced by the exploration of a new extractive frontier in Salamina, beyond traditional altitude parameters (see Suarez, 2024).

Thus, large-scale plantations represent a different approach to using the biophysical (allocative power). Within this framework, certain authors highlight the need to channel capital through natural systems to increase productivity and foster new avenues for capital accumulation (Almestad, 2015; Boyd et al., 2001). In this sense, capital becomes a creator of "natures", enabling capital accumulation processes (Moore, 2015). However, channeling capital through nature in the form of plantations implies a regressive pattern in the use of nature. Plantations often lead to simplified landscapes and decreased biodiversity, particularly in the Global South (Suarez & Gwozdz, 2023). Ironically, these degraded natural environments must support the same plantations they sustain.

The literature extensively addresses this contradiction, which arises as an endogenous struggle (Cai, 2021; Giraldo, 2019; Veltmeyer & Lau, 2020), particularly in the context of large-scale agricultural exploitation (Artiga-Purcell, 2022). Giraldo (2019) emphasizes that the environmental crisis, stemming from the inherent conflict of agro-capitalism, creates a unique opportunity to legitimize a new dual agrarian framework that intertwines social and environmental interests. This effort often disguises itself under the discourse of sustainability, driven by the agendas of large companies (Washington, 2015). In this vein, my research reveals that this contradiction permeates interventions associated with sectoral governance (both for productive and environmental purposes). On the one hand, these interventions aim to guide plantations toward sustainability by adopting environmental standards, sustainability guidelines, and legal regulations. However, paradoxically, they also actively promote plantations as a strategic path for Salamina (Suarez, 2024; Suarez, 2025).

Applying Backhouse et al. (2022) to the context of HAP, incorporating sustainability criteria, one can perceive HAP as an attempt to "green" the existing food regime. This is further reinforced by the fact that Hass avocados symbolize a lifestyle and represent new food consumption patterns (Magrach & Sanz, 2020), which, in a sense, legitimizes HAP. However, it is essential to recognize that this approach may not effectively address the fundamental power dynamics and social inequalities that have contributed to global

social and environmental changes due to food systems (Backhouse et al., 2022; Moore, 2015; Suarez & Ume, 2024).

Therefore, the expansion of HAP in Salamina reflects the intertwined dynamics of the next enabling conditions:

- Land concentration reduces transaction costs by consolidating control under large landholders, streamlining decision-making and resource allocation.
- Labor market flexibility enables the availability of an informal, adaptable workforce, allowing plantations to adjust quickly to changing economic demands.
- External capital drives the continuous pursuit of profit maximization and spatial expansion, fostering the growth of monoculture plantations.
- Governance mechanisms create contradictions by simultaneously regulating and promoting plantation expansion, leading to policy gaps that facilitate large-scale agricultural growth.

1.7.2. Causal explanation

Having identified the enablers of HAP expansion, I now turn to the deeper causal mechanisms that sustain socio-natural transformation. I identify a causal mechanism centered on a *shift in priorities*, rooted in authoritative power. This mechanism articulates the previous enablers and represents a deliberate phenomenon aimed at transitioning from a socio-natural regime based on use-value to one driven by the exploitation of exchange-value. This shift does not occur in isolation; it emerges within arenas of power, where regional and local actors reshape priorities through decisions that both reflect and reinforce HAP's boom (Suarez, 2024b). Crucially, agency plays a decisive role: those who profit (financially, socially or politically) from HAP wield more influence over these shifts than those who do not.

This *shift in priorities* is not merely an outcome but a key driver of HAP's expansion and transformation. Even with Salamina's surplus labor, fertile land, and global demand, the socio-environmental impacts linked to HAP would not materialize without this mechanism. It represents a break from traditional agricultural systems, historically shaped by smallholder farmers embedded in the cultural landscape, and it redirects focus toward external extractive strategies (Suarez, 2025).

However, this shift is embedded in a broader global context. Countries in the Global South face pressures to integrate into global markets through the attraction of foreign investments that target land and high-demand commodities (Delgado-Wise, 2020). This dynamic frame extractive projects as necessary for development, often sidelining social justice concerns (Sauer & Oliveira, 2021; Allen & Gillon, 2022). The promotion of intensive land use and monocultures, as Crétois (2023) notes, not only boosts yields but also disrupts local livelihoods and erodes traditional agricultural practices.

Salamina's transformation illustrates how extractive projects operate at the local level, materializing through the commodification of land (Suarez, 2025), and the increased reliance on local labor within exploitative agricultural cycles (Petras, 2020). These dynamics are not unique to HAP; similar patterns are evident in the expansion of agave (Tetreault et al., 2021), onions, potatoes (Blake et al., 2023), bananas (Toro López & Van Den Broeck, 2021), pineapples (Araya, 2021), and forestry (Kröger & Ehrnström-Fuentes, 2021), revealing a consistent logic of resource extraction across contexts. In this sense, the change in priorities, which is driven by human agency, seeks to take advantage of existing structures and thus to reproduce extractive logics.

While structural factors set the stage for these transformations, my analysis, grounded in the analytical trinity, emphasizes the role of human agency in either reinforcing or resisting them (Suarez, 2024b). The case of Salamina shows that structural conditions alone do not determine outcomes; rather, agency shapes how these conditions manifest. Despite theoretical discussions on the potential for food system transformations in the Global South (Suarez & Ume, 2024), Salamina reveals the need for stronger social mobilization to counterbalance extractive pressures. This mobilization takes two primary forms:

- Pushing agency, which advances HAP through supportive policies, dominant discourses, and active participation by stakeholders aligned with extractive interests (Suarez, 2024).
- Pulling agency, which challenges HAP's socio-environmental impacts through legal actions, grassroots protests, and advocacy (Suarez, 2024b).

However, resistance through agency has achieved only limited success, highlighting the persistent structural and power asymmetries that shape Salamina's evolving socio-natural regime. This asymmetry underscores the challenge of confronting deeply embedded extractive logics, even in the face of organized resistance.

1.7.3. Take away message

This dissertation addresses critical gaps in existing research by overcoming methodological and theoretical limitations to provide new insights into the socio-natural transformations driven by HAP in Salamina, northern Caldas, Colombia. By analyzing the expansion of HAP, I contribute to the understanding of how land-use changes, landscape transformations, environmental degradation, and social impacts are interconnected and shaped by enabling conditions and causal mechanisms.

These findings reveal how Colombia's rapid integration into global agricultural markets perpetuates existing inequalities and ecological degradation, reflecting broader patterns observed in other monoculture contexts (McMichael, 2009; Borras et al., 2012). Salamina serves as a case study to examine how global economic forces intersect with local realities, offering insights into the causal mechanisms through which commodity booms promote transitions in socio-natural regimes. While previous studies, such as Khan et al. (2021) and Magrach & Sanz (2020), have documented the environmental impacts of avocado monocultures globally, my research differentiates itself by situating these dynamics within Colombia's unique socio-political and cultural context—addressing a significant gap in the literature given the country's rapid emergence as a major Hass avocado exporter (Escobar & Betancur, 2021).

Methodologically, this dissertation bridges gaps through a mixed-methods approach grounded in Critical Realism, integrating qualitative and quantitative data to provide a stratified, nuanced analysis of socio-natural dynamics. This approach overcomes the limitations of prior studies that rely on single-method designs (e.g., Panz-Pinto et al., 2018), offering a more comprehensive understanding of the complexities at play. Theoretically, I apply an interdisciplinary framework that draws from political ecology, critical resource geography, and critical political economy, linking global economic forces with local landscape transformations. This framework extends the work of Serrano & Brooks (2019) and Budds (2008), who explored land-use conflicts and institutional drivers of environmental exploitation but did not fully integrate these perspectives into a cohesive analytical model.

The implications of these findings are significant. They underscore the need for integrated policies that balance economic growth with environmental sustainability, highlighting the importance of promoting agroecological practices and crop diversification to reduce dependency on monocultures and preserve biodiversity (Altieri & Nicholls, 2017). Strengthening land tenure rights for small farmers and implementing

participatory land-use planning can help mitigate conflicts and promote social equity (Fairbairn, 2014; Serrano & Brooks, 2019). Moreover, this study contributes to global food systems debates by illustrating how local communities can resist exploitative food regimes and advance food sovereignty (Patel, 2009; Suarez & Ume, 2024). By connecting Salamina to broader theoretical debates, I offer a critical lens through which socio-natural dynamics in agricultural commodity booms across the Global South can be understood.

1.8. Conclusions and recommendations

A review of HAP in Colombia reveals a complex landscape of socio-economic and environmental challenges. While the crop has brought prosperity and employment opportunities to regions like Salamina and Caldas, it has also given rise to urgent issues that demand attention. Colombia stands at a crossroads where economic progress is deeply intertwined with environmental and social responsibilities. Striking a balance between development and the conservation of ecosystems and cultural heritage is the central, yet contradictory, objective. Policymakers bear the responsibility of advancing the economic potential of Hass avocados while safeguarding Colombia's ecological and social conditions for future generations. To navigate this complexity, decisive action is necessary. A coordinated effort involving government authorities, environmental agencies, and the agricultural sector, including the peasantry—must be orchestrated to design and enforce public policies oriented towards sustainability.

In this dissertation, I posed an overarching research question: Why are Hass avocado plantations expanding and transforming the socio-natural dynamics in the Global South? To address this, I employed a multilevel and systematic approach structured around four sub-questions. In this section, I summarize my findings for each, beginning with a response to the main research question.

The expansion of Hass avocado plantations in Salamina, like other commodity booms embedded in traditional agricultural landscapes, transforms socio-natural dynamics due to the emergence of authoritative power aimed at surplus extraction, which in turn influences how traditional agricultural landscapes are managed (allocative power). This process is driven by a shift in priorities, moving from local support to externally driven strategies, justified by a "there is no alternative" logic. As a result, peasant communities face increasing constraints, and the agricultural landscape is becoming increasingly corporatized, raising critical questions about agrarian transformations in the region.

From my first sub-research question, I conclude that monocultures cannot be considered sustainable production systems due to their expansive scale and nature. The relationship between monocultures and ecosystem services involves a dialectical interaction, marked by trade-offs and synergies. However, these trade-offs, often framed as inevitable costs of development, should not be accepted without question—especially in the complex socio-historical contexts of the Global South. In these regions, socio-economic challenges and political conflicts add layers of complexity to any evaluation of monocultures. Monocultures function as mechanisms of capital accumulation, promoting socio-natural dynamics in ways that skew the distribution of benefits and burdens, thereby creating clear winners and losers.

From my second sub-research question, I conclude that monocultures, framed as plantations and functioning as social systems, generate conflicts over the use of traditional landscapes. These plantations also reinforce historical patterns of land accumulation, exacerbated by unequal land ownership structures in Salamina, which enabled rapid transitions of capital and land among elites. Governance models intended to mitigate the negative impacts of plantations exhibit significant shortcomings in their implementation.

Salamina's socio-natural regime transitioned due to HAP. Land in Salamina is shifting from representing use values to generating exchange values, driven by the compulsion to extract ecological surplus. This shift goes beyond material changes in traditional landscapes' ecological dynamics. It signifies a specific socio-natural configuration at a historical moment, representing a model based on the exploitation of landscapes, leading to conflict. This answers my third research sub-question. My response to the final research sub-question, concerning radical transformations, is that political approaches must go beyond merely transforming productive practices. This is why I propose embracing radical political agroecology as a framework for driving transformative dynamics.

Building on my research questions, I present additional conclusions. From a methodological perspective, I argue that complex research problems require comprehensive frameworks. I employed a multilevel mixed-method approach, with differentiated sub-designs tailored to each research question. This design allowed me to address critical issues from multiple perspectives: historical, socio-economic, political, and material, progressively developing answers to the overarching research question.

Theoretically, I incorporated various approaches with a shared critical focus across disciplines. I drew from political ecology, critical resource geography, and critical political economy, providing useful tools for framing this research. I also emphasize, in line with Critical Realism, that reality is informed by theory but not determined by it. My dissertation examined the research questions through specific theoretical lenses while also developing additional theoretical understandings, such as the conceptual resource-making framework.

For future research, I suggest incorporating additional theoretical perspectives and empirical investigations. From a theoretical standpoint, the causal mechanism I identified, the "change in priorities", resonates with literature in decolonial studies. This shift in priorities, sidelining local processes in favor of external strategies, reflects a neocolonial perspective in agriculture. It involves external agents exploiting local potential while often overlooking or co-opting local initiatives for the benefit of external entities, promising improvement for the exploited.

Future empirical research should focus on the dynamics necessary to achieve sustainable transformations in traditional agricultural landscapes. Identifying pathways that challenge the existing models and structures is crucial to fostering social empowerment. I also recommend exploring leverage points that can drive transformation, as outlined in our article (Suarez & Ume, 2024), and analyzing governance approaches to design more equitable agricultural transformations. A key future research question is: What governance approaches are necessary to design more equitable and just transformations of traditional agricultural landscapes in the Global South?

To apply the results of this thesis to concrete public policy scenarios, I recommend promoting land-use planning processes that go beyond large-scale commodity production. Planning should incorporate local activities and capacities, reflecting the interests and knowledge of those who inhabit agricultural landscapes. Governance models that promote horizontal communication between decision-makers, companies, and the peasantry, facilitating the negotiation of multifunctional and inclusive landscapes, should accompany this. Furthermore, promoting land reform is crucial to limit land concentration and prevent the potential proletarianization of rural areas. While this issue is complex within the Colombian context, this research aims to strengthen arguments supporting its importance and urgency.

I would like to highlight additional considerations of this study. The research problem must be examined through specific theoretical lenses, and my positionality has guided me toward particular interests. As a

result, some areas were not fully addressed but could contribute to future research. I did not consider social class and labor in depth, especially within the agrarian context. Including this could provide a deeper analysis of the social dynamics surrounding land-use changes and the implications of plantation introduction. Additionally, I did not address gender-related aspects, including how the introduction of HAP intersects with gender disparities and social reproduction. Exploring these aspects could provide greater insight into the research question regarding HAP expansion and socio-natural transformation.

As a final point, it is critical to underscore the deeper structural issues inherent in plantation agriculture. While this system prioritizes efficiency and maximizes economies of, effectively integrating land and labor into the exploitation circuit, as seen in Salamina it is fundamentally exclusionary. Its primary limitation lies in its inability, and often unwillingness, to incorporate the diverse range of actors that constitute the agricultural landscape. Despite the expansive reach of plantations, they systematically marginalize neighboring peasant communities, who not only remain outside these large-scale production networks but also actively resist being subsumed by them. This exclusion is not a peripheral issue; it is a central driver of land conflicts, fueling social tensions and contestation over resource control. Addressing these dynamics requires a shift in focus. Future research should move beyond productivity metrics to critically examine the mechanisms of access and exclusion that underpin plantation economies, highlighting how these processes shape rural inequalities and territorial disputes.

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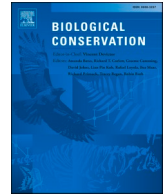
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Chapter 2. Research sub-question 1.

Suarez, Andres, & Gwozdz, W. (2023). On the relation between monocultures and ecosystem services in the Global South: A review. *Biological Conservation*, 278, 109870.



Review

On the relation between monocultures and ecosystem services in the Global South: A review

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ABSTRACT

The countries of the global south are characterized by high levels of biodiversity. In addition, these countries have suffered -and will suffer- even more ecological pressures due to agricultural production, mainly monocultures. When considering areas of high biodiversity with highly intensive agricultural systems, the scientific literature highlights the role provided by Ecosystem Services (ES) both *to* monocultures and *from* monocultures to their contexts. In this sense, the objective of this paper is to provide a Systematic Literature Review (SLR) to understand the relationship between monocultures and ES in the global south. Furthermore, in this research we provide a context analysis to broaden the understanding of the implications of monocultures in this region. We provide correlations between trends in monocultures harvested areas and forest cover in the countries identified through the SLR. Our SLR identified information from 15 countries and 11 monocultures. We found several negative correlations between harvested area and forest cover, mainly in megadiverse countries. In addition, we depicted trade-offs and synergies related to monocultures. We conclude that more research is needed in this regard, especially since there is great interest in monocultures for economic development in the global south, and this area will support world food production in the future.

1. Introduction

Originally, countries of the global south are characterized by healthy ecosystems with high levels of biodiversity. However, ecosystems such as forest, grassland or aquatic ecosystems in the global south have suffered -and will suffer even more- pressures due to increasing demand of agricultural production and commodities from the global north (Barbier, 2004; Defries et al., 2010; Potapov et al., 2022). While the global south heavily depends on its agriculture, there are structural weaknesses and thus inefficiencies, as the southern agricultural sector has not yet fully undergone an agrarian transition that happened in the north (Carlson, 2018). To enhance efficiency and meet a growing demand of food commodities, monocultures are often the preferred agricultural production system. When considering areas of high biodiversity with highly intensive agricultural systems such as monocultures, the scientific literature highlights the important role of ecosystem services (ES) both, *from* and *to* monocultures. As the ES are the benefit provided by

ecosystems –and agroecosystems (Zhang et al., 2007), this paper aims to shed lights on the relation between agricultural production systems and the surrounding ecosystems by analyzing which ES are used by monoculture production systems as well as their implications on them. With this paper, we address the need to consider monocultures more carefully and we contribute to the current state-of-the-art on the relation between monoculture and ES by providing comprehensive existing evidence regarding this relation.

1.1. Land use and ecosystem change

By cultivating land, humans have increasingly altered ecosystems to advance socioeconomic development (Li et al., 2020). Agriculture is an important activity generating agricultural commodities, income and employment alike. However, an increasing demand for agricultural commodities by a steadily growing global population has led to a widespread detrimental transformation of natural ecosystems

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(O'Connell et al., 2018). Thus, >75 % of the Earth's ice-free land has been transformed by human-led occupation (Ellis and Ramankutty, 2008), shifting the global trend from mainly wild to mainly anthropogenic land use in the last 300 years (Ellis et al., 2010). Seminal scientific contributions have drawn attention to current trends in land use and the simultaneous decline in the capacity of the world's ecosystems to provide ecosystem services (Foley et al., 2005, 2011; Tilman et al., 2011).

While land use such as agriculture has become more efficient in commodity production due to modern practices and technological advance, it has also caused significant detrimental environmental impacts (Foley et al., 2005; Tilman et al., 2011). According to Gibson et al. (2011), biodiversity diminishes in degraded forests where agriculture is considered a significant driver of change – however, the extent of loss in biodiversity varies considerably by geographic region. Between 1985 and 2005 the world's croplands and pastures expanded by 154 million hectares (about 3 %) (Foley et al., 2011) – a trend that will likely continue as the demand for agricultural commodities is expected to increase by about 50 % by 2050 (Gibbs et al., 2010). This also means that agriculture undergoes a significant process of intensification.

As stated by Lambin and Meyfroidt (2011), agricultural intensification could also indirectly affect land use in other areas than where the food is demanded. It means that the demand for food in the global market increases – a demand that has to be satisfied by some producing countries where agriculture often is a main source of income. Results reported by Potapov et al. (2022) depict that from 2003 to 2019, global cropland areas increased by 9 %, primarily due to agricultural expansion in Africa and South America. In fact, exports of agricultural commodities have been correlated to deforestation in Africa, Asia and Latin America (Defries et al., 2010). Agriculture production often occurs in the global south where countries are struggling with structural problems resulting in low agricultural productivity which often leads to converting forests to cropland to enhance agricultural output (Barbier, 2004).

Considering the high demand for agricultural commodities in the global north and the substantial supply from the global south suggest the existence of structural relation that promote unequal flows between the wealthier global north and global south countries (Givens et al., 2019). Countries in the global north have decreased their agricultural area while global south countries have faced the opposite trend (Gibbs et al., 2010). For instance, Winkler et al. (2021) found trends for increasing afforestation and cropland abandonment in the global north and growing trends in deforestation and agricultural expansion in the south. Givens et al. put these developments briefly by stating that “*Global South nations are structurally positioned as both a tap for resources and a sink for waste within the world-economic system of extraction, production, and consumption*” (Givens et al., 2019, p 2). The problem is that many global south countries are rapidly changing land use by transforming natural ecosystems to agriculture land use (Barbier, 2004), and as stressed by Creutzig et al. (2019), agricultural intensification in global south countries has produced biodiversity loss and natural habitat degradation mainly in Latin-America, Eastern Asia and Africa.

1.2. Agriculture and ecosystem services

The conversion of natural lands to agricultural uses is a significant threat to biodiversity and ecosystems (Grab et al., 2018). Within agriculture, monoculture systems are the most adopted practices (Tarigan, 2019), which often result in low biodiversity systems (Dolezal et al., 2019). Monoculture is also related to a landscape simplification – a term comprising the expansion of farmed land, the loss of plant species across landscapes, changes in biotic interactions, and high intensive management (Barrio et al., 2013; Blary et al., 2021; Dominik et al., 2017; Felipe-Lucia et al., 2020; Mori et al., 2015; Morteo-Montiel et al., 2021). Such simplification processes occur at all levels, e.g., field, farm, landscape, and region (Lemaire et al., 2015) with monocultures producing consistently negative effects on species richness compared to other uses (Kremen and Miles, 2012), and producing little natural habitat (Meehan

et al., 2011). Such a complex relationship entails benefits and costs for agriculture (Zhang et al., 2007).

In this context, agriculture plays a vital role in the transformation of ecosystems through a process of supply and demand for ES (Zhang et al., 2007). The concept of ES in agriculture has been widely used in environmental research and is important for bridging scientific knowledge production and support for decision-making. Although ES is a contested concept, it could be understood as the contributions (or benefits) provided by nature (or agroecosystems) to people's quality of life (Maes et al., 2018; Pascual et al., 2017; Pires et al., 2020). In addition, ES benefits can be classified into the following three categories: 1) material benefits (i.e. substances, objects, or other material elements from nature), 2) non-material benefits (i.e. nature's effects on subjective or psychological aspects underpinning people's quality of life, both individually and collectively), and 3) regulating benefits (i.e. functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people and/or regulate the generation of material and nonmaterial contributions) (Díaz et al., 2018). The ES framework enables an understanding of the relations between ecosystems and agricultural production.

Agriculture and ES are in an intricate relationship as sustainable agriculture provides positive effects on the ecosystems (e.g. promotion of biodiversity, soil conservation) and unsustainable agriculture generates negative effects on ecosystems, so-called trade-offs (Shah et al., 2019). To be more specific, trade-offs in this context refer to conflicts that emerge between the increasing need of exploiting ES (such as production of agricultural commodities such as food, fiber or bioenergy) and the negative implications on regulating ES (such as water purification, soil conservation or carbon sequestration) (Power, 2010).

Therefore, measuring ES supply, demand and trade-offs in general and from monocultures in particular is of utmost importance but often problematic because they are not easily identifiable (Moreau et al., 2019). Monoculture agriculture promotes material ES which are generally less regulated and yield un-marketed services compared to other non-intensive systems (Chabert and Sarthou, 2020). But scholars pinpoint to the benefits of regulating ES as a driver of crop production and the resilience of social-ecological systems (Raudsepp-Hearne et al., 2010). For instance, monocultures decrease the capacity of ecosystems to provide beneficial functions such as pest control (Grab et al., 2018; Larsen, 2013; Rivera-Pedroza et al., 2019) or pollination (Aizen et al., 2019; Enríquez-Acevedo et al., 2020; Jackson et al., 2007; Kremen and Miles, 2012; Reed et al., 2017). Therefore, it is necessary to find a balance between ecosystem conservation and agriculture to promote sustainable development in large-scale production areas (Araujo et al., 2021), because ES is one of the most important public goods provided by agriculture (Antle and Stoorvogel, 2006).

1.3. Problem statement

As mentioned before, monocultures produce landscape simplification resulting in a decrease in ES. Considering this, a significant body of literature explores the relationship between ES and agriculture (both ES *to* and *from* agriculture), particularly with monocultures. However, even more work is needed to understand and consolidate the dynamics of ES regarding monocultures in the global south where in particular a tremendous increase in agricultural production over the coming 40 years is expected (Foley et al., 2011). Therefore, the aim of this paper is to consolidate and systematize existing knowledge on the relationship between monoculture and ES through a systematic literature review. We thus address the research question: *How is the relation between monocultures and ES in the global south?* We highlight ES demand (ES *to*) and supply (ES *from*) in the context of monoculture production in the global south. Therefore, the contribution of the study is twofold: 1) this is the first study reviewing literature regarding demand and supply of ES in monocultures and 2) this research add concerns regarding the land use transformations due to monocultures in the global south.

2. Methods

To identify the implications delivered by monocultures in countries located in the global south, we first carried out a Systematic Literature Review (SLR) to get an overview of existing knowledge on the relationship between monocultures and ES, and second, we put the findings of the SLR into the corresponding country’s context. We considered the economic status of each country, the extent of agriculture, the specific monocultures in their performance, and some implications on forest ecosystems as a proxy of the ecological impacts of monocultures.

For the SLR, we used the Search, Appraisal, Synthesis and Analysis (SALSA) analytical framework provided by Grant and Booth (2009). The first step Search is an exhaustive search process for systematically finding all papers that appear when using the overall search terms. Second, the Appraisal step is to refine the search by inclusion/exclusion criteria, for further Synthesis and data processing. Finally, the process of Analysis and implications of the results.

Beginning the analysis with the Search, we used the SCOPUS database and we provided search criteria based on our research problem. That is, we consolidated the search by analyzing monocultures, ecosystem services and the global south. Nevertheless, to focus our search, we split those concepts with Boolean operators in the following form: “crop production” OR “agriculture” AND “ecosystem services” OR “nature contributions” AND “monoculture” OR “intensive agriculture”. We performed the search in December 2021 resulting in 320 articles.

Although currently there is an academic debate regarding the need to reframe the concept of ES towards a concept such as Nature Contribution to People (Díaz et al., 2018; Ellis et al., 2019), different scholars call for continue with the initial term (Braat, 2018; Kenter, 2018; Maes et al., 2018), and even to use them in a complementary way (Kadykalo et al., 2019; Pires et al., 2020). For this reason, we used ES and nature contributions as complementary searching criteria. We did not include global south per se in the search, as this would enhance the likelihood to miss relevant studies. In addition, to delimitate our analysis, we understood monocultures as the prevalent presence of a crop with a high level of specialization on a single crop production within an agricultural region (Franco et al., 2022). Moreover, we considered the global south not as a global location per se, but as a “reference of an entire history of colonialism, neo-imperialism, and differential economic and social

change through which large inequalities in living standards, life expectancy, and access to resources are maintained” (Woon, 2013, pp. 13).

In the Appraisal, we implemented the inclusion/exclusion criteria to determine the final sample (Maier et al., 2021; Palomo-Campesino et al., 2018). We provided a set of inclusion/exclusion criteria comprising the identification of monocrops, reported ES supply or demand and finally of being geographically located in the global south (see also Fig. 1). Applying a stepwise approach, we first scrutinized the initial 320 papers’ titles and abstract for the inclusion criteria (monocultures and ES demand or supply) leaving us with 87 papers. Next, we read the remaining papers and only kept the ones that were centered around monocultures and ES reducing the sample further to $n = 40$ papers. Finally, only studies investigating monocultures and ES in the global south were kept resulting in a final sample of 27 papers (Supplementary material 1). The articles’ metadata such as authors, year of publication, keywords, type of crop, ES demand, and ES supply were processed.

Next, we carried out the Synthesis step. First, we used text mining to support the interpretation of texts from the selected articles, and to highlight graphically the frequencies of key concepts (i.e. keywords and abstracts) from all included articles (Mengist et al., 2020). In general, the concepts were considered as a proxy for the relation between agriculture and the environment. We proceeded to support our understanding of the relation between ES and monocultures (Fig. 2) where demand are defined as positive contributions of the ecosystems, their ecological functions, of biodiversity as well as human-made contributions like irrigation. Supply are defined as trade-offs and synergies. Synergies are understood as the positive implications produced by the crop (e.g., benefits for ecosystems) and trade-offs as the negative implications (e.g., ecosystem disservices).

Finally, in the Analysis step, we identified the specific crop in each paper, its ES demand (i.e., whether the paper identified that the crop used ES for its development), and supply (i.e., whether the crop ultimately produced other ES or trade-offs, impacts or synergies on ES). We classified ES in three categories, namely material ES, non-material ES and regulating ES (Díaz et al., 2018; Pascual et al., 2017).

While highlighting ES particularly related to monocultures is a valuable outcome, merely mentioning ES demand and supply in isolation from a particular country’s context is insufficient to address the research problem. Therefore, we wanted to complement our review with

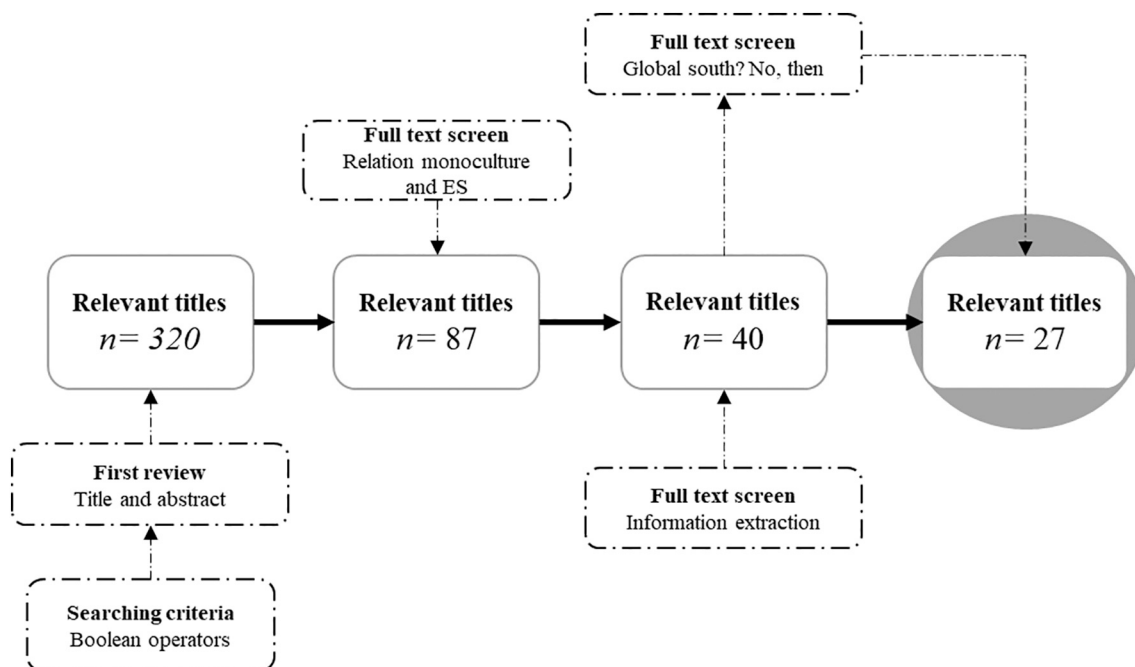


Fig. 1. Steps followed to perform the systematic literature review.

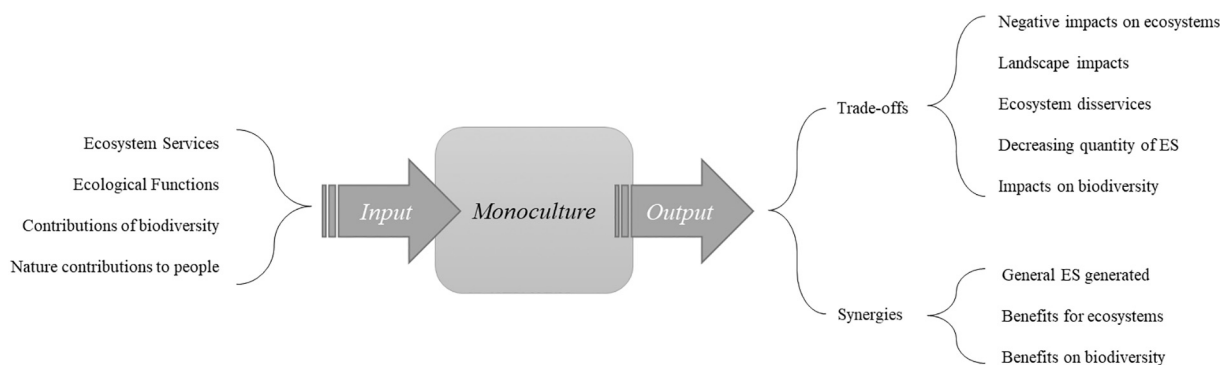


Fig. 2. Criteria for considering both the ES inputs to and the outputs from monocultures (based on Zhang et al., 2007).

some country-level context to provide inferences supported on literature and in our results regarding the implications of monocultures on the environment in the global south. To that end, firstly, we correlated key aspects such as countries' Gross Domestic Product (GDP) and forest cover given that these are key variables in global south countries related to agriculture and environment relation (c.f. Lambin and Meyfroidt, 2011). Forest cover was considered as a general proxy to prove the environmental dimension (forest as important providers of ES), for two reasons. By one hand, forest could be considered as the structure that supports ecological functions and final ES to people (Potschin et al., 2016); on the other hand, because of the literature that documented the implications produced by monocultures on forests (Gibson et al., 2011; Tenius Ribeiro et al., 2019; Winkler et al., 2021). Secondly, we highlighted historical changes in the harvested areas of the crops identified in the SLR, and we correlated this history with trends in forest cover in order to provide specific analysis between monocultures and forests cover. We provided a further context of biodiversity in each country based on the National Biodiversity Index provided (NBI) by the Convention on Biological Diversity in the Global Biodiversity Outlook 1 (<https://www.cbd.int/gbo1/annex.shtml>).

For the correlation analysis, we took 2005 to 2019 as the time-frame. We considered 2005 as a starting point because then the seminal report of the Millennium Ecosystem Assessment was published and this report established a strong link between ecosystem services and agriculture (Ch. 26 Cultivated Systems). Therefore, the following variables were included in the analysis: i). GDP trend over 15 years/country (million USD), ii). Trends in harvested area in for each crop identified in the SLR over 15 years (millions hectares); iii). Trend of forest cover area in the same period (millions hectares). We used FAO statistics (2021) for harvested area per crop/country and WDI (2021) for forest cover and GDP per country. The frame 2019 was used because data were complete for all the countries to that date.

3. Results

3.1. General characteristics of the literature and context

We found literature information for 15 countries from the global South where: six countries were from Latin America, two from Africa and seven from Asia (Fig. 3). China was the country with the most

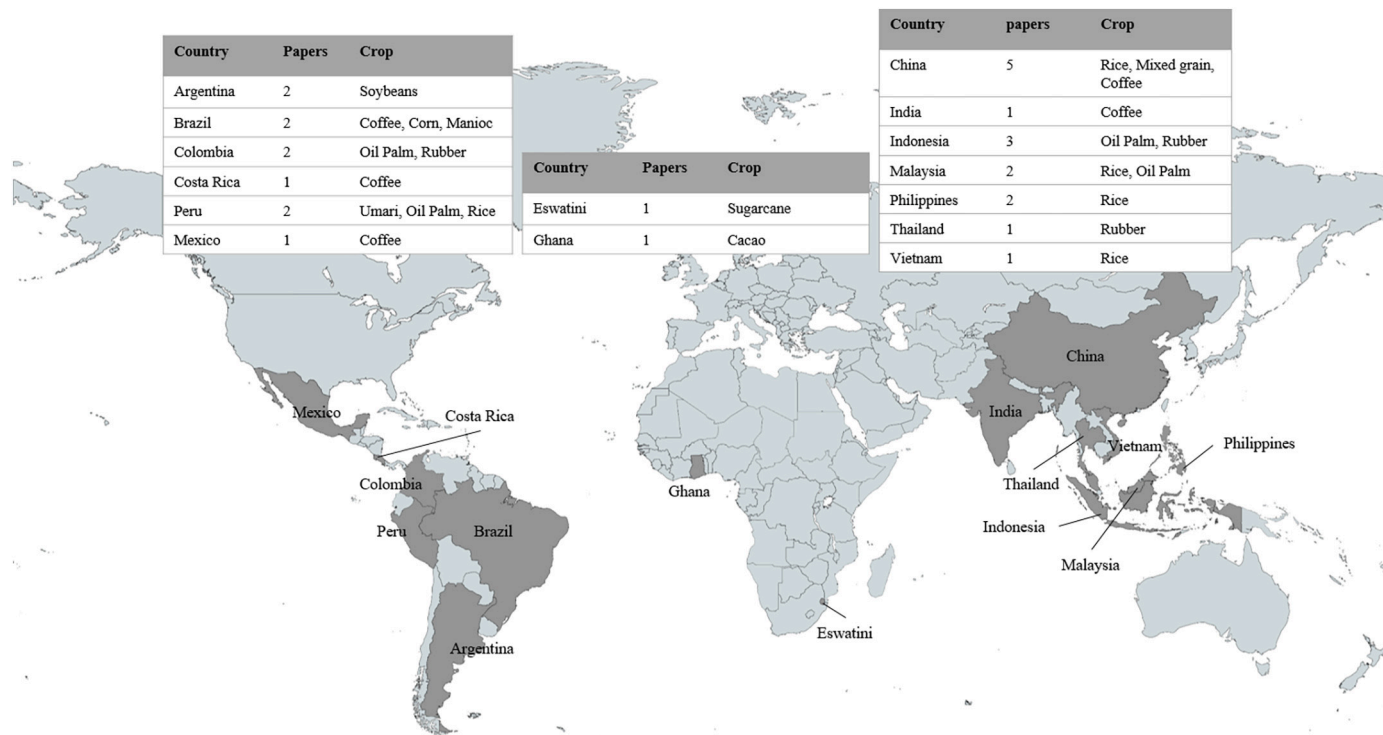


Fig. 3. Overview of the SLR: crops identified by country and frequency of papers per country.

studies (five in total), followed by Indonesia with three studies. In addition, we found eleven monocultures: soybeans, coffee, corn, manioc, rice, mixed grain, oil palm, rubber, sugarcane, cacao, and umari.

In our SLR, we found 145 different keywords used by the included papers whereof 25 % related to the following six categories: Agricultural intensification (four times), Agroforestry (five times), Biodiversity (seven times), Ecosystem Services (15 times), Trade-offs (four times) and Bats (four times). In addition, through a word cloud (recurrence of words in the 27 Abstracts), we found overview of where the monocultures were embedded (Fig. 4). We highlight the specific importance given to concepts such as ecosystem services, ecosystems and agriculture (and concepts related such as systems, rice, yield, farming, plantations etc.). In addition, it is important to point out the prominence of words that appeared repetitively throughout all the papers such as forest, biodiversity, natural, soil or even proximity, which represents that the monocultures of this review were embedded in environments with important ecological characteristics.

In addition, when analyzing study area description of the papers, the authors mostly described their study area with outstanding natural context no matter the landscape transformations by the crops. To cite some examples, authors mention: areas with remnant native grasslands (Hodara and Poggio, 2016), with dense vegetation (Tenius Ribeiro et al., 2019), mountains dominate region (Rigal et al., 2020), subtropical mountain region (Liu et al., 2020), preserved savannas (Lavelle et al., 2014), host of rich biodiversity (Marquardt et al., 2013), or even Peruvian amazon (Dominik et al., 2017).

3.2. The demand: ES to monocultures

The review allowed us to identify important ES for some crops. We found six main ES –or ecological functions or benefits such as water supply, nutrient regulation, pest control, shade, pollination and species richness (sometimes-called biodiversity). Water supply was linked to all crops as a necessary service. Although not all studies identified ES demands, we identified that crops of great importance such as rice depend on nutrient regulation, pollination and pest control. Coffee, for example, needs pollination, pest control, shade, weed suppression, soil moisture and soil erosion protection, and sugarcane requires pest control for its cultivation.

In that sense, Burkhard et al. (2015) researching about ES in rice stated that rice crops are highly dependent on regulating ES. They summarized for example that nutrient regulation ensures successful

yields. In addition, Amira et al. (2018) mention that in rice fields, foraging by wetland birds can suppress plant pests (i.e. species richness that is beneficial for crops). This is supported by Zhang et al. (2012) who stressed the importance of neighboring ecosystems that provide reproductive habitat for rice pollinators and biocontrol agents. Now regarding coffee plantations, Rigal et al. (2018) found that shade (provided by other tree species) produce lower inter-annual variation in coffee yields, and improve coffee quality; Davidson (2005), mention that shade provide microclimate for coffee, reducing water stress, and Meylan et al. (2017) found that shade affect coffee flowering and cherry development. Now, regarding sugarcane ES demand, the SLR showed that the foraging function of bats is useful to suppress populations of insect pests in this agricultural system (Mtsetfwa et al., 2018).

3.3. The supply: ecosystem services and monocultures

In general, we found a total of 23 ES (or ecological functions) from monocultures. These were four material ES (food, timber, charcoal and raw materials), four non-material ES (scenic beauty, tourism, identity, and medicinal use) and 15 regulating ES/functions (carbon sequestration, erosion control, habitat for species, nutrient regulation, pest control, soil fertility, soil moisture, species richness, water regulation, water quality, air purification, climate regulation, net primary productivity, oxygen, and pollination). We identified that some monocultures provided benefits and others provided trade-offs. According to the recurrence of these supply in the papers, we found negative involvement mainly in regulating ES, and more synergies in material and non-material ES. We highlight synergies related to CO₂ sequestration, climate regulation and O₂ production, and we stress the negative implication on species richness (or biodiversity).

3.3.1. ES from monocultures: synergies

As a first element, is not novel to mention that material ES in the form of food, raw materials or fiber production is the main contribution of monocultures. However, this review found that monocultures produce several ES beyond materials ES. One interesting aspect found was the identification of non-material ES from rice crops such as tourism (Liu et al., 2020), scenic beauty or identity (Burkhard et al., 2015). In addition, regulating ES were widely highlighted. Regarding water, studies on coffee (Meylan et al., 2017), grain (Wang et al., 2015), palm oil (Lavelle et al., 2014), and rice (Zhang et al., 2012) found positive contributions for water regulation. Now, for soil quality, some studies stressed the contributions on soil erosion control made by coffee



Fig. 4. Words cloud with the most recurrent words in the abstracts of all the 27 papers.

(Meylan et al., 2017), rice (Liu et al., 2020), and umari (Wood et al., 2016); improvements in carbon stock in topsoil was reported by palm oil (Labrière et al., 2015). Moreover, climatic regulation, air purification, oxygen generation and CO₂ sequestration were reported in palm oil, rubber plantations and rice (Lavelle et al., 2014; Liu et al., 2020; Nattharom et al., 2021; Zhang et al., 2012). Other positive contributions of monocultures were net primary production in grain (Li et al., 2020), and contributions for pollination by coffee (De Beenhouwer et al., 2013), or even maintenance of bats species richness in palm oil plantations (Cely-gómez et al., 2021).

3.3.2. ES from monocultures: trade-offs

Although literature depicts some positive outcomes from monocultures since the ES perspective, it is important to mention the negative implications. Let us begin with material ES. In the SLR, we only found that coffee and cacao produced negative implications in food production and also produced a trade-off regarding the production and use of timber (De Beenhouwer et al., 2013). Now, related to regulating ES, we found many trade-offs. What is important to stress is the negative implications on biodiversity, species habitat or species richness. This is an implication mentioned in almost all the crops. See for instance cacao (Wade et al., 2010), coffee (Anand et al., 2010; Davidson, 2005), corn (Tenius Ribeiro et al., 2019), grain (Wang et al., 2015), oil palm and rubber (Marquardt et al., 2013; Mumme et al., 2015), rice (Dominik et al., 2017), soybeans (Hodara and Poggio, 2016), and umari (Wood et al., 2016). In addition, there were further trade-offs on regulating ES identified (Table 1). The implications on non-material ES were mentioned in cacao crops, which has been highlighted for affecting the use of medicinal plants (De Beenhouwer et al., 2013).

Finally, it is important to put into context all the positive and negative contributions of monocultures. The review showed that monocultures produce contradictory implications. On the one hand, some crops support water regulation, but at the same time they can produce trade-offs on water. The same as - for example - soil fertility or erosion control. This is an interesting result, as the analysis of the relations between monocultures and ecosystem services in the global south needs to be nuanced and contextualized. To see better this aspect, see Fig. 5 to visualize the flows on ES in monocultures according to the SLR and the proposed model.

3.4. Context analysis

Once identified the ES related to the monocultures in our SLR, the next step was to put in context those monocultures in order to provide a proxy of their performance in the global south countries. From our SLR, nine countries are categorized as upper middle income and six are lower

middle income. In addition, most of the countries have a high proportion of agricultural land in relation to the country's total land area (>40 % of their land devoted to agriculture). Moreover, Malaysia, Colombia, Brazil and Costa Rica stand out for their high proportion of forested land (over 50 %). Comparing the values 2005 and 2019, Brazil, Ghana, India, Indonesia, and Mexico have increased in 1 % the share of agriculture in their GDP. Colombia and Malaysia stay constant and the rest of the countries have faced a decrease in this index. In 2020, Eswatini, India and Vietnam had the higher share of agricultural sector in their GDP (19 %, 18 % and 15 % respectively). Additionally, we found some negative correlations between GDP and forest cover in the last 15 years (Table 2).

We stress that all the countries found in the SLR have high levels of biodiversity (Table 3). According to the National Biodiversity Index (NBI), countries' NBI were mostly high (NBI > 0.6), but countries such as Indonesia (NBI = 1), Colombia (NBI = 0.93), Mexico (NBI = 0.92) and Brazil (NBI = 0.87) stand out. In these contexts of high biodiversity, important areas have been oriented to monocultures. Adding the harvested area of these crops in the 15 countries, we found that in 2019 the total harvested area reached 247,492,142 ha. The most widespread crop was rice with 110,169,795 ha, followed by soybean (72,995,222 ha), oil palm (22,194,835 ha), sugarcane (21,401,951 ha), rubber (10,371,919 ha), coffee (6,247,378 ha), and cocoa beans (4,111,042 ha).

Now, considering the crops produced by each country, we provided a calculation of the evolution of the harvested area in 15 years. We found a high increase in countries such as Argentina (19 %), Brazil (29 %), Colombia (22 %), Indonesia (33 %) or Peru (26 %), and very low in countries such as China (0.01 %), and Costa Rica or Vietnam (5 %). We highlight that Argentina, Indonesia and Brazil lost 11 %, 8 % and 7 % of forest cover respectively in the analyzed period. In addition, from Table 3 we highlight the correlations between the harvested area of the crops identified in the SLR by country and forest cover. We found that eight countries showed negative correlations, being Brazil, Colombia, Indonesia and Peru the countries with higher values ($r \geq -0.90$) and greater explanatory power in forest variation ($r^2 > 0.8$). In addition, we highlight megadiverse countries such as Brazil, Colombia, Indonesia, Malaysia and Mexico that have maintained or increased agriculture GDP share in the period 2005–2019, present negative correlations between harvested area and forest cover.

4. Discussion

4.1. Balancing ecosystem services in monocultures

As showed in our results, we support the links highlighted by Zhang et al. (2007) regarding the important relation between agriculture and ES, but mainly adding concerns on monocultures. According to our SLR,

Table 1
Trade-offs produced by the monocultures identified in the systematic literature review.

Crop	Regulating ES						
	Carbon sequestration	Erosion control	Nutrient regulation	Pest control	Soil fertility	Soil moisture	Water regulation
Cacao	Wade et al., 2010; De Beenhouwer et al., 2013	De Beenhouwer et al., 2013					
Coffee	Davidson, 2005; De Beenhouwer et al., 2013	De Beenhouwer et al., 2013			De Beenhouwer et al., 2013		
Corn					Tenius Ribeiro et al., 2019		
Grain	Wang et al., 2015						Li et al., 2020
Oil palm			Marquardt et al., 2013			Marquardt et al., 2013	
Rubber Plantations						Marquardt et al., 2013	
Rice				Burkhard et al., 2015			Zhang et al., 2012
Soybeans	Wilson et al., 2020				Wilson et al., 2020		Wilson et al., 2020

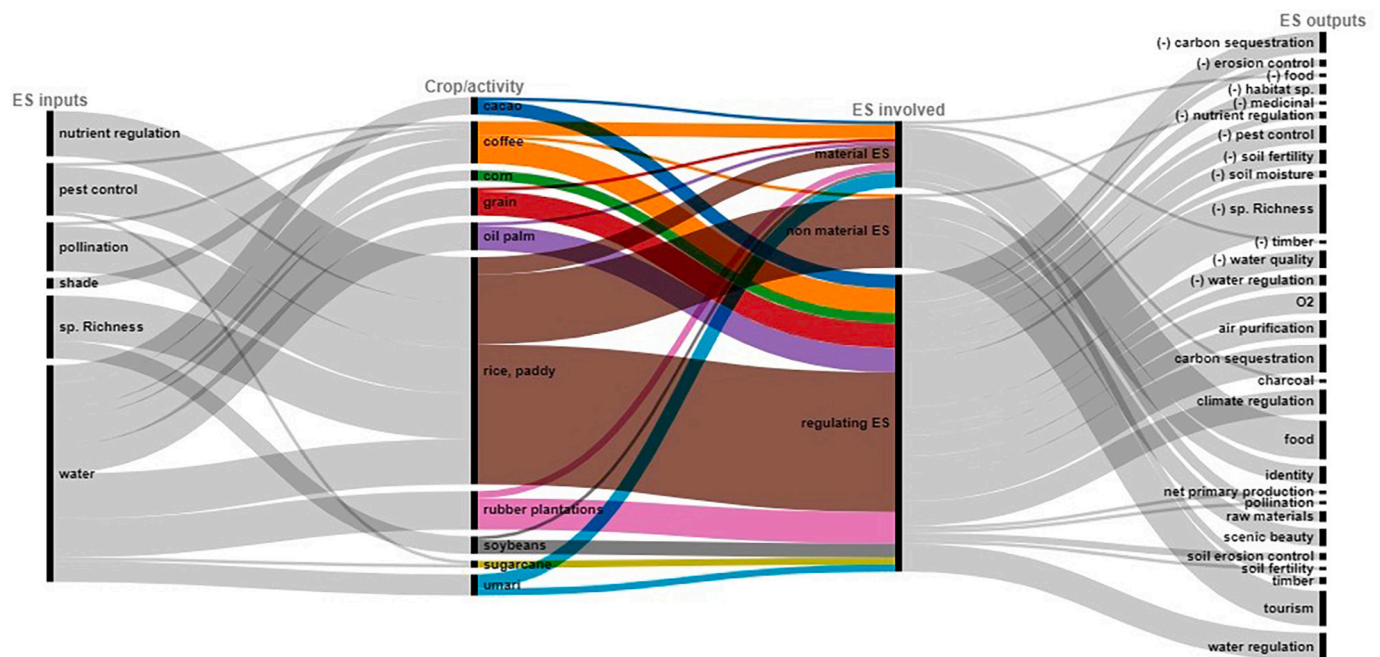


Fig. 5. ES flows to and from monocultures in the global south according to the SLR. Symbol (-) means trade-off. Diagram based on (Herbst et al., 2020).

Table 2

General information regarding GDP, agriculture and forests in the countries identified from the SLR.

Country	Income Level	Agriculture area/land area ^a	Forest area/land area ^a	Agr. forestry, and fishing (% of GDP) 2020 ^a	Δ Agr. value added % GDP ^b	GDP/forest cover ^c
Argentina	Upper Middle	54 %	10 %	6 %	-2 %	r = -0.89
Brazil	Upper Middle	28 %	59 %	6 %	1 %	r = -0.67
China	Upper Middle	56 %	23 %	8 %	-4 %	r = 1.00
Colombia	Upper Middle	45 %	53 %	8 %	0 %	r = -0.73
Costa Rica	Upper Middle	35 %	59 %	5 %	-4 %	r = 0.93
Eswatini	Lower Middle	71 %	29 %	19 %	-18 %	r = -0.76
Ghana	Lower Middle	65 %	35 %	14 %	1 %	r = -0.87
India	Lower Middle	60 %	24 %	18 %	1 %	r = 0.99
Indonesia	Lower Middle	33 %	49 %	4 %	1 %	r = -0.73
Malaysia	Upper Middle	26 %	58 %	8 %	0 %	r = 0.17
Mexico	Upper Middle	55 %	34 %	8 %	1 %	r = -0.94
Peru	Upper Middle	18 %	57 %	10 %	-3 %	r = 0.42
Philippines	Lower Middle	42 %	24 %	8 %	-3 %	r = 0.67
Thailand	Upper Middle	43 %	39 %	9 %	-1 %	r = 0.66
Vietnam	Lower Middle	39 %	47 %	15 %	-4 %	r = 0.99

^a Period 2005–2019. Own calculations based on the SLR and FAO stats (<https://www.fao.org/faostat/en/#data/QCL>) (2021).































^b Change 2005–2020.

^c Absolute values for 2020. Based on the SLR and WDI (<https://data.worldbank.org/indicator/AG.LND.FRST.ZS>) (2021).

we found that monocultures face a metabolic process, which take inputs from ecosystems and finally produce outputs to ecosystems. Those outputs some times are positive, but in most case are negative, particularly affecting regulating ES (Fig. 5). Then, our results go in line with studies which show that low complex landscapes such as croplands,

provide high quantities of material ES, but low quantities of regulating ES (Araujo et al., 2021). The problem is that, when considering the scale of monoculture production in the global south, we face an amplification problem. Considering a general perspective, only the crops identified encompass about 247 million ha in the 15 countries analyzed (stressing

Table 3
Information related to biodiversity, monocultures and forest area in the SLR countries.

Country	NBI \ddagger	Crops according SLR \pm	Trend in harvested area 2005–2015*	Trend in forest cover 2005–2015**	Harvested area/forest*
Argentina	0.615	(a), (e), (i)	 16%	 -11%	$r = -0.67$; $r^2 = 0.46$
Brazil	0.877	(a), (b), c, d, (e), (g), (h), (i), (j)	 29%	 -7%	$r = -0.91$; $r^2 = 0.85$
China	0.839	(a), (b), (e), (g), (j), (h), (i)	 0.014%	 13%	$r = 0.03$; $r^2 = 0.07$
Colombia	0.935	(a), (b), (e), (g), (h), (j), (i)	 22%	 -4%	$r = -0.91$; $r^2 = 0.82$
Costa Rica	0.820	(a), (b), (e), (g), (h), (j), (i)	 5%	 5%	$r = 0.13$; $r^2 = 0.01$
Eswatini	0.609	(e), (i)	 14%	 3%	$r = 0.98$; $r^2 = 0.90$
Ghana	0.646	(a), (b), (e), (g), (h), (i), (j)	 0.001%	 -5%	$r = -0.24$; $r^2 = 0.05$
India	0.732	(a), (b), (e), (h), (j), (i)	 8%	 5%	$r = 0.69$; $r^2 = 0.48$
Indonesia	1.000	(a), (b), (e), (g), (h), (i), (j)	 33%	 -8%	$r = -0.93$; $r^2 = 0.86$
Malaysia	0.809	(a), (b), (e), (g), (h), (j), (i)	 13%	 -1%	$r = -0.04$; $r^2 = 0.002$
Mexico	0.928	(a), (b), (e), (g), (h), (i), (j)	 6%	 -3%	$r = -0.83$; $r^2 = 0.69$
Peru	0.843	(a), (b), (e), (g), (h), (i), (j)	 26%	 -3%	$r = -0.936$; $r^2 = 0.91$
Philippines	0.786	(a), (b), (e), (g), (h), (i), (j)	 14%	 1%	$r = 0.19$; $r^2 = 0.03$
Thailand	0.670	(a), (b), (e), (g), (h), (j), (i)	 14%	 2%	$r = 0.81$; $r^2 = 0.65$
Vietnam	0.682	(a), (b), (e), (h), (i)	 5%	 14%	$r = 0.81$; $r^2 = 0.66$

\pm Here are included all the crops identified in the SLR per country when applied. For instance, we aggregated in Argentina rice, soybeans and sugarcane. (a) Soybeans, (b) Coffee, (c) Corn (not available in FAOSTATS), (d) Manioc (not available in FAOSTATS), (e) Rice, (f) Mixed grain, (g) Oil Palm, (h) Rubber, (i) Sugarcane, (j) Cacao, (k) Umari (not available in FAOSTATS).

*Change in the period 2005–2019. Own calculations based on the SLR and FAO stats (2021).

**Based on the SLR and WDI (2021).

that there are a lot more monocrops in those countries). It means, that the trade-offs mentioned in Section 3.3 will appear not only in those 247 million ha, but in their landscape-contexts too, and particularly those trade-offs related to biodiversity loss, habitat fragmentation and species richness in the global south.

With this, we added concerns on seminal scientific contributions regarding the more frequent biodiversity loss (Foley et al., 2005), habitat loss and fragmentation (Fahrig, 2003; Myers et al., 2000) due to land use. Moreover, we add alarms regarding the implications of monocultures in a global south-scale, given that in these countries biodiversity is outstanding. This is not a minor aspect, because of it has been highlighted that land system change (Steffen et al., 2015) and biodiversity loss (Rockström et al., 2009) are planetary boundaries that should not be trespassed.

4.2. Monocultures in the global south

The keywords we found mostly considered concepts that influence the understanding of monocultures, both in the sense of practices (i.e. agroforestry and intensification), the connection with ecosystems, their functions and services (i.e. biodiversity, bats, ecosystem services) and monoculture impacts (trade-offs). These go in line with scientific discussion on the consideration of sustainability in agriculture practices

(Tilman et al., 2002; Tschardt et al., 2005), and the more and more growing body of literature considering the importance of ES for agriculture (Kremen and Miles, 2012; Zhang et al., 2007).

Our SLR showed that monocultures are embedded in high biodiverse areas, not just for the descriptive analysis provided in Fig. 4, but also for the context of the producer countries; a context of mega diversity (Table 3). This is a trend highly recognized in literature, where biodiversity hotspots are used by agriculture as means for development and generation of capital for national industrialization (Dobrovolski et al., 2011), producing an “agricultural bomb” (Laurance et al., 2014). In particular, all the countries identified in this SLR although high biodiverse, are into the high level predictions for fauna extinction (Gonçalves-Souza et al., 2020). The aforementioned goes in line with forest cover trends in most of the SLR countries, where the change in forest cover through the period 2005–2019 was negative. Although we found that some countries had positive changes in forest cover (e.g. China, Philippines), literature also highlight the high levels of habitat loss and fragmentation in all the SLR countries (Kong et al., 2021).

One vision of monocultures according to tropical farming economics, is that natural ecosystems limit what can be harvested (Almestad, 2015). Therefore, ecosystem complexity is a problem, and then is economically better landscape simplification for improving agricultural outputs. On the other hand, other approaches have suggest that capital should flux

through nature in order to increase productivity and create new opportunities for accumulation (Boyd et al., 2001). For this reason, the crops found in this SLR are those related to high landscape transformations. In this sense, there is a multidimensional problem: countries with middle-low incomes, with important levels of agricultural GDP share and high biodiversity are facing deforestation and biodiversity loss. The aforementioned reinforce the idea of the ecologically unequal exchange between wealthier nations (global north) which tend to impact the ecosystems in marginalized nations (global south) through exports (Bunker, 1986). This is related to a challenge of sourcing northern economies through monocultures—for example, while southern countries struggle to reduce poverty and face ecosystem degradation (LaRota-Aguilera et al., 2022). Therefore, as mentioned by Austin (2010), the relationship between deforestation and the flow of monocultures from less-developed (south) nations to more-developed nations (north) is a specific form of ecologically unequal exchange.

5. Final remarks

The overall results provided in this SLR showed a qualitative relation and fluxes between ES and monocultures in the global south. We found some high-value crops and we identified that producer countries are very high biodiversity nations. In addition, we found that the literature reviewed stress the ecological characteristics where the monocrops were embedded. We highlight that we did not provide causality relations, rather, we provided correlations as proxies to point out the implications of the growing crops areas in the countries; we were able to reinforce this relation with literature. We recommend providing local analysis for a better understanding of the ES demand-supply in monocultures.

Our results suggest to strength policy approaches to address the sustainability of agroecosystems—mainly in monoculture systems—particularly in those mega diverse countries, which face every-day ecological degradation and high need for increasing their GDPs. However, as showed in this paper, there is a difficult problem to solve: how to balance demand and supply of ES in monocultures? We consider that this problem is challenging to address if business as usual continues. The literature in general and our review in particular, allowed us to understand that monocultures produce transformations in ecosystems, synergies and trade-offs. Although monoculture still produce ES, it is very improbable that monocultures could be understood as sustainable use systems, both for their nature and for their scale. More research is needed in this sense particularly because there is a high interest on monocultures for economic development in the global south, and this area will support the global food production in the future.

Finally, we would like to mention some limitations of the present study. The first is the analysis only of literature published in English and indexed in the SCOPUS database. In addition, the few amount of countries identified is a limitation. A more detailed research should take into account context-specific information in different languages and context, and consider gray literature. This could provide valuable information to complement our results. Second, our approach was only intended to point out qualitative relationships between monocultures and ES, but quantitative information would be even revealing. Finally, it is important to provide further considerations on the role of China - in isolation - since it has been mentioned as a country that externalizes monoculture-related impacts even in more peripheral countries (Tasmim et al., 2022), and we did not address it in our work.

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Ethical statement

- Conflict of interest: The authors declare they do not have a conflict of interest.
- Authors' contributions: A. Suarez: Conceptualization, Methodology, Writing original draft. W. Gwozdz: reviewing, editing.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability

The original documents analyzed in this research are included in the article/supplementary material. Data related to background information are open access provided by FAO and WDI. For more information, please contact the corresponding author.

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Supplementary Material 1: Identified papers in SCOPUS for the Systematic Literature Review

#	Authors	Year	Title	Journal	Country	Crop
1	Amira et al	2018	Effects of intensive rice production practices on avian biodiversity in Southeast Asian managed wetlands	Wetlands Ecology and Management	Malaysia	Rice
2	Anand et al	2010	Sustaining biodiversity conservation in human-modified landscapes in the Western Ghats: Remnant forests matter	Biological Conservation	India	Coffee
3	Burkhard et al	2015	Land cover-based ecosystem service assessment of irrigated rice cropping systems in southeast Asia-An explorative study	Ecosystem Services	Vietnam, Philippines	Rice
4	Cely-Gomez et al	2021	Bat Assemblage in an Oil Palm Plantation from the Colombian Llanos Foothills	Tropical Life Sciences Research	Colombia	Oil palm
5	Davidson	2004	Shade coffee agro-ecosystems in Mexico: A synopsis of the environmental services and socio-economic considerations.	Journal of Sustainable forestry	Mexico	Coffee
6	De Beenhouwer et al	2013	A global meta-analysis of the biodiversity and ecosystem service benefits of coffee and cacao agroforestry	Agriculture, Ecosystems and Environment	Global	Coffee, cacao
7	De Marco et al	2004	Services performed by the ecosystem: forest remnants influence agricultural cultures' pollination and production	Biodiversity and Conservation	Brazil	Coffee
8	Dominik et al	2017	Regional-scale effects override the influence of fine-scale landscape heterogeneity on rice arthropod communities.	Agriculture, Ecosystems and Environment	Philippines	Rice
9	Edwards et al	2014	Sustainable Management in Crop Monocultures: The Impact of Retaining Forest on Oil Palm Yield	PlosOne	Malaysia	Oil palm
10	Hodara et al	2016	Frogs taste nice when there are few mice: Do dietary shifts in barn owls result from rapid farming intensification?	Agriculture, Ecosystems and Environment	Argentina	Soybeans
11	Labrière et al	2015	Ecosystem services and biodiversity in a rapidly transforming landscape in northern Borneo	PlosOne	Indonesia	Oil palm, rubber plantations
12	Lavelle et al	2014	Soil ecosystem services and land use in the rapidly changing orinoco river basin of colombia	Agriculture, Ecosystems and Environment	Colombia	Oil palm, rubber plantations
13	Li et al	2020	Tradeoffs between agricultural production and ecosystem services: A case study in Zhangye, Northwest China	Science of the Total Environment	China	Grain
14	Liu et al	2020	Valuation of ecosystem services of rice-fish coculture systems in Ruyuan County, China	Ecosystem Services	China	Rice
15	Marquardt et al	2013	Farmers' Perspectives on Vital Soil-related Ecosystem Services in Intensive Swidden Farming Systems in the Peruvian Amazon	Human Ecology	Peru	Oil pal,
16	Meylan et al	2017	Evaluating the effect of shade trees on provision of ecosystem services in intensively managed coffee plantations	Agriculture, Ecosystems and Environment	Costa Rica	Coffee
17	Mtsetfwa er al	2018	Changes in bat community composition and activity patterns across a conservation-agriculture boundary	African Zoology	Eswatini	Sugarcane
18	Mumme et al	2015	Functional diversity and stability of litter-invertebrate communities following land-use change in Sumatra, Indonesia	Biological Conservation	Indonesia	Oil palm, rubber plantations

19	Nattharom et al	2021	The Economic Value of Ecosystem Services of Rubber-Based Agroforest Plantations in South Thailand	Journal of Sustainability Science and Management Volume	Thailand	Oil palm, rubber plantations
20	Ribeiro et al	2019	Forest fragmentation and impacts of intensive agriculture: Responses from different tree functional groups.	PlosOne	Brazil	Corn, manioc
21	Rigal et al	2018	Using farmers' local knowledge of tree provision of ecosystem services to strengthen the emergence of coffee-agroforestry landscapes in southwest China	PlosOne	China	Coffee
22	Simamora et al	2021	Looking for indicator bird species in the context of forest fragmentation and isolation in West Kalimantan, Indonesia	Global Ecology and Conservation	Indonesia	Oil palm
23	Wade et al	2010	Management strategies for maximizing carbon storage and tree species diversity in cocoa-growing landscapes	Agriculture, Ecosystems and Environment	Ghana	Cacao
24	Wang et al	2015	Quantifying changes in multiple ecosystem services during 1992-2012 in the Sanjiang Plain of China	Science of the Total Environment	China	Grain
25	wilson et al	2020	Conservation of ecosystem services in argudolls of Argentina	Agriculture	Argentina	Soybeans
26	Wood et al	2016	Intensification of tropical fallow-based agriculture: Trading-off ecosystem services for economic gain in shifting cultivation landscapes?	Agriculture, Ecosystems and Environment	Peru	Umari
27	Zhang et al	2012	Ecosystem service tradeoff between traditional and modern agriculture: A case study in Congjiang County, Guizhou Province, China	Frontiers in Environemntal Sciences and Engineering	China	Rice

Chapter 3. Research sub-question 2.

Suarez, Andres. (2024). Critical overview of the expansion of Hass avocado plantations in Salamina, northern Caldas, Colombia. *Journal of Land Use Science*, 19(1), 230-238.



Critical overview of the expansion of Hass avocado plantations in Salamina, northern Caldas, Colombia

Andres Suarez

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Critical overview of the expansion of Hass avocado plantations in Salamina, northern Caldas, Colombia

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ABSTRACT

This paper sheds light on the broader impacts of high-value commodity crops in the tropics by examining critically the rapid expansion of Hass avocado plantations (HAP). Using Salamina as a case study, this paper provides empirical evidence of local impacts and highlights the need for more sustainable and equitable governance strategies to manage emerging socio-economic and environmental challenges. HAP are transforming Salamina's traditional landscape by seizing considerable areas for avocado cultivation in response to the ongoing coffee sector crisis. Since 2018, the region has transitioned from a coffee-centered economy to one dominated by capital- and labor-intensive avocado production. While HAP has become a significant economic driver, it has also exacerbated social grievances and inequalities among local communities. This paper stresses the economic shift, environmental disturbances, and comments on governance policies for inadequately addressing sustainability and social issues.

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Introduction

The rapid expansion of Hass avocado plantations (HAP) in Salamina, Colombia, illustrates the swift changes occurring in local agricultural landscapes from the global South. Since 2018, this region has undergone a profound transformation, shifting from a traditional economy centered on coffee cultivation to one dominated by the capital-intensive production of avocados. Previously, large areas were dedicated to pastures and small coffee plots, reflecting the longstanding land tenure of the region. However, today, corporate-led avocado cultivation has emerged as the predominant agricultural activity. While HAP is now acknowledged as a significant economic driver, its impact is multifaceted, with mixed outcomes. Notably, the sector has created employment opportunities, but it also presents various challenges and complexities.

The resource-intensive (including labor-intensive) HAP has emerged as a counter-strategy to the recent crisis affecting the Colombian coffee sector (particularly in Caldas). The export of avocados, mainly to countries in the Global North, is one of the main strategies in Colombia (Arias et al., 2018).

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However, HAP expansion is a major social and environmental disturbance in the Global South (Bolados et al., 2018; Eldrige, 2024; Esteve-Llorens et al., 2022). Considering second sources of information, this paper seeks to provide a critical overview of the rapid expansion of HAP and its effects by considering the municipality of Salamina, located in northern Caldas, Colombia. This paper also argues that while policies and governance strategies attempt to promote sustainability in HAP, they fail to address the overarching implications of this intensive process of land use change.

Study area

Caldas is divided into six sub-regions and 27 municipalities, of which the northern sub-region faces the greatest increase in HAP. Salamina (Figure 1), located in northern part of Caldas was selected for this discussion because, in addition to representing an important increase in area and production in the context of Caldas, it is a municipality with several competing claims against avocado corporate growth.

Economies of scale drive HAP expansion in northern Caldas, necessitating vast tracts of land. According to the Public Rural Agricultural Planning Unit Agency (UPRA in Spanish), Colombia possesses significant potential for avocado cultivation, with approximately 3.19 million hectares deemed suitable (Fonseca et al., 2018). Land suitability refers to the ability of a particular type of land to sustain a specific use, assessed by evaluating multiple factors. In the context of Hass avocado farming, 22 criteria were identified: nine physicals, five socio-environmental, and eight socio-economic (Fonseca et al., 2018). In Caldas, UPRA identified over 120 thousand hectares as suitable for avocado cultivation. In Salamina, 23.3% of its rural land is suitable for growing Hass avocado, encompassing 9,027 hectares categorized into low, medium, and high suitability (Figure 2). Within these 9,027 hectares, 39% are highly suitable, 59% are moderately suitable, and 1% has low suitability.

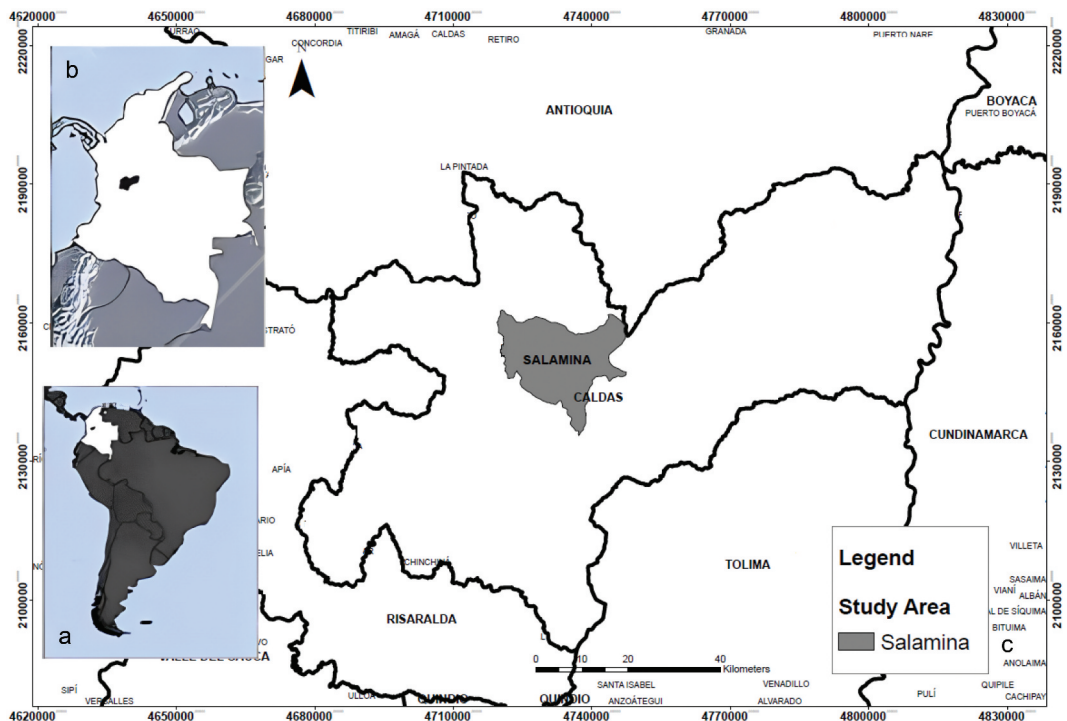


Figure 1. Location of Salamina. a. South America; b. Colombia; c. Department of Caldas and Salamina.

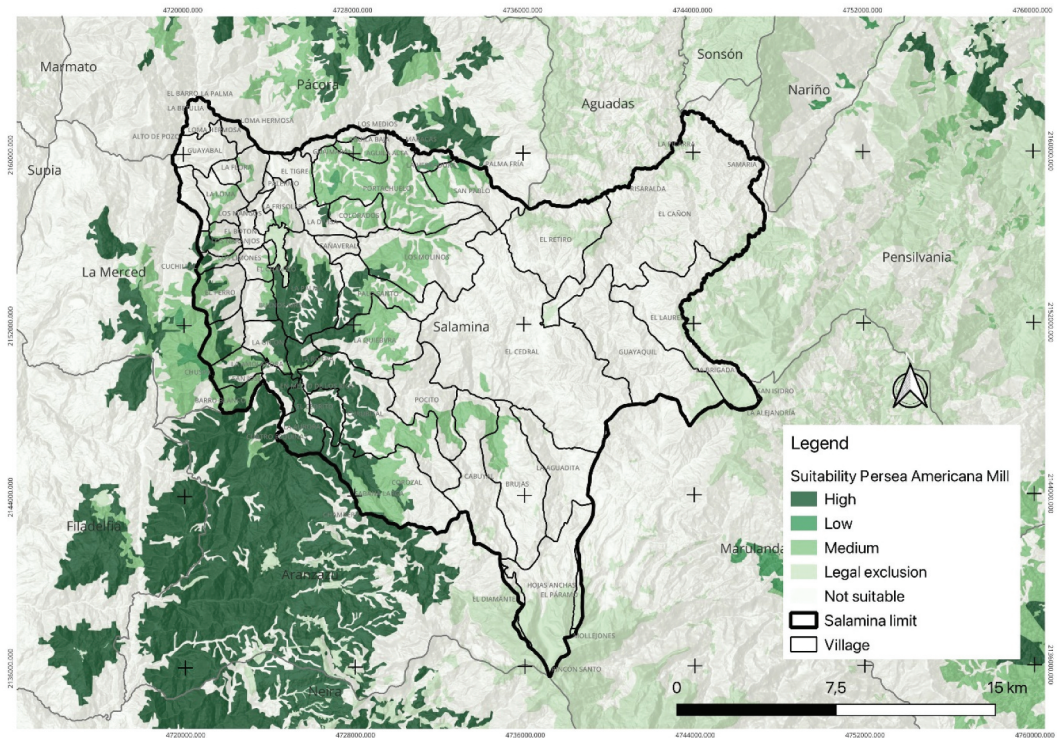


Figure 2. Hass avocado suitability in Salamina. Source: Author based on SIPRA (<https://sipra.Upra.gov.co>).

Despite current plantations covering over 2,000 hectares, substantial untapped potential remains, with approximately 3.3 times the current extent available for expansion. This study examines the implications of HAP expansion in Salamina and introduces a critical approach to understanding HAP in Colombia. While focusing on a specific case study, the dynamics observed here reflect broader global trends in agricultural expansion and development.

HAP and land use change

Salamina, a small municipality with around 19,923 residents, grapples with significant socioeconomic challenges. Roughly 38% of its population lives in rural areas, where 10.3% experience unmet basic needs and 1.4% live in poverty. Multidimensional poverty among rural residents is 40.8% (PDM Salamina, 2020). A long-standing economic crisis in the coffee sector has put even more pressure on the area. Decreasing coffee prices and rising production costs have led to a significant decline in the coffee cultivation area, with a reduction of over 670 hectares (approx. 28%) between 2007 and 2022¹. The crisis not only threatens coffee farming in the region but also facilitates the introduction and expansion of HAP. Surplus labor, previously engaged primarily in coffee picking, is now available for working in HAP (UMATA Salamina, 2023).

In 2018, avocado represented 7% of the total area planted with different agricultural products in Salamina, but by 2020, this area reached 33% of the total area. During the same period, there was a decrease of 119 hectares in coffee areas and a 19% decrease in livestock production systems between 2019 and 2022; i.e. from 618 to 500 farms.¹ The reduction in livestock systems decreased over 27,000 livestock units in 2019 to 25,000 in 2022. When comparing trends in permanent crops in Salamina, it is evident that most important crops decreased, except plantain, which is mostly for self-consumption, and Hass avocado, which has seen a boom (Figure 3). Notably, while Hass avocado

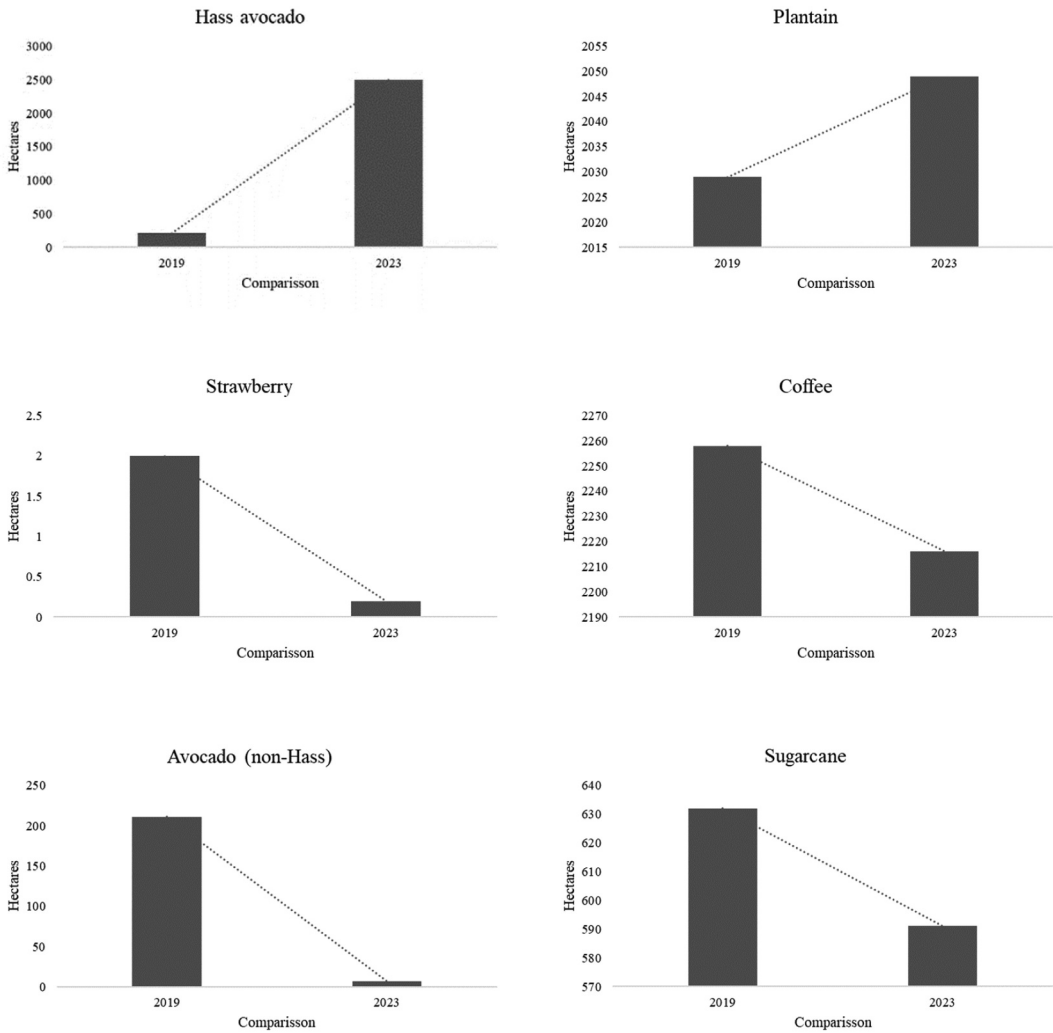


Figure 3. Comparison of areas under permanent crops in salamis between 2019 and 2023¹.

increased over 500%, plantain increased by only 0.25%. Coffee decreased by 1.86%, strawberry by 90%, sugarcane by 6.4%, and other varieties of avocado by 96%.

Traditionally, coffee, plantain, and livestock were prioritized. Recently, the focus has shifted toward HAP, with promotion at the national, regional (Caldas), and municipal (Salamina) levels (Supplementary material 1). National entities promote Hass avocado as the key to advancing Colombia’s rural sector. Regionally, developmental and environmental authorities are also crucial. Caldas, now Colombia’s second-largest avocado producer, has expanded cultivated areas and increased productivity through policies like Ordinance 734 of 2014. In 2018, the agriculture secretariat issued Resolution 6509, which provided guidelines for HAP to prevent deforestation by promoting expansion in extensive pasture areas, significantly impacting local land use.

The significant growth in plantations (500%), represent an increase of over 2,000 hectares in four years through the conversion of pastures to HAP. In Salamina, land ownership is divided into extensive pastures owned by wealthy farmers and peasant-managed farms cultivating coffee and plantains on hilly areas with limited resources. Most coffee farms range from one to 3.4 hectares

(Lince et al., 2018). Non-mechanized coffee farming on steep slopes, integral to rural income and cultural identity, defines Salamina's landscape. Located in the UNESCO-recognized coffee cultural landscape, this region's coffee cultivation is now threatened by the expansion of HAP.

Concerns about HAP expansion

The pressing issue of land distribution in Salamina mirrors broader challenges within Caldas, which ranks fourth among Colombia's 32 departments in the GINI land index reaching 0.84.² According to the Government of Caldas (2020), Salamina has a GINI land index ranging from 0.76 to 0.84, primarily due to pasture farms dominating the landscape. Historically, this concentration of land ownership has not only been used for livestock exploitation but also as a capital reserve strategy. Pasture coverage in Salamina spans over 20 thousand hectares, accommodating more than 25 thousand livestock units, reflecting a low-intensity grazing system with approximately one cow per hectare. These pastures cover a significant 53% of the municipal area, presenting substantial potential for plantation expansion. However, the transition from pasture to HAP often involves elite-to-elite land ownership transfer, further consolidating land holdings. While this transformation facilitates HAP expansion, it intensifies land ownership inequality and increases foreign land ownership.

Avocado production in Salamina has evolved over the past 16 years, starting with small-scale farming by local smallholders, typically cultivating 1–2 hectares of land for the local market. A significant change occurred in 2016, when international large-scale corporations were introduced. This shift included the acquisition of land³ and the adaptation of crops to the industrialization of avocado farming. Since 2018, this trend has intensified and there are currently seven corporations operating in Salamina, covering more than 2.6 thousand hectares. There are also plots where coffee farms concentrate, and these rarely exceed 4 ha in size. Small avocado growers target local markets and corporations international. The majority of these companies are from Chile and Peru, and one is Colombian but foreign to Salamina.

Among these large-scale avocado companies, four occupy a significant portion of the land, totaling 1,613 hectares across 21 properties. Current avocado properties have an average size of 158 hectares (ranging from 46 to 748 ha). Notably, one company exploits 133 hectares (18%) within a protected area named 'El Gigante,' which is critical for Salamina's urban water supply (Corpocaldas Corporación Autónoma Regional de Caldas y WCS, 2020). As part of an experimental initiative, a company is cultivating avocados over 278 hectares at an elevation of 2,950 meters above sea level, aiming to expand the cultivation area beyond the agro-ecological optimal zone. However, this area is considered unsuitable for the Hass cultivar.⁴ What is concerning is that many of the pastures acquired by the corporations include crucial water sources, intake areas and delimited water supply areas, particularly focusing on elevations ranging from 1,800 to 2,100 m above sea level where essential water springs are located.

Rural Salamina encompasses 49 villages (see Figure 2). Despite this number of villages, corporate HAP mainly consolidates in five villages. This consolidation varies significantly, ranging from 11% in Corozal to 82% of the total area in Pocito (Geoambiental Corpocaldas, 2023). This distinctive concentration pattern highlights the localized impact and dominance of HAP in specific areas (Figure 4).

Among the land consolidation process driven by HAP, extensive pasture areas have been transformed into orchards. Constructing ditches and roads to adapt the land for avocado has resulted in elevated sediment levels in water sources intended for human consumption. Consequently, local peasants have voiced grievances due to the adverse effects on their livelihoods (Table 1). In response, these communities have appealed to the environmental authority, prompting Corpocaldas (environmental authority) to impose penalties on certain corporate growers. As a result, Salamina's corporations have incurred in the highest number of legal sanctions (13 sanctions or preventive measures) and rank second in complaints (6 complaints) in Caldas in 2022.

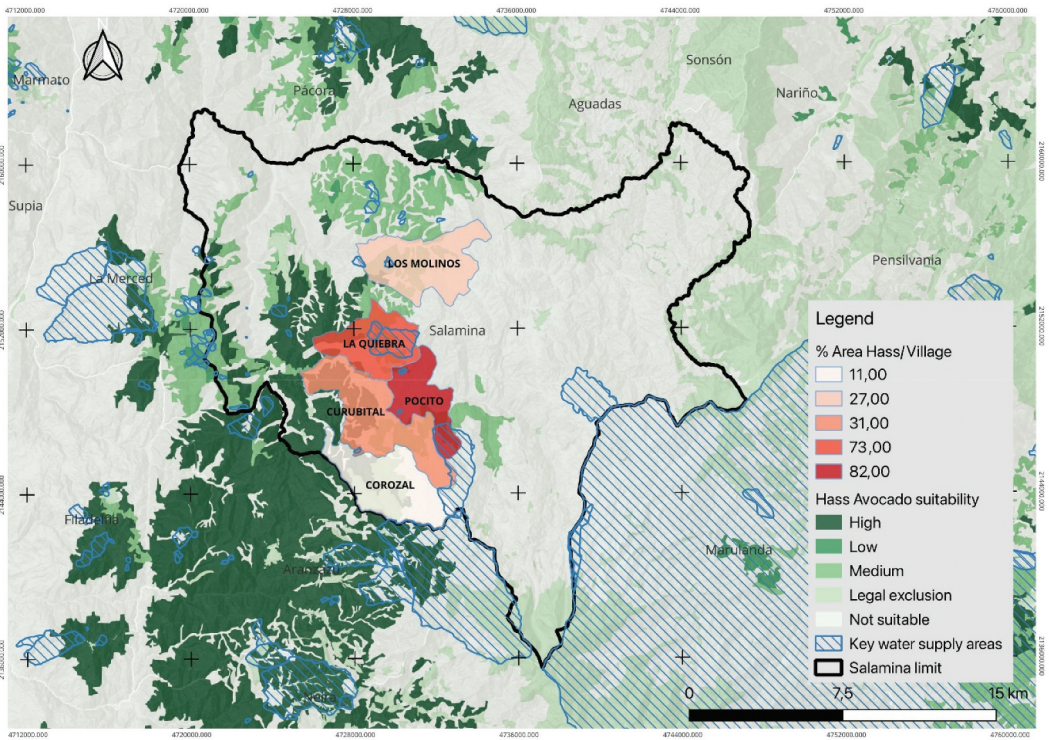


Figure 4. Concentration of Hass avocado farms in five villages in Salamina. Currently, avocado farms occupy 17% of the area of the municipality’s main water supply areas.

Complaints and requests for environmental assessment against avocado growers in Salamina highlight complex socio-environmental issues.⁵ Beyond quantifiable impacts, these actions reveal deeper concerns. Calls for assessment indicate a lack of trust between growers and communities. Allegations of violating protected areas show the cultural significance of landscapes. Petitions addressing contamination and landscape changes stress community rights to clean water and land protection. Concerns about village changes signify disruptions to traditional land use and community identity. The occupation of watercourses, unauthorized logging, and sedimentation from road construction harm the environment. Agricultural burns threaten protected zones and water sources. Allegations of stream contamination and excavation waste disposal pose direct threats to water quality and access. Unauthorized tree felling intensifies deforestation concerns and impacts water bodies. Although various sanctions have been implemented since 2022, the conflicted dynamics in Salamina remain.

Challenges in governing avocado consolidation

With the significant HAP expansion and regional policies promoting their cultivation in Caldas, Corpocaldas plays a crucial governance role. Acting as an advisory and coordinating body, Corpocaldas provides sustainability guidelines that directly influence land use changes in Salamina. Among these changes, conflicting scenarios arise where public and private interests intersect, particularly regarding the use of the agricultural landscape in the context of the considerable land suitability for HAP.

Public organizations develop sector-specific agendas that enable avocado corporations to negotiate land use during planning. These corporations engage in direct negotiations to align

Table 1. List of complaints and concerns filed against avocado companies.

#	Details of the complaints
1	Petition: Request for information and visit to avocado farm for environmental assessment
2	Complaint: Water contamination by avocado plantations
3	Denouncement: Violation of protected areas as ecological heritage by avocado growers
4	Right of petition: request actions for contamination and dewatering because of avocado plantation
5	Right to petition- protected areas-damage to avocado growers and water source presents coloration
6	Right of petition: The geography of several villages is being altered by avocado cultivation
#	Details of legal sanctions
1	Occupation of several watercourses and forest harvesting without a permit, and sedimentation and impact on water bodies with material left over from the opening of roads.
2	Agricultural burns that endangered the environmental protection zone and the Curubital aqueduct zone in Salamina.
3	Alleged affectation of the Chagualito stream because of the disposal of material from road excavation, contamination of drainage, and affectation of the water supply to the municipal capital of Salamina.
4	Sediment contribution to the Curubital creek due to the absence of trenches or structures to control mass movements coming from the road.
5	Impact on water sources supplying the La Frisolera micro power generation plant because of the opening and use of roads and the disposal of debris over bodies of water.
6	Felling of trees without a logging permit and possible impact on a water body.
7	Alleged agricultural burning on the Riobamba property.
8	Inadequate disposal of waste from road construction, deterioration of the protective forest strip, and occupation of watercourses without authorization from Corpocaldas.
9	Alleged damage to protective forest strips, lack of protection of springs, occupation of watercourses, and related activities.
10	Opening of internal roads within the area that corresponds to the protected forest area and inadequate disposal of debris.
11	Opening of internal roads, inadequate disposal of debris from water sources, waterway intervention without permission, and impact on the protective forest strip. Damage to vegetation cover and watercourse and intervention of forest areas protecting watercourses due to road construction.
12	Impact on vegetation cover and watercourses and the intervention of forest areas protecting watercourses due to road construction.
13	Impact on vegetation cover and watercourse and the intervention of forest areas protecting watercourses because of road construction, the use and exploitation of natural resources, and the generation of discharges because of activities carried out on the property without the respective environmental permits.

Source: Corpocaldas.

productive activities with ecosystem conservation, facilitated by initiatives like the inter-sectoral Hass avocado-working agenda in Caldas. This agenda operates regionally but affects municipalities where avocados are produced, and is supported by an 'inter-institutional avocado roundtable' in Salamina. From 2020 to 2023, the local government launched the 'Agreement of Wills for Good Agricultural and Sustainable Practices of Avocado Cultivation in the Municipality of Salamina' to address environmental concerns associated with HAP. The agreement established a consensus space to mitigate environmental impacts and outline obligations for stakeholders in the avocado chain.

The agreement emphasized active community participation to mitigate the impacts of avocado production and conserve water resources. An inter-institutional avocado roundtable following face-to-face dialog, including local and regional authorities, avocado producers, and local communities, was established to coordinate and monitor actions. However, power dynamics favoring corporations over those affected by the avocado boom hindered fair negotiation outcomes. This imbalance limited the peasantry's ability to raise concerns and achieve equitable resolutions.

Conclusion

This paper highlights significant concerns regarding HAP's in a traditional agricultural landscape. Critical questions persist about the land consolidation processes driven by corporations, the use and enclosure of resources such as water, and the resulting dynamics of inequality, as evidenced by the GINI coefficient of land in Salamina. Uncertainties also remain about labor migration to HAP and the maintenance of the coffee sector as both an economic activity and a driver of the cultural coffee

landscape. Furthermore, it is essential to consider the complaints and grievances of the affected local farming communities.

More generally, the paper draws attention to the role of corporate agricultural intensification in transforming social and physical conditions in traditional tropical landscapes, ostensibly for economic development and employment opportunities. Although the dynamics presented reflect impacts driven by commodity-oriented agriculture, this case provides valuable insights into the conflicted dynamics related to local agricultural crises (such as the coffee crisis), land suitability and availability (pastures), labor availability, and institutional articulation. To safeguard the local peasantry and the cultural landscape, it is imperative to enhance coordination efforts to address the challenges posed by corporate-led HAP. This includes developing strategies that prioritize the well-being of local communities and preserve the cultural heritage embedded in traditional agricultural practices.

Notes

1. EVAS-Evaluaciones agropecuarias municipales 2007-2022. Raw statistics of the agricultural sector in Colombia. <https://upra.gov.co/es-co/Paginas/eva.aspx>
2. The Gini coefficient of land represents how evenly or unevenly land is distributed among landowners. It is measured between zero and one. The higher the value, the more unequal the land. If a perfect land equality is a GINI= 0, Salamina is highly unequal.
3. The value of one hectare of pastures in 2018 was approximately 5 million COP (1,305-USD).
4. The area is unsuitable mainly for two reasons. First, it is outside the optimal altitudinal range of 1,800 to 2,200 meters above sea level. Second, according to the UPRA's land suitability report for the Hass avocado cultivar, where the orchard is located is labeled as unsuitable in Salamina.
5. Response to author's request for information in 2022.

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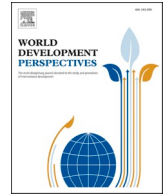
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Supplementary Material 1. Actors related to the Hass avocado market

Actors	Description	Scale	Role
✓ Ministry of Rural Development	<ul style="list-style-type: none"> Responsible for national agricultural policy and rural development, which in the last years has focused on Hass avocado as a development strategy. 	National	Promotion
✓ Agrosavia	<ul style="list-style-type: none"> Creating scientific knowledge and agricultural tech advancements through research and adapting technologies to enhance Hass avocado productivity. 	National	Promotion
✓ ICA- Instituto Colombiano Agropecuario	<ul style="list-style-type: none"> ICA ensures sustainable agricultural development by preventing, monitoring, and managing health, biological, and chemical risks for plants and animals. It holds a crucial role in certifying Hass avocados for international export. 	National-regional	Promotion
✓ Asohofrucol	<ul style="list-style-type: none"> Representing the interests of Colombian fruit and vegetable producers and to promote the productive and competitive improvement of their agribusinesses, contributing to the integral rural development of the country. This actor takes national guidelines and helps in implementing them at regional and local levels 	National	Promotion
✓ CorpoHass	<ul style="list-style-type: none"> Developing a relationship strategy with different actors in the production chain, both nationally and internationally, to position Hass avocado as an ultimate exporting product. 	National	Promotion
✓ Avocado Private capital fund	<ul style="list-style-type: none"> Investing in the entire Hass avocado chain in Colombia that includes the entire process, from land acquisition, cultivation, nursery, to the commercialization of the fruit. 	National	Promotion
✓ Finagro	<ul style="list-style-type: none"> It is a development bank that promotes the Colombian rural sector, with financing instruments that stimulate investment, and promote resources for Hass avocado growing. 	National	Promotion
✓ Government of Caldas	<ul style="list-style-type: none"> Planning and promoting economic, social and physical development within the territory of Caldas, including agricultural development. Caldas has an important policy for increasing Hass avocado areas and productivity to 2035. 	Regional	Exercise of authority/ Promotion of Hass avocado
✓ Corpocaldas	<ul style="list-style-type: none"> Corpocaldas, an environmental authority, enforces environmental policies and legal provisions governing disposal, administration, management, and use. It supports Hass avocado production through inter-sectorial negotiations, promoting greener practices. 	Regional	Exercise of authority
✓ Government of Salamina	<ul style="list-style-type: none"> Planning and promoting economic, social and physical development within the territory of Salamina, including agricultural development. Salamina promotes and allows the increasing Hass avocado productive areas 	Local	Exercise of authority/ Promotion of Hass avocado
✓ Large-scale Hass producers	<ul style="list-style-type: none"> Prominent financial capital enables large-scale producers in Salamina to reshape the landscape and shift labor dynamics. Both multinational and national companies are targeting global markets. 	Multilevel	Production
✓ Small-scale producers	<ul style="list-style-type: none"> Small-scale avocado producers (Hass and other varieties) aiming for national and local markets. 	Local-Regional	production
✓ Rural inhabitants and producers	<ul style="list-style-type: none"> Rural dwellers that inhabit Salamina who perform as small-scale growers of diverse agricultural products, mainly coffee, plantain and others. In addition, they are who face day-to-day dynamics related to HAP. 	Local	Production/in situ awareness
✓ Marketers	<ul style="list-style-type: none"> Different actors that intermediate between suppliers and consumers in different setups and scales. 	Multilevel	Connection supply demand
✓ Consumers	<ul style="list-style-type: none"> Final people who consume Hass avocado, either local, regional or global 	Multilevel	Consumption/demand

Chapter 4. Research sub-question 3.

Suarez, A. (2025). (Re) making landscapes into resources: the role of Hass avocado plantations in Salamina, Colombia. *World Development Perspectives*, 39, 100695.



Research paper

(Re)making landscapes into resources: the role of Hass avocado plantations in Salamina, Colombia

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ABSTRACT

The landscape of Salamina (Caldas, Colombia) has historically fulfilled multiple functions and undergone diverse transformations. The expansion of Hass avocado plantations (HAP) has marked a significant shift, redefining the landscape from a space of peasant self-sufficiency and social reproduction—characterized by landscape use-values—to a market-driven asset centered on the extraction of ecological surplus, represented as landscape exchange-values. This transition has been propelled by market compulsions, reinforced in recent years by the Hass avocado boom. This article applies a critical resource geography perspective to examine how land is reconfigured through the process of resource-making. It identifies the socio-historical, political, economic, and material factors that converge to facilitate HAP expansion, emphasizing the role of the state-capital nexus in enabling the commodification and exploitation of Salamina's landscape.

1. Introduction

This paper engages with ongoing debates on the factors driving pressures on farmlands and equitable access to land, commonly referred to as *land squeeze* (IPES-Food, 2024). The phenomenon of land squeeze involves processes of land concentration, fragmentation, and degradation—each shaped by distinct drivers and challenges, particularly in the context of large-scale export-oriented agriculture and other extractive land uses in the Global South (IPES-Food, 2024). Critically, land squeeze can be examined from multiple perspectives. In this regard, this paper aims to shed light on how land is subjected to increasing pressure by considering processes of land concentration. Additionally, it seeks to contribute to the broader inquiry posed by Mitchell (1996) on what landscape is and how it becomes a contested resource.

Valdivia et al. (2022) argue that while a resource is commonly understood as something useful to someone, this definition oversimplifies the complexities surrounding its utilization—particularly in terms of how, by whom, and for what purpose it is used. In the case of natural resources, this entails recognizing their availability in “nature” and their subsequent appropriation by social groups for their benefits (Valdivia et al., 2022). Consequently, natural resources should be understood as social products, shaped by both the material conditions of the resource itself and the social processes that define their resourceness. This

perspective underscores the concept of resource-making, which refers to the transformation of elements from the biophysical world into recognizable and exploitable resources through societal mechanisms (Bakker & Bridge, 2006; Li, 2014; Lilford & Allen, 2023). Various forms of ideational, discursive, or non-material control over resources drive this transformation (Tilzey, 2018), creating patterns of resource exploration, extraction, and commodification (Rasmussen & Lund, 2018).

To explore the dynamics of resource-making, this paper adopts the landscape production perspective, which incorporates both biophysical and social dimensions (Mitchell, 1996). This perspective suggests that landscapes should be understood as produced spaces, shaped by the commitments and struggles of social actors. As Mitchell (1996) emphasizes, landscapes emerge through both material production and the meanings ascribed to them, making them dynamic rather than static entities.

This paper argues that the making of landscapes as resources is based on a dialectical relationship between social and biophysical dynamics (Tilzey, 2018). A key feature of this dialectic is contradiction: landscapes function as sources of capital accumulation (Mitchell, 1996) while simultaneously being embedded in social-property relations through the appropriation of land's ecological surplus. This occurs as the social realm appropriates the ecological domain, leading to contradictions in resource use (Tilzey, 2018). Ecological surplus refers to the human

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capacity to generate output beyond the subsistence needs of producers by intensifying human-made inputs into the productive capacity of the biophysical world (Tilzey, 2018). While this surplus can serve multiple purposes (Cameron & Gibson-Graham, 2022), contemporary agricultural models—rooted in the neoliberal food regime—are overwhelmingly market-driven (Tilzey, 2024). As such, the production of landscapes is shaped by both social and ecological conditions of the historical moment, including commodity booms (Lee Peluso, 2012; Tilzey, 2019).

The resourcefulness of landscapes is not an intrinsic or natural quality but rather a dynamic interplay of material conditions, social relations, technologies, and discourses. This interplay is deeply embedded in a global context that compels countries in the Global South to conform to trends characterized by the expanded flow of resource-seeking foreign investments, land acquisitions, and the extraction of high-demand commodities for global markets (Delgado-Wise, 2020).

The conceptualization of landscapes as resources carries two key implications. First, landscapes constitute tangible, material spaces that sustain societies. Second, they embody ideational dimensions, as they are imbued with meanings and values (Mitchell, 1996). The former relates to the material conditions of land, while the latter concerns its value-laden interpretation, oscillating between use-values and exchange-values. In agrarian systems, use-values support community subsistence, whereas exchange-values relate to market transactions aimed at generating monetary capital (Fraser et al., 2018). According to Pirgmaier (2021), use-values entail the appropriation of landscape for human needs and well-being, whereas exchange-values reflect the dominant logic of capitalist production, where goods and services are produced primarily for market exchange (Bieler & Morton, 2022).

Building on Tilzey (2024), this article argues that within the process of resource-making, landscapes transition from sites of use-value production to sites of exchange-value extraction. That is, landscapes shift from supporting subsistence and social reproduction—where market participation is optional rather than obligatory (landscape use-values, LUV) (Tilzey, 2018)—to becoming spaces of exchange-value production, where coercive mechanisms extract ecological surplus for market-driven purposes (landscape exchange-values, LEV).

Through this analysis, the paper seeks to elucidate the processes by which landscapes gain significance as resources and the mechanisms that drive their transformation (Valdivia et al., 2022). This discussion is situated within the broader phenomenon of land squeeze, with particular attention to the dynamics of land concentration. The following sections examine the elements and processes that must align to produce landscapes as resources. Specifically, this paper explores how socio-historical, economic, political, and material conditions facilitate the expansion of Hass avocado plantations (HAP) in Colombia's traditional agricultural landscapes, and how this process reconfigures landscapes into sites of extraction and exploitation.

2. Framing the making of landscape as a resource through the introduction of HAP in Colombia

2.1. Context of HAP

The global appeal of Hass avocado (*Persea americana* Mill. c.v. Hass) stems from its unique blend of physical and nutritional characteristics (Dreher & Davenport, 2013). Fulgoni et al. (2013) emphasized that adding avocados to the diet is associated with improved dietary quality, increased nutrient intake, and reduced risk of developing metabolic syndrome. Hence, the authors emphasize that it is essential for dietitians to consider these advantages when providing guidance to individuals. Being an important source of nutrients, Hass avocado has become one of the most engaging sources of diet, mainly in the Global North (Arias et al., 2018; García et al., 2021), prompting major corporations to create vast plantations, mainly in the Global South, where Colombia is not an exception.

In Colombia, different national policies trying to seize market opportunities lead by the Hass sector,¹ since 2014 have re-emphasized on agriculture. The public Rural Agricultural Planning Unit agency (UPRA in Spanish) played a crucial role in this endeavor, tasked with efficiently planning land use and natural resources. UPRA's focus included identifying areas for agriculture, such as Hass avocado cultivation, by defining the so-called "land suitability." Land suitability refers to the capacity of a specific land type to support a particular class of use, determined through the analysis of a combination of criteria (Fonseca et al., 2018). For Hass avocado cultivation, 22 criteria were identified: nine physicals, five socio-environmental, and eight socio-economic. This analysis enabled the creation of a Colombian Hass avocado suitability map at a 1:100,000 scale.

As a result, UPRA issued a public document reporting that Colombia has a suitability for producing Hass avocado, reaching 3.19 million hectares, of which 632 thousand hectares exhibit high suitability, 1.8 million hectares have medium suitability, and 1.4 million hectares have low suitability (Fonseca et al., 2018). Harnessing the possibilities, Colombia currently boasts approximately 110,000 ha devoted to Hass avocados, yielding over 167,000 tons in 2020. Notably, Antioquia's departments, Caldas, Quindío, Risaralda, Valle del Cauca, Tolima, Huila, and Cauca have emerged as primary producers. The avocado sector engages approximately 16,500 producers, operating across approximately 39,172 production units, with avocado cultivation serving as their primary economic activity and generating approximately 54,000 jobs (MADR, 2020).

However, I stress that UPRA's report and their orientations are framed in a non-realist context, despite including some socio-economic criteria. This approach overlooked critical issues such as trajectories of land concentration, disparities in land tenure and the high levels of land-inequality that profoundly impact land use in Colombia (World Bank, 2021). Additionally, the report suggested, "the areas suitable for the development of Hass avocado cultivation, resulting from this document [UPRA's report], may coincide with areas suitable for other products." This statement misrepresents the Colombian reality of the peasantry, their productive dynamics, and the imbalanced power in rural areas, especially when Hass avocado corporations enter the productive scene (Serrano & Brooks, 2019). Considering the above, this article aims to understand HAP as a widespread agricultural development strategy in Colombia, with particular attention to the role played by the definition of land's suitability and land's availability. To bring this about, this study adopts an approach focused on understanding landscape as a resource that undergoes a transformation for exploiting avocados.

2.2. Research gap and contribution

Scientific literature has highlighted the role played by the delimitation of physical and geographical conditions for avocado growth (e.g. Campos-Campos et al., 2018; Ramírez-Gil et al., 2018). These suitability conditions present a scenario in which plantations can expand for market-compulsive ecological surplus. Authors such as Ramírez-Mejía et al. (2022), Charre-Medellín et al. (2021), and De la Vega-Rivera and Merino-Pérez (2021) expressed concerns because land suitability for expanding avocados could generate diverse impacts on key ecosystems

¹ Colombia's HAP boom is driven by rising global demand for healthy products in Europe, Asia, and North America. Over the past five years, Hass avocado production has increased by 89%, with a 62% rise in cultivated area and a 17% increase in yield (MADR 2020). High avocado prices have cemented its status as a promising crop (Montoya et al., 2019). Colombia's consistent harvest calendar offers a competitive edge (García et al., 2021). As a result, Colombia has moved from sixth to third among avocado exporters, with exports reaching 44,600 tons in 2020, behind Mexico and Peru. Future projections suggest Colombia could become the second-largest exporter (Escobar & Batancur, 2021).

and on people in the future. At the same time, Pérez-Llorente et al. (2019) emphasized that precisely in areas that are less suitable for HAP, it has been possible to advance forest conservation processes. However, although land suitability is recognized as a potential driver of negative socio-environmental dynamics, there remains a gap in the literature regarding its role in the process of resource-making. This gap is particularly evident in the conceptualization of landscape as a resource, which emerges through the assemblage of diverse elements and processes. Furthermore, it is not enough knowledge regarding the promotion of public land suitability initiatives as a market-compulsive ecological surplus strategy. In other words, the transition from LUV to LEV.

This paper examines how HAP expansion in a Colombian case study reflects a complex interplay of socio-political, economic, and material factors that make landscape a source of large-scale exploitation. This transformation shifted a traditional landscape from a small-scale, low-peasantry-based,² and locally-used resource to one appropriated by large corporations. Accordingly, this article delves into the transition from traditional agricultural land use, centered on coffee, plantain, and low-intensity livestock production that used the market as an opportunity, to a fully market-oriented land use exemplified by HAP. In this context, we assume that the public definition of land suitability for Hass avocados promotes LEV over LUV and then create conflicts.

3. Methods

Methodologically, this paper employs a mixed methods approach using a parallel design (Creswell & Creswell, 2018). We collected and analyzed qualitative and quantitative data simultaneously, giving them equal importance and integrating them for interpretation. Additionally, we conducted a single cross-sectional explanatory case study (Yin, 2013, 2018), grounded in theory, to understand how landscape transforms from LUV to LEV. This case study analyzes the municipality of Salamina, situated in the northern region of Caldas's department (Fig. 1). Northern Caldas encompasses approximately 127,000 ha and spans a wide altitudinal gradient, ranging from 550 to 3,750 m above sea level, encompassing various thermal zones and biome types. However, human interventions have significantly altered the current landscape of the region. Presently, a significant portion of the territory falls within the highly developed agricultural area of the coffee axis, which is characterized by coffee growing, cattle ranching, HAP, and pastures (Suarez et al., 2022).

In an attempt to go beyond a simplistic approach of contrasting quantitative changes in land use before and after HAP, following relevant literature presented in previous sections, by considering the reach of the landscape production approach, this paper seeks to present the interplay of historical, socio-economic, and political-discursive contexts represented by HAP. In this paper, we provide three analytical categories: a) context-specific elements from Caldas and Salamina, b) triggers that transcend the specific context, and c) outcomes as localized issues (Fig. 2). We consider HAP-oriented policies and discourses as triggers of landscape transition, embedded in the current dynamics in the global avocado market.

Additionally, we pay special attention to the material conditions of Salamina's land that facilitate the expansion of HAP. Although materiality can be understood from a different perspective (Bakker & Bridge, 2021), this article presents an approach based on the dialectical essence of the nonhuman because it considers a process of "co-constitution" in the analyzed phenomenon (Bakker & Bridge, 2021, p46). This is particularly relevant when analyzing the magnitude and constitution of

the guidelines regarding land suitability for planting Hass avocado. For example, Fonseca et al. (2018) pointed out that the UPRA's land suitability map at a scale of 1: 100,000 considered aspects of not only soil quality (physical criteria) but also socioeconomic and socio-environmental criteria.

To gather relevant information, we utilized secondary sources, including historical records of Salamina, local agricultural sector statistics, field observations, and context interviews (Table 1). To analyze the history (i), I focused on the recent productive history of Salamina and incorporated an interview with a local historian to supplement narratives, thereby facilitating the understanding and reconstruction of the area's historical dynamics and context. Land materiality (ii) was examined through secondary sources, context interviews, and in-field observations. This analysis included the process of land use change promoted by HAP and the land's suitability for growing the Hass cultivar.

In step (iii), socio-economic factors, I conducted context interviews to capture diverse perspectives on HAP. These included interviews with three peasants, four HAP companies, a former HAP employee, a former landowner who sold his land to Hass avocado companies, and a representative of small avocado growers (not limited to the Hass variety). Additionally, an interview with an environmental consultant working with HAP was included to assess the broader environmental implications. These interviews aimed to provide a comprehensive understanding of the socio-economic impact of HAP in Salamina. In step (iv), policy, the research examines national and local policies, with a particular focus on guidelines governing Hass avocado cultivation. This analysis seeks to uncover the policy trends that have shaped the current HAP expansion. In step (v), discourses, the study explores how Hass avocado is framed in public narratives, particularly through national and regional discourses.

As a result, I provided a theory-driven narrative on the resource-making process in Salamina by integrating all empirical sources. Finally, in step (vi), following the main assumption, the research examines conflict scenarios emerging from the tensions between landscape use-values (LUV) and landscape exchange-values (LEV).

4. Results

4.1. Historical evolution of Salamina's landscape and the shift toward exchange values

For over a century, coffee production has been a cornerstone of Colombia's economy, and Salamina was no exception. The municipality's coffee landscape—primarily based on use-values—has undergone multiple transformations. Coffee became Salamina's main economic driver in the 1930 s, positioning it as one of the region's largest coffee-producing areas. Its volcanic soils, rich in minerals and organic matter, provided optimal conditions for cultivation (Jaramillo Alzate, 2022). Initially grown on small plots for local consumption, coffee quickly evolved into a key cash crop. By the 19th century, rising international demand spurred significant increases in production across Salamina and other coffee-growing regions in Colombia.

Over time, local enterprises and landowners diversified their activities, engaging in mineral extraction, sugarcane and cacao cultivation, and extensive cattle ranching. Wealthy landowners, who dominated both cattle raising and coffee production, controlled Salamina's economy. However, as ownership of coffee-growing areas gradually shifted to smaller farmers, large pastures remained in the hands of elites (Jaramillo Alzate, 2022). Today, most of Salamina's coffee is cultivated on small farms ranging from one to 3.4 ha (García, 2018).

A major turning point occurred in 1989 with the dissolution of the Pacto Cafetero (Coffee Pact), which led to a decline in coffee production across Colombia while simultaneously driving intensification. Before its dissolution, coffee production operated within a regulated framework that ensured price stability, enabling growers to sustain a predictable

² This paper embraces Tizley's (2024) position, arguing that peasantry is not a homogeneous class but is differentiated. For instance, peasants with small plots (lower peasants) often need to work off-farm to support their families. Middle peasants can sustain themselves independently, whereas upper peasants produce surplus for sale, acting as small-scale capitalist farmers.

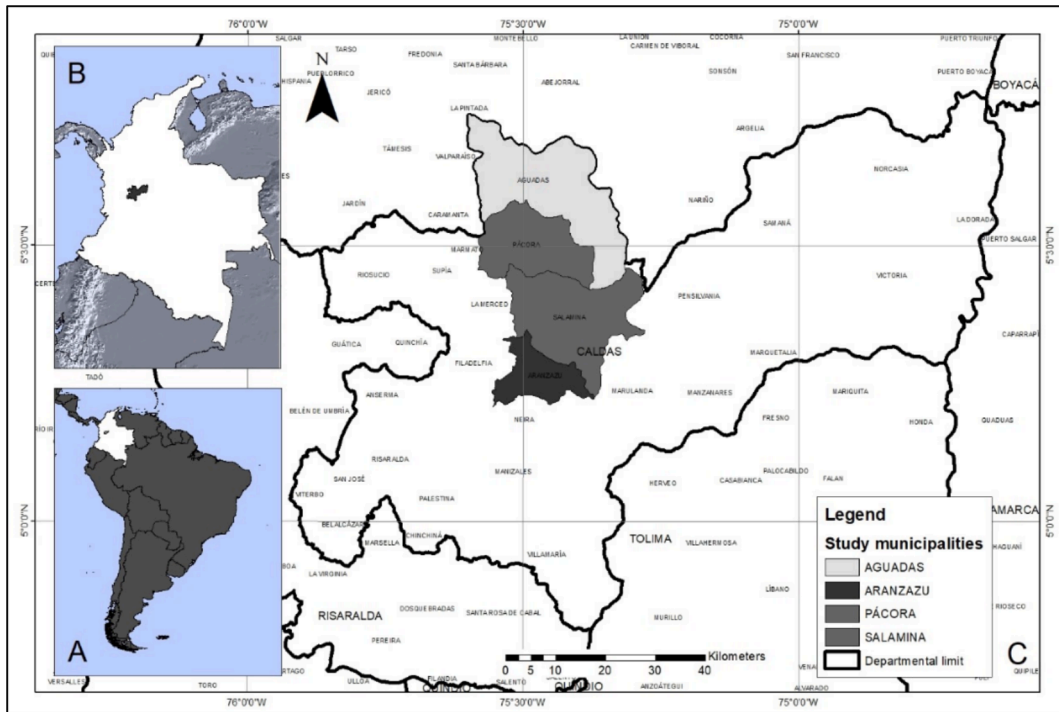


Fig. 1. Study area. Salamina, located in Northern Caldas, Colombia.

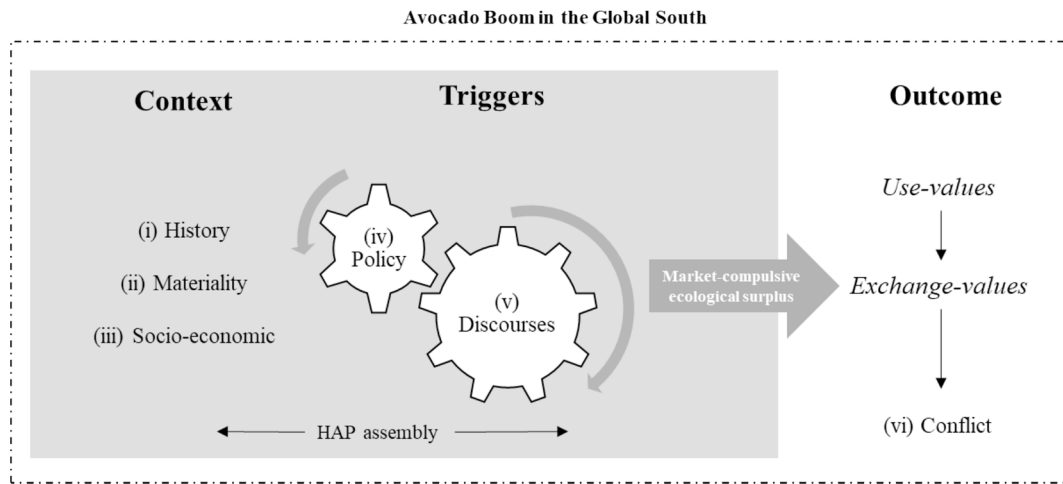


Fig. 2. Approach to analyze the making of landscape as resource of exploitation in Salamina, Colombia.

economy and strong institutional support. However, with the return to a free-market system, coffee prices plummeted in the early 1990 s, severely affecting small- and medium-scale producers, some of whom abandoned their plots (Jaramillo Alzate, 2022).

Although Colombia initially maintained a robust institutional framework to support coffee growers, market fluctuations and the price crisis of the early 21st century pushed production costs above international market prices (Guhl, 2008). In response, many farmers in Salamina diversified their crops (Jaramillo Alzate, 2022). Despite this shift, a significant number of coffee growers persisted, driven not only by economic considerations but also by a deep cultural and personal attachment to coffee (Guhl, 2008). Thus, in Salamina, landscape transformation was shaped not just by economic forces but also by

social, demographic, and cultural factors.

Recognizing the historical and cultural value of the coffee landscape, local actors sought to preserve its heritage amid the shifting dynamics of the coffee sector. In the 1990 s, efforts began to secure UNESCO recognition, aiming to safeguard the landscape’s cultural and historical significance. Salamina’s coffee landscape, characterized by high-altitude slopes and non-mechanized farming systems, has long been central to the livelihoods and identities of rural communities (UTP et al., 2021). Notably, the initiative for UNESCO recognition—now encompassing 52 municipalities across four departments—originated in Salamina (Jaramillo Alzate, 2022). In 2011, the Coffee Cultural Landscape of Colombia was officially designated as a UNESCO World Heritage Site, emphasizing the importance of preserving the region’s unique

Table 1
Research data and sources.

Category	Information	Sources
(i) History	Historical trajectories in rural Salamina	Context interviews, secondary sources.
(ii) Materiality	Land suitability	Map, hectares, sub regional, local level.
	Land use change	Hectares Hass, production (ton), change in livestock. Sub-regional level and Salamina, in-field observations.
(iii) Socio-economic	Importance of agriculture, employment Land consolidation by HAP	Context interviews, in-field observations, policies, development plans. Hectares in Hass vs hectares villages from Salamina.
(iv) Policy	Promotion of Hass for developing rural areas	Policies, development plans.
(v) Discourses	Narratives and statements	Public statements and communications.
(vi) Conflict	Complaints and grievances	Context interviews, reports on complaints and grievances.

environmental and cultural heritage amid economic and agricultural transformations.³

According to a local historian, coffee cultivation in Salamina extends far beyond its economic significance; it is deeply embedded in the social fabric of the community. Many small producers continue to grow coffee as a family-based activity, where labor is not merely a means of production but a shared practice that strengthens social bonds and preserves traditional knowledge. Working together in the fields fosters cooperation among family members, ensuring the intergenerational transmission of agricultural wisdom.

Alzate (2015) highlights that this deep-rooted connection to the land reinforces a strong sense of territorial identity. Coffee farming is more than just an agricultural practice—it symbolizes cultural heritage, shaping the landscape and defining daily life. Coffee fields are not just spaces of labor but also places of memory and belonging, where traditions are upheld, and community ties are nurtured. Through these practices, coffee farming remains a vital expression of identity, resilience, and social cohesion in Salamina.

Despite its cultural significance, Salamina's coffee sector, like the broader coffee industry in Caldas, has faced economic decline. Falling prices and rising production costs have contributed to a 28 % reduction in coffee-growing areas between 2007 and 2022. This crisis has paved the way for shifts in land use, particularly the expansion of Hass avocado plantations. However, similar to broader trends in Caldas, Salamina's coffee sector faces an economic downturn, with falling prices and rising production costs contributing to a 28 % decline in coffee-growing areas between 2007 and 2022 (Fig. 3). This crisis has paved the way for shifts in land use, particularly the rise of Hass avocado plantations.

Over time, Salamina's landscape has evolved to sustain the livelihoods of low-income coffee growers while simultaneously serving as a capital reserve for elites who maintain large pastures. Contemporary socio-economic dynamics have further catalyzed a paradigm shift, transforming land into a substantial exploitable asset. This shift marks a transition from landscapes valued for subsistence and social reproduction (landscape use-values, LUV) to landscapes increasingly oriented toward exchange-values (LEV)—where land is viewed primarily as a

commodity for capital accumulation.

4.2. Land materiality

Regional statistics show that for the four municipalities that make up the northern sub-region of Caldas (Aranzazu, Pácora, Salamina and Aguadas) Hass avocado areas have increased since 2020. During this period, Northern Caldas increased its area by more than 2,000 ha, where Aranzazu increased the most in area, followed by Salamina. Although Salamina has the lowest yield per hectare (6 t/ha), compared with Aguadas (20 t/ha), Aranzazu (10 t/ha), and Pácora (14 t/ha), it saw a remarkable 21-fold increase in avocado production tons in 2022 compared to 2020, leading among the municipalities in Caldas (EVAS, 2022) (Table 2). Data from 2023 depict a Hass avocado cultivation area spanning 2,965 ha (Geoambiental Corpocaldas, 2024).

HAP increased in Salamina, growing from 380 ha in 2018 to 2,500 ha in 2022 (over 2,000 ha in 4 years). This means that in 2018, Hass avocado represented 7 % of the total area planted with different agricultural products in Salamina, but by 2020, this area would have reached 33 % of the total area planted with agricultural products. During the same period, coffee decreased by 119 ha and livestock production reduced 19 % between 2019 and 2022; i.e. from 618 to 500 farms. The reduction in livestock systems resulted in a decrease from over 27,000 livestock units in 2019 to 25,000 in 2022. While coffee, plantains, milk, and meat are staple foods nationwide, Hass avocados are an exception to this trend (90 % of Hass avocados are exported, leaving only 10 % that cannot meet standards for the local market).

Material conditions in Salamina are both of quality and quantity. The first relates to the suitability of Salamina soils to support the growth and development of avocado trees (Fig. 4a), and the second relates to the availability of area in quantity for growing avocados. Approximately 3590.6 ha (40 % of total suitability) are classified as highly suitable, 5,379 ha (56 %) as moderately suitable, and 103.19 ha (1 %) as having low suitability to grow Hass avocado. Informants emphasized this by stating: “when they [Companies] saw the potential, because there is environmental and water potential on these lands; the climate is perfect for the activities that they perform. Obviously, this interested them, attracted them, and that is why they came to Salamina” [Peasant_1]. Even in the interview with Hass avocado companies, four of the five representatives emphasized that the main reason for being in Salamina was the topographic, climatic, and altitude characteristics of the Salamina's land. For instance, altitude between 1400 and 2400 m.a.s.l., temperatures ranging 12 °C and 25 °C, and annual rainfall between 15,001 and 2000 mm. Salamina has the suitability to grow avocado over 9 thousand ha. Currently, Hass avocado areas reach over 2.6 thousand hectares and concentrate large properties (Fig. 4b), with an average size of 158 ha (min: 46 ha, max: 748 ha). On Salamina, there are also plots where coffee peasantry farms are concentrated, and these rarely exceed four ha in size.

Rural Salamina encompasses 49 villages, but the cultivation of Hass avocados predominates in only five of them. This concentration exhibits significant variation, with representation ranging from 11 % in Corozal to as high as 82 % in Pocito, with intermediate levels observed in Los Molinos (27 %) and Curubital (31 %). The discernible pattern of this concentration underscores the localized influence and prevalence of Hass avocado farming in specific regions of Salamina, particularly in areas formerly utilized for pasture (Suarez, 2024a). This dynamic creates a feeling of suffocation among the population, as the peasants have increasingly found themselves surrounded on their properties. As Peasant_1 comments: “So, for me [being surrounded by HAP], this would be the beginning of a limitation on the dominion one has over one's property. ...[]... Even the coexistence with them, I have realized

³ Criteria accordingly to UNESCO for having in Colombia a Cultural Landscape (<https://whc.unesco.org/en/criteria/>):—to be an outstanding example of a traditional human settlement, land use, or sea use that is representative of a culture (or cultures), or human interaction with the environment, especially when it has become vulnerable under the impact of irreversible change;—to be directly or tangibly associated with events or living traditions, ideas, beliefs, and artistic and literary works of outstanding universal significance.

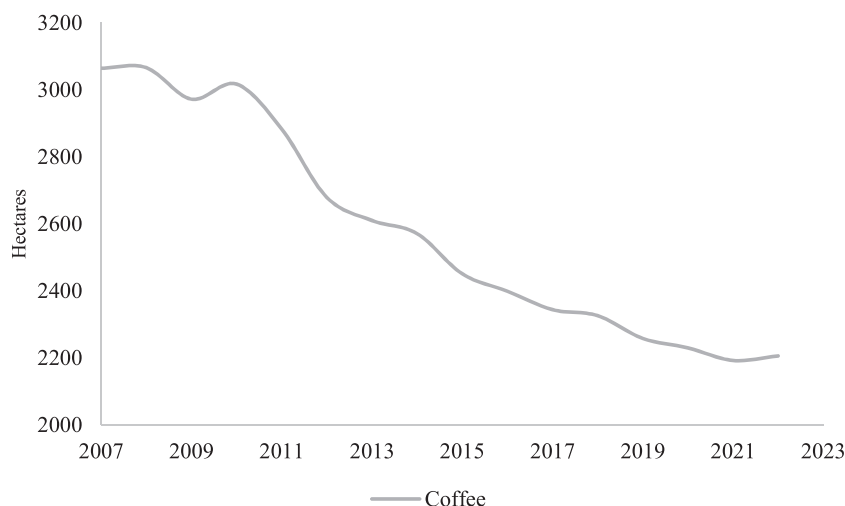


Fig. 3. Tendency from 2007 to 2022. Own elaboration based on EVAS 2007–2022.

Table 2
Changes in Hass avocado, coffee, and livestock in the northern Caldas sub-region.

Region	Hass planted area (ha)			Hass production (t)			Coffee planted area (ha)			Cattle ranches (# farms)		
	2020	2022	(+)	2020	2022	(+)	2007	2022	(-)	2019	2022	(-)
Northern Caldas	6,647	9,336	2,689	15,261	86,772	71,511	14,291	10,831	3,460	1,962	1,691	271
Aguadas	1,201	1,702	501	4,227	30,040	25,813	4,620	4,050	570	519	443	76
Aranzazu	1,200	2,894	1,694	1,588	19,002	17,414	2,597	1,581	1,016	422	376	46
Pácora	2,200	2,240	40	9,127	30,800	21,673	4,010	3,180	830	403	372	31
Salamina	2,045	2,500	455	319	6,930	6,611	3,064	2,020	1,044	618	500	118

Source: Elaboration based on EVAS agriculture 2007–2022.

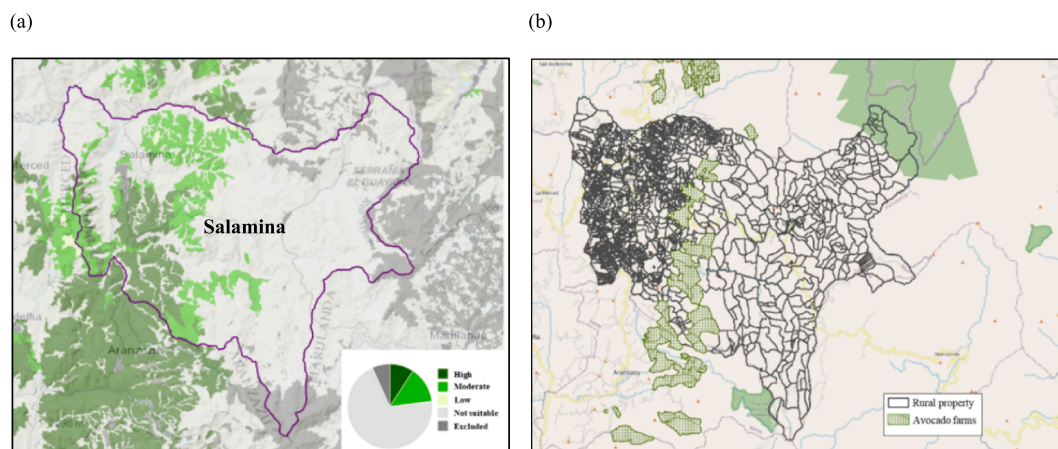


Fig. 4. (a) Land suitability for growing Hass avocado in Salamina. Author based on SIPRA (<https://sipra.upra.gov.co>). (b). Current Hass avocado farms in Salamina. Extensive property dedicated to pastures and smaller areas for coffee. (Geoambiental Corporacaldas, 2023).

that sometimes it is not so easy because of the privatization of easements.”

Before the expansion of HAP in Salamina, the land was primarily used for large areas with low-intensive pastures⁴ and non-mechanized

⁴ The livestock production in Salamina focuses on areas that are outside of the defined suitable zones for Hass growing, particularly in the San Felix district, which is situated above 2800 m above sea level.

coffee cultivation systems. Coffee systems mostly locate on high slopes and develop by family labor. Low peasantry combined coffee mainly with plantains and other minor crops that supported family reproduction and self-subsistence (Supplementary material 1). However, following regional guidelines for growing avocado in pasture lands (Section 4.4 later), regional policies opened the door for the expansion of Hass avocado in an important area of Salamina (Table 3, Fig. 4b), considering that pastures cover 20,603 ha, representing 53.3 % of the total rural land use.

Table 3
Rural land use in Salamina in 2019.

Rural land use	Area (ha)
Water bodies	59.7
Forests	6,494
Annual and transitory crops	11
Permanent crops	2,762
Pastures	20,603

Source: EOT Salamina (2021).

With over 9,000 ha of suitable land for cultivating Hass avocados, there is a possibility for expansion (see Fig. 4a). In Salamina, the Hass avocado landscape transformation comprises extensive areas planted after land clearing, soil preparation, and planting of avocado saplings. As Salamina has an important level of precipitation (1501 mm a 2500 mm annual average), there is no need for an irrigation system. However, because of the high inputs of rainfall, it is necessary to build ditches to channel rainwater and prevent water logging. Ditches help manage water runoff in hilly terrains such as Salamina's. Proper water management is critical for avocado trees, which require consistent moisture but are susceptible to root rot if soil drainage is inadequate. Roads are also important for extracting avocado fruits. However, ditches and roads caused a rise in the sediment levels in the water used for human consumption in several villages from Salamina, causing grievances and conflicts (Suarez, 2024a,b). There is also a need to construct roads for the future extraction of the fruit, which will create important changes in the Salamina's hilly landscape (Fig. 5).

4.3. Socio-economic conditions

Salamina, a small municipality with less than 20 thousand inhabitants, faces substantial socio-economic difficulties. In the rural regions, which are home to about 38 % of the population, 10.3 % of the residents have unmet basic needs, and 1.4 % are living in poverty. Additionally, 40.8 % of the rural inhabitants experience multidimensional poverty (PDM Salamina 2020). Although coffee production had been the most important economic activity in Salamina, recent crises have affected the sector. As a result, surplus labor, previously engaged primarily in coffee picking, is now available for working in HAP (UMATA Salamina, 2023).

HAP in Salamina has spanned and began with small-scale farming (1–2 ha) managed by smallholders in the local market. According to a representative of small-scale avocado producers in Salamina [Local_Rep], a harmonious relationship exists between large and small avocado producers. In 2016, large-scale production of Hass avocado started with companies acquiring land and adapting crops [Env_rep_1], but [Local_rep] stated that since 2018, international corporations (mainly from Chile and Peru) have been exploiting Hass avocado in a “corporate manner” (large-scale). It is noteworthy that Salamina has a high GINI of land ranging from 0.76 to 0.84, with pasture farms being the predominant land-use system, concentrating largest area.

In terms of employment generation, notably avocado producers offer formal employment, which has not been the case in other employment-generating activities such as coffee plantain production (Supplementary material 2). Reports suggest that Hass corporations provide approximately 800 formal employments. The labor currently employed by the companies comes mainly from coffee systems that, overcoming difficulties in the coffee sector, move to avocado plantations. Although there is no formal data to identify the amount of formal labor structure in Salamina, Peasant_1 notes that regarding the supply of employment, “now in the community about 70 % of the workers are with the avocado plantations and around 30 % in the coffee farms”. Former livestock producer [Ex_owner] expressed the benefits of HAP, stating, “HAP is

very helpful for employment in Salamina. Approximately 95 % of the workforce is employed, and those not working are usually considered lazy.” The impact on employment dynamics is noticeable, with “many workers returning from plantations in the afternoon”, as highlighted by Local_Rep.

4.4. Policy

In Colombia, the prioritization of the Hass avocado value chain in the National Development Plan 2018–2022, supported by rural capitalization incentives,⁵ and the establishment of the first private capital fund for Hass avocados in 2020,⁶ has significantly boosted nationwide avocado production. Moreover, national strategies for promoting HAP include four key initiatives: 1) sanitary diplomacy, 2) contract farming, and 3) production planning, complemented by the national agro-logistics plan.⁷ Additionally, the Ministry of Agriculture provides sector-wide incentives through special credit lines for the avocado production chain, covering establishment, maintenance, pest management, and the acquisition of agricultural machinery. Another available instrument is the agricultural insurance incentive, which allows avocado producers to insure their plantations against climatic and pest-related risks, among other agricultural hazards.

At the regional level, various policies and agreements have triggered significant transformations in key avocado-producing regions, such as the Department of Caldas. Currently, Caldas is Colombia's second-largest Hass avocado producer because of significant production growth. Caldas expanded the cultivated areas and increased productivity by following a regional policy (Ordinance 734 of 2014). With this policy, Caldas is committed to promoting avocado production for economic growth. The policy aims to increase the avocado growing areas in Caldas by 2035, expanding the planted area by 8,000 ha to reach a total of 20,000 ha, and boosting productivity to 14 tons per hectare. Following this trend, in 2018, Caldas' departmental agriculture secretariat issued Resolution 6509, which provided guidelines for Hass avocado production. These guidelines aimed to prevent deforestation by redirecting and promoting HAP expansion mainly in pasture areas (See Fig. 4).

Regional_Rep manifested that the regional government has an interest in motivating HAP through formal institutional arrangements. According to Env_rep_1, these arrangements encompass both small- and large-scale producers and include initiatives such as training, promotion of export-oriented practices, environmentally friendly guidelines, and promotion of productive clusters. Under the Hass avocado guidelines established by the Ministry of Rural of Agriculture and Development, their associated agencies, and regional and local governance bodies, HAP is intended to embody sustainable development principles.

4.5. Discourses

In Colombia, Hass avocado is considered as the “green gold⁸”, the

⁵ Ministry of Rural Development. Rural capitalization incentives. Information available at: <https://www.minagricultura.gov.co/Normatividad/Paginas/Decreto-1071-2015/INCENTIVO-A-LA-CAPITALIZACION-RURAL-ICR.aspx>. Retrieved 03.24.25.

⁶ Forbes Colombia. Aguacate Hass logra su propio fondo de capital privado. Information available at: <https://forbes.co/2021/06/08/economia-y-finanzas/aguacate-hass-logra-su-propio-fondo-de-capital-privado>. Retrieved 03.24.25.

⁷ Answer to a personal request number 20,215,200,140,211 before the Ministry of Agriculture and Rural Development on 30.06.2021.

⁸ Soho 2024. El Aguacate Hass: El Oro Verde Colombiano que Conquista el Mundo. Available at: <https://www.soho.co/que-pasa/noticias/articulo/el-aguacate-hass-el-oro-verde-colombiano-que-conquista-el-mundo/2Soho02457/>. Retrieved 03.24.25.



Fig. 5. Hass avocado plantation with trees in the early stages of growth in Salamina (Fabian Gaviria, 2019).

“flagship fruit⁹” or even the “fruit of prosperity¹⁰” because of its important increasing in production and exports. According to the director of Corpohass (Corporation of producers and exporters of Hass from Colombia): “Hass avocado stands out in more than 30 countries where it reaches, not only because of its flavor, but also because it makes its way as a referent of sustainability for the world, from its three dimensions. Its positive impact translates into well-being and quality of life for those who are part of its value chain, economic growth and responsible use of resources¹¹”.

The production of avocados has thus attained a privileged position in the country. At the national level, the head of the national Ministry of Agriculture emphasized,¹² “We aim to support peasants in maintaining ownership of their lands. The significant advantage of this initiative lies in its direct purchase of avocados from producers, bypassing intermediaries and linking them directly to markets in Europe and Saudi Arabia. This initiative plays a crucial role in diversifying our export portfolio.” However, it is important to note the diversity among peasantry and their varying capacities to produce Hass avocado. This is especially pertinent in contexts like Caldas, where the production costs

associated with cultivating Hass avocados are excessively high (Government of Caldas, 2020).

Nevertheless, the Hass avocado is being used as the main alternative for rural sector development¹³ in Colombia, Caldas and Salamina. Employment and income generation are widely acknowledged as key strengths of HAP.¹⁴ It is noteworthy that beyond the agriculture and development agencies from Caldas and Salamina, even the regional environmental authority in its formal communication platform,¹⁵ depicts Hass avocado plantations as champion of sustainable development. The authority cites “good environmental performance practices,” “well-organized management of surface waters,” “effective control of materials resulting from road construction,” and “proper rainwater handling on slopes.” The communication made by the director of the environmental authority also stressed, “[t]his highlights the importance of debunking myths related to agrochemicals, water supply, and water pollution related to Hass avocado plantations.” In making this statement, the environmental authority dismisses many pieces of evidence, including sanctions within its jurisdiction that substantiate the implications associated with HAP (Suarez, 2024a), and promote the consolidation of HAP as the main strategy in the region.

4.6. Conflict

HAP introduction in Salamina, in addition to the material characteristics of the land (suitability and availability in large pastures areas),

⁹ MSN 2024. Aguacate Hass, producto estrella, que jalonó las exportaciones de tres departamentos. Available at: <https://www.msn.com/es-co/alimentaci%C3%B3n-y-bebidas/general/aguacate-hass-producto-estrella-que-jalon%C3%B3-las-exportaciones-de-tres-departamentos/ar-AA1zjdCF?ocid=BinGNewsVerp>. Retrieved 24.03.25.

¹⁰ ANEIA 2024. La Fruta de la Prosperidad: El Fenómeno del Aguacate Hass en Colombia. Available at: <https://aneia.uniandes.edu.co/la-fruta-de-la-prosperidad-el-fenomeno-del-aguacate-hass-en-colombia/>. Retrieved 24.03.25.

¹¹ Corpohass [Oficial]. (2024, 13.03). En 2024 duplicamos los envíos de Hass Origen Colombia para el Super Bowl 1.496 toneladas de Aguacate Hass colombiano acompañarán la popular celebración deportiva de Estados Unidos. <https://www.corpohass.com/post/en-2024-duplicamos-los-env%C3%ADos-de-hass-origen-colombia-para-el-super-bowl>.

¹² Colombian Ministry of Agriculture [Oficial]. (2019, 18.01). Colombia se convierte en productor de aguacate Hass de clase mundial. <https://www.minagricultura.gov.co/noticias/Paginas/Colombia-se-convierte-en-productor-de-aguacate-Hass-de-clase-mundial.aspx>.

¹³ LatinPyme 2024. Aguacate Hass: Motor de Crecimiento en las Exportaciones de Colombia en 2025. Available at: <https://www.latinpyme.com/a-guacate-hass-motor-de-crecimiento-en-las-exportaciones-de-colombia-en-2025/>. Retrieved 24.03.25.

¹⁴ Eje 21. Aguacateros del norte de Caldas y gobierno departamental fortalecen unión para consolidar el esquema productivo de este sector. Available at: <https://www.eje21.com.co/2022/06/aguacateros-del-norte-de-caldas-y-gobierno-departamental-fortalecen-union-para-consolidar-el-esquema-productivo-de-este-sector/>. Retrieved 24.03.25.

¹⁵ Corpocaldas [Oficial]. (2020, 20.09). Llegamos hasta la vereda Curubital ubicada en el municipio de Salamina, con el objetivo de conocer de primera mano los planes de manejo agroambiental que ha ejecutado la empresa aguacatera Agrícola pacífico sur Pacífico Sur. [Video]. Facebook. <https://www.facebook.com/watch/?v=186875363549479>.

and the availability of surplus labor (from coffee sector), was due to two important conditions. The first factor was the low price of land, and the second was the interest that upper peasants, such as owners of pastures, had in selling their land to the new arriving corporations in the northern region of Caldas (e.g., Ex_owner). According to Env_consult, the prevailing cost of land with pastures in Salamina was notably low, with an average valuation of 5 million Colombian Pesos per hectare (approx. 1,224 USD/ha). Peasant_1 explained that Salamina landowners began contacting and brokering with neighboring companies from neighboring municipalities (i.e. Pácora or Aranzazu) in response to the phenomenon, which led to a regional trend of land sales. This outreach involved not only transferring land owned by the initial liaisons but also successfully persuading other upper peasants to participate in the land sale. Citing Peasant_1: “some families from Salamina who owned land contacted those big producers located in neighboring municipalities in order to sell their lands and also, they convinced more people to sell their lands too”.

According to Peasant_1, “when these people arrived [the companies], making offers to buy land at much higher prices per hectare, obviously, everything in the one who had a farm of say, 300 ha of five hundred, they speak that there was a sold farm of 900 ha.” Then, as Peasant_3 mentioned, “that people [pasture owners] sold their lands because they “got very excited about money.” However, the demand generated by HAP companies led to price escalation to 10 or even 15 million COP per hectare.

This massive purchases of land resulted in landscape transformation processes, where corporations have received various fines and sanctions¹⁶ from the environmental authority. To cite the content of some complaints made by local peasantry, there are “violation of protected areas as ecological heritage by avocado growers,” “the geography of several villages is being altered by avocado cultivation,” and the sanctions mainly based on the impact on forests and water resources¹⁷ (Suarez, 2024a).

In this context, the loss of access to land benefits emerges as a significant concern, particularly in light of the prevailing sentiment surrounding the gradual deprivation of local communities’ water access due to pollution. Peasant_1 articulated, “So, if water in this micro-watershed becomes inaccessible due to contamination [from HAP], the corporate growers possess the financial means to seek out alternative micro-watersheds, whereas we do not.” Additionally, there is the loss of intangible benefits provided by nature, such as the enjoyment of scenic beauty. Peasant_1 lamented, “Well ... you see, these corporate growers own the upper reaches, encompassing everything from the road upwards. Given that these are private properties, we are barred from accessing them. Consequently, we are deprived of the once-enjoyed pleasure of traversing this area.” In this line, the introduction of newly developed land as a resource for land exchange values generates conflicts with land use values not necessarily tied to market compulsions. As a result, there have been aspects related to shifting perceptions of land values within the region. As stressed by Peasant_2, “They [corporate growers] did not recognize the value of the land as that spirit apart, that spirit, that tradition, that culture, the magic it harbors, they just aim to produce avocado.”

Although employment in HAP has been a significant factor in boosting the economy of Salamina, further major conflicts have emerged. First, inflationary prices have arisen, not only for land but also for everyday essentials. Peasant_2 highlighted, “They [Hass

corporations] have greatly activated the economy. So much, but they raised prices in many things; for example, in food and transportation. When you try to take a Jeep [a rural transport vehicle], they either tell you they are busy [with avocado employees] or charge double the price for the service. This price increase affected many aspects of the municipality. Housing is scarce, with no place to rent or buy, and land is even harder to find for rent or purchase.” Additionally, Peasant_1 noted, “The impact of HAP on us is significant because there are no more cattle, and meat prices have skyrocketed. They increased tremendously since all those farms are now avocado plantations, but they used to be for cattle. Now, only a few farms remain with cattle. Consequently, milk prices have also risen substantially.”

Secondly, employment dynamics have caused conflicts due to changes in production relationships. Peasants, such as coffee growers, who used to work for themselves, now sell their labor to corporations. Peasant_2 explained, “We were highlighting the issue of land occupation and the proletarianization of the countryside. Many sold their land and went from being owners to workers on their own land because many workers stopped being owners to work on their land.”

5. Discussion

5.1. Land suitability and exchange values

Critical literature on avocado production has directly considered how, for example, water and its materiality becomes an important resource for HAP (Bolados et al., 2018; Budds, 2008; Panez Pinto et al., 2018). At the level of land use *per se*, there are some extreme dynamics where HAP expansion changed directly from forested areas to plantations (Barsimantov & Navia Antezana, 2012; Bravo-Espinosa et al., 2014; Campos-Campos et al., 2018; Cho et al., 2021; De la Vega-Rivera & Merino-Pérez, 2021; Denvir et al., 2021; Friedmann & McNair, 2009; Pérez-Llorente et al., 2019; Ramírez-Mejía et al., 2022). Other approaches highlight a more progressive but still striking process of increasing plantations. Here, the literature describes how avocados directly absorbed traditional land uses by changing annual crops for the domestic market to plantations (Bolados et al., 2018; Budds, 2004, 2008; Panez Pinto et al., 2018). In this line, HAP has transformed the role of landscapes: that is, from small-scale and traditional LUV to intensive ecological surplus-seeking LEV.

One aspect highlighted in the literature is the role of defining land suitability for land development and modern agriculture (Everest, 2021; Pedron et al., 2006; Safitri et al., 2021; Zabel et al., 2014). However, as demonstrated in the scholarship on avocado land suitability, this definition overlooks the social and ecological implications of implementing such guidelines (Charre-Medellín et al., 2021; De la Vega-Rivera & Merino-Pérez, 2021; Ramírez-Mejía et al., 2022). Ramírez-Mejía et al. (2022) illuminates the influence of economic policies and strategies on the determination of land suitability for avocado cultivation, a dimension also acknowledged in the present study. As an additional contribution of this research is the analysis of the material conditions of suitability in addition to historical, socioeconomic, discursive and policy elements in a specific context that moves landscape from use-values to exchange-values.

In delineating the suitability of land for Hass avocado production in Salamina (covering more than 9,000 ha), several factors are overlooked. Questions remain regarding global trends on land squeeze applicable to local contexts such as Salamina. Additionally, policies that leverage land suitability to promote land consolidation through HAP fail to address the need for changing production relations. In Salamina, these policies primarily benefit long-standing local elites (upper peasants) who own land in suitable areas. They sell this land to large-scale corporations, thereby establishing new elites. Conversely, local actors, such as low-middle peasants, are unable to benefit from the new made “avocado land,” given that, according to government agencies, Hass avocado production entails high costs and low-middle peasants cannot afford it.

¹⁶ Corporations located in Salamina have incurred the highest number of legal sanctions (13 sanctions or preventive measures) and ranks second in complaints (6 complaints) in Caldas in 2022.

¹⁷ This issue continues to promote grievances in 2025. See La Patria 2025. Sigue la discordia por el aguacate en Caldas: campesinos exigen cuidar el agua ante Gobernación y Minambiente. Available at: <https://www.lapatria.com/caldas/sigue-la-discordia-por-el-aguacate-en-caldas-campesinos-exigen-cuidar-el-agua-ante>. Retrieved 24.03.25.

In this case, the most profitable actors are those that have the financial resources—such as corporations—not only to purchase the land but also to perform the process of adapting the land and making the necessary investments for avocado exploitation (market-compulsive ecological surplus).

Additionally, the definition of land suitability fails to consider land ownership and existing property regimes where suitability is mapped. Salamina exhibits high levels of land concentration (GINI of land 0.76 to 0.84), predominantly in the hands of the elite who have historically owned vast tracts of pastures. Regarding the relations of production, the definition of land suitability also does not foresee how change occurs, for example, in labor dynamics, where people are no longer in charge of and leaders in the development of low peasant coffee plantain growing, but transition to being employees of avocado corporations. Then, as presented by Valdivia et al. (2022), resources do not innocently “become,” and the case of land in Salamina is not an innocent becoming resource, but results from a complex assemblage led by HAP.

5.2. Conditions enabling HAP

It is important to analyze the conditions that enable the configuration of HAP as a resource-making strategy in Salamina. According to Tilzey (2018, 2024), a crucial aspect is the “state-capital nexus”, which legitimizes and promotes the dynamics of market-compulsive ecological surplus accumulation. Thus, governmental entities such as UPRA, regional and local governments, supported by the Colombian state constitution, promote technical strategies for defining land suitability, although this approach neglects land use values and overlooks the socio-historical complexities of the land.

In that sense, Salamina engages in a predominant political-economic pursuit within the global food system (Kelinsky-Jones et al., 2023; McMichael, 2021; Suarez & Ume, 2024). Ye et al. (2020) emphasize that dispersed extractive activities combine to shape a cohesive trajectory of extractive development. Building on the insights of Ye et al. (2020), this transformation links Salamina, which was once a localized and secluded participant in the global market with a predominant focus on LUV, to a pivotal role within the machinery that fortifies the existing food regime by re-making landscapes (LEV) as a resource through HAP. Within the context of Salamina, the adoption of crop commodities like the Hass cultivar serves as the driving catalyst for structural reproduction in contemporary global agricultural development strategies (McMichael, 2009).

6. Conclusion

Various socio-historical, economic, political and material aspects have intertwined to transform landscape –supported by the public and formal institutions– into a resource aimed at exploiting ecological surplus based on a market compulsion. Materiality matters, but so do politics, history, discourses, and social context. As a causal mechanism, the state-capital nexus stands out, which legitimizes the transition from LUV to LEV through technocratic strategies such as “land suitability,” compulsively seeking participation in the global boom of the Hass cultivar. However, the definition of land suitability considers land as a space devoid of socio-historical dynamics and does not address the constraints related to land ownership (who owns it and how), the role of peasant diversity (autonomous class or proletarian) and non-market oriented values.

Understanding the introduction of Hass avocado plantations from a landscape perspective was a key aspect of this study. This approach not only allowed me for an analysis of the trajectories associated with biophysical transformations in Salamina but also provided insights into the representations that emerge from the appropriation of material elements (LUV to LEV). The inclusion of both use-value and exchange-value frameworks played a crucial role in achieving a more comprehensive understanding of the phenomenon associated with the commodity

boom.

The approach outlined in this paper aids in qualitatively understanding the trajectories of landscape change, offering a more profound analysis than mainstream considerations such as opportunity cost, economies of scale, or trends in agricultural modernization. In this vein, considering further implications, this paper echoes the recommendations made by Fraser et al. (2018). Policies should extend their focus beyond the management of capital assets and place greater emphasis on use values rather than solely on the market realm of exchange values.

As a recommendation, the need for critical approaches in defining strategies such as land suitability mapping is highlighted, and critical resource geography can shed light on this process. As a limitation of the present study, I argue that the approach is useful only for understanding trajectories of land use change, especially where a smooth transformation from traditional to plantation agriculture is taking place. Other trajectories should be approached with different lenses. I believe that further research should also address class dynamics such as elite-to-elite change, processes of proletarianization, the role of labor in reshaping landscapes, and strategies led by the state and corporations to address emerging conflicts.

Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.wdp.2025.100695>.

Data availability

Data will be made available on request.

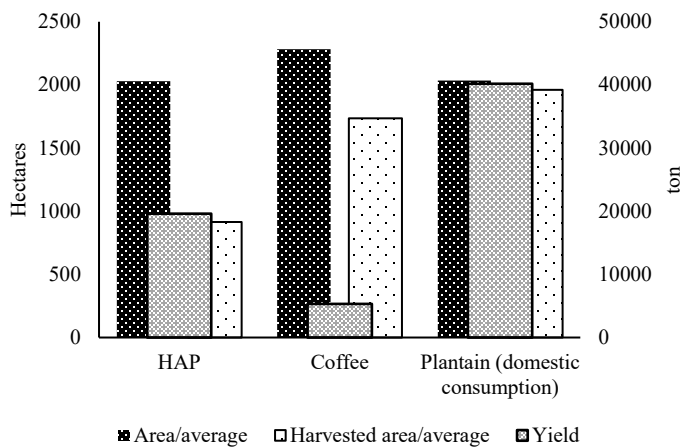
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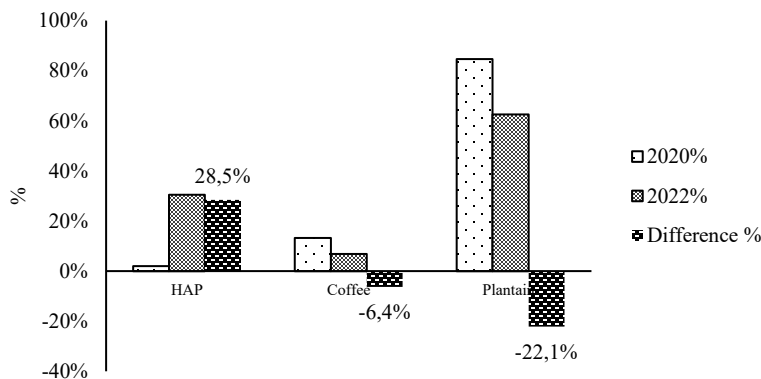
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Supplementary material 1. Coffee and plantain compared to HAP

Peasantry in Salamina mainly cultivate plantains and coffee for local consumption, whereas corporate-led Hass avocados target for international markets. Comparing coffee, plantain, and HAP from 2020 to 2022 (average area and yield), Figure S1 shows plantain dominated with 13,398 tons on 2,034 hectares, followed by Hass avocado with 6,538 tons on 2,030 hectares, and coffee with 1,782 tons on 2,282 hectares. Combining the three products, the total yield was 15,573 tons in 2020 and 22,696 tons in 2022. Further comparative analysis shows a 28% increase in HAP, a 6.4% decrease in coffee production, and a 22% decline in plantain (Figure S1).



(a) Area, harvested area and yield 2020 to 2022



(b) Comparison of yield in percentage from 2020 to 2022

Figure S1. Comparative analysis of HAP, coffee and plantain in the period from 2020 to 2022. Own elaboration based on EVAS 2019-2022.

Supplementary material 2. Socio-economic context of Caldas

The boom in avocado production and growth is necessarily based on land available for this purpose. In that line, the case of Caldas is remarkable because Hass avocado in Caldas occurs in a land-complexity context. According to Cortés et al. (2020), Caldas has a GINI land index (i.e. land inequality) of 0.84, placing the department in the fourth position nationally (4th out of 32) and on the Colombian coffee axis (composed by Caldas, Quindío, Tolima, northern Valle and Risaralda). Caldas also ranks third nationally in the land ownership disparity index, with the top 10% (over six thousand owners) of landowners possessing 788.800 ha (43% of the departmental area).

Most privately owned agricultural land in the department, over 86%, is less than 10 hectares. Notably, family agriculture accounts for 38% of Caldas' total area, covering 43% of all farms with less than one hectare (UPRA, 2023). 83.5% of the farms in Caldas correspond to micro and small farms with areas ranging from 0.5 ha to 10 ha, in contrast to the 1.5% of large farms, larger than 200 ha. This means that the rural population (low peasantry), reliant on this land for their livelihoods, does not have the minimum required area for productive farming per family (Government of Caldas, 2020).

Although in rural areas of Caldas unemployment reaches 12.1% (UPRA, n. d.), agriculture, following the commercial sector, is the second most significant employment-generating activity, accounting for 15.8% of labor (Heno and Velásquez, 2022). Producing and harvesting coffee has become the primary activity in the region, providing direct and indirect employment for approximately 300,000 individuals. This accounts for 54% of the departmental agricultural GDP and 49% of agricultural exports. For 19% of low peasant coffee producers (less than 0.5 ha and 1.5 ha), the sale of labor is the main source of income, which involves over 20,000 people (MADR, 2020).

Although coffee production has increased in the last decade in Caldas, projections for 2031 show that coffee production will decrease by approximately 30% (Heno and Velásquez, 2022). This evidences a problem for the department in terms of its productive structure and employment options for rural inhabitants. For this reason, in the search for alternatives to overcome the problem, Hass avocado has emerged as a viable option, given that this crop has nationwide strategic support. This presents significant challenges for the local low peasantry in Caldas, who cannot move from growing coffee to Hass avocado.

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Chapter 5. Research sub-question 4.

Suarez, Andres, & Ume, C. (2024). Transforming food systems in the Global South: a radical approach. *Frontiers in Sustainable Food Systems*, 8, 1397100.



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Transforming food systems in the Global South: a radical approach

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Sustainability within food systems (FS) transcends approaches that only consider FS transformation via changing agricultural practices or consumption patterns. The essence lies in addressing the root causes of current unsustainable FS and their associated social and environmental ramifications. This paper aims to outline the solutions needed to revamp these challenges, by paying special attention to the state-capital nexus in the context of the FS'global core-periphery dialectics. Thereby, we embrace radical political agroecology as being essential in promoting sustainability within the FS, especially in the Global South. Agroecology is proposed as the strategy to address the food system's complexity in terms of the social, environmental, and economic embeddedness. We conclude with potential solutions that contribute to the pathway for FS sustainability.

KEYWORDS

critical realism, state-capital nexus, food regime, class struggle, radical political agroecology

1 Introduction

Food systems (FS) are complex webs of processes and products, involving production, processing, packaging, distribution, retail and consumption of food, which finally have implication on social and natural systems (Eliasson et al., 2022). Current challenges of FS arise from several dynamics shaped by capitalist values (Bakker and Gill, 2019). Various authors have highlighted the need to consider social, economic, and ecological outcomes within FS as the starting point in their transformation (FAO, 2019; Giraldo, 2019; Ume, 2023). Others have called for transformative processes in socio-natural relationships, the urgency of shifting mental models, and the need for more democratic and less oligopoly-driven FS (El Bilali et al., 2019; Fanzo et al., 2021; Kugelberg et al., 2021). Achieving sustainability in FS therefore requires addressing root causes and avoiding simplistic approaches. Literature reveals various proposed approaches that emphasize the importance of holistic strategies, innovative collaboration, and systemic transformation (Table 1). Equity, inclusivity, interdisciplinary efforts, and resilience are consistently mentioned priorities that aim to shift paradigms toward more sustainable FS. Yet, there is no universally accepted approach to FS transformations (Juri et al., 2022).

Table 2 in this paper, we aim to offer an initial guide for approximating FS' transformation toward sustainability, by recognizing their non-linear nature. We reflect on the intricate process of transformation particularly needed in and coming from the Global South to highlight two main points: unequal ecological exchange and peasant resistance. Global North's reliance on extractive practices in the South affects environmental sustainability (core-periphery relation),

TABLE 1 Complex emergent problems of FS in the Global South.

Scale	Characteristic current food system
The planet as a whole	Global capitalism, globalization of FS
Traditions and civilizations	Neoliberal food regime
The understanding entire societies or regions functioning	Waves of colonization
Sub-national institutions and functional roles	Neo-liberal agriculture, policy oriented toward agroextractivism
Social relations	Master–slave relations, patronage, inequality
Individual or biographical level	Personal experiences dealing with market-oriented FS

while Southern peasants play a crucial role in challenging the dominant neoliberal food regime (Tilzey, 2020). We propose a bricolage approach, incorporating various strategies to navigate the complex journey toward achieving more sustainable FS, but from a radical perspective (Tilzey, 2024). By grounding this process in the principles of Critical Realism,¹ we aim to comprehend the root pathways of radical transformation by answering: What is needed to achieve radical FS transformation toward sustainability in the Global South?

2 The nature of radical transformations

Previous studies underscore the nonlinear nature of FS transformation by considering imbalances and the dynamic nature of power in the agricultural sector (Kok et al., 2019; Eliasson et al., 2022). According to Eliasson et al. (2022) confronting the inherent power structures across geographical scales and promoting social movements advocating for food sovereignty are important. Collective understanding and agency are also deemed crucial for creating more sustainable FS. Examining structural and agential aspects in FS transformation through the lens of Critical Realism is also important for understanding to understand the dialectics of socio-natural relations in FS (Tilzey, 2018). Following the critical realist Transformational Model of Social Activity (Bhaskar, 2008), this paper seeks to reveal the interplay between social-natural-agrarian structures and human agency as a “structured agency” (Potter and Tilzey, 2005). The approach posits that social structures influence human actions, which, through social interactions, can reproduce or transform these structures. Critical Realism provides a comprehensive framework for navigating the complexity of FS transformation through human agency, by considering material transactions with nature, social interactions, social structure, and

¹ Critical realism is a philosophical framework that seeks to understand the underlying structures and mechanisms that shape reality. It acknowledges the that our knowledge of this reality is mediated through our social context (Danermark et al., 2019). For this paper, critical realism is key because this approach seeks human emancipation by providing tools to analyze and critique existing social structures and systems of power.

individuals’ inner being (Bhaskar, 2008; Buch-Hansen and Nesterova, 2023). This wide insight into the FS posits that its essence is profoundly interconnected across these 4 dimensions. Acknowledging and actively addressing this interconnected nature enhances the potential of radical transformative initiatives to foster sustainable changes.

Since FS unfold in these four dialectically interrelated dimensions of human agency, it is essential to determine the origin of the causal mechanisms that lead to discrepancies across these four planes. This comprehension introduces even greater complexity, specifically, when considering the open and multi-scaler nature of social-natural-agrarian systems, which requires a layered explanation (Collier, 2013). According to Bhaskar and Danermark (2006), layered systems pertain to multiple levels of reality organized on a hierarchical scale. In such systems, it is possible to delineate distinct levels of agency and collectivity. Explanations within layered systems involve mechanisms at various of these levels. This involves understanding comprehensively all aspects of society and not only what and where things happen, as represented by the four-planar social being, but also exploring how and why they occur (causal mechanisms), as depicted in the multi-scalar social being (Figure 1).

While various approaches aim to provide guidance for achieving sustainability transformations in food systems, (Table 2) it is crucial to recognize that the complexity inherent in this transformation (Figure 1) requires a comprehensive perspective, and in our case, a radical one. We will navigate the intricacies discussed earlier by examining the instance of FS in the Global South.

3 A layered approach for analyzing FS transformations

The recognition that social-natural-agrarian phenomena unfold across the four dialectically interrelated planes provides a comprehensive framework for understanding FS transformations. Recognizing transactions with nature, social structures, social interactions, and deep personality enables a nuanced understanding of the scenario where mechanisms behind FS unsustainability across various scales emerge (Table 1). Therefore, the challenge is to address transformations in the myriad of scales that produce unintended and unsustainable consequences in global FS occurring in the four planes throughout multiple scales.

The structural framework enabling and constraining human agency on the four planes when analyzing contemporary FS consists of the complex state-capital nexus, which acts as the primary source of legitimation and enforcement by facilitating capital accumulation through varying degrees of mediation (Tilzey, 2020; Tilzey and Sudgen, 2024). This structure enables the intricate web of the global economy, where the world is starkly divided into dialectical imperial-peripheral relations; i.e. the Global North pressures the socio-natural systems of the Global South (Tilzey, 2020). Large-scale corporations (supported by the state-capital nexus), wielding immense power, spearhead the production and commercialization of commodities (Tilzey, 2024). The deeply rooted historical legacy of colonization lingers, perpetuating extractive activities in the agricultural sector (McKay et al., 2021; Petras and Veltmeyer, 2023). National, regional, and municipal policies, rather than nurturing local initiatives, fuel the relentless expansion of commodity cultivation (Veltmeyer and Lau, 2020). Amidst this backdrop, non market-oriented peasantry (c.f. Tilzey, 2024) find themselves marginalized, overshadowed

TABLE 2 A mini review of literature related to FS transformations.

Author	Requisites for FS transformations toward sustainability
Anderson (2015)	Sustainable food systems necessitate healthy soil, clean water, skilled farmers, secure intergenerational resource transfer and knowledge, as well as dispersed, decentralized food and energy production.
Kok et al. (2019)	Scaling agroecological practices, co-producing local knowledge in organic agriculture, fostering collaboration in technology development, and co-designing governance strategies with small-scale fisheries are key for sustainability.
El Bilali et al. (2019)	Enhancing efficiency (e.g., sustainable intensification), promoting demand restraint (e.g., sustainable diets), and transforming food systems (e.g., alternative systems) are crucial. This involves promoting healthy consumption, scaling up innovations, optimizing yield, encouraging agro-ecological practices, diversifying farms, and advocating landscape approaches in supply chains.
Dupouy and Gurinovic (2020)	Coordinated interdisciplinary changes, including nutrition-sensitive agriculture, increased investments in research and innovation, promotion of dietary change, and the shift toward circular economies. The goal is to facilitate stable and healthy diets amid the ongoing structural transformation of food and agriculture.
Ridolfi et al. (2020)	Transforming food systems is a complex process, requiring an integrated systemic approach to avoid narrow technical fixes and recognize trade-offs amid diverse challenges in achieving multiple outcomes.
Ruben et al. (2021)	Shift from food security to system resilience, combining efficient production with affordable nutrition, inclusive livelihoods, and sustainability. Improve connectivity and responsiveness, transitioning to circular food systems. Anchor governance through integrated approaches, moving beyond targeted incentives.
Fanzo et al. (2021)	Addressing diets and health, environment and climate, livelihoods and equity, governance, and resilience.
Levkoe (2021)	To foster equity and sustainability in food systems, it is essential to examine diverse factors contributing to inequity and understand how power operates across different regions, even when these issues may seem unrelated initially.
Niewolny (2022)	The key focuses encompass agroecological research, policy formulation, worker protections, intersectional food justice scholarship, narrative-led methodologies, and multi-sector coalitions challenging conventional practices.
Sonnino and Milbourne (2022)	The central themes include the socio-natural composition of place, the positive interactions and connections forming spatial identity, the social processes (including power dynamics) influencing everyday spatial practices, and the flows of ideas, materials, people, and resources transcending space.
Patay et al. (2023)	The key concepts involve the socio-natural composition of place, positive interactions shaping spatial identity, social processes influencing everyday spatial practices, and the crosscutting flows of ideas, materials, people, and resources.
Eliasson et al. (2022)	Essential elements include the Paradigm (encompassing goals, governance, information, knowledge, infrastructure, and mindset), Targets (concrete formulations and objectives), Governance (rules and power for system change), Information and Knowledge (flows, production, traceability, transparency), and Infrastructure (physical elements and connections).
Zhu et al. (2023)	The transformation paths for the food system involve establishing a globally beneficial, cleaner, and fair participatory system, enhancing innovation capabilities, and implementing an effective organizational guarantee system.

by the preeminence of corporate growers, with a surge in land grabbing and rural proletarianization exacerbating their plight (Tilzey and Sudgen, 2024). In the midst of these dynamics, plantations become arenas of conflicted experiences, where individuals navigate through a process of apprehension, particularly in the Global South (Suarez and Gwozdz, 2023). Meanwhile, in the Global North, a personal quest for healthy and trendy diets further complicates the intricate tapestry of global agricultural dynamics.

4 Toward FS sustainability

4.1 Radical transformations

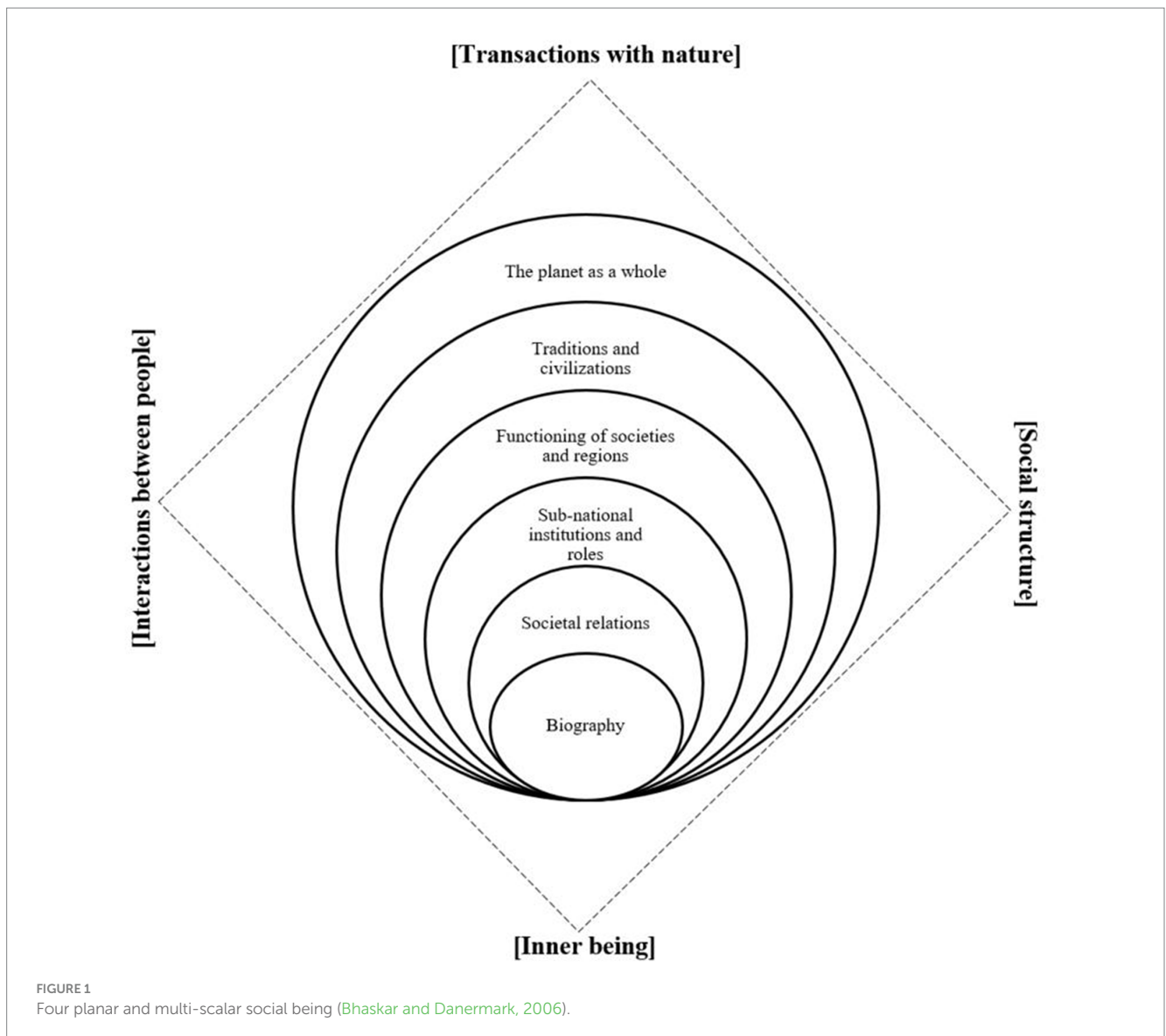
The transformations needed in the four-planar social being of current FS could be rooted in the principles of agroecology². As

underscored by Botelho et al. (2016), agroecology emerges as a strategic agenda for restructuring prevailing models of agricultural development. It has evolved into an encompassing framework for advancing FS, strategically addressing the interconnected social, economic, and environmental challenges inherent in current dominant systems (Coe and Coe, 2023). However, agroecology has undergone co-optation processes (Biel, 2016a; Walthall et al., 2024), therefore its proposal must manifest clear positionalities.

In order to outline pathways toward a radical FS transformation, our approach must be based on aspects that support such radicality. Thus, our positionality is based on a counter-hegemonic approach (Tilzey, 2016, 2024), which differs from other positions that also embrace agroecology as a transformative strategy (c.f. Tilzey, 2024). Following Tilzey (2024), we stress that FS transformations needed in the four-planar social being could be rooted in radical political agroecology. Here, reversing the causal mechanism of unsustainable

² Agroecology is the proposition that agroecosystems should strive to replicate the biodiversity and functioning of natural ecosystems. However,

agroecology suggests more than agricultural practices by including social resistance and subverting the state-capital nexus (Tilzey, 2024).



FS embodied by the state-capital nexus depends on “class struggle” acting as a structured agency that challenges both the discursive and material predicates of capitalism (Tilzey, 2016, 2018). In this sense, an important driver of transformation in the Global South is the middle and low peasantry,³ which, through processes of resistance (prioritizing use values over exchange values), can mobilize FS transformations, and prevent co-optation within existing hegemonic FS social-property relations (Tilzey, 2018).

Once this counter-hegemonic positionality is clear, we emphasize how an agroecological approach, driven by the organized efforts of the middle and low peasantry in the Global South, can facilitate significant transformations across the four dimensions of social being (Figure 1). First, at the level of social structures, the structured agency of middle and lower peasants can counteract the centralized, top-down approach

in which society and production are organized by elites through class struggle (Biel, 2016a,b). Here, the radical transformative approach must reckon not only with capitalism (social-property relations and access to land) and neoliberalism (market compulsion), also with the entire history of exploitation, particularly in FS (Biel, 2016b), which overlap with the state-capital nexus (Tilzey, 2019).

In the plane of *transactions with nature*, if ecological degradation produces class struggle (Vlachou, 2004), then class struggle can also confront the capitalist roots of current ecological threats (Shantz, 2004). One way to subvert this dynamic is by promoting agroecological principles and practices, which have shown efficacy in promoting biodiversity-based agriculture (Duru et al., 2015a,b). Beyond this, agroecology also seeks to address *social interactions*, including considerations of gender (Ume et al., 2022), liberation from oppressive relations (Bezner Kerr et al., 2019), and the enhancement of skills, knowledge, work capacity, and health. Furthermore, agroecology, as emphasized by Coe and Coe (2023), supports transitions in thought. Involving the *inner being*, refers to non-material factors intertwined with culture, values, ethics, identity, and emotions. Some authors argue that the practice of agroecology leads middle and low peasants to strengthen their religious beliefs

³ One of Tilzey’s (2024) criticisms of other approaches promoting agroecology is the lack of differentiation of the peasant class. There, Tilzey proposes low, middle and upper peasants that have different characteristics and positions in resisting the state-capital nexus.

and redefine personal relationships with the natural and social environment (Botelho et al., 2016).

4.2 Radical solutions needed

Transformation in FS requires multifaceted mechanisms (Gupta et al., 2021), particularly those challenging the current state-capital nexus (Tilzey, 2024). We explore six different radical-solutions through the lens of the multi-layered scale (Figure 1). The identified solutions are interconnected components of a comprehensive strategy for transforming FS.

First, it is important to advocate for a diversified and locally adapted FS that promotes healthier diets and involves recognizing the inherent class struggle within the current global FS (Biel, 2016a; Tilzey, 2018). This advocacy inherently challenges the dominance of capitalist interests prioritizing profit over people and planet, and encourages policies and initiatives that prioritize indigenous and sustainable food sources (Agrawal et al., 2021) and represents a form of counter-hegemonic resistance against the prevailing narrative of globalized and resource-intensive crop production, that often exploits both labor and natural resources for the benefit of capitalist elites (Biel, 2016b; Tilzey, 2024). Second, struggles for regulations and incentives to support decentralized and community-based (use-value oriented) agricultural models further disrupt the core-periphery dynamics perpetuated by capitalist exploitation, allowing low and middle peasantry to control their own means of production (Tilzey and Sudgen, 2024).

Third, addressing historical injustices through land reform policies acknowledges the legacy of colonialism and imperialism, that systematically marginalized and exploited indigenous peoples and peasants (Scheidel et al., 2024). The prioritization of sustainable agricultural practices focusing on soil health, biodiversity, and community well-being challenges the capitalist logic of endless growth and profit (Veltmeyer and Lau, 2020), and lays the groundwork for more equitable and resilient FS. Fourth, struggles for policy changes that prioritize diversified and locally driven agricultural practices amplify the voices of marginalized communities and challenge the dominance of corporate interests in shaping agricultural policies (Sargani et al., 2020).

Five, strengthening land rights for low and middle peasantry is crucial for preventing further dispossession and promoting sustainable and equitable land use (Nyantakyi-Frimpong and Bezner Kerr, 2017; Akram-Lodhi et al., 2021; McKay et al., 2021). Finally, promoting agroecological practices that integrate environmental sustainability with local dietary needs challenges the dominant paradigm of industrial agriculture (Agrawal et al., 2021), which favors monoculture and chemical inputs at the expense of environmental and human health (Biel, 2016a). Educational programs and awareness campaigns empower consumers to make informed choices supporting local and sustainable FS, thereby challenging the dominance of corporate agribusiness in shaping consumer preferences.

5 Discussion

Literature on scaling-up agroecology have reported various additional challenges. Some authors emphasize the need to recognize agroecological systems as systems in transition, and that supportive policies are required to scale up agroecology (Dumont et al., 2021).

Similarly, scaling-up agroecology requires understanding constraints at the farmer level, an agricultural knowledge system favoring mainstream approaches, adverse and intertwined political and economic interests, and cross-cutting ideological and discursive pressures (Isgren, 2016). Other aspects that requires attention are insecure land tenure and unequal access to land, unequal systems of exchange, and a culture that favors silver bullet narratives (Jiménez-Soto et al., 2024). To attain sustainable FS, it is important to explore diverse solutions while acknowledging their interconnected components. This entails embracing radical transformation through a counter-hegemonic stance (Tilzey, 2024). This approach is crucial for comprehending root problems, such as the pervasive state-capital nexus, and the development of the green revolution paradigm and its discourses (Mier y Terán Giménez Cacho et al., 2018).

Drawing on this counter hegemonic positionality, we emphasize the need to confront power structures through class struggles embedded in FS advocating for food sovereignty (Biel, 2016a; Tilzey, 2018, 2020, 2024; Tilzey and Sudgen, 2024). Such emphasis puts a spotlight on power dynamics within FS and addressing the unequal distribution of resources and the marginalization of certain groups. Recognizing power imbalances highlights the crucial role of agroecology in challenging these power dynamics through processes imbedded in class struggles, promoting fairer access to resources and inclusive decision-making processes. We expand on this narrative by highlighting the significance of social movements in fostering transformation. We argue that agroecology goes beyond ecological practices and encompasses a socio-political dimension (Biel, 2016a). Social movements advocating for food sovereignty through class struggle, align with agroecological principles by seeking to empower local communities, challenge corporate dominance, and promote participatory decision-making in food production.

6 Recommendations

Conflicted dynamics reflecting the tensions between economic motivations, health-conscious consumer trends, and environmental sustainability. These tensions underscore the complexities inherent in transforming FS, highlighting the need for a comprehensive approach. This perspective paper contributes to the broader literature on food systems' transformation by providing guidelines rooted in Critical Realism and the four-planar and multi-scalar social being framework. By acknowledging the interplay between social-natural-agrarian structures and human agency as a structured agency (Potter and Tilzey, 2005), our proposal provides a theoretical foundation for navigating the intricate journey toward sustainable food systems.

In this vein, and acknowledging the transformative role of the peasantry in the Global South due to their dynamics of constant resistance and social reproduction (prioritization of use values over exchange values), we offer recommendations that must necessarily be grounded in a dialectical process. Through class struggle and the subversion of center-periphery dynamics, this process enables the construction of pathways that contribute to more sustainable FS.

- Promote Agroecological Principles: building on the agroecological framework discussed, advocate for adopting practices that integrate environmental sustainability with local and global food needs.

- Advocate for Local Empowerment through Policy Reforms: extend the paper's call for policy changes to various governance levels, prioritizing diversified and locally driven agricultural practices, thus empowering low and middle peasantry.
- Secure Land Rights for Sustainable Agriculture: addressing historical injustices, champion strengthened land rights for local communities, countering land grabbing and dispossession, and rectifying past exploitation.
- Challenge Corporate Dominance in Agriculture: corresponding to the paper's recommendations, lobby for regulations favoring decentralized agricultural models, ensuring fair profit distribution, and implementing policies that prioritize local farmers over large corporations.
- Foster Global Collaboration for Dietary Sustainability: engaging in efforts to counter pressures from the global North's push for resources. Advocate for policies prioritizing indigenous and sustainable FS, thus fostering a global shift in dietary habits and challenging the core-periphery logics.

Collective efforts identify and address potential weaknesses in the proposed approach is essential. One concern is the feasibility of implementing recommended strategies across diverse socio-political regimes. While advocating for agroecological principles and local empowerment through policy reforms is crucial, future research should delve deeper into challenges such as resistance from entrenched interests, bureaucratic hurdles, and the need for substantial financial and technical support to facilitate meaningful change.

Considering the long-term sustainability and scalability of proposed solutions is crucial, given factors like the state/capital nexus, market changes and climate variability. Future research should investigate these aspects to ensure effectiveness. Additionally, exploring unintended consequences of challenging neoliberal dominance in agriculture is essential, requiring careful consideration of supply chain disruptions and socio-economic impacts. Through empirical research, valuable insights can enhance the proposed approach's robustness and applicability.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix section

1 Case study protocol

Conceptual research question	
<i>Why are Hass avocado plantations expanding and transforming the socio-natural dynamics in Salamina, Caldas?</i>	
Objectives	Empirical questions
To characterize the implications promoted by large-scale avocado growers on rural population	What are the implications of the expansion of Hass plantations in Colombia?
To describe how plantations expand in Salamina	How do Hass plantations in a Colombian case study reflect a complex assemblage of socio-political, economic, and material factors that make land a source of large-scale exploitation?

2

3 This research followed a multi-scale approach to the empirical work. It considered a micro level (farmers),

4 a meso level (neighborhood) and a macro level (the municipality, department and national level) analysis.

5 This was proposed due to the perspectives and implications of large-scale avocado growing are

6 differentiated among who is directly affected, who produces the change, and who supports since policy or

7 if the productions are socially supported too. The data was collected at different times and at different

8 levels. First of all, it is important to mention the sources of information. The sources were primary

9 information (different actors) in the area and secondary information.

Overarching research question	RQ. Why are Hass avocado plantations expanding and transforming the socio-natural dynamics in Salamina, Caldas?				
Philosophical standpoint	Critical Realism				
Methodological approach	Mixed methods approach				
In-field research strategy	Explanatory single-case study				
Temporality	Cross-sectional				
Sub-research questions	Scale	Source	Data type	Methods	Taxonomy
RQ ₂ . What are the implications of the expansion of Hass plantations in Salamina, Caldas, Colombia?	Local/Northern	Regional	Quantitative	Review of secondary sources of information	Sec_Sources
	Caldas, Salamina	agricultural statistics	e		es
		Regional, local	Policies	Qualitative	
		Dataset on complaints and sanctions (local)	Qualitative		Sec_Sources
Taxonomy: Equal-status convergent design					
Mixed = Sec_Sources + Sec_Sources + Sec_Sources					
RQ ₃ . How do Hass plantations in a Colombian case study reflect a complex assemblage of socio-political, economic, and material factors that make land a source of large-scale exploitation?	Local/Northern	Regional	Quantitative	Review of secondary sources of information	Sec_Sources
	Caldas, Salamina	agricultural statistics	e		es

Regional statistics on land and environment	Quantitative		Sec_Sources
Regional, local Policies	Qualitative		Sec_Sources
Local inhabitants, representatives of public agencies,	Qualitative	Context-interviews	Inter

Taxonomy: Equal-status convergent design
Mixed = Sec_Sources + Sec_Sources +
Sec_Sources + Inter

10

11 Secondary information

12 The secondary information was acquired through the next sources:

Level	Information	Source
National	Policies and norms related to agriculture development (production, chain, exports, incentives, and so on), and strategies for promoting avocado growing	DNP- National development plan (last 2 or 3) MARD CorpoHass Sectorial plans
	Policies and norms related to the environmental dimension of agriculture	MADS Sectorial plans
Regional	-Policies, norms and acts related to the environmental dimension of agriculture. It include sanctions, strategies and incentives. -Society complains	Environmental authority
	Policies and norms related to agriculture development (production, chain, incentives, and so on), and strategies for promoting avocado growing	Gobernación de Caldas Sectorial plan
Local	-Policies and norms related to agriculture development (production, chain, incentives, and so on), and strategies for promoting avocado growing -Society complains	Alcaldía of the selected municipality Sectorial plans

13

14 Semi-structured interview (Context interviews)

15 It was performed semi-structured interviews in order to gather context and identify the trajectories of
16 avocado settlement. The people were representatives of:

Interviews	Interviewees	Description	Procedure
Env_rep_1	Public servants from the regional environmental authority	Specialized professional with functions related to avocado.	Visit to the regional offices to know the environmental context of HAP.
Env_rep_2		Specialized professional with functions related to social dimension in environmental management.	On-line interview.

Regional_rep	Public servant from the regional administration	Representative of the secretary of agriculture at regional level	Visit to the regional offices to know the productive context of HAP.
Local_rep	Local Hass avocado producer	Representative of small-scale avocado producers.	
Env_consult	Environmental consultant	Person that has been working in environmental advisory for Hass avocado companies.	Face-to-face interview in Salamina's urban area.
Local_hist	Local historian	Person which has knowledge of Salamina's history, who is part of a collective of people who works offering services of guiding people on local history.	
Ex_worker	Ex-HAP worker	Local ex-worker in an avocado company.	Face-to-face interview in Salamina's urban area.
Ex_owner_1	Former Salamina's farmers	People who sold their lands to avocado growers.	
Ex_owner_2			
Company_A	Large-scale companies	National or international companies are present in Salamina.	Telephonic interview to know: year of arriving, area, # employees, reason for being in Salamina.
Company_B			
Company_C			
Company_D			

17

18 The next questions were applied

- 19
- How and when was the process of introducing your company in the municipality and why did you find it attractive?
- 20
- What restrictions or facilities have you found for the development of your productive activity?
- 21
- How avocado cultivation does relates to nature?
- 22
- How do you think your activity should be to prevent or control possible social and environmental impacts in the area?
- 23
- What restrictions or facilities have you found for the development of your productive activity?
- 24
- 25

26 Semi-structured in-depth interview

First round interview		
Domain-type inquiry	Phases	Interview Question
Empirical		
(1) The process	Structural elaboration-access	¿Cómo cree usted que es (se comporta) el cultivo de aguacate en relación con aspectos sociales (acceso a apoyo organizaciones), económicos (acceso al mercado) y ambientales (acceso a la naturaleza) en su predio? How do you think avocado cultivation is (behaves) in relation to social (access to support organizations), economic (access to market) and environmental (access to nature) aspects in your plot?
(3) The experience	Interactions-sensitivity	¿Cómo se relaciona/interactúa usted con los productores de las aguacateras? How do you relate/interact with avocado growers? ¿Cómo se ve afectado usted (es) y/o su actividad por la producción de aguacate? How are you (ours) and/or your activity affected by avocado growing?

(5) The pre-existing conditions to act	Structural conditioning-exposure	¿De qué manera la escala/forma del cultivo de aguacate ha forzado cambios en sus actividades productivas, personales/familiares/ de acceso a la naturaleza? How has the scale/shape of avocado cultivation forced changes in your productive, personal/family/ access to nature activities?
Real		
(2) The driver	Structural elaboration-exposure	¿Quién (es) cree que son los responsables de los cambios (positivos/negativos) que ha experimentado y por qué? ¿Solo las aguacateras? Who(s) do you think are responsible for the changes (positive/negative) you have experienced and why? ¿Qué clase de influencia cree que ejercen esos actores? What kind of influence do you think these actors exert?
(4) The agency	Interactions-adaptive	¿Está conforme con lo que está pasando, o le gustaría cambiar/transformar/mejorar/detener los cambios que están sucediendo en el área? How would you like to change/transform/improve/stop the changes that are happening in the area?
(6) The causal powers	Structural conditioning-exposure	¿Podría describir los aspectos políticos, normativos, culturales, ambientales o económicos que crea usted que hayan permitido que ese cambio/impacto generado por las aguacateras se haya producido? Could you describe the political, regulatory, cultural, environmental or economic aspects that you consider have allowed this change/impact generated by the avocado plantations to take place?

27

28 Analytical framework

Step	Description
Abstraction	Selection of the constitutive and structural elements that supports the inequality.
Observation/description	Complete description of the results generated in each method applied. It will be needed the description of the context, agents, interventions and results. Here, it will be provided the first approach to generative mechanisms.
Division and sorting	Division of the empirical data in smaller units. Use of categories involving the mixed results provided by all the methods.
Abduction/redescription/theoretical reinterpretation	Reinterpretation of the categories and results in more abstract models and understandings according to the theoretical framework description. After this, it will be needed the formulation of tentative mechanisms that will be the theoretical basis for the next step.
Retroduction	Identify and describe the generative mechanism that can explain a phenomenon. Inference process that lead to answer transfactual question such as: <ul style="list-style-type: none"> • What is fundamentally constitutive for the structures and relations (X) that are studied? • How is X possible? • What properties must exist for X to be what X is? • What causal mechanisms are related to X?

29

30 Ethical statements

31 a. Consent for questionnaires

Purpose: The purpose of this protocol is to inform you about the research project and to request your consent. If you agree, the investigator will keep a copy of this document, and you will have a signed by the researcher copy too.

Scope: The present research is entitled "*Understanding the ecosystem services inequality produced by large-scale avocado growing in northern Caldas, Colombia*". Andres Suarez, Ph.D. student at the Justus Liebig University Giessen directs this project. The purpose of the research is to understand the implications both social, economic and environmental of large-scale avocado production in the northern region from Caldas.

Process: To do so, you are asked to participate in a survey that will take xxx minutes of your time. Your participation in the research is voluntary and you may decide to discontinue it at any time, without any harm to you. If you have any questions about the research, you are welcome to ask them at your convenience.

Your identity will be treated anonymously, i.e., the researcher will not know the identity of the person who completed the survey.

In addition, your information will be analyzed and will be used for the elaboration of articles and academic presentations.

The information will be kept for xxx years, counted from the publication of the results, in the personal computer of the researcher responsible, which can also be accessed by his or her research group.

If you agree with the above, please mark the following box:

I agree (Participant):

Date: ____/____/____

Sign of the researcher: _____

32

33 b. Consent for interviewed people

Purpose: The purpose of this protocol is to inform you about the research project and to request your consent. If you agree, the investigator will keep a copy of this document, and you will have a signed by

the researcher copy too.

Scope: The present research is entitled " *Understanding the ecosystem services inequality produced by large-scale avocado growing in northern Caldas, Colombia*". Andres Suarez, Ph.D. student at the Justus Liebig University Giessen directs this project. The purpose of the research is to understand the implications both social, economic and environmental of large-scale avocado production in the northern region from Caldas.

Process: To do so, you are asked to participate in an interview that will take **xxx** minutes of your time. Your participation in the research is voluntary and you may decide to discontinue it at any time, without any harm to you. If you have any questions about the research, you are welcome to ask them at your convenience.

Your identity will be treated anonymously, i.e., the researcher will not know the identity of the person who completed the survey.

In addition, your information will be analyzed and will be used for the elaboration of articles and academic presentations.

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If you agree with the above, please mark the following box:

I agree (Participant):

Date: ____/____/____

Sign of the researcher: _____



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ACTA No. 146 COMITÉ DE ÉTICA

El día DIECIOCHO DE JUNIO 2023. Se citó de manera virtual el Comité de Ética de la Universidad de la Costa para discutir los aspectos relacionados a los proyectos que más adelante se identifican las siguientes personas:

EDUARDO CRISSIEN BORRERO	RECTOR
HENRY ALFONSO MAURY ARDILA	VICERRECTOR DE CIENCIA, TECNOLOGÍA E INNOVACIÓN
NATALIA GONZALEZ AUQUE	JEFE DE PROPIEDAD INTELECTUAL
DIANA PINTO OSORIO	DECANA DE DEPARTAMENTO DE CIVIL Y AMBIENTAL

Los tres primeros quienes asisten en su calidad de miembros permanentes del comité ética y el último en su calidad de miembro no permanente llamado como experto técnico en el asunto a tratar en el presente comité de ética, los suscritos atendieron la convocatoria en donde se propuso el siguiente orden del día:

1. Análisis y Discusión del proyecto de investigación **“Addressing the ecosystem services inequality produced by large-scale avocado growing in northern Caldas, Colombia.”** Presentado por el investigador principal: Andres Suarez
2. Aprobación de los proyectos de investigación señalados en el numeral 1.
3. Decisión final del comité sobre el proyecto de investigación señalado en el numeral 1.

El cual procedió a desarrollarse como se relaciona a continuación:

1. Análisis y Discusión del proyecto de investigación **“Addressing the ecosystem services inequality produced by large-scale avocado growing in northern Caldas, Colombia.”**

Este proyecto tiene como objetivo general comprender los mecanismos que generan implicaciones negativas debido al cultivo de aguacate a gran escala en el norte de Caldas, Colombia.

El cultivo de aguacate a gran escala produce trastornos socioecológicos porque los monocultivos afectan la estructura ecológica de la tierra (capital natural) y su capacidad para proporcionar Servicios Ecosistémicos. En este sentido, esta investigación -siguiendo una filosofía realista crítica-, busca acercarse a esta afirmación a través de una profunda comprensión ontológica de la realidad, para analizar esto, la estrategia de investigación será un estudio de caso, y se seguirá metodológicamente un diseño de métodos mixtos. Con esta investigación, el resultado esperado más importante es la identificación del mecanismo causal que genera las implicaciones negativas debido al cultivo de aguacate a gran escala en el norte de Caldas, Colombia.

Realizó: Andrea Dávila Mojica
Aprobó: Natalia González Auque

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Nit: 890104530-9

2. Aprobación del proyecto de investigación **“Addressing the ecosystem services inequality produced by large-scale avocado growing in northern Caldas, Colombia.”**

Luego de revisado y discutida la propuesta de investigación es aprobada por unanimidad por los miembros del Comité de Ética.

Expuesto lo anterior y siendo las 2:30 p.m. se levanta la sesión. Se firma por los asistentes y quien levanta la presente acta en la ciudad de Barranquilla, el día DIECIOCHO DE JUNIO DE 2023.

EDUARDO CRISSIEN BORRERO
RECTOR

HENRY MAURY ARDILA
SECRETARIO DEL COMITÉ DE ÉTICA
VICERRECTOR DE CIENCIA, TECNOLOGIA E
INNOVACION

DIANA PINTO OSORIO
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