

Governance for Adoption of Agroecological Practices in Hass Avocado Production:

Case study of San Vicente de Ferrer, Colombia.



Figure 1 Avocado plantation in San Vicente de Ferrer, Colombia. July 2022.

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Summary

Conventional avocado production has had an impact on Colombia's environmental dynamics, such as soil degradation, water pollution and loss of biodiversity, and socioeconomic dynamics, such as threats to the livelihood of small-scale farmers and threats to food security. Agroecological avocado production offers a more sustainable alternative to address the environmental and socioeconomic challenges, but its uptake thus far is limited. It is then important to understand in more detail what is impeding and what can stimulate avocado farmers to adopt agroecological practices in avocado production. Theory suggests that there are four key conditions -*ability, motivation, demand & legitimacy*- necessary for farmers to adopt agroecological practices, which are influenced by *economic, social, informational and political factors*, which stimulate or impeded the presences of the four conditions. Governance arrangements then influence these factors, through strategies that (in)directly affect the promotion and support of agroecological practices. Several actors participate in these arrangements, such as international actors, national and regional governments, non-governmental organizations, private actors, and farmers. Thus, this research aims to answer the question of *how can governance arrangements stimulate the conditions for adoption of agroecological practices in avocado production?*

The research was designed as a most similar, single-case study with two embedded sub-cases, namely associated and independent farmers, in the municipality of San Vicente de Ferrer, Colombia, the biggest producer of Hass avocado in the Antioquia region. Data was gathered through semi-structured interviews. The results show that, in this context, farmers are generally motivated to adopt agroecological practices, but there are barriers that hinder their abilities, especially for independent farmers. Moreover, factors such as lack of trust in the government (legitimacy), lack of pressure from -local- markets and government to adopt agroecological practices (demand) and community support in the case of independent farmers (ability and motivation), need to be addressed to have all the conditions. Current governance arrangements are aimed at addressing economic availability through subsidy schemes and credits for farmers, and informational factors by providing training on sustainable farming practices. Nevertheless, they are insufficient addressing factors as corruption, trust and community building, which are key factors to increase the uptake of agroecological avocado practices. **Key concepts:** governance arrangements, influencing factors, conditions for adoption, agroecology.

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1. Introduction

1.1. Introduction to Sustainability Issue

1.1.1. Sustainability Impacts of Avocado Production

The increasing popularity of avocados in recent years has had several impacts on the environment, society, and the economy in many countries (Sommaruga and Eldridge, 2020). According to data from the Food and Agriculture Organization, worldwide the demand for the variety Hass of avocado (*Persea Americana*) is increasing and its production has doubled between 2010 and 2019 (FAO, 2021a). While consuming avocados offers health benefits such as boosting the immune system and providing dietary fibre (Stephen & Radhakrishnan, 2022; Bhore et al., 2021), the conventional methods for production of this fruit are associated with various negative environmental and socio-economic impacts (Sommaruga and Eldridge, 2020). Conventional avocado production, characterized by its use of synthetic fertilizers, pesticides, monoculture practices, water-intensive irrigation systems, and energy-intensive machinery (Sommaruga and Eldridge, 2020; Denvir et al., 2022), poses significant environmental and socioeconomic challenges.

Negative *environmental* impacts include, to an equally important extent, soil and water depletion and pollution (Sommaruga and Eldridge, 2020), exacerbating freshwater scarcity issues that have arisen since the green revolution and impacting both food production and daily life (Falkenmark, 2013). In Michoacan, Mexico, for instance, approximately 80% of groundwater is allocated to avocado irrigation, leading to local resource competition (Bhore et al., 2021). Additionally, deforestation, particularly in Michoacán, where 23% of forests have vanished in under 30 years due to avocado demand (Bhore et al., 2021), further exacerbates environmental degradation, replacing native species with Hass avocado plantations (Sommaruga and Eldridge, 2020; Bhore, et al., 2021; Denvir, et al., 2022).

Conventional avocado production also comes with *socioeconomic* impacts. Sommaruga and Eldridge (2020) mention that, because of the export-based production of Hass avocado, domestic food security is threatened. In Colombia, the livelihood of pre-existing small farmers is being threatened by the government's policies aimed at increasing export of Hass avocado (Serrano and Brooks, 2019). Nevertheless, Hass avocado is increasingly gaining track as one of the most lucrative crops to farm, bringing wealth and job opportunities to a selected few in

the region where avocado is being produced (Sommaruga and Eldridge, 2020; Denvir, et al., 2022). Furthermore, in Mexico, the involvement of narcotraffic groups in the production of avocado for profiting, has increased the poor working conditions, economic inequality and exacerbated armed conflict. (Denvir et al., 2022).

1.1.2. Agroecological Practices to Address Impacts of Avocado Production

To tackle the negative impacts of conventional avocado farming, exploring alternative agricultural practices is crucial. Sustainable alternatives to avocado production can help decrease negative environmental impacts by prioritizing the use of natural resources and ecosystem services in the production, over synthetic fertilizers, and pesticides (DeLonge, et al., 2016). There are advantages of more sustainable farming practices in avocado production, having benefits such as soil fertility, mitigation of climate change effects, and improving biodiversity (Sommaruga and Eldridge, 2020; Bhore et al., 2021; Denvir et al., 2022). Nevertheless, practices like organic agriculture do not account for socioeconomic issues (Oberč and Schnell, 2020) that arise from avocado production, opening an opportunity for other alternative agricultural practices, such as agroecology.

Agroecology is defined as a holistic practice that encompasses ecological processes, ecosystem services *and* socioeconomic aspects of the food system (Gliessman, 2018; Wezel et al., 2014). Transdisciplinary approaches such as agroecology are important to address the environmental and socioeconomic challenges of conventional Hass avocado production. Agroecology, depending on the context, can help with issues such as soil and water pollution, income and labour (Mouratiadou et al., 2024), encompassing the different dimensions of challenges posed by avocado production.

1.1.3. Problematizing the Adoption of Agroecological Practices for Avocado Production.

Despite the numerous benefits of adopting agroecological practices, the process of adopting new farming practices can be challenging. Adopting new farming practices is challenging for farmers due to several barriers. Economic constraints, such as high initial costs and financial risks, make farmers cautious (Pannell, 1999; Pannell et al, 2006; Lubell, Hillis and Hoffman, 2011; Pannell, Llewellyn and Corbeels, 2014; Schoonhoven and Runhaar, 2018). Lack of knowledge and technical skills, coupled with strong ties to conventional methods and community influence, further impede change (Isgren, 2016; Lalani et al., 2016; Mees et al, 2014). Inadequate access to resources and infrastructure, insufficient regulatory support, and

weak extension services also pose significant barriers (Isgren, 2016; Carlisle, 2016; Serrano and Brooks, 2019). Lack of social pressure, support and cultural norms and values (Lalani et al., 2016; Carlisle, 2016; Isgren, 2016; Schoonhoven and Runhaar, 2018; Teixeira et al, 2018) also add to the difficulties.

Several conditions are thus necessary for farmers to adopt agroecological practices (Therond et al. 2017; Runhaar et al. 2017). These include intrinsic and extrinsic *motivations* of farmers, their *ability* to adopt agroecology, market/government/society *demand*, and the *legitimacy* of agroecological practices in regulatory and social contexts (Runhaar et al., 2017). The presence of these conditions is crucial for fostering a supportive environment conducive to the adoption of sustainable farming methods. The conditions for adopting agroecological practices are influenced by a range of factors (Schoonhoven and Runhaar, 2018). These include: *economic* factors, such as availability of resources (Saltiel, Bauder, & Palakovich, 2010; Schoonhoven and Runhaar, 2018; Teixeira, 2020); *social* factors, such as community support (Lalani et al, 2016; Knowler and Bradshaw, 2007; Sayadi, Calatrava Requena & Guirado Sánchez, 2005); *informational* factors, such as knowledge of practices and regulations (Isgren, 2016; Lalani et al., 2016; Mees et al, 2014); and *political* factors, such as available subsidies and policies (Isgren, 2016; Carlisle, 2016). Understanding these factors and their dynamics is essential for developing effective environmental governance strategies that incentivize and support the conditions for adoption of agroecological practices (Runhaar et al., 2017; Schoonhoven and Runhaar, 2018; Melchior and Newig, 2021).

1.1.4. Governing the Adoption of Agroecological Practices

Environmental governance encompasses deliberate measures aimed at preventing, reducing, or mitigating harmful impacts on the environment (Driessen et al., 2012). Furthermore, governance can be described in terms of arrangements, defined as the efforts to steer actors towards more sustainable behaviours (Runhaar et al., 2017), which in the context of this research are aimed at promoting and supporting agroecology. Governance arrangements are thus crucial for the adoption of agroecological practices (Runhaar et al., 2017). These arrangements influence economic, social, informational, and political factors, which are integral to provide the conditions necessary to adopt agroecological practices (Schoonhoven and Runhaar, 2018; Runhaar et al., 2017). These arrangements are needed, because the market alone often fails to address the challenges and incentivize the adoption of agroecological practices due to inherent market failures such as externalities, high initial costs, and uncertain

returns (Piñeiro et al., 2020). By shaping policies, regulations, incentives, strategies and infrastructure development, governance arrangements create an enabling environment that encourages farmers to adopt agroecological practices.

Developing effective governance arrangements is crucial for the widespread adoption of agroecological practices (Runhaar et al., 2017) in avocado production. Strong governance can incentivize farmers towards the adoption of more sustainable farming methods, provide technical assistance and financial support, and coordinate collective action (Piñeiro et al., 2020; Melchior and Newig, 2021). Inclusive governance that engages diverse actors, from small-scale producers to policymakers, can help align interests and build legitimacy around agroecological approaches (Melchior and Newig, 2021). Thus, by having effective governance arrangements, challenges encountered through the different factors can be addressed, providing farmers with the conditions necessary to adopt agroecological practices.

1.2. Knowledge Gap, Aim and Research Questions.

Academic literature on avocado production is on the rise, considering the increased demand of this fruit in the last two decades, resulting in several environmental and socioeconomic issues, as previously discussed. One can find literature about the taxonomy and diseases of avocado and how it affects its production, the health benefits avocado has on humans and the potential avocado has to become a key ingredient in beauty products (Bhore et al., 2021). In the sustainability realm, literature on avocado production has taken a significant role, especially in the region of Michoacán, Mexico, where most research on the socioeconomic and environmental impacts of avocado production has been done (Sommaruga and Eldridge, 2020; Bhore et al., 2021; Denvir et al., 2022). Nevertheless, context is crucial when developing agricultural solutions for the environmental and socioeconomic challenges posed by avocado production (Oberč and Schnell, 2020; Duru et al., 2015; Mouratiadou et al., 2024). Economic, social, informational, and political factors all vary depending on the specific context (Sayadi, Calatrava Requena & Guirado Sánchez, 2005; Denvir et al., 2022). Thus, it is important to look at other countries in the region that are gaining importance in the avocado production industry, which could be influenced in their initial stages to adopt sustainable agricultural practices to mitigate the negative impacts of avocado production.

Sommaruga and Eldridge (2020) and Denvir et al. (2022) have recommended the implementation of more sustainable practices in avocado farming to reduce its environmental and socioeconomic impacts. However, there is a lack of research explicitly linking agroecology

and avocado production and what factors are influencing the conditions needed to have adoption of agroecology in this context. The lack of research on these factors hinders the understanding of the food system as a whole and neglects the importance of contextual factors that affect the adoption of agroecological practices. While there is research on the factors that influence the conditions necessary for the adoption of agroecological practices in European countries (Runhaar, et al. 2016; Schoonhoven and Runhaar, 2018), context matters when talking about adoption of agroecology (Oberč and Schnell, 2020; Duru et al., 2015; Mouratiadou et al., 2024), leaving an interesting gap for research, particularly for Latin American countries, where Hass avocado is mainly produced, and the political, social and economic factors play a significant role in agricultural practices.

The aim of the research is to fill these gaps by first exploring what factors are influencing the conditions needed for adoption of agroecological farming practices in Hass avocado production in Colombia. And secondly, by analysing the different governance arrangements that currently influence these factors, uncovering the current dynamics around agricultural practices in avocado production. To achieve this, the following research question is presented, to guide the research and give recommendations regarding governance for the adoption of agroecological practices in Hass avocado production in Colombia.

Central Research question: how can governance arrangements stimulate the conditions for adoption of agroecological practices in avocado production?

To answer this question, it is important to first explore which conditions are present and what factors are influencing them. Furthermore, knowing what is out there in terms of governance arrangements aimed at adoption of agroecological practices, and who is governing them is key. By knowing this, a conclusion can be made in terms of how to strengthen current governance arrangements, in this context, for the factors to have a positive influence over the conditions, to ultimately enhance farmers' opportunities to adopt agroecological practices in avocado production. Thus, the following sub-questions are formulated:

1. To what extent are the conditions necessary for adoption of agroecological practices present in the case study?
2. What are the factors that influence these conditions in the case study?
3. What factors would needed to be addressed in order to meet all the conditions necessary for the adoption of agroecological practices in the production of Hass avocado in the case study?

4. To what extent and how are factors influenced or created by current governance arrangements?
5. What changes in existing/new governance arrangements are needed to ensure the positive influence of all factors to provide the conditions necessary for adoption of agroecological practices?

1.3. Scientific and Societal Relevance

Researching the conditions necessary for the adoption of agroecology in avocado production holds scientific relevance for several reasons. Firstly, it contributes to the understanding of how agroecological principles can be effectively applied in specific agricultural contexts, shedding light on the factors that facilitate or hinder adoption (Runhaar et al., 2017; Schoonhoven and Runhaar, 2018). It is expected that the factors will interact differently in this case study due to the context, as compared to the context (Spain) and crop (almonds) in which the framework was originally developed. For example, regulations on agriculture tend to be less strict in Latin American countries (Conte Grand, Schulz-Antipa and Rozenberg, 2024; Gutiérrez Rodríguez, 2015; Schrank, 2013; Nivia and Perfecto, 2009). Secondly, it contributes to governance literature by exploring how governance arrangements influence economic, social, informational and political factors, and how these shape the provision of the conditions for adoption of agroecological practices in the specific context of avocado production, which was not previously done.

The societal relevance of researching the conditions necessary for the adoption of agroecology in avocado production is profound. Firstly, it addresses pressing concerns related to environmental sustainability and food security, by exploring alternative farming practices that reduce reliance on synthetic inputs and promote ecological balance. By fostering more sustainable avocado production methods, this research has the potential to mitigate environmental degradation, preserve natural resources, and safeguard the health of ecosystems, which benefits society at large. Moreover, understanding the socioeconomic factors that influence the adoption of agroecological practices in avocado production can contribute to building more fair and resilient food systems. By empowering farmers, especially small-scale producers, to adopt agroecological approaches, this research promotes socioeconomic development, enhances livelihoods, and fosters community resilience. Additionally, by prioritizing inclusive approaches, this research can promote social cohesion, empower marginalized communities, and contribute to more just and fair food systems.

1.4. Geographical Focus of the Research

This research focuses on the geographical area of San Vicente de Ferrer, in the department of Antioquia in Colombia (figure 2). The motivation behind this is the growing environmental and socioeconomic challenges due to the growing uptake of avocado production in the region in the past decade (Álvarez Vélez & Monsalve, 2019; Quiceno Rico et al., 2020). This location has a long agricultural history, with crops going from potatoes, beans, corn, fruits, and a lead producer of furcraea, a plant that is used to produce natural fiber (or *Cabuya*). In the past two decades, avocado production has been growing exponentially in this location (Álvarez Vélez & Monsalve, 2019). Nevertheless, the production is still very local, and only a few big producers have entered the municipality (Álvarez Vélez & Monsalve, 2019). Despite being a relatively new player in the global avocado market, San Vicente de Ferrer is experiencing rapid growth in its production, which is exacerbating soil degradation from the past production of furcraea, threatening native forests and water resources, and disrupting the overall ecosystem and food supply, making it an interesting case study.



Figure 2 Map of the municipality of San Vicente, Antioquia. Adapted from Milenioscuro (2010), CC BY-SA 3.0.

The area is of interest for this research also because there are several governance arrangements, such as the *Agro Antioquia exporta 4.0* program, actively pushing for intensification of the production of avocado, but at the same time calling for the adoption of sustainable farming practices due to the environmental and socioeconomic impacts of conventional agriculture. Moreover, this municipality is the location of the “associative Buffer Zone”, a requirement for each region of Colombia to be able to enter the North American and Chinese market. This buffer zone puts this location at the centre of attention of different actors involved in agricultural practices for avocado production. This can have the potential to transform avocado production to be more sustainable, or become even more intensive, due to the high demand of Hass avocado internationally (Sánchez Garzón, 2021).



Figure 3 Hass Avocado farm, with intercropping of oranges and arracacha.

2. Theoretical Framework

In this chapter the theoretical foundations for this research will be discussed. This section is structured as followed: First, agroecology will be defined, employing scientific literature. This with the aim of generating a comprehensive definition that will fit the context of the case study. Second, the conditions for adoption of agroecological practices will be discussed. Here the subject of conditions needed for adoption of agroecological practices, and its influencing factors will be talked about. This will be based on Runhaar et al. (2017) for the conditions and Schoonhoven and Runhaar (2018) for the factors influencing these conditions. These concepts will be then used in the results section to answer the sub-questions proposed. Finally, this chapter will close by talking about governance arrangements, their characteristics, and how can they support the adoption of agroecological practices. This will be based on the modes of governance framework developed by Driessen et al. (2012). This last step is crucial for understanding the current governance arrangements aimed at agroecological adoption and will be used to answer sub-questions 4 and 5, finally providing an answer to the main research question.

2.1. Sustainable Farming Practices: Agroecology

Faced with the current goals of increasing food production while minimizing environmental impacts, researchers are delving on the various approaches to more sustainable agriculture. Two main options include *technology-based* practices and *ecology-based* practices (Wezel et al., 2014). For instance, genetic modification of organisms (GMOs) could address the demand for food, and biological control of pests could decrease the use of pesticides (Wezel, et al., 2014). Industrial agriculture has short-term benefits increasing crop yield and productivity of labour (Therond, et al., 2017). Nevertheless, Therond et al. (2017) mentions that this type of agriculture, although popular, creates harmful long-term impacts on the different ecosystem services, which are ultimately key for agriculture. Conventional agriculture is the norm for Hass avocado production, with intense usage of synthetic fertilizers and pesticides, in order to supply an ever-growing demand for the fruit (Sommaruga and Eldridge, 2020; Bhore et al., 2021; Denvir et al., 2022; Serrano and Brooks, 2019). Nevertheless, environmental changes and socioeconomic challenges have prompted researchers and the agroindustry to seek alternative, more sustainable farming practices (Sommaruga and Eldridge, 2020; Denvir et al., 2022).

Going beyond technical fixes for sustainable agriculture, agroecology can be a suitable alternative to tackle the challenges presented by avocado production. Agroecological practices are techniques, which have been around for a long time but were renamed during the agroecological movement in the 1980s (Wezel, et al., 2014). Francis et al., (2003) defined agroecology as “the integrative study of the ecology of the entire food system” (p. 100). Moreover, the definition of agroecology by Wezel et al. (2014) involves employing techniques that prioritize the production of substantial quantities of food while also acknowledging and safeguarding the environment's worth and ecosystem services as an integral aspect of agriculture. Rather than relying on conventional farming techniques, such as chemical fertilizers and pesticides, agroecology harnesses nature to its advantage. Diversification is an essential technique in the implementation of agroecology, involving the integration of various crops into the system or utilizing natural biodiversity for agricultural purposes (Wezel, et al., 2014). Moreover, combining traditional crop and animal farming can enhance productivity through improved farm organization, efficient use of labour, and local resources (Altieri, 1999; Tomich, et al., 2011; Oberč and Schnell, 2020; Mouratiadou, et al., 2024).

It is crucial to also understand what agroecology does *not* entail. Therond et al. (2017) mentioned that agroecology does not involve elements linked to "industrial agriculture," which differs from agroecology in terms of their utilization and effects of nitrogen, phosphorous, and pesticides, irrigation and water shortage, tillage, bare soil and soil depletion, dependence on fossil fuels and climate implications, specialization in farming systems, landscape simplification, and reduction in biodiversity.

Moreover, agroecology can be confused with nature-inclusive agriculture, organic farming, and regenerative agriculture. While there are overlaps between them, each approach has its unique focus. Agroecology is more broadly concerned with ecological principles in agriculture, including diversified farming systems (Oberč and Schnell, 2020), and encompasses more social interactions and community building (Giraldo and Rosset, 2019). Nature-inclusive agriculture places a particular emphasis on enhancing biodiversity at a landscape scale (Oberč and Schnell, 2020; Vermunt et al., 2022). Organic farming, while also valuing ecological principles, is characterized by the avoidance of synthetic inputs and adherence to specific organic standards (Oberč and Schnell, 2020; Vermunt et al., 2022). Regenerative agriculture, although also concerned with social and economic dimensions of sustainable food production, it uses soil conservation as its main point to address ecosystem challenges (Schreefel, et al., 2020). The four approaches often share the common goal of promoting sustainable and environmentally

friendly agricultural practices and are good alternatives to conventional farming practices. Nevertheless, agroecology includes socioeconomic factors and a holistic view on the ecosystem, making it the most suited practice to address all the challenges that avocado production has.

Agroecology goes beyond the quick fixes. It is a multidisciplinary study, which also looks at the socioeconomic implications of food production, making it an attractive practice, as it enables us to look closer at the structure and processes at every level of the food system (Francis et al., 2003). As Bezner Kerr et al. (2022) mention, agroecology has the potential to transform agriculture by creating a fairer food system for humans while respecting the worth of the environment. Francis et al. (2003) emphasized the importance of understanding agriculture as an open system, which interacts with both nature and society, to have sustainable food production. Moreover, Giraldo and Rosset (2019) talk about agroecology as political movement, shedding light on justice and sovereignty of food, and the emancipation of agrarian communities in the Latin American context, who have been marginalized by the global food system, becoming a lifestyle more than a simple agricultural practice.

To address the negative environmental and socioeconomic effects of conventional agriculture in Hass avocado production, various agroecological practices can be used, including water conservation, and integrated pest management, which can result in minimizing soil, water, and air pollution. Moreover, specific practices have specific impacts on socioeconomic challenges, such as income, labour requirements and infrastructure, and will depend on the context (Mouratiadou et al., 2024). Specific practices depend on factors such as climate, soil type and pest presence (Wezel et al., 2014). See table 1 for a summary of recommended practices specific for agroecological avocado production.

Table 1. Agroecological practices. Adapted from Wezel et al. (2014) and Ferwerda (2015), focused on avocado production with input from a literature review on avocado agroecology: Cortéz et al. (2007), Silva-Laya, et al. (2016), Salazar et al. (2020), Henríquez-Piskulich et al. (2021).

Agroecological practices	Specific Practices	Effects
Organic fertilizers	Compost, manure, biofertilizers (AMF, PGPR, and nitrogen fixing rhizobia).	Improve soil fertility and provide essential nutrients, possible increase in crop yield.
Mulching	Mulching with organic materials such as leaves, straw, or bark	Help with conservation of soil moisture, suppress weeds, and add organic matter to the soil, regulate soil temperature.
Crop rotation	Intercropping, cover cropping, agroforestry.	Help controlling soil-borne pests and diseases and maintain soil fertility. Cover crops such as legumes

		can fix nitrogen in the soil, suppress weeds, and improve soil structure. Agroforestry helps with soil health, reduces erosion, and increases biodiversity.
Water conservation	Drip irrigation, micro-sprinklers, subsurface irrigation, smart irrigation controllers, rainwater harvesting.	The best irrigation system will depend on soil type, climate, and water availability. Overall reduction of water loss. Mulching can add to water conservation.
Pest and disease management	Integrated pest management, biological control, resistant varieties, sanitation.	Aimed at independence from the use of synthetic pesticides. Improves soil health, creates a diverse agroecosystem that helps control pests and diseases. Increases biodiversity. Effectiveness of this practices will depend on climate, soil type and the specific pest/disease present in the area.

2.2. Conditions for Adoption of Agroecological Farming Practices

For agroecological practices to be adopted by farmers, certain conditions need to be in place. Runhaar et al. (2017) explored these conditions necessary for farmers to adopt nature conservation measures, identifying four key conditions: *Ability*, *Motivation*, *Demand* and *Legitimacy*. Schoonhoven and Runhaar (2018) found that the conditions also influence one another, for example: if there is no ability, motivation will decrease.

Ability, also referred to as capacities or capabilities, refers to the ownership of resources and skills necessary for adopting agroecological practices. This includes having the necessary knowledge, tools, financial resources, and support systems to engage effectively (Runhaar et al, 2017) in agroecology. Social capital, which encompasses shared norms and trust among stakeholders, is highlighted as a crucial resource for farmers (Pretty, 2008). It enables cooperation and collective action, ultimately facilitating the implementation of conservation measures, also adding to motivation to adopt these practices (Runhaar et al., 2017).

Motivation refers to the inner drive or desire individuals have to participate in nature conservation governance arrangements (Runhaar et al., 2017). It is intricately linked to a sense of ownership of nature conservation, which suggests a personal connection or responsibility towards preserving nature. External incentives, such as a demand for sustainable products, can also create motivation to change behaviour (Mitrokostas & Apostolakis, 2013). These incentives can come from various sources, such as market trends or societal pressures, nevertheless, motivation should always be voluntary (Runhaar et al, 2017).

Demand encompasses both external actors pushing for a change in farming behaviours and the coerciveness of that request (Mees et al., 2014; Runhaar et al., 2017). This can include

governmental bodies, NGOs, or other stakeholders representing parts of society. The coerciveness of the request can vary, with contractual requirements being more binding and coercive compared to agreements in a covenant (Mees et al., 2014; Runhaar et al., 2017). The level of coercion influences the opportunities available to avoid or weaken the required behavioural change (Mees et al., 2014; Runhaar et al., 2017).

Legitimacy refers to the extent to which behavioural change is justified or accepted, both legally and normatively (Mees et al., 2014; Runhaar et al., 2017). Legal legitimacy involves adherence to governmental regulations, which may either inhibit or support particular forms of conservation (Buizer, Arts and Westerink, 2015; Runhaar et al., 2017). On the other hand, normative legitimacy relates to societal norms and values that shape perceptions of appropriateness or acceptability regarding production practices (Hall et al., 2015). Stakeholders play a role in shaping these norms and influencing perceptions of legitimacy (Runhaar et al., 2017).

2.2.1 Factors that Influence Conditions for Adoption of Agroecological Practices

Therond et al. (2017) stress the importance of context in farmers' choice of agricultural practice. Moreover, farmers are a diverse group, and they are influenced differently (Torquebiau et al., 2012; Teixeira et al., 2018). Thus, conditions will vary depending on the farmer's context and what factors are influencing these conditions. Schoonhoven and Runhaar (2018) developed a framework using the four conditions, but taking it a step further to see how these conditions are influenced by *economic, social, political, and informational* factors and their interactions (Table 2 summarizes the conceptualization of each factor), and a distant and a direct context, adding to what Therond et al. (2017) mentioned on the importance of context on farmers' choices. Factors can influence different conditions, for instance, *information* can influence the ability of a farmer to adopt a practice through skills and can legitimize the practice through knowledge about the benefits that come with the practice (Schoonhoven and Runhaar, 2018).

Table 2. summary of definition of factors that influence the conditions necessary for adoption of agroecological farming practices. Adapted from Schoonhoven and Runhaar (2018)

Economic Factors	Degree of freedom with contracts/legislation, regulations, demand for sustainable products, market conditions, available finances, subsidies, investment possibilities, among others. Values, recognition, peer pressure, community support, norms, cultural setting, social control, among others.
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Social Factors	Values, recognition, peer pressure, community support, norms, cultural setting, social control, among others.
Political Factors	Legislation standards, framing of agriculture in policy and communication, involvement of NGO's, support from government, corruption in government, bureaucracy.
Informational Factors	Education, training, understanding of the ecosystem, skills, faming style, learning, information about benefits, innovativeness, among others.

Economic factors, as noted by Pannell (1999), is the main factor driving farmers to adopt new farming practices. He suggests that ensuring the profitability of the practice, is key for farmers to take the steps towards adoption of say practice (Pannell, 1999; Pannell et al, 2006; Lubell, Hillis and Hoffman, 2011; Schoonhoven and Runhaar, 2018). Labour, capital, risks, and uncertainties are influential economic factors that affect farmers adoption of new practices (Pannell, Llewellyn and Corbeels, 2014). The readiness to explore regenerative practices hinges on the perceived success rate of implementation. Moreover, adequate financial stability is posited to positively impact the adoption of novel farming techniques (Saltiel, Bauder, & Palakovich, 2010; Schoonhoven and Runhaar, 2018; Teixeira, 2020). Economic factors then influence, for example, the ability of farmers to invest in new practices.

Social factors, such as social pressure, perceptions and cultural norms and values, are important influential variables (Lalani et al., 2016; Carlisle, 2016; Isgren, 2016; Schoonhoven and Runhaar, 2018; Teixeira et al, 2018). Being part of a farmer's group influences the adoption of new farming practices by creating a space to share knowledge, forming a shared identity, and connecting farmers (Lalani et al, 2016; Knowler and Bradshaw, 2007; Sayadi, Calatrava Requena & Guirado Sánchez, 2005). Teixeira (2020) mentioned that farmers who adopt agroecological practices have higher social participation than conventional farmers. Pretty (2008) also mentioned the importance of shared norms and trust among the farmers to drive collective action and adopt more sustainable farming practices. Social factors can influence, for example, the legitimacy of agroecology by creating a community where agroecological practices are valued.

Informational factors also play an important role in the adoption of agroecological practices. Lalani et al. (2016) mentioned that education does not have a significant influence on adoption of new farming practices. On the other hand, Carlisle (2016) states that demographics such as education age and gender do play a significant role. Understanding the farm ecosystem, the benefits that agroecology can have for the farm and the farmer's economy, and the knowledge of the different practices and regulations is key for farmers to make

decisions when adopting a new farming technique (Isgren, 2016; Lalani et al., 2016; Mees et al., 2014). Informational factors can influence, for example, the motivation of a farmer to adopt agroecological practices, as they will have a better understanding of the farm ecosystem and can explore what fits their situation better.

Finally, *political* factors influence the conditions for adoption of agroecological practices. Subjects such as subsidies, policies, and regulations put pressure on the farmers to adopt certain farming practices (Isgren, 2016, Carlisle, 2016). In some cases, this political factor might be influencing the conditions in a negative way. For example, Serrano and Brooks (2019) mention that government policies aimed at increasing export, incentivise the use of conventional farming practices to be able to cope with the international demand of certain crops.

The onion model (Figure 4) by Schoonhoven and Runhaar (2018) the interaction between factors and context, affecting the different conditions to adopt agroecological practices.

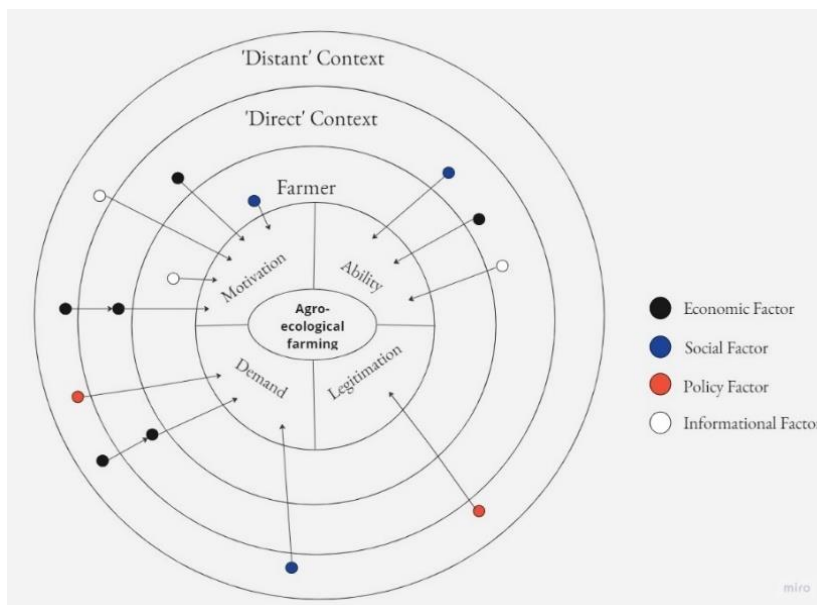


Figure 4 Onion Model from Schoonhoven and Runhaar (2018).

2.3. Governance for Adoption of Agroecological Practices

Environmental governance, as defined in Driessen et al. (2012), is “all kinds of measure deliberately taken to prevent, reduce and/or mitigate harmful effects on the environment” (p. 144). Furthermore, governance can be described in terms of arrangements, defined as the efforts to steer actors towards more sustainable behaviours (Runhaar et al., 2017), which in the context of this research are aimed at promoting and supporting agroecology. Governance arrangements are of importance in this research as they are governing economic, social,

informational, and political factors, key to have the conditions necessary to adopt agroecological practices (Schoonhoven and Runhaar, 2018; Runhaar et al., 2017), as mentioned previously.

These arrangements can present in different modes, or ways in which the stakeholders are organized to tackle the problem at hand. The idea of modes of governance is valuable for “mapping and comparing governance arrangements” (Daugbjerg, 2023, p.272), useful when trying to understand their differences and effectiveness. Driessen et al. (2012) identified 5 modes of governance, where state, market and civil society interact to address environmental issues. The modes are: *Centralized*, *Decentralized*, *Public-Private*, *Interactive* and *Self-governance* (see table 3 for a summary description of each mode).

Centralized governance involves specific actor features wherein initiating actors are predominantly central government agencies or supranational bodies (Driessen et al., 2012). Here, the autonomy of stakeholders is dictated by the principal agency, operating within the policy level of the (supra)national state (Driessen et al., 2012). The power dynamics are characterized by coercion, authority, and legitimacy, alongside democratic representation at the national level (Driessen et al., 2012). In terms of institutional features, centralized governance adopts a pluralist model of representation, relying on popular (supra)national elections and lobbying (Driessen et al., 2012). Formal rules such as laws and fixed procedures govern interactions, emphasizing a top-down approach rooted in control and command mechanisms (Driessen et al., 2012). Uniform goals and targets are pursued through the utilization of legislation, permits, norms, and standards as instruments (Driessen et al., 2012).

Decentralized governance follows the same features as centralized governance, albeit with a greater propensity for stakeholder involvement and dynamics occurring predominantly at local levels rather than national ones (Driessen et al., 2012). Furthermore, decentralized governance employs a distinct mechanism of social interaction, characterized by sub-national governments autonomously determining collaborations within top-down delineated boundaries (Driessen et al., 2012). Additionally, decentralized governance allows for the incorporation of issue-specific and contextually relevant knowledge, tailored to specific times and places (Driessen et al., 2012).

Public/private governance involves actor features wherein central government agencies play a key role, while the private sector assumes a role conditioned by predetermined parameters (Driessen et al., 2012). Market stakeholders operate autonomously within set

boundaries, spanning from local to international policy levels (Driessen et al., 2012). The power dynamics are characterized by competitiveness, contractual agreements, legal recourse, and legitimacy derived from mutual agreement on relations and procedures (Driessen et al., 2012). In terms of institutional features, Public/Private governance adopts a corporatist model of representation, relying on formalized public-private governing arrangements (Driessen et al., 2012). It employs both formal and informal exchange rules for interaction, with mechanisms for social interactions centered around private actors autonomously deciding collaborations within predetermined boundaries (Driessen et al., 2012). Uniform goals are pursued, targeting specific actors, with incentive-based instruments such as taxes, grants, and performance contracts utilized (Driessen et al., 2012).

With an *interactive* governance, multiple initiating actors from government, private sector, and civil society participate on an equal footing within the network (Driessen et al., 2012). The policy landscape spans across multiple levels, with its power derived from legitimacy, built upon trust, knowledge, and consensus regarding roles, positions, procedures, and processes (Driessen et al., 2012). Institutionally, interactive governance operates under a partnership model of representation, fostering participatory public-private governing arrangements (Driessen et al., 2012). Interaction is governed by a broad array of institutions, encompassing both formal and informal rules. Social interaction is characterized by its interactive nature, emphasizing social learning, deliberation, and negotiation (Driessen et al., 2012). Goals and targets are seamlessly integrated and tailored to specific contexts, utilizing negotiated agreements, trading mechanisms, covenants, and entitlements as instrumental tools (Driessen et al., 2012).

Lastly, *Self*-governance is characterized by the private sector and/or civil society as the initiating actors, with the government playing a subsidiary role (Driessen et al., 2012). Entities practicing self-governance determine the extent of involvement of other stakeholders, operating across policies ranging from local to international levels (Driessen et al., 2012). Its power dynamics are rooted in autonomy, group size, social capital, and legitimacy, grounded in consensus on relations and procedures (Driessen et al., 2012). Institutionally, self-governance adopts a partnership model of representation similar to interactive governance, fostering participatory public-private governing arrangements (Driessen et al., 2012). Interaction follows a rule-based framework comprising informal norms, self-created non-imposed rules, and formal regulations (Driessen et al., 2012). Social interaction operates in a bottom-up fashion, emphasizing social learning, deliberation, and negotiation (Driessen et al.,

2012). Customized goals and targets are pursued using private contracts, labelling, and reporting mechanisms, and voluntary instruments (Driessen et al., 2012).

Table 3 Description Modes of Governance adapted from Driessen et al. (2012)

Mode of governance	Description
<i>Centralized</i>	Governance arrangement is initiated by governmental agencies, interacting with other actors in a top-down structure.
<i>Decentralized</i>	Governance arrangement is toppled down to lower, more local level of government. Top-down interaction is used, but involvement of other stakeholders is more likely.
<i>Public/Private</i>	Governance arrangement is characterized by joint efforts between the public and the private domains, mainly government and market collaborations.
<i>Interactive</i>	Governance arrangement is characterized by collaboration between governments, market, and civil society actors, on equal terms.
<i>Self-governance</i>	Private actors drive governance arrangement. Collaborations mainly involve civil society and market actors, with the government going into a background role.

In the context of adoption of agroecological practices in avocado production, the modes of governance play a crucial role in shaping the outcomes and impacts of the adoption (Gaitán-Cremaschi et al., 2020). Effective modes of governance can ensure that the adoption of sustainable avocado production practices is guided by clear policies, regulations, and incentives (Tittonell, 2020).

Governance arrangements can influence the factors discussed in chapter 2.2 by facilitating or putting barriers on them. Because of this, it is important to analyse the underlying structures of governance arrangements to better understand how they enable or hinder the adoption of agroecological practices. In Runhaar et al. (2017), they highlight that, depending on which mode of governance is employed in certain governance arrangements, the conditions -ability, motivation, demand, and legitimacy- will be low, moderate, or high. As these conditions are key for the adoption of agroecological practices, modes of governance in current governance arrangements are essential to understand the dynamics that lead farmers to adopt agroecological practices.

Effective modes of governance can address key factors that influence the conditions for adoption of sustainable farming practices. For example, economic factors such as inadequate access to finance, limited availability of infrastructure and market access, and informational factors such as technical assistance for farmers, and lack of proper knowledge and skills (Piñeiro et al., 2020), can influence the conditions of ability, motivation and demand, for farmers to adopt agroecological practices. Moreover, effective governance can facilitate

collaboration and coordination among different actors (Chen, Tang and Liu, 2022), addressing social, informational, and political factors, fostering the necessary conditions of ability, motivation and legitimacy, to adopt agroecological practices. Additionally, through governance arrangements, innovation and knowledge sharing can be fostered, further influencing informational factors (Sayadi, et al., 2005). This can lead to the adoption of sustainable farming practices and the promotion of biodiversity conservation in avocado production (Aryal et al., 2020).

In this research, the goal is to use these modes of governance to identify the governance arrangements implemented and currently being developed with regards to the adoption of agroecological practices, that directly or indirectly affect the production of Hass in the case study. For example, an interactive governance arrangement found is the sowing capabilities program, which was developed in 2019 with the aim of strengthening instruments and policies and resulting in a handbook for agroecological transitions in the country, which was developed through workshops and events with different farmers (FAO, 2021b). Ultimately, this will serve as a guide to map and analyse the experiences of the farmers with the different arrangements and draw empirical conclusions regarding which arrangements seem to be encouraging the farmers towards the adoption of agroecology practices.

Figure 5 illustrates the conceptual framework used to explore the different dimensions of this research, showing how governance arrangements influence the factors and how the factors influence conditions to have adoption of agroecological practices.

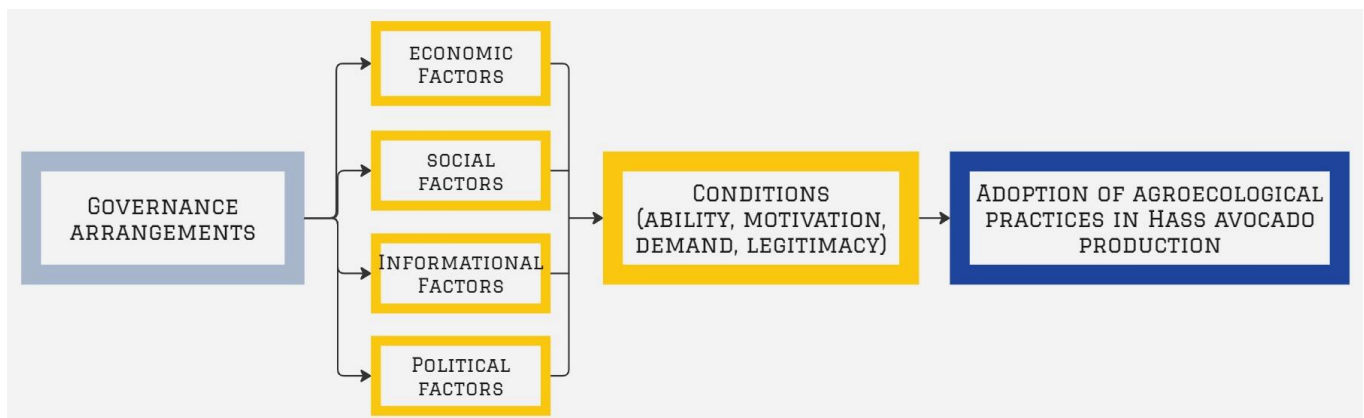


Figure 5 Conceptual framework used in this research.

3. Methodology

This section discusses the research strategy used in this research, the operationalization of the variables and the data collection methods used.

3.1. Research Strategy.

The research strategy developed for this thesis was built on different empirical and theoretical elements, employing a combination of methods (Figure 6) such as desk research, involving analysis of policy documents and grey literature and field research involving semi-structured interviews with farmers and field observations. An abductive reasoning was chosen for this study to explore the underlying drivers and identify the conditions, factors, and governance arrangements influencing the adoption of agroecological practices. Abduction is particularly effective in this context because it allows for an iterative process, moving from observations to theory and back to observations without requiring predefined hypotheses (Dubois and Gadde, 2002). This flexibility is crucial for investigating new or poorly understood phenomena, such as the adoption of agroecological practices for avocado production. The approach enabled continuous refinement of understanding, theory building, and creative problem-solving based on the best available information (Dubois and Gadde, 2002). By accommodating qualitative data and navigating uncertainties, abductive reasoning provided a holistic and adaptive approach to uncover the complex interactions and influences at play in the adoption of agroecological practices in avocado production in the case study.

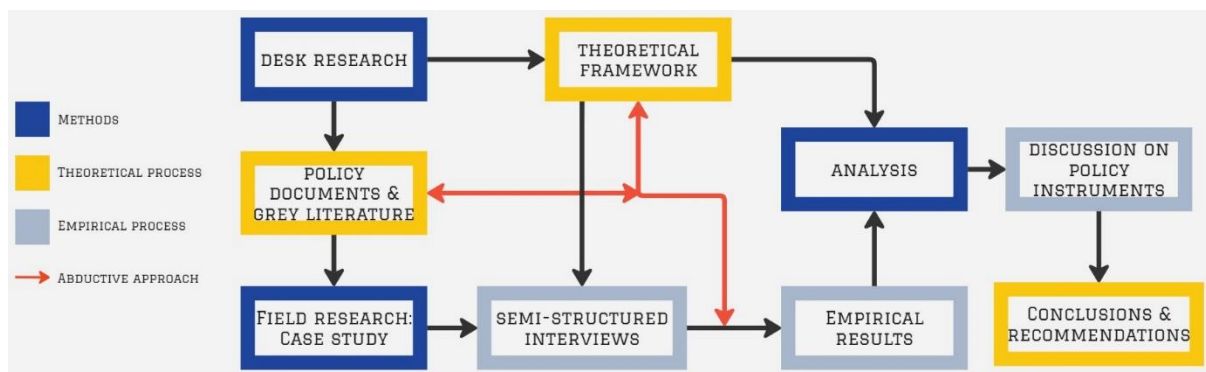


Figure 6 Research framework.

The research was developed as a most-similar, single case study with two embedded sub-cases (Yin, 2009), to allow for an in-depth examination of the factors influencing the conditions necessary for the adoption of agroecological practices within a specific context. This method allows for comparative depth, as the sub-cases share the same general context, helping to control for extraneous variables. Nevertheless, the cases vary regarding influencing factors, such as the economic factor of availability of resources, informational factors such as level of education and training, political factors such as support from the government, and social factors like community support. This qualitative method supports the iterative process of abductive reasoning by enabling continuous refinement of understanding through observations and theory breadth (Verschuren and Doorewaard, 2010). The embedded sub-cases facilitate a holistic analysis, considering multiple perspectives and layers of influence, essential for comprehending complex phenomena (Yin, 2009), as it is the adoption of agroecological practices in this context. Additionally, it prioritizes depth over breadth, providing detailed insights that can inform both theory and practice (Verschuren and Doorewaard, 2010).

Initially, an in-depth desk research was made to analyse the problem and get an understanding of the agricultural and general context. Through this, a distinction of two sub-groups of avocado farmers was found in the location: farmers that belong to a farmer's association and farmers that do not belong to any association (hereafter as associated farmers and independent farmers). Theory suggested that being part of a farmer's group or association, highly influences the adoption of agroecological practices by creating spaces to share knowledge, form a shared identity and connect communities of farmers (Lalani et al, 2016; Knowler and Bradshaw, 2007; Sayadi, Calatrava Requena & Guirado Sánchez, 2005). Through further preliminary research, it was clear that other factors such as availability of finance (economic factor) and education (informational factor) varied in each sub-group. Based on this, the two sub-cases were selected.

Semi-structured interviews, with 11 farmers (6 associated and 5 independent) and 2 experts (agronomists), and field observations, were conducted to understand the farmers, their current farming practices, what factors are influencing these practices and how are the conditions allowing or hindering their adoption of agroecological practices. This would not have been possible through surveys or questionnaires, as more depth in the subject was needed, instead of breadth (Verschuren and Doorewaard, 2010, p.179), due to the exploratory nature of this research. Finally, governance arrangements were analysed by combining both theoretical and empirical information gathered through the literature and the interviews with the farmers.

3.2. Operationalization of the Variables

3.2.1. *Dependent Variable: Adoption of Agroecological Practices for Hass Avocado Production*

The dependent variable of adoption of agroecological practices was measured by looking at five different agroecological practices suitable for Hass avocado production (crop rotation, mulching, organic fertilizer, pest and disease management, and water conservation: See table 1). These practices were identified through the literature on agroecology and sustainable farming for avocado, as discussed in chapter 2.1. As the cases were not picked based on their adoption of these practices, a lot of attention was put on understanding the different practices used by the farmers, even if they did not perfectly fit the description of agroecology, to get a better overview of their practices. This opened the door for more conversations about their reasons and possible outside barriers that are keeping them from adopting agroecology as their main practices. In the analysis process, the interviews were first coded using NVivo, coding each practice mentioned by the farmers. For example, if a farmer said they used the residues of grass after mowing their land, to mulch avocado trees, this was coded as mulching (see table 1). Later, these codes were given a +n, -n or a 0 in an excel sheet, depending of the frequency to which the farmers mentioned the practice (n) and if the farmer was implementing the agroecological practice (+), implementing an agroecological contradictory practice (-), or if the practice was not mentioned or was not sure of the practice (0).

3.2.2. *Independent Variable: Conditions*

The conditions necessary for adoption of agroecological practices is based on the framework by Runhaar et al. (2017), with the associated influencing factors based on Schoonhoven and Runhaar (2018). Operationalization is aimed looking if the current adoption of agroecological practices is mainly coming from internal conditions -ability and motivation- or from external conditions -demand and legitimacy-, and what factors are influencing these conditions. In this case, the operationalization was made associating conditions to each influencing factor (see table 4). This is then defined, for example, as economic ability, social motivation, informational demand, and political legitimacy to adopt agroecological practices.

Table 4 Operationalization of conditions, based on Schoonhoven and Runhaar (2018)

Conditions	Factors	Operationalization	Description
Ability	Economic	Economic ability	Economic, social, informational and political factors that influence the ability to adopt agroecological practices.
	Social	Social ability	
	Informational	Informational ability	
	Political	Political ability	
Motivation	Economic	Economic motivation	Economic, social, informational and political factors that influence the motivation to adopt agroecological practices.
	Social	Social motivation	
	Informational	Informational motivation	
	Political	Political motivation	
Demand	Economic	Economic demand	Economic, social, informational and political factors that influence the demand to adopt agroecological practices.
	Social	Social demand	
	Informational	Informational demand	
	Political	Political demand	
Legitimacy	Economic	Economic legitimacy	Economic, social, informational and political factors that influence the legitimacy to adopt agroecological practices.
	Social	Social legitimacy	
	Informational	Informational legitimacy	
	Political	Political legitimacy	

3.2.3. Independent Variable: Factors

The interviews were focused on the four factors that either hinder or enhance the conditions to adopt agroecological practices, namely economic, social, information and political factors. These factors were measured by identifying key variables from the theory, following the operationalization made by Schoonhoven and Runhaar (2018). This was adapted to exclude factors such as the EU CAP subsidies, not applicable in this case (see table 5). General questions about what they found as challenging when trying to adopt agroecology in their farming practices were asked. Later, the interviews were guided by open, but specific questions on the social, economic, political, and informational aspects of their farming practices. This was later coded in NVivo, using the operationalization as base for the coding. Following the same methodology used for the dependent variable, the factors were plotted in an excel sheet, adding every time a farmer would discuss a factor. This, with the intention of looking at which factors are influencing the adoption of agricultural practices.

Table 5 Operationalization of factors, in relation to the conditions necessary for adoption of agroecological practices. Based on Schoonhoven and Runhaar (2018).

Factors (related to conditions)	Operationalization
Economic ability	Availability of new business models
	Available finances
	Market conditions
Social ability	Peer pressure
	Values
	Community support/trust
Informational ability	Skills
	Communities of practise
	Research
	Learning
	Information about benefits
Political ability	Involvement of NGO's
	Support from government
Economic motivation	Impact of measures on primary processes
	Cost benefits
	Investment possibilities
Social motivation	Recognition
	Rewards
	Degree of autonomy in choosing and implementing results
	Values
	Peer pressure
Informational motivation	Education
	Training
	Understanding of the farm ecosystem
Political motivation	Bureaucracy
	Corruption
Economic demand	Environmental/market regulations
	Demand for sustainable products
	Conditions in contracts with customers
Social demand	Public opinion about agriculture
	Religious values
	Peer pressure
Informational demand	Understanding request of doing regenerative practices
Political demand	Pressure from government
	Pressure from NGO
	Subsidies
Economic legitimacy	Degree of freedom with contracts/legislation
Social legitimacy	Peer pressure
	Cultural setting
Informational legitimacy	Community of farmers
	innovation
Political legitimacy	Indirect effect of adjacent policies
	Framing of agriculture in policy and communication
	Strictness of legislation

3.2.4. Independent Variable: Governance Arrangements

This variable was operationalized using Driessen et al. (2012) framework on modes of governance. The 5 modes of governance discussed in the framework were used— *centralized, decentralized, public/private, interactive and self-governance*. To categorize the governance arrangements into each mode, several features were considered. Mainly, governance arrangements were identified by looking at who are the initiating actors, how are they interacting with other involved actors, what power dynamics are present, and the integration of goals. Other characteristics were not considered. Firstly, because of lack of available information for some arrangements, secondly because they were not of significant relevance for the purposes of this research (see table 6). This means that, for each arrangement found, first the actors initiating the arrangement were identified. Secondly, the way in which these actors interact with other secondary actors was analysed. Thirdly, the power dynamics of these interactions were described. Finally, the goals of the governance arrangement were identified, further explaining how they are integrated in the arrangement. Moreover, the analysis of each governance arrangement was made based on which factors are they (potentially) influencing/creating, and which conditions are being enabled by them.

The governance arrangements that have the potential to help a broader adoption of agroecological practices in avocado production were determined using both, documents and talks with the farmers. Governance arrangements found were then compared to the information given by the farmers. Discussions with famers helped characterized some of the arrangements found, especially to determine which factors were being addressed by the arrangements, or how could the governance arrangements be challenged to further address factors, to ultimately create an optimal environment where the conditions necessary for adoption of agroecological practices are present.

Table 6. Operationalization of governance arrangements, based on Driessen et al., (2012).

Mode of governance	Operationalization
<i>Centralized</i>	<u>Initiating actors</u> : governmental agencies. <u>Interaction with other actors</u> : top-down structure. <u>Power dynamics</u> : coercion, authority and legitimacy. <u>Goal integration</u> : uniform goals through use of legislations, permits and norms.
<i>Decentralized</i>	<u>Initiating actors</u> : toppled down to lower, more local level of government. <u>Interaction with other actors</u> : top-down structure, but likelihood of involvement of other actors.

	<u>Power dynamics</u> : coercion, authority and legitimacy. <u>Goal integration</u> : uniform goals through use of legislations, permits and norms.
<i>Public/Private</i>	<u>Initiating actors</u> : government and market actors. <u>Interaction with other actors</u> : market actors are autonomous but operate in boundaries set by government. <u>Power dynamics</u> : competitiveness, contractual agreements, legal recourse <u>Goal integration</u> : uniform goals are pursued, targeting specific actors.
<i>Interactive</i>	<u>Initiating actors</u> : governments, market and civil society. <u>Interaction with other actors</u> : all actors on equal terms <u>Power dynamics</u> : legitimacy, built upon trust, knowledge, and consensus regarding roles, positions, procedures, and processes. <u>Goal integration</u> : tailored to specific contexts.
<i>Self-governance</i>	<u>Initiating actors</u> : private actors or civil society <u>Interaction with other actors</u> : initiating actors decide the involvement of other stakeholders, operating across local to international policies. <u>Power dynamics</u> : in autonomy, group size, social capital, and legitimacy <u>Goal integration</u> : customized to fit actors' needs.

3.3. Data Collection

The main research question aims to analyse which governance arrangements can stimulate the conditions necessary for adoption of agroecological practices. To answer this question, the sub-questions proposed need to be answered first. These, aimed at assessing the presence or absence of the conditions necessary for adoption of agroecological practices, then uncovering the factors that influence the conditions currently present in the cases of study, which factors would be needed to have the conditions missing in place, and how are current governance arrangements hindering or enhancing these factors. Data was collected by triangulation methods, in order to increase the validity and reliability of the research (Verschuren and Doorewaard, 2010, p.179), by using a combination of literature, interviews and field observations.

3.3.1. Desk Research

A combination of scientific and institutional papers was used to analyse the problem. Scientific papers on the current state of Hass avocado production and its impact on land, water and biodiversity degradation were analysed, to understand the general landscape and built the theoretical foundations. This was done on different levels, looking at different countries in the world that export Hass avocados. Moreover, a closer look was taken to see how this problem presented in Colombia, where this research takes place. For this, Scopus and google scholar were used, using the following keywords: "Hass avocado production," "land degradation,"

“ecological impacts of avocado production,” “Socio-environmental impacts of avocado production,” “Colombia avocado production.”

Papers on agroecology, adoption of agroecological practices and agroecological transitions were reviewed. This, in combination with policy papers on agroecology in Colombia, were used to know which agroecological practices are relevant for the case study and what socioeconomic and environmental challenges can these practices potentially address. Moreover, a set of agroecological practices were selected from this literature review, checking against literature of sustainable Hass avocado production practices, to make sure that the agroecological practices aligned with this type of production (see table 1 in chapter 2.1). For this, Scopus and google scholar were used, using the following keywords: “agroecology,” “agroecology for avocado production,” “agroecology in Colombia,” “agroecological practices for avocado.”

Through the literature, different conditions necessary to adopt agroecological practices, and how are they influenced by different factors, were identified. Additionally, papers on effective governance arrangements aimed at adoption of agroecological practices were analysed. This was later compared with current governance arrangements being developed and implemented in Colombia. For this, Scopus and google scholar were used, using the following keywords: “Governance arrangements,” “policy instruments for agriculture,” “agroecology Colombia,” “governance arrangements for adopting agroecology.”

3.3.2. Field Research: Interviews & Field Observations

Through 11 in-depth semi-structured interviews with farmers (see Appendix A), information about adoption processes, obstacles, and general opinions about the current state of agricultural governance arrangements in the country was gathered. Before and after the interviews, there were informal conversations with the interviewees, to ease them into the subject. These were usually accompanied by a walk through the farm to gather field observations (see pictures throughout the document), which made the farmers more comfortable and safer to share their experiences. Moreover, they showed willingness to share their farming techniques, especially in the cases where experimental agroecological techniques were being developed. The results of the interviews were analysed both in a qualitative and a quantitative way. The quantitative analysis was used for personal visualization of the results, to get a clearer picture of the data, because of the small sample size. Two additional interviews

were conducted with agronomists that guide farmers in their practices (See Appendix B), to corroborate information.

Interviews were then coded, based on the different variables used in this research. This with the goal of linking the empirical evidence gathered to the theory found in the literature. Codes were divided in five groups: agroecological practices, motivation, ability, demand, and legitimacy. Within the last four, codes were grouped by economic, social, political, or informational factors (see table 5). The total sample size of interviewed people was of 13 interviewees (2 agronomist and 11 farmers) which can be seen as a small sample. Nevertheless, as argued by Crouch and McKenzie (2006), having a small sample can be seen as positive when the interviews are in-depth, loosely structured conversations, that dwell on sensitive topics for the interviewees, which was the case in this research.

The sample was gathered using snowball sampling methods. A first contact was made with the president of the avocado association of San Vicente de Ferrer “Asociación Agropecuaria Hass” (AAH). Through him, contact was made with other members of the association and two agronomists. From the association, a total of six interviews were made (sub-case of associated farmers), despite contacting more than twenty farmers. Through one of the agronomists, it was possible to find other avocado farmers with no ties to the association (sub-case of independent farmers). Five independent farmers were interviewed. This was the hardest part of the process, as they live in remote areas, where the phone reception is not optimal, and most of them do not have internet access. Moreover, they have busy schedules, and finding a proper time to conduct the interview was difficult.

Interviews were conducted in Spanish, following a semi-structured method, with both closed and open questions, to encourage a fluid discussion. The farmers were asked about the challenges they present when adopting of agroecological practices and asked directly about conditions when these were not mentioned by them. Conversations usually started introducing the research and giving an overview of what agroecology means. In this stage, farmers would ask what agroecology is, the difference between agroecology and, for example, organic agriculture, and would give their general thoughts on the practice. The interview then followed a series of general questions to get to know them better, including educational level, years in farming and size of their farm and avocado production. Then, a more general question regarding their understanding of agroecology was made. Following this, an in-depth talk followed, discussing about their current farming practices, guiding it with the agroecological

practices previously selected. The aim was to talk about which practices they use, independently if they were agroecological or not. This, with the goal of correcting for response biases and get truthful answers. Additional questions were made regarding why they chose those practices and no others, what influences their decisions when choosing certain practices, and what would it take for them to start adopting agroecology, in the case they were not already doing it. They also discussed their feelings and opinions towards the political landscape with regards to agricultural policies, when asked about subsidies and government support. In all the interviews, a supplement document was given to the farmers, with a definition of agroecology and a table with the different agroecological practices useful for avocado production (see Appendix C).



Figure 7 Farmer showing how he stores rainwater for conservation.

4. Results

Empirical results of the research are showed in this section. The field research was aimed at exploring which of the necessary conditions for adoption of agroecological practices were present, understanding the factors that influence these conditions and collecting knowledge about current governance arrangements that could be influencing these factors. The results of this study show that there is a growing interest in agroecological or more sustainable farming practices, but there are several factors influencing the adoption of these practices. The results are presented by, first introducing the general case study, and then answering the sub-questions proposed in chapter 1. These are given referring to all the practice in general, as this was how the farmers answer the questions. They did not mention specific factors influencing the adoption of specific practices, but more in general what factors influence the decision of adopting either more sustainable practices or sticking to conventional practices in general.

4.1. Introduction Of the Case Study: Hass Avocado Agriculture in Colombia and The Case of San Vicente De Ferrer.

As mentioned before, research on Hass avocado production has been focused mainly on Mexico, but there are other players in the Hass avocado production, that are gaining track in the international market at a fast pace. Colombia, with a fast expansion of Hass avocado crops, is one of the most biodiverse countries in the world, with rich hydrological resource (Ramírez-Gil, Morales, and Peterson, 2018). Avocado production can put these resources in danger if it is not properly done. Hass Avocado production in Colombia has grown significantly in recent years (see Figure 8), and the country is now one of the leading producers of avocados in the world (Bernal and Cipriano, 2014; Arias-García et al., 2021).

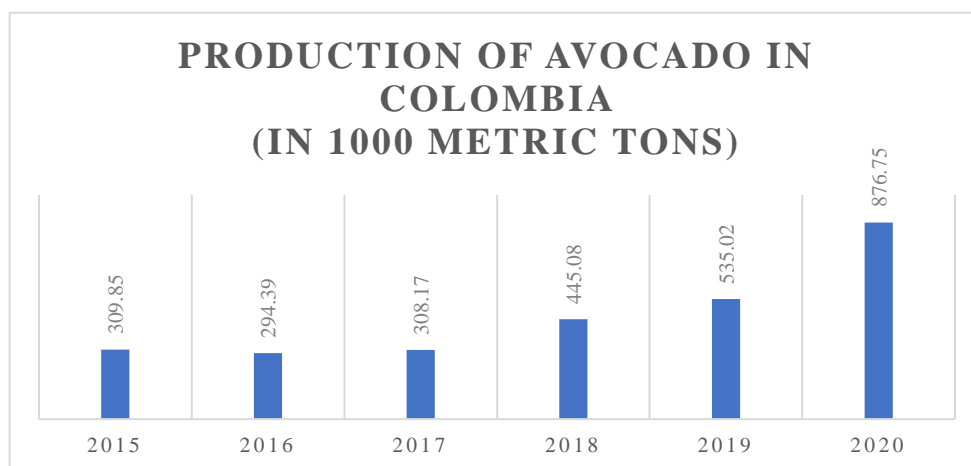


Figure 8 Avocado production in Colombia, (adapted from FAOSTATS 2022).

FAO (2021) reports that exports of avocado from Colombia rose by 73% in 2020, showing that 86% of these were destined for the European Market. The Colombian government has several programs in place to help the agricultural productivity of the country, as a response to clearing illicit cocaine plantations. One of these programs, in company with the Colombian Agricultural Institute (ICA), was aimed at consolidating export markets between 2010 and 2014, in which they signed 53 export protocols, allowing Colombian avocados to enter 18 countries (Arias-García, et al. 2021). This program comes with training and guidance with professional agronomists to educate farmers in the correct management of avocado plantations, and members of the ICA to help with bureaucratic paperwork to apply for export certificates.

The region of Antioquia is the main producer of Hass avocado in Colombia, with the municipality of San Vicente de Ferrer being a new location for production. This municipality is located in the Andean mountains at an altitude of 1900-2300 meters above sea level, with a climate that oscillates between 10°C to 25°C and two rainy seasons. The soil is unique in composition, derived from volcanic ashes from the Nevado del Ruiz volcano, making it a non-renewable resource (Hermelin, 1992). The land has been extensively cultivated and pastured, resulting in only small areas of natural forest. In the past, the municipality was the country's leading fiber producer, but after being abandoned during the narco-trafficking war in the 90s, the land is now occupied by stubble (41%), agriculture (34%), pastures (17%), and native forests (4%) (Consejo Municipal San Vicente de Ferrer, 2017).

Being one of the municipalities in Antioquia with the biggest number of properties with avocado cultivation (Álvarez Vélez & Monsalve, 2019), the municipality of San Vicente de Ferrer is a fairly new location for Hass avocado production, starting in 2006 with a group of local farmers interested in its cultivation. From here, a farmer's avocado association was consolidated, from which the local communities can collaborate and educate themselves (Alcaldía Municipal de San Vicente Ferrer, 2019). The interest for the selection of this municipality is based on the opportunities present for adoption of agroecological practices in avocado production, to address socioeconomic and environmental challenges. As mentioned before, this location is where the associative buffer zone, for the department of Antioquia, is located. Some of the challenges presented in the zone include pollution of soil and water sources, and general impact -both positive and negative- in the livelihood of the inhabitants of the municipality (Álvarez Vélez & Monsalve, 2019).

4.1.1. Sub-case: Independent Farmers.

This sub-case of study is comprised of farmers in the municipality that cultivate Hass avocado, but are not associated, and do their business independently. Most of these farmers are traditional farmers, which used to have different crops such as potatoes, strawberries, corn, and beans. For most of these farmers, this is the only source of income they have. The majority of the interviewed farmers come from a line of farmers, learning their practices from their parents and grandparents. They usually share borders with 2 or 3 other farms, not necessarily avocado farms. See table 7 for demographics on the interviewed farmers in this group.

*Table 7 Demographics of independent farmers. * Years in the current farm, used to work at a different farm in another municipality.*

Farmer	age	size of farm	Number of avocados	Years in farm	Level of education
Farmer 4	41	1.5 ha	155	5	Middle school
Farmer 5	53	1ha	250	38	Primary education
Farmer 9	76	1.3ha	350	12*	Primary education
Farmer 10	57	0.9ha	190	29	Primary education
Farmer 11	37	13ha	4000	5*	No formal education

4.1.2. Sub-case: Associated Farmers.

The Hass Agricultural Association (AAH), of San Vicente de Ferrer, Antioquia, was founded in 2006, with the objective Seeking economic and social improvement for members and their communities through various economic, social, and cultural endeavours. It promotes the integration of associates and support them in the establishment, maintenance, and/or enhancement of production, distribution, commercialization, and transformation of fruits and other agricultural products and by-products, always aiming for economic, social, labour, and housing development of its members. The activities they engage in are related to the harvest, post-harvest, and commercialization of avocados and their derivatives (Asociación Agropecuaria Hass, 2023). The AAH participates in the municipal council for rural development, where they analyse projects aimed at the rural sector to be implemented in the

municipality of San Vicente de Ferrer. The association has a current total of 35 members, although 14 of them are inactive. See table 8 for demographics on the interviewed farmers in this group.

The association is divided into three committees: Social welfare committee, commercialization committee and the technical committee, which work together to achieve the goals of the association. Additionally, they have a directive board, which is democratically elected every year, with a president, a vice president, a secretary, a treasurer, and a spokesperson. In the annual report of activities, there are five main objectives that the association has been working towards: 1. Strengthen the organizational structure of the association, through the construction and implementation of administrative processes that allow for better results; 2. Improve the “good agricultural practices” in every farm, through strategies that incentivise the practice, with the end of offering quality products and with characteristics demanded by the national and international markets; 3. Develop a commercial strategy, through the opening of new markets, in order to achieve the positioning of the products in the national and international field; 4. Identify market trends with innovative products, through research that leads to the development of new products, seeking to enter other markets with greater added value; and 5. Create comprehensive strategies to support the associate through different activities such as the organization's service offering.

The past year, the association provided a course in the agricultural management of Hass avocado cultivation and social strengthening, dictated by Asohofrucol, another association at the national level. The AAH as an association has partnerships with Asohofrucol (horticultural association of Colombia) and two financial cooperatives: Confiar and Cootrasena.

Table 8 Demographics of associated farmers.

Farmer	Age	Size of farm	Number of avocados	Years in farm	Level of education
Farmer 1	70	11ha	2	38	Primary education
Farmer 2	55	10ha	200	20	Technician in agriculture
Farmer 3	47	19ha	1100	10	Primary education
Farmer 6	41	1ha	130	5	University degree (civil engineering)
Farmer 7	66	0.5ha	125	5	University degree (Geological engineering)
Farmer 8	57	4ha	210	4	Master’s in education

4.2. Adoption of Agroecological Practices

From the data gathered through the interviews and field observations, there was evidence that most farmers implement at least one of the agroecological practices selected (Figure 9). The practice that ranked lowest was integrated pest and diseases management. This is the area in which all farmers use synthetic pesticides. Nevertheless, through the Association, a couple of the interviewed members are investing into entomopathogenic fungi, a practice that requires a lot of knowledge, time, and motivation. They all use mulching, in an innate way, even so that some of them did not consider this as a practice. The farmers that have other crops, mentioned doing intercropping and crop rotation of corn, beans and root crops like arracacha. There was a couple of farmers who were in the process of cutting down their other crops, as they believed that *“avocado roots should not be disturbed”* (Farmer 5). Nevertheless, by recommendation of the agronomists interviewed, avocado roots should be moved occasionally, otherwise the tree starts to wither. *“If they manage a good distance, they can plant other crops between the avocado, there is no issues. The avocado tree likes the soil and the root to be moved”* (Agronomist 1), stating that there are no technical issues to practice intercropping (an agroecological practice) in avocado production.

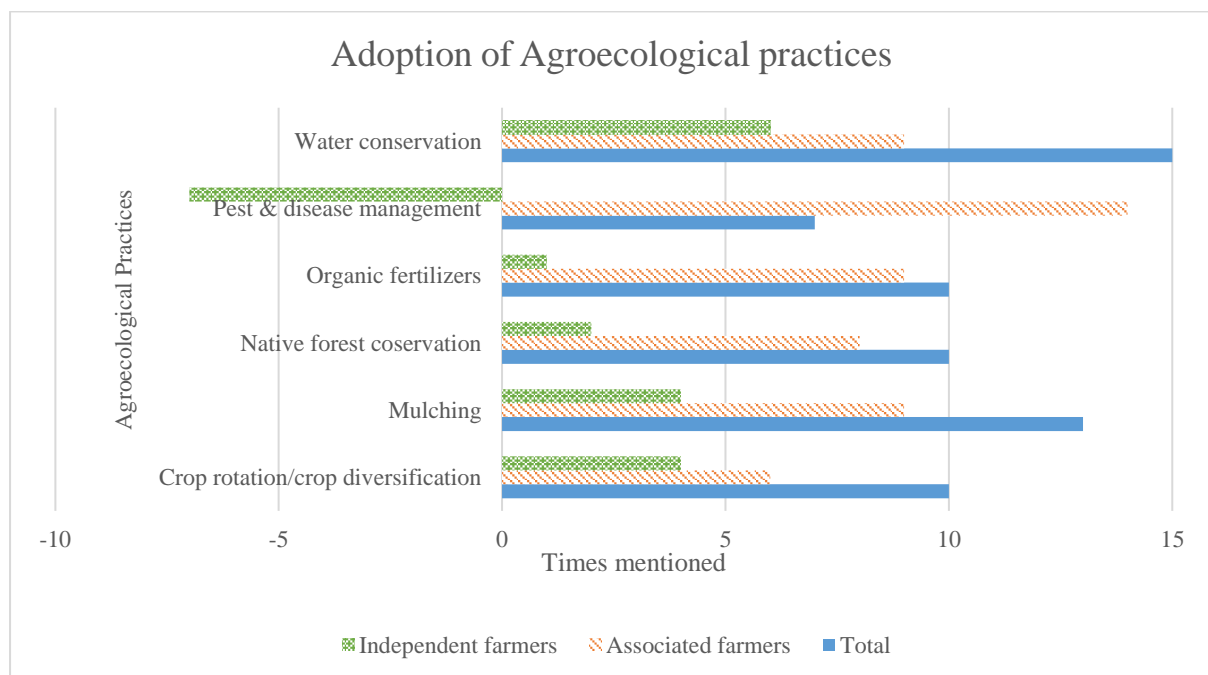


Figure 9. Agroecological practices adopted by farmers. The number shows the number of times each practice was mentioned, not the total sample of farmers. The negative values were given when a farmer mentioned they used conventional practices when asked about the agroecological practice. For instance, in pest and disease management, a -1 was given every time they mentioned a different pesticide/fungicide they use.

Water conservation was talked about, but more in terms of how little water they need to use. Drawing from literature on avocado production in Mexico and Chili, water depletion and

pollution are the biggest issues regarding avocado production (Sommaruga and Eldridge, 2020). For the moment, this does not seem to be an issue in the area studied, as there is a culture of relying on rainwater to water avocado crops. Nevertheless, during the interviews with one agronomist, who works in other regions, it was discussed how water is becoming a scarce resource in places where avocado production is more intensive *“water scarcity has never been an issue in this region, but right now we are dealing with climate change and El Niño phenomenon, so I am always telling them [farmers] to create water reservoirs, and collect rain water, but also I recommend this organic fertilizer that is liquid, so it doesn’t get crystallized with the lack rain these days”* (Agronomist 2)

Regarding native forest conservation, most farmers have a designated piece of their lands that has native forest and refuse to touch. They understand, to different extents that native forest is fundamental for their water sources, but also for the functioning of the ecosystem. A couple of farmers expressed their fears regarding “veraneros,” city folk that have holiday houses and go during the weekends to use all the water. Moreover, some farmers mentioned that they had issues with neighbouring farms, because they -the neighbour- have try to set fire to their native forests.



Figure 10 Avocado farm showing part of native forest and a lake made with rainwater.

From the 11 farmers interviewed, 82% (9 farmers) of farmers use some kind of crop rotation or intercropping and mulching. With mulching, it was observed that 100% of the interviewed farmers used this practice, but 18% (2 farmers) of them did not mention it during the interviews. Comparing associated and independent farmers, 100% of associated farmers do crop rotation/intercropping and mulching. On the other hand, only 60% (3farmers) of the independent farmers mentioned adopting these practices.

Concerning native forest conservation, 64% (7 farmers) of interviewed farmers mentioned adopting this practice. Comparing the two sub-cases, 83% (5farmers) of the associated farmers talked about their native forest conservation practices. On the other hand, only 40% (2 farmers) mentioned adopting this practice. Nevertheless, during the walks around the farms, it was visible that one other farmer had a patch of land with native forest. Whether the farmer plans to cut it down or keep it untouched, is unknown, as the farmer did not answer the question.

With respect to organic fertilizer, 45% (5farmers) of the farmers interviewed mentioned using organic fertilizers. In some cases, it was used in combination with synthetic fertilizers. This was due to the regeneration of the soil. Farmers mentioned that the soil was accustomed to synthetic fertilizers, so they needed to introduce organic fertilizers slower and gradually, to give the soil time to get used to it. Regarding associated farmers, 66% (4farmers) currently using organic fertilizers, the other 34% (2 farmers) said they used it in the past, but it did not work well, so they went back to using synthetic. On the other hand, only 20% (1 farmer) of independent farmers mentioned using always organic fertilizer, while the other 80% mentioned that they had tried once but the tree showed withering after, so they preferred synthetic.

Regarding pest and disease management, this was the practice that had the most challenges. Even though 55% of interviewed farmers mentioned trying some alternative, more natural pesticides, they currently use chemical pesticides and fungicides. A couple of farmers mentioned that they are researching new ways of dealing with pests and diseases. Comparing the two subgroups, 83% of associated farmers mentioned at least trying more sustainable ways of dealing with pests. In comparison, only 20% (1 farmer) of independent farmers mentioned combining natural pesticides and synthetic.

Lastly, water conservation was not a big problem. Because of the weather conditions of the region, farmers do not need irrigation systems and rely on rainwater to water the avocado crops. All the farmers commented on how when there are dryer weather patterns, they are lucky to have a water source near and can use it when needed. During the interviews, the El Niño

phenomenon was occurring, and most farmers commented on it saying that they had rainwater gathered for these times.

In conclusion, avocado farmer in San Vicente de Ferrer have adopted agroecological practices to certain extent. Mulching was the practice most adopted, with all the farmers in the sample using it. Moreover, all farmers discussed the importance of actively conserving their forests. Additionally, water conservation was another practice that farmers often used, but mostly referring to caring for natural water bodies, as the region experiences a lot of rain, thus not needing additional water usage (yet). Crop rotation/diversification was a practice that, although most farmers used, some had erroneous preconceptions with this practice relating to avocado production, leading to the abandonment of the practice. The practices that were least used were organic fertilizers and pest and disease management. These varied most between the cases, with associated farmers actively researching and learning about these practices, if not adopted yet. In comparison, independent farmers mostly used synthetic and chemical products for their pests and disease management and used mixed combination of synthetic and organic fertilizers. In general, associated farmers are adopting agroecological practices in a larger scale compared to independent farmers. The factors affecting these decisions will be discussed in the following sections.



Figure 11 Farmer showing his research on entomopathogenic fungi, an alternative to conventional pesticides.

4.3. Q1 To what extent are the conditions necessary for adoption of agroecological practices present in the case study?

This section is structured to answer sub-question 1. It is divided by conditions, giving a general result regarding it, and then giving a description of the factors that influenced the condition the most in this context. A contrast between the two sub-cases is made for each condition, when these differences are considered substantial. This is not only made regarding what the graphs show, but the content of the interviews, for which quotes are provided, when necessary, to further illustrate the point.

These conditions were analysed using questions designed to explore to what extent these conditions are present (or not), and how are the different factors influencing this presence. This was measured indirectly by asking farmers if, for example, they felt they had the necessary economic resources to implement agroecological practices, referencing to economic ability. As mentioned in chapter 3, a numeric visualization was made. Figure 12 shows that, overall, ability and motivation are the conditions more talked about, thus strongly needed for the adoption of agroecological practices. On the other hand, demand and legitimacy are less mentioned.

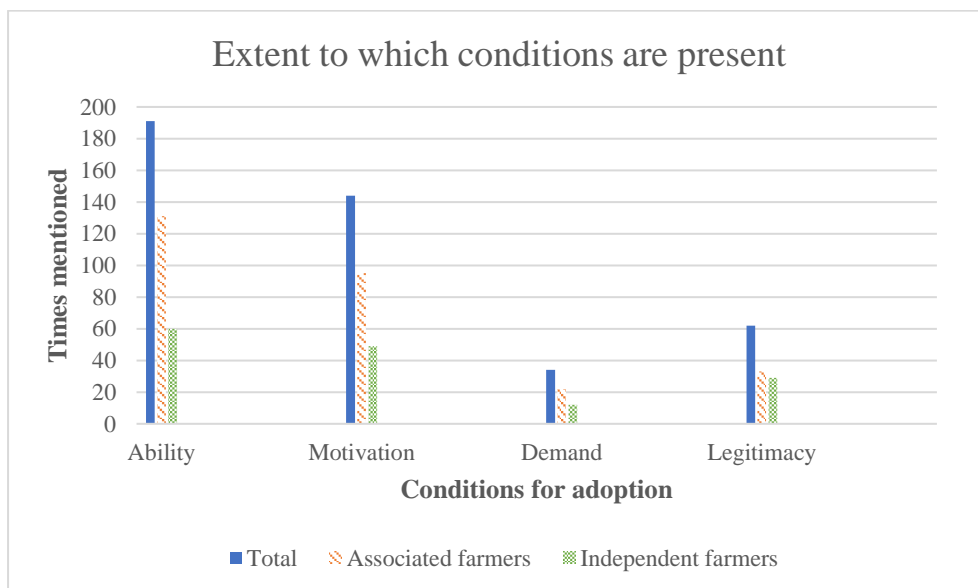


Figure 12 Extent to which conditions are present in the case study.

4.3.1. Ability

Regarding the condition of ability, which implies that farmers are able to adopt agroecological practices in terms of different factors, was the condition farmers indirectly talked about the most. Things such as education and economic stability were discussed, to have

a baseline of their ability regarding skills and resources. In general, all farmers agreed that information about agricultural practices was easy to find. Nevertheless, they rely on the expertise of an agronomist to corroborate practices and products (more on this in section 4.2.3). Overall, it is clear that associated farmers have more abilities to adopt agroecological practices than independent farmers. Economic and informational capabilities were discussed in a larger extent with the associated farmers. Nevertheless, both are key factors for farmers to be able to adopt agroecological practices. Regarding political ability, this subject was discussed less, but the content of what was discussed showed a gap with this condition. Farmers mentioned how they are lacking support from the government, that they feel abandoned, and the institution is not supporting the farmers' endeavours.

Independent farmers were mostly people with a long family tradition of farming practices, learned by working the land, and not by formal education. Some of them had received trainings in farming practices for avocado production in their process of certifying their farms for export purposes. Nevertheless, they mentioned that *“for the ones that have the property certified with ICA, we get every now and then some talks about how things should be, for example in regard to maintenance of the property, where to keep the supplies and things like that”* (Farmer 9). This reflects a lack of guidance from the government and other entities. Most of them mentioned that the things they know are from the experience and agricultural traditions passed down from their families. From this, there is a general understanding of how the agricultural ecosystem works. Nevertheless, a couple of comments from some of the farmers stood out when talking about how they perceive the different environmental impacts that avocado production has: *“there are people who say that it [synthetic pesticides] can pollute, but I think not, what happens is that many times we start to think and we get that into our minds and that is not the case. I fumigate and it spreads a little around, but not enough to reach where the source is and contaminate the water. That does not go there”* (Farmer 9). Regarding economic ability, these individuals had no structured economic system, nor the knowledge of how to improve their accountings. This limits their economic ability, as they live paycheck to paycheck, and do not have savings or investments other than their own lands. Linking this to political ability, independent farmers mentioned constantly that the government abandoned them. The few known subsidies were discussed by the farmers, mostly with regards to how inefficient they are, and how much farmers are in dire need of some extra economic incentives to be able to practice their farming. The mentioned constantly that if the government helped

them more economically, they could make better choices to have more sustainable farming methods.

In contrast, associated farmers get more opportunities to increase their capabilities. Through the association, they have educational programs provided by other associations and organizations at the national level: *“Here we have an association called Asohofrucol, a national-level association and it gives us training every month for 6 months on many things about products. That is very good because that is why I belong to the association. It is good because one is enriched with this content. I do not miss those talks”* (Farmer 7). Adding to this, they also have a network that provides investment opportunities and new business models. They get training on how to manage their production and the earnings that come with it. The associated farmers are, mostly, highly educated individuals. Three out of the 6 interviewed had advanced university degrees (see table 8). These individuals were the ones commenting the most on new agricultural techniques. Looking back at the theory, there was a disagreement around if education plays a role in influencing the adoption on agroecological practices (Lalani et al., 2016; Carlisle, 2016). In this case, this seems to be a particularly key factor influencing the ability of farmers. Regarding political ability, associated farmers also criticized the government and other institutions for the lack of support. Nevertheless, this criticism was directed at the lack of support with trainings and community building opportunities, contrasting with the lack of economic support mentioned by independent farmers.

One thing that kept coming was that, to implement, or even start looking for agroecological practices, time availability is of the essence. In this regard, it was clear that members of the association had a better-established economic system, and thus had more available time to invest in learning and implementing new techniques. Moreover, they had a much deeper understanding of the ecosystem functions: *“The agriculture of 60-80 years ago, there were no chemicals, so my grandfather would tell me: A small scoop of earth from one place to another is fertilizer. I did not understand why, but you know why I came to understand after, when I started studying geology. Well, the whole thing is that the chemical composition of a rock that is there is very different from that which is somewhere else, which is what happened with that, because you know that the formation of the soil is due precisely to the weathering of the rocks”* (Farmer 7). By understanding the technicalities behind agricultural processes, they could use this knowledge to leverage new practices and improve their farming systems.

Ability, in this case, showed to be the most important condition for all the farmers. They agreed that, if they had the money, the knowledge and/or the support of government/institutions and a community, they would adopt agroecological practices, as they see the value in sustainable farming methods. Although figure 12 shows that ability is high, the interviews showed that farmers longed to be able (as they mentioned the subject many times), but the condition is still lacking in some respects (from the content of what they discussed). There is a lack of opportunities reinforced by the systemic inequality of the country. People from rural areas have to give up basic education in order to help their families with the farms and have a sense of economic control. This is further hindered by market conditions that take advantage of the farmers. This can be seen in the difference of abilities between the two sub-cases, as independent farmers seem to have less ability to adopt agroecological practices both because of the lack of technical and economic capabilities.

4.3.2. Motivation

Motivation was explored to the extent to which the farmers want to change their practices. Motivation shows to be the second most talked about condition, in terms of the factors that influence it. Throughout the interviews, farmers seemed motivated to learn about agroecological practices and share what they knew about it. They were also very eager to show their farms and some of them were proud of their land and crops. In general terms, all farmers had motivation to explore new practices, but some got discouraged when they tried them, *“because with organic [products] it is not possible. I see that I am not able. The tree starts to turn yellow, but then I add the chemicals again and it perks up”* (Farmer 3).

Exploring different dimensions of motivation, social motivation was a key factor playing in the decision to adopt agroecological practices. This was clearer in the sub-group of associated farmers, as they have a social structure. In contrast, independent farmers valued economic and informational motivation more than social. Political motivation to adopt agroecological practices was less discussed. Nevertheless, when farmers talked about political dimensions, they expressed their concerns and hopes with a higher sentiment, showing demotivation coming from the political side -as perceived by the interviewer-.

When analysing the answers of the independent farmers, there is clear economic and informational motivations. They emphasized that, if they could see how these practices can work, in a tangible way, they would implement them. Nevertheless, there is a misconception about the monetary investment that needs to be made to adopt these practices. They mentioned

that organic supplies are usually more expensive, and they do not work properly, and that demotivates them. One farmer also mentioned that not even the current pesticides work: *“I remember when we had potatoes, and for all the pests we had one poison, and we use it one or two times and it was done. We did not need anything else. Now we have a pesticide per pest, and every 8 days I am slaving with the poison”* (Farmer 5). There was an agreement from this group of farmers with regards to how expensive everything is, both organic and synthetic, blaming previous governments for the lack of support to small farmers. Something that stands out is the love they have for farming and the land. They comment on how the bees were not around anymore and how they would really like to make things better. Nevertheless, they were missing the connection between using synthetic pesticides and the lack of bees. In one of the informal conversations, it was mentioned to one farmer that maybe the bees were not around anymore because of all the pesticides used were killing them and he was surprised about this conclusion.

In contrast, associated farmers have their motivations also influenced by economic factors, but instead of information, they are also influenced by social factors. Nevertheless, the economic motivation is opposite to what it means for the independent farmer. For example, two farmers mentioned how much money they are saving by implementing agroecological practices: *“with clean production, I did calculations this week, and I am lowering between 40 to 50% of the expenses in comparison to traditional production. Of course you need money, but you need it less”* (Farmer 6). Nevertheless, they mentioned that what they save in money, they must invest in time. Agroecology is more labour intensive than traditional agriculture: *“agroecology requires a lot of labour, so people do not like it. It requires a lot of time, not money. Is not money but it is a lot of work, all the family needs to be involved”* (Farmer 1). This group of farmers were also very motivated because they have a social support system in place. With the association, they can rely on everyone’s knowledge and share their experiences when they meet. They try new things and through several communication channels they share these experiences, so people do not waste time and energy in something that did not work.

This was also discussed with the agronomists interviewed. They mentioned that farmers nowadays seem “lazy.” They explained that, since the popularization of techniques coming from the green revolution, farmers got used to over feeding the soil and overusing pesticides as precaution. This led the soil to also be lazy, as it does not produce the nutrients needed. They also mentioned that because of this history, farmers *“learned to kill. Not coexist and control, but kill”* (Agronomist 1), *“killing everything they did not understand, creating an imbalance in*

the ecosystem services” (Agronomist 2). This was reflected very clear in an interview with one of the independent farmers: *“science is what is killing the farmers now. Scientists come up with those different poisons, one for each pest, so to not kill the bees and stuff. But it is too much, and people cannot work like that”* (Farmer 5), referring to how nowadays, because of all the different products, the work has become more labour intensive.

Overall, farmers seem very motivated to adopt agroecological practices, although associated farmers seem to be more motivated than independent farmers. In general, they are eager to learn new, more sustainable practices and, the ones who have more knowledge, are very driven to share this with other farmers and to create a sustainable farming community. Nevertheless, there are some dimensions that make this motivation fluctuate. Economic motivations are low sometimes, because the market is not trustworthy, demotivating farmers to adopt agroecological practices, as they do not wish to risk their livelihoods without strong evidence. Moreover, political motivation is lacking. As mentioned in the previous section, institutions are not supporting farmers how they need to be supported, hence they get demotivated to change their current practices, as their efforts will not be validated.

4.3.3. Demand

Demand, as seen in figure 12, was the condition that was, indirectly, discussed the least. The conversation was mostly centred around political and economic demands. Mostly, farmers talked about the need for subsidies to be able to adopt new practices. There was also an apparent lack of knowledge on the regulations the government has regarding agroecology or sustainable agricultural practices. When asked if they knew about environmental regulations on agricultural practices, they all replied “no.” It was mentioned by some farmers that they follow the regulations dictated by the export certification process, which has certain synthetic pesticides and fertilizer prohibited from usage. Nevertheless, the regulations do not encourage the usage of only biological substitutes, it only warns against the use of strong chemical alternatives. Social and informational demands are not influencing the overall condition, as they were not talked about by the farmers when asked about this.

Moreover, farmers are opting to sell their products locally, even if they have their crop certified, because it is easier to deal with local markets than getting involved with regulations of the export companies. This was more noticeable with the independent farmers *“If you want to export, they say you cannot use any fungicide or pesticide, but you must use what they say. So, how are we supposed to leave a tree that has pests, without giving any pesticide? They say*

to leave it without any poisons for 5 months, but if you do that, 5 months later there is a tree with pests, and you can only see a dried-out avocado” (Farmer 5). They choose to sell their produce at the local market, because there is no testing or regulations enforced. This shows that the strictness in demand for less harmful produce is influencing farmers. Having the option to sell their harvest in the local market, which have no strict regulations, is hurting the demand for agroecological practices.

After analysing the interviews, it can be concluded that demand is not a condition that is prevalent in this context. Market regulations regarding organic production are very scarce at the national and local levels, and only applies when farmers want to export their products. From a political perspective, there is demand for more sustainable farming practices, showed in developmental plans at the national and regional level, but there is a lack of communication between the government and the farmers and enforcement, as farmers seem to not know about any regulations and guidelines (see table 9 in section 4.6). Governments and NGOs in the country should push for stricter environmental regulations at the local level, to incentivise the adoption of agroecological practices. There are no striking comparisons between the two subgroups. Demand is present to the same extent in both sub-cases, which is very low. This is an important finding, as this can help to strengthen governance arrangements to be focused on helping increase the demand for agroecological practices and influence the farmers to adopt these practices.

4.3.4. Legitimacy

Legitimacy was discussed to a lesser extent, in comparison to motivation and ability. In this context, information legitimacy seems to be the most important aspect for the farmers. If the information is perceived as legitimate, farmers are more willing to adopt agroecological practices. In this sense, most farmers talked about legitimacy in terms of how much they rely on the information provided by agronomists and established agricultural organizations, such as AGROSAVIA. When asked about their current agricultural practices, they would always reply with *“but I always check with my agronomist”* (several farmers). Each farmer has an agronomist that visit their farm once every two months. They check the state of the crops, see if there are pests or diseases and then they recommend what to use and with what intensity. Although in the graph legitimacy does not seem to have a lot of weight, during the interviews it was clear that nothing is done in the farms without having the agronomist’s endorsement.

Another subject that came up when addressing legitimacy conditions was the credibility of products in the market. Farmers commented on how they would buy these products if there was a way to know they worked. They mentioned that they would use a product and then they would never see it again in the agricultural store, or the prices would fluctuate very aggressively *“It has to be that the company that makes them is very well established and that they offer stable products, that they don’t have a lot of varieties that you they come out in the market and then they disappear”* (Farmer 8).

From Runhaar et al. (2017), legitimacy is understood in the extent to which farmers are allowed to implement these practices. Nevertheless, in this case there is no external resistance for farmers to implement agroecological practices, on the contrary, the government has started to include agroecology as a key pillar in the rural development plans from the ministry of agriculture and rural development (MADR) and the ministry of environment and sustainable development (MADS) but, as mentioned in the previous section, farmers do not know about these new policies. This shows a lack of effective communication between the government and the farmers.

Comparing the two subcases, independent farmers put more weight on the legitimacy of information. Even though both groups rely on agronomists, independent farmers are more hesitant to try new things without talking to the expert. This can be linked to the condition of information ability, in section 4.3.1, which showed that independent farmers are lacking informational ability. In contrast, associated farmers share information between them and trust this information, as they all receive the same trainings, having social legitimacy as a key condition, even though it was not extensively discussed. On the other hand, economic legitimacy is not a condition talked about substantially. This was only discussed a couple of times, in terms of how much freedom they had regarding contracts. Nevertheless, there is a lack of legitimacy in terms of market regulations, complementing what was said in the previous section on political demands.

Overall, there is a lack of legitimacy in this context. Farmers mostly rely on informational legitimacy, but other legitimacy aspects are lacking. Economic legitimacy should be strengthened through clearer contract and legislations that increase the trust of farmers, by lowering the risks of investing in agroecological practices. Moreover, the content of the interviews revealed that political legitimacy is widely affected by a lack of trust in the government and other institutions, which can be corrected through enhancing communication

of new policies aimed at incentivising agroecological practices and re-building trust with farmers by supporting them with the adoption of agroecological practices.

In conclusion, the conditions for adoption of agroecological practices are present to different extents. There is notable motivation and ability among farmers, especially associated farmers, to adopt agroecological practices. However, the overall adoption is significantly hindered by a lack of demand and legitimacy. While farmers are willing and somewhat capable of adopting more sustainable practices, the external environment does not adequately support or validate these efforts. This imbalance indicates that despite farmers' readiness and partial capacity to adopt agroecological practices, there is insufficient external encouragement. Market forces do not create enough demand for sustainably produced avocados, and there is a lack of institutional support and recognition, which undermines the legitimacy of these practices. This highlights the need for stronger governance arrangements, including policies and incentives, to foster a supportive environment that enhances demand and legitimizes agroecological practices. Without addressing these external barriers, the widespread adoption of sustainable farming methods will remain challenging.

4.4. Q2 What are the factors that influence these conditions in the case study?

In this section, results are presented to answer sub-question 2. This section is divided into each factor, giving results regarding how they are influencing the four conditions in this context. A contrast between the two sub-cases is made for each factor, when these differences are considered substantial. This is not only made regarding what the graphs show, but the content of the interviews, for which quotes are provided, when necessary, to further illustrate the point. Finally, this section ends with new factors discovered through interviews that were not (extensively) talked about in the theory. The results are analysed in relation to general adoption of agroecological practices and not for specific practices, as this is how the farmers discussed they answers. Specific challenges per practice were discussed in chapter 4.1.

As mentioned in chapter 3, a numeric visualization was made (figure 13 and 15). The figures show that informational and economic factors are, overall, the most influential on conditions for adoption, followed by political and finally social factors. Nevertheless, the extent of the influence of each factor changed depending on which condition was affected by it. Other categories within factors found, like time and credits for farmers, are included in the graphs and analysis, nevertheless, these will be talked about in more detail in section 4.4.5.

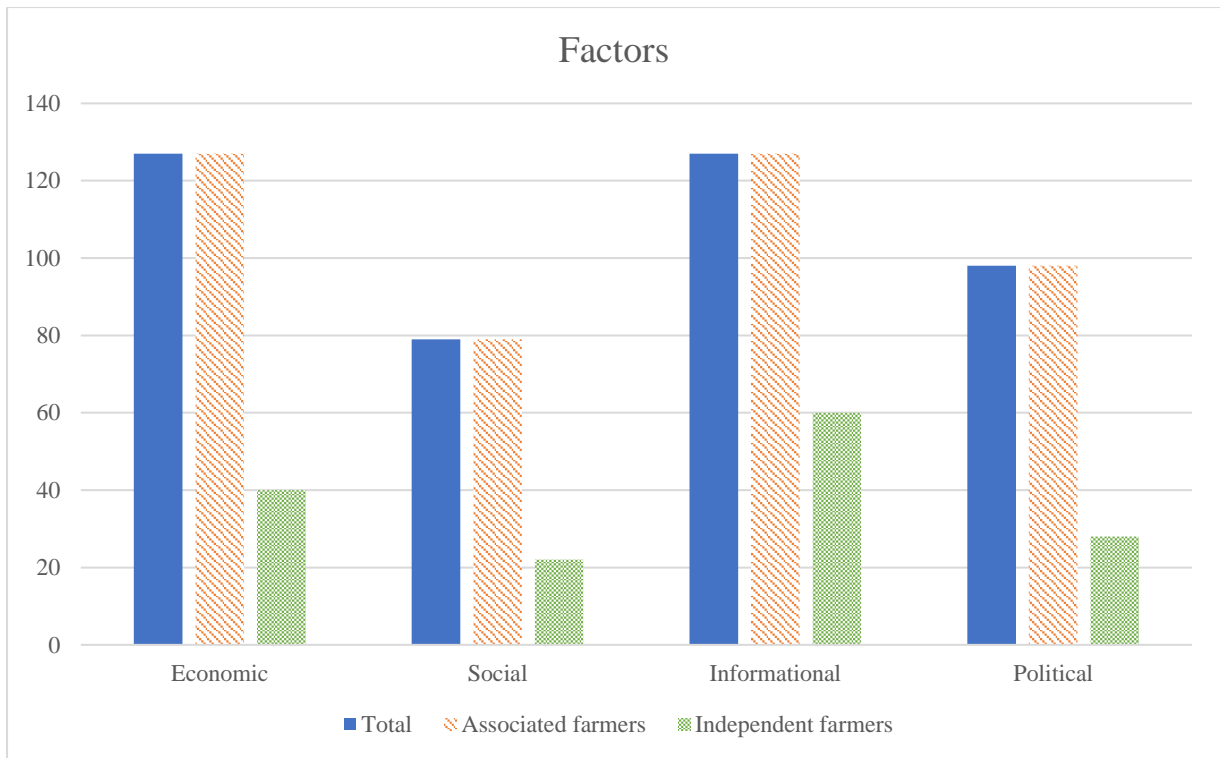


Figure 13 General results of influence of factors.



Figure 14 Avocado farm, with tomato greenhouse and native forest in the background.

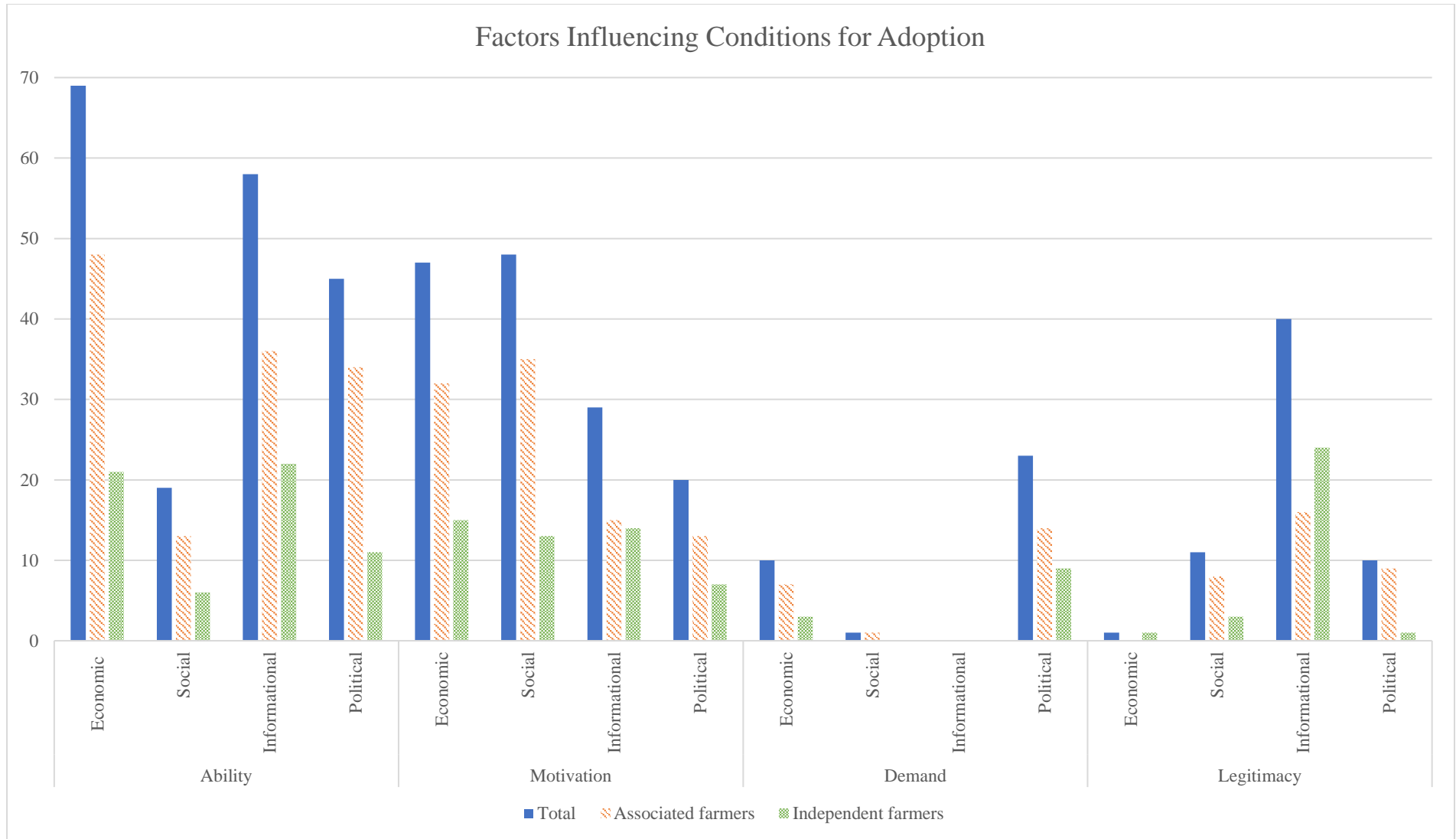


Figure 15 General influence of factors on specific conditions.

4.4.1. Economic Factors

Based on Schoonhoven and Runhaar (2018) framework, economic factors were operationalized (see table 6). The factors mentioned in the table were the operationalized from the economic factors given by the framework. Nevertheless, it was expected that this factor will be presented in new ways. Figure 16 shows the different economic factors affecting each condition, with the negative values representing when farmers mentioned the factor as a barrier/lacking, and with the positive values representing when farmers talked about the factors as enabling the conditions for adoption of agroecological practices.

Through the interviews, the subject of farmer credits was lengthily discussed, which was not seen in the theory, and are different from subsidies. In Colombia, banks have special credits for small and medium farmers, aimed at helping farmers with various agricultural activities, such as buying general agricultural supplies, not related to specific farming methods. Some from private banks, but also there is a bank created from the government specifically to support farmers called “Banco Agrario” (Agrarian bank). The farmers mostly talked about credits being a “scam” and that they were a trap to take away their land if they could not pay. For this reason, they keep those credits at bay and try not to request them, unless completely necessary. Another farmer mentioned that some of the requirements to get these credits, are not in line with the reality of the farmers: *“for you to be able to get a credit, you need to have land or some kind of property, to be able to back up the credit, but then, there’s no access to land, so it becomes a game of what was first, the chicken or the egg? With the peasants, if they do not have land, they do not have rights to credits... how do you expect development like this?”* (Farmer 2). Although these credits are not directly related to agroecology, they have the potential to enable farmers in the adoption of agroecological practices by providing economic support. Nevertheless, as the farmers mentioned, the credits do not work properly.

Cost benefit is another economic factor that was talked about by most farmers (only one did not mention it). They comment on how being a “jornalero,” a peasant that works in farms for a daily fee, is more rentable than owning your own farm. Farmers often have to hire these jornaleros because the work is too much for one person, but this is not rentable in avocado farming, as the tree only gives fruit in two different periods a year. This relates to adoption of agroecology in the sense that, firstly, jornaleros would need additional training, but this is not worth it, as the jornalero is not hired permanently to one farm, but they work every day in a

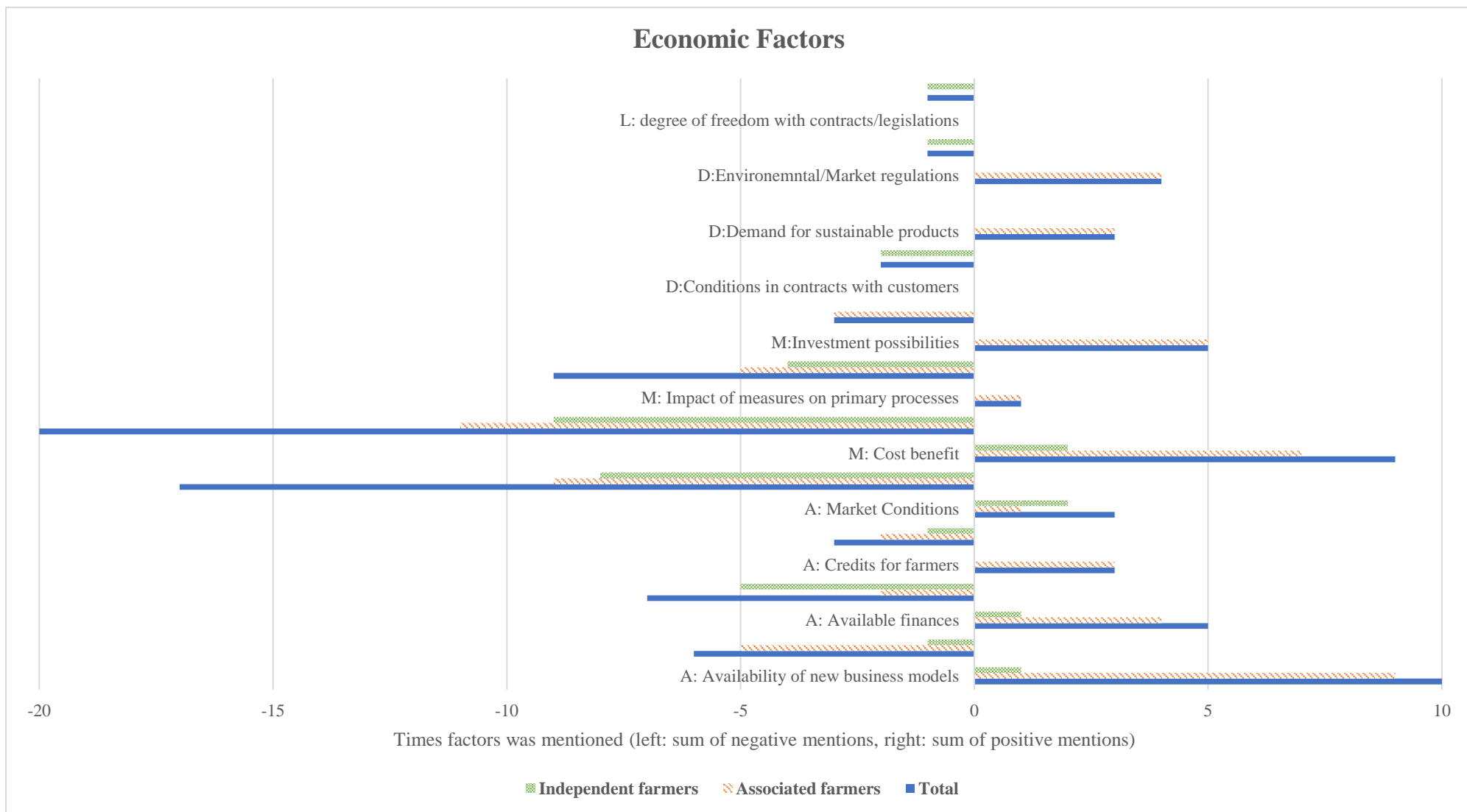


Figure 16 Economic factors influencing each condition. A: Ability, M: Motivation, D: Demand, L: Legitimacy

different farm, with different crops. Secondly, this affects the economic availability of the farm owners, as it is an extra expense they must account for, taking from money that could be used to invest in the adoption of agroecological practices. Nevertheless, this is a forced decision, as the owners of the farms do not earn much, after paying the jornaleros, supplies, transportation, agronomists and, in the case of export, all the chemical analysis the fruit needs in order to sell it in the international market. Adding to this, the market schemes for international export of Hass are tricky: *“For example, if I want to export 10ton of avocado, I need to wait 6 months for them to pay me. And let us say the shipment sunk, or something like that... then they do not pay you”* (Farmer 5). With this little assurance, farmers do not want to risk their crops by experimenting new techniques, sticking to conventional practices.

Other farmers commented on how some businesses offer contracts to export the product, including who picks the fruit from the tree and selects the fruit, and the transport from the farms to the warehouses, but the farmer must pay these things from their own pockets before even getting paid. And if after all that they test the fruit and from 10 Ton only 2 can be exported, they will pay half right then, and the other half in 6 months. They mentioned that some farmers that did this contract, never got paid that second half. There was a consensus among the farmers that the market conditions should be better. On the one hand, the international market has a lot of demand about the farming practices, which in hindsight is good, because they require fewer synthetic pesticides and fertilizers. On the other hand, the contracts are *“derisory,”* as one farmer said. They have no guarantees, and they take advantage of the farmers. This demotivates farmers to make the effort of adopting more sustainable farming practices, as they do not want to put in the effort it requires if it will not give back to them equally.

One thing that really stood out is how availability of finances, although not talked about to a lengthy extend, it has more weight for independent farmers than for associated farmers. The general feeling gotten through the interviews and the field observations is that associated farmers are *“better off”* economically, they do not have to worry about making ends meet with their farm production, as independent farmers do. This means that independent farmers are going to stick to what they know works, and take less risks in their farming practices, which is also noticeable in figure 9. Nevertheless, one independent farmer repeatedly mentioned that all he needed to fully adopt agroecological practices was money: *“I only need the money, so I can get some chickens and be able to make my own fertilizers. I do use organic fertilizers, but my goal would be to have a self-sustaining avocado farm”* (Farmer 4).

Overall, looking at figure 16, it is clear that economic factors are mostly negatively influencing the adoption of agroecological practices. Especially, motivation is being affected in a negative way by the lack of cost-benefit knowledge on agroecology and market conditions. On the other hand, availability of new business models seems to be a good motivator, especially for associated farmers, as they have access to different models, as compared to independent farmers, which have to deal with wither local markets or individually be taken advantage of by international commercial enterprises. This affects the adoption of agroecological practices as international markets have more strict rules in the usage of synthetic pesticides and fertilizers compared to local markets, but the risks of selling international are higher. Thus, farmers stick to conventional farming practices to lower their risks, and chose to sell their products locally, even though the prices are not optimal.

4.4.2. Social Factors

Based on Schoonhoven and Runhaar (2018) framework, social factors were operationalized (see table 6). The factors mentioned in the table were the expected social factors given by the framework. Nevertheless, it was expected that this factor will be presented in new ways. Figure 17 shows the different social factors affecting each condition, with the negative values representing when farmers mentioned the factor as a barrier/lacking, and with the positive values representing when farmers talked about the factors as enabling the conditions for adoption of agroecological practices.

Through the interviews, the subject of time availability was talked about, which was not present in the framework. This theme was recurrent, especially among associated farmers, which in practice were the ones with more experience using agroecological practices. This factor was coded as influencing motivation, but throughout the interviews it can be seen that it directly also affects the condition of ability. This will be talked about in more detail in section 4.2.5.

Peer pressure was only mentioned a couple of times, with regards to demand and motivation. They talked about it, not in the sense that they used agroecological practices because of peer pressure, but that the people that are already doing it, should push the other farmers to adopt these practices: *“I think that the people that are already starting with these organic products should go to other people and incentivise them and help them and motivate them to adopt these practices too”* (Farmer 7). From the interviews, it was clear that even though they rely on community support, and they trust the knowledge and experiences of other

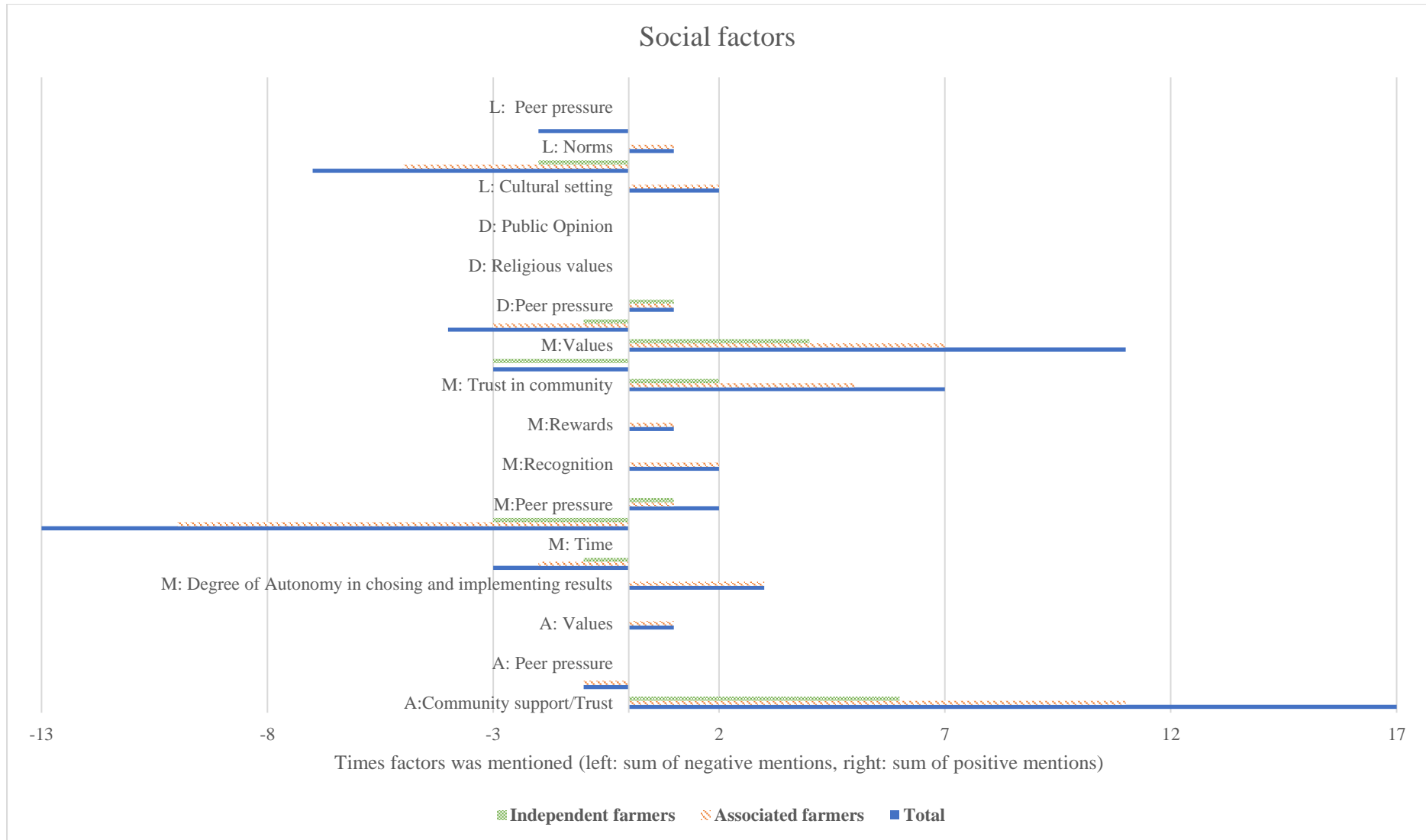


Figure 17 Social factors influencing each condition. A: Ability, M: Motivation, D: Demand, L: Legitimacy

farmers, they do not feel compelled or pressured to follow anyone's advice, only the agronomists (more on this in section 4.2.3).

As in the research by Schoonhoven and Runhaar (2018), the farmers did not mention religious values and public opinion about agricultural practices. Nevertheless, their personal values do have a substantial influence in the motivations to adopt agroecological practices. These values could be related to a deeper level to their religious upbringing, but this was not explicitly mentioned. Farmers value healthy lifestyles, and they worry that their products can be harmful for the consumers, thus why they feel motivation to “clean” their practices from synthetic pesticides. *“I have very clear that using less pesticides, the avocado will be of better quality for consumption. Those chemical pesticides are very harmful for the health”* (Farmer 10).

As mentioned previously, the farmers rely on their community support and trust. From the associated farmers, there was a clear sense of community and mutual support and trust, they spoke highly of the other members and showed a lot of appreciation for the opportunities to learn and share, but also to socialize. They have cookouts in different farms occasionally, and in this more informal setting they converse about their practices and share their experiences with new products and information. On the other hand, the independent farmers acknowledged the importance of having a community but said that, even though they help their neighbours, they wished they had a stronger community of farmers and to be able to share more. One independent farmer in particular mentioned that, when he recently moved there and was trying to get his property to produce, he tried to reach out to neighbouring farmers, but he has *“felt rejected by the community, like they [the neighbours] are very selfish with their knowledge and at the beginning when I was asking about which crop was better for this land, they gave me wrongful information, that made me feel very bad”* (Farmer 4). He also mentioned that he is actively considering joining the association, and he joined for some interviews with associated farmers, in which he mentioned later that he really enjoyed the exchange of knowledge and learned a lot.

Regarding social dynamics, the agronomists mentioned that, to have agroecology, social cohesion and support is key. One of them mentioned that he can see this with the associated farmers, how that network has helped some farmers he knew before they associated themselves. He also mentioned that the independent farmers have a culture of working independently and

it is hard to create cohesion like that, but that in every visit he does, he always tries to point out the advantages of being associated and having a good social network.

In conclusion, social factors have a significant role influencing motivation and ability. From figure 16, it can be seen that community trust/support is a key element when talking about adoption of sustainable farming practices, especially for associated farmers, which have a built a good community through the association. Moreover, farmers personal values, especially regarding how their products can affect consumers' health, is positively influencing the motivation, but not the ability, to adopt agroecological practices. On the other hand, there are mainly two factors that negatively influence the conditions for adoption. Time, a new factor in this category, seems to be the biggest social factor negatively influencing the motivation to adopt agroecological practices. Moreover, the cultural setting is also negatively influencing adoption. This was discussed in terms of how conventional farming practices (e.g. using synthetic pesticides and fertilizers) is so deeply ingrained in the Colombian agricultural culture, negatively influencing the condition of legitimacy to adopt agroecological practices. These two factors are interesting also because associated farmers mentioned them the most, but they would talk about it regarding independent farmers, whilst independent farmers will talk about them, but in a more general way. Overall, social factors seem to be more important to associated farmers than independent farmers. This might be because by being part of the association, they have learned the value communities have in the process of adopting agroecological practices.

4.4.3. Informational Factors

Based on Schoonhoven and Runhaar (2018) framework, informational factors were operationalized (see table 6). The factors mentioned in the table were the expected informational factors given by the framework. Nevertheless, it was expected that this factor will be presented in new ways. Figure 18 shows the different social factors affecting each condition, with the negative values representing when farmers mentioned the factor as a barrier/lacking, and with the positive values representing when farmers talked about the factors as enabling the conditions for adoption of agroecological practices.

Through the interviews, the subject that was discussed the most in terms of information was the use of agronomists to get and corroborate information. This was coded as "experts," influencing the condition of legitimacy, and was not a concept seen in the theoretical framework. All avocado farmers interviewed had in common that, once every two months, an

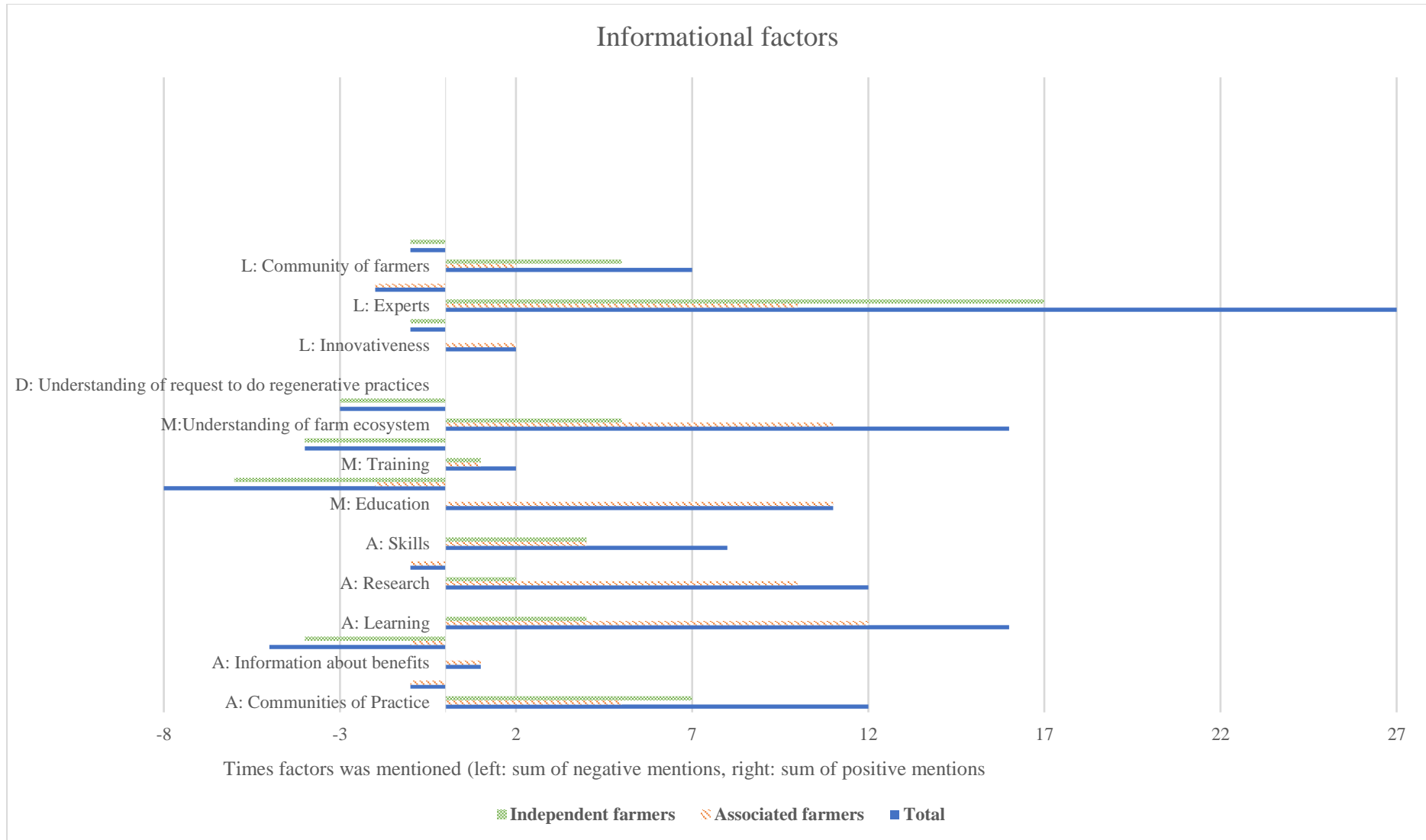


Figure 18 Informational factors influencing each condition. A: Ability, M: Motivation, D: Demand, L: Legitimacy

agronomist comes to their property to check the state of the crops. This is their main source of information about practices in general, influencing the adoption process the most in this category. In figure 18, it can be seen that independent farmers have more reliance on the experts. For example, one farmer said, *“When I recommend things to other farmers, they do not try them, because they said that the agronomist didn’t mention it and they are scared of trying it”* (Farmer 9). This factor has the potential to change practices in this context. This means that if visiting agronomists approached the farmers with agroecological alternatives, instead of the conventional solutions, farmers will adopt these practices more easily, as it builds legitimacy of the practices through experts.

In contrast with associated farmers, this could be attributed to the community of support that associated farmers have, which was discussed in section 4.2.3. Nevertheless, an associated farmer that specialises in organic agriculture mentioned that he does not have an agronomist because *“The agronomists trained themselves to manage the chemical products, the synthetics, and that’s the problem”* (Farmer 1). This farmer was a especial case, as he does not have an avocado farm, only a couple of avocado trees for he and his family’s consumption, but he has an organic farm that exports aromatic plants, in which he also produce his own fertilizer and has a fully functional integrated pest and disease system.

Going back to figure 18, it is clear that farmers know the value of information and acknowledge how important good training is to be able to adopt agroecological practices. When asked what they would need to fully adopt agroecological practices, they all agreed that guidance and training were the most important factors. They mentioned their fears of trying new things, but that if they had trustworthy information and someone to guide the process and show results, they would adopt agroecological practices without thinking twice. During the interviews with the agronomists, this was also thoroughly discussed. They mentioned that one thing that was missing in avocado production in the region was “schools” to try new farming practices. *“I have this idea for a big proposal for the municipalities, to have big demonstrative farms, where farmers from the same municipality can go and learn how to do agroecology there [...] and have bio factories, where they can go and learn how to make their own supplies, their own fertilizers”* (Agronomist 1).

This also links to research and learning factors. Most farmers are willing to learn new practices and find ways to research how to best improve both their crops and their economic wellbeing. Nevertheless, there is a striking difference between associated and independent

farmers. Associated farmers in general mentioned that they use the internet to research and learn about new, cleaner ways of farming avocados. On the other hand, independent farmers are more reliant on the agronomists and their own farming skills passed down for generations, mentioning that they do not use the internet. In this groups there was one exception, which differs from other independent farmer as he does not come from a farming family, and all the initial knowledge he had was from researching the internet and asking neighbours.

Another key factor is the understanding of the farm ecosystem. This factor varied strongly between the two groups, with misinformation affecting the motivation of independent farmers. This factor could be linked to education, which in this context was measured as the level of education the farmer has. Table 7 and 8 in section 4.1.2 and 4.1.3 shows the educational level of farmers. Most associated farmers have a higher degree of education, in comparison to independent farmers that, for the most part, have primary education as their higher level. In the theory, this was a contested factor, with some authors saying it did not affect the adoption of agroecological practices, and other saying it did. In this context, education seems to be actively affecting, not only motivation, but other conditions like ability and legitimacy. As mentioned before, associated farmers seem more able, as they are constantly researching and learning. Additionally, legitimacy in this case is high because of the strong reliance on experts, mainly from independent farmers.

One thing that was consistently missing from the answers of the farmers, was the knowledge on benefits of adopting agroecological practices. In general, they knew that it was better for the environment and the health of consumers, but they did not know about the social and economic benefits of agroecological practices, especially independent farmers, affecting their ability to adopt these practices. Moreover, the understanding of request to do regenerative practices was completely missing. This factor is important as it helps build demand for agroecological practices and helps understanding the ecosystem and social processes that agriculture has.

In conclusion, figure 18 shows that informational factors are mostly positively influencing the conditions of ability and legitimacy for adoption of agroecological practices. Experts, the new factor uncovered in this category, is strongly influencing legitimacy, nevertheless, it could be leveraged more to increase the uptake of agroecological practices. Moreover, learning, research and training are key factors influencing ability in a positive way, especially for associated farmers. Independent farmers on the other hand rely on the information given by

experts and their skills from years of farming, rather than researching new farming practices. Nevertheless, independent farmers mentioned the importance of training, mentioning that they would like to have more opportunities to learn about new farming practices and be able to adopt agroecological practices.

4.4.4. Political Factors

Based on Schoonhoven and Runhaar (2018) framework, political factors were operationalized (see table 6). The factors mentioned in the table were the expected political factors given by the framework. Nevertheless, it was expected that this factor will be presented in new ways. Figure 19 shows the different social factors affecting each condition, with the negative values representing when farmers mentioned the factor as a barrier/lacking to adopt agroecological practices, and with the positive values representing when farmers talked about the factors as enabling the adoption of agroecological practices.

Political factors were a delicate subject, due to Colombia's political history. In general terms, farmers talked mostly about how they feel the government does not support them. They constantly mentioned that the government should support small and medium farmers more. There was a constant theme here, discussing that the reality of farmers did not match with what the government says *"I had the opportunity some time ago to talk to a person from MADR, and the disconnection is total. He would say to me that most of the times they try to do things under certain blueprints, and that now that he was having some closer contact with farmers, he could see there is two quite different versions of 'reality'"* (Farmer 2). The policies regarding agriculture in Colombia have been historically aimed at big producers, whilst these are only the 35% of agricultural producers in the country. In contrast, 65% of agriculture comes from small and medium producers, with family farms, which have less than one hectare of land. Following this, it is clear that there is a disconnect in the framing of agricultural development in the country, affecting the adoption of agroecological practices.

Subsidies were a key subject of discussion among the farmers. In general terms, they would mention that it would be very beneficial for them if the government could provide subsidies, especially to help when weather conditions are not favourable and destroys the crops. This was a point that independent farmers would mention constantly. They hear that the government takes pride with these kind of helps to farmers, but that they have never experience a good process, or when they do receive some subsidy, is not even a quarter of what they lost *"a couple years ago there was a hailstorm that damaged a lot of crops, and one farmer lost 7 or 8 million*

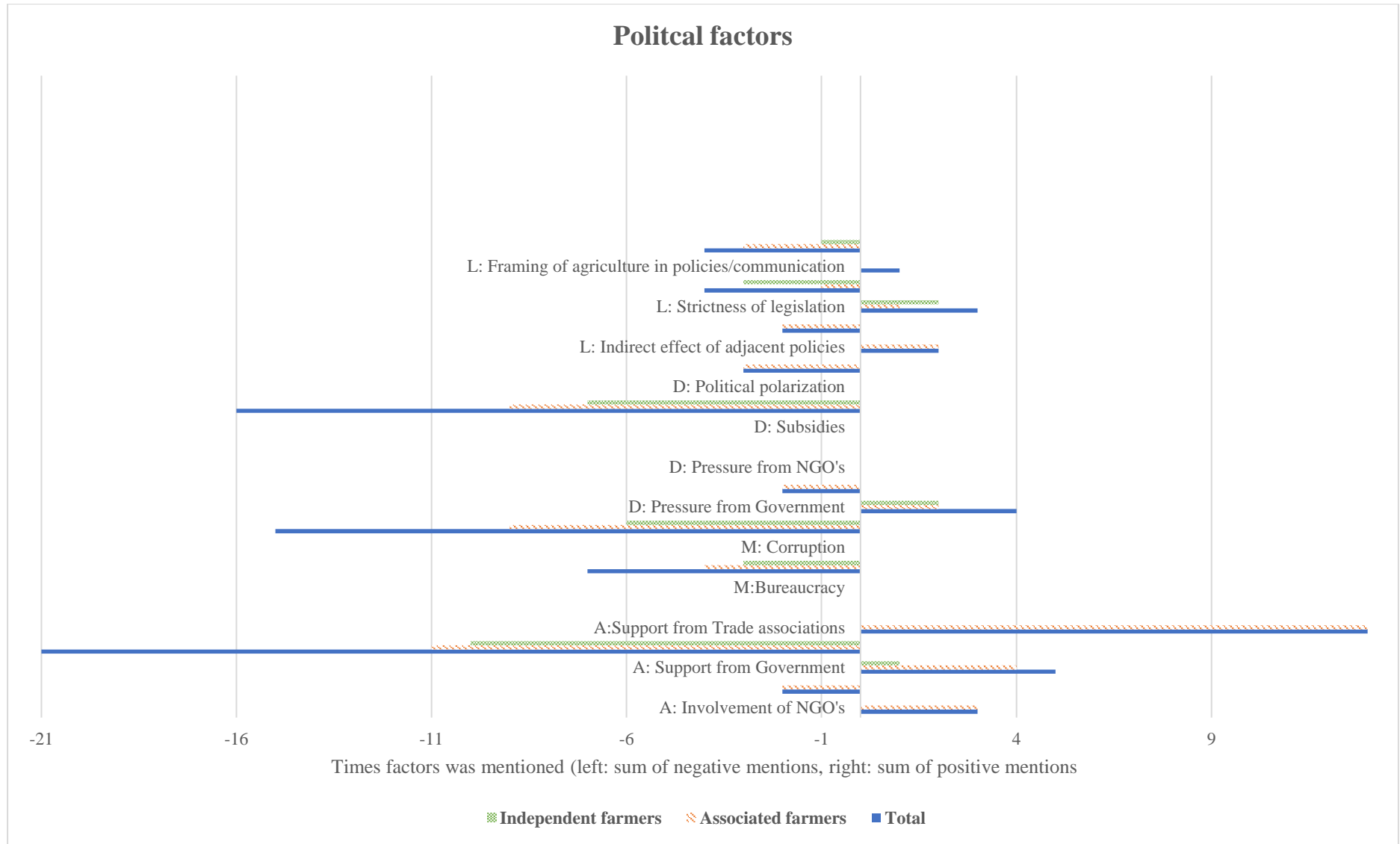


Figure 19 Political factors influencing each condition. A: Ability, M: Motivation, D: Demand, L: Legitimacy

pesos, and he applied for the subsidy, and he had to wait one year, and only got 400.000 pesos back. That is not fair” (Farmer 2). This also touches upon the subject of corruption, which was the third subject the farmers talked about the most regarding politics. Something that stood out when corruption was talked about, was the sentiment, the anger with which the farmers were talking. They felt abandoned and, even though they mentioned that the new government seems to be doing good things for farmers, they have little faith that the plans will get somewhere useful for them (more on this in section 4.3.5).

Independent farmers talk about getting monetary subsidies, but associated farmers, even though they do not want any subsidies for themselves, said that the government should help farmers more, but not only with money, but with education. Not specifically about farming practices, but more about the value of farming, and incentivise the creation of house gardens, for their own consumption, so they do not have to depend on money to subsist *“for example, support more the farmers and the production of avocado with systems, let’s say with seeds, with supplies, with equipment, because is not only the avocado, the producer needs other things, especially the peasant producer needs to learn about home gardens, this should be more promoted, because peasants should have, first and foremost, what to eat, and to eat healthy”* (Farmer 7). One of the agronomist also mentioned the importance of the government supporting small farmers with something else than monetary incentives *“I usually tell the farmers about subsidies but not focused on the production but on improving their quality of life, subsidies that are aimed at improving their homes and lives”* (Agronomist 1).

NGOs are mentioned only a couple times, referring to the BancO2 strategy. The farmer that mentioned it said that *“they give some monetary help to protect native forest, I have a couple of hectares I want to protect, but so far it has been) difficult, impossible. I made the proposal, applied, but have not heard anything yet”* (Farmer 8). Because of the lack of trust in government, support from NGOs has the potential to be very beneficial in this context. In this case it was the trade associations or corporations that had some positive input, which is a new factor in this category, having the most positive influence. Asohofrucol – a national agricultural trade association – and AGROSAVIA – an agricultural research institution – were mentioned constantly, being key for the ability to adopt agroecological practices, as showed in the graphs from associated farmers.

In general, independent farmers only mentioned political issues to say that they felt abandoned and not supported. In contrast associated farmers have a little more knowledge

about the realities of political dynamics. In the association there are former mayors of San Vicente de Ferrer, and people that are actively involved in political participation. Following this, political polarization was a subject mentioned explicitly in one interview, which is something not found in the theory. This polarization is a big problem in the country and affects the policies and its implementation. Something that happens in a large scale is that “*politicians make plans but are all for show*” (Farmer 7). For example, with the export certifications, they show it as progress and that they are helping small producers to have stable incomes, but the reality is that, to be able to get a certification, a lot of money needs to be invested and the government does not help with that. This affects the adoption of agroecological practices, as the main demand for sustainable products comes from the export market.

In conclusion, political factors are mostly having a negative influence on the conditions for adoption. Corruption, subsidies and (lack of) support from government are the main factors negatively influencing demand, motivation and ability, respectively. In general terms, there is a visible lack of support from the government to agriculture in Colombia, which is affecting all the conditions for adoption of agroecological practices, but is also showing a bigger, deeper problem regarding agriculture. On the other hand, the factor that is influencing positively the most in this case is the support from trade associations. This factor was not initially in the operationalization, but it came out repeatedly in the interviews with associated farmers, showing that through association, farmers enable themselves and support each other to adopt agroecological practices, which was not the case for independent farmers.

4.4.5. Other Factors Found

Other factors within the categories of economic, social, informational and political factors were uncovered that were not explicitly mentioned in the framework by Schoonhoven and Runhaar (2018). See table 9 for a summary of the new factors/ category of factors and what conditions are they influencing.

Something that was mentioned in the interviews constantly was that farmers tend to be lazy, or do not want to invest the time it requires to start a transition towards agroecology. This was categorized as a social factor influencing motivation during the coding process and talked about in section 4.2.2, but it also affects the ability of farmers. This factor did not show up in the desk research, but it was mentioned at least one time by each farmer, and the agronomists made this the centre of their answers. Following this, it was clear that farmers that had adopted more agroecological practices, are farmers that do not rely on the farm to subsist, linking this time

factor to economic availability (economic factor), thus influencing ability. They are, for the most part, pensioned and have the time and money to invest in to adopt agroecological practices, in comparison with independent farmers that count on their harvest to subsist. Independent farmers want to spend little time, effort, and money in the process and, even though they have underlying motivations to have more sustainable farming practices, they do not want to risk their subsistence with experimenting new techniques and risking their crops. *“I started the avocado here for export but when I saw all the requirements and that you cannot use certain chemicals, I thought to myself that it is a lot of work that you have to put in it, so I opted to sell national, because there are no regulations and I do not need to risk the crop experimenting with those ecological products and lose the harvest”*(Farmer 5).

*Table 9. Summary of new factors/category of factors and the respective conditions they are influencing. *Corruption is not a new factor, but in this context was of higher importance than the original framework and was recategorized as a historical factor. **Experts are not discussed in this section, as they were thoroughly discussed in section 4.4.3.*

New factor	Category	Influencing condition
Time	Social/economic factors Historical factors (new category)	Ability and motivation
Unpredictability of nature	Nature factors (new category)	Ability and motivation
History of green revolution	Historical factors (new category)	Ability, motivation, demand and legitimacy
Armed conflict	Historical factors (new category)	Ability, demand and legitimacy
Energy transition	Historical factors (new category)	Ability, demand and legitimacy
Corruption*	Historical factors (new category)	Ability, motivation, demand and legitimacy
Experts**	Informational factors	Ability and legitimacy

Another factor that was underlying many of the arguments and opinions made by the farmers was how unpredictable nature is, especially lately with climate change. They mentioned that avocado trees used to have two harvests a year, but since a couple of years ago, the weather patterns have been changing abruptly and the trees are giving fruit at odd times. This can interfere with contracts with exporters, as they require certain quantities of the fruit and specific times in which the crop can be picked up and shipped. Moreover, these uncertainties with the weather affect the availability of rainwater, and the change in weather patterns can bring upon new diseases and pests (Skendžić, et al. 2021). Because of the

unpredictability of the weather patterns, independent farmers opt to stick with conventional practices, as they know them and have certainty that they will work, as mentioned before. This factor could be categorized as informational. Nevertheless, the influence this factor is having on the ability and motivation to adopt agroecological practices, goes beyond information, thus it is proposed to be a new category of factors for future research.

Another factor that was uncovered in this context are historical factors. These go from the history of green revolution in the country, to the current energy transition, to the country's history of armed conflict, which is now influencing policies. Regarding the green revolution, farmers have become "lazy", as mentioned before, which could include the time factor in this new category. This was discussed explicitly with the agronomist, mentioning that from their expert point of view, the green revolution has brought negative consequences to the agriculture in the country. They mentioned how traditional farming practices, based on Indigenous knowledge, are being forgotten, and the intensification in the use of chemicals to deal with pests is killing other species. The agronomists mentioned that "*farmers do not really think or know about the real consequences of using these chemicals for so long, and the soil and the whole ecosystem needs to recover, but farmers just want the fast, easy way, of putting one chemical to deal with everything*" (Agronomist 2).

Concerning the armed conflict, even though the region has some issues with this back in the 80's and 90's, it has not been affected recently by it. Nowadays, the agricultural policies are mainly focused to address regions that are suffering or suffered the consequences of illegal cocaine plantations, or settlements of guerrillas "*Fortunately, this region has not been strongly marked by the conflict. But we lose some government support because we are in a limbo. San Vicente doesn't have a very strong economy to be good, so the income of the municipality is low, but because we are not in the violent category, the policies do not apply to us*" (Farmer 2).

The energy transition in the country is also putting pressure on the farmers, as there is a phase out of fossil fuels, and they want to replace the income the country gets from this with agricultural export. Nevertheless, to be able to supply the demand, conventional agriculture is "necessary". At the same time, the countries that buy the avocado products, have strong policies regarding these chemical inputs, which are also imported from there, but cannot be used to produce the products that will be exported. This leads to policy-making just for show, pushing farmers to get certified for export, but not providing the sufficient tools to help them maintain

the regulations *“I have my property certified for export, but I think all the talk from the government to certify the farms is just for show. To tell the people ‘Look, in my government we certified all these farms are we are now exporting a lot of avocados’. But the reality is that they come, certify, but then do not help people to maintain the certification. There is a lot of money and effort that goes into that, and the government just wants the numbers”* (Farmer 7).

As mentioned in section 4.3.4, corruption was a factor that really affected farmers when they talked about it. This was mentioned in Schoonhoven and Runhaar (2018) as a potential political factor affecting motivation. Nevertheless, it was not extensively talked about, nor showed in the results of their research. on the other hand, in this context, corruption is a key influencing factor, that affects all the conditions, and has been re-categorized to historical factors. One key governance arrangement that has scarred farmers around the country is the “Agro Ingreso Seguro” policy. Farmers oftentimes referred to it when talking about corruption and the lack of trust they have on the government and its policies for agriculture, affecting not only motivation but also legitimacy: *“look at all the issues we had with Agro Ingreso Seguro. It was so long ago, and we still talk about it. It has scarred us, and now we can’t trust anything the government says. We don’t even look for subsidies anymore, because we know we won’t get them, because of all the corruption”*(Farmer 2).

The program was developed by MADR and the government back in 2007, and was aimed at giving low interest credit to farmers to incentivise development. Nevertheless, in 2009, a research found that millions of pesos from this policy had been given to narco-traffickers, and other powerful families in the country, creating a scheme in which they fractioned their farms and applied for subsidies (El Espectador, 2016). One of these families had COP2.200.000.000 on subsidies. This has created a lack of trust in the government, policies and governance arrangements in general. Benedetti (2017), mentions that this corruption scandal was exacerbated because the formulation of the program was top-down and, even though there was input from the rural and peasant communities, MADR was the one to formulate and implement the policy in its totality.

Concluding, this research showed that there are other contextual factors that are directly influencing the conditions for adoption of agroecological practices. These factors affect the farmers equally, for the most part, with the exception of time factor. The historical dimension of this case, highlights the importance of taking context into consideration when talking about agroecology, as previously mentioned.

4.5. Q3 What factors would need to be addressed in order to have all the conditions necessary for adoption of agroecological practices in the case study?

In this section, an analysis on specific factors that need reinforcement to positively influence the conditions for adoption will be done. As described in previous sections, farmers highlighted the importance of certain factors in their decision to adopt agroecological practices, or to stick with conventional practices. Here this will be addressed, to further explore in section 4.6 and 4.7 how governance arrangements can help address these factors. This section is structured by condition, discussing the factors that need to be addressed to have the condition present/enhanced, and drawing comparisons between the sub-cases when this is pertinent.

4.5.1. Factors That Need Addressing to Have *Ability*

From the interviews, it was clear that *economic factors* are of important weight for the ability of farmers to adopt agroecological practices. For both sub-cases, the factor of market conditions was discussed as something that needed reinforcement, because the market is not guaranteed, especially at the national level. Farmers feel that, without guarantees in the market, it is impossible to start adopting new practices “*One thing that has to change is to guarantee the market, for example, that the government takes the position of partnering with the producer... If I do not have commercialization, to start, I do not have a future, then agroecological projects will not work*” (Farmer 2).

Availability of new business models was a key economic factor for associated farmers to adopt new farming practices. This is possible because they have a network, which provides them with market possibilities. For example, through the association they are “*in a project with a small company that makes guacamole. This is good, because we can take advantage of the avocados that are not aesthetically pleasing for the export market, which is a lot, especially if one is just starting with the process of using organic supplies*” (Farmer 6). This is something that needs to be addressed for independent farmers, as they have less ability to get these types of businesses.

Another economic factor that needs to be addressed to enhance ability is availability of finance, especially influencing independent farmers. Associated farmers talked about this but referring to how less money they needed to invest with agroecological practices, thus influencing their motivation to adopt agroecological practices, and expanding their availability of finance to invest in other things. On the other hand, independent farmers mentioned the

opposite, talking about how expensive and useless these practices are, especially for pesticides and fertilizers, driving farmers to feel demotivated to adopt these practices.

Social factors need significant strengthening to increase ability, especially for independent farmers who often lack the strong support networks that associated farmers enjoy. Enhancing community support for independent farmers could provide them with much-needed access to information about innovative business models and opportunities for learning. Community support networks also facilitate the sharing of resources, expertise, and experiences among farmers, creating an environment where learning and adaptation are encouraged, as seen with the associated farmers (Bruce, Jackson and Lamprinopoulou, 2021). Independent farmers, who may feel isolated in their efforts, would greatly benefit from the collective knowledge and moral support that comes from being part of a larger, supportive community. This communal approach can significantly reduce the perceived risks and challenges of adopting agroecological practices, enhancing ability overall.

As mentioned in section 4.3.3., level of education is a key *informational factor* influencing ability in this case study. This needs to be addressed from a policy perspective, as it uncovers a deeper issue in the general landscape of the country. Improving the overall education level of these communities is crucial for empowering farmers with the knowledge and skills necessary for adopting agroecological practices. Finally, *political factors* that need addressing to have overall ability in this case are support from government, NGO's and trade associations. The biggest political factor negatively influencing the ability to adopt agroecological practices is the lack of support from the Colombian government, which needs to be strengthened. In the case of trade associations, associated farmers showed to have an advantage in in terms of ability. Thus, it is key to encourage independent farmers to join or seek support from trade associations.

In conclusion, the factors discussed need addressing through governance arrangements to enhance the ability to adopt agroecological practices. First, several economic factors are negatively influencing the ability to adopt agroecological practices, especially for independent farmers. Thus, economic incentives, or subsidies, to help independent farmers' capabilities, are key to streamline the adoption of agroecological practices in this context. Additionally, independent farmers would benefit more from higher community support, as the associated farmers have. This can help farmers to get information about new business models and participate in trainings aimed at enhancing the knowledge of agroecological practices and its

benefits. Moreover, there is a lack of information about the benefits of agroecological practices. Especially with independent farmers, they know that using conventional farming practices is not good for the environment and the health of the people that consumes their products, but a perception that ecological, or more sustainable practices, are too expensive, keeps these farmers from adopting agroecological practices. Finally, support from different governance actors, such as NGO's, national and local governments and trade associations are key to increasing the ability of farmers to adopt agroecological practices.

4.5.2. Factors That Need Addressing to Have *Motivation*

Addressing *economic factors*, particularly the cost-benefit aspect, is crucial for enhancing farmers' motivation to adopt agroecological practices. Farmers are often deterred by the perceived high initial costs and uncertain financial returns of adopting agroecological practices. Providing financial incentives, subsidies, and demonstrating long-term cost savings and benefits can help address the perceived risks. Ensuring that farmers understand the economic advantages of agroecological practices, such as reduced input costs and potential premium prices for organic products, can significantly boost their motivation to adopt these methods.

Social factors, including time aspects and community values, play a significant role in the adoption of agroecological practices. Farmers may be motivated to adopt sustainable practices if they see them as aligned with their community values and cultural practices. However, time constraints often hinder their motivation to invest in learning and implementing new methods. Addressing these social factors involves creating community-based initiatives and peer support networks that encourage collective learning and implementation. This approach can help farmers manage their time better and feel supported in to adopt agroecology, thereby increasing their motivation and also their ability.

Informational factors are critical for strengthening both the motivation and ability of farmers to adopt agroecological practices. Providing more training opportunities and educational resources, especially for independent farmers who lack access to these resources, is essential. These farmers often have the motivation to learn but lack the platforms to acquire the necessary knowledge and skills. Establishing accessible training programs that allow farmers to explore and practice agroecological methods without risking their crops can enhance their understanding of the farm ecosystem and boost their motivation in adopting these practices.

Political factors, such as corruption and bureaucracy, significantly impact farmers' motivation to adopt agroecological practices. The prevalence of corruption has led to a deep distrust in government institutions, discouraging farmers from participating in government-led initiatives. Addressing these political issues involves creating transparent, accountable governance structures and reducing bureaucratic obstacles that farmers face. Building trust through consistent and fair policy implementation and involving farmers in decision-making processes can improve their perception of government support, thereby enhancing their motivation to adopt sustainable farming practices.

In conclusion, the condition of motivation could be strengthened by addressing informational and political factors, which are the ones less talked about by farmers. Economic factors such as cost-benefit is a key factor that needs addressing to enhance motivation. Informational factors need strengthening by providing more spaces for training, especially for independent farmers. They have the motivation to learn, but lack the opportunities, linking this with the condition of ability. Creating spaces in which independent farmers can learn and explore agroecological practices, without risking their crops, can be an effective way of increasing the motivation to adopt agroecological practices. Finally, corruption and bureaucracy need to be addressed to rebuild trust towards governance and enhance motivation of the farmers to participate in government-led initiatives that can aid them in the process of adopting agroecological practices.

4.5.3. Factors That Need Addressing to Have *Demand*

The combination of environmental/market regulations, demand for sustainable products and conditions in contracts with customers are key *economic factors* needed to be addressed, for the presence of demand as a condition to adopt agroecological practices. These factors were talked about with negative connotations by independent farmers. They mentioned that because of the strict export regulations with supplies (e.g. not using certain chemical and synthetic pesticides and fertilizers) they chose to sell their produce in the local market. As the local and national regulations are not well known, nor strict, it affects the demand to adopt agroecological practices.

Social factors such as peer pressure and public opinion are lacking in this case, affecting the demand needed for adoption of agroecological practices. In this case, peer pressure can be further strengthened by incentivizing farmers that have adopted agroecological practices to put more pressure on their neighbours. As for public opinion, it is trickier to address at the farmer

level. Nevertheless, the Colombian government should increase the knowledge of the public of about the benefits of agroecology, thus pressuring farmers to adopt these practices by increasing the public demand for healthier produce that is cultivated with environmentally and socially friendly practices.

Informational factors influencing demand are not plentiful. From the operationalization, only one factor in this category should be influencing the demand to adopt agroecological practices: understanding of request to do regenerative practices. In this case, this factor was not mentioned by the farmers at all. This shows a lack of understanding of requests, or, at a deeper level, there is not request to adopt these practices. Either way, this factor should be addressed to increase the overall demand.

Finally, *political factors* influencing demand, which need addressing the most are pressure (from both NGO's and government organizations) and subsidies. There is a clear lack of pressure, from institutions in general in the country, to adopt more sustainable farming practices. the rhetoric of the new government is aimed at increasing agricultural input to supply the economic whole that the energy transition will leave. Nevertheless, the policies aimed at increasing agricultural production are not well known by the farmers, showing a communication problem between institutions and farmers. This also adds to the lack of trust talked about in previous sections. Additionally, subsidies are seen as negative by farmers. In this context, subsidies are not helping farmers as they should. First, because farmers do not trust these subsidies. Second, because there is a lot of barriers and requirements to acquire the subsidies, adding to the demotivation talked about in the previous section. Finally, subsidies are not aimed at adoption of sustainable practices, but are mostly directed at alleviating economic pressures of farmers. Subsidies need to be reformulated and communicated, to increase the demand for adoption of agroecological practices.

In conclusion, the condition of demand is greatly missing from the case study. In sections 4.3 and 4.4, it was discussed that demand was lacking in regulatory processes, especially at the local and national level. Moreover, when there are regulations in place, farmers do not have knowledge of them. There is also no pressure from NGOs nor the general public. For this condition, there are no striking differences between the sub-cases, with the factors influencing equally both groups. Peer pressure can be addressed by associated farmers that have adopted agroecological practices, by strongly incentivizing other farmers, both independent and associated, to adopt the practices that have worked for them. this can also be tied to the

understanding of request to do regenerative practices. If other farmers adopt more agroecological practices, and are outspoken about them, this can create a communal understanding of the advantages of adopting these practices. Finally, political factors influencing demand that need addressing include pressure from NGOs and government organizations, and the reformation of subsidies. There is a lack of institutional pressure and communication issues between institutions and farmers, leading to distrust and ineffective subsidies that are not geared towards promoting the adoption of sustainable farming practices.

4.5.4. Factors That Need Addressing to Have *Legitimacy*

Economic factors are key to enhancing the legitimacy of agroecological practices. A deeper understanding of contracts and legislation is essential for farmers, as it influences their level of freedom when adopting these practices. Providing farmers with clear, accessible information about their rights and obligations can empower them to make informed decisions. Additionally, ensuring that contracts and legislation support the flexibility needed to adopt sustainable practices, can remove economic barriers and enhance the attractiveness of agroecological methods.

Social factors, including cultural settings, peer pressure, and community norms, significantly impact the adoption of agroecological practices. In this context, conventional methods are deeply ingrained, and shifting these norms requires concerted effort. Promoting agroecological practices through community leaders and successful early adopters can create a ripple effect, normalizing these practices within the community. Peer pressure and cultural acceptance can thus become powerful legitimators, encouraging more farmers to adopt agroecological practices.

Informational factors are crucial for building legitimacy and fostering the adoption of agroecological practices. Creating a robust community of farmers who share knowledge, and experiences can enhance collective learning and innovation. The new informational factor, experts, need to be better leveraged. Encouraging agronomists to research agroecological practices, share their knowledge with farmers, and incentivize adoption is crucial for building legitimacy and promoting widespread adoption of these practices.

Political factors, such as the framing of agriculture in policies, the strictness of legislation, and the indirect effects of adjacent policies, play a critical role in the legitimacy for adoption of agroecological practices. Current legislation is often inadequate and needs to be more

stringent to support sustainable farming. Furthermore, the way agriculture is presented in policies and communicated to farmers is often disconnected from their realities. Improving communication and aligning policies with the practical needs and challenges of farmers can enhance trust and compliance. Addressing these political factors ensures that policies not only support but actively encourage the adoption of agroecological practices, thereby fostering a legitimate environment where sustainable methods can thrive.

In conclusion, there are several factors influencing legitimacy in the case study that need to be addressed. Economic factors include the need for more knowledge about contracts and legislation, as well as understanding the level of freedom available when adopting agroecological practices. Social factors such as peer pressure and cultural norms also play a crucial role, as it can lead to normalize the adoption of agroecological practices over conventional practices in the production of avocado. The new factor, experts, needs to be better leveraged. Experts are crucial for establishing legitimacy; therefore, it would be beneficial to encourage agronomists to research agroecological practices, share their knowledge with farmers, and incentivize adoption. Politically, the strictness of legislation is inadequate and needs to be more stringent. Moreover, the framing of agriculture in policies and communication needs addressing, as it is clear that there is a disconnect with the reality the farmers live. Addressing these factors will help build the legitimacy needed for the widespread adoption of agroecological practices.

To summarize the results of this section, several key factors must be addressed through governance arrangements to enhance the adoption of agroecological practices. Economically, independent farmers need more support through subsidies and incentives to build their capabilities and streamline adoption. Socially, higher community support and training can help farmers understand and implement agroecological methods. Informationally, providing spaces for farmers to learn and explore without risking their crops is crucial. Politically, addressing corruption and bureaucracy is essential to rebuild trust in governance, while improved communication and stricter legislation can better align policies with farmers' realities. Enhancing motivation, demand, and legitimacy through these measures will support the widespread adoption of agroecological farming practices.

4.6. Q4 To what extent and how are factors influenced or created by current governance arrangements?

There are several governance arrangements aiming towards the adoption of more sustainable agricultural practices, which are potentially influencing economic, social, informational and political factors. Table 10 shows the current governance arrangements addressing the adoption of sustainable agricultural practices, which factors are they – potentially – influencing and which conditions are subsequently affected (for an extended description, see Appendix D). The initial search was aimed at analysing governance arrangements that specifically addressed agroecology in the location of the case study. Nevertheless, the search did not show an extensive list, and this narrowed the understanding of governance in this context. Thus, other governance arrangements were looked at that indirectly have an influence on the different factors. This includes governance arrangements at the global, regional, national, and local level. Moreover, specific economic instruments provided at the national level were included in this list, as they can potentially affect economic factors discussed before. This section is structured as follows: First, the types of governance arrangements are discussed. Second, the factors influenced/created by these arrangements are talked about. Finally, the opinions of farmers over the governance arrangements they know will be explored.

4.6.1. Types Of Governance Arrangements

The search and analysis showed that there are several governance arrangements that (in)directly address economic, social informational and political factors influencing the conditions necessary for adoption of agroecological practices. From the 13 governance arrangements analysed, 7 are characterized as centralized, 2 are decentralized, 1 is public-private, and 3 are interactive. There was only one governance arrangement that could be classified as self-governance.

The centralized governance arrangements focus mainly on economic subsidies to help farmers alleviate the burden of credits they might have. Only one of these arrangements was focused on helping farmers pay for supplies. The subsidy only covered 20% of the price, had to come from an authorized store (the government supplied a list of authorized stores), and there were several forms that needed to be submitted. Centralized/decentralized arrangements also focused on providing guidelines to other government agencies/actors to address agriculture from different perspectives. For example, the *Gender and climate change* guidelines are aimed

at training government official into including a gender perspective in the different programmes developed to tackle challenges coming from climate change. The subject of agriculture is mentioned in these guidelines, encouraging the ministry of agriculture and rural development to create programmes that incentivize sustainable agricultural practices, such as agroecology.

For the most part, the other governance arrangements found, regardless of the mode of governance, were aimed at creating guidelines for the implementation of more sustainable farming practices, which in hindsight is good. Nevertheless, there is a lack of involvement from farmers in these programs. Only two arrangements, namely *Sowing capabilities* (interactive mode) and *Agro Antioquia exporta 4.0* (public-private mode), were programmes that actively involved farmers, providing them with training for sustainable farming practices.

From this analysis it can be said that governance arrangements are lacking greatly. Centralized/decentralized arrangements are dominant, but not actively encouraging the participation of farmers. Moreover, for farmers to access the benefit of these arrangements, they have to go through many bureaucratic hurdles, investing time and effort, for a little economic relief, which is also not guaranteed. This was constantly talked about in the interviews and will be discussed in section 4.6.3. Moreover, there were no active arrangements, other than the farmer's association and the BancO2 initiative, which encourages big companies and corporations to pay for their environmental footprint, then this money is given to farmer families and ethnic communities that protect and actively conserve ecosystems. Nevertheless, this was also criticized by farmers interviewed, which will be discussed in section 4.6.3.

The lack of self-governance shows that the control over which practices are to be used in this case lays on the government and market actors. This could explain why the uptake of agroecological practices is not sufficient. The analysis shows that the arrangements, for the most part, are doing the bare minimum regarding sustainable farming practices, especially coming from centralized/decentralized modes of governance. This connects well with what farmers have discussed in previous sections, criticizing the government over the lack of support and the farmers' ever-growing mistrust in policies and subsidies. Moreover, it reflects the lack of power farmers, especially independent farmers, have over their own practices. Nevertheless, by considering the Hass Agricultural Association (AAH) as self-governance, it can be seen that these types of arrangements have sufficient power and influence over the associated farmers to adopt agroecological practices.

In conclusion, current governance arrangements primarily offer limited economic subsidies with significant bureaucratic hurdles and lack active farmer participation. These centralized and decentralized programs fail to adequately incentivize sustainable agricultural practices, contributing to farmers' mistrust in government policies. While some initiatives provide essential training, most arrangements fall short in engaging farmers. The dominance of government and market actors over farming practices hinders the adoption of agroecological practices. However, self-governing bodies like the AAH show potential for more effective, farmer-led approaches to promote sustainability.

4.6.2. Factors Influenced/Created by Governance Arrangements

As seen in table 10, governance arrangements are mostly influencing economic and informational factors. Nevertheless, this influence is insufficient, and, in the case of centralized/decentralized governance arrangements, it seems to be negatively influencing the conditions for adoption of agroecological practices.

In the case of *economic* factors, centralized governance arrangements are, in this context, having a negative influence. Specifically, there is a negative impact on the market conditions and the factor of available finances. Regarding market conditions, these centralized governance arrangements are not tackling the issues that farmers are presenting regarding lack of market guarantees. As mentioned before, the local market is barely regulated, and does not minimize risks of changing agricultural practices, thus farmers stick to conventional practices. The export market, on the other hand, is more regulated, but it is lacking guarantees. Farmers have the option of sticking to these strict regulations, improving their farming practices, but risking derisory contracts that take advantage of them. Or, they have the option to keep their current practices and sell their produce in the local market, which has no strict regulations. Either way, there is no win-win situation regarding the market. Although the Colombian government is currently reforming the agricultural sector, the new reform is only tackling issues of land ownership for farmers, a problem that arose from the Colombian armed conflict. Regarding available finances, the arrangements analysed are insufficient. Mostly, these are specifically made to alleviate existing credits the farmers have, but the conditions to attain them are strict and vague, and there are many bureaucratic hurdles the farmers need to go through. Moreover, farmers do not trust these credit subsidies, as they, in general, do not trust the government. Especially if there is money involved, farmers are wary of it, due to the past corruption scandals.

With regards to *social* factors, these are the factors that are influenced the least by governance arrangements. Only 4 out of 14 arrangements are actively including social aspects into the programmes. Especially, two of these arrangements, namely the AAH and Sowing Capabilities, have had a positive influence on social factors such as community support and trust, and values. Although Sowing Capabilities was not mentioned by the farmers interviewed, this programme did include farmer families in the location of the case study, which can, in the long run, have an impact in the way farmers and the community that surrounds them see the value of agroecological farming practices. Regarding the Hass Agricultural Association, this arrangement influences social factors very strongly, by what the associated farmers mentioned. They have changed their views on agriculture thanks to the network of farmers and the different experiences and knowledge each farmer brings to the association. They have several social encounters a year, to strengthen the bonds between them, which is fundamental when practicing agroecology.

Informational factors are greatly influenced by the arrangements analysed. Several of the arrangements are based on exclusively providing information and guidelines on agroecology or sustainable farming practices in general. Nevertheless, it was noticed that, oftentimes, farmers do not know about these. This comes from a lack of communication, as the information is not easy to find, but also from a lack of involvement of farmers in these arrangements. The guidelines are created by researchers and policy-makers but lack the input of farmers. On the other hand, governance arrangements like the *Agro Antioquia Exporta 4.0*, positively influenced informational factors by providing training in sustainable farming practices, and teaching farmers about innovative programmes to keep track of the different aspects of avocado farming.

Lastly, *political* factors are influenced only by 5 out of 15 arrangements. Governance arrangements like *gender and climate change*, has a positive, indirect effect on adoption of agroecological practices. Nevertheless, this arrangement is aimed at governmental agencies and as mentioned before, there is a disconnect between their realities and farmers' realities. Corruption and bureaucracy, as political factors, are both being reinforced by governance arrangements, specifically centralized and decentralized governance arrangements. As previously discussed, there is no perceived support from the government, and, as reflected in the subsidies analysed, these lack connection to what farmers are going through. For example, subsidies are mainly tackling economic shortcomings regarding existing credits that farmers have, which is not sufficient to address the adoption of agroecological practices. Moreover,

these subsidies are not well-received by farmers, mainly because of the historical corruption previous subsidies and policies had. In some cases, farmers stated that they reached out to get one of these subsidies, but that the economic incentive never arrived, and the only answer they got from the government institution in charge was “*we don't know anything about it*” (Farmer 3). The only political factor being positively influenced by these arrangements is the support of trade associations, coming directly from the only self-governance arrangement found in the analysis.

4.6.3. Farmer's Opinions on Governance Arrangements

Through the interviews, it was asked to the farmers if they had knowledge of environmental guidelines, subsidies and other projects and the answer was consistently “*no*”. Farmers did not know about the environmental regulations regarding agricultural practices, nor which opportunities they could have to address the challenges they go through. Looking through table 10, and analysing the interviews, there are some governance arrangements that were known by the farmers and have actually participated. The association is not discussed in this section, as the benefits and challenges of it are discussed throughout the research with the sub-case of associated farmers.

One interviewee mentioned that he reached out to get the subsidy support for purchase of inputs, which gives back 20% of what they spent on fertilizers “*It happened to me, they told us about the subsidy on inputs, and I never saw it. Some people got it, but others did not. I called the municipality and they said they got the money, but it looks like it disappeared on the way here -he laughs-*” (Farmer 3). This reflects the corruption and lack of trust in the government. Farmers are used to not getting these subsidies when they apply for them. Thus, with time, they give up on hopes of getting any kind of support.

Another farmer commented on the BancO2 initiative, that he was excited about the opportunity, but that he has not heard from them “*I made the proposal, because I have 3 or 4 hectares of native forest that I want to protect, but nothing happens. It has been difficult*” (Farmer 8). Although the initiative is well received by farmers, the arrangement is showing to be inefficient in delivering, or even communicating with the farmers.

The governance arrangement that was mentioned the most was the *Agro Antioquia exporta 4.0*, a public-private governance arrangement that trained avocado farmers in the region with 4.0 technology, to get export certifications. Although 4.0 agricultural technology is not aimed

at agroecology, it can help streamline the farm processes, freeing time to invest in agroecological practices, a key factor discussed in section 4.3. This arrangement had a good impact on the farmers. They got to learn important information about the production of avocado in the region, how to utilize technology to streamline the processes, and sustainable farming techniques, like creating water mirrors, to conserve water. *“I had the opportunity to attend the Agro Antioquia Exporta training, and I really liked it. There were some interesting talks on sustainable agriculture for avocado, how to create your own fertilizers and things like that. I hope I can do that soon”* (Farmer 4).

Lastly, some farmers mentioned the UMATA, a technical assistance unite for farmers, that each municipality in the country must have. There were conflicting opinions about it. A couple of independent farmers mentioned that they would get information on sustainable farming practices from the UMATA, and also, they would get in contact with agronomists that the government provides to help through the process of starting an avocado farm. On the other hand, associated farmers would mention the UMATA in a negative way, saying that *“I don’t even know if that thing exists. I go to their office here in the town, and it’s always empty, no one is there”* (Farmer 8).

In summary, from the 14 arrangements analysed, only 4 were known by the farmers, without counting the Hass Agricultural Association. The interviews revealed a significant gap in farmers' awareness and engagement with environmental guidelines, subsidies, and various governance arrangements. Most farmers were unaware of existing regulations and potential opportunities to address their challenges. For instance, while some farmers knew about the subsidy support for purchasing inputs, their experiences were marred by corruption and distrust, as subsidies often failed to reach them. Similarly, initiatives like *BancO2*, despite being well-received, suffered from poor communication and inefficiency. However, the *Agro Antioquia Exporta 4.0* program stood out as a positive example. This public-private arrangement successfully trained farmers in advanced agricultural technology and sustainable practices, illustrating the potential impact of effective governance arrangements. Lastly, the *UMATA*, a technical assistance unit for farmers, received mixed reviews. While some farmers benefited from its services, others found it unreliable and poorly managed. Overall, these findings underscore the need for more transparent, efficient, and farmer-inclusive governance arrangements to foster trust and support the adoption of agroecological practices.

Table 10 Governance arrangements addressing adoption of sustainable agricultural practices and their influence on factors.

Mode of governance	Name of arrangement	Description	Factors influenced/created	Conditions influenced
Centralized	Gender and climate change ¹ .	<p><u>Initiating actors:</u> National Government (ministry of environment and sustainable development)</p> <p><u>Interaction with other actors:</u> the guidelines are aimed to train other ministries.</p> <p><u>Power dynamics:</u> Authority, through guidelines to include gender in policies across all ministries.</p> <p><u>Goal integration:</u> uniform. Guidelines made to streamline gender inclusion across all ministries to address climate change</p>	<i>Political, social and informational</i> factors are influenced. This program can be leveraged to increase information about the importance of gender in agriculture and get the government closer to the realities of agricultural practices, increasing trust and legitimacy.	Legitimacy.
	Support program for small producers for the purchase of inputs. ²	<p><u>Initiating actors:</u> National government (ministry of agriculture and rural development)</p> <p><u>Interaction with other actors:</u> top-down. Aimed at support farmers.</p> <p><u>Power dynamics:</u> authority, through norms that need to be followed to attain the support.</p> <p><u>Goal integration:</u> Uniform. Provided economic support, through a 20% refund on the value of the purchase of inputs within a list defined by the ministry. (end of program: 2023)</p>	<i>Economic</i> factors influenced by providing subsidies to farmers to aid them with the purchase of specific agricultural inputs.	Ability
	Agricultural guarantee fund (FAG) ²	<p><u>Initiating actors:</u> National government (ministry of agriculture and rural development)</p> <p><u>Interaction with other actors:</u> top-down. Aimed at supporting farmers.</p> <p><u>Power dynamics:</u> authority, through norms that need to be followed to attain the support.</p> <p><u>Goal integration:</u> Uniform. Collateral support for producers seeking credit for their business operations when they lack standard guarantees typically required by lenders.</p>	<i>Economic</i> factors influenced by providing subsidies to farmers, to back credit requests to develop projects. They do not apply to purchase agricultural land.	Ability

¹ Colombia. Ministerio de Ambiente y desarrollo sostenible (2020)

²Colombia. Ministerio de agricultura y desarrollo rural (n.da)

Rural Capitalization Incentive (ICR) ²		<p><u>Initiating actors:</u> National government (ministry of agriculture and rural development)</p> <p><u>Interaction with other actors:</u> top-down. Aimed at supporting farmers.</p> <p><u>Power dynamics:</u> authority, through norms that need to be followed to attain the support.</p> <p><u>Goal integration:</u> uniform. Aimed at stimulating capitalization investments in the field to conduct new projects aimed at improving the competitiveness, sustainability, and modernization of agricultural activities.</p>	<p><i>Economic</i> factors influenced by providing subsidies to help with any credit the farmers have, related to sustainable agricultural projects.</p>	Ability
Special Line of Credit (LEC) ²		<p><u>Initiating actors:</u> National government (ministry of agriculture and rural development)</p> <p><u>Interaction with other actors:</u> top-down. Aimed at supporting farmers.</p> <p><u>Power dynamics:</u> authority, through norms that need to be followed to attain the support.</p> <p><u>Goal integration:</u> uniform. Offers a subsidized interest rate that is intended for the financing of short-cycle products related to the basic food basket.</p>	<p><i>Economic</i> factors influenced by providing subsidies to farmers in special conditions.</p>	Ability
Agricultural Solidarity Fund (FONSA) ²		<p><u>Initiating actors:</u> National government (ministry of agriculture and rural development)</p> <p><u>Interaction with other actors:</u> top-down. Aimed at supporting farmers.</p> <p><u>Power dynamics:</u> authority, through norms that need to be followed to attain the support.</p> <p><u>Goal integration:</u> uniform. Provides economic relief to pay debts of credits, when farmers face unforeseeable situations that affect their crops.</p>	<p><i>Economic</i> factors influenced, by providing to help with any credit the farmers have</p>	Ability

	Guidelines for the Development of Low Impact Agricultural Activities ³	<p><u>Initiating actors:</u> National Government (ministry of environment and sustainable development & ministry of agriculture and rural development)</p> <p><u>Interaction with other actors:</u> top-down.</p> <p><u>Power dynamics:</u> Authority, through guidelines to develop agricultural activities of low impact in páramos.</p> <p><u>Goal integration:</u> uniform. 5 guidelines regarding ecosystem conservation and 7 guidelines for sustainable agricultural practices that recommend incorporating green fertilizers and maintaining soil cover, implementing rotational grazing, and supplementary feeding for livestock.</p>	<i>Informational</i> factors influenced, but providing knowledge of sustainable agricultural practices, including agroecological practices. Although aimed at agricultural practices in a very specific ecosystem (páramo), these guidelines could be streamlined to fit other ecosystems.	Ability, demand and legitimacy.
Decentralized	Municipal Agricultural Technical Assistance Units (UMATA) ⁴	<p><u>Initiating actors:</u> National government, toppled down to local governments.</p> <p><u>Interaction with other actors:</u> top-down, but farmers are encouraged to approach these units to get assistance.</p> <p><u>Power dynamics:</u> authority.</p> <p><u>Goal integration:</u> uniform. Created by “National Decree 1929 of 1994.” Its main function is to guarantee the provision of agricultural technical assistance service to small and medium-sized rural producers in a municipality.</p>	<i>Informational</i> factors are influenced, by providing technical assistance to farmers regarding agricultural practices	Ability and motivation.
	Antioquia departmental plan for agroecology. ⁵	<p><u>Initiating actors:</u> Regional governance (secretary of agriculture and rural development of Antioquia)</p> <p><u>Interaction with other actors:</u> Top-down.</p> <p><u>Power dynamics:</u> Authority and legitimacy</p> <p><u>Goal integration:</u> Uniform. It is an instrument developed to plan, orient and implement actions for transition and transformation of the agricultural sector into agroecology, in the department during the period of 2023 to 2040.</p>	Influences <i>political and informational</i> factors, by providing information and training guidelines for creating and implementing policies aimed at agroecological adoption.	Ability, demand and legitimacy.

³ Resolución 1294 de 2021

⁴ Colombia. Ministerio de agricultura y Desarrollo Rural (n.db)

⁵ Secretaria de Agricultura y Desarrollo Rural de Antioquia SADRA (2023)

Public-private	Agro Antioquia exporta 4.0 ⁶	<p><u>Initiating actors:</u> regional government actors, Colombian Agricultural Research Corporation (AGROSAVIA), Colombian institution of Agriculture (ICA) and Hass Avocado Producers and Exporters Corporation of Colombia (Corpohass)</p> <p><u>Interaction with other actors:</u> boundaries set by the government, but actors act autonomously.</p> <p><u>Power dynamics:</u> contractual agreements by providing certifications under GLOBAL G.A.P and implementing 4.0 agricultural technologies.</p> <p><u>Goal integration:</u> uniform goals, towards specific actors (avocado farmers). The program sought to increase the export supply of certain crops in the department.</p>	Influenced <i>informational, social and economic</i> factors, by exploring new technologies, creating a space for collaboration, introducing the subject of sustainable agriculture and providing new business models. Additionally, the results of this program are used to track weather changes for Hass production, which can help address the new nature factors.	Ability, motivation and legitimacy.
	Sowing capabilities ⁷	<p><u>Initiating actors:</u> Food and Agriculture Organization of the United Nations, Brazilian and Colombian government. Civil society (peasant and farmer families)</p> <p><u>Interaction with other actors:</u> equal terms.</p> <p><u>Power dynamics:</u> Legitimacy, built upon consensus regarding roles, trust and knowledge.</p> <p><u>Goal integration:</u> Tailored to specific context to strengthen instruments and policies for campesinos, Family and Community Agriculture in Colombia, based on knowledge management and the exchange of experience. (FAO 2021b).</p>	Influenced <i>social, informational and political</i> factors, by providing close training and monitoring to small and family farms. Several manuals were created from this arraignment, which are accessible to other farmers.	Ability, motivation and legitimacy
Interactive	Voluntary guidelines for agro-environmental policies in Latin America and the Caribbean ⁸	<p><u>Initiating actors:</u> Food and Agriculture Organization of the United Nations.</p> <p><u>Interaction with other actors:</u> voluntary participation from government agencies across Latin America. Nevertheless, other actors, such as farmers, fishers and other agricultural organizations are encouraged to use the guidelines.</p>	Influences <i>political and informational</i> factors, by providing information and training guidelines for creating and implementing policies aimed at adoption of sustainable agricultural practices.	Ability and legitimacy.

⁶ Instituto Colombiano Agropecuario ICA (2021)

⁷ FAO (2021b).

⁸ FAO (2016)

		<p><u>Power dynamics:</u> Authoritative, as it provides guidelines, but mainly legitimacy.</p> <p><u>Goal integration:</u> tailored to specific context. to guide States in improving policies using an agro-environmental approach that integrates society, territory, environment, and economy, and for developing these policies in collaboration with various social actors.</p>		
	BancO2 ⁹	<p><u>Initiating actors:</u> government agencies, private actors (grupo éxito, nutresa, alion, cenit), regional corporations and civil society (afrocolombian communities, farmer families and Indigenous communities)</p> <p><u>Interaction with other actors:</u> BancO2 determines the extent to which other actors are to be involved.</p> <p><u>Power dynamics:</u> legitimacy, built upon consensus regarding roles, trust and knowledge.</p> <p><u>Goal integration:</u> Customized goals, to fit the initiating actor's needs, this is the first Colombian strategy focused on payments for environmental services.</p>	It influences <i>economic</i> factors, by allowing farmers to get paid for conserving their native forests.	Ability and motivation.
Self-governance	Asociación Agropecuaria Hass (AAH) ¹⁰	<p><u>Initiating actors:</u> Hass avocado farmers (civil society)</p> <p><u>Interaction with other actors:</u> farmers in the association decide the extent of involvement of other actors.</p> <p><u>Power dynamics:</u> mainly autonomy, with group size and social capital aiding the power dynamics.</p> <p><u>Goal integration:</u> customized to fit associated farmers' needs. As needed, they collaborate with other organizations to provide trainings, establish networks with companies for future contracts to commercialize their products, etc.</p>	Influences <i>economic, social, informational and political</i> factors, by creating a social space for farmers to generate and share knowledge. Through their status as association, farmers can get better contracts and connections with other organizations at the local, regional and national level.	Ability, motivation, demand and legitimacy.

⁹ BancO2 (n.d)

¹⁰ From conversations with the president and secretary of the association.

4.7. Q5 What changes in existing/new governance arrangements are needed to ensure the positive influence of all factors to provide the conditions necessary for adoption of agroecological practices?

The adoption of agroecological practices hinges on the presences of ability, motivation, demand and legitimacy, which have a complex interplay of economic, social, informational, and political factors. To ensure these factors positively influence the conditions necessary for a widespread adoption, existing and new governance arrangements must be re-evaluated and adjusted accordingly. This section explores the necessary changes in current governance arrangements, and proposes new ones, to enhance motivation, ability, demand, and legitimacy among farmers. By addressing these key areas through targeted policies, incentives, and support mechanisms, governance structures can create an environment conducive to sustainable agricultural practices.

During the search for these governance arrangements, it was difficult to understand where to go to apply for some of the subsidies. There are also many bureaucratic steps to be made and many conditions that the farmers have to attain for before applying. This is a complicated process, which puts barriers, especially to older farmers, as it can only be done through the internet, and the accessibility of the platforms is not optimal. During the interviews, older farmers mentioned that they are not willing to use technology to look for information *“I don’t use that, there are a lot of things for the youth there, [...] with new, modern actualized things, but one being this old is scared to take those things”* (Farmer 9).

It was found that the communication and accessibility regarding these governance arrangements are not optimal. One example of this is the last update made to environmental guidelines for agricultural practices in the country. There was a post on the website of the ministry for environmental and sustainable development (MADS), talking about the last update made to these guidelines, but the guidelines themselves were not found. Additionally, as mentioned before, farmers only knew about a few of the arrangements presented in the table. Thus, platforms to access information about governance arrangements need to be made more accessible. Not only to support the elder population of farmers, but to make it easier for new farmers to participate. Communication needs to also be improved. Centralized arrangements need to be transformed to fit the realities of the farmers. Also to change the conventional farming to more sustainable, which is in the plans of the MADS, but it gets undermined by

policies aimed at increasing agricultural yields. This needs to be directly discussed with farmers.

Farmers should be directly involved in the development and implementation of governance arrangements aimed at the adoption of agroecological practices for several key reasons. First, farmers possess firsthand knowledge and experience with their land, ensuring that governance arrangements are practical, relevant, and tailored to actual farming conditions and challenges. Their involvement builds trust and legitimacy in the arrangements, leading to greater acceptance and adherence to agroecological practices (Montenegro de Wit and Iles, 2016). Additionally, direct participation allows policies to more accurately address the specific economic, social, and informational needs of the farming community (Asai et al., 2018). This alignment with real-world needs increases the effectiveness of support mechanisms. Moreover, involvement empowers farmers, increasing their motivation to adopt new practices as they feel a sense of ownership and responsibility. Improved communication between farmers and policymakers results in smoother implementation and better dissemination of information (Asai et al., 2018). Farmers' participation also encourages innovation and adaptation, leading to the development of more resilient farming practices suited to local conditions (Vermeulen et al., 2018). Finally, involving farmers fosters a sense of community and collective effort towards sustainable agriculture, promoting social cohesion and collaboration essential for the widespread adoption of agroecological practices (Lacombe, Couix and Hazard, 2018).

Furthermore, improving communication and accessibility of governance arrangements is crucial for the adoption of agroecological practices. To achieve this, enhanced information dissemination is essential. Distributing information through multiple channels such as social media, local radio, community meetings, and printed materials ensures a wider reach. Information must be clear and concise, avoiding technical language, and utilizing visuals like infographics to explain complex concepts. Localized content tailored to the specific community needs will address particular concerns more effectively. Stakeholder engagement is also vital; involving local leaders can bridge the gap between authorities and farmers, while participatory approaches ensure that the needs and perspectives of farmers and other stakeholders are considered in decision-making processes.

Lastly, capacity building plays a significant role in the effort of adopting agroecological practices, by providing training sessions and workshops to educate farmers and stakeholders about governance arrangements, their benefits, and how to access them. Establishing support

networks and peer groups can enable farmers to share knowledge and experiences. Utilizing technology, such as developing digital platforms and mobile applications, provides real-time information and resources about governance arrangements, while interactive tools like chatbots and hotlines offer assistance. This can help engage the newer generations into farming. Nevertheless, it can have potential backlash with older generations that are not tech savvy, as discussed in previous sections. This can be tackled by simplifying procedures and streamlining application processes, and establishing one-stop centres, subsequently reducing bureaucratic barriers. Additionally, creating regular feedback mechanisms can ensure continuous improvement of governance arrangements, while transparency initiatives build trust through consistent and reliable communication. These strategies can collectively enhance the ability of farmers to adopt agroecological practices, fostering a supportive environment for sustainable agriculture.

Improving current arrangements is not enough. As discussed with some farmers and the agronomists, new governance arrangement focused on communal farms, dedicated to teaching agroecology in avocado production can significantly enhance the adoption of sustainable practices. By pooling resources and sharing investment risks, communal farms can reduce the financial burden on individual farmers, making it easier for them to adopt agroecological practices. This collaborative approach could foster a sense of community, where farmers can support each other and share experiences, thus building a strong network of mutual assistance and learning. Information building and sharing are integral components of this arrangement, with regular workshops, training sessions, and demonstration projects that highlight the benefits and techniques of agroecological practices. This not only has the potential to equip farmers with practical knowledge but also promotes continuous learning and innovation. Moreover, by demonstrating the success and viability of agroecology in a communal setting, this arrangement helps to legitimize these practices, encouraging wider acceptance and implementation. Through communal efforts, the principles of agroecology gain credibility and visibility, ultimately leading to more sustainable and resilient avocado production systems.

In summary, enhancing communication and accessibility of governance arrangements is essential to positively influence the factors discussed, ultimately creating the conditions necessary for the adoption of agroecological practices. Improved communication ensures that farmers are well-informed about available resources, training opportunities, and policy benefits, while accessible governance arrangements make it easier for farmers to engage with and benefit from these initiatives. Establishing communal farms focused on teaching

agroecology in avocado production can play a key role in this process. By reducing investment risks, fostering community, facilitating information sharing, and legitimizing sustainable practices, communal farms provide a practical and supportive framework for farmers. These combined efforts create a robust environment that encourages and sustains the transition to agroecological methods, ultimately contributing to more sustainable and resilient agricultural systems.



Figure 20 Intercropping of avocado with banana plants.

5. Discussion

This chapter is structured to discuss the limitations encountered in the research, new theoretical insights and implications for future governance arrangements and future research.

5.1. Theoretical Implications

The findings of this research provide several theoretical implications that can enhance and expand existing frameworks used to understand the adoption of agroecological practices. Primarily, the factors influencing adoption can be comprehensively understood within the framework proposed by Runhaar et al. (2017), which emphasizes various conditions necessary for the adoption of sustainable practices. Additionally, the four key factors identified by Schoonhoven and Runhaar (2018)—economic, social, informational, and political—were evident in the context of this study. However, the research also identified additional factors that suggest an expansion of these theoretical frameworks is warranted.

5.1.1. Integration With Existing Frameworks

The data collected in this study aligns well with the four conditions in Runhaar et al. (2017) framework. This framework outlines necessary conditions for the adoption of sustainable agricultural practices, including intrinsic and extrinsic motivations, ability to adopt, market demand, and the legitimacy of the practices. These conditions were confirmed, and no new conditions were identified. The presence of economic, social, informational, and political factors from the Schoonhoven and Runhaar (2018) model was also confirmed in this research, supporting the robustness of these models in explaining the dynamics of agroecological adoption.

5.1.2. Identification of New Factors

Despite the alignment with existing models, this research found additional factors/category of factors that were not originally included in these frameworks, highlighting areas for theoretical expansion. Two new categories of factors were identified, namely *historical* factors and *nature* factors. Within these new categories, 5 new factors were identified. *Historical* factors in this context include the history of green revolution, armed conflict and the energy transition. Moreover, corruption, although a new factor, it can be further categorized as part of historical factors. Furthermore, the time factor was identified. This factor can be categorized as a historical factor, but also as a social and economic factor. With regards to *nature* factors,

the unpredictability of nature, due to climate changes has been identified. Lastly, the new factor of experts was discovered, categorized in the informational factors.

The *history* of corruption and governance issues in the region significantly impacted farmers' trust in government initiatives and policies. Historical mistrust influences farmers' willingness to adopt new practices, indicating that past political contexts are crucial for understanding current adoption dynamics.

The *time* required to properly adopt agroecological practices was a significant factor influencing the case study. Farmers are often hesitant to adopt practices that do not yield immediate results, thus attaching themselves to conventional practices that “minimise” the risks, as they know what to expect from them. Taking into account the need for temporal factors in adoption models, can expand the understanding of the decision-making processes of farmers.

Observations and interviews revealed that *nature* factors, particularly those related to climate change, heavily influence the adoption of agroecological practices. In regions severely affected by climate change, these natural factors become critical considerations for sustainable agriculture. This suggests that environmental variability and climate resilience should be integrated into theoretical models. Moreover, the inherent unpredictability of natural conditions, such as weather patterns and pest outbreaks, although not lengthily, was discussed as a major influence on adoption of farming practices. This highlights the need to account for environmental uncertainties in frameworks of agricultural practice adoption, especially in the light of current climate change challenges.

Moreover, the involvement of *experts* – agronomists – was identified as a key factor in facilitating the adoption of agroecological practices. Experts provide essential knowledge transfer and technical support, emphasizing the importance of expertise and advisory services in theoretical models.

5.2. Implications for Governance Arrangements

The design of this study as a most-similar single case with two embedded sub-cases—associated and independent farmers—revealed that community engagement and supportive governance are critical for adopting agroecological practices. Despite the similar overall context, associated farmers demonstrated higher adoption rates due to greater community support and better access to information and resources. This contrast highlights the significant role of community structures and resource availability in enhancing farmers' ability to adopt

new practices. Moreover, while the factors of demand and legitimacy were not markedly different between the two sub-cases, associated farmers showed more potential for enhanced legitimacy. The strong community support among associated farmers provided a solid foundation for building legitimacy for agroecological practices.

These findings suggest that improving communication and resource distribution, particularly for independent farmers, could enhance adoption rates in other similar settings. By identifying these transferable factors, the study contributes to a broader understanding applicable to other regions facing similar challenges. It underscores the importance of tailored governance arrangements that consider the specific needs and contexts of different farmer groups. Enhanced community support and resource accessibility, coupled with efforts to boost demand and legitimacy, are essential for fostering the widespread adoption of agroecological practices. This approach provides valuable insights and practical recommendations for policymakers and practitioners aiming to promote sustainable agriculture in diverse contexts.

However, significant challenges remain. One major issue is whether all governing actors—government, private actors, consumers, and others—are willing and able to promote agroecology. Further research must address fundamental questions, such as the level of commitment among these actors and their capacity to support sustainable practices. Additionally, there are less instrumental but crucial questions about how to foster a cultural shift toward valuing agroecological practices and how to ensure equitable access to the necessary resources and support.

5.3. Implications for Further Research

The explorative nature of this research highlights the necessity for further, more comprehensive research to understand the specific needs and challenges faced by farmers. By addressing these foundational issues and promoting agroecology, there is potential to create a more sustainable and resilient agricultural system that benefits both farmers and the environment. To achieve this, incorporating participatory action research to assess the impact of agroecological practices on avocado production could be highly beneficial. This approach fosters a collaborative and inclusive research environment, allowing community members to actively participate in shaping the research agenda and interpreting the results. Engaging farmers in various stages of the research process—from defining objectives to analysing findings—can facilitate a deep and collective reflection on their realities, challenges, and

practices. Therefore, future research should consider participatory action research as a valuable and effective methodology.

Governance arrangements should prioritize creating demand and legitimacy for agroecological practices. This includes promoting -local- market demand for sustainably produced goods and establishing regulatory frameworks that recognize and legitimize agroecological methods. Future interventions must address political and social factors more robustly. This includes increasing political commitment to sustainable agriculture and fostering a cultural shift towards valuing ecological practices within farming communities. Enhancing community engagement is critical. Robust community networks can provide essential social support and knowledge sharing (Lalani et al, 2016; Knowler and Bradshaw, 2007; Sayadi, Calatrava Requena & Guirado Sánchez, 2005). Efforts to rebuild trust in government institutions are paramount (Jones et al., 2022). Transparent, accountable, and inclusive governance practices can help mitigate the historical distrust stemming from corruption and align farmers' interests with policy objectives. Finally, effective communication channels between policymakers, experts, and farmers must be established to ensure that governance arrangements are responsive to the needs and realities of the farming community.

Addressing the challenges inherent in promoting agroecological practices requires navigating complex political, social, and economic landscapes, as seen in this research. Key challenges include overcoming entrenched agricultural practices that prioritize conventional methods, fostering political commitment to sustainability, and building trust between farmers and government institutions. Fundamental research questions emerge from these challenges, which can be addressed in future research: How can deep-seated cultural norms around agriculture be shifted to value ecological practices? What strategies are effective in incentivizing policymakers and private actors to prioritize agroecology? How can governance arrangements be adapted to ensure inclusivity and transparency in decision-making processes? Addressing these questions is essential to fostering a supportive environment for the widespread adoption of agroecological practices, ensuring their long-term viability and impact on agricultural sustainability.

5.4. Limitations

There are some limitations to this research, which affect the reliability, validity and generalizability of it. First the operationalization of the dependent variable was limited to five agroecological practices. This was because of limited literature on specific agroecological

practices for avocado production. It is a possibility that other practices related to agroecology were being adopted by the farmers, but because they were not part of the operationalization, they were not talked about. Moreover, conversations with farmers often turned into broader discussions about agriculture in general. Their individual farming practices were discussed, but not to the extent that was intended. Nevertheless, the discussions indicate a deeper, systemic issue within the agricultural sector in the country that needs to be addressed before pushing farmers to adopt other practices. This suggests that the foundational problems in agriculture must be resolved to create a conducive environment for the adoption of new practices like agroecology. However, agroecology has the potential to address some of these underlying issues by strengthening community bonds, which could lead to better communication with other stakeholders and more effective implementation of governance arrangements.

During the interviews, it became evident that most farmers did not fully understand the concepts of agroecology, sustainable, or ecological farming as intended by the research. Many answered with comments such as, “*No, I don’t get involved with the ecological things; that is too complicated*” (Farmer 8) or “*It just means that the farm needs to be self-sustained*” (Farmer 5). This lack of understanding meant that responses often veered away from specific questions about avocado production or their farming practices and instead focused on broader issues such as market conditions or a lack of trust in government bodies. This shift in focus made the initial analysis of the interviews challenging, necessitating a restructuring of how the results were presented. Instead of finding clear conditions for each agroecological practice or identifying specific influencing factors, the research revealed a more general understanding of the agricultural dynamics in the region.

The location of the study is severely under-researched. This unfamiliarity made farmers apprehensive about participating at first, as they were not accustomed to this type of engagement, especially the sub-case of independent farmers. However, once initial contact was made and the purpose of the research explained, the farmers became eager to collaborate, highlighting their farms and sharing their knowledge and experiences. The lack of prior research also posed challenges during the preliminary stages, as it was difficult to find accurate information regarding the number of properties cultivating avocados. Due to limited time, it was only possible to interview a small number of participants, affecting the generalizability of the findings. Consequently, the representativeness of the sample might be questionable, as available databases were outdated by at least 10 years. Furthermore, the demographic profile of the sample, primarily consisting of men aged between 40 and 60, can further limit the

generalizability of the results. Caution should be exercised in interpreting the results, as they are specific to the location of the case study. Agroecology, as emphasized throughout this research, is highly influenced by local contexts. Therefore, the findings can be applied more reliably when considering the specific characteristics described in this study.



Figure 21 Avocado farm. The farmer interviewed for this farm, commented that the owner wants to cut down the crops and have a milk farm instead.

6. Conclusions

A central question and four sub questions are answered in this research. The findings of this study illuminate several critical aspects influencing the adoption of agroecological practices among farmers. The results underscore four key conclusions that can inform future interventions and policy developments.

Sub-question 1 asked to what extent the four conditions, from Runhaar et al. (2017), were present in the case study. It was found that there is a notable motivation and, to a certain extent, ability among farmers, especially associated farmers, to adopt agroecological practices. However, the overall adoption is significantly hindered by a lack of demand and legitimacy. This imbalance suggests that, while farmers are willing and somewhat capable of adopting more sustainable practices, the external environment does not adequately support or validate these efforts.

Sub-question 2 asked what are the factors influencing the conditions in the case study. It was found that economic and informational factors positively influence the conditions necessary for adopting agroecological practices. Access to financial resources, training, and knowledge dissemination helps foster a conducive environment for sustainable agriculture. This was clearer for the sub-case of associated farmers, concluding that independent farmers need more support with economic and informational factors. However, the deficiency in political and social factors creates a gap that prevents these conditions from fully manifesting. Political and social support are crucial for the widespread adoption and normalization of agroecological methods. Moreover, new factors and categories of factors influencing these conditions, were uncovered. It introduced historical factors such as the green revolution's legacy, the Colombian armed conflict, and the energy transition, including corruption as a subset. Time emerged as a significant factor affecting adoption decisions, spanning historical, social, and economic dimensions, influencing ability and motivation. Nature factors, particularly climate change unpredictability, were found to heavily influence adoption dynamics, highlighting the need for climate resilience in adoption frameworks. Additionally, the role of agronomists was crucial in facilitating agroecological practice adoption, emphasizing knowledge transfer and technical support.

Sub-question 3 asked what factors would need addressing, in order to have all the conditions necessary for the adoption of agroecological practices. From the interviews, it was

clear that there are specific factors such as the availability of finance, community support, and trust in government are pivotal. The research highlights that addressing financial barriers, enhancing community support structures, and rebuilding trust in government institutions—eroded due to corruption—are essential steps towards enabling the conditions for agroecological practice adoption. Without addressing these specific challenges, broader efforts may fall short.

Sub-question 4 asked about governance arrangements and how are they influencing/creating the different factors. A total of 14 governance arrangements were identified, directly or indirectly related to adoption. These arrangements primarily impact economic and informational factors, with centralized and decentralized governance often proving inadequate or even detrimental. Centralized arrangements, which dominate, adversely affect market conditions and financial access, failing to assure market guarantees and burdening farmers with bureaucratic hurdles and mistrusted credit subsidies. Social factors see minimal influence, except in rare cases where community support and values are positively impacted through farmer networks and social interactions. Informational factors receive attention but suffer from poor communication and farmer disengagement. Political factors show minimal overall impact, except in targeted government agency initiatives, while self-governance arrangements exhibit promise for empowering farmer-led sustainability efforts.

Sub-question 5 asked about the changes needed in current/future governance arrangements to overcome barriers. Current governance arrangements primarily offered limited economic subsidies with significant bureaucratic hurdles and lacked active farmer participation, failing to adequately incentivize sustainable agricultural practices and contributing to farmers' mistrust in government policies. Most arrangements fell short in engaging farmers, and the dominance of government and market actors over farming practices hindered the adoption of agroecological practices. Improving communication and resource distribution, particularly for independent farmers, could have enhanced adoption rates. Enhanced community support and resource accessibility, coupled with efforts to boost demand and legitimacy, are essential for fostering the widespread adoption of agroecological practices. Moreover, it is proposed that establishing communal farms to teach agroecology in avocado production can reduce investment risks, foster community, facilitate information sharing, and legitimize sustainable practices. These combined efforts create a supportive environment that encourage the adoption of agroecological practices, contributing to more sustainable and resilient agricultural systems.

Finally, the main question asked *how can governance arrangements stimulate the conditions for the adoption of agroecological practices in avocado production?* By answering the sub-questions, it was found that some of the analysed governance arrangements have the potential to address the factors influencing the four conditions —motivation, ability, demand, and legitimacy— to be in place in order to have an optimal environment for the adoption of agroecological practices. However, challenges persist. Communication gaps between initiating actors and farmers undermine the effectiveness of these arrangements. Additionally, corruption and bureaucracy erode trust in governments and institutions, hindering farmer participation in various initiatives. Governance arrangements can stimulate agroecological adoption in avocado production by addressing these key factors. Well-designed economic incentives, like streamlined subsidies and financial support, can mitigate risks associated with agricultural practice changes and restore farmer confidence. Improving communication strategies is vital to ensure farmers are informed about resources, training opportunities, and policy benefits through accessible channels. Engaging farmers in guideline creation is essential for efficacy. Arrangements such as *Agro Antioquia Exporta 4.0*, which offered practical training and innovative practices, serve as successful examples to expand and replicate.

Enhancing community engagement is also vital; governance arrangements should focus on fostering strong farmer networks and facilitating social encounters, as demonstrated by self-governance arrangements such as the *Hass Agricultural Association*. Creating demand and legitimacy for sustainably produced avocados is another critical aspect. This can be achieved by promoting local markets and establishing stronger regulatory frameworks that recognize and legitimize agroecological methods. Political commitment is necessary, with efforts to increase dedication to sustainable agriculture and foster a cultural shift towards valuing ecological practices within farming communities. Transparent, accountable, and inclusive governance arrangements are essential to rebuild trust and align farmers' interests with policy objectives. Additionally, establishing communal farms focused on teaching agroecology can reduce investment risks, foster a sense of community, facilitate information sharing, and legitimize sustainable practices. By bridging the communication gap and focusing on building trust and farmer communities, governance arrangements can more effectively support the adoption of agroecological practices, ultimately contributing to more sustainable and resilient agricultural systems.

7. References

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Appendix A

Interview structure for farmers. Interviews were conducted in Spanish.

Nombre y apellidos:	
Edad	
Dirección de la finca (vereda y nombre)	
Correo/teléfono	
Nivel de educación	
Es miembro de la Asociación Agropecuaria Hass?	
Superficie de la finca (ha)	
Cantidad de aguacates en la finca	
Que otros cultivos maneja?	
Desde cuando maneja la finca	
Como ha aprendido la agricultura?	
Qué entiende como agricultura ecológica/sostenible?	
Que problemas tiene en concreto? Ej. Plagas, calidad del suelo, etc	

Semi-structured interviews, where the following subjects were discussed.

- Identification of farming methods: que tipo de prácticas utiliza respecto al uso del agua y suelo, otros árboles y biodiversidad?
- Future perspectives: Estaría dispuesto a modificar su método de agricultura por uno más amigable con el medio ambiente? Que le ayudaría a tomar la decisión de utilizar practicas más sostenibles?

Agroecological practices	Reasoning for (not) using them
Fertilizantes orgánicos	Por qué estas prácticas y no otras? Cuáles son los obstáculos que ha encontrado para implementar la practica? Qué condiciones necesitaría para implementar esta práctica?
Acolchado	
Rotación de cultivos	
Conservación de aguas	
Manejo de plagas y enfermedades	

Identification and characterization of conditions & factors	
Economic	Tiene Sistema de control económico? La finca le da suficiente para vivir bien? Sino, que falta? Son los costos muy altos, o el precio del cultivo está muy bajo? Tiene subsidios?
Social	Colaboras con tus vecinos? Por qué? Pruebas productos nuevos? (ej. Pesticidas, fertilizantes). Si pruebas cosas nuevas, lo compartes con los vecinos? (no) por qué? Cree que a los vecinos les parece bien que pruebe cosas nuevas o te miran y tratan raro?
Informational	Has recibido asesoramiento o talleres de alguien? Cree que es fácil obtener información sobre prácticas agrícolas? Quien da esta información? Cree que la información es confiable?
Political	Que cree que el gobierno quiere de los aguacateros/agricultores? Siente que el gobierno lo ayuda? Sabe sobre los subsidios y reglas ambientales para agricultura que el gobierno tiene? Creen que funcionan bien?

Appendix B

Interview structure for agronomists. Interviews were conducted in Spanish.

Nombre y apellidos:	
Edad	
Correo/teléfono	
Nivel de educación	
Cuántas fincas visita	
¿Qué tipos de agricultura sostenible conoce?	
¿Qué piensa de la agroecología?	
¿Cómo cree que la agroecología puede ayudar la producción de aguacate?	
¿Cuál otro tipo de agricultura sostenible cree usted que sería más efectivo en el cultivo de aguacate?	

- Identification of farming methods: ¿qué tipo de prácticas recomienda a los agricultores respecto al uso del agua y suelo, otros árboles y biodiversidad?
- Future perspectives: ¿Estaría dispuesto a recomendar otros métodos de más amigable con el medio ambiente? ¿Si no, por qué? Si sí, ¿cómo le ayudaría a los agricultores?

Identification and characterization of conditions & factors	
Economic	¿Como ve que los agricultores manejes su sistema económico? ¿Cree que una producción agroecológica de aguacate les dé a los productores para subsistir económicamente? ¿Como cree que está el mercado?
Social	¿Cómo ve que los agricultores se ayuden mutuamente? ¿Cree que, si se ayudaran más, la conservación de la tierra sería mejor o peor? ¿Qué cree que es necesario para que los agricultores se ayuden más y creen una comunidad más colaborativa?
Informational	¿Cree que es fácil comunicar información sobre prácticas agrícolas? ¿Cree que los agricultores confían en su información?
Political	Que cree que el gobierno quiere de los aguacateros/agricultores? ¿Siente que el gobierno los ayuda? ¿Sabe sobre los subsidios y reglas ambientales para agricultura que el gobierno tiene? ¿Creen que funcionan bien? ¿Ha recomendado estos subsidios a los agricultores? ¿Usted les presta ayuda para navegar las reglas ambientales del gobierno?

Appendix C

Definition of agroecology and different agroecological practices. Supplement given in Spanish to farmers interviewed.

Qué es la agroecología? La agroecología es una disciplina que se ocupa del estudio de los sistemas agrícolas desde una perspectiva ecológica, integrando principios y conceptos de la ecología en la producción de alimentos. Se centra en el diseño y manejo sostenible de sistemas agrícolas, promoviendo prácticas que favorecen la biodiversidad, el equilibrio ecológico, la eficiencia en el uso de recursos naturales y la resiliencia frente a perturbaciones. La agroecología busca armonizar la producción de alimentos con la conservación del medio ambiente, promoviendo la salud del suelo, la diversidad de cultivos y la reducción del impacto ambiental asociado a la agricultura convencional.

En otras palabras, la agroecología es una manera de cultivar alimentos que presta mucha atención a cómo interactúan las plantas, los animales y el ambiente. Se trata de hacer que los cultivos crezcan de manera saludable sin dañar demasiado la tierra y los recursos naturales. La agroecología se enfoca en prácticas que ayudan a mantener un equilibrio en la naturaleza, como usar menos químicos y cuidar la diversidad de plantas y animales. En resumen, es una forma de agricultura que intenta ser buena tanto para las personas como para el planeta.

Prácticas agroecológicas

Práctica agroecológica	Práctica específica	Efectos
Fertilizantes orgánicos	Compost, estiércol, biofertilizantes (hongos micorrícicos arbusculares, bacterias promotoras del crecimiento vegetal y rizobios fijadores de nitrógeno).	Mejora la fertilidad del suelo y proporciona nutrientes esenciales, puede incrementar el rendimiento del cultivo.
Acolchado	Acolchado con materiales orgánicos como hojas, paja o corteza.	Ayuda con la conservación de humedad del suelo, suprime las malezas, y añade materia orgánica al suelo. Regula la temperatura del suelo.
Rotación de cultivos	Asociación de cultivos, cultivos de cobertura, agrosilvicultura	Ayuda a controlar plagas y enfermedades del suelo y a mantener la fertilidad del suelo. Cultivos de cobertura, como las legumbres, ayuda a regular los niveles de nitrógeno del suelo, suprime malezas, y mejora la estructura del suelo. Agrosilvicultura ayuda con la salud del suelo, reduce la erosión e incrementa la biodiversidad.
Conservación de aguas	Riego por goteo, microaspersores, riego subsuperficial, controladores de riego inteligentes, recolección de agua de lluvia.	El mejor sistema de riego dependerá del tipo de suelo, el clima y la disponibilidad de agua. Reducción general de la pérdida de agua. El acolchado puede contribuir a la conservación del agua.
Manejo de plagas y Enfermedades	Manejo integrado de plagas, control biológico, variedades resistentes, saneamiento.	Reduce el uso de pesticidas sintéticos. Mejora la salud del suelo, crea un ecosistema agrícola diverso que ayuda a controlar las plagas y enfermedades. Incrementa la biodiversidad. La efectividad de estas prácticas va a depender del tipo de suelo, el clima y la plaga/enfermedad específica presente en el área.

Appendix D

Governance practices that potentially affect the adoption of sustainable farming practices in the case study. Practices are divided by what mode of governance it is.

Mode of governance	Name	Description of arrangement
<i>Centralized</i>	Gender and climate change.	Guidelines for the integration of gender focus on projects, programs, plans, and policies for the management of climate change in the agricultural sector.
	Support program for small producers for the purchase of inputs	Provide economic support, through a 20% refund on the value of the purchase of inputs within a list defined by the Ministry of Agriculture and Rural Development, to small producers in prioritized production chains, in order to mitigate the adverse effect of the increase in the acquisition costs of agricultural inputs, promoting the continuity of productive activities and the improvement of the food supply.
	Agricultural guarantee fund (FAG)	It is a complementary guarantee that supports the credits requested to finance the working capital and investment of producers who cannot offer any type of guarantees ordinarily required by financial intermediaries.
	Rural Capitalization Incentive (ICR)	It is an economic benefit that aims to stimulate capitalization investments in the field to conduct new projects aimed at improving the competitiveness, sustainability, and modernization of agricultural activities.
	Special Line of Credit (LEC)	This line offers a subsidized interest rate that is intended for the financing of short-cycle products related to the basic food basket, which are characteristic of the campesino economy, with high sensitivity or export interest.
	Agricultural Solidarity Fund (FONSA)	Provides economic relief to pay debts of credits, when farmers face unforeseeable situations that affect their crops.
	Guidelines for the Development of Low Impact Agricultural Activities	5 guidelines on ecosystem conservation by preserving native vegetation, safeguarding water sources, employing landscape management tools, restoring key species populations, and adhering to environmental authorities' directives regarding wildlife-human interactions. These measures collectively aim to sustain ecosystem services, maintain biodiversity, and mitigate human impact on these critical habitats. And 7 guidelines for sustainable agricultural practices that recommend incorporating green fertilizers and maintaining soil cover, implementing rotational grazing, and supplementary feeding for livestock. They suggest slope management techniques, minimum tillage practices, and the use of bioinputs for pest control while adhering to environmental regulations. Soil fertilization should be based on soil analysis, and spontaneous vegetation should be managed through mechanical tools and crop rotation. Waste

		management should comply with environmental regulations, and grazing of livestock should be excluded from areas with natural plant cover to support soil fertility and ecosystem health.
<i>Centralized/decentralized</i>	Municipal Agricultural Technical Assistance Units (UMATA)	The UMATA is a unit attached to the Ministry of Environment and Rural Development, created by “National Decree 1929 of 1994.” Its main function is to guarantee the provision of agricultural technical assistance service to small and medium-sized rural producers in a municipality.
	Agroecological departmental plan of Antioquia.	Part of the development plan of the department. It is an instrument developed to plan, orient and implement actions for transition and transformation of the agricultural sector in the department during the period of 2023 to 2040. It includes guidelines on how to follow and evaluate results. The goal is to promote develop and consolidate the campesino, family community and multiethnic economy. It has 6 strategic guidelines: (1) promote agroecology production, (2)Encourage strategies for proper use and conservation of natural environments, (3)Strengthen distribution and consumption mechanisms with a territorial focus, (4)Provide differential treatment to rural families, with emphasis on special protection for women and youth, (5)Strengthen services of rural extension, research and rural education from the ethnic approach and the agroecological approach, (6)Create an exclusive institutional network for agroecology
<i>Public-private</i>	Agro Antioquia exporta 4.0	seeks to increase the export supply of these items from the department. By complying with regulations, guaranteeing the quality and safety of agricultural products, producers will be able to improve their income and the quality of life of their families. The program considers five components: updating and linking the Technological Offer (OT) of AGROSAVIA and other organizations in the prioritized areas, support in the implementation of the Exporter Property Registry (ICA), certifications under the GLOBAL G.A.P V5.2 standard for producers of Hass avocado, implementation of 4.0 agricultural technologies and equipment and the establishment of an associative buffer area in Hass avocado, in the municipality of San Vicente Ferrer.
<i>Interactive</i>	Sowing capabilities	Developed through FAO and the minister of agriculture and rural development of Colombia and was conducted between 2019 and 2021. It had four axes: extention and agricultural innovation, agroecology, differentiated markets and information systems. It sought to strengthen instruments and policies for campesinos, family and community agriculture in Colombia, based on knowledge management and exchange of expertise. It conducted 47 events and workshops with more than 7000 participants in the three years. It also resulted in a map of initiatives and agroecological collective processes in the country. One of the results was a handbook for agroecological transitions, illustrating 8 practices and strategies for agroecological transitions in the country. (1) property planning, (2)recovery, conservation and use of agrobiodiversity, (3)ecological restoration and agroforestry systems, (4) rainwater collection and storage, (5) preparation of organic and bioprepared fertilizers to regenerate and protect the soil, (6) Developer of short circuits of circular and solidarity economy, (7) exchanges of experiences and appreciation of local knowledge and (8) gender and youth approach.

	Voluntary guidelines for agro-environmental policies in latinamerica & the Caribbean	The document aims to provide guidelines for improving policies regarding agricultural approaches that are aimed at preserving the environment and integrating social, environmental, and economic factors in its strategies.
	BancO2	Created by the Masbosques ONG, BancO2 is the first Colombian strategy focused on payments for environmental services. Payments for environmental services work as a system that provides economic incentives and benefits to families or individuals who provide environmental services, such as conserving a watershed or a forest. Voluntary agreements are signed once the resources for payment are available. Based on this, and the efforts of the financial area of Masbosques, with Bancolombia they created a Savings at Hand account so that families receive the incentives. Companies, such as Nutresa, pay for their environmental footprint, and then this money goes to benefit families that, for example, protect native forests.
<i>Self-governance</i>	Asociación Agropecuaria Hass (AAH)	Created in 2006 by a group of farmers interested in learning more about Hass avocado production and supporting each other in the process. They hold meetings every 2 months, to discuss new partnerships, businesses and trainings. They also have social gatherings, strengthening their bonds. To be part of the association, an avocado producer must submit a letter to the board, stating their interest, the size of the farm, and how many avocado trees they have and the board will evaluate, once approved, the new member needs to pay an entrée fee and a monthly fee (350.000COP and 22.000COP respectively). They have had trainings from different organizations, like Asohofrucol (a national-level agricultural association), AGROSAVIA (a research institution for agriculture) and the ICA (Colombian institute for agriculture). Currently, they are waiting for a new business proposal from a guacamole company that can potentially buy the left-over produce that is not adequate for export.