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BUILDING RESPONSIBLE
GLOBAL VALUE CHAINS
**FOR SUSTAINABLE
TROPICAL FRUITS**

Resilience assessment of avocado and pineapple value chains



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Contents

Abbreviations	v
Acknowledgements	vi
Executive summary	vii
1. Introduction	1
2. Resilience: What is it and why is it important for tropical fruit value chains	3
3. Methodology to assess resilience of avocado and pineapple value chains	7
3.1 Limitations	10
4. Understanding resilience on avocado and pineapple value chains	11
4.1 Resilience to what: Understanding the main risks and vulnerabilities	11
4.2 Identification of gaps in the resilience capacities of value chains	17
4.3 How do value chain actors perceive their own resilience capacities?	20
5. Reflections and recommendations for companies to build resilience capacities	25
6. Conclusions and recommendations	35
Annexes	41
Livelihoods resilience framework. Table of indicators and scoring system used to assess the resilience of the avocado and pineapple value chains	42
Online consultations with participants of the Responsible Fruits project	46
Analysis of the shocks, stressors and risks affecting the performance of the avocado and pineapple value chains	48
Graphs of resilience capacities by sector (self-assessment)	62
References	65

Figures

Figure 1. Resilience capacities and response to a shock: different capacities and actions taken determine how shocks affect the functioning of value chains	5
Figure 2. Sources of vulnerability as assessed by producers, associations and companies surveyed	12
Figure 3. Resilience gaps identified in the avocado value chain	18
Figure 4. Resilience gaps identified in the pineapple value chain	19
Figure 5. Aggregated results of the self-assessment of the different resilience capacities, disaggregated by commodity	21
Figure 6. Aggregated results of the self-assessment of the different resilience capacities, disaggregated by value chain actor	22
Figure A3.1. Mean temperatures projected by 2100, by SSP model and producing country and commodity	49
Figure A3.2. Precipitation change rate by 2100, using the SPSP2 - 4.5 model	51
Figure A4.1. Self-assessment of actors' preventive and anticipatory capacities, by sector	62
Figure A4.2. Self-assessment of actors' absorptive and adaptive capacities, by sector	62
Figure A4.3. Self-assessment of actors' transformative capacity, by sector	63

Tables

Table 1. Livelihood capitals and related resilience capacities	9
Table 2. Risk areas identified as within the climate and environmental domain	13
Table 3. Risk areas identified as within the economic domain	14
Table 4. Risk areas identified as within the institutional domain	15
Table 5. Risk areas identified as within the social domain	15
Table 6. Examples of actions taken by companies to build anticipatory capacity	26
Table 7. Examples of actions taken by companies to build absorptive and adaptive capacities	28
Table 8. Examples of actions taken by companies to build transformative capacity	32
Table A1.1. Indicators used to assess the resilience capacities	42
Table A1.2. Thresholds used to determine resilience levels of avocado and pineapple companies	43
Table A1.3. Scoring system used to assess the resilience of the avocado and pineapple value chains	43

Abbreviations

ANEXCO	Ananas Export Company, S.A.
APEAJAL	Asociación de Productores Exportadores de Aguacate de Jalisco
APEAM	Asociación de Productores y Empacadores Exportadores de Aguacate de México
ASOPROPIMOPLA	Asociación de Productores de Piña de Monte Plata
EBRD	European Bank for Reconstruction and Development
FAO	Food and Agriculture Organization of the United Nations
IPCC	Intergovernmental Panel on Climate Change
IPPC	International Plant Protection Convention
OECD	Organisation for Economic Co-operation and Development
OHCHR	Office of the High Commissioner for Human Rights
R&D	research and development
RBC	responsible business conduct
SERS	Subjectively-Evaluated Resilience Score
SSP	Shared Socioeconomic Pathways
UNHCR	United Nations High Commissioner for Refugees

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Executive summary

FAO is implementing the project *Building responsible global value chains for the sustainable production and trade of tropical fruits* to help avocado and pineapple industry actors to strengthen or establish risk-based due diligence systems that will make their operations more sustainable and resilient. To contribute to this objective, FAO conducted a comprehensive study during the last quarter of 2022 to identify the main resilience challenges that the avocado and pineapple sectors are facing. The study also aimed to understand the capacities of actors from both value chains to prevent, anticipate, absorb, adapt and transform in view of shocks, long term stresses and future risks.

The identification of resilience challenges will help the project to prioritize activities and the development of technical materials to enhance the resilience of avocado and pineapple value chains. The study findings will also be used by the project as the first step towards establishing a working group on resilience, which will work on common areas of interest amongst participants.

The project relied on available methods suitable for elaborating a robust study, complemented with consultations with some of the main actors from the global avocado and pineapple industries. These included companies and producer associations from Chile, Colombia, Costa Rica, the Dominican Republic, Malaysia, Mexico, Peru, South Africa, Togo, the United States of America and Viet Nam. The report presents the main results from the study, which were presented and validated by project participants during a workshop held on 6 December 2022.

The results are presented in an aggregated manner, with selected examples of positive strategies being used by avocado and pineapple actors to enhance their resilience. The project does not officially endorse any practices, as there was no opportunity for field verification, but rather uses them as illustrations of actions that could have positive contributions to the resilience of businesses in the tropical fruit sector. The main audience of this report are the companies and associations participating in the project, some of whom have partaken in the study itself.

The report is organized in five sections. The **first Section** introduces the study and project. **Section 2** presents the working definition of resilience and its meaning in the context of value chains and **Section 3** outlines the study methodology. **Section 4** presents the main findings from the study. **Section 5** identifies some recommendations and good practices already applied by value chain actors to address the resilience gaps identified. Conclusions and recommendations for the project and other stakeholders are presented in **Section 6**.

Key findings on main shocks, stressors and risks faced by the industries:

Climate change, extreme weather events and environmental degradation were identified as the main risks affecting avocado and pineapple value chains in the main producing and exporting countries. The avocado sector is facing water deficits, prolonged droughts, rainfall variability, warmer

weather, strong winds and unpredictable hailstorms. The pineapple sector is challenged by increasing humidity, rising temperatures and solar radiation, soil degradation, and more recurrent and resistant pests and diseases. Projected warmer temperatures and precipitation variability in the main producing regions are expected to negatively influence productivity and product quality of both commodities. However, due to the presence of microclimates at subnational levels, climate change is projected to have differentiated effects on producing countries.

Issues related to **economic and institutional capitals** were also identified as key challenges to the resilience of both sectors. High market concentration and increased production costs, further exacerbated by the war in Ukraine and the high costs of key inputs such as fuels and fertilizers, were indicated as the main issues affecting the performance of the avocado and pineapple sectors. Actors from the pineapple industry also noted that shrinking revenue margins are threatening the continuity of the sector, particularly of smaller-size companies. In the avocado sector, addressing land use and tenure regulations for the legal expansion of avocado plantations was also considered by stakeholders as important to reduce the vulnerability of the sector and promote sustainability. Concerns over excessive agrochemical use and changing international trade regulations, for instance on maximum residue level (MRL) requirements or deforestation-free products, were also expressed by informants from avocado and pineapple sectors. Informants from both industries also acknowledged the need for further collaboration with other value chain actors, including research institutions and governments. This is considered necessary to improve access to technology, knowledge and services to address some of the main constraints to building resilience.

The study also found that actors from the avocado and pineapple sectors **did not consider the social dimension as a barrier** to the continuity of their operations. However, factors such as labour rights, working with migrants and gender issues require additional attention in supply chain due diligence.

Key findings on gaps affecting the resilience capacities of value chain actors:

The avocado and pineapple sectors display some weaknesses in indicators linked to natural, economic and human capitals. The still relatively low level of investment to **develop the capacities** of value chain actors (e.g. farmers, packers and other workers) on sustainability issues might be slowing the transition towards the use of more responsible business conduct (RBC) along the value chain. The adoption of RBC is important for resilience building as it ensures that value chain operations do not exacerbate or lead to adverse environmental, economic or social impacts that threaten the continuity of the businesses in the future.

Also, the **high concentration in few markets for the commercialization of products** observed in both industries and **insufficient budgeting for crisis response** might negatively affect the way in which companies anticipate, adapt to and manage compounded shocks in the future. For instance, the heavy reliance on a single exporting market can make supply chains, including production, revenues, and employment, very vulnerable to fluctuations in that market.

Increased production costs and in some cases, tight revenues, have also resulted in **low investment in research and development (R&D)** that is necessary to improve preparedness of the industry, and promote the transformation of the operations towards more sustainable and resilient approaches.

The **avocado sector** also presented gaps in institutional capital, due to weak internal mechanisms at the company or association level to prepare and respond to risks. In the **pineapple sector**, a gap identified was in the insufficient engagement with key stakeholders, such as communities, research institutions, and government. The inadequate adoption of practices or policies at the business level to empower different actors along the value chain was also noted as an area of constraint in the pineapple sector.

Collaboration with different stakeholders and empowerment are desirable for resilience as they can help companies to de-risk operations and improve the production of more and higher-quality crops, by providing equal access to knowledge, information and services to all stakeholders. Having more high-quality product that can be commercialized at international and domestic markets will make the sectors more profitable. When accompanied by more responsible business conduct, higher profitability will promote a better distribution of value along the supply chains and improve the livelihoods of the actors participating in them.

The study also found that **most companies** in both commodities **did not have contingency or risk management plans in place**, despite having identified their key risks. Instead, companies are taking ad-hoc actions to address some of the most pressing issues. It is likely that some of these actions are driven by compliance with voluntary sustainability standards to manage risks (e.g. through certification schemes) and to fulfill requirements of international markets. It is important to note that investing in single, isolated solutions, rather than in more encompassing risks management plans, might be connected to the low investment capacity (due to low profitability, inadequate access to insurance and credit) some companies have claimed.

Key findings on value chain actors' self-evaluation of their resilience performance:

The survey results indicate that working on **strengthening the preventive and anticipatory capacities** of the avocado and pineapple stakeholders is a high priority. As mentioned, most actors do not have contingency plans in place, limiting their preparedness for future risks. In fact, over 50 percent of companies from both sectors **did not feel able to fully recover in the short term** (less than six months) if a crisis would emerge. The majority of companies would need more time – but less than a year – to bounce back and be able to supply domestic and international markets. The recovery time would be tied to the type of shock, as well as the intensity and impact on the operations. The COVID-19 pandemic exemplified this. Avocado and pineapple companies were hard hit by the early outbreak in 2020, and the pineapple industry also suffered throughout the lockdown measures in the main importing markets. However, both industries were on a positive recovery path from 2021 onwards and before the war in Ukraine started.

Amid a difficult operating environment, an overall positive finding is that **the vast majority of avocado and pineapple companies are taking proactive approaches to mitigate present and future risks**. The actions mostly focus on addressing climate change and environmental degradation, where production is put at the centre of the actions. Good practices such as protection of pollinators, reforestation practices, soil mapping, underground water monitoring, water efficient irrigation systems, nature-based solutions for slope stabilization, crossbreeding practices, and waste reduction are some examples of these.

Both sectors also perceived themselves as highly flexible and able to transform their operations and structures in difficult times. This was particularly noted by actors in the pineapple industry. Flexibility in the pineapple sector might be attributed to the consolidation of operations (for instance, through the full integration of value chains) widely observed in the different regions, allowing supply chains to rapidly switch practices when needed.

Social capital – such as stakeholder collaboration and better value chain integration – appeared as a key enabler of resilience in value chains. Being part of **associations seems to generate a positive environment for members to develop and strengthen their resilience capacities**, for instance, through capacity development and knowledge sharing. The study also indicates that **companies that are well integrated have a comparative advantage to generate and share information** among the different value chain nodes (and actors within them) in timelier and more efficient manners. This has also influenced the flexibility of the operations as discussed above. Nonetheless, industry consolidation (i.e. when the different competitors or segments of the value chain integrate to improve processes or gain market share) could also pose a risk to the resilience of global value chains, as the impact of shocks can have wider repercussions. Also, consolidation might constitute an important entry barrier for smaller competitors.

Finally, the consulted stakeholders valued the peer-learning events organized by the project as these events allowed them to learn from other companies in different countries and share their own experiences. It was recommended by participants that the sessions keep their “hands-on” or example-based focus to enhance the value of these sessions for companies and increase motivation to participate.



1. Introduction

The tropical fruit sector has expanded rapidly during the last decades. It provides livelihood opportunities and export earnings in developing countries, where most production takes place, while also representing an important component of healthy diets in producing and importing countries. However, the agricultural sector, including the increasingly popular tropical fruit sector, faces multiple environmental, climatic, socioeconomic, and institutional risks that threaten food production and the viability of businesses. As these risks are projected to become more frequent and intense (FAO, 2021a), the resilience of agrifood value chains must be strengthened to ensure the feasibility of the operations over time.

Agrifood systems are becoming more global and industrialized to meet market demands, and have important socioeconomic advantages (e.g. specialization, economies of scale). However, as they grow, these systems also risk having unparalleled negative environmental and social impacts. For instance, in order to meet the increasing demand for tropical fruits in international markets, producers and companies might be pushed to adopt practices that can be harmful to the environment (e.g. expansion into forestland, increased agrochemical use). This could exacerbate existing risks,

while creating new ones (e.g. presence of new pests, higher likelihood of zoonosis). Increased risks can result in a higher susceptibility of agrifood systems to suffer from damage and losses when hit by sudden or recurring shocks, especially if these events occur in combination with others.

Thus, **strengthening the resilience of agrifood systems is crucial, not only to enhance preparedness and respond to challenges, but also to minimize and mitigate future risks.** Taking a resilience-sensitive approach in business operations along the value chain will help companies to:

- **improve business performance** by minimizing risks and ensuring the continued supply of key commodities to domestic and international markets even when crises emerge;
- **reduce the likelihood of future disasters** by addressing key sources of vulnerability; and
- **contribute to environmental, social and economic benefits** in value chains, including employment, income and value generation.

The multi-stakeholder project **“Building responsible global value chains for the sustainable production and trade of tropical fruits”** (henceforth “the project”) is working with private sector entities worldwide, including producers and their organizations, trade associations, processors, packers, transporters, exporters and importers to improve the sustainability and resilience of avocado and pineapple value chains. The focus on avocado and pineapple is driven by the increasing demand for these commodities in recent years, which has important implications for sustainable agriculture, as well as climate change adaptation and mitigation efforts.

To be able to strengthen the resilience of tropical fruit value chains, the first step is to identify the main challenges and constraints that the value chains are facing vis-à-vis major external shocks, long term stresses and risks. This study responds to that objective. The study considers a sustainability lens, aligned with the OECD-FAO Guidance for Responsible Agricultural Supply Chains to ensure resilience can be achieved and maintained in the long term by adopting more responsible practices and business conduct along the value chain.

The study also aims to bring companies in the avocado and pineapple sectors closer to the topic of resilience. Although there is general understanding on what resilience is and why strengthening it is important, there is less awareness of all the different dimensions of resilience, particularly beyond the ability to buffer and adapt to shocks.



2. Resilience:

What is it and why is it important for tropical fruit value chains

Resilience is understood as the **ability of systems (such as avocado and pineapple value chains) or system components to prevent, anticipate, absorb, adapt and transform when facing a wide range of risks**. At the same time, the systems or their components should be able to **continue functioning** in spite of these risks **and without compromising long term prospects** for sustainable development and wellbeing for all (United Nations, 2020).

The definition of resilience **embeds a component of change and transformation** and goes beyond the simplified concept of the ability to “bounce back” or merely cope with an event. This distinction is important for value chains, as resilience is perceived as a **set of capacities** that allows actors **to recover after a shock**, while **taking proactive actions toward reducing their vulnerability and exposure** to future shocks, risks and/or long term stressors.

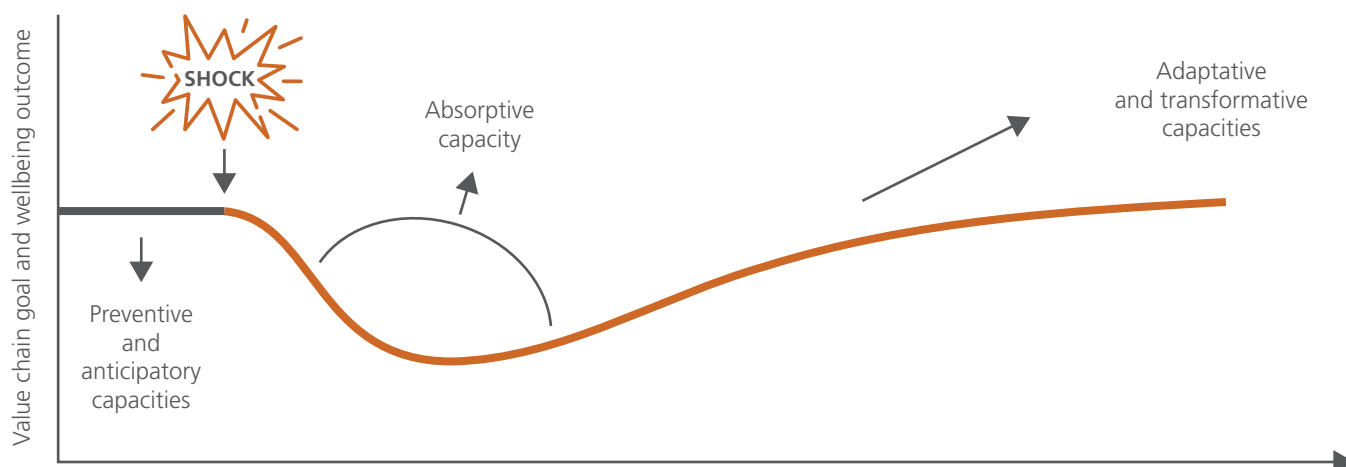
The main features of the resilience capacities are defined as follows:

- **Preventive:** The ability of actors to prepare by taking actions to reduce existing risks and avoid creating new ones. This can be conducting risks assessments and developing a contingency plan for the business (FAO, 2021a).
- **Anticipatory:** The capacity to take early actions to minimize risks. This could imply accessing systems and services that provide timely information to value chain actors, such as weather forecasts or information about market trends, or by purchasing crop insurances.
- **Absorptive:** The ability to maintain desired levels of output despite the occurrence of disturbances (Termer, Dewulf and Biesbroek, 2016). For example, maintaining production levels at the end of the season even in the presence of droughts or hailstorms.
- **Adaptability:** The capacity of value chain actors to modify functions or practices in response to shocks (Tendall *et al.*, 2015). Adaptability can mean shifting agricultural inputs, using climate-proofing infrastructure or changing marketing strategies, among others.
- **Transformability:** The capacity to significantly change the internal structure and feedback mechanisms of the value chain or of some segments in response to a shock, particularly where adaptation is not enough to sustain operations in the long term (Folke *et al.*, 2010). This could mean changes in governance structures, adoption of due diligence mechanisms, reorganization of power configurations, among others.

There is some overlap in these capacities and there is no established sequence of when they come into play. However, in general, **prevention** and **anticipatory** action take place before a shock occurs , i.e. to prepare for it. **Absorption** takes place in the short to medium terms and **adaptation** spans across the short, medium and long terms once the shock has occurred. Both speak to the robustness of the value chains to withstand shocks or long term stressors and take actions to minimize the impacts. **Transformation** is linked to a long term process that supports sustained recovery from current shocks and stresses, and reduction or prevention of future ones as illustrated in **Figure 1** (Tendall *et al.*, 2015).

It is important to highlight that **building value chain resilience is a continuous process that takes time**, and it is not expected that all capacities are built concurrently.

Figure 1. Resilience capacities and response to a shock: different capacities and actions taken determine how shocks affect the functioning of value chains



Source: Tendall, D., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B. & Six, J. 2015. Food system resilience: Defining the concept. *Global Food Security*, 6, 17–23 p. doi.org/10.1016/j.gfs.2015.08.001

Resilience building of avocado and pineapple value chains through this more encompassing view has two main objectives. On one hand, tropical fruit value chains face multiple risks simultaneously, which threaten the long term continuity and sustainability of operations (FAO, 2021a). On the other hand, the increasing demand for avocado and pineapple in international markets could lead value chain actors to adopt practices or strategies that could have environmental or socioeconomic consequences. Thus, building resilience is needed to:

- **Ensure continuity and profitability when shocks occur, while mitigating and preventing risks** that the value chain operations may directly contribute to, including climate change.
- **Stimulate risk-sensitive operations** by making investments and adopting more responsible practices along the value chains.
- **Improve cost-efficiency** by de-risking operations and minimizing costs associated with losses and damages, especially where multiple risks are faced.

This is in line with adopting more responsible business conduct to ensure that value chain operations do not lead to adverse environmental, economic and social impacts.

Every actor within the avocado and pineapple value chains has a role to play in building and sustaining resilience. It would be ideal if every segment developed all five resilience capacities. However, in practice, this might not always be possible as not all actors have the same skillsets and knowledge, nor benefit from the same access to assets and services. Thus, the capacities of value chain actors or segments might need to be developed in different stages.

It is important to note that as global value chains, the avocado and pineapple industries maintain multiple links with other sectors at national and international levels. This implies that **resilience also relies on many factors and actors within and outside the specific supply chain.** Effective communication, collaboration and connectivity among all involved parties are additional attributes

enabling the five capacities for resilience (FAO, forthcoming a). This study, however, only focuses on the actors directly involved in the processes ranging from production to import, including midstream actors as discussed in **Section 3**.

Box 1. Key definitions of resilience, adapted to the context of value chains

- **Shocks:** A sudden expected or unexpected event that usually has a limited duration (e.g. few hours, one day, one week). These can have high, moderate or low impacts on the value chains and actors. Examples of shocks are droughts or landslides.
- **Stresses:** Long term trends or pressures that weaken the stability of a system and increase vulnerability within it. Stresses can result from natural resource degradation, demographic pressure, climate change, political instability or economic decline.
- **Risks:** The potential of shocks and stresses to negatively affect value chains, their actors and their operations, based on the likelihood of a hazard to occur, the exposure, the vulnerability levels. These could be extreme temperatures, irregular rainfall, and changes in consumer preferences.
- **Hazard:** A phenomenon, process or human activity that has the potential to cause loss, damage or negative impacts on the systems or their components. This could be environmental degradation, infrastructure damage or social or economic disruption.
- **Exposure:** The degree to which value chains or their components are at risk from harmful events.
- **Vulnerability:** The conditions determined by physical, social, economic and environmental factors or processes that increase the susceptibility of a value chain or its component to the adverse impacts of shocks and stresses. These can be prevalent poverty levels, natural resource degradation, and gender inequality, among others.

Source: Adapted from FAO. 2021a. *The State of Food and Agriculture 2021. Making agrifood systems more resilient to shocks and stresses*. Rome, FAO and United Nations. 2020. United Nations Common Guidance on Helping Build Resilient Societies. New York, United Nations.



3. Methodology to assess resilience of avocado and pineapple value chains

The study centred on analyzing the resilience of the following actors:

- **Avocado:** producers, producer organizations, trade associations, and vertically integrated companies.
- **Pineapple:** producers, traders, cooperatives, and vertically integrated companies.

Unless otherwise specified, the report will refer to these actors as “companies” as most of them are engaged in multiple processes along the value chain. This study does not include analyses of individuals (e.g. consultants, advisers) or of other downstream and upstream actors such as input suppliers, retailers, aggregators, local communities, consumers and governments, as these groups are beyond the scope of this activity.

The study followed a series of steps to explore the resilience capacities of avocado and pineapple companies, and to attempt to measure the resilience performance of the sectors:

- i) Identification of main shocks, stressors and risks** affecting the functioning of avocado and pineapple value chains. This step consisted of a literature review of shocks, risks and stressors in the main producing and exporting regions, and how these are experienced by the value chain actors. Drawing from available data, the research aimed to understand how the presence and impacts of the identified shocks, stresses and risks are expected to influence the functioning of value chains in the future. The linkages and compounding effects among these (e.g. changes in market trends and extreme weather events taking place at the same time) were also analysed.
- ii) Understanding vulnerabilities** by identifying the many environmental, economic, social and institutional factors that increase the susceptibility of value chains to risks. This was done through the literature review, a short resilience survey developed by the project (**Annex 2**) and bilateral consultations with actors from the avocado and pineapple sectors. The first questions of the survey asked avocado and pineapple stakeholders to identify the factors that they consider to be the main sources of vulnerability for their operations. The questions did not ask stakeholders to rate the factors by importance or intensity.
- iii) Assessment of resilience capacities and identification of response strategies** to identify the main resilience challenges and existing resilience capacities among the value chain actors. The project built on the **livelihood resilience framework** to analyse the resilience performance of the avocado and pineapple value chains (Choptiany *et al.*, 2016; FAO, 2021a; FAO, forthcoming a). Through the use of different proxy indicators, the framework helped to explore how the access to and use of physical, natural, social, human, economic and institutional capitals can support value chain actors to develop resilience capacities (Mukhovi and Jacobi, 2022) to face future shocks and stresses (see **Table 1**). Each of the proxy indicators was assigned a score to measure its resilience level and identify resilience gaps. The data gathered from the baseline survey (2021)¹ were used to feed information into each of the proxy indicators, drawing from FAO's work on resilience assessment of the cocoa value chain (Artavia Oreamuno and Croppenstedt, 2022). Refer to **Annex 1** for more details on the indicators selected and scoring system used.

The framework was complemented with a **resilience survey** developed by the project, which included questions following the Subjectively-Evaluated Resilience Score (SERS) to allow participants rate their own capacities (**Annex 2**). The survey consisted of three questions, each with four response options, to understand the extent to which companies felt confident about the different resilience capacities. Subsequently, scores of 0, 3, 6, or 10 were assigned based on the response given and the average of all the responses were computed to calculate the final score.

¹ The Baseline survey is an assessment conducted by the Responsible Fruit project in 2021 to identify the current challenges and practices implemented by the firms related to sustainability (economic, social, and environmental) faced by the avocado and pineapple industries. The baseline survey also aimed to understand companies' priorities and information needs on specific sustainability topics; their awareness and adoption of risk-based due diligence systems; and a preliminary assessment of the extent to which they believe their business operations are resilient to external shocks.

Finally, fourteen **bilateral conversations** were organized with actors from some of the most important stakeholders from the avocado and pineapple industries in Costa Rica, Chile, Colombia, the Dominican Republic, Malaysia, Mexico, Peru, South Africa, Togo, the United States of America and Viet Nam to discuss and corroborate the survey responses before analysis. The project organized a workshop on 6 December 2022 to present, discuss and validate the preliminary findings with project participants. The feedback received was incorporated in the present report.

Table 1. Livelihood capitals and related resilience capacities

Capital	Definition	Resilience capacities
Natural	The value chain functions as much as possible within the means of the local natural resource base and ecosystem services, reducing the need for external inputs to maintain the system.	Anticipatory, absorptive, adaptive and transformative
Human	The system builds resources through increased knowledge and education. Human and labour rights are respected. Actors learn from experience and experimentation to anticipate change.	Anticipatory, absorptive, adaptive and transformative
Economic	Value chain operations are profitable and do not rely too heavily on subsidies. Actors can invest to make operations more resilient and sustainable.	Preventive, absorptive, and adaptive
Social	The value chain builds social relationships, trust and fosters collaboration with other stakeholders to jointly identify and address common issues.	Absorptive, adaptive, transformative
Physical	The value chain has the capacity to invest in and use technology, equipment and infrastructure to make processes more efficient. Physical capital can also help actors to manage risks.	Anticipatory, absorptive and adaptive
Institutional	The value chain access systems, technologies and information that supports their operations.	Preventive, anticipatory, absorptive and adaptive

The process helped to identify how value chain actors were accessing and using different assets and services to prepare and respond to shocks, and to identify susceptible segments or functions of the value chains. By identifying the areas with weaker performance, practical suggestions can be put forward to support actors' efforts to strengthen their resilience capacities.

3.1 Limitations

Specialized studies on resilience and sustainability of tropical fruit value chains as a whole remain scant, thus the literature review focused on available research in different isolated segments of value chains (e.g. production, transportation, packing, etc.), and whenever existing, on the commodities targeted by the project. The bilateral discussions helped to fill in important information gaps and given the highly integrated nature of companies consulted, these allowed the project to obtain a broader understanding of the value chain functioning.

Regarding representativeness of the avocado and pineapple producers and companies globally, the relatively small sample covered by the baseline and resilience surveys is not enough to conduct statistical and inference analyses, which may reflect a certain level of bias. Likewise, the largest share of participants in the consultations and surveys were from Latin America, the region with the largest share in avocado and pineapple global exports. This could skew the results and restrict the generalization to other geographical zones. However, efforts were made to engage with companies in Africa and Asia to ensure the representation of these producing and exporting regions.

Despite these limitations, the actors surveyed in 2021 and consulted in 2022 do represent some of the main producer organizations, associations and companies in the global avocado and pineapple industry. Also, some companies and networks in Africa and Asia were interviewed and the literature review was conducted to also capture their specific challenges.

Lastly, social issues overall, including gender dynamics and labour conditions, represent a major limitation in the analysis. Information is narrow around gender dynamics and employment in the avocado and pineapple value chains, as well as in the wider tropical fruit sector. This has restricted a deeper understanding of the role of women and men in these global value chains, the differentiated challenges they face, their susceptibility to future risks and their resilience capacities.



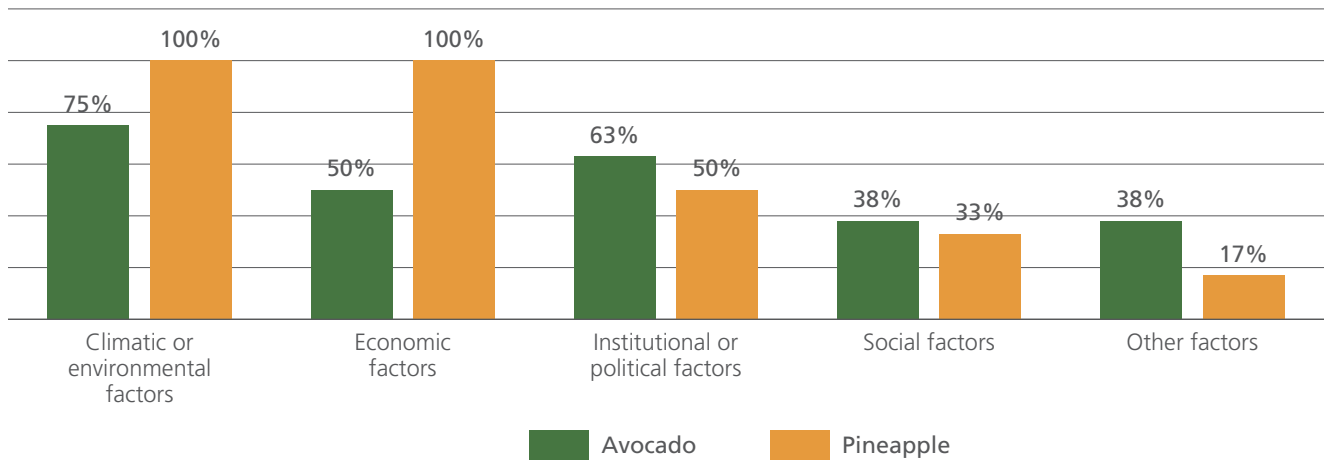
4. Understanding resilience on avocado and pineapple value chains

4.1 Resilience to what: Understanding the main risks and vulnerabilities

Avocado and pineapple value chain actors considered environmental and climatic factors as the main drivers of vulnerability of their businesses (100 percent of pineapple actors and 75 percent of avocado actors) (**Figure 2**).

For respondents in the **pineapple** sector, economic factors (100 percent of respondents) were identified as concerning with regards to their vulnerability, followed by institutional or political factors (50 percent). Social aspects were considered a less important driver of vulnerability (17 percent). On the other hand, actors in the **avocado** sector indicated institutional or political factors (63 percent), economic (50 percent), social and other aspects (38 percent equally) as issues increasing their operations' susceptibility to risks.

Figure 2. Sources of vulnerability as assessed by producers, associations and companies surveyed



Source: Author’s elaboration.

Note: The drivers of vulnerability were exemplified as follows: climatic or environmental factors (e.g. lack of preparation for climatic risks, continuous degradation of natural resources); economic factors (e.g. low business profitability, high reliance on subsidies, inadequate access to credit/loans to invest, inadequate infrastructure, lack of emergency savings, lack of crop insurance); social factors (e.g. security concerns, health concerns, high rates of poverty in the community/among workers, possible exclusion of certain groups); Institutional or political factors (e.g. regulations that restrict market access, guidelines that control the use of inputs); other factors.

These concerns are consistent with findings from research and the baseline survey as summarized in the tables below. **Annex 3** includes detailed analysis of each of the aspects summarized below and provides examples from companies and feedback from the stakeholders consulted.

a) Climatic and environmental factors

Table 2. Risk areas identified as within the climate and environmental domain

Area	Current effects on value chains	Expected trends or impacts on value chains
Climate change and extreme weather events	<p>Temperature: Warmer weather is negatively affecting productivity by reducing flowering, fruit setting, pollinating activity and increasing radiation. In the case of pineapple production, higher temperatures accelerate fruiting and ripening.</p> <p>Precipitation: Insufficient water promotes the loss of flowers, reducing fruit production. Excessive rainfall impairs pollination activity, leads to flower loss (avocado), facilitates the proliferation of diseases and reduces productivity and fruit quality.</p>	<p>Temperature: Expected to increase in all avocado and pineapple producing regions</p> <p>Precipitation: Differentiated patterns across regions.</p> <p>Pineapple: Thailand and the Philippines will see increased average rainfall. Avocado: Chile, Mexico and South Africa will experience lower average precipitations.</p>
Soil and land degradation	<p>Reduced soil health has decreased soil fertility and productivity, with collateral impacts on water availability and quality. Increased degradation has resulted in growing requirements for external inputs and labour for land preparation, incrementing production costs.</p>	<p>Land use change for agricultural expansion can put further pressure on soil health. The use of unsustainable practices to manage soil can worsen its quality, reducing fertility and negatively impacting production.</p>
Plant health issues and agrochemical use	<p>The recurrence of plant health issues has resulted in the increasing use of synthetic pesticides and herbicides, which in turn has augmented the resistance of pests, diseases, and weeds. This situation has created a negative dependency cycle between input use and agroecosystem degradation, already recognized as a main challenge by avocado and pineapple companies.</p>	<p>Changes in temperatures and humidity will bring about shifts in pests' geographical distribution, changes in timing of outbreak and population dynamics. This is accompanied by more stringent phytosanitary requirements and agrochemical use regulations in importing markets.</p>
Water stress	<p>The variability in the rainy season and the slowdown in the replenishment of aquifers due to lower precipitations and water extraction for irrigation have reduced the water available for production in some regions, especially among avocado producers. Growing water competition with other industries and for domestic use have resulted in some cases in tensions and conflicts.</p>	<p>Inefficient irrigation systems and water management practices can intensify various water-related risks, including aquifer depletion and the reduction of surface water levels in rivers if mitigation actions are not taken.</p>

b) Economic factors

Table 3. Risk areas identified as within the economic domain

Area	Current effects on value chains	Expected trends or impacts on value chains
Outbreak of COVID-19 in 2020	<p>The pineapple exporting sector was particularly hit following sudden closures in the hospitality sector and lockdown measures in the main importing markets. Cancelled orders and disrupted transportation routes led to substantial losses in production and revenues.</p> <p>The avocado exporting sector was affected especially at the onset of the outbreak, but the climatic nature of avocado and the perceived health benefits of the product helped producers navigating the crisis by being able to maintain production quality, prices and sales.</p> <p>Lockdown measures in pineapple and avocado producing countries reduced the availability of labour, hampering different processes such as packing, transportation and logistics.</p>	<p>Although the long term impacts and evolution of COVID-19 are difficult to predict, it is important to highlight that most avocado and pineapple producing countries were in a positive recovery track (before the war in Ukraine), with optimistic economic predictions for the coming decade.</p>
War in Ukraine	<p>The reduced supply of fuel, gas and agricultural inputs brought by the war, has exacerbated already growing pressure on prices of energy and fertilizers. The war has also disrupted transportation routes to and from Ukraine and the Russian Federation.</p> <p>For the pineapple sector, the war in Ukraine has posed a new risk to the viability of the operations due to the negative impact on the profitability of the industry due to the growing production costs, thus far absorbed by producers and midstream actors. The avocado sector has also suffered from increases supply costs; however, the higher average export value of the product has potentially offset some of the growing input costs.</p>	<p>The full long term effects of the war is challenging to project. However, preliminary market analyses point to a reduction in exports of avocado and pineapple and higher retail prices of both fruits as a result of escalating production costs. This might potentially influence the demand for these commodities in importing markets.</p>
Costs and problems of local transportation, infrastructure and logistics	<p>Generalized problems in logistics, including weak post-harvest infrastructure, delays in the management of the product in the port, or inadequate cold storage, can significantly reduce the quality of the product and thus, the marketable output. Domestic transport costs can represent a third of the price of agricultural products.</p>	<p>For countries selling to markets with stringent phytosanitary measures, this is a direct shortcoming affecting the viability of global operations and the export potential.</p>

c) Institutional and political factors

Table 4. Risk areas identified as within the institutional domain

Area	Current effects on value chains	Expected trends or impacts on value chains
Trade regulations	Trade restrictions create uncertainty influencing the investment strategies of the firms and may reduce confidence in international sources of supply (and demand), undermining incentives for sustainable production. Likewise, bilateral or multilateral trade agreements may exacerbate existing vulnerabilities of value chains due to potential power imbalances among actors between importing and exporting countries.	The complexity of the influence of national and international institutional environment and regulatory frameworks on the sustainability and resilience of the avocado and pineapple sectors requires further investigation. The project will develop a technical brief on policy incentives and their effect on shaping more sustainable operations and trade in the tropical fruit sector.
Land governance and tenure	Regulations on land tenure and use among different stakeholders (e.g. agricultural producers, foresters, indigenous and local communities) and enforcement of the rule of law play a key role in the use of more responsible and sustainable practices. In some countries it has been noted that inadequate land use and conversion regulatory mechanisms are incentivizing the illegal expansion of agricultural areas into forest areas.	

d) Social factors

Table 5. Risk areas identified as within the social domain

Area	Current effects on value chains	Expected trends or impacts on value chains
Working conditions and inequality	Poverty and inequality are exacerbated by imbalanced contractual arrangements among workers. Third-party contractual arrangements (e.g. through labour cooperatives), instead of direct contracts with the companies has led to a reduction in salaries of contractual workers, who earn significantly less and perceive fewer social benefits than directly hired employees. This has been mainly noted in the pineapple industry, although the avocado sector also experiences this. Third-party contracting has reduced work stability and duration of contracts, and workers tend to be excluded from other labour rights such as dismissal compensations, credit access and retirement. However, in the avocado sector, it was noted that associations tend to be more compliant with labour laws than non-association contractors or informal growers.	Workers facing higher job insecurity might be more motivated to leave, moving to more profitable farms or sectors. This translates into workforce shortage for sectors that do not offer better conditions. This has already been noted in both industries.

Area	Current effects on value chains	Expected trends or impacts on value chains
Gender issues	<p>Women tend to face multiple drivers of discrimination in the agrifood sector. In the avocado industry, women appear to have lower participation in producer and trade associations. This may have negative effects on their access to training, inputs, improved avocado trees and participation in high-value markets. In the pineapple industry, women's involvement is higher in packing and processing activities, and be predominantly hired under third-party contractual arrangements (see point above). Studies have also shown that violence against women is more pronounced after natural disasters, with other negative consequences on women's wellbeing.</p>	<p>While the importance of gender in rural and value chain development is gaining attention, gender inequalities remain an important driver of vulnerability in the agriculture sector. Women's limited access to productive resources, knowledge and services, make them less able to make informed decisions to prepare, adapt and cope with external shocks.</p>
Migration	<p>In some regions, avocado and pineapple companies are engaged with domestic and (undocumented) international migrant workers. Undocumented migrants might be particularly susceptible to (gender-based) violence, exploitation and abuse, as they often have limited social networks and experience fear retaliation or deportation if they report an incident. Some companies in Costa Rica and Mexico are looking for ways to regularize migrant work and provide social benefits.</p>	<p>It is expected that climate change will cause population movements around the globe, as some regions will become hazardous and inadequate to sustain livelihoods. Most people displaced by weather and environmental causes will likely look for homes in countries close to their own.</p>
Security	<p>In some of the producing regions, the avocado sector has faced safety issues, including theft and violence, linked to the high value the commodity represents to the local economy. The risk of criminality and violence implies economic losses for producers and other value chain actors.</p>	<p>Security risks threatens to damage the reputation of the industry, resulting in retailers diversifying origins and clients shifting consumption patterns based on the supplying country</p>
Social customs and beliefs	<p>Stakeholders from the avocado sector in Mexico mentioned that religious beliefs and ingrained cultural customs needed attention as they influence how communal natural resources are being used. In Costa Rica and the Dominican Republic, actors from the pineapple sector pointed at the lack of trust in sustainable practices as producers fear negative impacts on yields and perceive the practices as high investment risks.</p>	<p>Culturally sensitive capacity development, participatory approaches and sensitization strategies that can foster transformation in behaviors, attitudes and practices, could yield positive benefits.</p>

4.2 Identification of gaps in the resilience capacities of value chains

The resilience capacities of the avocado and pineapple value chains were assessed against a set of indicators derived from the livelihood resilience indicator framework presented in **Section 3**, using the data collected through the baseline survey.

Avocado

Figure 3 outlines the resilience indicators for the avocado value chain, highlighting those with low resilience levels (4 points or less out of 10 in the x-axis) and moderate levels (between 4 and 6 points out of 10 in the x-axis).

The results indicate that indicators linked to **economic capital** are those with the weakest performance (below 4 points). These include limited value added to the commodities, restricted access to financial instruments, and high concentration of exports (80 percent or more) into one or two markets (e.g. the European Union or the United States of America). Value addition plays a role in generating greater income for producers and midstream actors; access to new markets; and new processes to improve packaging and storage to reduce waste and ensure greater food safety. On the other hand, financial instruments can provide financial protection to the business. Market diversification can buffer impacts of sudden changes in the supply and demand of the commodity. From the resilience capacity perspective, these measures contribute to enhancing preparedness and adaptation to future shocks, while fostering transformation of value chains.

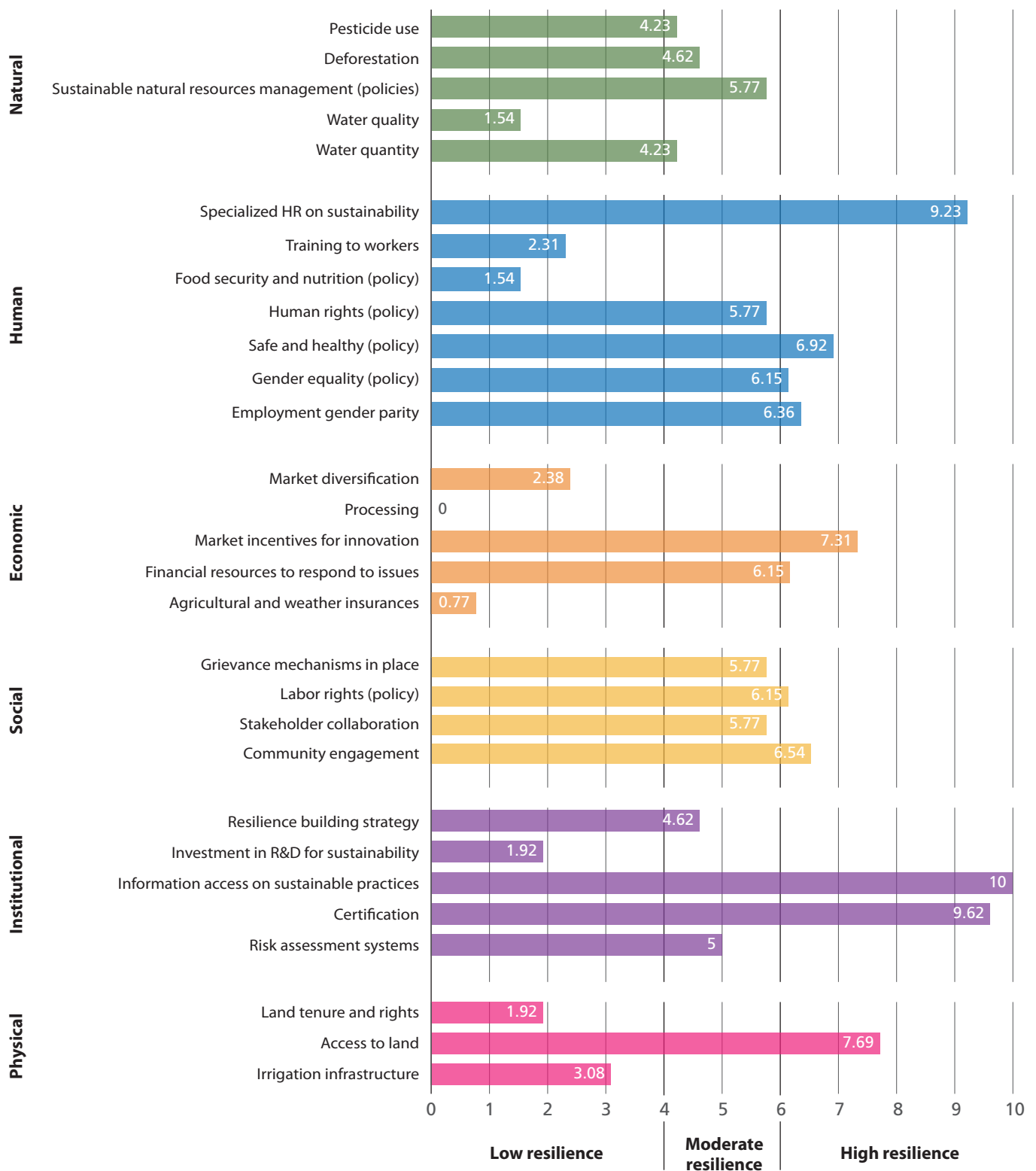
Within **human capital**, insufficient consideration of food security and nutrition as part of business policies, and low investment in training workers on sustainability issues are hindering the absorptive, adaptive and transformative capacities of the value chain. Strengthening skills of workers (e.g. pesticide management and disposal or food safety protocols in packing) and improving their living standards and food security can reduce the vulnerability of the whole value chain.

Low water quality and actions to address the issue, part of **natural capital**, also appeared as a main gap. Although stakeholders have identified water pollution due to agrochemicals runoff and land degradation processes, there is still insufficient action to address the issue. It is important to note that all the other indicators considered in this capital, i.e. pesticide use, deforestation, water quantity and sustainable natural resource management, scored from low to moderate. This suggests that action is needed by the avocado sector to address the climate and environmental challenges faced, and potentially aggravated by the industry.

Linked to the water scarcity problem, is the fact that companies have experienced challenges to invest in efficient irrigation systems as seen by the low score of this indicator in physical capital, and the low investment in R&D for sustainability (e.g. drought resistant plants), part of institutional capital. The underperformance can potentially be due to a combination of factors including access to technologies, financial investment requirements and time required to develop and adopt adaptation strategies.

Under **physical capital**, limited considerations of land tenure rights in business policies might also be increasing the vulnerability of the sector, as it may indirectly promote the use of unsustainable practices in view of business growth (e.g. deforestation, land grabbing, forest encroachment).

Figure 3. Resilience gaps identified in the avocado value chain



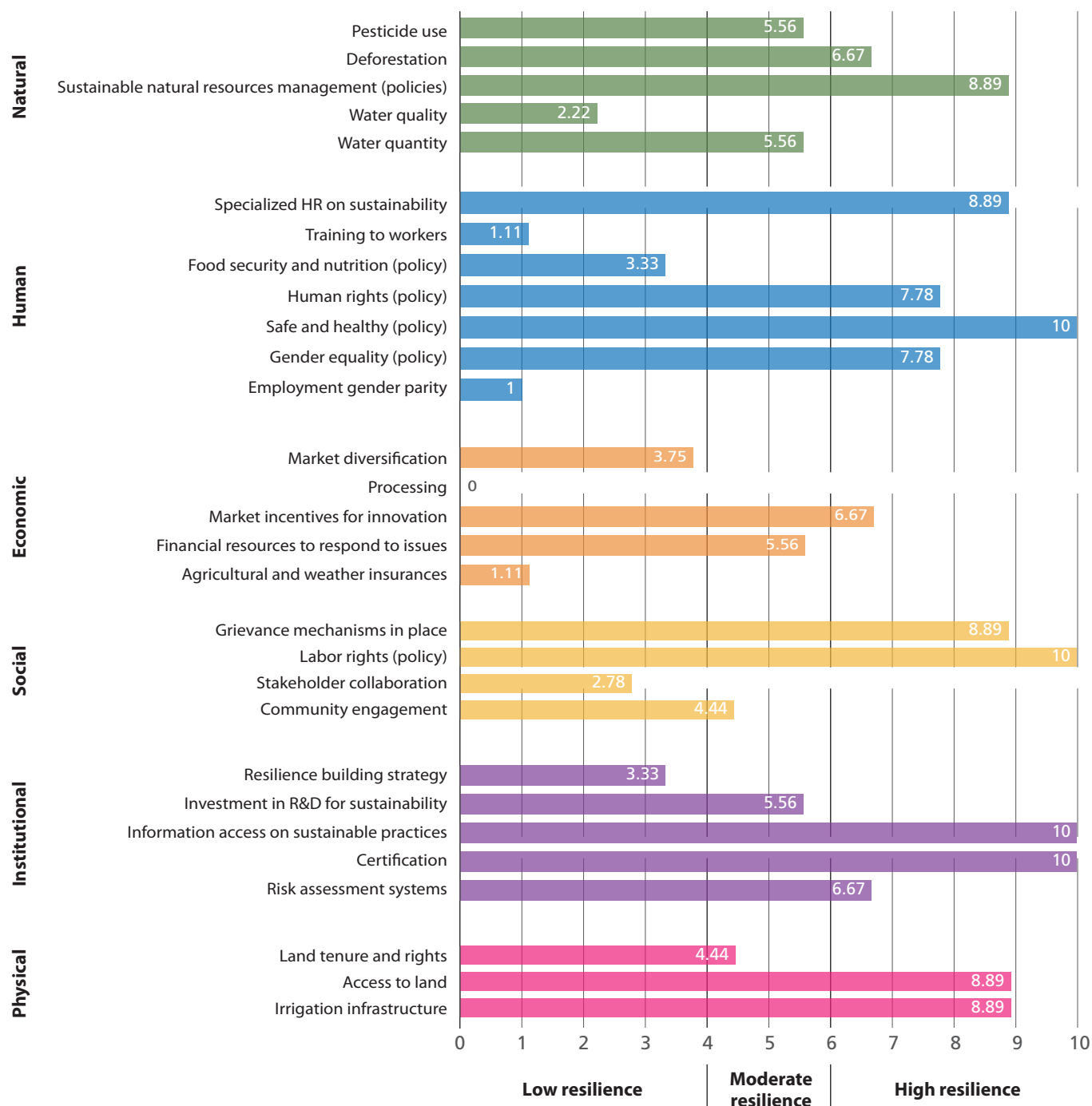
Note: The thresholds chosen to identify the resilience gaps follows the cocoa value chain resilience analysis conducted by Artavia Oreamuno and Croppenstedt (2022), Mukhovi and Jacobi (2022), Monastyrnaya, et al. (2016) and Hernandez Lagana, Phillips and Poisot (2022). Scores range from zero to 10 based on the response provided by the companies. Indicators with scores lower than 4 are considered as weak, i.e. where resilience gaps exist.

Source: Author’s elaboration based on baseline survey results.

Pineapple

The pineapple value chain presents the lowest scores for indicators in human and economic capitals (see Figure 4).

Figure 4. Resilience gaps identified in the pineapple value chain



Note: The thresholds are chosen to identify the resilience gaps follows the cocoa value chain resilience analysis conducted by Artavia Oreamuno and Croppenstedt (2022), Mukhovi and Jacobi (2022), Monastyrnaya et al. (2016) and Hernandez Lagana, Phillips and Poisot (2022). Scores range from zero to 10 based on the response provided by the companies. Indicators with scores lower than 4 are considered as weak, i.e. where resilience gaps exist.

Source: Author's elaboration based on baseline survey results.

Insufficient capacity development programmes for workers and limited considerations of food and security aspects as part of the business' policies were raised as factors needing consideration as part of **human capital** indicators. The underperformance of these features can limit the capacity of value chains to absorb and recover from shocks and stressors. For instance, food insecure, unskilled workers living in conditions of poverty are unlikely to be ready to face or positively cope with future shocks, or to fully recover to return to a productive life.

Regarding **economic capital**, gaps were found in the indicators for access to insurance and credit (contributing to preparedness and adaptation), market diversification (associated with absorption and adaptation), and value addition (linked to adaptive and transformative capacities). Moderate performance was noted in the availability of the financial resources that companies have to respond to issues.

On **social capital**, insufficient engagement with key stakeholders, including communities and government is lowering the capacity of the sector to anticipate and prevent future risks. Due to the global nature of the pineapple sector, effective communication, collaboration and connectivity among all relevant stakeholders can support resilience building efforts.

As in the avocado sector, diminished water quality and practices to mitigate this appear as a key resilience challenge within **natural capital**. Low to moderate gaps are also observed in indicators linked to water availability and heavy use of agrochemicals.

For **institutional capital**, the absence of resilience building strategies at the business level weakens the capacity of the sector to identify, prepare and invest in mitigating future risks. Low scores were also noted in the indicator for investments in R&D for sustainability and resilience. This is likely influenced by the limited investment capacity companies have (moderate scores in the resources available to respond to issues) and restricted access to financial services as mentioned above. Together, these limiting factors influence the capacity of value chains to prevent and adapt to future shocks, while transforming to ensure long term continuity.

4.3 How do value chain actors perceive their own resilience capacities?

Avocado and pineapple value chain actors were asked to rate their own resilience capacities through a short resilience survey (**Annex 2**). The results present the average scores obtained from the responses.

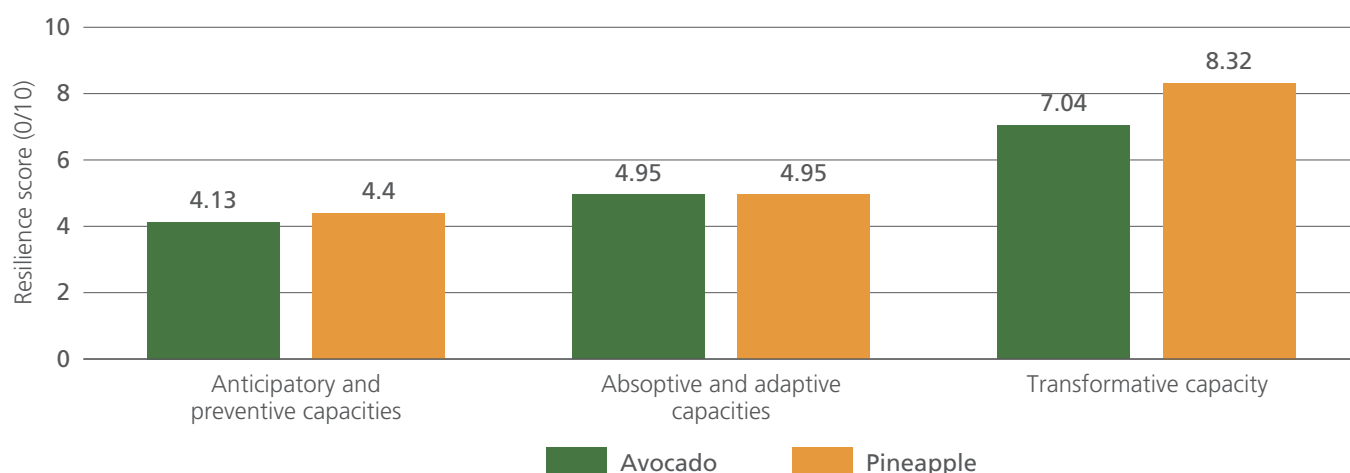
The findings are presented by commodity and by value chain actor to find potential linkages between the resilience capacities and the level of integration of value chains. The survey respondents included eight stakeholders from the avocado sector and six from the pineapple sector. Of these, three were producers or midstream companies², four were associations, five were vertically integrated companies and one was an importer.

² For this study, midstream companies are companies active in the "middle" part of the value chain, including packers, processors, exporters and transporters. Vertically integrated companies are large (often global) companies with integrated operations covering a large portion of the value chain from production to distribution.

The survey results indicate that avocado and pineapple stakeholders need to further strength their preventive and anticipatory capacities, as these presented the lowest scores (4.13 and 4.40 out of 10 respectively, see Figure 5) amongst all the capacities assessed (see Annex 4 for the disaggregated responses).

Transformative capacity displayed the highest scores in both pineapple and avocado sectors (7.04 and 8.32 out of 10, respectively), as 43 percent of respondents felt confident about their ability to change the structure of their operations (or a part thereof) to continue producing and supplying to national and international markets during difficult times. This flexibility was mostly noted in the pineapple sector, where 67 percent of respondents (compared to 25 percent in the avocado sector) consider the structures of their operations as very flexible, allowing them to change quickly if necessary. On the other hand, 63 percent of avocado actors and 17 percent of pineapple actors mentioned that their operations were somewhat flexible, allowing them to deal with the crisis only momentarily. About 17 percent of pineapple and 13 percent of avocado companies said that their operations could only change minimally in difficult times.

Figure 5. Aggregated results of the self-assessment of the different resilience capacities, disaggregated by commodity



Note: Scores range from zero to ten based on the response provided by companies surveyed. Zero indicates low resilience levels, and ten suggests strong resilience.

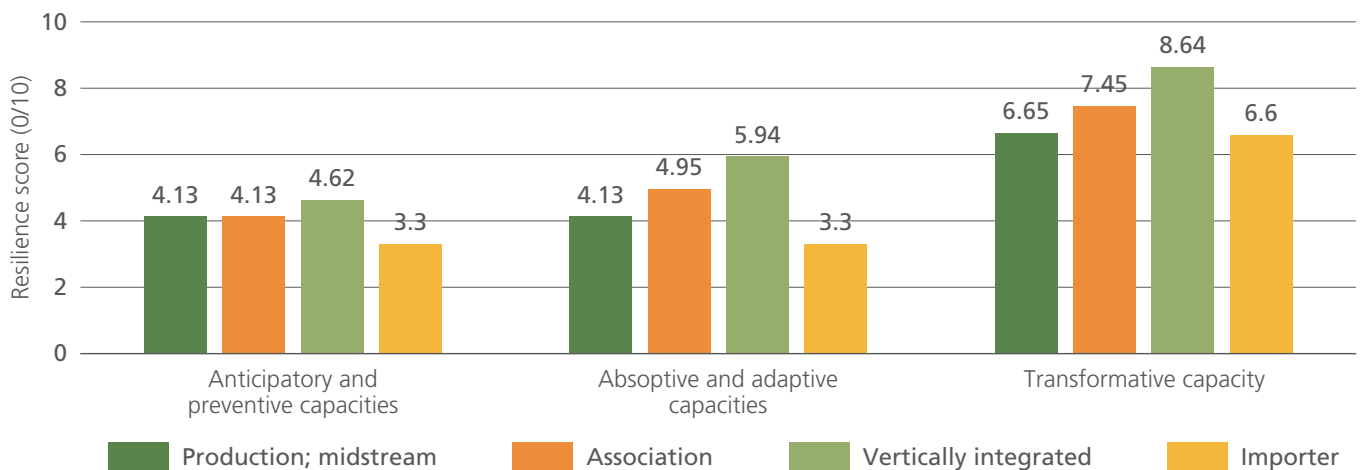
Source: Author's elaboration based on online survey results.

An important finding is that flexibility was mostly noted on the production side, compared to other areas of the operations (e.g. processing, exporting, importing). For instance, the participants consulted from both sectors mentioned that they could adjust their irrigation practices, use different inputs and shift packing practices to align to market demands. Some participants claimed that flexibility was also reflected on the capacity to change the geographical location of production – within or outside the country – to ensure production and commodity supply.

The disaggregation by value chain segment indicates that vertically integrated companies, followed by producer associations, present the highest scores across the different capacities. Conversely, actors that work in relative isolation, such as producers, midstream companies, or importers, seem to be in need of support to strengthen their resilience (Figure 6).

- Anticipatory and preventive capacities:** Most companies, including those vertically integrated, do not yet feel prepared to face any major crisis. These companies noted that they are still working toward the development of a risk management plan. Two vertically integrated companies (of five), one association (of four), and one production and midstream company (of four) claimed to have a contingency or risk management plan in place. However, companies feel that such plans need to be improved to duly address the multiple risks faced.
- Absorptive and adaptive capacities:** Four vertically integrated companies (of five), and half of the associations and companies in the production/midstream segments believe that they can recover within six months from severe shocks, with minimal difficulties. The importing company mentioned that they would need almost a year to recover, whereas one producer/midstream company (of four) indicated that they would need over a year to bounce back.
- Transformative capacity:** Producers and midstream companies were found in the two extremes of the scale. Half of the companies felt that their business structures were very rigid, making it very difficult to modify their operations, whereas the other half considered their operations as very adjustable to warrant the continuity of their functions despite crises. The contrasting responses might be linked to the size of the company and connectedness to other value chain actors, influencing their ability to make investments and decisions. Three vertically integrated companies (of five) and one association (of four) considered the structures of their operations to be very flexible. The importer, three associations and two vertically integrated companies judged that their operations can be adjusted to momentarily cope with difficult times.

Figure 6. Aggregated results of the self-assessment of the different resilience capacities, disaggregated by value chain actor



Note: Scores range from zero to ten based on the response provided by companies surveyed. Zero indicates low resilience levels, and ten suggests strong resilience.

Source: Author’s elaboration based on online survey results.

The divergence in these results may be attributed to the **comparative advantage that vertically integrated companies have to make changes along a large part of the value chain**. Through the consultations, it was noted that the integrated companies have greater potential to **generate information and share it among the different value chain nodes (and actors within them)**. Likewise, the close integration and collaboration among different value chain segments and stakeholders may be having a positive influence on the flexibility of value chains operations. Namely, the closeness might be allowing integrated companies to swiftly adjust to (expected or unexpected) shocks and stresses. As noted above, this has been mostly observed among pineapple companies, which might be attributed to high investments needed to enter the sector versus the low profitability margins obtained at the production and midstream levels.

However, the consolidation of value chains might also promote power concentration among larger companies and further constitute an entry barrier to smaller competitors. The consolidation could potentially be a source of vulnerability in the long term, as sudden shocks might have more distressing impacts on the sector as whole.

Despite **associations** covering only few functions (e.g. production, export) of the value chains compared to fully integrated companies, they also **seem to be enablers of a positive environment for members to develop and strengthen their resilience, for instance, through access to capacity development activities and knowledge**. Associations can also improve the collective bargaining power of producers by concentrating supply and improving marketing. This can particularly help isolated producers and midstream companies reduce transaction costs and collaborate when aggregating, processing and marketing their products, with a positive influence on revenues.

The differentiated results among value chain segments can also indicate that the actors that are at both ends of the value chains, that is producers and importers, may perceive and experience risks differently than actors that are fully intertwined in the chains, and acting upon such risks accordingly. For instance, isolated or smaller-scale producers might not have the same resources and capabilities to prepare, absorb and recover from risks compared to large-scale producers. Likewise, when supply disruptions occur, importers might not be flexible enough to source from different origins. This also highlights the importance of other external stakeholders, such as governments, to create an environment that enables resilience. For instance, the role of governments and public institutions is important to provide services and capacity development for farmers (human, economic and institutional capitals), promoting communication and collaboration with research institutions and other private sector actors (social and economic capitals), and investment in infrastructure that facilitates production, transportation and marketing (physical capital).



5. Reflections and recommendations for companies to build resilience capacities

Despite the challenges identified, the results indicate that companies – either integrated or not – and associations in both the avocado and pineapple sectors already possess valuable resilience capacities. This is reflected in the proactive approaches taken at different levels to address both current and expected resilience and sustainability challenges.

At the same time, there are dimensions that do need attention to allow value chain actors to better prevent, anticipate, absorb, adapt and transform to future shocks and risks. The below tables include suggested areas for action to strengthen anticipatory (**Table 6**), absorptive and adaptive (**Table 7**), and transformation (**Table 8**) capacities, based on resilience gaps identified through the project's research and discussions with stakeholders.

The tables include some examples of positive resilience responses being taken by the companies consulted. It is important to note the inclusion of a practice is not an endorsement by FAO or the

project. Rather, these are presented to provide examples of how resilience might be strengthened. Also, while organized by individual resilience capacity, many of the strategies and actions presented can contribute to multiple resilience capacities concurrently.

Building anticipatory capacities

Table 6. Examples of actions taken by companies to build anticipatory capacity

Area	Why is it important?	What companies are doing?
<p>Conducting risk assessments at the company level and along the value chain</p> <p>Related capitals: Institutional</p>	<p>To identify and create awareness of the main risks the value chains and their operations face, and to detect the value chain’s segments and actors most at risk. Risk assessments are also crucial to identify whether and where the industry operations are creating new risks.</p> <p>Conducting risk assessments as part of the businesses’ due diligence should be an integral part of a business plan that takes a proactive approach to prevent disasters to occur, reduce vulnerability and minimize losses.</p>	<ul style="list-style-type: none"> • Westfalia Fruit (South Africa; avocado) has set up a sustainability platform with key sustainability performance indicators that are tracked annually. This gathers information to monitor progress towards more sustainable business performance and identify potential gaps. • APEAM (Mexico; avocado) is working hand in hand with producers to understand the health status of the soil in the avocado producing region, as well as to assess the incidence of avocado pathogens generated by changes in climate.
<p>Development of plans, strategies and actions responsive to the main resilience and sustainability issues</p> <p>Related capitals: Human, social, institutional, Economic</p>	<p>To improve the preparedness of the sectors to future hazards. Risk-management plans should also go together with adequate budgeting and accountability mechanisms for more responsible anticipatory and response actions. The socialization of the plan among value chain actors and capacity development on how to implement it are also crucial.</p>	<ul style="list-style-type: none"> • Equal Exchange (The United States of America; avocado) is looking into diversifying the supply origin and increase the market outlets for lower quality avocados imported (i.e. category-2 fruit, instead of category-1 fruit only) in preparation for sudden supply shortages (due to weather events or safety risks) and to meet the growing avocado demand in the US market. • Anonymous (Latin America; avocado) instituted a technical committee internally and at industry level to regularly assess sustainability risks (e.g. water and energy use) and provide technical guidance to address these. • Westfalia Fruit (South Africa and Peru; avocado) has developed a Global Water Plan for the next seven years after a detailed risk assessment. This aims to reduce the water consumption of its operations by 50 percent by 2030, for which it is considered to improve the efficiencies of water consumption, implement controls to measure consumption, capacity development, peer learning and investment in the sector.

Area	Why is it important?	What companies are doing?
<p>Access to information and investments in training programmes</p> <p>Related capitals: Human, social, institutional</p>	<p>Although access to information ranks high in the list of indicators, the bilateral consultations shed light on the lack of capacity of some companies and associations in Costa Rica, Colombia and Mexico to use the information they have available and translate it into actionable plans that prepare them for future events and that promote adaptation.</p> <p>Both pineapple and avocado producers and companies highlighted that information needs to be very context-specific to be relevant to their sectors, especially for production.</p>	<ul style="list-style-type: none"> • Anonymous (Costa Rica; pineapple) shares information on pest cycles with producers to allow them to take adequate action. • Anonymous (Latin America; avocado) is training farm personnel on agrochemicals use and pest monitoring. • APEAJAL (Mexico; avocado) disseminates information among avocado farmers in Jalisco on the value of forest preservation, use of integrated pest management practices and the importance to preserve pollinators. In partnership with international organizations, the association is designing a digital platform to identify avocado orchards that have not been planted on natural ecosystems. This aims to validate them as deforestation-free orchards and comply with future deforestation-free import regulations of the European Union and other markets. • Anonymous (Latin America; avocado) is developing a capacity development plan to share best practices among farmers and promote peer-learning to address industry-wide sustainability challenges.
<p>Improved access to weather insurance and other financial instruments</p> <p>Related capitals: Social, institutional, economic</p>	<p>Financial instruments can offer producers and companies financial protection against losses due to adverse weather or market events. Currently, lack of adequate budgeting to respond to shocks, and limited availability and awareness about financial instruments may limit the capacity companies to prepare, respond and adapt to shocks.</p> <p>These insurances might be more relevant to value chains that rely heavily on smallholder farmers fully reliant on avocado or pineapple production, as the potential losses may also threaten their food security and overall wellbeing.</p>	<ul style="list-style-type: none"> • Westfalia Fruit (South Africa; avocado) has protected its operations and revenues from unexpected hailstorms by purchasing agricultural insurances. The instruments have helped to prevent important losses for the company when damaging hailstorms were experienced in the summer of 2021. • APEAM (Mexico; avocado) is working with producers and local communities to improve the potential of ecosystem services in the region, promoting practices to increase soil moisture retention or to increase carbon sequestration by forests. However, local customs and beliefs have been a challenge for the full implementation of good practices.

Building absorptive and adaptive capacities:

Table 7. Examples of actions taken by companies to build absorptive and adaptive capacities

Area	Why is it important?	What companies are doing?
<p>Adoption of adaptation practices to extreme weather events and climate change</p> <p>Related capitals: Environment, Human</p>	<p>The use of better natural resources management practices can support producers in their efforts to adapt to changes in precipitation, humidity and temperatures.</p> <p>Some of these may include mulching, organic manure, intercropping and agroforestry systems to preserve soil moisture, nutrients and temperature, and reduce the use of chemical fertilizers.</p> <p>Water management practices (e.g. supplementary irrigation, water harvesting) can promote the more efficient use of water resources.</p> <p>Implementing living fences can protect crops from strong winds and regulate humidity and temperature levels around the main crops.</p> <p>Integrated pest management techniques can diminish the strong dependence on agrochemicals, with positive environmental and health impacts.</p>	<ul style="list-style-type: none"> • Anonymous (Southeast Asia; pineapple) has been heavily investing in R&D, including breeding practices to develop seeds and fruits that are more resistant to pathogens arising from increasing humidity. • Anonymous (Latin America; pineapple) is working on incorporating organic matter and vegetative cover and reducing tillage to preserve the soil structure and health. The company planted banana trees around the production areas to prevent predators (monkeys) to eat the growing fruits. The trees also served as shields to minimize the presence of other pests. The company has also set up hydration stations and (water) breaks during the work schedule to respond to warmer weather and radiation affecting the health of field workers. • ASOPROPIMOPLA (the Dominican Republic; pineapple) is investing jointly with other institutions in a project to produce pesticide-free products, made with beneficial microorganisms (bacteria and fungi), to naturally help the nutrition and growth of pineapple plantations, soil improvement and pest control and diseases. • Westfalia Fruit (Peru; avocado) is testing practices to help prevent and reverse soil degradation. The use of cover crops and mulch is yielding positive results in improving soil moisture, reducing surface temperature, increasing organic matter content, water infiltration, and reducing water requirements for avocado production.

Area	Why is it important?	What companies are doing?
<p>Adoption of practices to adapt to non-climate shocks and stresses</p> <p>Related capitals: Economic, Human</p>	<p>To respond and adapt to market changes (demand and prices), future pandemics, safety issues, among others. By adding some level of redundancy and flexibility in the value chains, e.g. by applying simultaneous processes (expanding the products and services offered, diversifying export markets and the input/output supplier base) can help value chain actors adapt to sudden market disruptions.</p> <p>Placing safety management protocols, with accompanied capacity building, awareness raising and reporting channels, can limit the risks, damage and delays in the operations when health-related hazards are present (e.g. COVID-19 outbreak).</p>	<ul style="list-style-type: none"> • Anonymous (Southeast Asia; avocado) integrated higher-value crops (macadamia and pepper) in their avocado orchards to adapt to the declining avocado price trend and ensure income stability for farmers. • Anonymous (Southeast Asia; pineapple) opened a new fruit juice line that allowed the company to avoid the waste of fresh fruit and diversify their income sources in response to logistics disruptions due to COVID-19 and the current fuel crisis. Currently, the company is undergoing the formal registration of this new product for export to China. • Equal Exchange (The United States of America; avocado) has started a pilot programme to sell a more challenging avocado size (considered as such due to its small size). The aim is twofold: first, to reduce the waste generated due to lack of a sales outlet for this size; and second, to diversify markets and guarantee the availability for consumers and income stability for the business and for producers. • Fyffes (Costa Rica; pineapple), introduced a continued PCR testing programme throughout the COVID-19 pandemic for early detection of positive cases in its farm Ananas Export Company S.A. (ANEXCO). The company made large investments by applying a preventive isolation program, identifying workers with a risk factor and sending them home with payment to prevent contagion. Strict biosafety protocols were also applied, with no external visitors allowed. Hand washing and sanitation stations were implemented, face masks and social distancing were made mandatory. Partitions were installed, spaces were designated for identified workers to allow traceability in case of contagion, and processes were redesigned to avoid proximity between workers.

Area	Why is it important?	What companies are doing?
<p>Investments in climate-proofing farm infrastructure and technology</p> <p>Related capitals: Environment, Economic</p>	<p>Climate-proofing infrastructure and technology are relevant to prevent and absorb shocks and adapt to future risks.</p> <p>Efficient irrigation infrastructure could help address the strongest stresses and risks (extreme temperatures, droughts and irregular rainfall) the avocado sector is facing, while making the use of water and other agricultural inputs more effective (e.g. fertilizers).</p> <p>Nature-based solutions (e.g. slope stabilization measures, soil bunds, living fences, windbreaks) can protect production systems from landslides, waterlogging (particularly for pineapple production) and strong winds.</p> <p>Sustainable mechanization investments can enhance productivity at different stages of the value chain and compensate for the lack of labour available to some industries.</p> <p>Infrastructure investments must be risk-assessed and aligned with institutional regulations to prevent unintended negative effects. For example, water withdrawals for irrigation and aquifer levels need close monitoring to prevent their depletion and pollution through fertilizer runoff and salinization. Heavily mechanized processes can also reduce the demand of (unskilled) labour, with possible increases in local unemployment.</p>	<ul style="list-style-type: none"> • Anonymous (Latin America; pineapple) has put in place a new laboratory to develop biological molecules to reduce the use of agrochemicals. The cooperative has also conducted water and soil analyses to understand the status of the resources and make production decision based on the specific plant nutrition requirements. • Cartama (Colombia; avocado) and Anonymous (Southeast Asia; pineapple) has invested in implementing slope stabilization structures to prevent topsoil losses and landslides following heavy rainfalls. The company has built water retention ponds, and channel systems to redirect the excess of water off of production areas. • ASOPROPIMOPLA (the Dominican Republic; pineapple) is using soil bunds to prevent soil run off and water stagnation, while preserving vegetation cover. • Anonymous (Latin America; avocado) and Nicoverde (Costa Rica; pineapple) are using advanced technologies, such as satellite images and drones to improve water efficiency, as well as the application of biological products and biofertilizers to reduce soil contamination and promote its regeneration. Nicoverde developed the PineApp Costa Rica mobile application to promote the use of these practices. The investments have been reflected in decreased production costs. • Anonymous (Latin America; avocado) has been collaborating with different companies to pilot technology to improve water use efficiency in avocado production.

Area	Why is it important?	What companies are doing?
<p>Investments in technologies, infrastructure and practices that reduce loss and waste</p> <p>Related capitals: Economic, Environment, Human</p>	<p>Loss and waste management reduces the risk of economic losses and other potential health and sanitation hazards.</p> <p>Investment in practices or technologies (e.g. cool value chains, improved packaging and storage facilities), and that make processes more efficient, can increase the capacity of value chains to swiftly adapt to changes in market demands and consumption patterns.</p>	<ul style="list-style-type: none"> • Anonymous (Latin America; pineapple) is using technology to create new biomaterials for packing through waste processing and reduce the use of cardboard and plastics. This reduces crop waste at the farm level and generates (or retains) revenues for the industry that do not go to importing packaging material. • Anonymous (Southeast Asia; avocado) invested in cool storage warehouse to freeze avocado during high production seasons and be able to sell the production for further processing or when the (domestic) market conditions are more favorable. • ASOPROPIMOPLA (the Dominican Republic; pineapple) is transforming pineapple crowns into fiber to make shoes, bags and handcrafts. This reduces production waste and creates employment and income opportunities for the local communities. • Nature's Pride (Kingdom of the Netherlands; avocado) has partnered with Apeel to provide plant-based protection to ready-eat-avocados that allow them to have a longer shelf life and minimize waste from consumers. The technology also saves water and reduces carbon emissions.
<p>Environmental protection</p> <p>Related capitals: Environment, Human, Economic</p>	<p>To reduce risks to hazards, ensure healthy ecosystems with co-benefits to production systems and ensure continuity of the operations. This can also minimize losses and damages, and associated costs.</p> <p>This can be done by shifting to the adoption of more sustainable practices along the value chains, and by integrating natural resource management considerations in the business policies.</p>	<ul style="list-style-type: none"> • ASOPROPIMOPLA (the Dominican Republic; pineapple) has joined the Biodiversity Check Agrícola – Del Campo al Plato, to work towards biodiversity conservation by preserving native plant species, avoiding deforestation practices, placing shelters for birds and insects, and building beehives for pollination and honey production. • APEAJAL and APEAM (Mexico; avocado) have implemented living fences around avocado plantations in Jalisco and Michoacán, respectively, which have served as biological corridors for native species of birds, small mammals and pollinators. APEAJAL also collaborates with research institutes, avocado and berry producers, apiculture producers, and municipal governments to identify pollinating insects providing services to agriculture, and to disseminate practices that promote the preservation of pollinators' population and health.

Building transformative capacities:

Table 8. Examples of actions taken by companies to build transformative capacity

Area	Why is it important?	What companies are doing?
<p>Stronger multi-stakeholder collaboration, including local communities, research institutions and governments at different levels</p> <p>Related capitals: Institutional, Social</p>	<p>Improved information sharing and alignment of the vision throughout the value chain actors and other stakeholders will support timelier and better-informed decision-making and planning.</p> <p>Forward-looking institutions and regulations are needed to allow the access to services and systems (e.g. early warning systems, social protection, weather-indexed insurance, affordable credit lines, and R&D investments) that promote the adoption of more transformative approaches and increase the resilience of the avocado and pineapple sectors.</p>	<ul style="list-style-type: none"> • APEAJAL (Mexico; avocado) keeps a strong collaboration with research institutes, local communities, other avocado associations in Mexico and governments at national and sub-national level to identify the main risks the sector will be facing. The collaboration aims to serve as the basis to develop a response plan to ensure the sector remains afloat despite the presence of compounded risks. • APEAM (Mexico; avocado) works hand-in-hand with the phytosanitary sector to monitor and share information about emerging pathogens. • Nicoverde (Costa Rica; pineapple) works together with about 100 small producers to monitor and share information on beneficial fungi and bacteria to combat pests and diseases through biological control, under a program supported by the German GIZ Cooperation. • Anonymous (Latin America; avocado) works with different actors across the fruit production industry (e.g. producer associations, packers, freight) to share information about their operations and allow for a more efficient planning and collaboration (e.g. joint shipment of fruits that are in season to other countries) and reduce production and transportation costs. • Anonymous (Southeast Asia; pineapple) is highly integrated and has been successful at engaging with the different supply chain actors. This has given the company the flexibility to make changes and investments to respond, adapt and transform sudden shocks or long term climate and socioeconomic stresses.

Area	Why is it important?	What companies are doing?
<p>Market diversification and value addition</p> <p>Capitals: Economic, Institutional, Social, Human</p>	<p>Market diversification, within or outside the main importing region, is needed to increase the buffer capacity in view of swift market changes. This can be promoted by investment in value addition operations (e.g. processing, packing) as noted by some companies during the consultations.</p> <p>Opening new or niche markets and products might be particularly relevant to new competitors in both industries, who may face more restrictions to enter more consolidated industries.</p>	<ul style="list-style-type: none"> • Anonymous (Latin America; pineapple) is investing technology for the extraction of bromelain for cosmetic and pharmaceutical uses, which allow them to diversify their income options beyond selling fresh fruit exclusively. • Anonymous (Southeast Asia; avocado) invested in technology that allows them to create by-products (e.g. avocado powder, avocado milk, cosmetics) from avocado to respond to current export constraints in the avocado sector and forecasted market changes. This in turn will improve the value of avocado production and increase incomes along the value chain. • APEAM (Mexico; avocado). Various members of the avocado value chain seek to implement actions to create a circular economy and reduce fruit waste. An example is the production of guacamole sauce.
<p>Closing the gender gaps through businesses' policies</p> <p>and women participation along the value chain</p> <p>Related capitals: Social, Institutional</p>	<p>More inclusive and equitable operations, through an improved balance in women-men employment ratio, women's increased access to training and resources, more gender-sensitive business policies, services and facilities can have an important economic influence on value chains.</p> <p>Enhanced women's participation can increase productivity and revenues, bridge the labour scarcity gap in the production, and reduce risks from climate shocks and other events.</p>	<ul style="list-style-type: none"> • Fyffes (Costa Rica; pineapple) started the Fyffes Gender Equality Program, which trains women and men on gender and related issues, including health, household finances, interpersonal relationships, and stress management.

Area	Why is it important?	What companies are doing?
<p>Stronger consideration of human and labour rights as part of the organizational operations and policies</p> <p>Related capitals: Social, Institutional, Economic</p>	<p>Better working conditions, more stable and higher paying jobs can help reduce the vulnerability of value chain actors, particularly in the production and packing processes.</p> <p>This would also benefit the value chains, as better and longer-term contracts would also help reduce the stress generated by the lack of workforce available and even lead to a reduction in production costs, as noted by participants through the consultations.</p>	<ul style="list-style-type: none"> • Anonymous (Latin America; pineapple) is advocating for the establishment of joint contracts among different companies and allow farmers to have multiple 'supervisors' under the same arrangement. Currently companies pay for a full month of benefits even if workers are just hired for few days in a month. Having joint contracts would reduce the costs related to the payment of social benefits, as these would be co-shared among the different companies. For workers, this would improve their job security, benefit from longer engagements and have their labour rights respected. • Grupo Los Cerritos, a company associated to APEAJAL (Mexico; avocado) is running a pilot programme in collaboration with UNHCR and the Government of Jalisco to regularize migrant workers from Central America. The Group offers migrants employment in the avocado plantations and access to social security benefits. These actions will also help avocado farms access labour on a more regular basis.



6. Conclusions and recommendations

The purpose of the study was to identify the main resilience challenges the avocado and pineapple sectors are facing, and to understand the resilience capacities that actors possess to prepare, withstand and mitigate future risks.

Avocado and pineapple companies identified **climate change, extreme weather events and environmental degradation as the main risks** to the continuity of their operations. For the avocado sector, issues related to water quantity and quality [i.e. water stress, droughts, rainfall variability (start of the rainy season and quantity), pollution], as well as warmer weather and hailstorms were the main issues noted. For pineapple companies, increasing humidity, rising temperatures, radiation, loss in water quality and higher prevalence of pests and diseases were identified as the main issues challenging their operations. The findings reaffirm the importance of strengthening and preserving natural capital for resilience building, and the relevance of the work the project is doing on climate change adaptation.

Economic aspects were also found to be important factors limiting the resilience of value chains. High market concentration observed in both commodities, increasing production costs in recent years – worsened by the war in Ukraine and the fuel crisis – and tight profit margins, especially among pineapple companies, included some of the risk factors linked to economic capital.

At the **institutional level**, national and international regulations and a policy environment (including import and export restrictions) that limit actors' access to services (e.g. financial, technology, climate information, infrastructure) are issues of concern to companies from both sectors. Improving the institutional and policy environment would be crucial to enhance the value chains' preparedness, adaptation and transformation of the tropical fruit sector in view of future risks. In the avocado sector, addressing **land use regulations** for the legal expansion of avocado plantations was also considered by stakeholders to be an important issue to reduce the vulnerability of the industry. Land tenure and use considerations play an important role in promoting environmental, economic and social sustainability by preventing further degradation of natural resources (e.g. deforestation), fostering uptake of more environmentally friendly approaches to manage agricultural land, and discouraging unfair competition. **Investments in research** in the avocado and pineapple sectors were also raised as a priority by companies. Access to seeds and crops that are more resistant to biotic and abiotic stresses, and environmental profiling for crop suitability were pointed to as key areas for improvement. Likewise, advancements on genetic amelioration of planting material through crossbreeding or the development of more efficient molecules for pest control were prioritized by actors from both sectors.

Actors from the avocado and pineapple industries claimed that closer **collaboration with research institutions and public entities was highly important** to create an environment that facilitates better communication and information flow among all interested parties. This is particularly important to smaller-size actors. The consultations revealed that companies and associations with investment capacity can rely on their own resources to generate data and information to make production and investment decisions. Meanwhile, smaller-size firms tend to draw on publicly available information (e.g. through Internet or extension services when provided by other actors) to plan ahead. Nonetheless, both small and large-scale companies in the avocado and pineapple sectors acknowledged the existence of some degree of disarticulation between the private sector, public entities and research institutions to access and share data, information and technologies.

Strong multi-stakeholder collaboration is highly desirable for resilience. On one hand, better access to knowledge, information and services provided by research institutions, governments at national and subnational levels and other private sector actors (e.g. financial institutions), would allow companies to produce crops of a higher and more consistent quality and quantity, which is needed to satisfy the market demands. On the other hand, more reliable production of higher-quality fruit for export will yield more profits to the industry. Subject to national and international regulations and power dynamics among the value chain actors, higher industry revenues may promote the better distribution of value along the supply chains and improve the livelihoods of the actors participating in them.

The study also sheds light on the **positive resilience capacities these private sector actors do possess** and are leveraging to overcome some of the risks identified. These actions tend to centre

on practices to adapt to climate change and associated hazards (for instance, water efficiency use, water diversion canals, radiation protection) and those driven by international trade requirements (for example, MRL use, deforestation prevention, biological conservation).

Social capital emerged as a positive feature influencing the performance of resilience across the difference capacities. This was reflected in the fact that companies that are better integrated and associations that keep good communication with other value chain actors seem to be more flexible to shift operations when crisis emerge and are better able adapt to future shocks. This is consistent with findings from research in other high-value export-oriented value chains. The work that the project does towards facilitating collaboration with other stakeholders and promoting information sharing is contributing to building social capital and it can be further strengthened as discussed below.

Also, **engagement with local communities** in which the companies operate, particularly to sensitize and make them part of the value chain, was identified as an area to motivate the adoption of more responsible and resilient approaches in both industries. Stakeholders from the pineapple and avocado sectors mentioned that working together with communities was needed to improve awareness of the benefits of using sustainable practices (across the different dimensions). Engagement with communities was deemed important by companies to address their fears of counterproductive effects that the shift towards more sustainable and responsible production practices may have on yield, income and livelihoods, compared to the use of a more conventional, business-as-usual approach.

However, the study notes that some issues within social capital, including the gender gap in employment, labour conditions or safety issues, are not considered as the main pressing “risk areas” by companies at the time of writing. Yet some companies in the avocado and pineapple sectors have taken innovative actions to address some of the social issues identified (for example, working with migrants, improving working conditions in the field, protection of field workers, developing gender equality plans).

Production appeared to be the most flexible node in both value chains, despite its relatively high level of vulnerability (e.g. larger exposure to changes in climate and extreme weather events). The stakeholders from the avocado and pineapple sectors mentioned that the production segment has a greater capacity to swiftly adapt to fluctuations in weather and market conditions, for instance by changing production practices, crops and packing.

Another important finding was that the **vast majority of companies did not have a contingency or risk management plan in place**, although most do assess the risks of their operations. This is in line with the findings from the baseline survey conducted by the project in 2021. Nonetheless, all companies consulted are taking individual actions to respond to the sectors’ most pressing concerns. Moreover, a subset of companies are working on the development of a company-wide risk management or contingency plan to prepare for future risks and minimize losses. This suggests that **avocado and pineapple companies are taking proactive actions to address urgent needs**, including those driven by changes in regulations by importing markets.

Recommendations for the project

Climate change adaptation and mitigation: The technical guide on climate change adaptation, as well as the commodity-specific guides under preparation by the project are two milestones that will directly contribute to bridge a gap in information regarding relevant adaptation practices in both industries. Given the importance stakeholders placed on the production and processing segments of the value chain, the project should focus on outputs that provide information that can be directly translated into action in the field. For instance, information sharing on specific tools, practices and methods such as tools to measure carbon footprints and land use change monitoring tools will be useful for companies to track and report on their progress towards their sustainability efforts, including climate adaptation and mitigation.

Enhancing preparedness for future risks: Further work is required to increase the avocado and pineapple industries' preparedness for expected shocks (e.g. changes in market regulations), unexpected events (e.g. frosts in avocado production and sharp temperature increase in pineapple production) and longer-term stressors (e.g. economic slowdown and high market concentration). This work should also be accompanied by strengthening the capacity of the avocado and pineapple industries to mitigate potential risks created by their own operations. The project's **technical guide on conducting a "gap analysis" to support due diligence in the avocado and pineapple sectors** and the **OECD-FAO Guidance for Responsible Agricultural Supply Chains** can be instrumental in achieving this. For example, the technical guide and dedicated capacity development sessions can support companies' efforts to identify and manage the potential negative environmental and social risks created by the processes along the value chains. This can serve as a starting point for companies to develop internal policies and due diligence processes, enhancing their ability to prevent, prepare and mitigate future risks created by their own operations.

Improving multi-stakeholder collaboration: As a first step, the project team can explore how to better engage with research institutions in project activities. This could include peer-learning events and capacity development activities with project participants from the avocado and pineapple sectors. This builds on the positive feedback that companies provided regarding the value of the peer-learning events organized by the project. It was noted that the sessions allow companies to share their own experiences and learn from others. It was recommended that the sessions and material produced by the project keep their practical information or example-based focus to enhance their value and to ensure motivation from participants. Thus, the organization of such forums will promote intersectoral collaboration and enable information exchange between the private sector from the avocado and pineapple industries, and academia and research institutions. This could also constitute a first step to establish a working group that supports information generation for decision-making for more sustainable and resilient operations.

Engagement with local communities: From the social perspective, the project could work with companies to better understand the barriers constraining the adoption of sustainable and resilient production practices by local communities. The project could explore existing strategies and participatory interventions that can help companies to improve awareness and foster sociocultural change among the local communities in which they operate. For instance, culturally sensitive capacity development and communication strategies that can motivate transformation in behaviors, attitudes and practices, could yield positive benefits towards the adoption of more sustainable practices along the value chain.

Other social aspects: The project recognizes that some social aspects, such as gender and labour regulations, remain a low-risk feature for companies. However, driven by demand, it is recommended that social aspects are touched upon in subsequent phases of the project, as social capital and related issues have important implications for resilience building. These include better compliance with health and safety measures at the workplace, faster recovery due to improved collaboration, mutual aid and support when crisis emerges, and enhanced access to information by all actors and populations groups, among others. Working on social aspects is also advised as companies may need to address these to be able to comply with voluntary schemes and international trade requirements.

Recommendations for value chain actors and policymakers

Global avocado and pineapple industries maintain multiple links with other sectors at national and international levels. As such, **resilience building depends on many actors within and outside the specific supply chain.**

Producers and producer and trade associations: Production appeared to be the most flexible node in the value chains studied. As such, companies and association engaged in fruit production have a great potential to improve the resilience of their operations by adopting more sustainable and responsible production practices. For instance, resilience of natural capital can be enhanced by replacing agrochemicals with biofertilizers, sustainable soil and water management practices, and integrated approaches to manage pest and diseases. The integration of more biodiversity in large plantations, the protection of pollinators and other beneficial insects, and preserving soil and water health are other recommended actions for resilience building. These actions can minimize both the risks faced by the industries to climate shocks and other events, as well as to reduce the potential negative impacts of large-scale avocado and pineapple production systems.

Associations can also offer producers economic resilience against market fluctuations and other socioeconomic shocks. For instance, by offering training to workers on health and safety protocols, marketing strategies and financial literacy, pesticide use, and other topics, can help producers and other actors to prevent, prepare and recover from unexpected shocks. Producer organizations also play an important role to procure inputs, aggregate and commercialize product in bulk, and offer services and technology to producers. Likewise, by enhancing association- or community-based storage capacities or post-harvest processes, producer organizations and other midstream companies may reduce their vulnerability to sharp price fluctuations and decrease potential production waste and revenue losses.

Associations and midstream companies may also improve their economic resilience by investing in the differentiation of their products. For example, the use of innovative agricultural waste management and the use of biodegradable packing material may lower reliance on imports of certain products (e.g. boxes, cans, fertilizers, etc.), lower production costs, and may even generate additional income sources. These actions may also have important implications on the carbon footprint of agricultural value chains.

Moreover, social self-organization already reflected in the formation of associations and organizations in some regions, also contributes to building social capital resilience. Self-organization improves trust

and cooperation among association and organization members needed to jointly address common problems. More comprehensive recommendations for companies are offered in **Section 5**.

Governments and policymakers: Public and private investment play a crucial role to improve the resilience and sustainability of agricultural value chains. Attention should be given by governments to strengthening regulations that protect natural resources, while ensuring viable economic livelihoods for agricultural producers and communities. Some regulations, policy measures and public investments that can improve the resilience and sustainability of avocado and pineapple industries may include:

- i) Developing or reinforcing land tenure and use agreements. **The Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security** can support this exercise. It should be accompanied by capacity development with producers, communities and other land, water and forest users to address potential conflicts over natural resources use and access.
- ii) Providing access to knowledge and technologies supporting efficient management of natural resources. This should be done in close collaboration with public and private research institutions and academia, as well as with avocado and pineapple industry actors, to generate and disseminate the knowledge needed. Partnership with research institutions is also required to generate tools and mechanisms to measure, map and monitor the progress and impact of regulations on sustainability and resilience outcomes of the industries.
- iii) Developing or enhancing information systems, such as early warning systems for climate and other non-climatic risks, to increase preparedness and adaptation of avocado and pineapple producers and other value chain actors.
- iv) Providing access to financial instruments for companies, such as agricultural loans or weather-indexed insurance, to carry out investments to adopt more sustainable production practices and technologies, as well as to speed recovery from external shocks.

Policies, rules and regulations, including investment incentives are needed to support the transition to more sustainable and resilient global value chains. More on ideas for incentives will be provided by the project through a dedicated technical brief (forthcoming).

Annexes

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Annex 1. Livelihoods resilience framework. Table of indicators and scoring system used to assess the resilience of the avocado and pineapple value chains

Table A1 outlines the six capitals and the proxy variable selected to measure the five resilience capacities. Each indicator was then assigned a score to be able to measure their level of resilience and identify gaps (**Table A2**).³ In this study, resilience gaps refer to those aspects that limit value chain actors' ability to adopt practices to prevent, anticipate, absorb, adapt, and transform when faced with shocks, stresses and risks.

Table A1.1. Indicators used to assess the resilience capacities

Capital	Definition	Proxy variables	Resilience capacities
Natural	The value chain functions as much as possible within the means of the local natural resource base and ecosystem services, reducing the need for external inputs to maintain the system.	Soil and water quality; use of sustainable practices to manage natural resources is part of the company policies; production aligns with local ecological parameters (e.g. agroecological practices).	Anticipatory; Absorptive; Adaptive; Transformative
Human	The system builds resources through increased knowledge and education. Human and labour rights are respected. Actors learn from experience and experimentation to anticipate change.	Access to training; specialized workers on sustainability issues; food security, Human rights, safety and health protocols are part of the company's policy.	Anticipatory; Absorptive; Adaptive; Transformative
Economic	Value chain operations are profitable and do not rely too heavily on subsidies. Actors can investment to make operations more resilient and sustainable.	Adequate budget to respond to challenges; market diversification; access to (climate-risk) insurance; value addition to production through processing.	Preventive; Absorptive; Adaptive
Social	The value chain builds social relationships, trust and fosters collaboration with other stakeholders to identify and address issues jointly.	Engagement with local communities, national or subnational governments; inclusivity and equality; gender equality as part of the company policies; labour rights are respected; grievance tools are in place.	Absorptive; Adaptive; Transformative
Physical	The value chain has the capacity to invest in and use technology, equipment and infrastructure to make processes more efficient. Physical capital can also help actors to manage risks.	Land access; land rights and tenure as part of the company policies; infrastructure investments; access to climate proofing assets (heat/drought/ flood resistant)	Anticipatory; Absorptive; Adaptive
Institutional	The value chain access systems, technologies and information that supports their operations.	Access to information; investment in research and development; enrollment to voluntary standards; market incentives for innovation; risk assessment systems in place.	Preventive; Anticipatory; Absorptive; Adaptive

³ The development of the scoring system follows research and methodologies on resilience assessment of agrifood systems developed by Mukhovi and Jacobi (2022), Monastyrnaya *et al.*, (2016) and HernandezLagana, Phillips and Poisot (2022).

Scores for each capital range from zero to ten depending on the response provided by the companies surveyed. The scores indicate the resilience level as follows:

Table A1.2. Thresholds used to determine resilience levels of avocado and pineapple companies

Score	Resilience level	Meaning
0 to 4	Low	High priority areas where major resilience gaps are observed. Value chain actors need strengthening these to avoid increasing their susceptibility to shocks and/or minimize the impacts of their operations.
>4 to 6	Moderate	Areas face some resilience constraints and need monitoring to prevent them from becoming high priority areas.
>6 to 10	High	Areas have good functioning and do not represent a resilience challenge at the time of the assessment.

Table A1.3. Scoring system used to assess the resilience of the avocado and pineapple value chains

Capital	Indicator	Score
Natural	Water conservation (companies include water management in their policies)	Yes=10 No=0
	Water quality	0= Companies have not taken actions to address / prevent water quality concerns (when observed) 10=Companies have taken any actions to address / prevent water quality issues
	Sustainable natural resources management (included in the company's policy)	Yes=10 No=0
	Deforestation (whether it is identified as a main challenge + whether actions have been taken to address it)	Deforestation is not identified as main challenge=10 + Reforestation or afforestation actions taken=10
	Pesticide use (whether it is identified as a main challenge + whether actions have been taken to address it)	Companies not rating agrochemicals as a main challenge=10 + Companies taking actions for improved use of agrochemicals=10
Physical	Irrigation infrastructure (Investment in climate-proofing and other infrastructure to prevent loss and damage)	Yes=10 No=0
	Access to land for productive activities	Yes=10 No=1
	Land tenure and rights (included in the company's policy)	Yes=10 No=0

Resilience assessment of avocado and pineapple value chains

Capital	Indicator	Score
Financial	Agricultural and weather insurances	Yes=10 No=0
	Financial resources to respond to issues (adequate budgeting)	Yes=10 No=0
	Market incentives for innovation (market premium received for being the first mover / innovating)	No extra costs associated=10 Extra costs associated=0
	Processing	Less than 10% of production is processed=0 30%+ of production is processed=10
	Market diversification	Sells less than 50% to a single market/region=10 Sells between 50% to 80% to a single market/region=5 Sells more than 80% to a single market (country/region) =0
Institutional	Risk assessment systems (Companies have a risk assessment plan or system in place)	Yes=10 No=0
	Certification (Companies are part of a certification scheme aligned with sustainability principles)	Yes=10 No=0
	Information access on sustainable practices, including adaptation (e.g. NRM, production practices)	Yes=10 No=0
	Investment in R&D to improve sustainability (carbon and/or water footprint)	Yes=10 No=0
	Resilience building strategy (companies have strategies in place to build/strengthen the resilience of their businesses)	Yes=10 No=0
Social	Community engagement (Companies engage with communities on sustainability issues)	Yes=10 No=0
	Stakeholder collaboration	With communities and government=10 With communities or governments=5 With neither=0
	Labour rights (included in the company's policy)	Yes=10 No=0
	Grievance mechanisms in place (included in the company's policy)	Yes=10 No=0

Capital	Indicator	Score
Human	Employment gender parity	Male-female or female-male employment ratio: 40/50:60/50=10 80/70:20/30=5 90:10 (and vice versa) = 0
	Gender equality (included in the company's policy)	Yes=10 No=0
	Safe and healthy (included in the company's policy)	Yes=10 No=0
	Human rights (included in the company's policy)	Yes=10 No=0
	Food security and nutrition (included in the company's policy)	Yes=10 No=0
	Companies provide training to workers on sustainability issues	Yes=10 No=0
	Companies have specialized HR dedicated to address sustainability aspects	Yes=10 No=0

Annex 2. Online consultations with participants of the Responsible Fruits project

Climate change adaptation technical guide and resilience study

Disclosure: ALL INFORMATION PROVIDED BY YOU WILL BE STRICTLY CONFIDENTIAL

i) Name of the company (optional): _____

ii) E-mail (optional): _____

iii) Main crop: _____

iv) You identify yourself as (select all relevant options):

- Producer: Companies that focus on avocado or pineapple production
- Association of producers or trade
- Packer
- Processor
- Transporter
- Exporter
- Midstream: Companies active in the “middle” part of the value chain, including packers, processors, exporters and transporters
- Importer: Companies that brings avocados or pineapples into a country from abroad for sale
- Vertically integrated: Large (often global) companies with integrated operations covering a large portion of the value chain from production to distribution
- Consultant: Consultancy firm or person who has a consultancy contract
- Certification scheme: Certification system related to specified products, to which the same specified requirements, specific rules and procedures apply
- Other

v) Country / Region: _____

1. From your point of view and experience, what do you think makes your sector vulnerable to shocks, both climate and non-climate? (please select all that are relevant)

- Climatic or environmental factors (e.g. climate risks, lack of preparation for climatic risks, continuous degradation of natural resources)
- Economic factors (e.g. low business profitability, high reliance on subsidies, inadequate access to credit/loans to invest, inadequate infrastructure, lack of emergency savings, lack of crop insurance)
- Social factors (e.g. security concerns, health concerns, high rates of poverty in the community/ among workers, possible exclusion of certain groups)

- Institutional or political factors (e.g. regulations that restrict market access, guidelines that control the use of inputs)
- Other factors

2. Is your company/sector fully prepared for future threats (of whatever nature) that may occur in your area?

- No, we are not (e.g. we don't have a contingency plan or anything to prepare for it)
- No, but we are getting ready (e.g. we do not have a risk management/contingency plan, but we are working on one)
- Yes, but we need to improve our current contingency/risk management plan
- Yes, fully (e.g. we have a contingency/risk management plan appropriate to the main risks we face)

3. If a severe shock were to occur tomorrow, would your business fully recover within six months to continue producing and supplying domestic and international markets?

- No, it would not recover at all, or it would take a long time (more than a year)
- No, but it would recover in a little more time (but less than a year)
- Yes, with some difficulties
- Yes, without any problem

4. During difficult times, could your company change its operations (or part of them) if necessary to continue producing and supplying the national and international markets? (For example, changing your suppliers, implementing social distancing, supplying other markets, etc.)

- No, the structures are very rigid, and it would be very difficult to change anything
- Yes, but minimally
- Yes, but only some that would allow us to cope with the situation momentarily
- Yes, the structures of our operations are flexible and allow us to change quickly if necessary

Annex 3. Analysis of the shocks, stressors and risks affecting the performance of the avocado and pineapple value chains

A3.1 Climatic and environmental factors

Climate change and extreme weather events

Climate and weather events play a key role in the production of tropical fruits as illustrated in this section. More details of climate change impacts on avocado and pineapple production will be provided in the project's Technical Guide on Climate Change Adaptation.

Temperature

- Avocado: Higher temperatures are affecting floral differentiation, anthesis, fruit setting and development. Temperatures above 33 °C in humid subtropical climates and over 21 °C in high-altitude areas shorten the flower opening period and reduce the number of flowers that open, decreasing pollen viability and fruit production (Álvarez-Bravo *et al.*, 2017). Temperatures from 28 to 33 °C are causing the abortion of Hass embryos and, when combined with low humidity, produce the fall of small-size fruits (below 5 mm). Nonetheless, the elevation of minimum temperatures has also reduced the risk of exposure to temperatures below 10 °C.
- Pineapple: Temperatures exceeding 32 °C cause the production of unevenly shaped fruits, especially of crowns, which constitutes one of the main planting materials. Higher differences in temperature between day and night of 8 to 14 °C also reduce crop yields and may lead to an increase in production costs due to the higher demand of inputs to protect the crops and workers from the heat and radiation (Custódio *et al.*, 2016). The development of diseases such as *Penicillium funiculosum* flourishes in temperatures oscillating from 16 to 20 °C (Manik *et al.*, 2019).

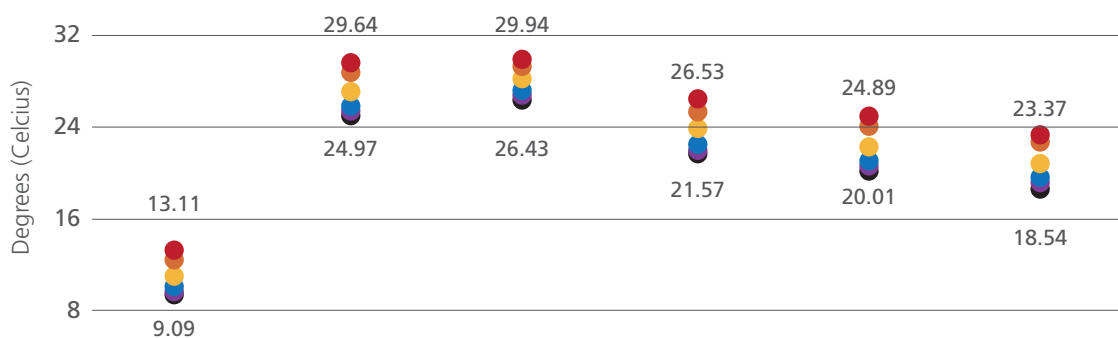
The World Bank (2022) estimates that average temperatures in all major avocado and pineapple producing countries will increase across all the five scenarios modelled.⁴ Considering a middle scenario (SSP2-4.5), where there is slow progress towards sustainable development, temperature in South Africa is expected to increase by 2.20 °C from 2014 to 2100. Mexico (2.16 °C) and Peru (2.14 °C) closely follow these trends. Considering a more pessimistic scenario (SSP5-8.5), temperatures in these countries are projected to surpass 3.7 °C by the end of the century.

⁴ The World Bank estimated future mean temperatures until 2100 by using five possible future scenarios that consider the levels of emissions and the Shared Socioeconomic Pathways (SSPs) model. Each scenario analyzes countries' emissions, mitigation efforts and development, using average temperatures between 1995 and 2014 as the reference period. The models are **SSP1-1.9**: Most optimistic scenario, describing a world where global carbon emissions are cut to net zero by 2050. **SSP1-2.6**: Net-zero is reached after 2050 and temperatures stabilize around 1.8 °C higher by 2100. **SSP2-4.5**: carbon emissions start to decrease after 2050 and do not reach net-zero by 2100. Progress toward sustainability is slow, with uneven development and income growth and temperatures rise 2.7 °C by 2100. **SSP3-7.0**: CO2 emissions roughly double from current levels by 2100 and temperatures rise by 3.6 °C by 2100. **SSP5-8.5**: Current carbon emissions levels almost double by 2050. The global economy grows quickly relying on fossil fuels and leading energy-intensive lifestyles; the average global temperature is 4.4 °C higher.

According to the IPCC, an increase of 2 degrees will lead to more frequent and intense extreme weather events (augmented droughts and heavy rains), the extinction of some animals and plants, and will put the production of some agricultural commodities at risk, among others (IPCC, 2021).

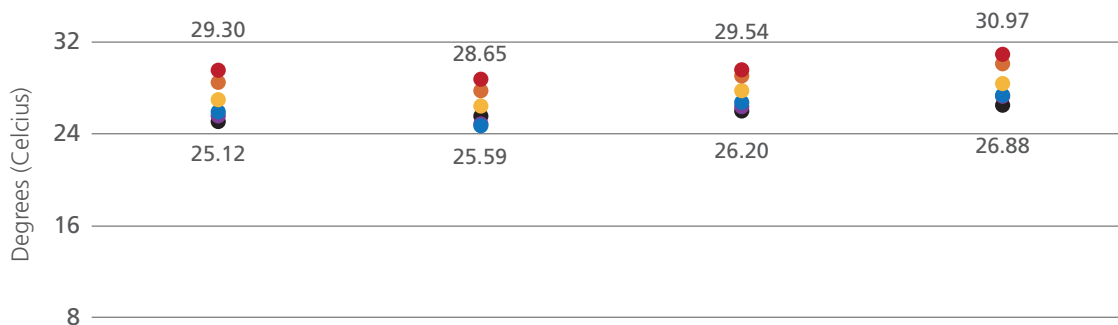
Figure A3.1. Mean temperatures projected by 2100, by SSP model and producing country and commodity

Avocado producing countries



	Chile	Colombia	Indonesia	Mexico	Peru	South Africa
● Reference year (2014—2016)	9.09	24.97	26.43	21.57	20.01	18.54
● SSP1-1.9	9.24	25.30	26.72	21.75	20.42	18.89
● SSP1-2.6	9.78	25.75	27.08	22.44	20.87	19.32
● SSP2-4.5	10.85	27.00	28.04	23.73	22.15	20.74
● SSP3-7.0	12.33	28.72	29.22	25.34	24.06	22.60
● SSP5-8.5	13.11	29.64	29.94	26.53	24.89	23.37

Pineapple producing countries



	Costa Rica	Dominican Republic	Philippines	Thailand
● Reference year (2014—2016)	25.12	25.59	26.20	26.88
● SSP1-1.9	25.49	24.93	26.49	27.54
● SSP1-2.6	25.85	24.74	26.82	27.71
● SSP2-4.5	26.90	26.39	27.84	28.70
● SSP3-7.0	28.34	27.71	28.99	30.26
● SSP5-8.5	29.30	28.65	29.54	30.97

Source : Adapted from **World Bank**. 2022. Climate Change Knowledge Portal for development practitioners and policymakers. In: *World Bank Group* [online]. Washington. [Cited 7 October 2022]. <https://climateknowledgeportal.worldbank.org>

Changes in temperatures are also likely to make hailstorms more frequent and severe. Although the prediction is less exact than other weather events, warmer weather will enable factors contributing to more frequent hailstorms and the formation of larger hailstones (Raupach *et al.*, 2021). This risk has been identified as a main concern to the avocado sector, particularly in Chile, Mexico and South Africa, as it has negatively impacted production. According to project participants, hailstorms have led to the reduction of productivity (due to loss of flowers and fruit setting) and fruit quality (smaller size) and has produced damages to trees and infrastructure.

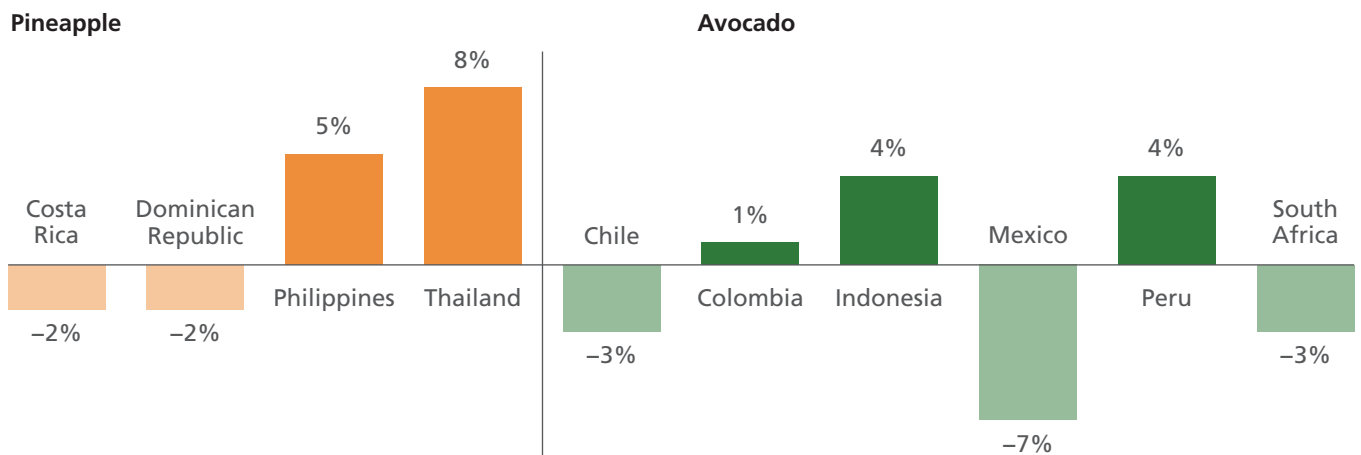
Precipitation

Precipitation variability (distribution, frequency and quantity during the year) and long term changes have varying effects on avocado and pineapple production, depending on whether water deficit or excess is experienced during plant development.

- **Avocado:** Insufficient rainfall without supplementary irrigation leads to the loss of flowers, reducing fruit production. Below 56 mm of precipitation and with insufficient underground water (e.g. due to extended droughts or intensive water extraction) will limit the establishment of new orchards or production continuity (Caldana *et al.*, 2019). On the other hand, excessive rainfall during the flowering period impairs pollinator action and pollen quality, affecting fruiting (*ibid*). High humidity also brings the proliferation of diseases such as *Phytophthora* that thrives in subtropical climates with temperatures between 21 and 27 °C. Humidity also increases the incidence of sporangia, the release of zoospores and the invasion of host roots. This situation is worsened if soils are degraded (Rocha-Arroyo *et al.*, 2011).
- **Pineapple:** Pineapple quality is sensitive to water excess and waterlogging. Abundant water supply increases the presence of diseases, such as *Chalara paradoxa*, which appears under high humidity conditions (Joy and Sindhu, 2012). During harvesting, water surplus increases the susceptibility of the crop to fungi causing heart rot and deteriorate the fruit quality (Manik *et al.*, 2019). At flowering stage, water excess stimulates stem growth and a large core, which is disadvantageous for companies processing fruits, particularly for canning (*ibid.*). On the other hand, water deficit in dry months and in the absence of supplementary irrigation affects flowering and accelerates fruiting and ripening. Compounded with rising temperatures, water deficits can lead to higher evapotranspiration, reducing soil moisture and cause water stress during production.

Under the SSP2-4.5 model, the World Bank estimates that Thailand will experience the greatest raise in precipitation of 8 percent by 2100 among the pineapple producing countries analyzed (World Bank, 2022). The Philippines will also see an increase of around 5 percent in the average precipitation rate by the end of the century (see **Figure A2**). For avocado producing countries, Indonesia and Peru are those where average precipitation is projected to increase by 4 percent under the SSP2-4.5 model. Mexico will be the avocado producing county with the sharpest decline in rainfall by 7 percent by the end of the century.

Figure A3.2. Precipitation change rate by 2100, using the SPSP2 - 4.5 model



Source : Adapted from **World Bank**. 2022. Climate Change Knowledge Portal for development practitioners and policymakers. In: *World Bank Group* [online]. Washington. [Cited 7 October 2022]. [https:// climateknowledgeportal .worldbank.org](https://climateknowledgeportal.worldbank.org)

Avocado and pineapple project participants have recognized problems associated with changes in precipitations patterns and water availability. According to the baseline survey, 42 percent of avocado producers and associations and 11 percent of pineapple companies identify water access as one of their main challenges for sustainable production. In some regions changes in water availability (deficit or surplus) are putting agricultural activities at risk as:

“Extended drought periods and shortened rainy seasons affects the capacity to collect fresh fruit and processing. Water management through irrigation is something that producers have to look into to ensure continuity of the business”.

Pineapple company, Togo. Online consultations, 2022.

“Intense rains cause waterlogging [...], increasing the risks of fungi in the field”.

Pineapple company, Costa Rica. Online consultations, 2022.

Water quality issues were also pointed out by participants, linked to the use of agrochemicals (fertilizers and pesticides), inadequate irrigation practices and excessive rainfall in some regions resulting in the runoff of inputs into streams and underground water. The expansion of agricultural areas and unsustainable land management practices has also led to waterlogging and salinization (Sommaruga and Eldridge, 2020).

Environmental degradation

Soil and land degradation

In the baseline survey, 22 percent of participants pointed to land degradation as one of the main sustainability challenges faced by their businesses. This was confirmed by all the stakeholders consulted for this study, acknowledging that poor soil health is already disturbing production in certain areas, particularly pineapples. Land degradation processes, such as soil salinization, have been

observed in low-altitude production areas in Chile, Costa Rica, Kenya, Malaysia, Mexico and Peru. Salinization is a sign of major land degradation and a key component of desertification, lowering soil productivity and negatively affecting ecosystems and biodiversity adjacent to agricultural production areas (European Commission, 2021).

Soil health issues largely manifests in systems where there is high concentration of the same plant species in the production area, such as avocado orchards and pineapple plantations. This occurs as there is an intensive absorption of soil nutrients and limited nutrient recycling in the absence of other species (plant or animal) (Altieri, 2011). Land use change also harms soil quality. Shifts from forest to farmland, particularly for intensive agriculture, impact the soil structure, promote gully formations, decrease soil fertility and productivity, and have collateral impacts on water availability and quality (Ramos, 2011), putting the resilience of agroecosystems and production systems at risk.

Increased land degradation and reduced soil health have resulted in a growing requirement for external inputs to supply the needed nutrients and water to cultivars, to protect the plants from pests and diseases and to replace plants that have become maladapted to different stresses (Altieri, 2011). Together, these have led to higher production costs among conventional and organic producers as reported by the stakeholders consulted, due to higher labour requirements for land preparation, expenditures on nutrient additives (e.g. fertilizers) and/or wider damage-related costs following climate events (FAO, 2022b).

“Low soil fertility and thus productivity is a big challenge to farmers. Certified organic restricts the use of chemical fertilizers, whereas preparation of compost is also expensive and very time consuming, so it is hard for producers to uptake these approaches.”

Pineapple company, Togo. Online consultations, 2022.

Addressing soil quality issues is necessary to reduce the economic and environmental fragility of production systems and reduce disaster risks (University of Cambridge and Robeco, 2022). The increasing exposure to climate risks and the associated production and infrastructure losses and damages may result in lower production and sales. Combined with higher production costs, the economic feasibility of businesses may be compromised.

Plant health issues and agrochemical use

Pests and diseases have a negative impact on avocado and pineapple value chains by reducing fruit production in pre- and post-harvest stages. Plant health issues are frequently observed in monoculture systems, as the limited farm and landscape agrobiodiversity disrupts self-regulating, self-defense mechanisms (e.g. natural enemies or beneficial insects) available in natural and diverse agroecosystems. These effects are being widely noted in the avocado and pineapple sectors:

“As natural habitats are lost, existing local fauna, such as monkeys, is taking advantage of pineapple plantations to feed themselves, affecting the quality of our production.”

Pineapple producer, Costa Rica. Online consultations, 2022.

“...there has been a decline in the presence of biodiversity, with less species competition bringing in new predators affecting crops, such as presence of moles eating tree roots.”

Avocado producer, Colombia. Online consultations, 2022.

The recurrence of plant health issues has resulted in the increasing use of agrochemicals (e.g. synthetic pesticides and herbicides), which in turn has augmented the resistance of pests, diseases and weeds. This situation has created a negative dependency cycle between input use and agroecosystem degradation (Altieri, 2011; Mukhovi and Jacobi, 2022), already recognized as a main challenge by 54 percent of stakeholders in the avocado and pineapple sectors (FAO, forthcoming b).

Climate change is expected to exacerbate the frequency and resistance of pests and diseases (Skendžić *et al.*, 2021). Changes in temperatures and humidity will bring about shifts in pests' geographical distribution, presence of pests in new areas or retreating from some regions, changes in seasonal phenology (e.g. timing of outbreak), and population dynamics (e.g. survival) (IPPC, 2021).

The projected increase in pests, compounded with more stringent phytosanitary requirements and agrochemical use regulations from the importing markets pose a resilience challenge to the avocado and pineapple sectors.

"... pests and diseases have increased, limitations in the use of active ingredients and changes in MRLs, production costs increase at the national level, the cost of imported materials has increased."

Pineapple producer, Costa Rica. Baseline survey, 2021.

To ensure continuity and permanence in international trade, value chain actors will need to guarantee the continued supply of these commodities despite the outbreaks, and while complying with international guidelines.

Water stress

Water stress has been a stress factor mainly felt in the avocado sector according to the baseline survey. Avocado plantations in Chile, Mexico, Peru and South Africa, which mainly rely on rainfall and groundwater resources for production, have already felt the effects of water scarcity. The variability in the rainy season and the slowdown in the replenishment of aquifers due to both lower precipitations and water extraction for irrigation (European Commission, 2021) have reduced the water available for production in some areas.

Studies indicate that inefficient irrigation systems and water management practices can intensify various water-related risks, including aquifer depletion and the reduction of surface water levels in rivers, with potential harm to ecosystems and biodiversity (Verones *et al.*, 2012). On the economic side, water scarcity also deepens the vulnerability of avocado farms, particularly of small-scale farms, as water becomes more expensive and preference in water allocation is usually given to large agribusiness (Sommaruga and Eldridge, 2020). In some regions, producers are experiencing growing water competition with other industries and for domestic use, particularly during the dry season (European Commission, 2021). Such competition has also created conflicts and tensions between producers and local communities according to participants.

"Low precipitation in upstream areas, limited replenishment of the rivers, and inadequate infrastructure are causing water scarcity in downstream production areas. This has created tension between agricultural production in both areas, among farmers and with local communities"

Avocado company. Peru. Online consultations, 2022.

A3.2 Economic factors

Changes in market conditions for the commodity trade

Sudden changes in market conditions, such as the outbreak of COVID-19 and the war in Ukraine, have important implications on the economic and productive performance of avocado and pineapple value chains. This section presents an overview of the impacts suffered by the avocado and pineapple industries following these events, and in-depth analysis of the market evolution can be found in the FAO's Major Tropical Fruits – Market review publications: **2020**, **2021** and **2022** (preliminary results).

It is important to note that the full long term impacts of COVID-19 and the war in Ukraine are difficult to project, as both are ongoing at the time of writing. The recovery path of the avocado and pineapple sectors from these major events will be tied to global geopolitics and economy, as well as to climatic factors. The recovery and insertion in a resilient path will also depend on the risk mitigation actions taken by companies (e.g. setting health protocols at the workplace, investing in adaptation strategies).

Outbreak of COVID-19 in 2020

The outbreak of COVID-19, the regulations imposed by governments to prevent the spread of the disease and the resulting economic slowdown, affected the performance of both avocado and pineapple exports and importing markets. Although the pandemic is still ongoing at the time of writing, the impact was greatest in 2020.

The **pineapple** exporting sector was particularly hit as the demand from the United States of America and the European Union shrunk due sudden closures in the hospitality sector and lockdown measures (OECD and FAO, 2021). It is estimated that the total pineapple export quantity in 2020 fell by 7.9 percent compared to 2019 (FAO, 2021b) due to cancelled orders and which resulted in significant production losses and waste for the industry. COVID-19 also disrupted market routes for importing agricultural inputs (e.g. agrochemicals, packing containers), with direct impact on production costs for producers, processors and packers. Likewise, lockdown measures in producing countries also reduced the availability of labour, which hampered different processes including packing, transportation and logistics (18; see section on **transportation**).

“The beginning [of the pandemic] highly disrupted sales and logistics, creating huge losses of fresh product as there was nowhere to sell. Logistics were also affected as there was no way to get the produce into the markets, as distribution collapsed due to the lack of workers in [the] destination. [...] in the area, other operations suffered due to lack of workers during several months at the start of the pandemic. [The] implementation of health practices to mitigate COVID-19 on site, such as social distancing in some of the processes, is near to impossible”.

Pineapple company, Costa Rica. Baseline survey, 2021.

Compounded, the impacts of COVID-19 put significant pressure on already increasing production costs and shrinking revenues, particularly of small and medium-sized producers and companies (FAO, 2022a; FAO, 2022b).

The COVID-19 outbreak had different effects on the **avocado** sector. In the United States of America, a 12.4-percent decline in imports was observed in 2020, while European Union imports grew by 13.8 percent in the same year. As in the pineapple sector, the measures to restrict the spread of the virus caused the disruption of transportation routes, contracted labour force availability and increased production costs, through higher input prices and COVID-19 monitoring at the workplace:

“Delays in shipping companies, reliable labour is not available, fertilizers have increased by 40 percent and our control and supervision costs due to COVID-19 effects have increased.”
Avocado company, Colombia. Baseline survey, 2021.

“Shipping delays, lost productivity due to employees being off sick, increased costs to ensure compliance with national COVID-19 regulations.”
Avocado company, South Africa. Baseline survey, 2021.

Although challenges were faced by avocado companies, especially during at the early stages of the pandemic, the sector was benefitted from the climacteric nature of avocado. That is, that given that the avocado fruit ripening takes place after cutting, this allowed growers and packers to carefully control harvests to avoid waste, oversupply and a downward pressure on prices during the first months of the pandemic (FAO, 2022b). Likewise, the perceived health benefits of the fruit supported the continued demand of avocado in the European Union and the United States of America. Both, the harvest control and awarded nutritional benefits could have played an important role for the economic resilience of the sector. On one hand, timing harvests helped producers maintaining the quality of the fruit for several weeks compared to pineapple and other tropical fruits, while a positive perception of the fruit might have kept sells up in spite of the crisis, enabling value chain actors to better navigate the health contingency.

War in Ukraine

The ongoing war in Ukraine has had important implications on international trade as the Russian Federation and Ukraine are some of the largest producers and exporters of energy and fertilizers in the world. To put in perspective, Costa Rica and Mexico, the main exporters of pineapple and avocado respectively, import from the Russian Federation between a fourth and a third of soil fertilizers for agricultural production (FAO, 2022a). This indicates the potential magnitude that unfavorable conditions could have on commodity production and international trade.

The reduced supply of fuel, gas and agricultural inputs brought by the war, has exacerbated already growing pressure on prices of energy and fertilizers. Likewise, the war itself and the restrictions imposed on the Russian Federation since 2022 have disrupted transportation routes to and from Ukraine and the Russian Federation. Together, these factors have limited the supply and commercialization of avocado and pineapple, particularly to the European Union and the United States of America (FAO, 2022e).

For the **pineapple** sector, the war in Ukraine has posed a new risk to the industry recovery after the COVID-19 outbreak. According to industry sources from Costa Rica, the Dominican Republic and Togo, the war has had a negative impact on the profitability of the industry due to the growing production costs (FAO, 2022b). So far, these costs have been largely absorbed by producers and

midstream value chain actors (FAO, 2022a) and the low average export unit value at which pineapple is sold in international markets has not compensated for the additional production expenses (FAO, 2022d).

“The war [in Ukraine] led to severe increases in the maritime freight costs, which are first absorbed by producers, and who in turn will have to transfer them to consumers. We [producers] are not prepared for such sharp production cost increases of about 130 percent, and which has a cascading effect on all processes in the [supply] chain.”

Pineapple producer, Dominican Republic. Online consultations, 2022.

Although lower retail prices benefit consumers in importing markets, these hamper producers and midstream actors at the origin, especially if the value is not well distributed along the value chain from retailers to upstream stakeholders.

“The issue of profitability has to do with increasing costs [...] but also with the international structure of market players, where it is difficult for the producer to defend themselves with direct sales. Lack of financial mechanisms and especially low interest rates for agriculture is essential for the sustainable growth of the sector.”

Pineapple producer, Costa Rica. Baseline survey, 2021.

If these imbalances are not addressed, they could worsen existing vulnerabilities of the industry, jeopardize the continuity of relatively small actors and stimulate the further consolidation/integration of the pineapple industry.

In the avocado sector, the disrupted transportation routes since the start of the war have altered avocado imports mainly from South America (Peru and Colombia) and South Africa into Ukraine and the Russian Federation. These restrictions have had negative impacts on input supply costs (OECD and FAO, 2022), also confirmed by companies across all the regions surveyed. However, unlike the pineapple sector, the avocado industry has benefited from higher average export unit value (FAO, 2022d), potentially being able to compensate for some of the increasing production costs.

Costs and problems of local transportation, infrastructure and logistics

Transportation is one of the most important links in the supply chain for perishable products, as the transport infrastructure (roads, ports and logistics) and storage have a direct influence on the costs and quality of the product. While international transport systems and costs tend to be the focus of global supply chains, domestic transport costs can still represent a third of the price of agricultural products (World Bank, 2012). Generalized problems in domestic logistics, including weak post-harvest infrastructure, delays in the management of the product in the port, or inadequate cold storage, can significantly reduce the quality of the product (Marmolejo-Gómez, 2020) and thus, the marketable output. For countries selling to markets where stringent phytosanitary measures are applied, this is a direct shortcoming affecting the viability of operations and the export potential.

Problems in transportation, infrastructure and logistics have been noted by both avocado and pineapple industries consulted. Among avocado producers, a company in Viet Nam has stated that long travel routes to reach the largest cities have increased the likelihood of damage and waste with avocados, resulting in lost revenues. In Chile, more expensive transportation has motivated some

companies to collaborate with the wider fruit sector to jointly export fruits to the same destinations. In the pineapple sector, Costa Rica, the Dominican Republic and Malaysia suffered from logistics disruptions brought on by COVID-19 and now the current fuel crisis threatens exports of fresh pineapple. Some companies have redirected part of their production toward processing (juice making, frozen fruit, fiber making) to minimize losses and maintain profits.

A3.3 Institutional and political factors

Trade regulations

Swift changes in national and international regulations could represent a major shock to tropical fruit value chains, especially when these are unexpected or if a transition period is not allowed. Trade restrictions create uncertainty influencing the investment strategies of the firms and may reduce confidence in international sources of supply (and demand), undermining incentives for sustainable production (OECD, 2022).

In the case of COVID-19, existing trade agreements did not prevent countries from introducing restrictive measures that worsened supply chain disruptions. Different types of export restrictions and lockdown measures affected trade of key agricultural inputs as discussed previously. Import bans of agricultural inputs in some countries (e.g. Sri Lanka) also distressed national agricultural production, exacerbating ongoing economic crisis (Rathnayake *et al.*, 2022).

“The beginning of the pandemic generated strong nationalism and anti-migrant policies, affected our operations”.

Pineapple company, Costa Rica. Baseline survey, 2021.

Likewise, bilateral or multilateral trade agreements may preserve or exacerbate existing vulnerabilities of value chains due to potential power imbalances among actors between importing and exporting countries. In the case of Latin America, the North American Free Trade Agreement (predecessor of the new United States, Mexico and Canada-Agreement) and the Central American Free Trade Agreement included clauses allowing companies in importing countries to challenge limitations of pesticide use if there is a potential to see their expected profits reduced (Brown, Flint and LaMay, 2020).

The complexity of the influence of national and international institutional environment and regulatory frameworks on the sustainability and resilience of the avocado and pineapple sectors requires further investigation. To partly fill this information gap, the project will develop a technical brief on policy incentives and their effect on shaping more sustainable operations and trade of avocado and pineapple.

A3.4 Social factors

Although this dimension does not rank as one of the main concerns of the involved value chain actors, social-related issues remain one of the main barriers to building resilient operations. Research suggests that real progress on environmental and economic sustainability requires solutions that incorporate social sustainability.

Working conditions and inequality

Poverty is both a driver and consequence of disaster risk, especially in countries or regions where weak governance mechanisms prevail. Economic hardship restricts access to knowledge and key services (early warning systems, health, and training, etc.) and tends to force people to live in unsafe and more vulnerable conditions, making them more prone to suffer the most from disasters (Wisner *et al.*, 2014).

Poverty and inequality are exacerbated by imbalanced contractual arrangements among workers. Third-party contractual arrangements (for example, through labour cooperatives), instead of establishing contracts directly with the companies have been noted in the avocado and pineapple sectors. In the **pineapple** industry, the outsourcing of workforces in some regions has led to a reduction in salaries of contractual workers, who earn significantly less and perceive fewer social benefits than directly hired employees (Fair Food International, 2020). Subcontracting means that contractual workers are not members of unions and are unable to raise grievances (Dubois *et al.*, 2016). Likewise, third-party contracting has reduced work stability (many of the contracts are verbal arrangement) and duration of contract (*idem.*). These workers also tend to be excluded from other labour guarantees such as bonuses, dismissal compensations, credit access (e.g. via fund associations, unions) and retirement (Gansemans and D’Haese, 2020).

In Costa Rica and the Philippines, the disparities in contractual arrangements have translated into lower salaries compared to other unskilled workers in the sector (Fair Food International, 2020; Gansemans and D’Haese, 2020). Research suggests that in some instances, workers do not always receive the minimum wage established by the law and receive their salary by completed tasks or on a weekly basis for the days actually worked excluding rest days, whereas other unskilled workers receive their salary on a fortnightly basis, inclusive of rest days (Dubois *et al.*, 2016). Outsourced workers are also estimated to receive 30 percent lower salary than company workers (Fair Food International, 2020; Henry and Chato, 2019).

In the **avocado** industry, contractual conditions follow a similar pattern as in the pineapple sector. It was found that growers who are members of associations tend to be more compliant with labour laws, whereas non-association members or informal growers may be only partially in compliance. Discrepancy in wages has also been observed and linked to the contract type, value chain segment and production orientation (domestic or international markets). In Michoacán and Jalisco, wages in avocado exporting areas were about 50 percent higher than the wages in non-exporting areas and other States in the country (Escobar, Martin and Stabridis, 2019). This potentially accounts for the relative importance of the States for agricultural production and export of high-value commodities (avocado and berries), compared to other States in the country. This is similarly observed among Kenyan avocado producers, where farmers working directly with exporters were making a living

income, compared to those producing for the domestic market (van Schouwenburg, 2018). Informal growers, indigenous workers and women working in the sector are allegedly receiving lower wages and fewer work-related benefits (Escobar, Martin and Stabridis, 2019).

Overall, research suggests that **workers facing higher job insecurity might be more motivated to leave, either by moving to more profitable farms or sectors** (Escobar, Martin and Stabridis, 2019); Gansemans and D’Haese, 2020). **This translates into workforce shortage for sectors that do not offer better conditions.** It also results in a reduction of benefits received by workers as they lose continuity and seniority, and some cases are temporarily unemployed as they seek new opportunities. This threatens the correct functioning of value chains’ operations, which has been observed in both avocado and pineapple companies.

Gender issues

While the importance of gender in rural and value chain development is gaining attention, gender inequalities remain an important driver of vulnerability in the agriculture sector. Social and gender discriminations can be simultaneously a driver and an effect of poverty, influencing women’s limited access to resources, knowledge and services compared to men (UN Women, n.d.). Living in rural contexts and agriculture-based economies tend to deepen such inequalities and forms of discrimination.

In rural areas, women generally have inferior land rights compared to men and face more restrictions to access agricultural inputs (including labour-saving technologies), financial and extension services (FAO and UNDP, 2020). To put this into perspective, about 37 percent of women work in agriculture globally, of which 48 percent in low-income countries (FAO, 2022e), but only 14 percent of them are landholders (UN Women, 2019). Women also appear to be underrepresented in agricultural organizations, resulting in their needs being overlooked (UN Women, n.d.) and their contributions neglected.

Gender dynamics also define whether and how women participate in employment. In some contexts, the unbalanced gender dynamics might direct women to some of the most precarious jobs, where they receive lower remuneration than men (UN Women, 2019), and in some cases, without appropriate measures on occupation safety and health. Evidence remains limited on women’s employment in the avocado and pineapple sectors. However, some research indicates that in the **pineapple** industry, women’s involvement is higher in packing and processing activities, whereas men comprise the workforce for agricultural production and managerial work (Fair Food International, 2020). In the field, men seem to benefit more from direct employment with companies, while women are predominantly hired under third-party contractual arrangements (Dubois *et al.*, 2016), making them more prone to experience disadvantaged conditions at work. In the **avocado** sector, some studies point at discriminatory gender practices against women, who have lower participation in producer and trade associations, with negative effects on their access to training, inputs, improved avocado trees and participation in high-value markets (Muriithi and Kabubo-Mariara, 2022).

The project baseline survey (2021) corroborated the gender gap in employment of women in the avocado and pineapple value chains. The results indicate that men represent the largest proportion of the workforce in the operations, with an average share of male to female full-time employees of 85:15 for pineapple companies and 70:30 in the avocado sector (FAO, forthcoming b). However,

these results do not capture how women contribute to the value chains or the time allocated to other non-paid family work.

Compounded, gender imbalances increase the susceptibility of both women themselves and of the value chains as a whole. On one hand, women's limited access to productive resources, knowledge and services, make them less able to make informed decisions to prepare, adapt and cope with external shocks. For instance, women's inability to access land restricts their capacity to decide about its use, invest to both benefit and protect themselves from risks, minimize losses and recover from shocks. On the other hand, women's higher dependency on low-paying informal work and the significant time women in many contexts spend on caregiving and domestic work reduce women's capacity to participate in paid work (Samtleben and Müller, 2022). This makes women's livelihoods more vulnerable to income losses and damages when experiencing economic and environmental shocks (UN Women, 2019), taking them longer to recover and reinsert in economic activities.

Studies have also shown that violence, including physical, psychological, and reproductive violence against women, is more pronounced after natural disasters, with other consequences on women's wellbeing (Sloand *et al.*, 2015). Women and girls face increased risks of gender-based violence following a natural disaster or other unexpected shocks (e.g. COVID-19 outbreak; Sloand *et al.*, 2015). For example, shocks tend to intensify domestic and social tensions due to increased unemployment, higher economic dependence of women on the breadwinning partner and shortages of basic services in some contexts (e.g. food, water, roads). In the case of COVID-19, movement restrictions due to lockdowns made it difficult for women to leave abusive households increasing intimate partner violence.

Girls also appear to be less likely to continue their education after a crisis compared to boys. This is further exacerbated as often women and other vulnerable groups do not have access to grievance mechanisms that can provide timely support to victims (UNHCR, 2011), meaning their cases go underreported. Gender-based violence has been an issue widely noted in other export-oriented agrifood value chains, including banana, grapes and vegetables (EBRD and CDC, 2019), suggesting that it could also be a concern in the avocado and pineapple sectors.

Migration

Stakeholder consultations shed light on the participation of migrant workers in the pineapple industry in Costa Rica and avocado production in Mexico, specifically Jalisco. Often, many migrants are living in the countries without a working visa or when production takes place close to the border, migrants cross to the neighboring country every day to work in farms that are nearby (Dubois *et al.*, 2016). Undocumented migrants might be particularly susceptible to (gender-based) violence, exploitation and abuse, as they often have limited social networks and experience fear retaliation (e.g. being blacklisted or unable to return the following cropping season) or deportation if they report an incident (EBRD and CDC, 2019).

These risks are frequently compounded by their dependence on employers for housing, transportation and right to stay, their restricted access to key services and unawareness of their rights to be able to address the impacts of the risks experienced (OHCHR, 2017). This highly vulnerable situation leaves migrant workers and populations extremely exposed to hazards and with limited capacities to prepare or recover from these once materialized.

Considering migrant work in value chains will be important in the future as it is expected that climate change will cause population movements around the globe, as some regions will become hazardous and inadequate to sustain livelihoods, such as agriculture. Most people displaced by weather and environmental causes will likely look for homes in countries close to their own (OIM, 2018) as stakeholders from Costa Rica and Mexico have already noted.

Security

In some of the producing regions, the avocado sector has faced safety issues, including theft and violence, linked to the high value the commodity represents to the local economy. The risk of criminality and violence implies economic losses for producers and other actors engaged along the value chain (e.g. exporters, transporters, importers). This risk can also damage the reputation and image of the industry, resulting in clients losing confidence, retailers diversifying suppliers and shifting consumption patterns based on the origin of the commodity (Marmolejo-Gómez, 2020). This has been pointed out by both producer associations and importing companies, indicating that

“Producers are hesitant to grow avocado in higher altitude areas even if they are more suitable for production due to the agroclimatic conditions, as there are safety concerns”.

Avocado producer, Mexico. Online consultations, 2022.

“The risk of robbery of avocado trucks has affected us as it puts at risk our ability ensure the continued distribution of the produce. [...] in our communication with customers, our company does not raise the security issues happening in the origin, as we want to protect the farmers and prevent from generating a negative reputation of the business. However, we are looking into diversifying the origin of the produce.”

Importing company, United States of America. Online consultations, 2022.

Social customs and beliefs

Social customs and practices were also noted by stakeholders as an element that is constraining the adoption of more sustainable and resilient practices, especially among producers and communities. For example, stakeholders from the avocado sector in Mexico mentioned that religious beliefs and ingrained cultural customs needed attention as they influenced how natural resources are being used, particularly in community lands (*ejidos*). In Costa Rica and the Dominican Republic, actors from the pineapple sector pointed at the lack of trust in sustainable practices as producers fear negative impacts on yields and perceive the practices as high investment risks.

Culturally sensitive capacity development, participatory approaches and sensitization strategies that can foster transformation in behaviors, attitudes and practices, could yield positive benefits.

Annex 4. Graphs of resilience capacities by sector (self-assessment)

Figure A4.1. Self-assessment of actors' preventive and anticipatory capacities, by sector

"Is your company/sector fully prepared for future threats (of whatever nature) that may occur in your area?"

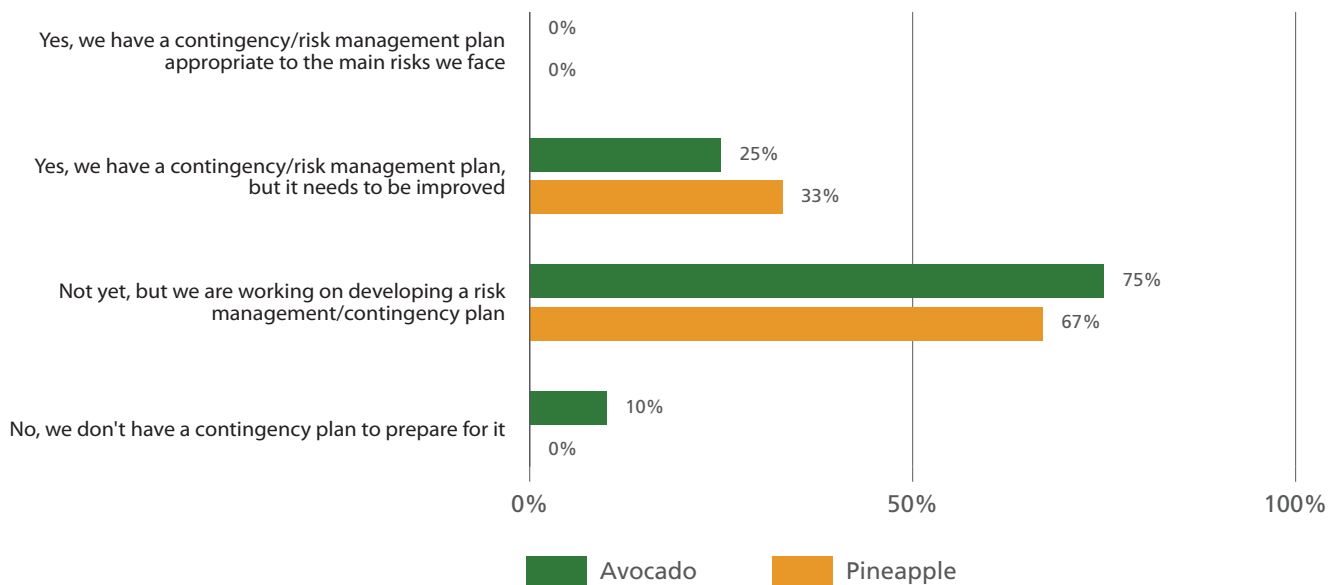


Figure A4.2. Self-assessment of actors' absorptive and adaptive capacities, by sector

"If a severe shock were to occur tomorrow, would your business fully recover within six months to continue producing and supplying domestic and international markets?"

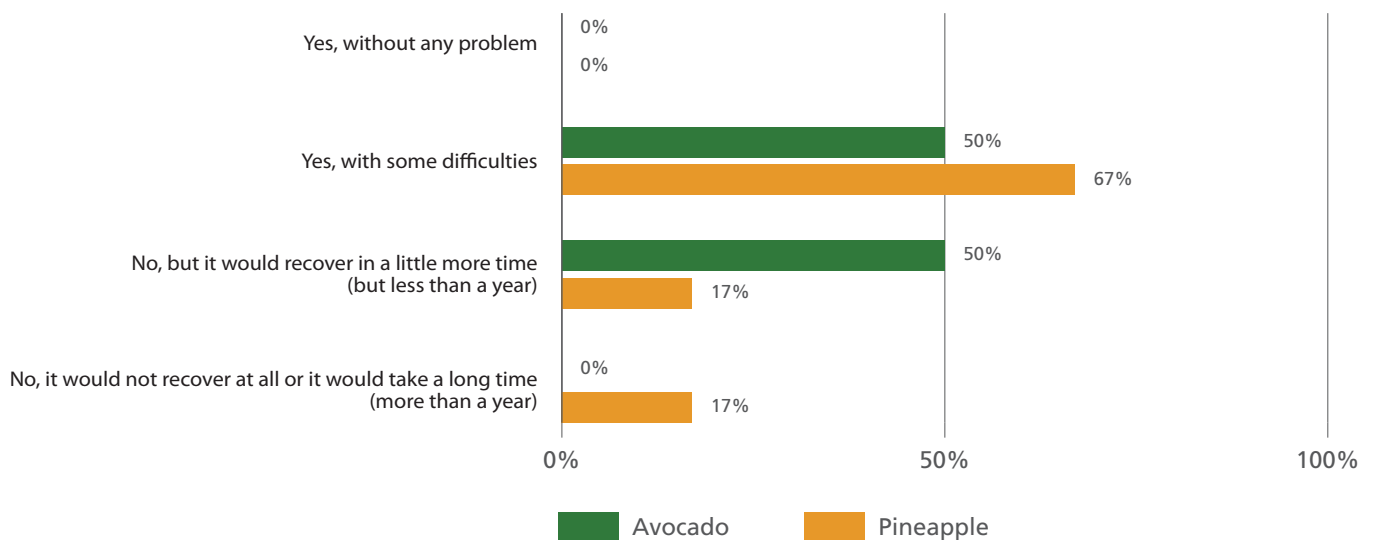
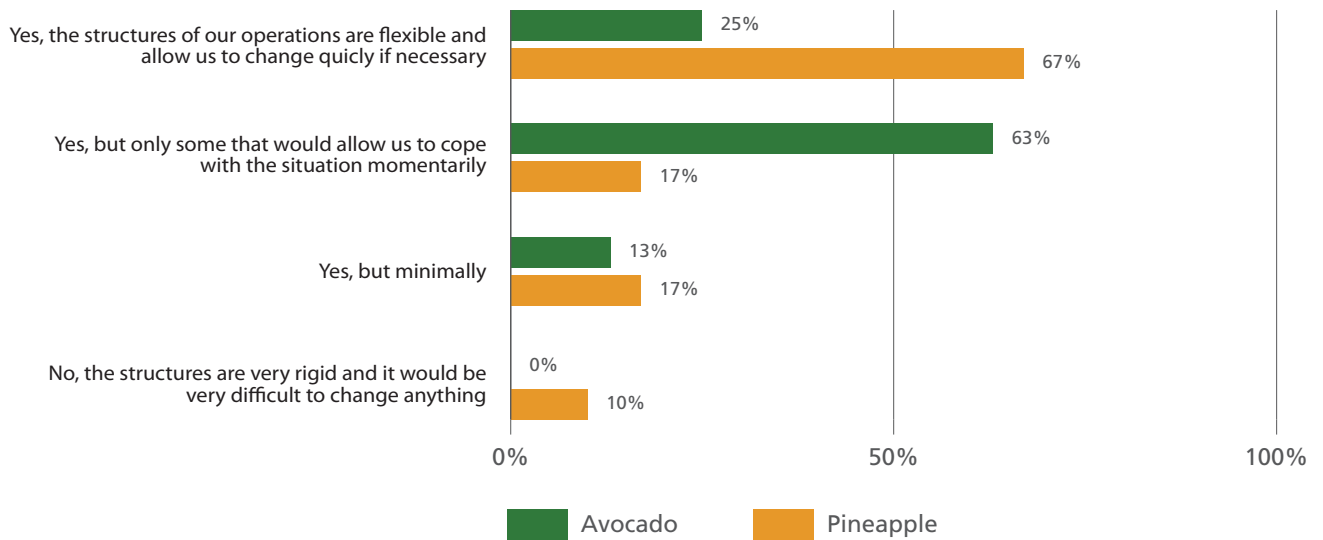


Figure A4.3. Self-assessment of actors' transformative capacity, by sector

"During difficult times, could your company change its operations (or part of them) if necessary to continue producing and supplying the national and international markets?"



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